



PERSEVERANCE: A VIRTUAL LEAD-UP TO LANDING EVENT

FREE virtual programming on Thursday, February 18, 2021 to celebrate the landing of
NASA's Perseverance rover on Mars!

1
00:00:04,360 --> 00:00:22,870

[Music]

2
00:00:27,429 --> 00:00:25,029

hey everybody welcome to the great lakes

3
00:00:29,669 --> 00:00:27,439

science center i'm john dar that science

4
00:00:32,470 --> 00:00:29,679

guy and we are here in our virtual

5
00:00:34,549 --> 00:00:32,480

control room waiting on word for an

6
00:00:37,590 --> 00:00:34,559

update from the perseverance rover that

7
00:00:39,830 --> 00:00:37,600

is currently cruising to the planet mars

8
00:00:41,830 --> 00:00:39,840

we have got an exciting day set for you

9
00:00:43,670 --> 00:00:41,840

today we're going to be following that

10
00:00:46,310 --> 00:00:43,680

that that vehicle as it makes us

11
00:00:48,630 --> 00:00:46,320

approach and it's landing on the surface

12
00:00:50,630 --> 00:00:48,640

of mars later on today it's going to be

13
00:00:52,310 --> 00:00:50,640

an exciting time we've got

14

00:00:54,069 --> 00:00:52,320

we've got some great subject matter

15

00:00:56,630 --> 00:00:54,079

experts that are going to drop by and

16

00:00:58,069 --> 00:00:56,640

share with you uh some of their work and

17

00:01:00,389 --> 00:00:58,079

some of the things that they've done to

18

00:01:02,950 --> 00:01:00,399

support this particular mission we'll be

19

00:01:05,030 --> 00:01:02,960

able to answer some of your questions

20

00:01:07,910 --> 00:01:05,040

some of the most common questions about

21

00:01:10,550 --> 00:01:07,920

mars we even take a look at the landing

22

00:01:13,109 --> 00:01:10,560

site for this particular mission and of

23

00:01:15,910 --> 00:01:13,119

course we'll be talking all day about

24

00:01:19,109 --> 00:01:15,920

the perseverance rover now this is an

25

00:01:21,830 --> 00:01:19,119

incredible machine it's uh it's nearly a

26

00:01:24,469 --> 00:01:21,840

ton and weight it's about the size

27

00:01:26,870 --> 00:01:24,479

of an suv and it's going to be landing

28

00:01:29,429 --> 00:01:26,880

today on the surface of mars we've got

29

00:01:31,350 --> 00:01:29,439

so much in store for you if you want a

30

00:01:32,870 --> 00:01:31,360

full schedule of today's events you can

31

00:01:36,550 --> 00:01:32,880

go to our website that's

32

00:01:41,109 --> 00:01:38,469

and all the information will be there

33

00:01:43,030 --> 00:01:41,119

for you oh and don't forget we do have

34

00:01:45,830 --> 00:01:43,040

an opportunity for those of you that are

35

00:01:47,670 --> 00:01:45,840

watching to participate in a hands-on

36

00:01:49,749 --> 00:01:47,680

science experiment if you don't know

37

00:01:51,990 --> 00:01:49,759

about this yet go ahead and take a look

38

00:01:53,670 --> 00:01:52,000

at our website go to the link that's

39

00:01:55,990 --> 00:01:53,680

there and it'll tell you everything that

40

00:01:57,749 --> 00:01:56,000

you need to gather in order to be able

41

00:01:59,830 --> 00:01:57,759

to conduct this experiment later on

42

00:02:02,709 --> 00:01:59,840

today it's going to be a lot of fun it's

43

00:02:04,870 --> 00:02:02,719

an official nasa design challenge and

44

00:02:06,190 --> 00:02:04,880

it's one that you don't want to miss

45

00:02:08,949 --> 00:02:06,200

so the

46

00:02:11,830 --> 00:02:08,959

perseverance rover

47

00:02:14,790 --> 00:02:11,840

is the next generation robotic

48

00:02:17,350 --> 00:02:14,800

explorer that will be on the surface of

49

00:02:19,990 --> 00:02:17,360

the red planet we are so excited about

50

00:02:22,869 --> 00:02:20,000

it now it has the same body the same

51
00:02:25,830 --> 00:02:22,879
chassis as the curiosity rover that

52
00:02:28,550 --> 00:02:25,840
landed uh nine years ago but this has

53
00:02:29,910 --> 00:02:28,560
got all new scientific instruments and

54
00:02:31,030 --> 00:02:29,920
throughout the day we'll be talking

55
00:02:32,309 --> 00:02:31,040
about some of those different

56
00:02:34,550 --> 00:02:32,319
instruments and telling you about some

57
00:02:37,190 --> 00:02:34,560
of the experiments that this new rover

58
00:02:39,990 --> 00:02:37,200
is going to be conducting once it once

59
00:02:44,070 --> 00:02:40,000
it lands on mars we'll also talk about

60
00:02:45,030 --> 00:02:44,080
the landing sequence as well there are

61
00:02:47,190 --> 00:02:45,040
well

62
00:02:49,509 --> 00:02:47,200
when you have something this heavy again

63
00:02:51,750 --> 00:02:49,519

it's about a ton in weight and you're

64

00:02:54,470 --> 00:02:51,760

trying to set it down on the surface of

65

00:02:57,030 --> 00:02:54,480

mars there's tons of things that can go

66

00:02:59,910 --> 00:02:57,040

wrong every single thing

67

00:03:02,869 --> 00:02:59,920

has to go right in that landing sequence

68

00:03:05,270 --> 00:03:02,879

for it to end up upright on the surface

69

00:03:08,390 --> 00:03:05,280

of mars when it enters the atmosphere

70

00:03:09,430 --> 00:03:08,400

it'll be moving at close to 1200 miles

71

00:03:11,270 --> 00:03:09,440

an hour

72

00:03:13,030 --> 00:03:11,280

moving at that speed and getting it all

73

00:03:15,670 --> 00:03:13,040

the way down to zero

74

00:03:17,190 --> 00:03:15,680

doesn't take luck it takes skill and

75

00:03:19,190 --> 00:03:17,200

some of the engineers that have worked

76
00:03:21,589 --> 00:03:19,200
on this vehicle the programmers that are

77
00:03:24,149 --> 00:03:21,599
involved they've applied all of their

78
00:03:25,990 --> 00:03:24,159
knowledge everything that we know into

79
00:03:28,309 --> 00:03:26,000
this incredible machine

80
00:03:30,550 --> 00:03:28,319
if all goes well it's going to be on the

81
00:03:33,190 --> 00:03:30,560
surface of mars this afternoon

82
00:03:35,910 --> 00:03:33,200
now earth and mars well they're about

83
00:03:38,949 --> 00:03:35,920
300 million miles apart and at that

84
00:03:41,830 --> 00:03:38,959
distance it's going to take about 14

85
00:03:43,830 --> 00:03:41,840
minutes for a signal from the robot to

86
00:03:46,470 --> 00:03:43,840
reach us here at our mission control

87
00:03:47,830 --> 00:03:46,480
center but when we get that word we'll

88
00:03:50,070 --> 00:03:47,840

share it with you

89

00:03:52,309 --> 00:03:50,080

hopefully if all goes well

90

00:03:54,710 --> 00:03:52,319

we'll be able to show you some pictures

91

00:03:57,350 --> 00:03:54,720

from this new rover as it begins to

92

00:04:00,149 --> 00:03:57,360

explore the martian frontier

93

00:04:02,550 --> 00:04:00,159

all that to be said we've got uh again a

94

00:04:04,789 --> 00:04:02,560

lot that's stored up for you uh or a lot

95

00:04:06,789 --> 00:04:04,799

of things that that we'll be doing today

96

00:04:09,270 --> 00:04:06,799

and i hope that you will look forward to

97

00:04:11,589 --> 00:04:09,280

it um

98

00:04:15,030 --> 00:04:11,599

again with regards to that schedule at

99

00:04:17,430 --> 00:04:15,040

uh 11 15 our first subject matter expert

100

00:04:19,509 --> 00:04:17,440

will be joining us uh they'll be talking

101
00:04:21,430 --> 00:04:19,519
about communications and how we stay

102
00:04:22,950 --> 00:04:21,440
connected to the rover a little bit

103
00:04:25,030 --> 00:04:22,960
later on we'll be talking about the

104
00:04:27,270 --> 00:04:25,040
power system that will be used in that

105
00:04:29,430 --> 00:04:27,280
that specific rover and then of course

106
00:04:32,710 --> 00:04:29,440
we'll be talking later on today about

107
00:04:35,990 --> 00:04:32,720
the parachute decelerator system how we

108
00:04:37,670 --> 00:04:36,000
uh how we get that robot to uh slow down

109
00:04:39,670 --> 00:04:37,680
so it will be able to land on the

110
00:04:41,990 --> 00:04:39,680
surface in one piece

111
00:04:44,230 --> 00:04:42,000
i did i did mention that parachute

112
00:04:46,150 --> 00:04:44,240
design challenge the design challenge is

113
00:04:48,390 --> 00:04:46,160

currently scheduled for about 1 pm this

114

00:04:50,310 --> 00:04:48,400

afternoon so you want to make sure that

115

00:04:52,390 --> 00:04:50,320

you find out what you need so that you

116

00:04:55,270 --> 00:04:52,400

can do that experiment too in fact we've

117

00:04:57,749 --> 00:04:55,280

got a great nasa contractor roger storm

118

00:04:59,430 --> 00:04:57,759

you'll be joining us to uh to lead that

119

00:05:02,469 --> 00:04:59,440

particular activity it's going to be a

120

00:05:04,230 --> 00:05:02,479

lot of fun a lot of fun

121

00:05:05,510 --> 00:05:04,240

and of course there'll be opportunities

122

00:05:07,909 --> 00:05:05,520

to share

123

00:05:10,469 --> 00:05:07,919

your uh your solution to this

124

00:05:12,230 --> 00:05:10,479

engineering design challenge with us

125

00:05:14,230 --> 00:05:12,240

and uh and again we'll be telling you a

126

00:05:15,270 --> 00:05:14,240

little bit more about that uh here in a

127

00:05:18,310 --> 00:05:15,280

bit

128

00:05:20,310 --> 00:05:18,320

five minutes into our our coverage of

129

00:05:22,950 --> 00:05:20,320

today's landing and we want to remind

130

00:05:24,950 --> 00:05:22,960

you that uh this has been years in the

131

00:05:27,510 --> 00:05:24,960

making earth and mars are in two

132

00:05:30,550 --> 00:05:27,520

different orbits and the two planets

133

00:05:32,390 --> 00:05:30,560

come close together only once

134

00:05:33,350 --> 00:05:32,400

every two years

135

00:05:35,189 --> 00:05:33,360

so

136

00:05:36,950 --> 00:05:35,199

it's taken a lot of planning a lot of

137

00:05:40,710 --> 00:05:36,960

time to make sure that this robot is

138

00:05:43,350 --> 00:05:40,720

ready to go and it was launched back in

139

00:05:45,510 --> 00:05:43,360

july 30th was when it took off from

140

00:05:47,749 --> 00:05:45,520

the kennedy space center and it's

141

00:05:49,830 --> 00:05:47,759

currently enroute to mars we're just

142

00:05:51,830 --> 00:05:49,840

minutes away from our first subject

143

00:05:53,830 --> 00:05:51,840

matter expert guest give me a moment to

144

00:05:55,590 --> 00:05:53,840

tell you a little bit about this uh this

145

00:05:56,870 --> 00:05:55,600

extraordinary person

146

00:05:59,189 --> 00:05:56,880

um

147

00:06:01,430 --> 00:05:59,199

this will be dr daniel rabel and he'll

148

00:06:04,230 --> 00:06:01,440

be here to discuss communications with

149

00:06:06,870 --> 00:06:04,240

mars and the challenges associated with

150

00:06:09,270 --> 00:06:06,880

sending and receiving messages

151
00:06:11,350 --> 00:06:09,280
throughout our entire solar system

152
00:06:13,909 --> 00:06:11,360
daniel is with the space communications

153
00:06:16,230 --> 00:06:13,919
and navigation network

154
00:06:19,350 --> 00:06:16,240
and one of the nasa field centers that

155
00:06:21,110 --> 00:06:19,360
supports the work of scan is the nasa

156
00:06:22,870 --> 00:06:21,120
glenn research center right here in

157
00:06:25,749 --> 00:06:22,880
cleveland ohio

158
00:06:27,830 --> 00:06:25,759
with that being said let's go and let's

159
00:06:37,510 --> 00:06:27,840
meet up with dr daniel

160
00:06:40,390 --> 00:06:38,870
looks like it's going to take a moment

161
00:06:42,469 --> 00:06:40,400
for uh for daniel to make that

162
00:06:45,270 --> 00:06:42,479
connection so we'll uh we'll keep on

163
00:06:47,189 --> 00:06:45,280

going um it's a really extraordinary

164

00:06:49,350 --> 00:06:47,199

when it comes to uh communications with

165

00:06:51,350 --> 00:06:49,360

objects so far away again the farther

166

00:06:54,150 --> 00:06:51,360

away you go the longer it takes for

167

00:06:55,990 --> 00:06:54,160

those signals to travel back and forth

168

00:06:58,390 --> 00:06:56,000

and that'll be one of the key things

169

00:07:00,390 --> 00:06:58,400

once we look towards the landing of this

170

00:07:02,950 --> 00:07:00,400

vehicle because earth and mars are so

171

00:07:04,790 --> 00:07:02,960

far away when the lander enters the

172

00:07:06,950 --> 00:07:04,800

atmosphere on its way down to the

173

00:07:08,790 --> 00:07:06,960

planet's surface it's going to literally

174

00:07:09,749 --> 00:07:08,800

be on its own remember what i said

175

00:07:12,150 --> 00:07:09,759

before

176

00:07:14,790 --> 00:07:12,160

it takes 14 minutes at this particular

177

00:07:16,950 --> 00:07:14,800

distance for a signal to get from mars

178

00:07:19,909 --> 00:07:16,960

all the way back to earth so by the time

179

00:07:21,589 --> 00:07:19,919

the the lander has signaled us that it's

180

00:07:23,909 --> 00:07:21,599

entering the atmosphere

181

00:07:26,469 --> 00:07:23,919

in reality it will already be on the

182

00:07:29,350 --> 00:07:26,479

surface the real question is will it be

183

00:07:33,430 --> 00:07:29,360

in pieces scattered across the terrain

184

00:07:35,589 --> 00:07:33,440

or will it be upright and in one piece

185

00:07:37,749 --> 00:07:35,599

nasa technicians scientists and

186

00:07:39,990 --> 00:07:37,759

engineers call this the seven

187

00:07:42,150 --> 00:07:40,000

minutes of terror because it takes seven

188

00:07:44,070 --> 00:07:42,160

minutes from the top of the atmosphere

189

00:07:45,589 --> 00:07:44,080

to get all the way down to the surface

190

00:07:47,670 --> 00:07:45,599

of mars

191

00:07:50,710 --> 00:07:47,680

and all we can do is wait

192

00:07:53,029 --> 00:07:50,720

the robot has been probed the landing

193

00:07:55,350 --> 00:07:53,039

system will be fully engaged but the

194

00:07:58,790 --> 00:07:55,360

robot will be operating on its own using

195

00:08:01,909 --> 00:07:58,800

its on-board sensors and its programming

196

00:08:04,230 --> 00:08:01,919

to get it from above the atmosphere down

197

00:08:06,790 --> 00:08:04,240

to the planet's surface it's going to be

198

00:08:09,749 --> 00:08:06,800

extraordinary and it'll be a nail-biting

199

00:08:11,430 --> 00:08:09,759

experience as we get closer to that

200

00:08:13,029 --> 00:08:11,440

actual landing and once we have word

201
00:08:15,029 --> 00:08:13,039
that the vehicle is actually entering

202
00:08:17,510 --> 00:08:15,039
the atmosphere we're going to depth in

203
00:08:19,189 --> 00:08:17,520
detail explaining what's going on in

204
00:08:21,909 --> 00:08:19,199
fact at that time we'll even have an

205
00:08:24,469 --> 00:08:21,919
animation to show you that will show

206
00:08:27,270 --> 00:08:24,479
each and every step that it will take to

207
00:08:29,670 --> 00:08:27,280
get the vehicle down to the surface of

208
00:08:32,230 --> 00:08:29,680
the red planet

209
00:08:34,310 --> 00:08:32,240
on this particular rover are a number of

210
00:08:37,029 --> 00:08:34,320
exciting experiments one of them that

211
00:08:39,269 --> 00:08:37,039
i'm very excited about is a mars

212
00:08:41,829 --> 00:08:39,279
helicopter that's right you heard me

213
00:08:44,149 --> 00:08:41,839

correctly it's an aerial drone and for

214

00:08:47,430 --> 00:08:44,159

the very first time we're going to

215

00:08:49,430 --> 00:08:47,440

launch an aerial drone on another world

216

00:08:53,110 --> 00:08:49,440

now mars has an extremely thin

217

00:08:55,430 --> 00:08:53,120

atmosphere so this particular robotic

218

00:08:57,910 --> 00:08:55,440

drone had to be designed with that in

219

00:09:00,470 --> 00:08:57,920

mind extra-large propellers moving at

220

00:09:02,550 --> 00:09:00,480

very high speeds will hopefully give it

221

00:09:05,509 --> 00:09:02,560

enough lifts to carry it a short

222

00:09:07,750 --> 00:09:05,519

distance into the air if it works well

223

00:09:09,590 --> 00:09:07,760

future missions will be able to do

224

00:09:13,110 --> 00:09:09,600

aerial reconnaissance of various

225

00:09:15,350 --> 00:09:13,120

locations once the uh rover sets down on

226

00:09:17,590 --> 00:09:15,360

the surface of mars by the way this

227

00:09:19,110 --> 00:09:17,600

particular rover has a unique mission

228

00:09:22,550 --> 00:09:19,120

among the many things that it's going to

229

00:09:23,990 --> 00:09:22,560

be doing it's going to be um gathering

230

00:09:26,070 --> 00:09:24,000

core samples

231

00:09:28,310 --> 00:09:26,080

you know it's amazing you can tell a lot

232

00:09:31,190 --> 00:09:28,320

about the geographic and the geologic

233

00:09:33,670 --> 00:09:31,200

history rather of a planet by drilling

234

00:09:34,949 --> 00:09:33,680

down into the soil and pulling up that

235

00:09:37,509 --> 00:09:34,959

core sample

236

00:09:39,509 --> 00:09:37,519

once you pull that that that coring up

237

00:09:42,070 --> 00:09:39,519

you can look at the individual layers

238

00:09:45,670 --> 00:09:42,080

and you can see what happened over time

239

00:09:47,350 --> 00:09:45,680

on the planet's surface well

240

00:09:48,949 --> 00:09:47,360

the perseverance rover is going to be

241

00:09:51,269 --> 00:09:48,959

doing this and not only will it be

242

00:09:53,990 --> 00:09:51,279

drilling these core samples it's going

243

00:09:57,110 --> 00:09:54,000

to be storing those core samples

244

00:09:59,829 --> 00:09:57,120

inside tubes that will be stashed and

245

00:10:01,910 --> 00:09:59,839

cached all across the planet's surface a

246

00:10:04,150 --> 00:10:01,920

future robotic mission will go there to

247

00:10:06,389 --> 00:10:04,160

retrieve those samples and eventually

248

00:10:08,230 --> 00:10:06,399

bring them back to earth that's right

249

00:10:12,790 --> 00:10:08,240

we'll have pieces of mars right here on

250

00:10:17,509 --> 00:10:15,269

so much that's going on today so many

251

00:10:20,069 --> 00:10:17,519

exciting things that are going on

252

00:10:21,670 --> 00:10:20,079

and of course a uh if you do have

253

00:10:23,670 --> 00:10:21,680

questions about anything that you see

254

00:10:25,990 --> 00:10:23,680

today you can always uh you can always

255

00:10:28,630 --> 00:10:26,000

feel free to contact us through

256

00:10:30,069 --> 00:10:28,640

social media and uh once we have those

257

00:10:32,389 --> 00:10:30,079

we'll do our best to answer some of

258

00:10:34,150 --> 00:10:32,399

those questions for you i know that my

259

00:10:35,670 --> 00:10:34,160

granddaughters had quite a few questions

260

00:10:37,670 --> 00:10:35,680

and we hope to be able to answer those

261

00:10:41,030 --> 00:10:37,680

questions for them as well it's going to

262

00:10:43,030 --> 00:10:41,040

be an exciting day packed with all kinds

263

00:10:45,430 --> 00:10:43,040

of neat stuff so make sure that you stay

264

00:10:47,190 --> 00:10:45,440

with us all day long we've got some

265

00:10:49,190 --> 00:10:47,200

great stuff for you

266

00:10:51,269 --> 00:10:49,200

once again if you need our website it's

267

00:10:53,110 --> 00:10:51,279

greatscience.com

268

00:10:55,350 --> 00:10:53,120

and once you go there you'll be able to

269

00:10:57,430 --> 00:10:55,360

uh to access through the

270

00:10:59,829 --> 00:10:57,440

special events page you'll be able to

271

00:11:01,670 --> 00:10:59,839

access our full schedule for today all

272

00:11:03,750 --> 00:11:01,680

the things that we've got planned and

273

00:11:05,030 --> 00:11:03,760

that way you can you can plan

274

00:11:06,790 --> 00:11:05,040

accordingly

275

00:11:10,550 --> 00:11:06,800

i can't wait it's going to be an

276

00:11:14,949 --> 00:11:11,990

once again in just a few minutes our

277

00:11:16,470 --> 00:11:14,959

first guest will be joining us

278

00:11:18,710 --> 00:11:16,480

and they'll be here to tell us a little

279

00:11:20,870 --> 00:11:18,720

bit about the space communications and

280

00:11:23,030 --> 00:11:20,880

navigation network

281

00:11:26,389 --> 00:11:23,040

that's set up they're actually three

282

00:11:28,150 --> 00:11:26,399

huge satellites that are about 120

283

00:11:31,030 --> 00:11:28,160

degrees apart all the way around the

284

00:11:34,069 --> 00:11:31,040

globe and those satellites allow us to

285

00:11:36,470 --> 00:11:34,079

uh to stay in contact with deep space

286

00:11:38,550 --> 00:11:36,480

vehicles both human intended vehicles as

287

00:11:40,550 --> 00:11:38,560

we prepare to go back to the moon and

288

00:11:43,350 --> 00:11:40,560

our deep space probes like the

289

00:11:46,389 --> 00:11:43,360

perseverance rover very shortly will be

290

00:11:48,949 --> 00:11:46,399

on the surface of mars there are i

291

00:11:51,670 --> 00:11:48,959

believe nine nasa field centers that

292

00:11:53,430 --> 00:11:51,680

supports the network and the nasa glenn

293

00:11:55,509 --> 00:11:53,440

research center right here in cleveland

294

00:11:58,790 --> 00:11:55,519

ohio is one of them once again you're

295

00:12:00,949 --> 00:11:58,800

watching live coverage of today's

296

00:12:03,590 --> 00:12:00,959

landing of the perseverance rover we're

297

00:12:06,389 --> 00:12:03,600

coming to you from the nasa glenn

298

00:12:08,870 --> 00:12:06,399

research center's own visitor center

299

00:12:10,790 --> 00:12:08,880

it's housed right here inside the great

300

00:12:13,190 --> 00:12:10,800

lakes science center on the shores of

301
00:12:15,430 --> 00:12:13,200
beautiful lake erie my name is john dar

302
00:12:18,150 --> 00:12:15,440
i'll be your host for the next several

303
00:12:30,550 --> 00:12:18,160
hours as we follow the progress of the

304
00:12:35,110 --> 00:12:32,470
once again for those of you who are just

305
00:12:38,710 --> 00:12:35,120
joining us perseverance was launched

306
00:12:40,710 --> 00:12:38,720
back on july 30th from cape canaveral

307
00:12:43,750 --> 00:12:40,720
air force station in florida and it was

308
00:12:46,230 --> 00:12:43,760
launched aboard an atlas v rocket this

309
00:12:47,910 --> 00:12:46,240
is one of the most powerful rockets that

310
00:12:52,870 --> 00:12:47,920
we have and it's able to deliver a

311
00:12:58,629 --> 00:12:55,670
after launch and staging the spacecraft

312
00:13:00,949 --> 00:12:58,639
began its seven month interplanetary

313
00:13:02,470 --> 00:13:00,959

cruise phase and is now approaching the

314

00:13:04,790 --> 00:13:02,480

planet mars

315

00:13:06,389 --> 00:13:04,800

we're just minutes away from the start

316

00:13:08,310 --> 00:13:06,399

of the final leg of its journey and

317

00:13:14,069 --> 00:13:08,320

that'll be the actual landing of

318

00:13:14,079 --> 00:13:18,629

a great day in store for you

319

00:13:22,949 --> 00:13:20,160

looking for that confirmation

320

00:13:24,870 --> 00:13:22,959

[Music]

321

00:13:26,389 --> 00:13:24,880

from nasa headquarters haven't received

322

00:13:28,230 --> 00:13:26,399

it yet

323

00:13:42,949 --> 00:13:28,240

but we'll be following it all the way

324

00:13:46,230 --> 00:13:44,629

giving you an idea of our mission

325

00:13:48,470 --> 00:13:46,240

timeline

326

00:13:50,470 --> 00:13:48,480

again the rover was launched back in

327

00:13:52,389 --> 00:13:50,480

july

328

00:13:54,389 --> 00:13:52,399

scheduled to land a little bit later on

329

00:13:56,310 --> 00:13:54,399

today and we'll be touching down in

330

00:13:57,910 --> 00:13:56,320

jezreel crater

331

00:14:00,069 --> 00:13:57,920

now this is an incredible place and a

332

00:14:02,310 --> 00:14:00,079

little bit later on today we'll go into

333

00:14:04,310 --> 00:14:02,320

depth about why that particular landing

334

00:14:07,350 --> 00:14:04,320

site was chosen and what we hope to

335

00:14:09,829 --> 00:14:07,360

discover once it gets there the vehicle

336

00:14:11,670 --> 00:14:09,839

is uh is designed to spend one martian

337

00:14:15,189 --> 00:14:11,680

year operating on the surface of mars

338

00:14:16,710 --> 00:14:15,199

that's two earth years by equivalent but

339

00:14:19,269 --> 00:14:16,720

if it's anything like the previous

340

00:14:21,990 --> 00:14:19,279

rovers we we fully believe that this

341

00:14:25,509 --> 00:14:22,000

rover will go long beyond its intended

342

00:14:29,430 --> 00:14:27,430

understand now that we have that we've

343

00:14:30,470 --> 00:14:29,440

made our connection with our first guest

344

00:14:33,030 --> 00:14:30,480

speaker today

345

00:14:35,750 --> 00:14:33,040

once again we'll be uh taking you to dr

346

00:14:39,269 --> 00:14:35,760

daniel rabil space communications and

347

00:14:41,110 --> 00:14:39,279

navigation network uh specialist and

348

00:14:43,189 --> 00:14:41,120

he'll discuss how we communicate with

349

00:14:45,189 --> 00:14:43,199

mars and the challenges that are

350

00:14:49,269 --> 00:14:45,199

associated with sending and receiving

351
00:15:03,350 --> 00:14:49,279
messages throughout our solar system

352
00:15:09,030 --> 00:15:06,069
hello i'm daniel rabel and i work for

353
00:15:11,350 --> 00:15:09,040
the nasa john glenn research center in

354
00:15:13,829 --> 00:15:11,360
cleveland ohio in space communications

355
00:15:16,470 --> 00:15:13,839
and navigation and i'd like to take a

356
00:15:18,629 --> 00:15:16,480
few minutes here to talk to you about

357
00:15:20,710 --> 00:15:18,639
some of the communication challenges and

358
00:15:23,509 --> 00:15:20,720
some of the engineering solutions

359
00:15:24,870 --> 00:15:23,519
that it were devised for the upcoming

360
00:15:26,389 --> 00:15:24,880
mars mission

361
00:15:28,550 --> 00:15:26,399
so i have some information

362
00:15:31,189 --> 00:15:28,560
i'd like to share with you here and i

363
00:15:35,189 --> 00:15:31,199

can pull that up on my screen now

364

00:15:37,430 --> 00:15:35,199

but just to give you an overall context

365

00:15:39,030 --> 00:15:37,440

for um what we're

366

00:15:42,550 --> 00:15:39,040

aiming to do here

367

00:15:46,069 --> 00:15:42,560

is add to a story that's been going on

368

00:15:48,870 --> 00:15:46,079

for a few decades in the solar system

369

00:15:52,230 --> 00:15:48,880

which is at any given time

370

00:15:53,990 --> 00:15:52,240

we typically have about 100 spacecraft

371

00:15:56,550 --> 00:15:54,000

at different points throughout the solar

372

00:15:59,030 --> 00:15:56,560

system uh performing experiments and

373

00:16:00,870 --> 00:15:59,040

making observations and that's an

374

00:16:04,310 --> 00:16:00,880

amazing fact because when you think

375

00:16:06,230 --> 00:16:04,320

about a century ago we had never visited

376

00:16:08,389 --> 00:16:06,240

any of these other worlds and now each

377

00:16:10,069 --> 00:16:08,399

time we go out to another planet

378

00:16:12,949 --> 00:16:10,079

we're adding yet another chapter to that

379

00:16:14,790 --> 00:16:12,959

story and getting more information

380

00:16:17,670 --> 00:16:14,800

from that particular mission and so

381

00:16:21,430 --> 00:16:17,680

we're about to add yet another chapter

382

00:16:24,310 --> 00:16:21,440

on to that with our perseverance mission

383

00:16:27,910 --> 00:16:24,320

and so mars is the destination

384

00:16:30,710 --> 00:16:27,920

for perseverance and going to mars uh is

385

00:16:34,150 --> 00:16:30,720

a very interesting endeavor you know

386

00:16:37,110 --> 00:16:34,160

earth takes earth uh one year

387

00:16:39,189 --> 00:16:37,120

to orbit around the sun and mars the

388

00:16:41,590 --> 00:16:39,199

next planet out in the solar system it

389

00:16:44,870 --> 00:16:41,600

takes roughly two years

390

00:16:45,910 --> 00:16:44,880

so we get an opportunity once every two

391

00:16:48,629 --> 00:16:45,920

years

392

00:16:51,829 --> 00:16:48,639

when mars and earth

393

00:16:53,269 --> 00:16:51,839

remain together at one side of the sun

394

00:16:55,990 --> 00:16:53,279

and we launch

395

00:16:57,910 --> 00:16:56,000

in a window that's approximately

396

00:16:59,590 --> 00:16:57,920

two to three weeks wide so we had to hit

397

00:17:02,069 --> 00:16:59,600

that launch window

398

00:17:04,390 --> 00:17:02,079

and get our spacecraft on a spiral

399

00:17:06,870 --> 00:17:04,400

trajectory from earth's orbit

400

00:17:09,270 --> 00:17:06,880

out to mars orbit we call that a home

401
00:17:11,110 --> 00:17:09,280
and transfer that's the green line that

402
00:17:13,189 --> 00:17:11,120
you see right here in the graph we have

403
00:17:14,630 --> 00:17:13,199
to accelerate very fast so any large

404
00:17:17,350 --> 00:17:14,640
rocket to do that

405
00:17:20,549 --> 00:17:17,360
this is a ula rocket that we used but to

406
00:17:23,189 --> 00:17:20,559
accelerate up to a speed of about 95 000

407
00:17:24,470 --> 00:17:23,199
kilometers per hour in order to catch

408
00:17:27,429 --> 00:17:24,480
the planet

409
00:17:30,070 --> 00:17:27,439
that trip takes a duration of about

410
00:17:33,350 --> 00:17:30,080
seven months long and during the course

411
00:17:35,110 --> 00:17:33,360
of that spiral transit out to mars we're

412
00:17:36,710 --> 00:17:35,120
continually communicating with the

413
00:17:38,549 --> 00:17:36,720

spacecraft

414

00:17:42,230 --> 00:17:38,559
and making observations on its

415

00:17:43,830 --> 00:17:42,240
trajectory both in terms of its speed

416

00:17:46,630 --> 00:17:43,840
and trying to make small course

417

00:17:48,950 --> 00:17:46,640
corrections based upon that speed try to

418

00:17:52,070 --> 00:17:48,960
try to take measurements down to very

419

00:17:54,470 --> 00:17:52,080
fine resolutions we're talking about 0.1

420

00:17:55,830 --> 00:17:54,480
millimeter per second velocities that

421

00:17:58,710 --> 00:17:55,840
we're able to resolve through our

422

00:18:00,470 --> 00:17:58,720
navigational systems and also when we

423

00:18:03,110 --> 00:18:00,480
get to the planet

424

00:18:05,190 --> 00:18:03,120
we have to be at a very critical angle

425

00:18:06,870 --> 00:18:05,200
for entry descent and landing and we're

426

00:18:09,029 --> 00:18:06,880

able to measure those angles again

427

00:18:10,789 --> 00:18:09,039

through our communication systems to

428

00:18:12,870 --> 00:18:10,799

make sure that we're precisely the right

429

00:18:15,909 --> 00:18:12,880

angle to enter the upper atmosphere of

430

00:18:18,150 --> 00:18:15,919

the planet we can measure that down to

431

00:18:21,029 --> 00:18:18,160

matters of about two and a half nano

432

00:18:24,150 --> 00:18:21,039

radians of angle which would translate

433

00:18:27,510 --> 00:18:24,160

to hitting a targeted landing zone of

434

00:18:29,990 --> 00:18:27,520

about one kilometer in size and we're

435

00:18:32,150 --> 00:18:30,000

able to do that all back from earth

436

00:18:34,789 --> 00:18:32,160

you know from our uh communications and

437

00:18:36,630 --> 00:18:34,799

navigational systems so that brings us

438

00:18:39,750 --> 00:18:36,640

to now that critical part of that

439

00:18:41,990 --> 00:18:39,760

transit which is the entry descent and

440

00:18:44,390 --> 00:18:42,000

landing phase

441

00:18:45,830 --> 00:18:44,400

for perseverance and this is a very

442

00:18:46,630 --> 00:18:45,840

complicated

443

00:18:49,590 --> 00:18:46,640

uh

444

00:18:51,110 --> 00:18:49,600

series of sequenced events you can see

445

00:18:54,830 --> 00:18:51,120

that there's multiple parts of the

446

00:18:58,789 --> 00:18:54,840

spacecraft that are going to detach and

447

00:19:02,789 --> 00:18:58,799

deploy from a parachute to base to a sky

448

00:19:05,110 --> 00:19:02,799

crane um and a tether lowering the rover

449

00:19:07,190 --> 00:19:05,120

down to the surface ultimately

450

00:19:09,270 --> 00:19:07,200

this is similar to what was done with

451

00:19:11,750 --> 00:19:09,280

the earlier curiosity

452

00:19:14,070 --> 00:19:11,760

rover but there's one interesting

453

00:19:16,789 --> 00:19:14,080

difference and that we've built some

454

00:19:19,909 --> 00:19:16,799

autonomy into the system known as

455

00:19:22,630 --> 00:19:19,919

terrain relative navigation or trn

456

00:19:25,190 --> 00:19:22,640

where the spacecraft during entry

457

00:19:27,510 --> 00:19:25,200

descent landing is going to be capturing

458

00:19:30,950 --> 00:19:27,520

images of the surface to try to

459

00:19:33,750 --> 00:19:30,960

fine-tune that descent in order to hit

460

00:19:36,070 --> 00:19:33,760

our ultimate landing zone um known as

461

00:19:38,470 --> 00:19:36,080

gizero crater which is part of an

462

00:19:40,870 --> 00:19:38,480

ancient martian lake and so it is going

463

00:19:44,549 --> 00:19:40,880

to have control over the final part of

464

00:19:46,310 --> 00:19:44,559

the descent in in case it sees some

465

00:19:47,669 --> 00:19:46,320

you know rocks or things on the surface

466

00:19:48,950 --> 00:19:47,679

that it needs to

467

00:19:51,110 --> 00:19:48,960

correct for

468

00:19:52,710 --> 00:19:51,120

and and really this is enabling us to

469

00:19:54,870 --> 00:19:52,720

hit this particular landing zone

470

00:19:57,190 --> 00:19:54,880

something that we weren't able to do

471

00:19:58,870 --> 00:19:57,200

with previous missions so each part of

472

00:20:00,070 --> 00:19:58,880

the spacecraft as you can see on the

473

00:20:03,029 --> 00:20:00,080

left here

474

00:20:04,230 --> 00:20:03,039

is instrumented and has several antennas

475

00:20:06,470 --> 00:20:04,240

on board

476

00:20:09,029 --> 00:20:06,480

so that this you can think of it like a

477

00:20:11,190 --> 00:20:09,039

demonstration of a new technology we can

478

00:20:14,710 --> 00:20:11,200

telemeter all of that information back

479

00:20:18,070 --> 00:20:14,720

to earth to see how well uh this trn

480

00:20:20,950 --> 00:20:18,080

system performed uh during entry descent

481

00:20:23,590 --> 00:20:20,960

and finally landing now once

482

00:20:26,470 --> 00:20:23,600

perseverance is down on the surface uh

483

00:20:29,110 --> 00:20:26,480

it won't be alone we have sent a lot of

484

00:20:32,870 --> 00:20:29,120

hardware to mars in fact more than any

485

00:20:36,549 --> 00:20:32,880

other planet there are several rovers

486

00:20:38,789 --> 00:20:36,559

and curiosity is is still there as well

487

00:20:40,549 --> 00:20:38,799

and we have several orbiters who have

488

00:20:41,909 --> 00:20:40,559

been there for a few years and this is

489

00:20:43,430 --> 00:20:41,919

going to be important we're going to try

490

00:20:47,270 --> 00:20:43,440

to take advantage

491

00:20:49,510 --> 00:20:47,280

of uh this as a communications network

492

00:20:53,510 --> 00:20:49,520

once we arrive as well going to the

493

00:20:56,870 --> 00:20:53,520

future we have several more uh surface

494

00:20:59,750 --> 00:20:56,880

assets as well as orbiters planned for

495

00:21:02,149 --> 00:20:59,760

the mars exploration program

496

00:21:05,430 --> 00:21:02,159

now the rover itself

497

00:21:08,310 --> 00:21:05,440

known as perseverance looks very similar

498

00:21:10,950 --> 00:21:08,320

and with locomotion wise as well

499

00:21:13,510 --> 00:21:10,960

with the original curiosity rover but it

500

00:21:15,750 --> 00:21:13,520

has a whole new host of instrumentation

501
00:21:18,630 --> 00:21:15,760
on board and like i mentioned this will

502
00:21:21,110 --> 00:21:18,640
be uh landing in a crater uh that is an

503
00:21:24,390 --> 00:21:21,120
ancient riverbed looking for

504
00:21:26,870 --> 00:21:24,400
signs of um microbiological organisms

505
00:21:29,110 --> 00:21:26,880
gathering rocks and soil and trying to

506
00:21:31,669 --> 00:21:29,120
identify things that we can utilize for

507
00:21:34,070 --> 00:21:31,679
future human exploration it certainly

508
00:21:35,830 --> 00:21:34,080
has a few high definition cameras on

509
00:21:37,909 --> 00:21:35,840
board and that together with the other

510
00:21:40,789 --> 00:21:37,919
scientific instrumentation

511
00:21:42,789 --> 00:21:40,799
is going to generate a lot of data to

512
00:21:44,230 --> 00:21:42,799
ultimately transmit

513
00:21:46,230 --> 00:21:44,240

back to earth and that's where our

514

00:21:47,590 --> 00:21:46,240

communications and navigation really

515

00:21:50,070 --> 00:21:47,600

needs to come

516

00:21:52,149 --> 00:21:50,080

in and try to make that possible there's

517

00:21:53,909 --> 00:21:52,159

a lot of challenges working against that

518

00:21:56,310 --> 00:21:53,919

goal of getting all the information from

519

00:21:58,470 --> 00:21:56,320

the surface of the martian planet uh

520

00:22:00,310 --> 00:21:58,480

back to earth no like i mentioned mars

521

00:22:02,549 --> 00:22:00,320

is very far away it takes us seven

522

00:22:05,430 --> 00:22:02,559

months uh to get there

523

00:22:08,070 --> 00:22:05,440

so uh it's so far away in fact that the

524

00:22:11,110 --> 00:22:08,080

radio signals themselves can take

525

00:22:12,390 --> 00:22:11,120

several minutes to to transit between

526

00:22:14,870 --> 00:22:12,400

mars and earth

527

00:22:17,190 --> 00:22:14,880

typically on the range of 5 to 20

528

00:22:19,830 --> 00:22:17,200

minutes depending upon the particular

529

00:22:21,590 --> 00:22:19,840

placement of earth relative to mars at

530

00:22:23,590 --> 00:22:21,600

that point of the year remember that's

531

00:22:26,390 --> 00:22:23,600

varying because we're in two different

532

00:22:28,070 --> 00:22:26,400

orbits a one-year orbit for earth and a

533

00:22:29,510 --> 00:22:28,080

two-year orbit

534

00:22:32,470 --> 00:22:29,520

from mars

535

00:22:34,310 --> 00:22:32,480

so we can't uh you know ask a question

536

00:22:37,270 --> 00:22:34,320

of the rover and get an instantaneous

537

00:22:40,230 --> 00:22:37,280

response we can send a command or ask a

538

00:22:42,470 --> 00:22:40,240

question and then takes up to 20 minutes

539

00:22:45,190 --> 00:22:42,480

for that to get to the rover and then

540

00:22:47,510 --> 00:22:45,200

perhaps 20 minutes back so conversation

541

00:22:49,590 --> 00:22:47,520

is very slow that way it's a very harsh

542

00:22:51,669 --> 00:22:49,600

environment uh it can get down to minus

543

00:22:53,270 --> 00:22:51,679

90 degrees centigrade

544

00:22:54,630 --> 00:22:53,280

at night which is the coldest

545

00:22:57,590 --> 00:22:54,640

temperature ever recorded down in

546

00:22:58,710 --> 00:22:57,600

antarctica here on earth uh there's also

547

00:23:01,190 --> 00:22:58,720

huge

548

00:23:03,909 --> 00:23:01,200

large-scale dust storms and radiation

549

00:23:05,669 --> 00:23:03,919

storms you can see just in a few weeks

550

00:23:07,590 --> 00:23:05,679

these are pictures of mars in the lower

551
00:23:10,710 --> 00:23:07,600
right hand corner here of how a dust

552
00:23:12,149 --> 00:23:10,720
storm can envelop the entire planet

553
00:23:14,789 --> 00:23:12,159
and that can

554
00:23:17,430 --> 00:23:14,799
knock out our communication systems

555
00:23:19,350 --> 00:23:17,440
the rover itself although fairly large

556
00:23:22,230 --> 00:23:19,360
as rovers go

557
00:23:25,590 --> 00:23:22,240
is still very limited in the available

558
00:23:27,830 --> 00:23:25,600
power and the available computing

559
00:23:29,110 --> 00:23:27,840
processing power that it has

560
00:23:31,350 --> 00:23:29,120
i believe

561
00:23:32,390 --> 00:23:31,360
after this my colleague lauren clayman

562
00:23:35,510 --> 00:23:32,400
is going to talk to you about the

563
00:23:37,430 --> 00:23:35,520

radioisotope thermal generation system

564

00:23:38,470 --> 00:23:37,440

and our communication systems are just

565

00:23:40,870 --> 00:23:38,480

one of

566

00:23:43,350 --> 00:23:40,880

many uh different payloads on the rover

567

00:23:46,390 --> 00:23:43,360

competing for that valuable power

568

00:23:48,230 --> 00:23:46,400

from that rtg and so we're limited in

569

00:23:51,270 --> 00:23:48,240

how much energy that we can have to

570

00:23:53,990 --> 00:23:51,280

transmit the signals back towards earth

571

00:23:56,630 --> 00:23:54,000

now there are planned outages uh as well

572

00:23:58,630 --> 00:23:56,640

you know certainly um mars is in orbit

573

00:24:00,470 --> 00:23:58,640

earth is in orbit we're both rotating as

574

00:24:02,630 --> 00:24:00,480

planets and the rover's driving around

575

00:24:04,310 --> 00:24:02,640

so everything's in motion and we can

576
00:24:06,630 --> 00:24:04,320
kind of pre-plan that out and know when

577
00:24:08,950 --> 00:24:06,640
we'll be able to to

578
00:24:10,789 --> 00:24:08,960
establish a communication link to the

579
00:24:13,110 --> 00:24:10,799
planet but there's also on planned

580
00:24:15,750 --> 00:24:13,120
outages we can have obviously weather

581
00:24:17,510 --> 00:24:15,760
effects here at earth um

582
00:24:19,269 --> 00:24:17,520
the way of thunderstorms that can knock

583
00:24:20,870 --> 00:24:19,279
out communications we also have what we

584
00:24:22,870 --> 00:24:20,880
call space weather

585
00:24:23,909 --> 00:24:22,880
which would be some of the radiation

586
00:24:26,310 --> 00:24:23,919
storms

587
00:24:28,630 --> 00:24:26,320
coming from our sun that can impede

588
00:24:30,710 --> 00:24:28,640

communication so a lot of things working

589

00:24:33,350 --> 00:24:30,720

against us and trying to work these

590

00:24:35,510 --> 00:24:33,360

signals back towards earth

591

00:24:38,230 --> 00:24:35,520

so on the rover where those signals

592

00:24:40,310 --> 00:24:38,240

start is we have three options three

593

00:24:43,510 --> 00:24:40,320

different antenna systems on board

594

00:24:46,630 --> 00:24:43,520

perseverance on the top deck the primary

595

00:24:48,870 --> 00:24:46,640

way of communicating is a small antenna

596

00:24:50,789 --> 00:24:48,880

known as an ultra high frequency antenna

597

00:24:53,830 --> 00:24:50,799

or uhf

598

00:24:56,950 --> 00:24:53,840

and that will transmit from the surface

599

00:24:59,110 --> 00:24:56,960

of the planet up to one of three

600

00:25:02,390 --> 00:24:59,120

available orbiters the mars

601
00:25:05,350 --> 00:25:02,400
reconnaissance orbiter and maven

602
00:25:07,909 --> 00:25:05,360
as well as the european orbit or the

603
00:25:09,830 --> 00:25:07,919
trace gas orbiter tgo

604
00:25:12,070 --> 00:25:09,840
and so those are already there and

605
00:25:13,669 --> 00:25:12,080
they'll come overhead about once a day

606
00:25:16,070 --> 00:25:13,679
for about eight minutes

607
00:25:17,909 --> 00:25:16,080
over the rover and when they're overhead

608
00:25:20,149 --> 00:25:17,919
we'll be able to transmit at a rate of

609
00:25:23,029 --> 00:25:20,159
two megabits per second

610
00:25:25,190 --> 00:25:23,039
from that uhf antenna and this works out

611
00:25:26,870 --> 00:25:25,200
well because those orbiters as you can

612
00:25:28,549 --> 00:25:26,880
see in the picture here they have very

613
00:25:30,789 --> 00:25:28,559

large solar panels so they have a lot of

614

00:25:32,950 --> 00:25:30,799

power and two from the pictures you can

615

00:25:35,990 --> 00:25:32,960

see they all have large antennas on

616

00:25:38,630 --> 00:25:36,000

board so they can ingest that two

617

00:25:40,870 --> 00:25:38,640

megabits per second from the rover and

618

00:25:43,350 --> 00:25:40,880

boost up the signal for the long haul

619

00:25:45,909 --> 00:25:43,360

path backwards earth

620

00:25:48,149 --> 00:25:45,919

and so the majority of the data will be

621

00:25:50,549 --> 00:25:48,159

transmitted in that fashion now in

622

00:25:53,110 --> 00:25:50,559

addition to that system

623

00:25:55,830 --> 00:25:53,120

there's two other systems at a different

624

00:25:57,269 --> 00:25:55,840

frequency called x-band there's a high

625

00:26:01,029 --> 00:25:57,279

gain antenna

626

00:26:02,549 --> 00:26:01,039

antenna you can see on the picture on

627

00:26:05,190 --> 00:26:02,559

the inside here

628

00:26:07,830 --> 00:26:05,200

is a steerable antenna now it's a very

629

00:26:11,750 --> 00:26:07,840

low data rate uh it's down to

630

00:26:14,230 --> 00:26:11,760

about 160 to 500 bits per second

631

00:26:16,950 --> 00:26:14,240

but it's steerable and it will be able

632

00:26:19,669 --> 00:26:16,960

to communicate with earth directly

633

00:26:21,909 --> 00:26:19,679

rather than relaying the signal through

634

00:26:24,789 --> 00:26:21,919

one of those orbiters for a fraction you

635

00:26:27,669 --> 00:26:24,799

know time a day and so this is how we'll

636

00:26:30,070 --> 00:26:27,679

be sending commands every morning to the

637

00:26:31,909 --> 00:26:30,080

rover so very low data rate but very

638

00:26:34,310 --> 00:26:31,919

important information we wouldn't be

639

00:26:36,149 --> 00:26:34,320

sending pictures and video back and

640

00:26:37,750 --> 00:26:36,159

forth on this link

641

00:26:40,230 --> 00:26:37,760

but this would be more for our

642

00:26:43,430 --> 00:26:40,240

commanding information and uh critical

643

00:26:46,149 --> 00:26:43,440

telemetry uh information and the nice

644

00:26:48,390 --> 00:26:46,159

thing about it being steered is that

645

00:26:49,750 --> 00:26:48,400

we can have the rover in whatever pose

646

00:26:51,590 --> 00:26:49,760

it needs to be in

647

00:26:53,669 --> 00:26:51,600

for its mission operations and

648

00:26:55,190 --> 00:26:53,679

independently steer the beam around so

649

00:26:57,750 --> 00:26:55,200

we don't have to worry about what

650

00:26:59,430 --> 00:26:57,760

position the rover is in to communicate

651
00:27:02,149 --> 00:26:59,440
and then finally there's a low gain

652
00:27:04,230 --> 00:27:02,159
x-band system again very low data rate

653
00:27:06,789 --> 00:27:04,240
just as a backup option to give us some

654
00:27:08,870 --> 00:27:06,799
flexibility and in case we had a problem

655
00:27:10,870 --> 00:27:08,880
and you know perhaps the rover's in safe

656
00:27:13,110 --> 00:27:10,880
mode and we're trying to recover um from

657
00:27:15,430 --> 00:27:13,120
some event unforeseen event like a you

658
00:27:17,669 --> 00:27:15,440
know radiation storm or that

659
00:27:19,830 --> 00:27:17,679
so we have three different channels here

660
00:27:21,830 --> 00:27:19,840
and different frequencies that we

661
00:27:24,470 --> 00:27:21,840
communicate in and those channels and

662
00:27:26,470 --> 00:27:24,480
you can imagine there's a lot of science

663
00:27:29,110 --> 00:27:26,480

and engineering that goes behind that

664

00:27:30,549 --> 00:27:29,120

and nasa is certainly full of you know a

665

00:27:33,190 --> 00:27:30,559

lot of science and engineers to build

666

00:27:35,590 --> 00:27:33,200

the systems to allow this to happen but

667

00:27:38,230 --> 00:27:35,600

i also wanted to take uh just a minute

668

00:27:40,549 --> 00:27:38,240

here to mention so these channels

669

00:27:43,350 --> 00:27:40,559

operate at different frequencies the

670

00:27:45,669 --> 00:27:43,360

same way that your cell phone

671

00:27:47,510 --> 00:27:45,679

has a certain frequency and your

672

00:27:50,149 --> 00:27:47,520

wireless internet your router at home

673

00:27:52,549 --> 00:27:50,159

has a certain frequency and just like

674

00:27:54,070 --> 00:27:52,559

all of those consumer grade products in

675

00:27:55,830 --> 00:27:54,080

space

676
00:27:58,789 --> 00:27:55,840
nasa has to

677
00:28:00,870 --> 00:27:58,799
get a allocation to use that frequency

678
00:28:02,630 --> 00:28:00,880
we have to get an authorization for each

679
00:28:04,310 --> 00:28:02,640
and every one of our spacecraft and each

680
00:28:06,789 --> 00:28:04,320
and every one of our spacecraft may need

681
00:28:09,830 --> 00:28:06,799
multiple channels so there's an entire

682
00:28:11,830 --> 00:28:09,840
team at nasa you know made up of folks

683
00:28:14,230 --> 00:28:11,840
that have a bit of a legal background

684
00:28:16,870 --> 00:28:14,240
and a management background that work

685
00:28:19,029 --> 00:28:16,880
with our international partners all year

686
00:28:21,110 --> 00:28:19,039
to make sure that all of our spacecraft

687
00:28:22,789 --> 00:28:21,120
are allocated the right channels that

688
00:28:25,590 --> 00:28:22,799

they need the right frequencies that

689

00:28:27,830 --> 00:28:25,600

they need in order to communicate to and

690

00:28:30,070 --> 00:28:27,840

from earth and that's an ongoing effort

691

00:28:31,990 --> 00:28:30,080

it takes a you know a few years prior to

692

00:28:33,909 --> 00:28:32,000

each of these missions to get those

693

00:28:35,029 --> 00:28:33,919

spectrum allocations and you know it's

694

00:28:37,430 --> 00:28:35,039

something that a lot of people don't

695

00:28:40,310 --> 00:28:37,440

know about so they're they're the onsen

696

00:28:41,590 --> 00:28:40,320

heroes of making all this work and and i

697

00:28:43,510 --> 00:28:41,600

just wanted to make the point that it

698

00:28:46,230 --> 00:28:43,520

takes you know a whole lot of different

699

00:28:47,510 --> 00:28:46,240

types of people to pull these systems

700

00:28:49,830 --> 00:28:47,520

together from the hardware and the

701
00:28:52,070 --> 00:28:49,840
software the science and the engineering

702
00:28:53,750 --> 00:28:52,080
but also the policy and the management

703
00:28:55,990 --> 00:28:53,760
of that and the spectrum allocation is a

704
00:28:59,430 --> 00:28:56,000
perfect example of a critical piece that

705
00:29:03,350 --> 00:28:59,440
you need to make these systems work

706
00:29:06,789 --> 00:29:03,360
one very new feature with this rover of

707
00:29:09,110 --> 00:29:06,799
other rovers is the mars helicopter

708
00:29:11,110 --> 00:29:09,120
known as ingenuity so there will be the

709
00:29:12,549 --> 00:29:11,120
first powered flight demonstration on

710
00:29:15,029 --> 00:29:12,559
another planet

711
00:29:17,110 --> 00:29:15,039
using ingenuity which will deploy uh

712
00:29:19,350 --> 00:29:17,120
from the perseverance rover what

713
00:29:21,430 --> 00:29:19,360

ingenuity is going to add from a mission

714

00:29:23,750 --> 00:29:21,440

capability standpoint is we'll be able

715

00:29:26,470 --> 00:29:23,760

to reach things like plateaus that the

716

00:29:28,230 --> 00:29:26,480

rover won't be able to climb and go to

717

00:29:30,310 --> 00:29:28,240

ranges where the rover will not be able

718

00:29:32,149 --> 00:29:30,320

to get to and get increased resolution

719

00:29:34,549 --> 00:29:32,159

and imagery from those particular

720

00:29:38,070 --> 00:29:34,559

locations now from a communication

721

00:29:39,830 --> 00:29:38,080

standpoint this creates a small network

722

00:29:41,190 --> 00:29:39,840

right down on the surface because all of

723

00:29:43,430 --> 00:29:41,200

that imagery

724

00:29:45,110 --> 00:29:43,440

captured by ingenuity will have to be

725

00:29:47,510 --> 00:29:45,120

relayed through

726
00:29:49,510 --> 00:29:47,520
the rover itself and then up to the

727
00:29:52,549 --> 00:29:49,520
orbiter and then back towards earth so

728
00:29:54,950 --> 00:29:52,559
we've basically built our own local mars

729
00:29:57,190 --> 00:29:54,960
communication network between each of

730
00:29:58,950 --> 00:29:57,200
those elements in order to get the data

731
00:30:00,710 --> 00:29:58,960
uh ultimately from the helicopter

732
00:30:02,950 --> 00:30:00,720
demonstration

733
00:30:04,389 --> 00:30:02,960
and uh and telemetered uh back to earth

734
00:30:07,269 --> 00:30:04,399
so very interesting and exciting

735
00:30:09,430 --> 00:30:07,279
demonstration um that'll be deployed

736
00:30:12,389 --> 00:30:09,440
from the rover itself

737
00:30:13,350 --> 00:30:12,399
now perseverance as well is going to

738
00:30:15,190 --> 00:30:13,360

have

739

00:30:16,950 --> 00:30:15,200

several cameras on board and we're

740

00:30:19,190 --> 00:30:16,960

greatly looking forward to the enormous

741

00:30:20,870 --> 00:30:19,200

amount of data that will be returned

742

00:30:23,669 --> 00:30:20,880

from those cameras

743

00:30:25,830 --> 00:30:23,679

so as that starts to roll in over the

744

00:30:28,870 --> 00:30:25,840

next few weeks please check out the the

745

00:30:30,389 --> 00:30:28,880

perseverance rover website for downloads

746

00:30:32,870 --> 00:30:30,399

of that information

747

00:30:35,750 --> 00:30:32,880

here's an example of just such a picture

748

00:30:37,590 --> 00:30:35,760

that was downlinked through curiosity

749

00:30:40,789 --> 00:30:37,600

now these images are very large some of

750

00:30:43,830 --> 00:30:40,799

them can even be gigabit large uh in

751
00:30:45,750 --> 00:30:43,840
file size so it can it can take a few

752
00:30:47,510 --> 00:30:45,760
days and sometimes even a few weeks to

753
00:30:50,310 --> 00:30:47,520
download something like a panoramic

754
00:30:52,230 --> 00:30:50,320
mosaic like you see in this very image

755
00:30:54,710 --> 00:30:52,240
due to those data rates because the long

756
00:30:56,789 --> 00:30:54,720
distances um but you know they'll be

757
00:30:58,470 --> 00:30:56,799
adding that to the repository over time

758
00:31:00,950 --> 00:30:58,480
and we're very much looking forward to

759
00:31:02,710 --> 00:31:00,960
seeing um the kinds of imagery that

760
00:31:04,549 --> 00:31:02,720
perseverance is going to give us on top

761
00:31:06,310 --> 00:31:04,559
of curiosity

762
00:31:09,029 --> 00:31:06,320
so back here at earth and that's the

763
00:31:11,990 --> 00:31:09,039

last part of communicating

764

00:31:14,950 --> 00:31:12,000

across this mars relay network

765

00:31:18,470 --> 00:31:14,960

are our deep space network antennas

766

00:31:21,110 --> 00:31:18,480

known as the ds10 so the dsn features

767

00:31:22,310 --> 00:31:21,120

the very largest antennas that nasa

768

00:31:24,310 --> 00:31:22,320

operates

769

00:31:26,470 --> 00:31:24,320

they have the most sensitive receivers

770

00:31:29,190 --> 00:31:26,480

on board they also have the most

771

00:31:31,590 --> 00:31:29,200

powerful transmitters inside so when we

772

00:31:34,549 --> 00:31:31,600

need to send the command and control

773

00:31:36,149 --> 00:31:34,559

information every morning to the rover

774

00:31:38,230 --> 00:31:36,159

so that it knows what operations it

775

00:31:41,190 --> 00:31:38,240

should do that day we're going to also

776
00:31:43,350 --> 00:31:41,200
use these antennas as our transmitters

777
00:31:45,350 --> 00:31:43,360
during that cruise phase that seven

778
00:31:47,509 --> 00:31:45,360
month cruise phase these are the

779
00:31:49,190 --> 00:31:47,519
antennas that also provided all those

780
00:31:52,070 --> 00:31:49,200
navigational

781
00:31:53,269 --> 00:31:52,080
we call them the radiometric analysis to

782
00:31:55,509 --> 00:31:53,279
make sure that we're at the right

783
00:31:56,710 --> 00:31:55,519
trajectory the right speed and the right

784
00:31:59,990 --> 00:31:56,720
angle

785
00:32:02,149 --> 00:32:00,000
and to do so we have to drive these

786
00:32:04,149 --> 00:32:02,159
systems with the best algorithms and the

787
00:32:06,389 --> 00:32:04,159
most stable timing

788
00:32:08,470 --> 00:32:06,399

you know with atomic clocks and such or

789

00:32:10,870 --> 00:32:08,480

to provide that navigation to the rover

790

00:32:12,870 --> 00:32:10,880

uh from from earth during cruise phase

791

00:32:15,509 --> 00:32:12,880

and typically at any given time we have

792

00:32:17,269 --> 00:32:15,519

about 30 different craft in deep space

793

00:32:18,789 --> 00:32:17,279

about 100 across the solar system about

794

00:32:21,669 --> 00:32:18,799

30 in deep space

795

00:32:22,789 --> 00:32:21,679

that the dsn is talking to on a daily

796

00:32:25,590 --> 00:32:22,799

basis

797

00:32:28,470 --> 00:32:25,600

so the dsn is a network and for network

798

00:32:31,430 --> 00:32:28,480

deep space network and there are three

799

00:32:33,990 --> 00:32:31,440

facilities for the dsn spread across the

800

00:32:35,350 --> 00:32:34,000

planet we have one in goldstone

801
00:32:38,070 --> 00:32:35,360
california

802
00:32:40,310 --> 00:32:38,080
canberra spain i'm sorry madrid spain

803
00:32:42,310 --> 00:32:40,320
and canberra australia

804
00:32:44,149 --> 00:32:42,320
and the reason that these various sites

805
00:32:47,350 --> 00:32:44,159
are picked is because

806
00:32:49,990 --> 00:32:47,360
they're roughly 120 degrees apart from

807
00:32:53,190 --> 00:32:50,000
each other on the earth and so whichever

808
00:32:56,149 --> 00:32:53,200
way the earth is rotated

809
00:32:58,149 --> 00:32:56,159
you were able to use one or sometimes

810
00:33:00,950 --> 00:32:58,159
even two of these ground terminal

811
00:33:04,710 --> 00:33:00,960
facilities to communicate with one of

812
00:33:06,870 --> 00:33:04,720
the deep spacecraft such as perseverance

813
00:33:09,029 --> 00:33:06,880

and so some of the signal will go to one

814

00:33:11,350 --> 00:33:09,039

of the antennas and the earth is slowly

815

00:33:13,110 --> 00:33:11,360

rotating so then you have to hand off to

816

00:33:15,590 --> 00:33:13,120

perhaps another one of the antennas to

817

00:33:17,909 --> 00:33:15,600

get the rest of the message or download

818

00:33:20,710 --> 00:33:17,919

the rest of the image and then

819

00:33:22,549 --> 00:33:20,720

ultimately those pieces of the signal

820

00:33:25,350 --> 00:33:22,559

need put together at a central

821

00:33:27,909 --> 00:33:25,360

operations facility which resides out in

822

00:33:30,789 --> 00:33:27,919

pasadena california out at the jet

823

00:33:32,789 --> 00:33:30,799

propulsion laboratory the jpl space

824

00:33:34,389 --> 00:33:32,799

flight operations facility and if you're

825

00:33:36,549 --> 00:33:34,399

ever out there you can you can get a

826

00:33:40,710 --> 00:33:36,559

public tour of that facility it's been

827

00:33:42,470 --> 00:33:40,720

in operations now 24 7 for over 40 years

828

00:33:43,590 --> 00:33:42,480

communicating with all of our deep space

829

00:33:44,950 --> 00:33:43,600

craft

830

00:33:47,350 --> 00:33:44,960

and of course we're in a very

831

00:33:50,310 --> 00:33:47,360

interesting time just like you and i are

832

00:33:53,509 --> 00:33:50,320

struggling to figure out how to get

833

00:33:56,310 --> 00:33:53,519

through our day today due to coven 19

834

00:33:59,269 --> 00:33:56,320

the space operations facility is doing

835

00:34:01,909 --> 00:33:59,279

the same and in fact in this past year

836

00:34:03,669 --> 00:34:01,919

it was the date of march 20th that was

837

00:34:06,149 --> 00:34:03,679

the first day

838

00:34:08,470 --> 00:34:06,159

for the nasa curiosity rover to be

839

00:34:11,510 --> 00:34:08,480
successfully operated from the

840

00:34:14,069 --> 00:34:11,520
operations team who was telecommuting

841

00:34:16,230 --> 00:34:14,079
from home uh and of course we've had to

842

00:34:18,629 --> 00:34:16,240
continue this mode of operation for some

843

00:34:21,430 --> 00:34:18,639
time but it's pretty amazing the the

844

00:34:23,829 --> 00:34:21,440
technological successes of figuring out

845

00:34:25,990 --> 00:34:23,839
um how to lay in secure channels where

846

00:34:27,990 --> 00:34:26,000
you're able to operate a spacecraft in

847

00:34:31,030 --> 00:34:28,000
deep space on the surface of another

848

00:34:34,389 --> 00:34:31,040
planet um from your house due to the

849

00:34:36,869 --> 00:34:34,399
constraints of a of a worldwide pandemic

850

00:34:40,310 --> 00:34:36,879
so big feather in jpl's cap for for

851
00:34:42,869 --> 00:34:40,320
figuring that out now you can watch live

852
00:34:44,710 --> 00:34:42,879
the operations of what those operators

853
00:34:49,349 --> 00:34:44,720
are doing anytime that you like this is

854
00:34:51,589 --> 00:34:49,359
up 24 7. if you go to the uh dsn now

855
00:34:53,829 --> 00:34:51,599
website i just took a screenshot of it

856
00:34:56,149 --> 00:34:53,839
here for you to take a look at this will

857
00:34:58,150 --> 00:34:56,159
show you the three different facilities

858
00:35:00,470 --> 00:34:58,160
and there's several antennas at each and

859
00:35:03,270 --> 00:35:00,480
it'll annotate which spacecraft we're

860
00:35:05,589 --> 00:35:03,280
talking to at that at that instantaneous

861
00:35:07,030 --> 00:35:05,599
uh time so right now on the screen at

862
00:35:09,990 --> 00:35:07,040
the very bottom in the center you can

863
00:35:11,990 --> 00:35:10,000

see that uh the canberra site um which

864

00:35:14,470 --> 00:35:12,000

was uh in the center of the 34 meter

865

00:35:16,310 --> 00:35:14,480

dish was actually talking to voyager 2

866

00:35:17,670 --> 00:35:16,320

um at at that time that i took that

867

00:35:19,349 --> 00:35:17,680

screenshot and if you'd like to learn

868

00:35:21,510 --> 00:35:19,359

more about the mission or the

869

00:35:23,190 --> 00:35:21,520

communication system you can click in

870

00:35:25,270 --> 00:35:23,200

the bottom right and find you know

871

00:35:27,670 --> 00:35:25,280

things like how far the mission is away

872

00:35:29,030 --> 00:35:27,680

what's the data rate what's the latency

873

00:35:31,430 --> 00:35:29,040

in time

874

00:35:34,310 --> 00:35:31,440

right now i think it's selected uh mars

875

00:35:36,950 --> 00:35:34,320

odyssey and there was a 42.94

876

00:35:38,310 --> 00:35:36,960

minute time delay talking to it so

877

00:35:39,750 --> 00:35:38,320

really neat website i encourage you to

878

00:35:41,990 --> 00:35:39,760

check that out especially now you know

879

00:35:44,790 --> 00:35:42,000

watching us start to bring perseverance

880

00:35:47,190 --> 00:35:44,800

online and it'll appear in here uh daily

881

00:35:48,790 --> 00:35:47,200

as we start to talk to it

882

00:35:51,829 --> 00:35:48,800

and so like i mentioned there will be a

883

00:35:54,150 --> 00:35:51,839

lot more hardware going out towards mars

884

00:35:55,910 --> 00:35:54,160

these are the robotic precursor missions

885

00:35:58,230 --> 00:35:55,920

where we can find out

886

00:36:00,870 --> 00:35:58,240

what type of resources are available to

887

00:36:03,109 --> 00:36:00,880

us to enable human exploration and we

888

00:36:05,030 --> 00:36:03,119

have to continue to do these firsts to

889

00:36:06,710 --> 00:36:05,040

learn more about ourselves and our solar

890

00:36:09,190 --> 00:36:06,720

system where we are and where we're

891

00:36:11,190 --> 00:36:09,200

going and we need a lot of help to do

892

00:36:13,510 --> 00:36:11,200

this and there are many ways that you

893

00:36:15,910 --> 00:36:13,520

the public can participate in this we

894

00:36:18,069 --> 00:36:15,920

have small business opportunities where

895

00:36:19,430 --> 00:36:18,079

you know the algorithms and the software

896

00:36:21,190 --> 00:36:19,440

and even the hardware that we use on

897

00:36:23,109 --> 00:36:21,200

these spacecraft

898

00:36:24,790 --> 00:36:23,119

can get developed from a small business

899

00:36:27,670 --> 00:36:24,800

interested in doing so

900

00:36:29,349 --> 00:36:27,680

we have larger contractual mechanisms

901
00:36:31,030 --> 00:36:29,359
for procurement but the one i really

902
00:36:32,630 --> 00:36:31,040
wanted to focus on is our academic

903
00:36:35,510 --> 00:36:32,640
collaborations

904
00:36:36,310 --> 00:36:35,520
we are very fortunate that every year we

905
00:36:39,589 --> 00:36:36,320
have

906
00:36:41,910 --> 00:36:39,599
a large segment of interns coming to

907
00:36:43,829 --> 00:36:41,920
join us and in fact right now this very

908
00:36:45,589 --> 00:36:43,839
second we're reviewing applications for

909
00:36:47,430 --> 00:36:45,599
the summer internship i believe they're

910
00:36:50,310 --> 00:36:47,440
they're open for another couple weeks

911
00:36:52,790 --> 00:36:50,320
here um and so if you know someone or

912
00:36:55,589 --> 00:36:52,800
you yourself are interested in helping

913
00:36:57,430 --> 00:36:55,599

us accomplish these missions by all

914

00:36:59,510 --> 00:36:57,440

means consider interning with us and

915

00:37:01,589 --> 00:36:59,520

that goes from high school to

916

00:37:04,310 --> 00:37:01,599

undergraduate to the graduate level to

917

00:37:07,190 --> 00:37:04,320

the to the post-doctoral level uh and

918

00:37:09,990 --> 00:37:07,200

even faculty fellowships um like i said

919

00:37:13,109 --> 00:37:10,000

this is uh something that is crucial to

920

00:37:15,910 --> 00:37:13,119

our success getting in uh young bright

921

00:37:17,270 --> 00:37:15,920

people with new ideas and help and

922

00:37:18,550 --> 00:37:17,280

getting their feedback on what we're

923

00:37:20,230 --> 00:37:18,560

trying to do and getting their help

924

00:37:22,790 --> 00:37:20,240

trying to get there

925

00:37:24,710 --> 00:37:22,800

again i'm from the glen research center

926

00:37:26,230 --> 00:37:24,720

which is in cleveland ohio

927

00:37:29,030 --> 00:37:26,240

in the great lakes region but we have

928

00:37:30,470 --> 00:37:29,040

facilities all over the country and so

929

00:37:31,750 --> 00:37:30,480

if you're not able to travel or you'd

930

00:37:32,870 --> 00:37:31,760

like to have something a little closer

931

00:37:34,870 --> 00:37:32,880

to home

932

00:37:35,750 --> 00:37:34,880

you can go through the main web portal

933

00:37:37,750 --> 00:37:35,760

and

934

00:37:39,430 --> 00:37:37,760

basically it's like a job board find

935

00:37:41,670 --> 00:37:39,440

something that you're interested in and

936

00:37:43,829 --> 00:37:41,680

put in for it and we will be most happy

937

00:37:46,230 --> 00:37:43,839

uh to have you aboard our team

938

00:37:48,390 --> 00:37:46,240

as we go forward so i hope that you

939

00:37:52,069 --> 00:37:48,400

found this very interesting thank you so

940

00:37:53,829 --> 00:37:52,079

much uh for your attention also um thank

941

00:37:56,230 --> 00:37:53,839

you to the to the great lakes science

942

00:37:58,950 --> 00:37:56,240

center for helping us get our message

943

00:38:01,589 --> 00:37:58,960

out here as we continue to add again

944

00:38:08,630 --> 00:38:01,599

more chapters to our story and explore

945

00:38:13,109 --> 00:38:10,550

once again folks that was dr daniel

946

00:38:15,190 --> 00:38:13,119

rebuild of the space communications and

947

00:38:17,430 --> 00:38:15,200

navigation network

948

00:38:19,670 --> 00:38:17,440

um just really fascinating learning

949

00:38:22,230 --> 00:38:19,680

about how we communicate with deep space

950

00:38:23,910 --> 00:38:22,240

objects and you saw in the video that he

951
00:38:26,470 --> 00:38:23,920
provided with you the mars helicopter

952
00:38:28,710 --> 00:38:26,480
that i told you about earlier um that

953
00:38:31,589 --> 00:38:28,720
mars helicopter is amazing it's only

954
00:38:34,630 --> 00:38:31,599
about four pounds it's solar powered so

955
00:38:38,310 --> 00:38:34,640
it will recharge on its own it uses a

956
00:38:41,990 --> 00:38:38,320
wireless communication system and uh the

957
00:38:44,550 --> 00:38:42,000
rotors on the vehicle are about uh about

958
00:38:46,630 --> 00:38:44,560
four foot long so that's uh that's

959
00:38:49,990 --> 00:38:46,640
pretty amazing it's also equipped with

960
00:38:52,870 --> 00:38:50,000
internal sensors and the laser altimeter

961
00:38:54,550 --> 00:38:52,880
and uh two cameras one in color and also

962
00:38:56,710 --> 00:38:54,560
one in black and white it's really

963
00:38:59,670 --> 00:38:56,720

fascinating and we'll delve a little bit

964

00:39:00,550 --> 00:38:59,680

deeper into that uh here in a few

965

00:39:02,870 --> 00:39:00,560

minutes

966

00:39:04,150 --> 00:39:02,880

um we do have another another speaker

967

00:39:06,310 --> 00:39:04,160

that's coming up we're trying to

968

00:39:07,910 --> 00:39:06,320

establish communications with them but

969

00:39:10,150 --> 00:39:07,920

in the meantime it's another great

970

00:39:12,310 --> 00:39:10,160

opportunity to talk more about the

971

00:39:14,630 --> 00:39:12,320

perseverance rover now the key

972

00:39:17,589 --> 00:39:14,640

objectives for this particular mission

973

00:39:20,470 --> 00:39:17,599

are to explore the uh geologically

974

00:39:22,870 --> 00:39:20,480

diverse landing site jezreel crater is

975

00:39:24,950 --> 00:39:22,880

amazing at one time that crater was

976
00:39:27,109 --> 00:39:24,960
filled with water and we can see where

977
00:39:29,109 --> 00:39:27,119
water flowed into the crater and also

978
00:39:31,030 --> 00:39:29,119
where it flowed out of the crater and

979
00:39:32,790 --> 00:39:31,040
the water sat there for a long time so

980
00:39:35,349 --> 00:39:32,800
there's plenty of sediment that settled

981
00:39:37,829 --> 00:39:35,359
down in the bottom we also can see a

982
00:39:40,950 --> 00:39:37,839
delta where water from the river that

983
00:39:42,870 --> 00:39:40,960
flowed in carried materials with it and

984
00:39:45,109 --> 00:39:42,880
left those materials there to sink at

985
00:39:47,750 --> 00:39:45,119
the bottom eventually all the water went

986
00:39:49,510 --> 00:39:47,760
away but the sediment is still there and

987
00:39:51,829 --> 00:39:49,520
by going there and doing our core

988
00:39:54,630 --> 00:39:51,839

sampling there we can learn so much

989

00:39:56,630 --> 00:39:54,640

about the about the planet's history and

990

00:39:58,310 --> 00:39:56,640

there's a great possibility that we

991

00:39:59,190 --> 00:39:58,320

might find signs of

992

00:40:04,710 --> 00:39:59,200

of

993

00:40:07,109 --> 00:40:04,720

sediment there from that delta and uh

994

00:40:09,270 --> 00:40:07,119

that's a step closer to determining if

995

00:40:11,270 --> 00:40:09,280

there ever was life

996

00:40:13,670 --> 00:40:11,280

on the red planet

997

00:40:15,829 --> 00:40:13,680

now another key uh key objective for the

998

00:40:18,390 --> 00:40:15,839

mission is to assess ancient

999

00:40:21,030 --> 00:40:18,400

habitability whether or not life could

1000

00:40:22,630 --> 00:40:21,040

have existed on mars and to seek out

1001

00:40:24,310 --> 00:40:22,640

those signs of ancient life as i

1002

00:40:26,710 --> 00:40:24,320

mentioned just a few minutes a few

1003

00:40:29,589 --> 00:40:26,720

minutes ago we'll be gathering rock and

1004

00:40:31,670 --> 00:40:29,599

soil samples from across the region and

1005

00:40:33,670 --> 00:40:31,680

they'll be returned to earth by uh by a

1006

00:40:35,910 --> 00:40:33,680

future nasa mission we'll be

1007

00:40:38,310 --> 00:40:35,920

demonstrating some neat technology like

1008

00:40:40,470 --> 00:40:38,320

the uh like the helicopter that we

1009

00:40:43,190 --> 00:40:40,480

talked about a moment ago but we're also

1010

00:40:44,710 --> 00:40:43,200

testing some special equipment on board

1011

00:40:48,390 --> 00:40:44,720

that has um

1012

00:40:50,550 --> 00:40:48,400

well that has uh ramifications for uh

1013

00:40:52,710 --> 00:40:50,560

crude missions to mars eventually one

1014

00:40:55,270 --> 00:40:52,720

day one of the experiments is called

1015

00:40:57,430 --> 00:40:55,280

moxie and we'll use that experiment to

1016

00:40:59,910 --> 00:40:57,440

try to determine if we can extract

1017

00:41:01,990 --> 00:40:59,920

oxygen from the martian atmosphere

1018

00:41:05,270 --> 00:41:02,000

martian atmosphere is uh primarily

1019

00:41:07,670 --> 00:41:05,280

carbon dioxide so if we can if we can

1020

00:41:10,710 --> 00:41:07,680

use a device like this just the bigger

1021

00:41:13,510 --> 00:41:10,720

device to manufacture oxygen for our

1022

00:41:14,470 --> 00:41:13,520

crews to survive that's going to be huge

1023

00:41:16,630 --> 00:41:14,480

and

1024

00:41:18,309 --> 00:41:16,640

in fact we'll be able to make oxygen for

1025

00:41:20,630 --> 00:41:18,319

crews once we get there anything we

1026
00:41:23,270 --> 00:41:20,640
don't have to carry with us means more

1027
00:41:24,950 --> 00:41:23,280
room for additional payload or

1028
00:41:27,190 --> 00:41:24,960
less fuel that it will take to get off

1029
00:41:28,790 --> 00:41:27,200
the surface of the earth so that's

1030
00:41:30,550 --> 00:41:28,800
really really cool and that'll be a neat

1031
00:41:33,349 --> 00:41:30,560
experiment that we'll be taking a look

1032
00:41:35,910 --> 00:41:33,359
at um we'll also be uh

1033
00:41:38,230 --> 00:41:35,920
we'll also be looking in in some new

1034
00:41:41,670 --> 00:41:38,240
ways the uh spacecraft is actually

1035
00:41:43,109 --> 00:41:41,680
equipped with 26 different cameras uh

1036
00:41:44,950 --> 00:41:43,119
and that's going to be that's going to

1037
00:41:47,349 --> 00:41:44,960
be really fascinating it'll allow us to

1038
00:41:48,470 --> 00:41:47,359

see mars in a way that we've never seen

1039

00:41:49,589 --> 00:41:48,480

it before

1040

00:41:51,510 --> 00:41:49,599

um

1041

00:41:53,829 --> 00:41:51,520

the advanced camera system that's part

1042

00:41:55,190 --> 00:41:53,839

of the mass cam z

1043

00:41:58,470 --> 00:41:55,200

is um

1044

00:42:00,550 --> 00:41:58,480

panoramic and stereographic imaging so

1045

00:42:02,870 --> 00:42:00,560

the camera is set up with uh with

1046

00:42:05,430 --> 00:42:02,880

stereoscopic cameras that are about the

1047

00:42:07,750 --> 00:42:05,440

same distance as the human eyes are on

1048

00:42:09,910 --> 00:42:07,760

your face so it'll give uh it'll give

1049

00:42:11,349 --> 00:42:09,920

people who look at those images uh the

1050

00:42:13,109 --> 00:42:11,359

feeling that they're almost on the

1051
00:42:15,430 --> 00:42:13,119
surface of mars and that's going to be

1052
00:42:18,870 --> 00:42:15,440
absolutely incredible that'll also

1053
00:42:20,710 --> 00:42:18,880
assist with rover operations

1054
00:42:24,470 --> 00:42:20,720
it's going to be so cool

1055
00:42:26,390 --> 00:42:24,480
there's a super cam planetary x-ray

1056
00:42:29,589 --> 00:42:26,400
x-ray instrument

1057
00:42:31,829 --> 00:42:29,599
scanning habitable environments

1058
00:42:32,950 --> 00:42:31,839
we did talk about moxie that's the mars

1059
00:42:35,589 --> 00:42:32,960
oxygen

1060
00:42:37,670 --> 00:42:35,599
institute a resource utilization

1061
00:42:40,069 --> 00:42:37,680
experiment

1062
00:42:42,710 --> 00:42:40,079
there is a mars environment dynamic

1063
00:42:45,109 --> 00:42:42,720

analyzer this is a small weather station

1064

00:42:48,069 --> 00:42:45,119

that's uh that's actually mounted on the

1065

00:42:49,910 --> 00:42:48,079

uh mounted on the vehicle so it'll give

1066

00:42:52,550 --> 00:42:49,920

us a clear picture of what the weather

1067

00:42:54,069 --> 00:42:52,560

conditions are like at that location and

1068

00:42:56,470 --> 00:42:54,079

that's going to be absolutely

1069

00:42:58,630 --> 00:42:56,480

fascinating

1070

00:43:00,550 --> 00:42:58,640

again the uh the rover is about the size

1071

00:43:01,990 --> 00:43:00,560

of a small suv

1072

00:43:03,750 --> 00:43:02,000

and uh

1073

00:43:05,270 --> 00:43:03,760

that's just incredible it's uh it's

1074

00:43:07,670 --> 00:43:05,280

amazing we were able to get it off the

1075

00:43:09,990 --> 00:43:07,680

ground weighing uh weighing a whole ton

1076

00:43:12,230 --> 00:43:10,000

um it's going to be even cooler trying

1077

00:43:14,870 --> 00:43:12,240

to land all that weight on the surface

1078

00:43:17,430 --> 00:43:14,880

of mars requires a special parachute to

1079

00:43:19,750 --> 00:43:17,440

do that a supersonic parachute that'll

1080

00:43:22,069 --> 00:43:19,760

open when the spacecraft is still moving

1081

00:43:23,829 --> 00:43:22,079

at close to 1 000 miles an hour so

1082

00:43:28,550 --> 00:43:23,839

that's going to be really fascinating as

1083

00:43:30,870 --> 00:43:28,560

we get closer to that to that point

1084

00:43:33,510 --> 00:43:30,880

we did have some questions that came in

1085

00:43:35,910 --> 00:43:33,520

uh lisa asked a question about how fast

1086

00:43:37,910 --> 00:43:35,920

the spacecraft was actually moving chris

1087

00:43:40,309 --> 00:43:37,920

hartenstein another one of our viewers

1088

00:43:42,230 --> 00:43:40,319

was able to answer that question for her

1089

00:43:45,990 --> 00:43:42,240

looking at about 24

1090

00:43:47,910 --> 00:43:46,000

600 miles per hour um it's uh it's

1091

00:43:50,309 --> 00:43:47,920

moving incredibly fast in this cruise

1092

00:43:52,309 --> 00:43:50,319

phase and uh very shortly it's going to

1093

00:43:54,630 --> 00:43:52,319

have to slow down so it'll be able to

1094

00:43:56,309 --> 00:43:54,640

land on the surface of mars so chris

1095

00:43:58,550 --> 00:43:56,319

thanks for tuning in thanks for helping

1096

00:44:02,870 --> 00:43:58,560

us to answer that question and lisa keep

1097

00:44:07,190 --> 00:44:05,270

our crew here is all very very excited

1098

00:44:09,349 --> 00:44:07,200

about the about the next phases we're

1099

00:44:12,230 --> 00:44:09,359

also pretty excited about our next uh

1100

00:44:13,990 --> 00:44:12,240

our next uh our next speaker uh another

1101

00:44:16,870 --> 00:44:14,000

subject matter expert that'll be joining

1102

00:44:19,109 --> 00:44:16,880

us and be sharing some information now

1103

00:44:21,910 --> 00:44:19,119

uh we'll be talking in that case about

1104

00:44:24,150 --> 00:44:21,920

the radio isotope power systems the

1105

00:44:27,109 --> 00:44:24,160

power system that makes it possible for

1106

00:44:29,270 --> 00:44:27,119

the rover to do its work lauren cayman

1107

00:44:31,270 --> 00:44:29,280

will be joining us she's a chief safety

1108

00:44:34,470 --> 00:44:31,280

and mission assurance officer for the

1109

00:44:37,589 --> 00:44:34,480

radio isotope power system program and

1110

00:44:39,270 --> 00:44:37,599

will present on thermal electric system

1111

00:44:42,390 --> 00:44:39,280

the thermoelectric system being used to

1112

00:44:44,790 --> 00:44:42,400

provide power uh both to the curiosity

1113

00:44:47,190 --> 00:44:44,800

rover that landed on mars nine years ago

1114

00:44:49,030 --> 00:44:47,200

as well as the perseverance rover that's

1115

00:44:51,109 --> 00:44:49,040

about to touch down i think we've got

1116

00:45:05,270 --> 00:44:51,119

her all cued up and ready to go lauren

1117

00:45:09,829 --> 00:45:07,910

hi everyone my name is lauren klein and

1118

00:45:11,510 --> 00:45:09,839

i'm with the radioisotope power systems

1119

00:45:13,430 --> 00:45:11,520

program which is at nasa's glen research

1120

00:45:16,150 --> 00:45:13,440

center in cleveland ohio

1121

00:45:17,990 --> 00:45:16,160

and you'll hear me say rps a lot today

1122

00:45:20,230 --> 00:45:18,000

which is actually short for radioisotope

1123

00:45:21,829 --> 00:45:20,240

power systems and for the program i'm

1124

00:45:22,790 --> 00:45:21,839

their chief safety and mission assurance

1125

00:45:24,550 --> 00:45:22,800

officer

1126

00:45:26,470 --> 00:45:24,560

i'm really excited to be here today to

1127

00:45:28,230 --> 00:45:26,480

talk to you and hopefully you'll learn

1128

00:45:29,589 --> 00:45:28,240

more about our program and more about

1129

00:45:31,349 --> 00:45:29,599

what i do

1130

00:45:32,950 --> 00:45:31,359

because this is a very exciting time for

1131

00:45:37,109 --> 00:45:32,960

rps

1132

00:45:38,870 --> 00:45:37,119

system

1133

00:45:40,630 --> 00:45:38,880

and i can't wait to share more with you

1134

00:45:42,790 --> 00:45:40,640

about it but before we get to

1135

00:45:45,190 --> 00:45:42,800

perseverance and mars i think it's

1136

00:45:47,510 --> 00:45:45,200

important for you to understand more

1137

00:45:50,230 --> 00:45:47,520

about what i do and the program and how

1138

00:45:54,309 --> 00:45:50,240

we help power extreme exploration for

1139

00:46:00,870 --> 00:45:58,230

so radioisotope power systems or rps

1140

00:46:04,069 --> 00:46:00,880

what what do these systems do well

1141

00:46:06,470 --> 00:46:04,079

we actually provide power to go to some

1142

00:46:08,630 --> 00:46:06,480

of the most extreme places in our solar

1143

00:46:10,309 --> 00:46:08,640

system i mean at nasa we are all about

1144

00:46:12,069 --> 00:46:10,319

exploring discovering and then

1145

00:46:15,190 --> 00:46:12,079

understanding what we get back from

1146

00:46:17,510 --> 00:46:15,200

those discoveries

1147

00:46:20,950 --> 00:46:17,520

what's really cool is that

1148

00:46:23,430 --> 00:46:20,960

in order to understand what's out there

1149

00:46:25,349 --> 00:46:23,440

we invest so much brain power into

1150

00:46:26,710 --> 00:46:25,359

getting to these destinations in our

1151

00:46:28,870 --> 00:46:26,720

solar system

1152

00:46:30,470 --> 00:46:28,880

that we learn things that we can do

1153

00:46:32,710 --> 00:46:30,480

better even here on earth with the

1154

00:46:35,109 --> 00:46:32,720

technologies that we use in space and

1155

00:46:37,190 --> 00:46:35,119

then we learn about the places in space

1156

00:46:38,069 --> 00:46:37,200

and the planetary bodies out there

1157

00:46:39,510 --> 00:46:38,079

and

1158

00:46:41,829 --> 00:46:39,520

end up learning more about earth's

1159

00:46:43,430 --> 00:46:41,839

origin just from all these places we go

1160

00:46:46,309 --> 00:46:43,440

and visit

1161

00:46:48,630 --> 00:46:46,319

and as as you can imagine compared to

1162

00:46:51,190 --> 00:46:48,640

some of the environments on earth space

1163

00:46:52,870 --> 00:46:51,200

is full of the most extreme environments

1164

00:46:55,190 --> 00:46:52,880

that you can think of they're really

1165

00:46:57,270 --> 00:46:55,200

harsh they're dark they're cold and

1166

00:46:59,430 --> 00:46:57,280

they're they're dusty

1167

00:47:01,430 --> 00:46:59,440

and we send our missions there and and

1168

00:47:03,829 --> 00:47:01,440

these missions would either be

1169

00:47:06,309 --> 00:47:03,839

impossible or very hard to do without

1170

00:47:07,910 --> 00:47:06,319

the use of nuclear power

1171

00:47:09,589 --> 00:47:07,920

and that's what a radioisotope power

1172

00:47:12,710 --> 00:47:09,599

system is

1173

00:47:14,870 --> 00:47:12,720

an rps harnesses the heat of the natural

1174

00:47:16,630 --> 00:47:14,880

radioactive decay of a material called

1175

00:47:19,109 --> 00:47:16,640

plutonium-238

1176

00:47:21,270 --> 00:47:19,119

and that heat from that decay is

1177

00:47:23,030 --> 00:47:21,280

converted into electrical power and we

1178

00:47:26,390 --> 00:47:23,040

use that to operate our spacecraft

1179

00:47:28,870 --> 00:47:26,400

systems and science instrumentation

1180

00:47:30,950 --> 00:47:28,880

and of course i talked about how

1181

00:47:34,950 --> 00:47:30,960

perseverance has one of these rps

1182

00:47:39,109 --> 00:47:34,960

systems on it but another recent example

1183

00:47:41,030 --> 00:47:39,119

of when we've used an rps system for a

1184

00:47:43,030 --> 00:47:41,040

mission was

1185

00:47:45,670 --> 00:47:43,040

the new horizons historic journey to

1186

00:47:47,670 --> 00:47:45,680

pluto that was made possible by an rps

1187

00:47:49,750 --> 00:47:47,680

system called an rtg

1188

00:47:51,190 --> 00:47:49,760

which is a radioisotope thermoelectric

1189

00:47:54,230 --> 00:47:51,200

generator

1190

00:47:57,030 --> 00:47:54,240

and um this is an rtg is exactly what we

1191

00:47:59,750 --> 00:47:57,040

have on mars curiosity rover which is

1192

00:48:02,950 --> 00:47:59,760

already up there on mars roving around

1193

00:48:04,309 --> 00:48:02,960

and um like i said what's going to be on

1194

00:48:05,910 --> 00:48:04,319

the perseverance and power and

1195

00:48:08,550 --> 00:48:05,920

perseverance

1196

00:48:14,470 --> 00:48:08,560

this particular type of rtg is called an

1197

00:48:17,750 --> 00:48:14,480

mm rtg and the mm just simply stands for

1198

00:48:19,589 --> 00:48:17,760

a system that was designed for

1199

00:48:21,109 --> 00:48:19,599

more than one specific destination in

1200

00:48:23,589 --> 00:48:21,119

mind therefore it can serve

1201
00:48:25,670 --> 00:48:23,599
multi-missions so that's a multi-mission

1202
00:48:28,069 --> 00:48:25,680
rtg

1203
00:48:31,270 --> 00:48:28,079
now i'd love to share

1204
00:48:34,069 --> 00:48:31,280
a great video with you this was made

1205
00:48:35,589 --> 00:48:34,079
several years ago back when curiosity

1206
00:48:38,390 --> 00:48:35,599
went up to mars

1207
00:48:41,030 --> 00:48:38,400
the video explains how a radioisotope

1208
00:48:43,990 --> 00:48:41,040
power system works but specifically an

1209
00:48:45,589 --> 00:48:44,000
mmrtg so just keep in mind this was on

1210
00:48:47,270 --> 00:48:45,599
curiosity and this is what's on

1211
00:48:51,490 --> 00:48:47,280
perseverance which is going to land

1212
00:49:01,510 --> 00:48:59,670
[Music]

1213
00:49:03,430 --> 00:49:01,520

if you want to drive a rover on mars you

1214

00:49:05,270 --> 00:49:03,440

have to keep in mind there's no gas

1215

00:49:08,630 --> 00:49:05,280

station for millions of miles and

1216

00:49:10,790 --> 00:49:08,640

there's no outlet to plug into for power

1217

00:49:12,549 --> 00:49:10,800

that's why nasa's curiosity rover on

1218

00:49:14,470 --> 00:49:12,559

mars and other nasa spacecraft that

1219

00:49:18,230 --> 00:49:14,480

explore the solar system is something

1220

00:49:20,630 --> 00:49:18,240

called radioisotope power

1221

00:49:23,750 --> 00:49:20,640

a radioactive substance releases heat as

1222

00:49:25,910 --> 00:49:23,760

it breaks down or decays

1223

00:49:27,990 --> 00:49:25,920

a system that converts that heat into

1224

00:49:30,549 --> 00:49:28,000

electricity is called a radioisotope

1225

00:49:31,430 --> 00:49:30,559

power system these systems get fancy

1226
00:49:33,630 --> 00:49:31,440
names

1227
00:49:37,030 --> 00:49:33,640
curiosity's power system is called the

1228
00:49:39,030 --> 00:49:37,040
mmrtg multi-mission radioisotope

1229
00:49:41,829 --> 00:49:39,040
thermoelectric generator

1230
00:49:42,790 --> 00:49:41,839
mmrtg's are reliable and lasts a long

1231
00:49:45,270 --> 00:49:42,800
time

1232
00:49:47,190 --> 00:49:45,280
engineers use this material in devices

1233
00:49:50,150 --> 00:49:47,200
called thermocouples which are used to

1234
00:49:52,470 --> 00:49:50,160
generate electricity

1235
00:49:53,990 --> 00:49:52,480
one of the thermocouple shoes is hot and

1236
00:49:55,829 --> 00:49:54,000
one is cold

1237
00:49:57,750 --> 00:49:55,839
this heat transferred across a big

1238
00:49:59,589 --> 00:49:57,760

temperature difference makes electrical

1239

00:50:01,510 --> 00:49:59,599

charges flow from the hot shoe to the

1240

00:50:03,829 --> 00:50:01,520

cold shoe and produces an electrical

1241

00:50:06,770 --> 00:50:03,839

voltage and this generates useful

1242

00:50:17,829 --> 00:50:06,780

electrical power

1243

00:50:21,109 --> 00:50:19,349

all right great

1244

00:50:24,069 --> 00:50:21,119

i love that video because i think it

1245

00:50:25,430 --> 00:50:24,079

breaks down exactly you know what this

1246

00:50:27,430 --> 00:50:25,440

what's happening when the heat is

1247

00:50:30,150 --> 00:50:27,440

released from this radioactive material

1248

00:50:31,910 --> 00:50:30,160

and the fact that we just take that heat

1249

00:50:34,309 --> 00:50:31,920

and turn it into electrical power with

1250

00:50:35,430 --> 00:50:34,319

these things called thermocouples

1251
00:50:37,589 --> 00:50:35,440
and um

1252
00:50:39,270 --> 00:50:37,599
and now it gets to power things that we

1253
00:50:41,670 --> 00:50:39,280
send up into space

1254
00:50:43,670 --> 00:50:41,680
and uh i want to show you this picture

1255
00:50:45,829 --> 00:50:43,680
it's a picture of uh

1256
00:50:46,950 --> 00:50:45,839
perseverance and

1257
00:50:48,470 --> 00:50:46,960
and uh

1258
00:50:51,430 --> 00:50:48,480
i don't know if you can

1259
00:50:54,630 --> 00:50:51,440
see very well there it's on the back of

1260
00:50:57,190 --> 00:50:54,640
this this rover and it's painted white

1261
00:51:00,549 --> 00:50:57,200
um there's a dotted line showing you

1262
00:51:02,230 --> 00:51:00,559
exactly where this mmrtg is

1263
00:51:05,910 --> 00:51:02,240

so um

1264

00:51:08,630 --> 00:51:05,920

you can imagine this particular rover is

1265

00:51:11,030 --> 00:51:08,640

i'd say roughly the size of a large golf

1266

00:51:12,549 --> 00:51:11,040

cart or a small vehicle

1267

00:51:15,510 --> 00:51:12,559

and

1268

00:51:18,710 --> 00:51:15,520

this mmrtg is giving off

1269

00:51:21,430 --> 00:51:18,720

the amount of power that i think all of

1270

00:51:23,589 --> 00:51:21,440

us are kind of used to thinking about

1271

00:51:25,829 --> 00:51:23,599

this is just a standard 100 watt light

1272

00:51:26,790 --> 00:51:25,839

bulb i have these in my house at home

1273

00:51:29,190 --> 00:51:26,800

and

1274

00:51:32,309 --> 00:51:29,200

this mmrpg is creating just over that

1275

00:51:34,950 --> 00:51:32,319

110 watts and all that power is all

1276

00:51:37,990 --> 00:51:34,960

that's needed to help this rover

1277

00:51:40,870 --> 00:51:38,000

move across across mars and do its job

1278

00:51:42,870 --> 00:51:40,880

so i think that's a big testament to the

1279

00:51:44,630 --> 00:51:42,880

ingenuity and brilliance of these great

1280

00:51:46,230 --> 00:51:44,640

scientists and engineers we have working

1281

00:51:47,829 --> 00:51:46,240

in the nasa community

1282

00:51:51,510 --> 00:51:47,839

to be able to build this kind of a

1283

00:51:53,270 --> 00:51:51,520

spacecraft with power that's equivalent

1284

00:51:55,430 --> 00:51:53,280

to about a light bulb and it can run on

1285

00:51:56,870 --> 00:51:55,440

that so i always i always that kind of

1286

00:51:58,950 --> 00:51:56,880

blows my mind a little bit i always like

1287

00:52:01,109 --> 00:51:58,960

to let people know because it's kind of

1288

00:52:06,150 --> 00:52:01,119

a very crazy thing to put in parallel

1289

00:52:12,150 --> 00:52:09,430

now i have another video for you um

1290

00:52:13,990 --> 00:52:12,160

this is a much better close-up of an

1291

00:52:16,230 --> 00:52:14,000

mmrtg

1292

00:52:17,990 --> 00:52:16,240

and i'll play this video and kind of try

1293

00:52:21,510 --> 00:52:18,000

to describe a little bit about what

1294

00:52:24,790 --> 00:52:22,230

so

1295

00:52:27,030 --> 00:52:24,800

the cylindrical portion in the center is

1296

00:52:28,790 --> 00:52:27,040

actually where the nuclear material goes

1297

00:52:31,190 --> 00:52:28,800

and it's surrounded by all these little

1298

00:52:33,270 --> 00:52:31,200

thermocouples

1299

00:52:35,270 --> 00:52:33,280

that are are taking the heat and turning

1300

00:52:37,109 --> 00:52:35,280

it into electricity

1301
00:52:38,790 --> 00:52:37,119
and if you want to break down a little

1302
00:52:40,230 --> 00:52:38,800
bit more of these these heat sources

1303
00:52:42,150 --> 00:52:40,240
made of the nuclear material they're in

1304
00:52:44,390 --> 00:52:42,160
these things that look like bricks

1305
00:52:47,270 --> 00:52:44,400
called gphs or general purpose heat

1306
00:52:49,270 --> 00:52:47,280
sources and the main thing to note here

1307
00:52:51,109 --> 00:52:49,280
is that you see these sort of orangey

1308
00:52:54,230 --> 00:52:51,119
peach colored pellets that's nuclear

1309
00:52:56,390 --> 00:52:54,240
material and there's lots of protective

1310
00:52:58,150 --> 00:52:56,400
cladding over it

1311
00:52:59,910 --> 00:52:58,160
and there's basically layers and layers

1312
00:53:01,990 --> 00:52:59,920
so once you can see how all the layers

1313
00:53:05,589 --> 00:53:02,000

fit together

1314

00:53:07,670 --> 00:53:05,599

to go inside of this gphs

1315

00:53:10,309 --> 00:53:07,680

um they're all stacked up and put in the

1316

00:53:11,829 --> 00:53:10,319

center of this mmrtg

1317

00:53:14,549 --> 00:53:11,839

that's where we keep

1318

00:53:16,630 --> 00:53:14,559

turned into electrical power

1319

00:53:18,549 --> 00:53:16,640

so i really like this animation because

1320

00:53:20,309 --> 00:53:18,559

it actually gets to show you how

1321

00:53:21,990 --> 00:53:20,319

everything fits together and i know that

1322

00:53:23,750 --> 00:53:22,000

that helps my mind understand things

1323

00:53:25,990 --> 00:53:23,760

quite a bit and then all this energy is

1324

00:53:27,589 --> 00:53:26,000

transported to the spacecraft for use

1325

00:53:30,309 --> 00:53:27,599

and you might wonder what those little

1326
00:53:33,190 --> 00:53:30,319
spokes are coming off of this thing and

1327
00:53:35,589 --> 00:53:33,200
those are just spokes for um releasing

1328
00:53:37,829 --> 00:53:35,599
or radiating off some of the extra heat

1329
00:53:39,670 --> 00:53:37,839
that comes from this nuclear material we

1330
00:53:41,190 --> 00:53:39,680
don't take all of it we can't convert it

1331
00:53:42,950 --> 00:53:41,200
all to electricity because we don't have

1332
00:53:45,349 --> 00:53:42,960
a process that's efficient enough to do

1333
00:53:47,589 --> 00:53:45,359
that so we have waste heat and we either

1334
00:53:49,270 --> 00:53:47,599
radiate it or sometimes spacecraft even

1335
00:53:52,390 --> 00:53:49,280
use this waste heat to keep their other

1336
00:53:54,390 --> 00:53:52,400
instrumentation warm enough because in

1337
00:53:55,910 --> 00:53:54,400
space in the harsh environments of space

1338
00:53:58,470 --> 00:53:55,920

you can't let certain things get too

1339

00:54:00,390 --> 00:53:58,480

cold so we can provide power and in some

1340

00:54:04,309 --> 00:54:00,400

cases we can provide heat to spacecraft

1341

00:54:10,390 --> 00:54:07,670

but um when we think about rps systems i

1342

00:54:13,430 --> 00:54:10,400

know our program likes to

1343

00:54:16,549 --> 00:54:13,440

refer to something we call the four ps

1344

00:54:18,230 --> 00:54:16,559

people power progress and production

1345

00:54:22,710 --> 00:54:18,240

you know because by nature we are

1346

00:54:25,030 --> 00:54:22,720

explorers and it all starts with people

1347

00:54:26,549 --> 00:54:25,040

the rps program is actually part of

1348

00:54:28,390 --> 00:54:26,559

nasa's science mission director it's

1349

00:54:29,990 --> 00:54:28,400

planetary science division and i

1350

00:54:31,589 --> 00:54:30,000

mentioned before we have some really

1351
00:54:32,630 --> 00:54:31,599
passionate bright people working for

1352
00:54:35,670 --> 00:54:32,640
this group

1353
00:54:37,270 --> 00:54:35,680
um and part of the responsibility i have

1354
00:54:39,750 --> 00:54:37,280
as the chief safety mission assurance

1355
00:54:42,069 --> 00:54:39,760
officer for this program is to enforce

1356
00:54:43,589 --> 00:54:42,079
nasa's top priorities

1357
00:54:45,589 --> 00:54:43,599
which is safety and of course the

1358
00:54:48,309 --> 00:54:45,599
success of our missions the safety of

1359
00:54:50,150 --> 00:54:48,319
the public and of our nasa teams is

1360
00:54:52,470 --> 00:54:50,160
always always our top priority in our

1361
00:54:55,270 --> 00:54:52,480
quest to succeed with our mission so so

1362
00:54:57,589 --> 00:54:55,280
obviously i i take that very seriously

1363
00:54:59,670 --> 00:54:57,599

and i get to work with a lot of experts

1364

00:55:01,190 --> 00:54:59,680

who know how to ensure that everything

1365

00:55:03,670 --> 00:55:01,200

that we do

1366

00:55:06,630 --> 00:55:03,680

you know during the design testing and

1367

00:55:09,750 --> 00:55:06,640

launching of an rps

1368

00:55:11,910 --> 00:55:09,760

all happen safely so i'm kind of here as

1369

00:55:13,030 --> 00:55:11,920

a resource or a checks and balance type

1370

00:55:13,829 --> 00:55:13,040

of function

1371

00:55:15,910 --> 00:55:13,839

to

1372

00:55:17,910 --> 00:55:15,920

help make sure everything works well and

1373

00:55:19,109 --> 00:55:17,920

it's successful

1374

00:55:21,190 --> 00:55:19,119

and of course

1375

00:55:22,470 --> 00:55:21,200

the the second p power we've talked

1376

00:55:25,670 --> 00:55:22,480

about that already

1377

00:55:28,950 --> 00:55:25,680

you know we provide power for spacecraft

1378

00:55:30,710 --> 00:55:28,960

for robotics um so that we can explore

1379

00:55:32,069 --> 00:55:30,720

these amazing places our solar system

1380

00:55:34,710 --> 00:55:32,079

has to offer

1381

00:55:36,549 --> 00:55:34,720

and um i think it's just quite amazing

1382

00:55:38,710 --> 00:55:36,559

when we think about the amount of power

1383

00:55:41,829 --> 00:55:38,720

that we're able to get by on using to

1384

00:55:43,829 --> 00:55:41,839

make all of these amazing things happen

1385

00:55:46,230 --> 00:55:43,839

and of course you know even though we

1386

00:55:47,829 --> 00:55:46,240

have these systems today we're always

1387

00:55:49,750 --> 00:55:47,839

pushing the boundaries and trying to

1388

00:55:51,510 --> 00:55:49,760

improve them

1389

00:55:53,349 --> 00:55:51,520

our program is continuing to invest in

1390

00:55:55,270 --> 00:55:53,359

new technology and improvements to those

1391

00:55:57,109 --> 00:55:55,280

technologies so that we can make better

1392

00:56:00,309 --> 00:55:57,119

systems and make them more efficient and

1393

00:56:02,230 --> 00:56:00,319

then in the end nasa and you know the

1394

00:56:05,750 --> 00:56:02,240

community at large we're going to lead

1395

00:56:08,069 --> 00:56:05,760

to even greater science returns

1396

00:56:11,190 --> 00:56:08,079

and then uh production

1397

00:56:12,789 --> 00:56:11,200

why is production important well um

1398

00:56:15,430 --> 00:56:12,799

you know we talked about nuclear

1399

00:56:16,549 --> 00:56:15,440

material being the fuel for these these

1400

00:56:20,069 --> 00:56:16,559

systems

1401

00:56:22,549 --> 00:56:20,079

and um you know we've gone roving on

1402

00:56:24,870 --> 00:56:22,559

mars using these systems and um we're

1403

00:56:26,549 --> 00:56:24,880

looking for in the future a mission

1404

00:56:27,829 --> 00:56:26,559

called dragonfly that plans to go to

1405

00:56:29,670 --> 00:56:27,839

saturn's moon titan we're going to have

1406

00:56:30,789 --> 00:56:29,680

an rps system there

1407

00:56:37,270 --> 00:56:30,799

and

1408

00:56:39,750 --> 00:56:37,280

missions to mars in our future um the

1409

00:56:41,030 --> 00:56:39,760

rps program has taken steps in in

1410

00:56:44,470 --> 00:56:41,040

partnership with the department of

1411

00:56:47,030 --> 00:56:44,480

energy to make sure that we have enough

1412

00:56:49,510 --> 00:56:47,040

fuel or radioactive material that makes

1413

00:56:52,390 --> 00:56:49,520

the fuel for our rps available

1414

00:56:53,510 --> 00:56:52,400

and um we're doing this with the dewey

1415

00:56:55,990 --> 00:56:53,520

through something they've established

1416

00:56:58,470 --> 00:56:56,000

called constant rate production

1417

00:57:01,670 --> 00:56:58,480

that just essentially means um

1418

00:57:03,030 --> 00:57:01,680

that material is continuously being

1419

00:57:04,789 --> 00:57:03,040

produced

1420

00:57:07,349 --> 00:57:04,799

and so that

1421

00:57:09,589 --> 00:57:07,359

once you know we can gauge what the

1422

00:57:11,510 --> 00:57:09,599

future needs of nasa are based upon

1423

00:57:14,470 --> 00:57:11,520

future missions that are planned and

1424

00:57:16,230 --> 00:57:14,480

then we'll have this fuel and material

1425

00:57:17,990 --> 00:57:16,240

available when these missions are

1426

00:57:19,750 --> 00:57:18,000

finally ready to launch

1427

00:57:21,910 --> 00:57:19,760

and this is also pretty significant

1428

00:57:23,670 --> 00:57:21,920

because in doing this the department of

1429

00:57:24,710 --> 00:57:23,680

energy has reestablished the united

1430

00:57:26,950 --> 00:57:24,720

states

1431

00:57:29,190 --> 00:57:26,960

production of this material and this was

1432

00:57:31,270 --> 00:57:29,200

just within the last several years about

1433

00:57:32,789 --> 00:57:31,280

30 years ago we lost the ability to do

1434

00:57:35,670 --> 00:57:32,799

that you know in the united states so

1435

00:57:37,910 --> 00:57:35,680

that's pretty cool for us and a fun fact

1436

00:57:39,829 --> 00:57:37,920

is that some of the first produced

1437

00:57:42,789 --> 00:57:39,839

plutonium-238

1438

00:57:44,710 --> 00:57:42,799

is even in the heat sources that are

1439

00:57:48,069 --> 00:57:44,720

going to be powering perseverance so how

1440

00:57:53,109 --> 00:57:50,870

all right well i mentioned that we have

1441

00:57:55,910 --> 00:57:53,119

a great history of

1442

00:57:57,430 --> 00:57:55,920

utilizing rps systems for some of nasa's

1443

00:58:00,950 --> 00:57:57,440

missions here you can see this is kind

1444

00:58:03,829 --> 00:58:00,960

of an eye chart but there's 25 missions

1445

00:58:05,750 --> 00:58:03,839

from the sun to pluto and beyond

1446

00:58:07,270 --> 00:58:05,760

a number of those are mars missions

1447

00:58:09,829 --> 00:58:07,280

right over here

1448

00:58:11,990 --> 00:58:09,839

um you know we're we're building a

1449

00:58:13,510 --> 00:58:12,000

pretty successful resume of of missions

1450

00:58:15,030 --> 00:58:13,520

that we've supported with our ps system

1451
00:58:16,950 --> 00:58:15,040
and that helps build our confidence that

1452
00:58:19,109 --> 00:58:16,960
these systems are reliable that they're

1453
00:58:21,109 --> 00:58:19,119
safe that they're long lasting so for me

1454
00:58:23,589 --> 00:58:21,119
in my position gathering this type of

1455
00:58:25,990 --> 00:58:23,599
information and data on the performance

1456
00:58:27,829 --> 00:58:26,000
of all these systems help to demonstrate

1457
00:58:29,030 --> 00:58:27,839
you know that you know they're

1458
00:58:30,549 --> 00:58:29,040
long-lasting and safe and that's what

1459
00:58:31,670 --> 00:58:30,559
it's important for us to do always at

1460
00:58:33,990 --> 00:58:31,680
nasa

1461
00:58:35,750 --> 00:58:34,000
and we often get asked why we use

1462
00:58:36,950 --> 00:58:35,760
plutonium-238

1463
00:58:39,510 --> 00:58:36,960

and not

1464

00:58:41,349 --> 00:58:39,520

something else and really the the truth

1465

00:58:43,430 --> 00:58:41,359

is that there are other materials

1466

00:58:45,910 --> 00:58:43,440

nuclear materials out there that are

1467

00:58:47,270 --> 00:58:45,920

radioisotope materials that would work

1468

00:58:49,510 --> 00:58:47,280

but this particular material was

1469

00:58:50,789 --> 00:58:49,520

carefully chosen for a number of reasons

1470

00:58:52,069 --> 00:58:50,799

because

1471

00:58:57,270 --> 00:58:52,079

those things made it technically and

1472

00:59:02,390 --> 00:58:59,670

as i mentioned before

1473

00:59:04,150 --> 00:59:02,400

one of the mmrtgs that's on perseverance

1474

00:59:05,670 --> 00:59:04,160

one of them is on curiosity which is

1475

00:59:07,910 --> 00:59:05,680

there right now

1476
00:59:10,950 --> 00:59:07,920
and what i like about showing some of

1477
00:59:12,789 --> 00:59:10,960
these pictures that curiosity um had

1478
00:59:15,030 --> 00:59:12,799
sent back is that

1479
00:59:17,030 --> 00:59:15,040
they're strikingly earth-like even

1480
00:59:18,789 --> 00:59:17,040
though they're extraterrestrial i mean i

1481
00:59:20,630 --> 00:59:18,799
love the bottom middle picture it really

1482
00:59:22,789 --> 00:59:20,640
does kind of just look like some place i

1483
00:59:25,510 --> 00:59:22,799
don't know maybe in in new mexico or

1484
00:59:28,230 --> 00:59:25,520
something but um you know this this did

1485
00:59:30,549 --> 00:59:28,240
a lot of excellent work taking samples

1486
00:59:33,030 --> 00:59:30,559
of rocks and soil and taking pictures

1487
00:59:35,750 --> 00:59:33,040
back for us and what's really cool about

1488
00:59:37,670 --> 00:59:35,760

this rover is that it's um

1489

00:59:40,150 --> 00:59:37,680

gosh it's been like

1490

00:59:42,710 --> 00:59:40,160

over 3 000 martian days we call them

1491

00:59:46,150 --> 00:59:42,720

souls since curiosity touched down in

1492

00:59:48,470 --> 00:59:46,160

august i think of 2012. so it's actually

1493

00:59:50,069 --> 00:59:48,480

worked well beyond its intended life and

1494

00:59:51,510 --> 00:59:50,079

keeps making new discoveries so let's

1495

00:59:52,950 --> 00:59:51,520

all keep our fingers crossed that that's

1496

00:59:57,030 --> 00:59:52,960

going to happen just the same with

1497

01:00:01,109 --> 00:59:59,589

speaking of perseverance

1498

01:00:03,670 --> 01:00:01,119

this rover

1499

01:00:05,589 --> 01:00:03,680

here and the it's the one of the top

1500

01:00:07,349 --> 01:00:05,599

left pictures this is a picture of it

1501

01:00:10,870 --> 01:00:07,359

launching it actually launched on its

1502

01:00:11,990 --> 01:00:10,880

journey to mars back in july of 2020

1503

01:00:13,990 --> 01:00:12,000

and um

1504

01:00:14,950 --> 01:00:14,000

and below it you can see actually a

1505

01:00:17,589 --> 01:00:14,960

picture

1506

01:00:19,829 --> 01:00:17,599

um of when it was getting assembled in a

1507

01:00:22,390 --> 01:00:19,839

clean room uh with the rest of the rover

1508

01:00:24,150 --> 01:00:22,400

the mmrpg is is getting you know

1509

01:00:26,470 --> 01:00:24,160

installed onto it and i think i'll talk

1510

01:00:27,270 --> 01:00:26,480

more about this picture in a few minutes

1511

01:00:29,109 --> 01:00:27,280

um

1512

01:00:31,349 --> 01:00:29,119

but the two middle pictures are pretty

1513

01:00:33,349 --> 01:00:31,359

cool because um

1514

01:00:35,430 --> 01:00:33,359

since persevere is actually the first

1515

01:00:37,270 --> 01:00:35,440

part of a three-part sample return

1516

01:00:38,630 --> 01:00:37,280

mission um we're going to end up

1517

01:00:40,630 --> 01:00:38,640

learning about

1518

01:00:42,470 --> 01:00:40,640

soil and rock samples that the rover

1519

01:00:45,030 --> 01:00:42,480

collects on mars but we're also going to

1520

01:00:47,030 --> 01:00:45,040

be testing the technology to launch a

1521

01:00:48,710 --> 01:00:47,040

spacecraft off of the mars surface which

1522

01:00:50,710 --> 01:00:48,720

has never been done before and then

1523

01:00:52,470 --> 01:00:50,720

rendezvous and dock around mars for a

1524

01:00:53,990 --> 01:00:52,480

return trip to earth which has also

1525

01:00:56,710 --> 01:00:54,000

never been done before

1526

01:00:57,829 --> 01:00:56,720

so um i mean this is a really really

1527

01:00:59,430 --> 01:00:57,839

interesting

1528

01:01:01,510 --> 01:00:59,440

thing and it's going to

1529

01:01:05,190 --> 01:01:01,520

be proving be the proving ground i think

1530

01:01:06,309 --> 01:01:05,200

for a lot of our future mars exploration

1531

01:01:08,630 --> 01:01:06,319

and um

1532

01:01:10,150 --> 01:01:08,640

you know really robotics they do pave

1533

01:01:11,670 --> 01:01:10,160

the way for human exploration they

1534

01:01:14,069 --> 01:01:11,680

provide us with a better understanding

1535

01:01:17,670 --> 01:01:14,079

of the conditions of the destinations

1536

01:01:19,589 --> 01:01:17,680

that we go to um like the geology or um

1537

01:01:21,430 --> 01:01:19,599

the atmosphere we learn if there's water

1538

01:01:24,470 --> 01:01:21,440

present or if it looks like there's

1539

01:01:27,670 --> 01:01:24,480

signs of water having existed previously

1540

01:01:30,549 --> 01:01:27,680

and really all of these types of robotic

1541

01:01:32,069 --> 01:01:30,559

missions become a precursor for human

1542

01:01:34,390 --> 01:01:32,079

exploration

1543

01:01:36,710 --> 01:01:34,400

um you know not only how we can make

1544

01:01:39,430 --> 01:01:36,720

these areas habitable

1545

01:01:41,270 --> 01:01:39,440

but also testing new technologies first

1546

01:01:43,270 --> 01:01:41,280

before we do that with humans so that we

1547

01:01:45,510 --> 01:01:43,280

don't put lives at risk and what's

1548

01:01:48,069 --> 01:01:45,520

really cool too is the apollo missions

1549

01:01:49,829 --> 01:01:48,079

that went to the moon um they also had

1550

01:01:51,990 --> 01:01:49,839

robotic precursor missions i think they

1551

01:01:53,829 --> 01:01:52,000

were it was called ranger and surveyor

1552

01:01:56,069 --> 01:01:53,839

and those missions were used to

1553

01:01:58,710 --> 01:01:56,079

determine how best to land humans on the

1554

01:02:00,150 --> 01:01:58,720

moon and return them safely home

1555

01:02:03,510 --> 01:02:00,160

so as i mentioned it's just it's so

1556

01:02:05,109 --> 01:02:03,520

important for the science to be done

1557

01:02:07,270 --> 01:02:05,119

this perseverance is going to collect

1558

01:02:09,589 --> 01:02:07,280

you can see in the bottom right is it a

1559

01:02:11,030 --> 01:02:09,599

depiction of a sample of rocks it might

1560

01:02:13,670 --> 01:02:11,040

collect it's going to think

1561

01:02:16,390 --> 01:02:13,680

take about 20 samples and leave them on

1562

01:02:18,390 --> 01:02:16,400

mars and they will be

1563

01:02:20,150 --> 01:02:18,400

intended to be picked up by a future

1564

01:02:22,230 --> 01:02:20,160

mission and brought back home so that we

1565

01:02:27,510 --> 01:02:22,240

can actually study martian

1566

01:02:30,230 --> 01:02:28,630

all right

1567

01:02:32,789 --> 01:02:30,240

well so

1568

01:02:35,349 --> 01:02:32,799

in our journey to mars of course we have

1569

01:02:37,750 --> 01:02:35,359

to integrate our mmrtg which you see

1570

01:02:38,789 --> 01:02:37,760

here in with the rest of the flight

1571

01:02:40,150 --> 01:02:38,799

hardware

1572

01:02:42,549 --> 01:02:40,160

um

1573

01:02:45,109 --> 01:02:42,559

it's really important that

1574

01:02:46,870 --> 01:02:45,119

um the system is safe while it's here on

1575

01:02:48,950 --> 01:02:46,880

earth but also when it reaches its

1576

01:02:51,510 --> 01:02:48,960

destination so you know my job has a lot

1577

01:02:52,549 --> 01:02:51,520

to do with ensuring safety and one of

1578

01:02:54,950 --> 01:02:52,559

the ways

1579

01:02:57,109 --> 01:02:54,960

we try to keep things safe for use on

1580

01:02:58,630 --> 01:02:57,119

other planets is through the extreme

1581

01:03:00,549 --> 01:02:58,640

cleanliness

1582

01:03:02,390 --> 01:03:00,559

measures being taken here on earth so we

1583

01:03:03,670 --> 01:03:02,400

use rooms called clean rooms to assemble

1584

01:03:05,270 --> 01:03:03,680

our hardware

1585

01:03:06,950 --> 01:03:05,280

and as you can imagine

1586

01:03:09,670 --> 01:03:06,960

the cleanliness of these rooms is very

1587

01:03:11,829 --> 01:03:09,680

very tightly controlled technicians

1588

01:03:14,309 --> 01:03:11,839

have to wear protective clothing at all

1589

01:03:15,589 --> 01:03:14,319

times really from like head to toe

1590

01:03:18,549 --> 01:03:15,599

and

1591

01:03:19,910 --> 01:03:18,559

you know so keeping these rooms clean

1592

01:03:21,190 --> 01:03:19,920

for the hardware and all the people in

1593

01:03:23,670 --> 01:03:21,200

the room's free from transferring

1594

01:03:25,430 --> 01:03:23,680

contaminants to the hardware you know

1595

01:03:28,230 --> 01:03:25,440

we're not only ensuring that we don't

1596

01:03:29,990 --> 01:03:28,240

scratch or gunk up the hardware but you

1597

01:03:32,630 --> 01:03:30,000

know we're keeping biological

1598

01:03:34,390 --> 01:03:32,640

contaminants off of the hardware um so

1599

01:03:35,910 --> 01:03:34,400

that whatever we send to another

1600

01:03:37,829 --> 01:03:35,920

planetary body

1601
01:03:39,109 --> 01:03:37,839
is is free from anything that we might

1602
01:03:41,029 --> 01:03:39,119
have brought from earth we don't want to

1603
01:03:42,710 --> 01:03:41,039
take any of our biology there whatever

1604
01:03:44,230 --> 01:03:42,720
we find on mars we want to know it's

1605
01:03:47,349 --> 01:03:44,240
really from mars and not something we

1606
01:03:50,390 --> 01:03:49,029
and here's really another picture kind

1607
01:03:52,309 --> 01:03:50,400
of from a different angle and with

1608
01:03:54,390 --> 01:03:52,319
people in it so it's kind of what you

1609
01:03:56,789 --> 01:03:54,400
just saw

1610
01:03:59,029 --> 01:03:56,799
but i love this picture because it gives

1611
01:04:00,630 --> 01:03:59,039
you this the sense of scale for how big

1612
01:04:03,029 --> 01:04:00,640
this is it really is kind of like the

1613
01:04:05,029 --> 01:04:03,039

size of a small golf cart

1614

01:04:06,789 --> 01:04:05,039

and here you can see

1615

01:04:08,950 --> 01:04:06,799

the the

1616

01:04:11,589 --> 01:04:08,960

technicians helping to install this this

1617

01:04:13,910 --> 01:04:11,599

was actually what's called a hot fit

1618

01:04:18,150 --> 01:04:13,920

check where wherein

1619

01:04:21,029 --> 01:04:18,160

the mmrtg is being loaded onto

1620

01:04:22,870 --> 01:04:21,039

the the rover and the hot part of hot

1621

01:04:25,109 --> 01:04:22,880

fit check simply means they're loading

1622

01:04:29,990 --> 01:04:25,119

in the fuel because once the fuel is in

1623

01:04:33,510 --> 01:04:32,150

it stays more generating heat and so

1624

01:04:35,829 --> 01:04:33,520

this is what's called a hot fit check

1625

01:04:37,990 --> 01:04:35,839

they have to make sure everything is uh

1626
01:04:38,870 --> 01:04:38,000
integrated properly

1627
01:04:40,870 --> 01:04:38,880
but

1628
01:04:43,109 --> 01:04:40,880
these are real people who are able to be

1629
01:04:44,789 --> 01:04:43,119
around this radioactive material because

1630
01:04:46,789 --> 01:04:44,799
of all the safety being built into

1631
01:04:48,710 --> 01:04:46,799
making the heat sources you know from

1632
01:04:50,789 --> 01:04:48,720
how the material is produced all the way

1633
01:04:52,470 --> 01:04:50,799
to how we have fully safeguarded the

1634
01:04:56,710 --> 01:04:52,480
system that's integrated with the rest

1635
01:05:03,109 --> 01:04:57,589
now

1636
01:05:05,270 --> 01:05:03,119
learn about the mmrtg that will be on

1637
01:05:06,390 --> 01:05:05,280
perseverance this is a cool animation

1638
01:05:07,910 --> 01:05:06,400

and you might have seen something like

1639

01:05:09,270 --> 01:05:07,920

this before or you will see something

1640

01:05:11,270 --> 01:05:09,280

like this later today but this is

1641

01:05:14,230 --> 01:05:11,280

basically the landing sequence that will

1642

01:05:16,390 --> 01:05:14,240

be happening um in just a few hours and

1643

01:05:18,710 --> 01:05:16,400

now hopefully you can pick out and see

1644

01:05:24,410 --> 01:05:18,720

where the mmrpg is

1645

01:05:24,420 --> 01:05:39,430

[Music]

1646

01:05:39,440 --> 01:05:48,770

so

1647

01:05:48,780 --> 01:06:03,109

[Music]

1648

01:06:20,630 --> 01:06:04,789

you see it

1649

01:06:23,750 --> 01:06:22,549

i love that video it's hard to believe

1650

01:06:26,870 --> 01:06:23,760

that that's what's going to be happening

1651

01:06:28,710 --> 01:06:26,880

later today um but another fun fact is

1652

01:06:31,750 --> 01:06:28,720

that i think the mars distance from

1653

01:06:34,549 --> 01:06:31,760

earth today is about 127 million miles

1654

01:06:36,549 --> 01:06:34,559

and we get to see this landing

1655

01:06:38,150 --> 01:06:36,559

near real time as it's happening on

1656

01:06:40,549 --> 01:06:38,160

something that far away

1657

01:06:41,750 --> 01:06:40,559

and um and i also find it very cool to

1658

01:06:43,910 --> 01:06:41,760

know that this thing is going to be

1659

01:06:44,710 --> 01:06:43,920

plummeting through mars atmosphere at

1660

01:06:46,630 --> 01:06:44,720

like

1661

01:06:48,390 --> 01:06:46,640

12 thousand miles per hour or something

1662

01:06:49,430 --> 01:06:48,400

like that and it's going to get slowed

1663

01:06:51,910 --> 01:06:49,440

down

1664

01:06:54,549 --> 01:06:51,920

um so to roughly something about two

1665

01:06:57,029 --> 01:06:54,559

miles per hour before it lands on the

1666

01:06:59,029 --> 01:06:57,039

surface of mars so i don't know how

1667

01:07:01,589 --> 01:06:59,039

these engineers do it but um it's going

1668

01:07:06,309 --> 01:07:01,599

to land slowly and softly and landing on

1669

01:07:09,990 --> 01:07:07,990

all right well one thing i like to share

1670

01:07:12,309 --> 01:07:10,000

with everybody is that

1671

01:07:15,069 --> 01:07:12,319

we have the rps program has a really

1672

01:07:17,589 --> 01:07:15,079

great website it's at

1673

01:07:19,270 --> 01:07:17,599

rps.nasa.gov and one of a really cool

1674

01:07:21,589 --> 01:07:19,280

new feature that we have on the website

1675

01:07:24,470 --> 01:07:21,599

is this thing called power to explore

1676

01:07:26,390 --> 01:07:24,480

experience it's a 3d viewer wherein you

1677

01:07:29,029 --> 01:07:26,400

can go and take a look a closer look at

1678

01:07:31,349 --> 01:07:29,039

the mmrtg on nasa's perseverance rover

1679

01:07:33,829 --> 01:07:31,359

so i really encourage you to go and try

1680

01:07:39,510 --> 01:07:33,839

to interact with this new 3d viewer on

1681

01:07:43,349 --> 01:07:40,309

and

1682

01:07:45,029 --> 01:07:43,359

like i said here's the website again um

1683

01:07:47,029 --> 01:07:45,039

and uh

1684

01:07:49,190 --> 01:07:47,039

we we have extra we have i think all the

1685

01:07:51,990 --> 01:07:49,200

videos that i showed today as well as

1686

01:07:53,910 --> 01:07:52,000

quite a few more on there um we have

1687

01:07:55,990 --> 01:07:53,920

excellent resources you can learn more

1688

01:07:59,109 --> 01:07:56,000

about other rps systems all of the

1689

01:07:59,990 --> 01:07:59,119

missions that we've had rps on

1690

01:08:01,910 --> 01:08:00,000

and

1691

01:08:04,150 --> 01:08:01,920

i i really hope you go take a look at

1692

01:08:05,910 --> 01:08:04,160

this this website um

1693

01:08:07,829 --> 01:08:05,920

i'm so happy again for having been here

1694

01:08:09,990 --> 01:08:07,839

with you today i know that perseverance

1695

01:08:11,990 --> 01:08:10,000

is i think the most sophisticated rover

1696

01:08:13,109 --> 01:08:12,000

that we've ever sent to mars

1697

01:08:14,789 --> 01:08:13,119

i mean it could be one of the most

1698

01:08:16,550 --> 01:08:14,799

sophisticated and complex spacecraft

1699

01:08:18,550 --> 01:08:16,560

that's ever gone into space

1700

01:08:21,749 --> 01:08:18,560

and uh i know the name perseverance

1701

01:08:23,990 --> 01:08:21,759

really embodies all of nasa's passion

1702

01:08:26,470 --> 01:08:24,000

for taking on an overcoming challenges

1703

01:08:28,390 --> 01:08:26,480

so you know in the future when we go

1704

01:08:30,070 --> 01:08:28,400

from from earth to

1705

01:08:31,990 --> 01:08:30,080

back to the moon you know more missions

1706

01:08:34,550 --> 01:08:32,000

to mars

1707

01:08:36,470 --> 01:08:34,560

the power for robotic and human missions

1708

01:08:38,550 --> 01:08:36,480

is going to be really critical and these

1709

01:08:39,669 --> 01:08:38,560

nuclear power systems can really pave

1710

01:08:41,669 --> 01:08:39,679

the way

1711

01:08:43,349 --> 01:08:41,679

so thank you so much for your time today

1712

01:08:45,430 --> 01:08:43,359

i really enjoyed talking to you and

1713

01:08:53,030 --> 01:08:45,440

enjoy the landing later thank you so

1714

01:08:57,269 --> 01:08:55,110

once again folks that was lauren kamen

1715

01:08:59,749 --> 01:08:57,279

she's the chief safety and mission

1716

01:09:01,829 --> 01:08:59,759

assurance officer for the radio isotope

1717

01:09:03,669 --> 01:09:01,839

power system program

1718

01:09:07,110 --> 01:09:03,679

and it was really a thrill to have her

1719

01:09:09,669 --> 01:09:07,120

with us um really fascinating i i loved

1720

01:09:11,510 --> 01:09:09,679

her explanations and uh and of course

1721

01:09:13,590 --> 01:09:11,520

the uh the visuals that she provided

1722

01:09:15,349 --> 01:09:13,600

were just amazing you know i've been

1723

01:09:17,189 --> 01:09:15,359

monitoring all of our different social

1724

01:09:19,269 --> 01:09:17,199

media channels and we've got folks that

1725

01:09:21,669 --> 01:09:19,279

are that are tuning in they're asking

1726

01:09:24,390 --> 01:09:21,679

all kinds of questions got a question

1727

01:09:26,149 --> 01:09:24,400

here from uh from little billy in rocky

1728

01:09:27,590 --> 01:09:26,159

river ohio

1729

01:09:29,030 --> 01:09:27,600

and um

1730

01:09:31,349 --> 01:09:29,040

and uh

1731

01:09:33,430 --> 01:09:31,359

very interesting question that he had

1732

01:09:35,510 --> 01:09:33,440

one that i that i actually hear a lot we

1733

01:09:38,789 --> 01:09:35,520

took a moment and had to search for a

1734

01:09:42,390 --> 01:09:38,799

video and i think we found one for it um

1735

01:09:44,390 --> 01:09:42,400

billy wanted to know is uh is mars

1736

01:09:49,430 --> 01:09:44,400

really red

1737

01:09:51,110 --> 01:09:49,440

twitter feed and and i think we've got a

1738

01:09:53,749 --> 01:09:51,120

video that might be able to answer that

1739

01:09:55,430 --> 01:09:53,759

question for you billy so uh so take a

1740

01:09:59,030 --> 01:09:55,440

look at this video that was produced by

1741

01:10:01,030 --> 01:09:59,040

the jet propulsion laboratory that's jpl

1742

01:11:03,830 --> 01:10:01,040

out in pasadena california might be able

1743

01:11:08,229 --> 01:11:05,910

so billy that was a great question that

1744

01:11:11,590 --> 01:11:08,239

you had and now you know the soil on

1745

01:11:14,470 --> 01:11:11,600

mars is oxidizing it's rusting right

1746

01:11:16,390 --> 01:11:14,480

before our very eyes very cool question

1747

01:11:19,030 --> 01:11:16,400

thanks for writing it in and keep those

1748

01:11:23,510 --> 01:11:19,040

questions coming uh again we see lots of

1749

01:11:26,950 --> 01:11:23,520

people who are joining us hi to uh c d z

1750

01:11:29,750 --> 01:11:26,960

and uh zac powell i i agree what we've

1751

01:11:31,910 --> 01:11:29,760

been seeing so far is amazing hey jersey

1752

01:11:34,390 --> 01:11:31,920

good to have you here we've also got

1753

01:11:36,790 --> 01:11:34,400

some uh some stem professionals that are

1754

01:11:40,070 --> 01:11:36,800

with us as well uh the person with the

1755

01:11:41,590 --> 01:11:40,080

handle f1 rocket engine very very cool

1756

01:11:44,630 --> 01:11:41,600

good to have you with us

1757

01:11:46,950 --> 01:11:44,640

and uh nasa glenn uh sent a quick

1758

01:11:49,350 --> 01:11:46,960

message if you want to follow the

1759

01:11:52,149 --> 01:11:49,360

progress of the uh of the perseverance

1760

01:11:55,910 --> 01:11:52,159

rover in real time you can do that by

1761

01:11:57,669 --> 01:11:55,920

simply going to mars.nasa.gov

1762

01:11:59,350 --> 01:11:57,679

mars 2020

1763

01:12:01,910 --> 01:11:59,360

slash timeline

1764

01:12:03,910 --> 01:12:01,920

slash cruise and that will give you the

1765

01:12:06,229 --> 01:12:03,920

up-to-date information

1766

01:12:08,950 --> 01:12:06,239

we have time for just one more question

1767

01:12:12,709 --> 01:12:08,960

before we move on and it's a quick one

1768

01:12:15,110 --> 01:12:12,719

this question came from uh from nora

1769

01:12:18,229 --> 01:12:15,120

and nora wanted to know uh how do we

1770

01:12:53,750 --> 01:12:18,239

land on mars let's take a look another

1771

01:13:26,149 --> 01:13:21,350

so

1772

01:13:28,470 --> 01:13:26,159

plenty of options just depends on the

1773

01:13:30,790 --> 01:13:28,480

size of your lander and what you want to

1774

01:13:32,709 --> 01:13:30,800

do with it once it gets here so i hope

1775

01:13:34,790 --> 01:13:32,719

that that answered your question i

1776

01:13:37,189 --> 01:13:34,800

thought that was a pretty cool video and

1777

01:13:39,750 --> 01:13:37,199

speaking of landing systems our next uh

1778

01:13:41,590 --> 01:13:39,760

our next featured uh stem professional

1779

01:13:44,070 --> 01:13:41,600

we'll be talking about the parachute

1780

01:13:46,790 --> 01:13:44,080

decelerator system that's being used for

1781

01:13:49,669 --> 01:13:46,800

the perseverance rover lance foster is a

1782

01:13:52,950 --> 01:13:49,679

research aerospace engineer who oversaw

1783

01:13:56,229 --> 01:13:52,960

the parachute testing in nasa glenn's 10

1784

01:13:58,470 --> 01:13:56,239

by 10 supersonic wind tunnel and and

1785

01:14:00,790 --> 01:13:58,480

he's here to talk not only about about

1786

01:14:03,189 --> 01:14:00,800

the testing but the role that nasa glenn

1787

01:14:04,870 --> 01:14:03,199

had in validating the various models

1788

01:14:06,630 --> 01:14:04,880

that were used for the parachute

1789

01:14:24,310 --> 01:14:06,640

decelerator system

1790

01:14:29,910 --> 01:14:27,750

hi i'm lance foster i'm an aerospace

1791

01:14:32,630 --> 01:14:29,920

engineer at nasa glenn research center

1792

01:14:35,110 --> 01:14:32,640

and i'm going to talk today about the

1793

01:14:35,910 --> 01:14:35,120

parachute testing that rules

1794

01:14:38,709 --> 01:14:35,920

uh

1795

01:14:41,030 --> 01:14:38,719

about the technical parachute or the

1796

01:14:42,870 --> 01:14:41,040

perseverance rover will develop all the

1797

01:14:46,709 --> 01:14:42,880

same kind of parachute we used for the

1798

01:14:48,310 --> 01:14:46,719

curiosity rover so first to just kind of

1799

01:14:50,310 --> 01:14:48,320

orient you and

1800

01:14:52,630 --> 01:14:50,320

give you an idea

1801
01:14:54,630 --> 01:14:52,640
when and how we use the parachute i'm

1802
01:14:57,110 --> 01:14:54,640
going to show a little video that's

1803
01:14:59,750 --> 01:14:57,120
going to show some of the uh

1804
01:15:02,870 --> 01:14:59,760
the process that perseverance is using

1805
01:15:13,270 --> 01:15:02,880
to enter the martian atmosphere so now

1806
01:15:13,280 --> 01:15:15,750
all right

1807
01:15:21,350 --> 01:15:19,030
so this is after the capsule uh

1808
01:15:24,310 --> 01:15:21,360
containing the perseverance rover has

1809
01:15:26,470 --> 01:15:24,320
finally reached the martian atmosphere

1810
01:15:29,430 --> 01:15:26,480
so it's just touching the atmosphere of

1811
01:15:31,910 --> 01:15:29,440
mars and it's getting very hot as it's

1812
01:15:34,390 --> 01:15:31,920
entering that front side the capsule is

1813
01:15:35,430 --> 01:15:34,400

the heat shield so we're entering mars

1814

01:15:38,709 --> 01:15:35,440

air

1815

01:15:40,550 --> 01:15:38,719

atmosphere

1816

01:15:42,790 --> 01:15:40,560

and the rove

1817

01:15:43,590 --> 01:15:42,800

inside of this capsule

1818

01:15:45,669 --> 01:15:43,600

so

1819

01:15:47,430 --> 01:15:45,679

as we're getting closer what you're

1820

01:15:49,910 --> 01:15:47,440

gonna see shortly

1821

01:15:52,630 --> 01:15:49,920

the heat shield which is on the front of

1822

01:15:55,510 --> 01:15:52,640

the capsule it's gonna release

1823

01:15:57,270 --> 01:15:55,520

that is the parachute opening which is

1824

01:16:00,149 --> 01:15:57,280

that is the part we will talk the most

1825

01:16:02,229 --> 01:16:00,159

about today um

1826

01:16:05,270 --> 01:16:02,239

once the parachute opens

1827

01:16:07,189 --> 01:16:05,280

this is still supersonic speed that uh

1828

01:16:09,189 --> 01:16:07,199

this capsule is falling super signing

1829

01:16:11,510 --> 01:16:09,199

meaning so we're still going faster than

1830

01:16:14,149 --> 01:16:11,520

the speed of sound and this parachute

1831

01:16:15,270 --> 01:16:14,159

opens and it's going to slow the rover

1832

01:16:17,510 --> 01:16:15,280

down

1833

01:16:19,830 --> 01:16:17,520

from supersonic speed

1834

01:16:21,750 --> 01:16:19,840

so we're going to get to subsonic speed

1835

01:16:23,750 --> 01:16:21,760

and once that happens

1836

01:16:26,950 --> 01:16:23,760

capsule cracks open

1837

01:16:28,310 --> 01:16:26,960

the sky crane comes out with the rocket

1838

01:16:30,310 --> 01:16:28,320

boosters

1839

01:16:32,790 --> 01:16:30,320

and it's going to

1840

01:16:35,590 --> 01:16:32,800

continue to lower the rover down to the

1841

01:16:38,390 --> 01:16:35,600

martian surface now a natural question

1842

01:16:40,470 --> 01:16:38,400

people ask is well you've got this thing

1843

01:16:42,550 --> 01:16:40,480

with the rocket boosters why wouldn't

1844

01:16:45,510 --> 01:16:42,560

you use the rocket boosters to lower it

1845

01:16:47,270 --> 01:16:45,520

all the way down to the surface

1846

01:16:50,390 --> 01:16:47,280

great question

1847

01:16:53,669 --> 01:16:50,400

this rover is heavier than previous

1848

01:16:55,750 --> 01:16:53,679

rovers and it's so heavy

1849

01:16:57,590 --> 01:16:55,760

that if they lowered it all the way down

1850

01:17:00,149 --> 01:16:57,600

to the martian surface the rocket

1851

01:17:02,390 --> 01:17:00,159

boosters would create a giant crater

1852

01:17:03,910 --> 01:17:02,400

around the rover and the rover would be

1853

01:17:06,550 --> 01:17:03,920

stuck and that would kind of be the

1854

01:17:07,590 --> 01:17:06,560

mission so the road the sky crane lowers

1855

01:17:13,030 --> 01:17:07,600

it

1856

01:17:15,910 --> 01:17:13,040

crane flies away

1857

01:17:18,950 --> 01:17:15,920

all right so that is it for that video

1858

01:17:24,229 --> 01:17:21,830

what we did at nasa glenn research

1859

01:17:26,870 --> 01:17:24,239

center in our 10 foot by 10 foot

1860

01:17:29,350 --> 01:17:26,880

supersonic wind tunnel we did wind

1861

01:17:32,149 --> 01:17:29,360

tunnel testing of the parachute that was

1862

01:17:33,189 --> 01:17:32,159

used for the rover so i'm going to

1863

01:17:34,870 --> 01:17:33,199

quickly

1864

01:17:36,709 --> 01:17:34,880

uh this is where i

1865

01:17:38,870 --> 01:17:36,719

i guess i'm not going to take much time

1866

01:17:41,990 --> 01:17:38,880

between i'm going to go to another video

1867

01:17:44,470 --> 01:17:42,000

i have and this will kind of show how

1868

01:17:45,990 --> 01:17:44,480

our test article a test article that's

1869

01:17:47,669 --> 01:17:46,000

what we call the model we put in the

1870

01:17:50,070 --> 01:17:47,679

tunnel and our test article is the

1871

01:17:51,030 --> 01:17:50,080

capsule and parachute and i'll show you

1872

01:17:53,830 --> 01:17:51,040

how

1873

01:17:58,709 --> 01:17:53,840

that relates to what you just saw

1874

01:18:02,630 --> 01:18:00,870

so yet again

1875

01:18:05,030 --> 01:18:02,640

this is our capsule attached to the

1876

01:18:06,709 --> 01:18:05,040

parachute and this is our tunnel this is

1877

01:18:09,990 --> 01:18:06,719

our model capsule

1878

01:18:11,830 --> 01:18:10,000

and you see lines coming from the model

1879

01:18:14,070 --> 01:18:11,840

these are technicians putting it

1880

01:18:15,750 --> 01:18:14,080

together that's christy our test

1881

01:18:18,550 --> 01:18:15,760

engineer and now

1882

01:18:20,390 --> 01:18:18,560

the test in the wind tunnel

1883

01:18:23,430 --> 01:18:20,400

this is where we

1884

01:18:25,110 --> 01:18:23,440

fire the charge and boom we pop open the

1885

01:18:26,870 --> 01:18:25,120

parachute

1886

01:18:29,270 --> 01:18:26,880

okay

1887

01:18:32,630 --> 01:18:29,280

so this is the actual test article that

1888

01:18:35,030 --> 01:18:32,640

we tested in the wind tunnel and we had

1889

01:18:37,270 --> 01:18:35,040

air blowing it mock

1890

01:18:40,149 --> 01:18:37,280

two and a half up to two and eight point

1891

01:18:48,149 --> 01:18:40,159

eight for some of the data i'm going to

1892

01:18:52,310 --> 01:18:50,149

so

1893

01:18:54,470 --> 01:18:52,320

i guess the first thing is

1894

01:18:56,550 --> 01:18:54,480

why are we doing this testing why did we

1895

01:18:57,830 --> 01:18:56,560

do this what did we want to know

1896

01:19:00,470 --> 01:18:57,840

um

1897

01:19:03,110 --> 01:19:00,480

so the job of the parachute first and

1898

01:19:05,430 --> 01:19:03,120

foremost uh the job of any parachute is

1899

01:19:07,430 --> 01:19:05,440

to decelerate an object that you're

1900

01:19:09,830 --> 01:19:07,440

dropping just like when a person jumps

1901
01:19:12,390 --> 01:19:09,840
out of a plane and they open a parachute

1902
01:19:14,790 --> 01:19:12,400
the job of the parachute is to slow down

1903
01:19:18,310 --> 01:19:14,800
the object that's falling so that it can

1904
01:19:19,910 --> 01:19:18,320
land at a safe speed so

1905
01:19:21,189 --> 01:19:19,920
coming into the test um

1906
01:19:23,030 --> 01:19:21,199
[Music]

1907
01:19:25,350 --> 01:19:23,040
we had already done

1908
01:19:27,669 --> 01:19:25,360
a lot of other testing and the jpl

1909
01:19:31,910 --> 01:19:27,679
people had already done some modeling

1910
01:19:34,310 --> 01:19:31,920
and this was a follow-on test to verify

1911
01:19:36,470 --> 01:19:34,320
that the models they were using were

1912
01:19:39,270 --> 01:19:36,480
accurate so what i don't show you

1913
01:19:41,669 --> 01:19:39,280

pictures of before that test we did a

1914

01:19:44,149 --> 01:19:41,679

test with a hard shell canopy and that's

1915

01:19:47,030 --> 01:19:44,159

where it was basically a parachute but

1916

01:19:49,430 --> 01:19:47,040

it was a metal model of the parachute

1917

01:19:52,149 --> 01:19:49,440

that didn't flex and it just sat there

1918

01:19:53,990 --> 01:19:52,159

and we we measured the forces that that

1919

01:19:56,709 --> 01:19:54,000

parachute was pulling on the capsule

1920

01:19:59,430 --> 01:19:56,719

with and after doing that test

1921

01:20:02,070 --> 01:19:59,440

and continued work by the jpl folks and

1922

01:20:05,030 --> 01:20:02,080

other modeling the uh that data looked

1923

01:20:07,669 --> 01:20:05,040

good so then we went to the the soft

1924

01:20:10,310 --> 01:20:07,679

shell canopy test and that was the

1925

01:20:13,030 --> 01:20:10,320

parachute that you just saw open and

1926

01:20:15,830 --> 01:20:13,040

what we were looking to see

1927

01:20:18,229 --> 01:20:15,840

we were looking to measure the loads uh

1928

01:20:19,510 --> 01:20:18,239

the the parachute put on the capsule so

1929

01:20:22,229 --> 01:20:19,520

we want to know

1930

01:20:25,189 --> 01:20:22,239

how hard is this parachute pulling on

1931

01:20:27,430 --> 01:20:25,199

the capsule that's called a drag force

1932

01:20:30,470 --> 01:20:27,440

so how much drag force do we have and

1933

01:20:32,950 --> 01:20:30,480

the amount of drag force that tells us

1934

01:20:35,590 --> 01:20:32,960

how well the parachute is going to slow

1935

01:20:36,950 --> 01:20:35,600

down the capsule and also

1936

01:20:40,790 --> 01:20:36,960

uh

1937

01:20:44,870 --> 01:20:40,800

i do want to show this picture again

1938

01:20:48,149 --> 01:20:44,880

so if you look here at the parachute

1939

01:20:51,110 --> 01:20:48,159

this is what's called a disc gap band

1940

01:20:54,550 --> 01:20:51,120

configuration and what that means is the

1941

01:20:56,790 --> 01:20:54,560

parachute consists of a disc like um

1942

01:20:59,350 --> 01:20:56,800

like most parachutes then there's a gap

1943

01:21:01,270 --> 01:20:59,360

there's a space where the fabric is open

1944

01:21:03,430 --> 01:21:01,280

and then another band

1945

01:21:06,229 --> 01:21:03,440

so this is called the disc gap band

1946

01:21:08,550 --> 01:21:06,239

parachute and we use this because it's a

1947

01:21:09,590 --> 01:21:08,560

supersonic parachute you know i'm sure

1948

01:21:12,310 --> 01:21:09,600

you've seen

1949

01:21:14,790 --> 01:21:12,320

usually um here on earth when somebody

1950

01:21:16,630 --> 01:21:14,800

jumps out in the parachute it's just the

1951

01:21:18,870 --> 01:21:16,640

i guess the disc part you know it's just

1952

01:21:20,229 --> 01:21:18,880

one side it's just one parachute with no

1953

01:21:23,110 --> 01:21:20,239

holes in it

1954

01:21:25,189 --> 01:21:23,120

because this parachute um is working at

1955

01:21:27,830 --> 01:21:25,199

supersonic speed

1956

01:21:29,830 --> 01:21:27,840

they found that it was more stable if

1957

01:21:31,990 --> 01:21:29,840

you have that gap in there so that it

1958

01:21:35,110 --> 01:21:32,000

can breathe and some of the air can get

1959

01:21:37,830 --> 01:21:35,120

out some so that um this this gap band

1960

01:21:39,430 --> 01:21:37,840

configuration is for a supersonic wind

1961

01:21:41,189 --> 01:21:39,440

tunnel

1962

01:21:44,470 --> 01:21:41,199

another thing you'll see

1963

01:21:47,189 --> 01:21:44,480

um there's a lot of little white dots on

1964

01:21:50,149 --> 01:21:47,199

the parachute all those white dots are

1965

01:21:52,790 --> 01:21:50,159

for a process we call photogrammetry now

1966

01:21:55,030 --> 01:21:52,800

some of you watching um probably like to

1967

01:21:57,750 --> 01:21:55,040

play video games and particularly if

1968

01:22:00,070 --> 01:21:57,760

you've seen on sports video games when

1969

01:22:02,790 --> 01:22:00,080

they're making the game and they'll put

1970

01:22:05,110 --> 01:22:02,800

the athlete in that black suit with the

1971

01:22:07,189 --> 01:22:05,120

little white dots on it and they use

1972

01:22:09,430 --> 01:22:07,199

that so they can get the motions just

1973

01:22:11,350 --> 01:22:09,440

right so that makes if you're playing a

1974

01:22:13,510 --> 01:22:11,360

basketball game it makes the motions

1975

01:22:15,750 --> 01:22:13,520

look really realistic or a football game

1976

01:22:17,669 --> 01:22:15,760

where they have the people do the moves

1977

01:22:20,790 --> 01:22:17,679

and they can make video game characters

1978

01:22:23,750 --> 01:22:20,800

that look like it so photogrammetry

1979

01:22:25,990 --> 01:22:23,760

we put these dots all over the parachute

1980

01:22:27,270 --> 01:22:26,000

and we have an array of cameras and what

1981

01:22:30,470 --> 01:22:27,280

happens

1982

01:22:33,270 --> 01:22:30,480

with the cameras working together we're

1983

01:22:36,070 --> 01:22:33,280

able to track in three dimensions the

1984

01:22:37,910 --> 01:22:36,080

positions of each of those dots and this

1985

01:22:40,470 --> 01:22:37,920

is important for this testing because

1986

01:22:41,910 --> 01:22:40,480

when that parachute opens it doesn't

1987

01:22:44,790 --> 01:22:41,920

just

1988

01:22:46,950 --> 01:22:44,800

open and sit there uh the parachute it

1989

01:22:50,070 --> 01:22:46,960

kind of moves around

1990

01:22:52,470 --> 01:22:50,080

and it breathes and kind and

1991

01:22:55,990 --> 01:22:52,480

and gyrates so

1992

01:22:58,390 --> 01:22:56,000

by doing photogrammetry um the jpl

1993

01:23:00,470 --> 01:22:58,400

researchers were able to measure the

1994

01:23:02,870 --> 01:23:00,480

motions of the parachute and see if

1995

01:23:06,310 --> 01:23:02,880

there were any particular frequencies

1996

01:23:07,830 --> 01:23:06,320

any patterns they wanted to see in what

1997

01:23:08,870 --> 01:23:07,840

was happening with the parachute

1998

01:23:12,790 --> 01:23:08,880

movement

1999

01:23:15,189 --> 01:23:12,800

um so that and we can stop

2000

01:23:17,030 --> 01:23:15,199

shouldn't have surprised you

2001

01:23:19,750 --> 01:23:17,040

can stop sharing so

2002

01:23:22,470 --> 01:23:19,760

that was um

2003

01:23:24,709 --> 01:23:22,480

a really exciting experience i think

2004

01:23:26,870 --> 01:23:24,719

it's funny when things like this happen

2005

01:23:29,669 --> 01:23:26,880

you know we did this test and

2006

01:23:33,110 --> 01:23:29,679

we the jpl folks got their data and they

2007

01:23:34,629 --> 01:23:33,120

went back and it was some years later um

2008

01:23:36,220 --> 01:23:34,639

i think this testing happened in

2009

01:23:37,910 --> 01:23:36,230

probably 2000

2010

01:23:39,910 --> 01:23:37,920

[Music]

2011

01:23:41,350 --> 01:23:39,920

maybe 2008

2012

01:23:44,790 --> 01:23:41,360

um so

2013

01:23:47,510 --> 01:23:44,800

we sent the curiosity rover uh nasa sent

2014

01:23:50,070 --> 01:23:47,520

that up in 2012 so

2015

01:23:52,790 --> 01:23:50,080

we had already done the testing and it

2016

01:23:54,550 --> 01:23:52,800

was years later when we heard oh yeah

2017

01:23:56,149 --> 01:23:54,560

you know that parachute that uh that

2018

01:23:59,030 --> 01:23:56,159

they tested here they're going to do

2019

01:24:01,189 --> 01:23:59,040

that they're sending it up so just the

2020

01:24:04,310 --> 01:24:01,199

timeline

2021

01:24:05,910 --> 01:24:04,320

when you see these things happening um

2022

01:24:07,750 --> 01:24:05,920

you know and we use that parachute to

2023

01:24:09,430 --> 01:24:07,760

land curiosity and that's the same kind

2024

01:24:10,790 --> 01:24:09,440

of parachute that's going to land

2025

01:24:13,270 --> 01:24:10,800

perseverance

2026

01:24:16,550 --> 01:24:13,280

on the surface when you see these things

2027

01:24:19,669 --> 01:24:16,560

happen it's a long timeline and a lot of

2028

01:24:21,110 --> 01:24:19,679

work by a lot of people uh that goes

2029

01:24:23,669 --> 01:24:21,120

into that when you see one of these

2030

01:24:26,709 --> 01:24:23,679

things happen so every piece of a

2031

01:24:28,550 --> 01:24:26,719

mission like this you've got thousands

2032

01:24:30,950 --> 01:24:28,560

of different systems you've got the

2033

01:24:33,990 --> 01:24:30,960

parachute you've got the rocket boosters

2034

01:24:36,149 --> 01:24:34,000

for the sky crane you've got materials

2035

01:24:38,790 --> 01:24:36,159

work for the heat shield you've got all

2036

01:24:41,430 --> 01:24:38,800

these thousands of components

2037

01:24:44,070 --> 01:24:41,440

so you have all these parallel research

2038

01:24:47,030 --> 01:24:44,080

programs going where people are working

2039

01:24:49,270 --> 01:24:47,040

um are gonna find different solutions to

2040

01:24:52,790 --> 01:24:49,280

problems we have to solve to make this

2041

01:24:54,790 --> 01:24:52,800

thing work i'm gonna show i've got a

2042

01:24:57,270 --> 01:24:54,800

picture of the

2043

01:25:02,390 --> 01:24:57,280

of some of the test team it's not

2044

01:25:08,149 --> 01:25:05,270

so there there's some of us that uh

2045

01:25:10,310 --> 01:25:08,159

that dapper young gentleman who uh who

2046

01:25:12,550 --> 01:25:10,320

looks very sleepy from third shift

2047

01:25:15,669 --> 01:25:12,560

testing in the back row that's me

2048

01:25:17,990 --> 01:25:15,679

and you see uh christy pastor barcy is

2049

01:25:19,669 --> 01:25:18,000

in there jim rohder anita sengupta and

2050

01:25:22,149 --> 01:25:19,679

that's um

2051
01:25:25,430 --> 01:25:22,159
engineers and technicians and this by no

2052
01:25:27,669 --> 01:25:25,440
means is the whole team i

2053
01:25:29,590 --> 01:25:27,679
i'll stop sharing that

2054
01:25:32,149 --> 01:25:29,600
that's not everybody when we do one of

2055
01:25:34,550 --> 01:25:32,159
these tests um

2056
01:25:37,590 --> 01:25:34,560
well first of all the testing happens on

2057
01:25:41,030 --> 01:25:37,600
on third shift usually uh and we third

2058
01:25:43,510 --> 01:25:41,040
shift for us is 11 p.m to 7 00 in the

2059
01:25:46,709 --> 01:25:43,520
morning and we do that for a variety of

2060
01:25:49,750 --> 01:25:46,719
reasons uh one first of all um the wind

2061
01:25:51,750 --> 01:25:49,760
tunnel is very large and it's very loud

2062
01:25:53,430 --> 01:25:51,760
even though the test section where we

2063
01:25:56,550 --> 01:25:53,440

put the article is

2064

01:25:59,030 --> 01:25:56,560

10 feet wide by 10 feet tall

2065

01:26:01,189 --> 01:25:59,040

the whole facility takes up like a whole

2066

01:26:03,669 --> 01:26:01,199

city block and when the wind tunnel is

2067

01:26:04,709 --> 01:26:03,679

running it's very loud so first of all

2068

01:26:06,870 --> 01:26:04,719

just

2069

01:26:08,870 --> 01:26:06,880

to not be a nuisance while people are

2070

01:26:11,750 --> 01:26:08,880

there during the day we run at night but

2071

01:26:13,590 --> 01:26:11,760

the truth uh they're not that concerned

2072

01:26:16,790 --> 01:26:13,600

about our well but the truth is that the

2073

01:26:18,629 --> 01:26:16,800

power is really cheaper than they're all

2074

01:26:21,030 --> 01:26:18,639

jokes aside they're concerned about us

2075

01:26:23,110 --> 01:26:21,040

but the electricity is a lot cheaper

2076

01:26:26,070 --> 01:26:23,120

during off hours so that's

2077

01:26:28,149 --> 01:26:26,080

a major driver for why we run then and

2078

01:26:30,709 --> 01:26:28,159

when we're doing a test like this it's

2079

01:26:32,790 --> 01:26:30,719

really an around-the-clock effort

2080

01:26:34,870 --> 01:26:32,800

because what happens

2081

01:26:37,750 --> 01:26:34,880

we come in and test at night and we'll

2082

01:26:39,189 --> 01:26:37,760

take our data all the way from midnight

2083

01:26:41,510 --> 01:26:39,199

up until

2084

01:26:44,229 --> 01:26:41,520

6 15 in the morning and that's when we

2085

01:26:47,189 --> 01:26:44,239

start to shut down and at that point the

2086

01:26:49,030 --> 01:26:47,199

day shift comes in so you've got a whole

2087

01:26:50,870 --> 01:26:49,040

other set of um

2088

01:26:52,870 --> 01:26:50,880

people with a lot of the same skills a

2089

01:26:55,430 --> 01:26:52,880

whole other set of engineers and

2090

01:26:58,390 --> 01:26:55,440

technicians come in because they have to

2091

01:26:59,350 --> 01:26:58,400

fix things that we broke um

2092

01:27:02,470 --> 01:26:59,360

we

2093

01:27:05,030 --> 01:27:02,480

i guess another secret of research that

2094

01:27:07,990 --> 01:27:05,040

uh i don't think should be a secret

2095

01:27:10,229 --> 01:27:08,000

we show you video of tests and you see

2096

01:27:13,110 --> 01:27:10,239

the video of when it works well and when

2097

01:27:16,470 --> 01:27:13,120

we pull it off but the reality is uh for

2098

01:27:18,550 --> 01:27:16,480

every accomplishment we um there's a lot

2099

01:27:20,870 --> 01:27:18,560

of stuff that doesn't work

2100

01:27:22,790 --> 01:27:20,880

so that video i showed you where the

2101
01:27:25,350 --> 01:27:22,800
parachute opened that was one where

2102
01:27:28,310 --> 01:27:25,360
finally the parachute successfully

2103
01:27:30,470 --> 01:27:28,320
opened but before that happened

2104
01:27:33,430 --> 01:27:30,480
we had issues with the charge with

2105
01:27:35,510 --> 01:27:33,440
making the parachute open on time uh

2106
01:27:36,550 --> 01:27:35,520
sometimes the parachute was opening

2107
01:27:39,270 --> 01:27:36,560
early

2108
01:27:41,830 --> 01:27:39,280
uh sometimes the parachute didn't open

2109
01:27:45,990 --> 01:27:41,840
all the way like all the bands didn't

2110
01:27:51,830 --> 01:27:49,110
engineering research period is very much

2111
01:27:54,629 --> 01:27:51,840
trial and error uh you know one of the

2112
01:27:56,629 --> 01:27:54,639
the jokes is that uh if you come in in

2113
01:27:57,910 --> 01:27:56,639

the morning and uh

2114

01:28:00,229 --> 01:27:57,920

you know usually we come in and things

2115

01:28:02,709 --> 01:28:00,239

are broken and if at the end of the day

2116

01:28:04,950 --> 01:28:02,719

you have fixed something that's a that's

2117

01:28:08,149 --> 01:28:04,960

a good day so

2118

01:28:09,990 --> 01:28:08,159

there's a whole lot of um

2119

01:28:11,910 --> 01:28:10,000

the whole process there's a lot of

2120

01:28:14,470 --> 01:28:11,920

growing pains and

2121

01:28:16,470 --> 01:28:14,480

research is about learning so at the

2122

01:28:18,149 --> 01:28:16,480

beginning you're trying to do something

2123

01:28:19,990 --> 01:28:18,159

we haven't done before that we didn't

2124

01:28:23,510 --> 01:28:20,000

know how to do and we're trying to learn

2125

01:28:25,510 --> 01:28:23,520

how to do it so at the end um when it

2126

01:28:28,390 --> 01:28:25,520

works it's fantastic for everyone and

2127

01:28:32,790 --> 01:28:28,400

you look at a at a situation like this

2128

01:28:34,629 --> 01:28:32,800

we're landing rovers on mars which is um

2129

01:28:36,629 --> 01:28:34,639

you know let's pause and think about

2130

01:28:39,510 --> 01:28:36,639

that that's amazing in itself we are

2131

01:28:43,430 --> 01:28:39,520

from earth launching rovers into space

2132

01:28:47,270 --> 01:28:43,440

and landing them on mars but when we put

2133

01:28:48,229 --> 01:28:47,280

that up there on mars you get one shot

2134

01:28:51,110 --> 01:28:48,239

um

2135

01:28:52,149 --> 01:28:51,120

and that one shot it has to work so just

2136

01:28:53,510 --> 01:28:52,159

like you

2137

01:28:54,950 --> 01:28:53,520

you look at a

2138

01:28:56,709 --> 01:28:54,960

basketball player shooting a

2139

01:28:59,350 --> 01:28:56,719

three-pointer and you get to and it's

2140

01:29:02,149 --> 01:28:59,360

the finals and the clock is ticking and

2141

01:29:04,950 --> 01:29:02,159

there's three seconds left and somebody

2142

01:29:06,790 --> 01:29:04,960

shoots a three-pointer that's not the

2143

01:29:09,590 --> 01:29:06,800

first time that person shot a

2144

01:29:12,390 --> 01:29:09,600

three-pointer um that that person has

2145

01:29:14,470 --> 01:29:12,400

spent hours and hours in the gym

2146

01:29:16,550 --> 01:29:14,480

shooting and missing and shooting in

2147

01:29:18,629 --> 01:29:16,560

different situations and finding out

2148

01:29:21,910 --> 01:29:18,639

what does and doesn't work for that

2149

01:29:24,870 --> 01:29:21,920

moment so when we get there and we put

2150

01:29:26,390 --> 01:29:24,880

perseverance on mars that is um

2151

01:29:30,149 --> 01:29:26,400

you know that is us hitting the

2152

01:29:33,110 --> 01:29:30,159

game-winning shot and we um we get one

2153

01:29:35,830 --> 01:29:33,120

shot at that and there's out thousands

2154

01:29:38,709 --> 01:29:35,840

of hours by thousands of brilliant

2155

01:29:40,709 --> 01:29:38,719

people working to create one moment so

2156

01:29:43,189 --> 01:29:40,719

for that moment to work we spend a lot

2157

01:29:45,430 --> 01:29:43,199

of time uh

2158

01:29:48,070 --> 01:29:45,440

trying things that do and don't work to

2159

01:29:50,950 --> 01:29:48,080

get ready for that um

2160

01:29:54,229 --> 01:29:50,960

so yeah and that is how we

2161

01:29:55,590 --> 01:29:54,239

that is how we at nasa glenn wind tunnel

2162

01:29:57,669 --> 01:29:55,600

tested the

2163

01:29:59,990 --> 01:29:57,679

the parachute that will be used to land

2164

01:30:02,950 --> 01:30:00,000

the perseverance rover that was used to

2165

01:30:05,990 --> 01:30:02,960

land the curiosity rover um and that's

2166

01:30:09,510 --> 01:30:06,000

just a small piece of the part that uh

2167

01:30:11,669 --> 01:30:09,520

that we here at nasa glenn in ohio have

2168

01:30:13,830 --> 01:30:11,679

played you know

2169

01:30:15,590 --> 01:30:13,840

in the effort to put the rover up there

2170

01:30:18,870 --> 01:30:15,600

i think you've already seen some other

2171

01:30:21,270 --> 01:30:18,880

talks about uh the power systems uh work

2172

01:30:23,350 --> 01:30:21,280

on that that was done here and uh and

2173

01:30:25,990 --> 01:30:23,360

work on the communications and on

2174

01:30:29,590 --> 01:30:26,000

previous rovers they did drop testing

2175

01:30:32,070 --> 01:30:29,600

for uh spirit and opportunity so we um

2176
01:30:34,070 --> 01:30:32,080
you know know that everybody's familiar

2177
01:30:36,709 --> 01:30:34,080
with houston because they hear houston

2178
01:30:39,590 --> 01:30:36,719
we have a problem in cape canaveral but

2179
01:30:42,229 --> 01:30:39,600
there are a dozen nasa centers and we

2180
01:30:46,070 --> 01:30:42,239
all have different specialties and

2181
01:30:48,470 --> 01:30:46,080
in ohio nasa glenn is very much involved

2182
01:30:49,990 --> 01:30:48,480
in in the successes you see for the

2183
01:30:52,709 --> 01:30:50,000
space program

2184
01:30:55,030 --> 01:30:52,719
and with that i uh i will get off my

2185
01:30:57,830 --> 01:30:55,040
soapbox and they tell me that you all

2186
01:31:00,310 --> 01:30:57,840
will also be testing your own parachute

2187
01:31:02,310 --> 01:31:00,320
so i don't want you to get discouraged

2188
01:31:04,070 --> 01:31:02,320

or feel away if your parachute doesn't

2189

01:31:06,470 --> 01:31:04,080

do exactly what you wanted to do the

2190

01:31:08,629 --> 01:31:06,480

first time because

2191

01:31:10,149 --> 01:31:08,639

the parachute that we're gonna use to

2192

01:31:12,310 --> 01:31:10,159

land the rover

2193

01:31:13,669 --> 01:31:12,320

didn't work right the first time either

2194

01:31:15,910 --> 01:31:13,679

we could we didn't get it right the

2195

01:31:18,470 --> 01:31:15,920

first time so you're gonna have to there

2196

01:31:20,950 --> 01:31:18,480

will be trial and error and you're gonna

2197

01:31:22,870 --> 01:31:20,960

try things and you're gonna reiterate

2198

01:31:23,750 --> 01:31:22,880

and you're gonna fix things and you're

2199

01:31:25,830 --> 01:31:23,760

gonna

2200

01:31:28,390 --> 01:31:25,840

you know try other solutions so don't

2201

01:31:31,910 --> 01:31:28,400

feel the way the best solution comes

2202

01:31:34,310 --> 01:31:31,920

from trying and failing more often the

2203

01:31:35,030 --> 01:31:34,320

more things you try the more things you

2204

01:31:38,149 --> 01:31:35,040

know

2205

01:31:40,790 --> 01:31:38,159

why

2206

01:31:42,070 --> 01:31:40,800

the winning solution really works

2207

01:31:45,110 --> 01:31:42,080

and that's it

2208

01:31:56,310 --> 01:31:45,120

so have fun out there and uh i'll see

2209

01:32:00,390 --> 01:31:58,629

hey folks welcome back

2210

01:32:02,629 --> 01:32:00,400

some really cool stuff talking about

2211

01:32:05,030 --> 01:32:02,639

that parachute deceleration system again

2212

01:32:08,149 --> 01:32:05,040

that was lance foster with the research

2213

01:32:09,430 --> 01:32:08,159

aerospace engineer um at the nasa glenn

2214

01:32:11,110 --> 01:32:09,440

research center he was telling you a

2215

01:32:12,390 --> 01:32:11,120

little bit about the supersonic wind

2216

01:32:15,189 --> 01:32:12,400

tunnel that was used

2217

01:32:17,350 --> 01:32:15,199

to uh to test the parachute uh that

2218

01:32:19,270 --> 01:32:17,360

would be used for the uh perseverance

2219

01:32:21,510 --> 01:32:19,280

rover you know everything really hinges

2220

01:32:23,350 --> 01:32:21,520

on that and uh

2221

01:32:25,510 --> 01:32:23,360

it'll help to slow this spacecraft down

2222

01:32:27,669 --> 01:32:25,520

quite a bit still not enough to actually

2223

01:32:29,510 --> 01:32:27,679

land on the surface but it'll bring it

2224

01:32:32,149 --> 01:32:29,520

from somewhere around a thousand miles

2225

01:32:34,470 --> 01:32:32,159

an hour a little over 900 miles an hour

2226

01:32:36,790 --> 01:32:34,480

down to about 200 miles an hour and

2227

01:32:38,550 --> 01:32:36,800

that's when the jet pack will take over

2228

01:32:40,870 --> 01:32:38,560

because it's still moving too fast to

2229

01:32:44,070 --> 01:32:40,880

actually touch down on the surface it's

2230

01:32:46,709 --> 01:32:44,080

going to be absolutely incredible

2231

01:32:49,189 --> 01:32:46,719

a lot of folks writing into us uh hey to

2232

01:32:52,870 --> 01:32:49,199

susan and jeremy to james

2233

01:32:58,229 --> 01:32:55,110

we have uh

2234

01:33:01,189 --> 01:32:58,239

beso pritifol from italy who joined us

2235

01:33:03,430 --> 01:33:01,199

and we also have raj hey raj from the uk

2236

01:33:06,149 --> 01:33:03,440

who's joined us as well

2237

01:33:08,550 --> 01:33:06,159

and of course to aaron's science and

2238

01:33:09,830 --> 01:33:08,560

space learning you know he wants to be a

2239

01:33:11,830 --> 01:33:09,840

scientist

2240

01:33:14,070 --> 01:33:11,840

when he grows up and

2241

01:33:15,510 --> 01:33:14,080

so he's asking the right questions he's

2242

01:33:16,870 --> 01:33:15,520

in the right place and don't forget

2243

01:33:19,270 --> 01:33:16,880

everything that you're learning now in

2244

01:33:21,350 --> 01:33:19,280

school is going to be critically

2245

01:33:23,750 --> 01:33:21,360

important the more science math

2246

01:33:25,430 --> 01:33:23,760

technology you can take uh

2247

01:33:27,270 --> 01:33:25,440

that's great but you also need to be

2248

01:33:28,629 --> 01:33:27,280

able to speak some other languages too

2249

01:33:31,270 --> 01:33:28,639

because space

2250

01:33:33,830 --> 01:33:31,280

is becoming uh an international place in

2251

01:33:36,470 --> 01:33:33,840

fact there are currently three different

2252

01:33:39,830 --> 01:33:36,480

missions from three separate countries

2253

01:33:41,750 --> 01:33:39,840

that are operating at mars today so uh

2254

01:33:44,870 --> 01:33:41,760

china was able to send a spacecraft

2255

01:33:46,870 --> 01:33:44,880

there the united arab emirates has a

2256

01:33:49,270 --> 01:33:46,880

probe that's uh that's currently in

2257

01:33:51,189 --> 01:33:49,280

orbit around mars it even has a lander

2258

01:33:54,310 --> 01:33:51,199

that they hope to uh set down in about a

2259

01:33:56,470 --> 01:33:54,320

month or so and obviously perseverance

2260

01:33:59,189 --> 01:33:56,480

is arriving today so it's pretty

2261

01:34:00,870 --> 01:33:59,199

exciting times that's going on right now

2262

01:34:03,030 --> 01:34:00,880

julie boswell

2263

01:34:04,470 --> 01:34:03,040

wanted to know if there's a backup

2264

01:34:07,110 --> 01:34:04,480

parachute

2265

01:34:09,189 --> 01:34:07,120

for perseverance and no

2266

01:34:11,669 --> 01:34:09,199

no

2267

01:34:14,149 --> 01:34:11,679

it's got to use the one that it has

2268

01:34:15,830 --> 01:34:14,159

that's been tested and retested by the

2269

01:34:18,229 --> 01:34:15,840

folks here at the great lakes science

2270

01:34:20,790 --> 01:34:18,239

i'm sorry at the nasa glenn research

2271

01:34:22,629 --> 01:34:20,800

center as you just saw and it's designed

2272

01:34:25,430 --> 01:34:22,639

to really take that load moving at

2273

01:34:26,229 --> 01:34:25,440

supersonic speeds and that's very very

2274

01:34:29,110 --> 01:34:26,239

cool

2275

01:34:31,830 --> 01:34:29,120

we've had a couple of parents that

2276

01:34:33,110 --> 01:34:31,840

that sent in some posts on social media

2277

01:34:35,350 --> 01:34:33,120

they were asking if there were some

2278

01:34:37,030 --> 01:34:35,360

activities that they could do with their

2279

01:34:39,270 --> 01:34:37,040

children that were similar to some of

2280

01:34:41,189 --> 01:34:39,280

the activities uh that will be taking

2281

01:34:43,270 --> 01:34:41,199

place with the perseverance rover one

2282

01:34:46,709 --> 01:34:43,280

that comes to mind right off the bat is

2283

01:34:49,510 --> 01:34:46,719

candy bar geology get this mom and dad

2284

01:34:51,669 --> 01:34:49,520

you can get snack sized candy bars a

2285

01:34:54,950 --> 01:34:51,679

couple of different varieties of candy

2286

01:34:57,750 --> 01:34:54,960

bars and you can use them as geologic

2287

01:34:59,510 --> 01:34:57,760

samples from your simulated mars

2288

01:35:02,149 --> 01:34:59,520

environment all you'll need are the

2289

01:35:05,430 --> 01:35:02,159

candy bars maybe um

2290

01:35:07,350 --> 01:35:05,440

a a knife like a plastic knife and uh

2291

01:35:09,990 --> 01:35:07,360

and you'll need a plastic straw and if

2292

01:35:12,310 --> 01:35:10,000

it's a clear straw the better

2293

01:35:14,550 --> 01:35:12,320

now here's what you'll do you'll open up

2294

01:35:17,030 --> 01:35:14,560

that that candy bar and the best way to

2295

01:35:18,950 --> 01:35:17,040

learn about someplace new is to examine

2296

01:35:20,709 --> 01:35:18,960

something that you know about so with

2297

01:35:24,070 --> 01:35:20,719

the first candy bar that'll be a

2298

01:35:26,149 --> 01:35:24,080

simulated sample from earth

2299

01:35:27,430 --> 01:35:26,159

ask your child to take a closer look at

2300

01:35:34,550 --> 01:35:27,440

it

2301
01:35:36,950 --> 01:35:34,560
they can set the candy bar on that'll be

2302
01:35:38,709 --> 01:35:36,960
great have them describe it to you if

2303
01:35:40,310 --> 01:35:38,719
they're able to if they're able to write

2304
01:35:41,830 --> 01:35:40,320
have them write down their description

2305
01:35:43,830 --> 01:35:41,840
of what they're looking at and if they

2306
01:35:45,830 --> 01:35:43,840
can't write yet just ask them to tell

2307
01:35:47,830 --> 01:35:45,840
you what they see

2308
01:35:50,709 --> 01:35:47,840
later you can do a street test that's a

2309
01:35:53,350 --> 01:35:50,719
test that geologists use with uh with

2310
01:35:55,910 --> 01:35:53,360
various geologic specimens they actually

2311
01:35:57,830 --> 01:35:55,920
take that rock and they'll rub it across

2312
01:36:00,149 --> 01:35:57,840
something in this case they can rub the

2313
01:36:02,550 --> 01:36:00,159

candy bar right there across that white

2314

01:36:04,229 --> 01:36:02,560

paper what color mark does it leave

2315

01:36:06,629 --> 01:36:04,239

behind that's one of the things that you

2316

01:36:08,709 --> 01:36:06,639

want to check out

2317

01:36:10,229 --> 01:36:08,719

now next you want to do your core sample

2318

01:36:12,470 --> 01:36:10,239

and to do the core sample you're going

2319

01:36:14,790 --> 01:36:12,480

to take that clear straw

2320

01:36:17,110 --> 01:36:14,800

and you're going to move that straw back

2321

01:36:19,510 --> 01:36:17,120

and forth between your fingers as you

2322

01:36:23,350 --> 01:36:19,520

begin to penetrate as you begin to

2323

01:36:25,750 --> 01:36:23,360

penetrate that candy bar

2324

01:36:28,550 --> 01:36:25,760

take it down so far and then pull it

2325

01:36:30,470 --> 01:36:28,560

back up and inside that clear section of

2326
01:36:33,270 --> 01:36:30,480
the straw you should be able to see the

2327
01:36:36,390 --> 01:36:33,280
various layers

2328
01:36:38,790 --> 01:36:36,400
that make up that geologic specimen

2329
01:36:40,229 --> 01:36:38,800
you can have your child count

2330
01:36:42,229 --> 01:36:40,239
the number of

2331
01:36:44,310 --> 01:36:42,239
layers that are there

2332
01:36:46,950 --> 01:36:44,320
asking if they've come across any rocks

2333
01:36:49,990 --> 01:36:46,960
or any boulders as they're drilling down

2334
01:36:52,709 --> 01:36:50,000
into their their simulated specimen that

2335
01:36:54,870 --> 01:36:52,719
could be peanuts or nougat have them

2336
01:36:56,709 --> 01:36:54,880
describe the different layers to you as

2337
01:36:58,390 --> 01:36:56,719
well

2338
01:37:01,350 --> 01:36:58,400

now one of the neat things that that you

2339

01:37:03,270 --> 01:37:01,360

can do with a with a core sample is that

2340

01:37:05,430 --> 01:37:03,280

you can study what the area is made of

2341

01:37:06,950 --> 01:37:05,440

but one of the drawbacks is

2342

01:37:09,430 --> 01:37:06,960

you might have missed something that was

2343

01:37:11,189 --> 01:37:09,440

right next to it that was really neat

2344

01:37:13,990 --> 01:37:11,199

for this next step you're going to use

2345

01:37:17,189 --> 01:37:14,000

the plastic knife and use that knife to

2346

01:37:19,430 --> 01:37:17,199

cut the candy sample in half

2347

01:37:21,590 --> 01:37:19,440

set one half aside and then have your

2348

01:37:23,350 --> 01:37:21,600

child look at the other one in fact

2349

01:37:25,030 --> 01:37:23,360

turn it so that they can look down

2350

01:37:27,189 --> 01:37:25,040

through that cross section and compare

2351

01:37:28,629 --> 01:37:27,199

the cross section to the core sample

2352

01:37:29,990 --> 01:37:28,639

that they just had

2353

01:37:31,990 --> 01:37:30,000

is there anything that they notice

2354

01:37:34,149 --> 01:37:32,000

different between the two those are

2355

01:37:35,830 --> 01:37:34,159

great questions to ask and great things

2356

01:37:37,669 --> 01:37:35,840

for them to begin thinking about

2357

01:37:39,990 --> 01:37:37,679

thinking like a scientist thinking like

2358

01:37:42,870 --> 01:37:40,000

an engineer using those great stem

2359

01:37:45,350 --> 01:37:42,880

skills that's a great way to do it

2360

01:37:47,590 --> 01:37:45,360

now in addition to that now that they

2361

01:37:48,870 --> 01:37:47,600

know what their simulated sample from

2362

01:37:50,709 --> 01:37:48,880

earth is

2363

01:37:52,070 --> 01:37:50,719

now it's time to look at the simulated

2364

01:37:53,350 --> 01:37:52,080

mars sample

2365

01:37:55,590 --> 01:37:53,360

now when i do this with my

2366

01:37:58,149 --> 01:37:55,600

granddaughters i usually put that other

2367

01:38:00,310 --> 01:37:58,159

half inside a ziploc bag

2368

01:38:01,109 --> 01:38:00,320

and now i give them a brand new candy

2369

01:38:04,870 --> 01:38:01,119

bar

2370

01:38:07,189 --> 01:38:04,880

seen before they're going to do the same

2371

01:38:09,350 --> 01:38:07,199

kind of test this streak test they're

2372

01:38:11,910 --> 01:38:09,360

going to sniff it they're going to see

2373

01:38:13,590 --> 01:38:11,920

if it smudges but they aren't going to

2374

01:38:15,669 --> 01:38:13,600

eat it

2375

01:38:17,109 --> 01:38:15,679

they'll do a core sample again and

2376

01:38:19,270 --> 01:38:17,119

they'll look at the core sample then

2377

01:38:21,510 --> 01:38:19,280

they'll do a cross section and they can

2378

01:38:23,590 --> 01:38:21,520

compare their two core samples from

2379

01:38:25,669 --> 01:38:23,600

their simulated earth rock and from

2380

01:38:27,350 --> 01:38:25,679

their simulated mars rock and then they

2381

01:38:29,590 --> 01:38:27,360

can do the same thing with the with the

2382

01:38:31,750 --> 01:38:29,600

cross section the best part of this

2383

01:38:33,430 --> 01:38:31,760

particular experiment after they've made

2384

01:38:34,629 --> 01:38:33,440

all their notes

2385

01:38:36,470 --> 01:38:34,639

is to

2386

01:38:38,629 --> 01:38:36,480

give them the opportunity to eat their

2387

01:38:40,229 --> 01:38:38,639

geologic sample that's always a lot of

2388

01:38:42,709 --> 01:38:40,239

fun by the way if you want to tie in

2389

01:38:44,790 --> 01:38:42,719

some math with all that great science

2390

01:38:47,590 --> 01:38:44,800

you can you can

2391

01:38:50,149 --> 01:38:47,600

you can estimate the age of the geologic

2392

01:38:53,109 --> 01:38:50,159

specimen by counting up the number of

2393

01:38:55,270 --> 01:38:53,119

layers and giving a numerical value or

2394

01:38:56,870 --> 01:38:55,280

date for each one of those and that'll

2395

01:38:59,669 --> 01:38:56,880

be fun that'll be a lot of cool that's

2396

01:39:03,430 --> 01:38:59,679

candy bar geology mom and dad and i hope

2397

01:39:07,750 --> 01:39:06,709

some other great experiments uh to talk

2398

01:39:10,550 --> 01:39:07,760

about

2399

01:39:11,669 --> 01:39:10,560

in fact as we as we look at the rover

2400

01:39:13,189 --> 01:39:11,679

itself

2401

01:39:15,109 --> 01:39:13,199

some neat things to know some new

2402

01:39:17,990 --> 01:39:15,119

technology that's being used and tested

2403

01:39:20,550 --> 01:39:18,000

for the very first time uh perseverance

2404

01:39:22,629 --> 01:39:20,560

is uh is using that technology and it's

2405

01:39:25,270 --> 01:39:22,639

paving the way for future human missions

2406

01:39:28,470 --> 01:39:25,280

to the red planet as well this includes

2407

01:39:30,870 --> 01:39:28,480

an autopilot for avoiding hazards and

2408

01:39:34,229 --> 01:39:30,880

that autopilot is called the terrain

2409

01:39:37,350 --> 01:39:34,239

relative navigation and it uses a set of

2410

01:39:39,109 --> 01:39:37,360

sensors that'll gather data during the

2411

01:39:40,790 --> 01:39:39,119

during the descent that's part of the

2412

01:39:43,510 --> 01:39:40,800

mars entry descent and landing

2413

01:39:45,350 --> 01:39:43,520

instrumentation package or medley ii

2414

01:39:48,390 --> 01:39:45,360

that'll be really really cool there's

2415

01:39:49,990 --> 01:39:48,400

also a new autonomous navigation system

2416

01:39:52,390 --> 01:39:50,000

that will allow the rover to drive a

2417

01:39:54,629 --> 01:39:52,400

little faster over challenging terrain

2418

01:39:57,430 --> 01:39:54,639

and that'll be pretty exciting as well

2419

01:39:59,189 --> 01:39:57,440

can't wait to see those those pieces of

2420

01:40:01,189 --> 01:39:59,199

equipment in action

2421

01:40:03,430 --> 01:40:01,199

uh perseverance uh

2422

01:40:05,189 --> 01:40:03,440

is again using that uh that baseline

2423

01:40:08,470 --> 01:40:05,199

power system that we talked about before

2424

01:40:12,229 --> 01:40:08,480

that was the uh the uh the uh radio

2425

01:40:14,310 --> 01:40:12,239

isotope uh thermoelectric generator uh

2426

01:40:17,270 --> 01:40:14,320

that's being provided by the us

2427

01:40:20,310 --> 01:40:17,280

department of energy it uses heat from

2428

01:40:22,070 --> 01:40:20,320

the natural decay of plutonium-238

2429

01:40:23,990 --> 01:40:22,080

to generate electricity for the

2430

01:40:25,990 --> 01:40:24,000

spacecraft uh we had a great

2431

01:40:28,310 --> 01:40:26,000

presentation on that earlier if you

2432

01:40:31,030 --> 01:40:28,320

missed it that's some really really cool

2433

01:40:36,870 --> 01:40:33,430

shared with you the size of the in the

2434

01:40:39,430 --> 01:40:36,880

dimensions of the spacecraft itself um i

2435

01:40:41,189 --> 01:40:39,440

told you just briefly about supercam one

2436

01:40:43,030 --> 01:40:41,199

of the instruments uh that we'll be

2437

01:40:45,990 --> 01:40:43,040

using this instrument can provide

2438

01:40:48,629 --> 01:40:46,000

imaging uh chemical composition analysis

2439

01:40:50,870 --> 01:40:48,639

and mineralogy at a distance and that's

2440

01:40:53,750 --> 01:40:50,880

pretty neat that principal investigator

2441

01:40:56,470 --> 01:40:53,760

is roger roger wiens from uh from los

2442

01:40:59,189 --> 01:40:56,480

alamos national laboratory in new mexico

2443

01:41:01,750 --> 01:40:59,199

the instrument also has his was also a

2444

01:41:04,470 --> 01:41:01,760

part of a significant contribution from

2445

01:41:07,430 --> 01:41:04,480

our uh from our international partners

2446

01:41:09,270 --> 01:41:07,440

in france so again that's some some

2447

01:41:12,310 --> 01:41:09,280

really neat equipment neat things to

2448

01:41:12,320 --> 01:41:18,070

let's see

2449

01:41:23,830 --> 01:41:21,030

another question in on our social on

2450

01:41:29,189 --> 01:41:23,840

another one of our social media channels

2451
01:41:32,950 --> 01:41:30,790
looks like they wanted to know how we

2452
01:41:35,350 --> 01:41:32,960
choose a landing site how we choose

2453
01:41:36,870 --> 01:41:35,360
landing sites on the red planet i'd

2454
01:41:39,350 --> 01:41:36,880
actually found a video but you know the

2455
01:41:42,149 --> 01:41:39,360
last video that we ran for you the audio

2456
01:41:43,990 --> 01:41:42,159
was a little sketchy on that and uh

2457
01:41:47,109 --> 01:41:44,000
that's unfortunate because i thought the

2458
01:41:49,990 --> 01:41:47,119
video was great but um but to answer

2459
01:41:51,590 --> 01:41:50,000
your question um

2460
01:41:55,189 --> 01:41:51,600
answer your question it's it's kind of

2461
01:41:56,950 --> 01:41:55,199
tricky for engineers and scientists um

2462
01:41:58,790 --> 01:41:56,960
they they go to a lot of hard work and

2463
01:42:00,310 --> 01:41:58,800

they want to choose a place that's safer

2464

01:42:02,229 --> 01:42:00,320

than the land but also that's going to

2465

01:42:05,430 --> 01:42:02,239

be interesting for them to work at and

2466

01:42:08,709 --> 01:42:05,440

discover so to land safety means that

2467

01:42:10,390 --> 01:42:08,719

you can't land in any higher elevations

2468

01:42:12,629 --> 01:42:10,400

where there's not enough atmosphere to

2469

01:42:14,310 --> 01:42:12,639

slow you down and

2470

01:42:15,990 --> 01:42:14,320

and you also want to try to avoid places

2471

01:42:17,669 --> 01:42:16,000

with very steep slopes and lots of

2472

01:42:19,830 --> 01:42:17,679

boulders you want to make sure that

2473

01:42:21,830 --> 01:42:19,840

whatever your lander is is going to be

2474

01:42:23,750 --> 01:42:21,840

upright when it touches down and isn't

2475

01:42:26,950 --> 01:42:23,760

going to fall over you also want to make

2476

01:42:28,790 --> 01:42:26,960

sure that it doesn't sink into a lot of

2477

01:42:31,510 --> 01:42:28,800

dust

2478

01:42:33,030 --> 01:42:31,520

and that could create some problems um

2479

01:42:34,709 --> 01:42:33,040

you probably want to choose a place that

2480

01:42:37,830 --> 01:42:34,719

will be close to the equator where the

2481

01:42:39,430 --> 01:42:37,840

seasons aren't quite so extreme and also

2482

01:42:40,870 --> 01:42:39,440

if it's using solar power you want to

2483

01:42:43,270 --> 01:42:40,880

make sure that it's in a place where

2484

01:42:44,870 --> 01:42:43,280

it's going to receive plenty of sunlight

2485

01:42:46,550 --> 01:42:44,880

and of course you don't want to send it

2486

01:42:48,629 --> 01:42:46,560

someplace where it's just not going to

2487

01:42:50,390 --> 01:42:48,639

be able to drive if it's a rover and

2488

01:42:52,629 --> 01:42:50,400

it's going to be a mobile

2489

01:42:54,790 --> 01:42:52,639

vehicle

2490

01:42:56,470 --> 01:42:54,800

most important you're picking a landing

2491

01:42:58,310 --> 01:42:56,480

site based on what you hope to discover

2492

01:43:00,149 --> 01:42:58,320

or what you're interested in finding

2493

01:43:02,229 --> 01:43:00,159

more about

2494

01:43:05,030 --> 01:43:02,239

sites that are great for studying rock

2495

01:43:08,310 --> 01:43:05,040

layers other sites might be perfect for

2496

01:43:10,950 --> 01:43:08,320

for listening for mars quick so

2497

01:43:12,550 --> 01:43:10,960

that gives you uh gives you some ideas

2498

01:43:14,629 --> 01:43:12,560

of places that you can go you've got a

2499

01:43:15,830 --> 01:43:14,639

whole planet to choose from you just

2500

01:43:18,310 --> 01:43:15,840

want to make sure that you choose

2501

01:43:20,629 --> 01:43:18,320

carefully so the time the energy the

2502

01:43:23,030 --> 01:43:20,639

money that was spent to get your uh to

2503

01:43:25,910 --> 01:43:23,040

get your scientific package to another

2504

01:43:28,149 --> 01:43:25,920

world is able to work when it gets there

2505

01:43:36,070 --> 01:43:28,159

that's really cool stuff

2506

01:43:42,070 --> 01:43:39,270

if i hadn't mentioned it to you before

2507

01:43:43,750 --> 01:43:42,080

we do have a great nasa design challenge

2508

01:43:46,470 --> 01:43:43,760

that's coming up it'll be coming up and

2509

01:43:50,550 --> 01:43:46,480

the one o'clock hour that's just a short

2510

01:43:54,070 --> 01:43:52,870

excuse me

2511

01:43:55,750 --> 01:43:54,080

and yo

2512

01:43:57,990 --> 01:43:55,760

you're going to be uh well i don't want

2513

01:43:59,270 --> 01:43:58,000

to give too much away but uh i do want

2514

01:44:01,669 --> 01:43:59,280

to let you know it's going to be pretty

2515

01:44:02,709 --> 01:44:01,679

exciting and if you haven't already done

2516

01:44:05,750 --> 01:44:02,719

so

2517

01:44:07,990 --> 01:44:05,760

make sure that you go to our website

2518

01:44:10,390 --> 01:44:08,000

that'll be greatscience.com and once

2519

01:44:12,470 --> 01:44:10,400

you're there make sure you access our

2520

01:44:14,629 --> 01:44:12,480

events page and on the events page if

2521

01:44:16,550 --> 01:44:14,639

you go to our landing

2522

01:44:18,310 --> 01:44:16,560

the information about our landing site

2523

01:44:19,830 --> 01:44:18,320

there's a link that you can go to and

2524

01:44:21,750 --> 01:44:19,840

it'll give you a list of all the

2525

01:44:23,910 --> 01:44:21,760

materials that you're going to need

2526

01:44:31,109 --> 01:44:23,920

for this particular experiment that you

2527

01:44:35,430 --> 01:44:33,189

control room if you can

2528

01:44:38,550 --> 01:44:35,440

we're going to take a a quick break and

2529

01:44:40,629 --> 01:44:38,560

i'll i'll be right back with you as we

2530

01:44:42,870 --> 01:44:40,639

as we continue with our live coverage of

2531

01:44:44,310 --> 01:44:42,880

the perseverance lander

2532

01:44:45,990 --> 01:44:44,320

control room if you can give me that

2533

01:45:05,910 --> 01:44:46,000

break folks i'll be back in just a

2534

01:45:09,990 --> 01:45:08,310

way uh just yet but uh that's okay

2535

01:45:15,669 --> 01:45:10,000

there's still plenty to talk about and i

2536

01:45:33,189 --> 01:45:18,950

so happy and excited to be here with you

2537

01:45:41,430 --> 01:45:35,830

again using my alcohol wipe because we

2538

01:45:45,189 --> 01:45:43,350

there are a lot of great experiments

2539

01:45:48,149 --> 01:45:45,199

that are on board this rover one of them

2540

01:45:49,990 --> 01:45:48,159

is the uh is sherlock that's a scanning

2541

01:45:52,390 --> 01:45:50,000

habitable environment

2542

01:45:54,390 --> 01:45:52,400

uh with raymond and luminescence for

2543

01:45:56,229 --> 01:45:54,400

organics and chemicals

2544

01:45:58,870 --> 01:45:56,239

that's a mouthful it's got a

2545

01:46:02,470 --> 01:45:58,880

spectrometer that will provide fine line

2546

01:46:05,669 --> 01:46:02,480

scale images and uses an ultraviolet

2547

01:46:08,310 --> 01:46:05,679

laser to map mineralogy and organic

2548

01:46:11,189 --> 01:46:08,320

compounds that's so exciting

2549

01:46:13,590 --> 01:46:11,199

sherlock will be the first uv

2550

01:46:15,109 --> 01:46:13,600

spectrometer to fly to the surface of

2551

01:46:16,950 --> 01:46:15,119

mars and will provide

2552

01:46:19,350 --> 01:46:16,960

all kinds of complementary

2553

01:46:21,510 --> 01:46:19,360

measurements with other instruments in

2554

01:46:23,590 --> 01:46:21,520

the payload

2555

01:46:26,950 --> 01:46:23,600

it uh it includes a high resolution

2556

01:46:29,990 --> 01:46:26,960

color camera for microscopic imaging of

2557

01:46:32,070 --> 01:46:30,000

the martian surface that's amazing just

2558

01:46:33,510 --> 01:46:32,080

amazing the other thing that i found

2559

01:46:36,390 --> 01:46:33,520

really exciting as part of the

2560

01:46:38,830 --> 01:46:36,400

instrument package is the radar imaging

2561

01:46:40,629 --> 01:46:38,840

from mars it's a subsurface

2562

01:46:42,870 --> 01:46:40,639

experiment

2563

01:46:45,830 --> 01:46:42,880

a ground penetrating radar that will

2564

01:46:49,109 --> 01:46:45,840

provide centimeter scale resolution of

2565

01:46:50,709 --> 01:46:49,119

the geologic structure of the subsurface

2566

01:46:52,950 --> 01:46:50,719

now that's going to be really really

2567

01:46:54,629 --> 01:46:52,960

cool so far on mars we've only been able

2568

01:46:56,470 --> 01:46:54,639

to look at the surface

2569

01:46:58,790 --> 01:46:56,480

we do have a spacecraft that's there

2570

01:47:00,950 --> 01:46:58,800

that's actually penetrating the surface

2571

01:47:02,709 --> 01:47:00,960

and it's studying those mars plates but

2572

01:47:05,270 --> 01:47:02,719

this is going to give us a look using

2573

01:47:07,750 --> 01:47:05,280

that using that ground penetrating radar

2574

01:47:09,669 --> 01:47:07,760

of what's underneath the surface and it

2575

01:47:13,109 --> 01:47:09,679

will be able to do it at a scale that's

2576

01:47:14,790 --> 01:47:13,119

just uh that's just amazing so i i can't

2577

01:47:17,350 --> 01:47:14,800

wait for perseverance to get there and

2578

01:47:21,430 --> 01:47:17,360

begin using some of this equipment uh so

2579

01:47:23,590 --> 01:47:21,440

much that we're gonna learn um and i i

2580

01:47:28,709 --> 01:47:23,600

i'm speechless i just can't get over it

2581

01:47:33,750 --> 01:47:30,629

once again the spacecraft itself was

2582

01:47:36,709 --> 01:47:33,760

launched uh back in july and has been

2583

01:47:39,510 --> 01:47:36,719

traveling for seven for seven months on

2584

01:47:41,510 --> 01:47:39,520

the way to mars and uh we're just uh

2585

01:47:43,270 --> 01:47:41,520

we're just a few hours away from it

2586

01:47:45,669 --> 01:47:43,280

actually touching down on the surface of

2587

01:47:47,590 --> 01:47:45,679

mars and uh boy we're all on pins and

2588

01:47:50,629 --> 01:47:47,600

needles here we are so

2589

01:47:52,629 --> 01:47:50,639

so very very excited now again coming up

2590

01:47:53,510 --> 01:47:52,639

in uh just about 10 minutes or so we

2591

01:47:57,830 --> 01:47:53,520

have

2592

01:48:00,709 --> 01:47:57,840

joining us a long time uh

2593

01:48:03,910 --> 01:48:00,719

subject matter expert

2594

01:48:05,910 --> 01:48:03,920

who is a nasa contractor he'll be uh

2595

01:48:07,350 --> 01:48:05,920

he'll be coming and talking to us

2596

01:48:09,189 --> 01:48:07,360

guiding us through this hands-on

2597

01:48:11,189 --> 01:48:09,199

experiment and i've got most of my

2598

01:48:14,310 --> 01:48:11,199

materials ready to go so i'm going to be

2599

01:48:16,870 --> 01:48:14,320

joining you and trying to uh trying to

2600

01:48:19,830 --> 01:48:16,880

come up with a solution for this unique

2601
01:48:21,350 --> 01:48:19,840
nasa engineering design challenge it is

2602
01:48:25,910 --> 01:48:21,360
going to be a lot of fun

2603
01:48:29,189 --> 01:48:27,430
and again that's going to be at one

2604
01:48:31,510 --> 01:48:29,199
o'clock this afternoon we talked a

2605
01:48:33,189 --> 01:48:31,520
little bit about the mars helicopter a

2606
01:48:34,629 --> 01:48:33,199
while ago that's a unique experiment

2607
01:48:37,030 --> 01:48:34,639
that's actually going to be carried

2608
01:48:39,430 --> 01:48:37,040
underneath the perseverance rover once

2609
01:48:42,870 --> 01:48:39,440
it gets to uh to a fairly decent launch

2610
01:48:44,709 --> 01:48:42,880
site um perseverance will roll up it

2611
01:48:46,870 --> 01:48:44,719
will lower the helicopter down to the

2612
01:48:49,270 --> 01:48:46,880
ground and then it will back away from

2613
01:48:52,709 --> 01:48:49,280

it giving it a clear place where it can

2614

01:48:54,709 --> 01:48:52,719

lift off well we'll start up the engines

2615

01:48:56,629 --> 01:48:54,719

and then the vehicle will uh will take

2616

01:48:58,550 --> 01:48:56,639

to the air two cameras on board that

2617

01:49:00,629 --> 01:48:58,560

mars helicopter and it should give us

2618

01:49:03,669 --> 01:49:00,639

some very unique views and i'm looking

2619

01:49:06,310 --> 01:49:03,679

forward to that as well again it weighs

2620

01:49:07,510 --> 01:49:06,320

about four pounds it's about four foot

2621

01:49:08,550 --> 01:49:07,520

maybe

2622

01:49:12,870 --> 01:49:08,560

meter

2623

01:49:14,629 --> 01:49:12,880

it's uh it's going to be neat and again

2624

01:49:16,709 --> 01:49:14,639

it's equipped with all kinds of internal

2625

01:49:18,470 --> 01:49:16,719

sensors a laser altimeter the two

2626

01:49:20,629 --> 01:49:18,480

cameras one in color one in black and

2627

01:49:23,590 --> 01:49:20,639

white it's going to be amazing it's

2628

01:49:25,590 --> 01:49:23,600

designed to operate autonomously

2629

01:49:28,550 --> 01:49:25,600

and again the helicopter will be using

2630

01:49:31,430 --> 01:49:28,560

solar power to charge its batteries and

2631

01:49:33,590 --> 01:49:31,440

will rely on internal heaters to remain

2632

01:49:36,390 --> 01:49:33,600

at the optimum temperature during the

2633

01:49:37,750 --> 01:49:36,400

cold martian nights it does it does get

2634

01:49:40,830 --> 01:49:37,760

cold

2635

01:49:44,149 --> 01:49:40,840

by the way i believe it was

2636

01:49:46,310 --> 01:49:44,159

tabitha who wrote in

2637

01:49:48,629 --> 01:49:46,320

sent a message in

2638

01:49:51,430 --> 01:49:48,639

uh sent us a tweet and she was

2639

01:49:57,030 --> 01:49:51,440

interested in finding out more about the

2640

01:49:58,790 --> 01:49:57,040

temperature on mars she she had a

2641

01:50:02,629 --> 01:49:58,800

she her question was

2642

01:50:04,790 --> 01:50:02,639

um if uh if mars is red how can it be

2643

01:50:07,109 --> 01:50:04,800

cold she thought that mars would be hot

2644

01:50:10,149 --> 01:50:07,119

because it was red in color but

2645

01:50:12,390 --> 01:50:10,159

in reality tabitha mars is about twice

2646

01:50:15,350 --> 01:50:12,400

the distance from the sun as the earth

2647

01:50:17,030 --> 01:50:15,360

is so uh it it um

2648

01:50:19,590 --> 01:50:17,040

it's gonna it's gonna be a little bit

2649

01:50:21,430 --> 01:50:19,600

colder as a very thin atmosphere and our

2650

01:50:23,030 --> 01:50:21,440

atmosphere here on earth is a lot like a

2651

01:50:24,629 --> 01:50:23,040

blanket it helps to even out the

2652

01:50:25,910 --> 01:50:24,639

temperature all the way around and

2653

01:50:28,550 --> 01:50:25,920

that's how we can stay nice and

2654

01:50:30,310 --> 01:50:28,560

comfortable even on cold chilly days in

2655

01:50:33,270 --> 01:50:30,320

cleveland like it is today but it's

2656

01:50:35,350 --> 01:50:33,280

relatively speaking much warmer um

2657

01:50:38,149 --> 01:50:35,360

on it's certainly much warmer than it is

2658

01:50:40,550 --> 01:50:38,159

on mars you know at the equator on mars

2659

01:50:44,470 --> 01:50:40,560

on the hottest summer day your toes

2660

01:50:45,430 --> 01:50:44,480

would feel fairly warm around 50 degrees

2661

01:50:47,750 --> 01:50:45,440

or so

2662

01:50:49,590 --> 01:50:47,760

but by the time you got up to your chest

2663

01:50:51,510 --> 01:50:49,600

your neck and even your head it would

2664

01:50:53,830 --> 01:50:51,520

feel like winter time again the

2665

01:50:57,030 --> 01:50:53,840

atmosphere is so thin there's not enough

2666

01:50:59,189 --> 01:50:57,040

of an insulating blanket of air to keep

2667

01:51:01,590 --> 01:50:59,199

you nice and warm uh the heat that's

2668

01:51:04,070 --> 01:51:01,600

radiating from the sun

2669

01:51:05,669 --> 01:51:04,080

well it's not it's not nearly as warm

2670

01:51:07,669 --> 01:51:05,679

and there's no way to really keep it

2671

01:51:09,830 --> 01:51:07,679

there with you that's why we need those

2672

01:51:12,070 --> 01:51:09,840

special electrical systems electrical

2673

01:51:14,709 --> 01:51:12,080

generating systems to help keep the

2674

01:51:18,390 --> 01:51:14,719

rover warm so it will operate in those

2675

01:51:21,109 --> 01:51:18,400

cold temperatures there on mars

2676

01:51:23,669 --> 01:51:21,119

neat stuff we are just a few minutes

2677

01:51:26,870 --> 01:51:23,679

away from the start of uh of that

2678

01:51:28,229 --> 01:51:26,880

exciting nasa challenge uh it's gonna be

2679

01:51:34,870 --> 01:51:28,239

a great one so you don't want to miss it

2680

01:51:38,950 --> 01:51:37,109

now jezreel crater is the site of the

2681

01:51:41,430 --> 01:51:38,960

landing for this mission and again we

2682

01:51:43,589 --> 01:51:41,440

told you once before it was chosen uh

2683

01:51:45,910 --> 01:51:43,599

because of the way that the the crater

2684

01:51:47,910 --> 01:51:45,920

looked it looked like it contained water

2685

01:51:49,430 --> 01:51:47,920

uh for a long period of time i i

2686

01:51:52,070 --> 01:51:49,440

mentioned to you that you could see

2687

01:51:54,470 --> 01:51:52,080

channels were uh where water flowed into

2688

01:51:56,390 --> 01:51:54,480

the crater and we even have uh we even

2689

01:51:57,990 --> 01:51:56,400

have an outflow channel on the other

2690

01:51:59,750 --> 01:51:58,000

side of the crater so you can see where

2691

01:52:01,030 --> 01:51:59,760

water flowed through the crater and out

2692

01:52:03,030 --> 01:52:01,040

the other side

2693

01:52:05,189 --> 01:52:03,040

eventually that water

2694

01:52:07,910 --> 01:52:05,199

the water started settled there in that

2695

01:52:09,430 --> 01:52:07,920

space and then eventually it all dried

2696

01:52:11,430 --> 01:52:09,440

up but not before leaving a lot of

2697

01:52:14,550 --> 01:52:11,440

sediment there and that's pretty neat

2698

01:52:16,149 --> 01:52:14,560

we'll be able to access it

2699

01:52:18,790 --> 01:52:16,159

so it looks like we've got just a few

2700

01:52:20,629 --> 01:52:18,800

more minutes to go before uh before that

2701

01:52:23,589 --> 01:52:20,639

uh before that

2702

01:52:25,350 --> 01:52:23,599

neat engineering challenge

2703

01:52:33,430 --> 01:52:25,360

make sure you have your supplies with

2704

01:52:45,830 --> 01:52:34,790

still taking a look at some of the other

2705

01:52:49,270 --> 01:52:47,350

looks like they're getting a message to

2706

01:52:51,430 --> 01:52:49,280

me

2707

01:52:53,669 --> 01:52:51,440

always giving updates about this uh

2708

01:52:56,629 --> 01:52:53,679

about this important mission again earth

2709

01:52:58,470 --> 01:52:56,639

and mars are more than 300 million miles

2710

01:53:00,709 --> 01:52:58,480

apart

2711

01:53:03,430 --> 01:53:00,719

but so far it appears that the uh that

2712

01:53:05,189 --> 01:53:03,440

the vehicle is performing nominally

2713

01:53:06,950 --> 01:53:05,199

about 10 minutes before it enters the

2714

01:53:09,510 --> 01:53:06,960

atmosphere it's going to shed the the

2715

01:53:13,189 --> 01:53:09,520

cruise stage for the vehicle and once

2716

01:53:15,589 --> 01:53:13,199

that's disconnected then a new new radio

2717

01:53:18,149 --> 01:53:15,599

receiver will have to kick in on the on

2718

01:53:21,350 --> 01:53:18,159

the landing uh aeroshell

2719

01:53:23,589 --> 01:53:21,360

and then once the uh once the rover shed

2720

01:53:26,070 --> 01:53:23,599

see uh sheds the uh

2721

01:53:28,550 --> 01:53:26,080

the aeroshell then another radio

2722

01:53:30,229 --> 01:53:28,560

transceiver will take over so there's

2723

01:53:31,510 --> 01:53:30,239

plenty of opportunities for something to

2724

01:53:37,750 --> 01:53:31,520

go wrong

2725

01:53:42,629 --> 01:53:39,430

looks like a question came in folks were

2726
01:53:44,709 --> 01:53:42,639
asking a little bit more about moxie

2727
01:53:46,629 --> 01:53:44,719
moxie is one of the unique experiments

2728
01:53:49,030 --> 01:53:46,639
that we'll be testing

2729
01:53:51,589 --> 01:53:49,040
now the information that i have here in

2730
01:53:53,910 --> 01:53:51,599
my notes

2731
01:53:56,070 --> 01:53:53,920
this is a technology demonstration that

2732
01:53:58,390 --> 01:53:56,080
will produce oxygen from the martian

2733
01:54:00,950 --> 01:53:58,400
atmosphere and in the atmosphere on mars

2734
01:54:03,589 --> 01:54:00,960
is mostly carbon dioxide

2735
01:54:06,550 --> 01:54:03,599
so if successful moxie's technology can

2736
01:54:09,830 --> 01:54:06,560
be used by future astronauts on mars to

2737
01:54:11,109 --> 01:54:09,840
burn rocket fuel for returning to earth

2738
01:54:12,390 --> 01:54:11,119

um

2739

01:54:14,870 --> 01:54:12,400

and it's going to be it's going to be

2740

01:54:17,189 --> 01:54:14,880

really neat as well as providing oxygen

2741

01:54:19,430 --> 01:54:17,199

for uh for a crew to supplement

2742

01:54:21,750 --> 01:54:19,440

what they already have as i think i

2743

01:54:22,470 --> 01:54:21,760

might have mentioned earlier if we can

2744

01:54:24,790 --> 01:54:22,480

make

2745

01:54:26,709 --> 01:54:24,800

our own oxygen and our own rocket fuel

2746

01:54:28,950 --> 01:54:26,719

there then we don't need to carry all

2747

01:54:31,830 --> 01:54:28,960

the fuel that we need to uh to leave

2748

01:54:34,310 --> 01:54:31,840

earth travel to mars and to go home

2749

01:54:36,390 --> 01:54:34,320

less fuel means less weight so

2750

01:54:39,750 --> 01:54:36,400

it doesn't take as much fuel to get us

2751

01:54:41,910 --> 01:54:39,760

off the ground also

2752

01:54:43,350 --> 01:54:41,920

if there's more room because we don't

2753

01:54:45,669 --> 01:54:43,360

have to carry the fuel we need to get

2754

01:54:48,390 --> 01:54:45,679

home that's more room for an additional

2755

01:54:50,629 --> 01:54:48,400

payload and that means that we can take

2756

01:54:52,709 --> 01:54:50,639

more experiments more stuff to the red

2757

01:54:54,790 --> 01:54:52,719

planet and that'll be so cool moxie

2758

01:54:57,990 --> 01:54:54,800

again is an acronym that stands for the

2759

01:55:00,390 --> 01:54:58,000

mars oxygen in sync2 resource

2760

01:55:03,030 --> 01:55:00,400

utilization experiment

2761

01:55:08,709 --> 01:55:06,070

e m-o-x-i-e we hope to be able to uh we

2762

01:55:11,109 --> 01:55:08,719

hope to be able to produce uh oxygen out

2763

01:55:12,950 --> 01:55:11,119

of the thin martian air that's going to

2764

01:55:17,270 --> 01:55:12,960

be really cool

2765

01:55:20,790 --> 01:55:19,189

we've got folks working in all kinds of

2766

01:55:23,109 --> 01:55:20,800

places to make sure that we have what

2767

01:55:24,790 --> 01:55:23,119

what it is that we need

2768

01:55:26,229 --> 01:55:24,800

still a few minutes left if you haven't

2769

01:55:27,750 --> 01:55:26,239

gathered up all those materials and

2770

01:55:29,750 --> 01:55:27,760

supplies that you're going to need to do

2771

01:55:32,550 --> 01:55:29,760

that science experiment you want to make

2772

01:55:38,470 --> 01:55:32,560

sure that you go ahead and get a hold of

2773

01:55:43,430 --> 01:55:40,709

so excited about this mission

2774

01:55:45,109 --> 01:55:43,440

and all that all it'll be able to do

2775

01:55:47,030 --> 01:55:45,119

again the

2776

01:55:49,510 --> 01:55:47,040

mission planners designed this mission

2777

01:55:51,589 --> 01:55:49,520

to last for uh for one martian year

2778

01:55:53,189 --> 01:55:51,599

that's two earth years and that

2779

01:55:55,030 --> 01:55:53,199

difference is because earth and mars

2780

01:55:56,390 --> 01:55:55,040

have different orbits around the sun it

2781

01:55:58,470 --> 01:55:56,400

takes the earth

2782

01:56:01,030 --> 01:55:58,480

one full year to complete a circuit

2783

01:56:03,270 --> 01:56:01,040

around the sun now mars is twice the

2784

01:56:05,189 --> 01:56:03,280

distance from the sun that the earth is

2785

01:56:07,830 --> 01:56:05,199

meaning that it's going to take mars

2786

01:56:10,550 --> 01:56:07,840

twice as long to get all the way around

2787

01:56:12,950 --> 01:56:10,560

the sun so one martian year is equal to

2788

01:56:15,430 --> 01:56:12,960

two earth years and this vehicle is

2789

01:56:17,830 --> 01:56:15,440

designed to last that long but again as

2790

01:56:19,669 --> 01:56:17,840

we talked about earlier if it's anything

2791

01:56:22,870 --> 01:56:19,679

like the great engineering that was done

2792

01:56:23,830 --> 01:56:22,880

on previous rovers it it will last much

2793

01:56:26,550 --> 01:56:23,840

longer

2794

01:56:28,950 --> 01:56:26,560

to give you an example uh our last rover

2795

01:56:30,950 --> 01:56:28,960

that went to mars landed nine years ago

2796

01:56:34,470 --> 01:56:30,960

that was a curiosity rover and by the

2797

01:56:35,910 --> 01:56:34,480

way curiosity is still operating on mars

2798

01:56:39,270 --> 01:56:35,920

just like this rover it was only

2799

01:56:42,550 --> 01:56:39,280

designed to operate for a period of

2800

01:56:44,470 --> 01:56:42,560

of two earth years but at the end of its

2801

01:56:47,589 --> 01:56:44,480

primary mission it was still going still

2802

01:56:50,229 --> 01:56:47,599

going strong and so the mission has been

2803

01:56:53,750 --> 01:56:50,239

extended and continues to this very day

2804

01:56:56,470 --> 01:56:53,760

curiosity made enormous number of uh

2805

01:56:58,790 --> 01:56:56,480

an enormous number of discoveries and we

2806

01:57:00,790 --> 01:56:58,800

expect nothing less from perseverance

2807

01:57:03,189 --> 01:57:00,800

and perseverance has new equipment more

2808

01:57:06,229 --> 01:57:03,199

sophisticated equipment that can tell us

2809

01:57:09,380 --> 01:57:06,239

more about the story of mars i can't

2810

01:57:12,149 --> 01:57:09,390

wait it's going to be so exciting

2811

01:57:13,910 --> 01:57:12,159

[Music]

2812

01:57:17,030 --> 01:57:13,920

other questions are coming in for us and

2813

01:57:19,830 --> 01:57:17,040

we're trying to keep up with them

2814

01:57:23,189 --> 01:57:19,840

want to say hi to al and to

2815

01:57:26,229 --> 01:57:24,950

swati i hope i'm pronouncing that

2816

01:57:28,470 --> 01:57:26,239

correctly

2817

01:57:31,430 --> 01:57:28,480

has joined us as well and that's uh

2818

01:57:33,669 --> 01:57:31,440

that's pretty exciting

2819

01:57:36,709 --> 01:57:33,679

having somebody here that's joining us

2820

01:57:39,510 --> 01:57:36,719

from the virgin islands how exciting is

2821

01:57:45,350 --> 01:57:39,520

that

2822

01:57:49,510 --> 01:57:47,350

we'll be able to look at them at look at

2823

01:57:52,390 --> 01:57:49,520

mars from the air we'll be able to

2824

01:57:54,390 --> 01:57:52,400

penetrate using ground penetrating radar

2825

01:57:58,310 --> 01:57:54,400

to be able to look underneath

2826
01:57:59,430 --> 01:57:58,320
new experiments that are there

2827
01:58:01,510 --> 01:57:59,440
ways to

2828
01:58:04,950 --> 01:58:01,520
to look for organics

2829
01:58:07,189 --> 01:58:04,960
to study the geology of mars all in new

2830
01:58:08,790 --> 01:58:07,199
ways with new and exciting equipment

2831
01:58:11,510 --> 01:58:08,800
plus we're demonstrating some great

2832
01:58:14,149 --> 01:58:11,520
technology that's going to allow the uh

2833
01:58:16,790 --> 01:58:14,159
the vehicle the spacecraft to touch down

2834
01:58:19,430 --> 01:58:16,800
on mars much closer to our target

2835
01:58:21,510 --> 01:58:19,440
landing site than ever before and again

2836
01:58:22,950 --> 01:58:21,520
these are all new technologies

2837
01:58:25,510 --> 01:58:22,960
that are being tested and utilized for

2838
01:58:27,270 --> 01:58:25,520

the very first time it's going to be so

2839

01:58:29,830 --> 01:58:27,280

very very exciting and we're so glad

2840

01:58:31,910 --> 01:58:29,840

that you were able to join us as we as

2841

01:58:32,870 --> 01:58:31,920

we bring you continuing continuing

2842

01:58:35,430 --> 01:58:32,880

coverage

2843

01:58:39,750 --> 01:58:35,440

of the uh of the upcoming mars

2844

01:58:44,790 --> 01:58:42,229

our friends at the uh at the nasa glenn

2845

01:58:47,030 --> 01:58:44,800

research center big sponsors here at the

2846

01:58:49,669 --> 01:58:47,040

great lakes science center have joined

2847

01:58:52,070 --> 01:58:49,679

us as well so as you have questions and

2848

01:58:54,070 --> 01:58:52,080

you enter those questions uh you post

2849

01:58:56,149 --> 01:58:54,080

your questions in addition to myself we

2850

01:58:57,910 --> 01:58:56,159

have subject matter experts at nasa

2851
01:59:00,310 --> 01:58:57,920
glenn who are responding to some of

2852
01:59:02,229 --> 01:59:00,320
those questions as well

2853
01:59:03,589 --> 01:59:02,239
uh deborah mccrory hey we're glad that

2854
01:59:05,589 --> 01:59:03,599
you're with us

2855
01:59:16,070 --> 01:59:05,599
and uh and keep on answering some of

2856
01:59:23,750 --> 01:59:18,149
raphael

2857
01:59:25,669 --> 01:59:23,760
joining us from uh from upstate new york

2858
01:59:37,109 --> 01:59:25,679
glad to have you with us tuning in to

2859
01:59:42,629 --> 01:59:40,950
so between the mars helicopter

2860
01:59:44,070 --> 01:59:42,639
moxie it's also

2861
01:59:46,070 --> 01:59:44,080
also one of the unique science

2862
01:59:48,870 --> 01:59:46,080
instruments in fact there's seven

2863
01:59:49,750 --> 01:59:48,880

instruments that are truly amazing that

2864

01:59:54,870 --> 01:59:49,760

are

2865

01:59:57,030 --> 01:59:54,880

we talked about mass cam z one of those

2866

01:59:58,709 --> 01:59:57,040

uh one of those seven instruments it

2867

02:00:02,070 --> 01:59:58,719

will help us to conduct

2868

02:00:03,750 --> 02:00:02,080

some unprecedented science and research

2869

02:00:05,430 --> 02:00:03,760

uh in addition to testing some of the

2870

02:00:07,430 --> 02:00:05,440

new technology that we talked about

2871

02:00:14,550 --> 02:00:07,440

before it's uh it's truly going to be

2872

02:00:19,510 --> 02:00:16,709

well it looks like it's that time

2873

02:00:22,629 --> 02:00:19,520

and and i can't wait to begin this uh

2874

02:00:26,390 --> 02:00:22,639

unique nasa design challenge

2875

02:00:28,470 --> 02:00:26,400

um it is uh it is a free activity and uh

2876

02:00:30,070 --> 02:00:28,480

and here to introduce that activity and

2877

02:00:32,950 --> 02:00:30,080

to guide us through it is a good friend

2878

02:00:35,189 --> 02:00:32,960

of mine roger storm he's a stem educator

2879

02:00:38,310 --> 02:00:35,199

with paragon tech supporting nasa

2880

02:00:40,629 --> 02:00:38,320

glenn's office of stem engagement he'll

2881

02:00:42,229 --> 02:00:40,639

be facilitating the activity roger good

2882

02:00:43,990 --> 02:00:42,239

to see you are you ready

2883

02:00:46,149 --> 02:00:44,000

john dar it's good to see you and we are

2884

02:00:47,910 --> 02:00:46,159

ready i am too i've got all my equipment

2885

02:00:50,629 --> 02:00:47,920

i'm ready to do this experiment it's all

2886

02:00:53,109 --> 02:00:50,639

yours sir super super well

2887

02:00:55,109 --> 02:00:53,119

hello everybody my name is roger storm

2888

02:00:57,270 --> 02:00:55,119

and i am at the nasa glenn research

2889

02:00:59,910 --> 02:00:57,280

center here in cleveland ohio

2890

02:01:02,070 --> 02:00:59,920

and we are set today to do an

2891

02:01:03,510 --> 02:01:02,080

engineering design challenge we're going

2892

02:01:06,390 --> 02:01:03,520

to involve you

2893

02:01:08,470 --> 02:01:06,400

in designing a drag device to slow

2894

02:01:10,950 --> 02:01:08,480

things down and that's going to be very

2895

02:01:13,030 --> 02:01:10,960

important in landing today just

2896

02:01:15,830 --> 02:01:13,040

wow just a little over two hours

2897

02:01:17,589 --> 02:01:15,840

for our perseverance rover

2898

02:01:19,189 --> 02:01:17,599

so uh

2899

02:01:20,830 --> 02:01:19,199

it's great to have you i hope you've

2900

02:01:22,629 --> 02:01:20,840

gathered your supplies

2901

02:01:25,990 --> 02:01:22,639

uh

2902

02:01:28,470 --> 02:01:26,000

to participate in the challenge

2903

02:01:30,790 --> 02:01:28,480

if not you can go to great lakes times

2904

02:01:33,589 --> 02:01:30,800

at greatscience.com

2905

02:01:35,270 --> 02:01:33,599

events and they have a list there

2906

02:01:37,109 --> 02:01:35,280

you can get can't get right today you

2907

02:01:38,550 --> 02:01:37,119

can do this another day or later today

2908

02:01:40,310 --> 02:01:38,560

but it's a great thing to try and do

2909

02:01:41,830 --> 02:01:40,320

you're going to become an engineer

2910

02:01:43,990 --> 02:01:41,840

one of the things that's exciting for me

2911

02:01:47,109 --> 02:01:44,000

about this is that i'm talking to some

2912

02:01:48,550 --> 02:01:47,119

people uh who could be the first people

2913

02:01:50,950 --> 02:01:48,560

on mars

2914

02:01:51,750 --> 02:01:50,960

uh we are taking kind of baby steps

2915

02:01:53,990 --> 02:01:51,760

still

2916

02:01:55,510 --> 02:01:54,000

uh it's a it's not a baby thing that

2917

02:01:58,229 --> 02:01:55,520

we're doing it's an exciting thing that

2918

02:02:00,070 --> 02:01:58,239

we're doing um but we're progressing so

2919

02:02:02,070 --> 02:02:00,080

we can get some people actually go to

2920

02:02:04,390 --> 02:02:02,080

mars and those people today are probably

2921

02:02:06,550 --> 02:02:04,400

in the fourth or fifth grade

2922

02:02:09,189 --> 02:02:06,560

so it could be you that would be the

2923

02:02:11,270 --> 02:02:09,199

first martian that's pretty neat well i

2924

02:02:13,030 --> 02:02:11,280

have some friends with me today from the

2925

02:02:14,629 --> 02:02:13,040

lakewood city schools

2926
02:02:15,669 --> 02:02:14,639
and they're going to be participating in

2927
02:02:17,830 --> 02:02:15,679
making

2928
02:02:20,229 --> 02:02:17,840
uh in doing this design challenge so

2929
02:02:21,589 --> 02:02:20,239
they've got their supplies ready um

2930
02:02:24,550 --> 02:02:21,599
we're going to do a little background

2931
02:02:27,030 --> 02:02:24,560
information i'm going to share my screen

2932
02:02:28,950 --> 02:02:27,040
uh with everybody today

2933
02:02:31,030 --> 02:02:28,960
and talk a little bit about what's going

2934
02:02:33,669 --> 02:02:31,040
to be involved in this

2935
02:02:35,030 --> 02:02:33,679
great endeavor so let's go to

2936
02:02:37,189 --> 02:02:35,040
screen number one

2937
02:02:39,589 --> 02:02:37,199
and we will share

2938
02:02:44,149 --> 02:02:42,629

let's see oh dear we got what happened

2939

02:02:45,270 --> 02:02:44,159

there we go

2940

02:02:46,470 --> 02:02:45,280

okay

2941

02:02:48,390 --> 02:02:46,480

so we're going to talk about lending

2942

02:02:51,430 --> 02:02:48,400

perseverance on mars it's exciting for

2943

02:02:52,709 --> 02:02:51,440

nasa to be here today uh particularly uh

2944

02:02:55,189 --> 02:02:52,719

with our partners the great lakes

2945

02:02:56,870 --> 02:02:55,199

science center who host our

2946

02:02:58,470 --> 02:02:56,880

visitor center they have an apollo

2947

02:02:59,990 --> 02:02:58,480

capsule and so many neat things if you

2948

02:03:01,750 --> 02:03:00,000

ever get a chance to go there boy don't

2949

02:03:03,510 --> 02:03:01,760

pass it up

2950

02:03:05,030 --> 02:03:03,520

this is our 80th anniversary here at the

2951

02:03:07,350 --> 02:03:05,040

glenn research center

2952

02:03:09,109 --> 02:03:07,360

we broke ground for uh the research

2953

02:03:11,430 --> 02:03:09,119

center which is next to the airport here

2954

02:03:15,030 --> 02:03:11,440

in cleveland 80 years ago

2955

02:03:16,070 --> 02:03:15,040

and it was created as a center to study

2956

02:03:18,950 --> 02:03:16,080

engines

2957

02:03:23,270 --> 02:03:18,960

fuels

2958

02:03:26,470 --> 02:03:25,189

we have about three thousand people over

2959

02:03:28,470 --> 02:03:26,480

three thousand people that work out

2960

02:03:29,430 --> 02:03:28,480

there at the research center

2961

02:03:30,790 --> 02:03:29,440

and

2962

02:03:32,310 --> 02:03:30,800

it is

2963

02:03:35,109 --> 02:03:32,320

an amazing place to be there are wind

2964

02:03:37,030 --> 02:03:35,119

tunnels four big wind tunnels there

2965

02:03:40,470 --> 02:03:37,040

we do research on like i say on engines

2966

02:03:42,390 --> 02:03:40,480

on fuels on microgravity on materials

2967

02:03:44,950 --> 02:03:42,400

things that make things fly better

2968

02:03:47,990 --> 02:03:44,960

on solar energy uh

2969

02:03:49,430 --> 02:03:48,000

on radioactive isotope energies uh if

2970

02:03:51,510 --> 02:03:49,440

you were with us earlier you heard is

2971

02:03:54,790 --> 02:03:51,520

what's powering perseverance what's

2972

02:03:56,310 --> 02:03:54,800

going to power perseverance on mars

2973

02:03:58,870 --> 02:03:56,320

so we are pushing boundaries and

2974

02:04:01,109 --> 02:03:58,880

breaking barriers and even uh it's kind

2975

02:04:03,750 --> 02:04:01,119

of neat that uh this logo that we use

2976
02:04:05,270 --> 02:04:03,760
for nasa was designed by a nasa glenn

2977
02:04:08,950 --> 02:04:05,280
engineer

2978
02:04:10,790 --> 02:04:08,960
okay we became part of nasa itself we

2979
02:04:12,229 --> 02:04:10,800
were originally part of what something

2980
02:04:14,870 --> 02:04:12,239
called naca the national advisory

2981
02:04:17,910 --> 02:04:14,880
council on aeronautics and in 1958

2982
02:04:19,669 --> 02:04:17,920
when president eisenhower organized nasa

2983
02:04:21,109 --> 02:04:19,679
uh we became part of that organization

2984
02:04:23,830 --> 02:04:21,119
there are 10 nasa centers around the

2985
02:04:25,990 --> 02:04:23,840
country and we are proud to be part of

2986
02:04:27,990 --> 02:04:26,000
that family

2987
02:04:29,109 --> 02:04:28,000
so let's uh

2988
02:04:31,030 --> 02:04:29,119

let's get into a little bit of

2989

02:04:33,830 --> 02:04:31,040

information here i'm gonna ask my

2990

02:04:35,750 --> 02:04:33,840

friends at uh at lakewood uh

2991

02:04:37,350 --> 02:04:35,760

we had a race uh who do you think's

2992

02:04:38,709 --> 02:04:37,360

gonna win the race

2993

02:04:40,950 --> 02:04:38,719

if you think it's the guy on the left

2994

02:04:42,229 --> 02:04:40,960

raise your hand

2995

02:04:43,430 --> 02:04:42,239

i don't see any hands what about the

2996

02:04:44,709 --> 02:04:43,440

person on the right think they're going

2997

02:04:47,830 --> 02:04:44,719

to win

2998

02:04:53,030 --> 02:04:47,840

oh no hands for that so why do you think

2999

02:04:57,350 --> 02:04:55,109

okay well it looks like they're running

3000

02:04:58,950 --> 02:04:57,360

through different fluids the person on

3001

02:05:01,109 --> 02:04:58,960

the left is running through a fluid we

3002

02:05:02,870 --> 02:05:01,119

call air

3003

02:05:05,109 --> 02:05:02,880

and the person on the right is running

3004

02:05:07,030 --> 02:05:05,119

through a fluid of water

3005

02:05:09,189 --> 02:05:07,040

and anytime you move through a fluid you

3006

02:05:10,229 --> 02:05:09,199

get some resistance

3007

02:05:14,070 --> 02:05:10,239

and

3008

02:05:16,310 --> 02:05:14,080

in this case the resistance we call drag

3009

02:05:17,030 --> 02:05:16,320

so the fluid resists you moving through

3010

02:05:18,550 --> 02:05:17,040

it

3011

02:05:20,310 --> 02:05:18,560

the thicker the fluid

3012

02:05:21,430 --> 02:05:20,320

okay the more resistance you're going to

3013

02:05:23,669 --> 02:05:21,440

have

3014

02:05:26,390 --> 02:05:23,679

also the faster you move the greater the

3015

02:05:28,470 --> 02:05:26,400

drag so drag is a force we have to

3016

02:05:31,350 --> 02:05:28,480

account for when we go through the air

3017

02:05:34,629 --> 02:05:31,360

with airplanes and aircraft so

3018

02:05:36,870 --> 02:05:34,639

drag always kind of pulls us back

3019

02:05:38,790 --> 02:05:36,880

as we kind of go through so to minimize

3020

02:05:41,030 --> 02:05:38,800

drag if you look at aircraft or you look

3021

02:05:43,030 --> 02:05:41,040

at fish or anything that moves through a

3022

02:05:46,390 --> 02:05:43,040

fluid they to get through easier they

3023

02:05:48,390 --> 02:05:46,400

have pointy noses and pointy tails and

3024

02:05:50,629 --> 02:05:48,400

that helps to minimize the drag so the

3025

02:05:52,709 --> 02:05:50,639

shape of an object influences how much

3026

02:05:54,709 --> 02:05:52,719

drag it encounters

3027

02:05:57,030 --> 02:05:54,719

when we landed the space shuttle when we

3028

02:05:59,189 --> 02:05:57,040

were flying the space shuttle uh we

3029

02:06:01,510 --> 02:05:59,199

wanted to take advantage of drag we

3030

02:06:02,390 --> 02:06:01,520

wanted to help use the drag to slow us

3031

02:06:04,950 --> 02:06:02,400

down

3032

02:06:07,270 --> 02:06:04,960

so this uh spacecraft that we commonly

3033

02:06:10,310 --> 02:06:07,280

call a space shuttle is a very very

3034

02:06:13,510 --> 02:06:10,320

blunt nose not a pointy nose a very

3035

02:06:15,510 --> 02:06:13,520

square back end not a pointy back end so

3036

02:06:17,910 --> 02:06:15,520

it created a lot of dragon so when we

3037

02:06:20,470 --> 02:06:17,920

landed coming in from his face at 25 000

3038

02:06:22,149 --> 02:06:20,480

miles an hour it used the drag of the

3039

02:06:24,470 --> 02:06:22,159

air to slow down you can also see we

3040

02:06:26,629 --> 02:06:24,480

used a parachute

3041

02:06:29,350 --> 02:06:26,639

it came out on landing to help slow the

3042

02:06:31,109 --> 02:06:29,360

aircraft down even more

3043

02:06:32,950 --> 02:06:31,119

so drag is really an important concept

3044

02:06:34,149 --> 02:06:32,960

for what we're talking about today and

3045

02:06:36,229 --> 02:06:34,159

for the challenge we're going to be

3046

02:06:38,550 --> 02:06:36,239

doing today okay

3047

02:06:40,629 --> 02:06:38,560

so in a few hours persevere it's going

3048

02:06:41,750 --> 02:06:40,639

to arrive at the edge of the martian

3049

02:06:44,310 --> 02:06:41,760

atmosphere

3050

02:06:46,550 --> 02:06:44,320

it's going to be going 12 500 miles an

3051
02:06:48,790 --> 02:06:46,560
hour you know to take off to leave the

3052
02:06:50,950 --> 02:06:48,800
earth it's hard to do

3053
02:06:53,109 --> 02:06:50,960
you can imagine going and taking a

3054
02:06:55,189 --> 02:06:53,119
cement block and trying to throw it up

3055
02:06:56,709 --> 02:06:55,199
on the roof of your house

3056
02:06:59,910 --> 02:06:56,719
well gravity's going to have a lot to

3057
02:07:03,189 --> 02:06:59,920
say about that not being very successful

3058
02:07:04,470 --> 02:07:03,199
can you imagine trying to get a 2 000

3059
02:07:06,310 --> 02:07:04,480
pound

3060
02:07:08,629 --> 02:07:06,320
rover off the earth and what kind of

3061
02:07:10,950 --> 02:07:08,639
energy that takes

3062
02:07:13,510 --> 02:07:10,960
we use rockets to do that rockets have a

3063
02:07:15,990 --> 02:07:13,520

lot of energy available they carry a lot

3064

02:07:19,030 --> 02:07:16,000

of fuel about 90 of the weight of a

3065

02:07:21,990 --> 02:07:19,040

rocket is just made up of just the fuel

3066

02:07:23,510 --> 02:07:22,000

and it gets this going very very fast to

3067

02:07:27,430 --> 02:07:23,520

leave the earth we've got to get going

3068

02:07:31,750 --> 02:07:27,440

25 000 miles an hour so back on july

3069

02:07:35,750 --> 02:07:31,760

uh july 30th okay of 2020 we launched

3070

02:07:38,790 --> 02:07:35,760

this spacecraft on an atlas v rocket

3071

02:07:40,790 --> 02:07:38,800

and it got it headed towards mars at 25

3072

02:07:42,390 --> 02:07:40,800

000 miles an hour now some people think

3073

02:07:43,830 --> 02:07:42,400

that to get

3074

02:07:46,470 --> 02:07:43,840

elevated water is going to take a lot of

3075

02:07:48,709 --> 02:07:46,480

fuel it's a long way away

3076

02:07:50,629 --> 02:07:48,719

we launched when when earth is closest

3077

02:07:52,470 --> 02:07:50,639

okay that happens about

3078

02:07:54,390 --> 02:07:52,480

about every 26 months because we have

3079

02:07:56,390 --> 02:07:54,400

different orbital speeds

3080

02:07:58,790 --> 02:07:56,400

and so sometimes mars is far away from

3081

02:08:00,310 --> 02:07:58,800

us sometimes mars is closer to us

3082

02:08:02,310 --> 02:08:00,320

well launched when it's close okay when

3083

02:08:04,390 --> 02:08:02,320

it's not so long a trip

3084

02:08:06,310 --> 02:08:04,400

in doing that okay

3085

02:08:08,149 --> 02:08:06,320

launched the rocket took a lot of energy

3086

02:08:09,910 --> 02:08:08,159

got it going 25 000 miles an hour and

3087

02:08:12,229 --> 02:08:09,920

the rocket was out of fuel in about 10

3088

02:08:14,069 --> 02:08:12,239

minutes

3089

02:08:16,229 --> 02:08:14,079

but

3090

02:08:19,430 --> 02:08:16,239

there's no fluid out in space space is a

3091

02:08:22,229 --> 02:08:19,440

vacuum so there's no drag

3092

02:08:23,589 --> 02:08:22,239

this aircraft this spacecraft coasted

3093

02:08:24,390 --> 02:08:23,599

all the way it's been coasting for the

3094

02:08:27,030 --> 02:08:24,400

last

3095

02:08:28,950 --> 02:08:27,040

seven months on its way to mars

3096

02:08:31,350 --> 02:08:28,960

through space now it's going to

3097

02:08:32,709 --> 02:08:31,360

encounter some atmosphere at mars

3098

02:08:33,910 --> 02:08:32,719

okay and that's going to be a little bit

3099

02:08:35,910 --> 02:08:33,920

of a problem we're going to take

3100

02:08:37,510 --> 02:08:35,920

advantage of that problem as well let's

3101
02:08:39,910 --> 02:08:37,520
talk about martian atmosphere for just a

3102
02:08:42,950 --> 02:08:39,920
minute okay if i take a quantity of

3103
02:08:45,109 --> 02:08:42,960
earth air okay i've got my air here and

3104
02:08:48,310 --> 02:08:45,119
let's say there's a thousand

3105
02:08:50,149 --> 02:08:48,320
molecules of gas in here mostly nitrogen

3106
02:08:52,390 --> 02:08:50,159
some oxygen some carbon dioxide some

3107
02:08:54,149 --> 02:08:52,400
water vapor but if that says there's a

3108
02:08:55,589 --> 02:08:54,159
thousand molecules actually there's

3109
02:08:57,830 --> 02:08:55,599
billions but we're going to say we've

3110
02:09:00,069 --> 02:08:57,840
got a thousand molecules in here if i

3111
02:09:01,189 --> 02:09:00,079
take that same quantity of martian

3112
02:09:02,550 --> 02:09:01,199
atmosphere

3113
02:09:04,229 --> 02:09:02,560

how many molecules do you think it would

3114

02:09:06,149 --> 02:09:04,239

be

3115

02:09:09,030 --> 02:09:06,159

more than a thousand

3116

02:09:10,390 --> 02:09:09,040

about a thousand less than a thousand

3117

02:09:13,270 --> 02:09:10,400

turns out

3118

02:09:15,990 --> 02:09:13,280

the answer is six

3119

02:09:17,189 --> 02:09:16,000

so for every thousand air molecules

3120

02:09:18,950 --> 02:09:17,199

around earth

3121

02:09:21,109 --> 02:09:18,960

there are six

3122

02:09:23,430 --> 02:09:21,119

gas molecules mostly carbon dioxide at

3123

02:09:25,030 --> 02:09:23,440

mars so we say a very thin atmosphere

3124

02:09:27,910 --> 02:09:25,040

that's what we're talking about at mars

3125

02:09:29,350 --> 02:09:27,920

a very very thin atmosphere but still an

3126

02:09:32,069 --> 02:09:29,360

atmosphere

3127

02:09:33,189 --> 02:09:32,079

so in perseverance okay arise at the

3128

02:09:35,270 --> 02:09:33,199

edge of that atmosphere it's going to

3129

02:09:37,189 --> 02:09:35,280

start hitting these molecules

3130

02:09:40,390 --> 02:09:37,199

even though there's not a whole lot of

3131

02:09:43,109 --> 02:09:40,400

them it does cause some drag in fact we

3132

02:09:45,189 --> 02:09:43,119

hit them going so fast 12 500 miles an

3133

02:09:47,430 --> 02:09:45,199

hour we set up shock waves and the shock

3134

02:09:49,350 --> 02:09:47,440

waves create heat and this capsule you

3135

02:09:52,310 --> 02:09:49,360

can see starts to heat up

3136

02:09:53,669 --> 02:09:52,320

and it gets very very very hot

3137

02:09:55,669 --> 02:09:53,679

okay

3138

02:09:58,229 --> 02:09:55,679

now we've got to take some precautions

3139

02:09:59,910 --> 02:09:58,239

if we don't a capsule will burn up so we

3140

02:10:01,109 --> 02:09:59,920

have a heat shield under the bottom of

3141

02:10:02,790 --> 02:10:01,119

the capsule

3142

02:10:06,229 --> 02:10:02,800

made of very special material that can

3143

02:10:08,149 --> 02:10:06,239

withstand okay these high temperatures

3144

02:10:09,830 --> 02:10:08,159

we can't land safely at twelve thousand

3145

02:10:11,270 --> 02:10:09,840

five hundred miles an hour we've gotta

3146

02:10:12,550 --> 02:10:11,280

slow down

3147

02:10:14,470 --> 02:10:12,560

so

3148

02:10:16,229 --> 02:10:14,480

the shape okay

3149

02:10:19,030 --> 02:10:16,239

is important we've got a very blunt

3150

02:10:20,149 --> 02:10:19,040

shape on our capsule that contains the

3151
02:10:21,189 --> 02:10:20,159
rover

3152
02:10:22,950 --> 02:10:21,199
okay

3153
02:10:23,910 --> 02:10:22,960
and this is going to create a lot of

3154
02:10:25,910 --> 02:10:23,920
drag

3155
02:10:27,990 --> 02:10:25,920
which is what we want to do because

3156
02:10:30,550 --> 02:10:28,000
we're sliding to slow down to get down

3157
02:10:31,350 --> 02:10:30,560
to zero miles an hour so we can land

3158
02:10:33,350 --> 02:10:31,360
well

3159
02:10:35,350 --> 02:10:33,360
getting into the atmosphere

3160
02:10:39,589 --> 02:10:35,360
and moving through it it's going to take

3161
02:10:41,910 --> 02:10:39,599
us down to about 940 miles an hour

3162
02:10:42,709 --> 02:10:41,920
if we hit the surface at 940 miles an

3163
02:10:43,990 --> 02:10:42,719

hour

3164

02:10:45,350 --> 02:10:44,000

mission over

3165

02:10:46,870 --> 02:10:45,360

way too fast

3166

02:10:48,229 --> 02:10:46,880

so now we've got to do something

3167

02:10:50,149 --> 02:10:48,239

different

3168

02:10:51,510 --> 02:10:50,159

and this is going to be involved in our

3169

02:10:53,030 --> 02:10:51,520

challenge today

3170

02:10:55,189 --> 02:10:53,040

we need to slow it down farther like i

3171

02:10:56,470 --> 02:10:55,199

say to zero or near zero so we're going

3172

02:10:59,030 --> 02:10:56,480

to talk about

3173

02:11:00,149 --> 02:10:59,040

another making a drag device today so

3174

02:11:03,109 --> 02:11:00,159

our challenge is going to involve what

3175

02:11:05,030 --> 02:11:03,119

happens next in this whole edl which

3176

02:11:07,430 --> 02:11:05,040

nasa calls

3177

02:11:08,870 --> 02:11:07,440

in it's called entry descent and landing

3178

02:11:11,430 --> 02:11:08,880

in the atmosphere

3179

02:11:13,109 --> 02:11:11,440

and so we're gonna put a parachute

3180

02:11:14,870 --> 02:11:13,119

gonna be about five miles sorry seven

3181

02:11:17,270 --> 02:11:14,880

miles above the surface

3182

02:11:18,390 --> 02:11:17,280

and we put out this 70 foot diameter

3183

02:11:24,470 --> 02:11:18,400

parachute

3184

02:11:26,229 --> 02:11:24,480

you're with us earlier you saw a

3185

02:11:27,910 --> 02:11:26,239

lance foster talk about how we tested

3186

02:11:30,709 --> 02:11:27,920

this out at nasa

3187

02:11:36,149 --> 02:11:33,109

this is going to slow us down

3188

02:11:39,430 --> 02:11:36,159

but only to about 200 miles an hour

3189

02:11:40,870 --> 02:11:39,440

so we can't land on just the parachute

3190

02:11:43,189 --> 02:11:40,880

we do that here on earth because we've

3191

02:11:46,709 --> 02:11:43,199

got denser air around us but that thin

3192

02:11:48,950 --> 02:11:46,719

air is not going to slow us down to zero

3193

02:11:51,750 --> 02:11:48,960

okay and if we hit the surface going 200

3194

02:11:53,990 --> 02:11:51,760

miles an hour that's going to be trouble

3195

02:11:56,229 --> 02:11:54,000

so we've got to do something else

3196

02:11:59,510 --> 02:11:56,239

and so about 6000 feet

3197

02:12:01,510 --> 02:11:59,520

what we do is uh cut the parachute loose

3198

02:12:03,510 --> 02:12:01,520

and eject the heat shield we don't need

3199

02:12:05,189 --> 02:12:03,520

that and now we have a device called the

3200

02:12:07,270 --> 02:12:05,199

descent vehicle

3201

02:12:09,030 --> 02:12:07,280

commonly called a sky crane

3202

02:12:11,350 --> 02:12:09,040

but underneath you can see underneath

3203

02:12:13,109 --> 02:12:11,360

the bottom here there's the rover tucked

3204

02:12:15,189 --> 02:12:13,119

up underneath the wheels are all folded

3205

02:12:18,390 --> 02:12:15,199

up

3206

02:12:20,470 --> 02:12:18,400

okay and we fire descent rockets

3207

02:12:23,189 --> 02:12:20,480

they fire in reverse to slow us down so

3208

02:12:24,870 --> 02:12:23,199

these are pushing now against uh the

3209

02:12:30,790 --> 02:12:24,880

gravity

3210

02:12:32,790 --> 02:12:30,800

against that slow down to one mile an

3211

02:12:34,790 --> 02:12:32,800

hour and then we get

3212

02:12:35,830 --> 02:12:34,800

that slow

3213

02:12:38,069 --> 02:12:35,840

okay

3214

02:12:40,709 --> 02:12:38,079

we don't want to land directly because

3215

02:12:42,550 --> 02:12:40,719

mars we saw the rover be underneath the

3216

02:12:44,390 --> 02:12:42,560

underneath the sky crane so what happens

3217

02:12:48,149 --> 02:12:44,400

is we lower it down to the surface on

3218

02:12:49,750 --> 02:12:48,159

some cables about 60 feet of cable and

3219

02:12:52,390 --> 02:12:49,760

and that lowering process the wheels

3220

02:12:54,709 --> 02:12:52,400

come out the rover unfolds

3221

02:12:57,109 --> 02:12:54,719

and when it touches the surface some

3222

02:12:59,990 --> 02:12:57,119

bolts fire off and break the cables and

3223

02:13:00,790 --> 02:13:00,000

the sky crane flies off

3224

02:13:02,390 --> 02:13:00,800

okay

3225

02:13:05,109 --> 02:13:02,400

it crashes somewhere safely out of the

3226

02:13:08,790 --> 02:13:05,119

way and now we are sitting on the

3227

02:13:10,629 --> 02:13:08,800

surface of mars after seven minutes okay

3228

02:13:12,310 --> 02:13:10,639

we are on the surface

3229

02:13:14,550 --> 02:13:12,320

on the surface we're ready to start

3230

02:13:17,109 --> 02:13:14,560

exploring the jezreel crater

3231

02:13:19,750 --> 02:13:17,119

which we think is a good place to uh to

3232

02:13:21,830 --> 02:13:19,760

land and we think it's a great place to

3233

02:13:23,990 --> 02:13:21,840

uh explore because we know there was a

3234

02:13:25,189 --> 02:13:24,000

lot of water there and it's left a lot

3235

02:13:27,350 --> 02:13:25,199

of clues

3236

02:13:28,870 --> 02:13:27,360

about what's like on mars and what

3237

02:13:30,550 --> 02:13:28,880

mars's past was like and we're going

3238

02:13:32,709 --> 02:13:30,560

gonna look for life on mars we're gonna

3239

02:13:34,629 --> 02:13:32,719

do experiments about changing carbon

3240

02:13:36,390 --> 02:13:34,639

dioxide in the atmosphere and

3241

02:13:38,790 --> 02:13:36,400

demonstrate making oxygen which we'll

3242

02:13:42,229 --> 02:13:38,800

need when we go to mars uh we've got

3243

02:13:43,750 --> 02:13:42,239

over 20 cameras on this on this uh this

3244

02:13:45,430 --> 02:13:43,760

rover it's got a little helicopter

3245

02:13:46,950 --> 02:13:45,440

underneath that's going to fly around

3246

02:13:48,550 --> 02:13:46,960

mars we do a lot of neat things when we

3247

02:13:49,910 --> 02:13:48,560

get to the surface but we've got to be

3248

02:13:51,910 --> 02:13:49,920

able to stop

3249

02:13:52,790 --> 02:13:51,920

and if we can't stop

3250

02:13:54,069 --> 02:13:52,800

okay

3251
02:13:55,910 --> 02:13:54,079
we're not going to do any science this

3252
02:13:58,950 --> 02:13:55,920
is a picture of uh

3253
02:14:01,350 --> 02:13:58,960
chrissy barcy who helped test

3254
02:14:03,109 --> 02:14:01,360
the parachutes

3255
02:14:05,109 --> 02:14:03,119
in our supersonic wind tunnel you can

3256
02:14:07,270 --> 02:14:05,119
see these are models we always test

3257
02:14:08,950 --> 02:14:07,280
models before we test real things it

3258
02:14:11,510 --> 02:14:08,960
would be hard to test a 70-foot

3259
02:14:14,149 --> 02:14:11,520
parachute in the low-density environment

3260
02:14:17,990 --> 02:14:14,159
of mars here on earth so we test models

3261
02:14:20,390 --> 02:14:18,000
we verify computer codes that uh

3262
02:14:23,350 --> 02:14:20,400
we design to go with these parachutes so

3263
02:14:26,310 --> 02:14:23,360

this is uh some of the work we did here

3264

02:14:28,310 --> 02:14:26,320

we did things about radioactive isotope

3265

02:14:30,470 --> 02:14:28,320

generators that are powering this rover

3266

02:14:31,430 --> 02:14:30,480

here at glenn

3267

02:14:34,470 --> 02:14:31,440

it's been

3268

02:14:37,109 --> 02:14:34,480

come together

3269

02:14:38,950 --> 02:14:37,119

well speaking of testing and speaking of

3270

02:14:41,109 --> 02:14:38,960

testing drag devices and parachutes we

3271

02:14:42,950 --> 02:14:41,119

have a challenge for you to do today

3272

02:14:45,350 --> 02:14:42,960

and the challenge for you to do today is

3273

02:14:47,510 --> 02:14:45,360

to make a drag device

3274

02:14:49,189 --> 02:14:47,520

okay so you decide number one design and

3275

02:14:50,790 --> 02:14:49,199

conduct the drag device that will slow

3276

02:14:53,669 --> 02:14:50,800

down its cargo and i hope you made the

3277

02:14:55,430 --> 02:14:53,679

cargo uh today when it's dropped from a

3278

02:14:57,030 --> 02:14:55,440

consistent height

3279

02:15:00,069 --> 02:14:57,040

the drag device must connect to the

3280

02:15:01,990 --> 02:15:00,079

cargo uh either couple nickels or cup

3281

02:15:04,390 --> 02:15:02,000

four pennies some of you i know have

3282

02:15:08,629 --> 02:15:04,400

washers that are hooked together uh to

3283

02:15:10,709 --> 02:15:08,639

be our stand in for our capsule and our

3284

02:15:11,910 --> 02:15:10,719

our rover coming down

3285

02:15:13,830 --> 02:15:11,920

you have to

3286

02:15:14,950 --> 02:15:13,840

drop this from a minimum height of six

3287

02:15:17,990 --> 02:15:14,960

feet

3288

02:15:20,069 --> 02:15:18,000

okay and it's got to maintain its its uh

3289

02:15:21,669 --> 02:15:20,079

integrity it can't come apart

3290

02:15:23,589 --> 02:15:21,679

okay it's gonna stay there through the

3291

02:15:25,750 --> 02:15:23,599

drop and landing and you're gonna need

3292

02:15:28,229 --> 02:15:25,760

to time this okay

3293

02:15:30,470 --> 02:15:28,239

you're gonna need to uh be safe that's

3294

02:15:31,910 --> 02:15:30,480

real important uh if you joined us

3295

02:15:34,149 --> 02:15:31,920

earlier you heard our engineers lord

3296

02:15:35,750 --> 02:15:34,159

klaman talk about safety how important

3297

02:15:38,229 --> 02:15:35,760

that is

3298

02:15:39,910 --> 02:15:38,239

so if you have some stairs

3299

02:15:41,510 --> 02:15:39,920

drop them over the railing or a balcony

3300

02:15:43,109 --> 02:15:41,520

you can drop them from

3301

02:15:46,790 --> 02:15:43,119

but if you need to you can use a step

3302

02:15:48,709 --> 02:15:46,800

ladder or a stable chair or a step stool

3303

02:15:51,589 --> 02:15:48,719

if you're using a chair

3304

02:15:53,510 --> 02:15:51,599

be safe have mom or dad give you help

3305

02:15:55,189 --> 02:15:53,520

to help drop the device but always try

3306

02:15:56,310 --> 02:15:55,199

and drop it from the same height and

3307

02:15:58,709 --> 02:15:56,320

time it

3308

02:16:02,629 --> 02:16:00,470

that's so we can compare information

3309

02:16:05,430 --> 02:16:02,639

compare data

3310

02:16:07,350 --> 02:16:05,440

speaking of data we always record that

3311

02:16:10,790 --> 02:16:07,360

so you need to write down how much time

3312

02:16:13,510 --> 02:16:10,800

it took for each drop for your design

3313

02:16:15,750 --> 02:16:13,520

the time to fall and the object okay is

3314

02:16:17,189 --> 02:16:15,760

to fall as slowly as possible the softer

3315

02:16:19,830 --> 02:16:17,199

the slower you go the softer you're

3316

02:16:23,430 --> 02:16:19,840

gonna land and the more chance you have

3317

02:16:25,109 --> 02:16:23,440

of your cargo staying intact

3318

02:16:26,470 --> 02:16:25,119

so uh

3319

02:16:28,709 --> 02:16:26,480

you've gotta i'm sorry i'm gonna go back

3320

02:16:30,390 --> 02:16:28,719

so we've got uh for each design you

3321

02:16:32,469 --> 02:16:30,400

wanna time the fall it takes and make

3322

02:16:34,870 --> 02:16:32,479

any comments uh that happened during

3323

02:16:36,790 --> 02:16:34,880

that test

3324

02:16:38,629 --> 02:16:36,800

i want to point out uh that since you're

3325

02:16:40,230 --> 02:16:38,639

being an engineer and designing in your

3326

02:16:42,230 --> 02:16:40,240

design process

3327

02:16:44,230 --> 02:16:42,240

sometimes things don't always go as you

3328

02:16:45,669 --> 02:16:44,240

plan

3329

02:16:47,669 --> 02:16:45,679

the first time we tried a supersonic

3330

02:16:49,270 --> 02:16:47,679

parachute in a wind tunnel it ripped the

3331

02:16:51,270 --> 02:16:49,280

shreds

3332

02:16:53,110 --> 02:16:51,280

uh so we go back to the drawing board as

3333

02:16:54,870 --> 02:16:53,120

they say and you try and figure out and

3334

02:16:56,070 --> 02:16:54,880

make a better design

3335

02:16:57,349 --> 02:16:56,080

so we should have some place in your

3336

02:16:59,349 --> 02:16:57,359

data table we're going to try and do a

3337

02:17:03,429 --> 02:16:59,359

couple designs today

3338

02:17:05,990 --> 02:17:03,439

of of your drag device

3339

02:17:09,190 --> 02:17:06,000

so we have these uh for testing do a

3340

02:17:11,110 --> 02:17:09,200

minimum of three test drops okay

3341

02:17:13,990 --> 02:17:11,120

all from the same height

3342

02:17:15,429 --> 02:17:14,000

record how many seconds it took to drop

3343

02:17:16,950 --> 02:17:15,439

so time how long it takes to or the

3344

02:17:17,990 --> 02:17:16,960

cargo to reach the ground or touch the

3345

02:17:19,509 --> 02:17:18,000

ground

3346

02:17:21,589 --> 02:17:19,519

record all this in your data table this

3347

02:17:23,589 --> 02:17:21,599

could just be a sheet of paper okay you

3348

02:17:25,030 --> 02:17:23,599

don't have to have fancy lines etc but

3349

02:17:26,629 --> 02:17:25,040

we have to make sure we always record

3350

02:17:29,669 --> 02:17:26,639

our data

3351

02:17:31,190 --> 02:17:29,679

okay then once we do that we want you to

3352

02:17:32,309 --> 02:17:31,200

think of some ways you can improve your

3353

02:17:34,309 --> 02:17:32,319

design

3354

02:17:35,509 --> 02:17:34,319

and construct and test your new ideas i

3355

02:17:36,870 --> 02:17:35,519

think we'll have enough time today for

3356

02:17:39,830 --> 02:17:36,880

you to do that

3357

02:17:41,589 --> 02:17:39,840

uh and test some more drops okay again a

3358

02:17:43,669 --> 02:17:41,599

minimum of three drops all from the same

3359

02:17:46,629 --> 02:17:43,679

height for each design

3360

02:17:48,629 --> 02:17:46,639

you've gathered your materials i'm sure

3361

02:17:50,549 --> 02:17:48,639

you have some weight of time

3362

02:17:52,950 --> 02:17:50,559

you have your cargo made you have a

3363

02:17:55,190 --> 02:17:52,960

ruler or a tape measure an instant

3364

02:17:56,629 --> 02:17:55,200

string and tape

3365

02:17:58,150 --> 02:17:56,639

plus the we gave you a list of

3366

02:18:00,549 --> 02:17:58,160

additional materials that you can have

3367

02:18:02,389 --> 02:18:00,559

available for you to use at this time

3368

02:18:03,589 --> 02:18:02,399

so any of these things that are on this

3369

02:18:05,030 --> 02:18:03,599

list

3370

02:18:06,469 --> 02:18:05,040

fine to use

3371

02:18:08,309 --> 02:18:06,479

again any other materials that adult

3372

02:18:10,549 --> 02:18:08,319

might approve is good

3373

02:18:11,830 --> 02:18:10,559

so we are not specifying what you have

3374

02:18:14,709 --> 02:18:11,840

to do here

3375

02:18:16,549 --> 02:18:14,719

we are specifying the constraints of

3376

02:18:17,990 --> 02:18:16,559

it's got to fall six feet okay it's got

3377

02:18:20,389 --> 02:18:18,000

to stay intact

3378

02:18:22,230 --> 02:18:20,399

and uh it's got to

3379

02:18:23,589 --> 02:18:22,240

be made of any of these things that you

3380

02:18:25,669 --> 02:18:23,599

think are going to work to make a good

3381

02:18:27,830 --> 02:18:25,679

drag device

3382

02:18:29,270 --> 02:18:27,840

cargo was ahead of time so we can skip

3383

02:18:31,190 --> 02:18:29,280

over this real quick everybody has the

3384

02:18:33,270 --> 02:18:31,200

cargo made up

3385

02:18:35,270 --> 02:18:33,280

just to give you some ideas

3386

02:18:37,509 --> 02:18:35,280

some of the things we do at nasa or do

3387

02:18:39,589 --> 02:18:37,519

here on earth we have some drag designs

3388

02:18:42,309 --> 02:18:39,599

like these parachutes

3389

02:18:43,990 --> 02:18:42,319

round parachutes are quite common

3390

02:18:45,270 --> 02:18:44,000

on the left of what's called a ram air

3391

02:18:48,469 --> 02:18:45,280

parachute you'll see these with

3392

02:18:50,790 --> 02:18:48,479

skydivers using these okay so these are

3393

02:18:53,429 --> 02:18:50,800

some possibilities that create drag

3394

02:18:56,309 --> 02:18:53,439

moving through the air

3395

02:18:58,870 --> 02:18:56,319

you see different numbers of parachutes

3396

02:19:00,230 --> 02:18:58,880

perseverance you have one parachute

3397

02:19:03,750 --> 02:19:00,240

one parachute

3398

02:19:05,110 --> 02:19:03,760

is easier to design less complicated and

3399

02:19:06,469 --> 02:19:05,120

test it over and over and over and over

3400

02:19:07,910 --> 02:19:06,479

again so we're pretty sure it's going to

3401

02:19:09,509 --> 02:19:07,920

work

3402

02:19:10,790 --> 02:19:09,519

some other things we're thinking about

3403

02:19:12,070 --> 02:19:10,800

nasa has looked at

3404

02:19:13,669 --> 02:19:12,080

inflatable

3405

02:19:15,589 --> 02:19:13,679

drag devices

3406

02:19:17,270 --> 02:19:15,599

so instead of a parachute you take you

3407

02:19:19,589 --> 02:19:17,280

get to your location wherever you're

3408

02:19:21,750 --> 02:19:19,599

going to try and land and things inflate

3409

02:19:24,230 --> 02:19:21,760

to create more drag as you move through

3410

02:19:26,309 --> 02:19:24,240

the fluid the air of the atmosphere of

3411

02:19:29,030 --> 02:19:26,319

the place you're trying to land

3412

02:19:31,429 --> 02:19:29,040

uh we've created some drag shields

3413

02:19:32,870 --> 02:19:31,439

uh these are also inflatable so this is

3414

02:19:35,110 --> 02:19:32,880

a little different instead of hanging

3415

02:19:36,870 --> 02:19:35,120

above you you're kind of inside this so

3416

02:19:37,830 --> 02:19:36,880

these are other kinds of designs we've

3417

02:19:40,389 --> 02:19:37,840

looked at

3418

02:19:41,830 --> 02:19:40,399

uh and are currently testing so that

3419

02:19:43,429 --> 02:19:41,840

should give you some ideas of some

3420

02:19:45,429 --> 02:19:43,439

things you can do

3421

02:19:48,070 --> 02:19:45,439

okay so now i would like you to get

3422

02:19:49,590 --> 02:19:48,080

together and work on your design i'd

3423

02:19:51,429 --> 02:19:49,600

like you to test it i'd like you to

3424

02:19:53,830 --> 02:19:51,439

collect data and then we're going to

3425

02:19:55,830 --> 02:19:53,840

come back in 15 minutes we have a time

3426

02:19:59,190 --> 02:19:55,840

constraint here just like we have a

3427

02:20:00,309 --> 02:19:59,200

constraint to launch every 26 months

3428

02:20:02,469 --> 02:20:00,319

from the earth you have a time

3429

02:20:04,950 --> 02:20:02,479

constraint to construct your device

3430

02:20:06,790 --> 02:20:04,960

okay in 15 minutes and we'll be timing

3431

02:20:08,150 --> 02:20:06,800

here i'll be reminding you

3432

02:20:09,990 --> 02:20:08,160

and since you've got all your materials

3433

02:20:12,230 --> 02:20:10,000

together this should should work pretty

3434

02:20:14,070 --> 02:20:12,240

great so design your drag device

3435

02:20:15,349 --> 02:20:14,080

whatever you want to slow things down as

3436

02:20:17,349 --> 02:20:15,359

it comes down

3437

02:20:19,190 --> 02:20:17,359

and then time those and then we'll come

3438

02:20:20,870 --> 02:20:19,200

back together and we'll take a look at

3439

02:20:22,230 --> 02:20:20,880

some of your design ideas and some

3440

02:20:24,230 --> 02:20:22,240

things you've done

3441

02:20:26,469 --> 02:20:24,240

and then we'll say let's go back and

3442

02:20:27,349 --> 02:20:26,479

we're going to redesign and retest

3443

02:20:31,510 --> 02:20:27,359

so

3444

02:20:32,630 --> 02:20:31,520

the construction engineers make your

3445

02:21:00,389 --> 02:20:32,640

designs

3446

02:21:04,150 --> 02:21:01,990

and again if you're working at home

3447

02:21:05,670 --> 02:21:04,160

you're watching us on on youtube live

3448

02:21:06,550 --> 02:21:05,680

this is a time for you to construct as

3449

02:21:07,590 --> 02:21:06,560

well

3450

02:21:10,950 --> 02:21:07,600

we're gonna have you share some of your

3451
02:21:12,710 --> 02:21:10,960
designs with us on social media so uh we

3452
02:21:13,830 --> 02:21:12,720
look forward to that as well and there's

3453
02:21:14,630 --> 02:21:13,840
a chat

3454
02:21:15,910 --> 02:21:14,640
uh

3455
02:21:18,790 --> 02:21:15,920
we're gonna answer some things in the

3456
02:21:20,469 --> 02:21:18,800
chat someone asked about uh

3457
02:21:22,070 --> 02:21:20,479
what elements make up the atmosphere

3458
02:21:24,790 --> 02:21:22,080
well for earth it's

3459
02:21:26,950 --> 02:21:24,800
mostly nitrogen about 78

3460
02:21:28,950 --> 02:21:26,960
about 21 oxygen

3461
02:21:31,910 --> 02:21:28,960
about one percent carbon dioxide water

3462
02:21:35,990 --> 02:21:31,920
vapor and some other uh gases like argon

3463
02:21:36,000 --> 02:21:38,790

okay

3464

02:21:43,030 --> 02:21:40,630

so we want to see what you're making as

3465

02:21:44,710 --> 02:21:43,040

you go along so if you could uh

3466

02:21:46,469 --> 02:21:44,720

kind of hold up some cameras i can see

3467

02:21:47,750 --> 02:21:46,479

uh some classes that are working i'm

3468

02:21:49,190 --> 02:21:47,760

looking over here

3469

02:21:58,710 --> 02:21:49,200

at pictures of

3470

02:21:58,720 --> 02:22:32,309

um

3471

02:22:36,790 --> 02:22:34,630

oh about the mars atmosphere

3472

02:22:38,469 --> 02:22:36,800

mars atmos let's see we can answer that

3473

02:22:41,510 --> 02:22:38,479

question the mars atmosphere is carbon

3474

02:22:43,110 --> 02:22:41,520

dioxide about 98 percent

3475

02:22:45,590 --> 02:22:43,120

there's a little bit of oxygen not

3476

02:23:50,870 --> 02:22:45,600

enough that we could breathe

3477

02:27:30,710 --> 02:27:26,790

so

3478

02:32:02,790 --> 02:27:30,720

we have another 10 minutes to finish

3479

02:32:02,800 --> 02:32:33,670

oh

3480

02:32:38,469 --> 02:32:36,469

okay we're in about 10 minutes right now

3481

02:32:40,550 --> 02:32:38,479

and i see a lot of construction going on

3482

02:32:43,190 --> 02:32:40,560

so that's let's extend our construction

3483

02:32:45,349 --> 02:32:43,200

time another five minutes so we will

3484

02:32:46,550 --> 02:32:45,359

um

3485

02:32:47,990 --> 02:32:46,560

give you another five minutes for

3486

02:33:26,630 --> 02:32:48,000

construction and maybe we can get some

3487

02:33:26,640 --> 02:36:55,429

uh

3488

02:36:55,439 --> 02:37:30,550

so

3489

02:37:33,910 --> 02:37:32,630

okay we're in about 15 minutes at this

3490

02:37:36,150 --> 02:37:33,920

current time

3491

02:37:39,590 --> 02:37:36,160

and i do see some tests going on so some

3492

02:37:40,870 --> 02:37:39,600

of you are making some good progress

3493

02:37:43,510 --> 02:37:40,880

in about five minutes we're going to

3494

02:37:45,110 --> 02:37:43,520

look at some designs that you've made

3495

02:39:13,590 --> 02:37:45,120

so if you can test

3496

02:42:30,389 --> 02:39:53,190

uh

3497

02:42:35,830 --> 02:42:33,750

okay everybody we're at 20 minutes now

3498

02:42:37,349 --> 02:42:35,840

and i have seen some testing going on so

3499

02:42:38,630 --> 02:42:37,359

we're going to come back if we could see

3500

02:42:52,790 --> 02:42:38,640

a

3501

02:42:54,630 --> 02:42:52,800

like to show us their design turn your

3502

02:42:56,870 --> 02:42:54,640

mic on we can unmute your mic if you

3503

02:42:59,030 --> 02:42:56,880

don't you can show us your design and

3504

02:43:07,429 --> 02:42:59,040

tell us how you thought it worked

3505

02:43:10,950 --> 02:43:08,950

so i'm not seeing any volunteers i'm

3506

02:43:12,630 --> 02:43:10,960

going to ask that all six of you who are

3507

02:43:20,230 --> 02:43:12,640

working at home hold up your design to

3508

02:43:20,240 --> 02:43:27,190

okay wow okay

3509

02:43:31,030 --> 02:43:29,750

and people at home people know six of

3510

02:43:32,710 --> 02:43:31,040

you at home raise your hand if you think

3511

02:43:34,309 --> 02:43:32,720

you've got a drag device

3512

02:43:35,990 --> 02:43:34,319

racing if you think you got yours to

3513

02:43:38,309 --> 02:43:36,000

slow down a little bit as it fell

3514

02:43:39,670 --> 02:43:38,319

towards the floor

3515

02:43:41,510 --> 02:43:39,680

okay

3516

02:43:42,389 --> 02:43:41,520

got some ideas that seem to have worked

3517

02:43:45,269 --> 02:43:42,399

okay

3518

02:43:48,710 --> 02:43:45,279

uh let's go to the classrooms and wow

3519

02:43:51,190 --> 02:43:48,720

there's a complex design

3520

02:43:53,429 --> 02:43:51,200

with lots of balloons

3521

02:43:54,630 --> 02:43:53,439

and tissue paper tell me about that

3522

02:43:55,910 --> 02:43:54,640

design

3523

02:43:58,950 --> 02:43:55,920

did it work

3524

02:44:01,349 --> 02:43:58,960

yes does it work alex

3525

02:44:03,510 --> 02:44:01,359

he's asking me he's talking to you

3526

02:44:03,830 --> 02:44:03,520

we don't

3527

02:44:05,590 --> 02:44:03,840

alex know

3528

02:44:07,349 --> 02:44:05,600

haven't tested it yet

3529

02:44:08,469 --> 02:44:07,359

no no okay

3530

02:44:10,230 --> 02:44:08,479

while we're talking you guys can

3531

02:44:12,309 --> 02:44:10,240

continue to work on your designs while

3532

02:44:14,070 --> 02:44:12,319

we're looking at some of these here alex

3533

02:44:14,870 --> 02:44:14,080

is going to go test and we got somebody

3534

02:44:17,670 --> 02:44:14,880

uh

3535

02:44:19,830 --> 02:44:17,680

in that same classroom who has tested

3536

02:44:26,950 --> 02:44:19,840

yeah their design out

3537

02:44:26,960 --> 02:44:31,590

come on up come on map

3538

02:44:34,469 --> 02:44:32,710

all right

3539

02:44:36,070 --> 02:44:34,479

basically a lot of

3540

02:44:40,150 --> 02:44:36,080

plastic bags

3541

02:44:42,950 --> 02:44:40,160

plate and where's your car go at show us

3542

02:44:44,389 --> 02:44:42,960

your car go hold it up it's right here

3543

02:44:46,150 --> 02:44:44,399

oh it's right on the bottom of that all

3544

02:44:48,469 --> 02:44:46,160

right excellent that's very much like

3545

02:44:52,469 --> 02:44:48,479

persevere it's like right underneath the

3546

02:44:52,479 --> 02:44:57,830

jax

3547

02:44:57,840 --> 02:45:05,670

so we're going to see a drop here

3548

02:45:15,830 --> 02:45:06,950

looks like we're going to see a drop

3549

02:45:19,190 --> 02:45:17,510

that didn't work very well he's going

3550

02:45:20,469 --> 02:45:19,200

back to the drawing board

3551

02:45:22,469 --> 02:45:20,479

well everybody's going to go back to

3552

02:45:24,150 --> 02:45:22,479

drawing board i think but it worked

3553

02:45:26,550 --> 02:45:24,160

better than just dropping the cargo all

3554

02:45:29,269 --> 02:45:26,560

by itself didn't it

3555

02:45:31,590 --> 02:45:29,279

yeah i think so okay let's uh go to the

3556

02:45:33,429 --> 02:45:31,600

other classroom the ones with the yellow

3557

02:45:34,870 --> 02:45:33,439

chairs if we could switch over to that

3558

02:45:36,469 --> 02:45:34,880

classroom and somebody come up and share

3559

02:45:37,670 --> 02:45:36,479

their design out i've been intrigued

3560

02:45:38,790 --> 02:45:37,680

about this so i've been watching it

3561

02:45:40,469 --> 02:45:38,800

being built

3562

02:45:50,469 --> 02:45:40,479

so we can mute your mic and tell us

3563

02:45:50,479 --> 02:45:56,950

okay we're not hearing you

3564

02:46:01,190 --> 02:45:59,670

there go for it uh i built a gigantic

3565

02:46:02,710 --> 02:46:01,200

parachute

3566

02:46:04,230 --> 02:46:02,720

with a um central structure in the

3567

02:46:05,990 --> 02:46:04,240

middle to hold

3568

02:46:08,950 --> 02:46:06,000

the

3569

02:46:13,429 --> 02:46:10,550

excellent excellent and where's your

3570

02:46:15,510 --> 02:46:13,439

cargo at where's it located

3571

02:46:19,429 --> 02:46:15,520

in the center all right so that's a cool

3572

02:46:20,710 --> 02:46:19,439

device did that rotate as it dropped

3573

02:46:34,550 --> 02:46:20,720

okay what do you think you might need to

3574

02:46:39,910 --> 02:46:37,269

get it to spin okay

3575

02:46:41,750 --> 02:46:39,920

we spin our spacecraft uh perseverance

3576

02:46:43,830 --> 02:46:41,760

spacecraft spins

3577

02:46:46,309 --> 02:46:43,840

at about two revolutions a minute just

3578

02:46:47,750 --> 02:46:46,319

so it heats up evenly as it goes uh out

3579

02:46:50,389 --> 02:46:47,760

in space and the sun doesn't just heat

3580

02:46:52,469 --> 02:46:50,399

one side so maybe if you look at a fan

3581

02:46:54,230 --> 02:46:52,479

get some ideas from a fan about how the

3582

02:46:56,790 --> 02:46:54,240

blades on a fan are they flat or are

3583

02:46:58,950 --> 02:46:56,800

they tilted a little bit

3584

02:47:00,550 --> 02:46:58,960

give that some thought okay about blades

3585

02:47:01,910 --> 02:47:00,560

on a fan maybe that'll help you when you

3586

02:47:02,950 --> 02:47:01,920

redesign

3587

02:47:04,630 --> 02:47:02,960

uh

3588

02:47:08,710 --> 02:47:04,640

how it works anybody else in the in this

3589

02:47:08,720 --> 02:47:12,389

is anybody tested

3590

02:47:15,030 --> 02:47:13,429

if not

3591

02:47:16,710 --> 02:47:15,040

could somebody come up that they think

3592

02:47:18,309 --> 02:47:16,720

they have kind of a unique design would

3593

02:47:20,870 --> 02:47:18,319

you want to bring that up to the camera

3594

02:47:22,150 --> 02:47:20,880

so we could see some interesting designs

3595

02:47:23,429 --> 02:47:22,160

that have come out you've noticed so far

3596

02:47:24,950 --> 02:47:23,439

and i've noticed so far that not

3597

02:47:25,830 --> 02:47:24,960

everybody did exactly the same thing did

3598

02:47:27,670 --> 02:47:25,840

they

3599

02:47:30,630 --> 02:47:27,680

we've got a lot of variety in what

3600

02:47:32,950 --> 02:47:30,640

you've tried to do which is good

3601

02:47:35,670 --> 02:47:32,960

okay

3602

02:47:38,790 --> 02:47:35,680

so here comes somebody up here

3603

02:47:41,349 --> 02:47:40,230

and tell us what's unique about your

3604

02:47:44,389 --> 02:47:41,359

design

3605

02:47:45,750 --> 02:47:44,399

um i have a balloon and then two coffee

3606

02:47:46,830 --> 02:47:45,760

filters

3607

02:47:49,910 --> 02:47:46,840

yeah

3608

02:47:52,389 --> 02:47:49,920

uh it's really just held together by

3609

02:47:54,389 --> 02:47:52,399

tape and paper clips

3610

02:47:57,190 --> 02:47:54,399

okay and where's your car go where's

3611

02:47:59,590 --> 02:47:57,200

your car go uh it's right here right by

3612

02:48:01,750 --> 02:47:59,600

the balloon

3613

02:48:03,429 --> 02:48:01,760

right there okay so so tell us tell us

3614

02:48:04,630 --> 02:48:03,439

share with everybody why you chose those

3615

02:48:06,790 --> 02:48:04,640

materials what do you think they're

3616

02:48:08,150 --> 02:48:06,800

going to do for you

3617

02:48:10,630 --> 02:48:08,160

really i just thought that they'd create

3618

02:48:13,110 --> 02:48:10,640

a good drag

3619

02:48:14,550 --> 02:48:13,120

yeah why do you think that um because

3620

02:48:28,710 --> 02:48:14,560

they're

3621

02:48:28,720 --> 02:48:34,309

more

3622

02:48:37,750 --> 02:48:36,309

i see back there one with green and red

3623

02:48:42,630 --> 02:48:37,760

balloons you want to bring that one up

3624

02:48:42,640 --> 02:48:46,230

it looks

3625

02:48:46,240 --> 02:48:48,330

all

3626

02:48:48,340 --> 02:48:57,030

[Applause]

3627

02:48:57,040 --> 02:49:02,389

confidence right nothing maybe not

3628

02:49:05,830 --> 02:49:04,309

more

3629

02:49:07,349 --> 02:49:05,840

sound

3630

02:49:10,150 --> 02:49:07,359

oh yeah we've got a really great design

3631

02:49:12,950 --> 02:49:10,160

over here sam come on down

3632

02:49:14,710 --> 02:49:12,960

that's all right it's the first draft it

3633

02:49:16,309 --> 02:49:14,720

kind of looks like

3634

02:49:19,269 --> 02:49:16,319

i need

3635

02:49:20,389 --> 02:49:19,279

i have like a big crash pad

3636

02:49:22,790 --> 02:49:20,399

okay

3637

02:49:31,750 --> 02:49:22,800

i have like a big trash pad and i have

3638

02:49:35,349 --> 02:49:33,830

that's good that's good you know always

3639

02:49:37,110 --> 02:49:35,359

compared to how it dropped without

3640

02:49:38,389 --> 02:49:37,120

anything you know you just dropped it

3641

02:49:40,070 --> 02:49:38,399

straight up so you've caught a lot of

3642

02:49:43,190 --> 02:49:40,080

air got a lot of drag in that one that's

3643

02:49:47,349 --> 02:49:45,429

we do that to some extent

3644

02:49:48,950 --> 02:49:47,359

have collapsible parts

3645

02:49:50,790 --> 02:49:48,960

uh your car

3646

02:49:52,550 --> 02:49:50,800

you know to survive a crash has

3647

02:49:54,950 --> 02:49:52,560

collapsible parts on the front of your

3648

02:49:57,269 --> 02:49:54,960

cars at home

3649

02:49:59,190 --> 02:49:57,279

so we've got about 10 minutes left and

3650

02:50:03,670 --> 02:49:59,200

uh i wanted to make some comments so if

3651
02:50:08,950 --> 02:50:05,190
back at the control room and we could

3652
02:50:12,790 --> 02:50:10,790
how many of you would uh

3653
02:50:14,950 --> 02:50:12,800
could think of a way to improve your

3654
02:50:16,309 --> 02:50:14,960
design

3655
02:50:17,990 --> 02:50:16,319
raise your hand if you think of a way

3656
02:50:19,990 --> 02:50:18,000
maybe to improve your design something

3657
02:50:22,870 --> 02:50:20,000
you want to try differently than what

3658
02:50:24,630 --> 02:50:22,880
you have right now okay

3659
02:50:27,110 --> 02:50:24,640
um

3660
02:50:28,710 --> 02:50:27,120
as as engineers okay and doing this

3661
02:50:29,429 --> 02:50:28,720
design challenge i want to share with

3662
02:50:31,990 --> 02:50:29,439
you

3663
02:50:34,150 --> 02:50:32,000

uh our first three rovers that we put on

3664

02:50:35,670 --> 02:50:34,160

mars we put if we're successful today

3665

02:50:38,630 --> 02:50:35,680

that'll be five

3666

02:50:40,950 --> 02:50:38,640

the first three did not have a sky crane

3667

02:50:43,349 --> 02:50:40,960

and lowering them on cables

3668

02:50:44,870 --> 02:50:43,359

they actually landed inside a bunch of

3669

02:50:46,790 --> 02:50:44,880

balloons

3670

02:50:48,870 --> 02:50:46,800

so they came down with a heat shield

3671

02:50:50,630 --> 02:50:48,880

then they had a parachute and then they

3672

02:50:53,670 --> 02:50:50,640

dropped inside these balloons they're

3673

02:50:54,790 --> 02:50:53,680

about 17 inches in diameter and they

3674

02:50:56,230 --> 02:50:54,800

bounced

3675

02:50:57,510 --> 02:50:56,240

and that's how they got rid of the last

3676

02:50:59,349 --> 02:50:57,520

bit of energy

3677

02:51:01,670 --> 02:50:59,359

perseverance and curiosity before are

3678

02:51:04,790 --> 02:51:01,680

too heavy to land this way but uh

3679

02:51:06,309 --> 02:51:04,800

spirit and opportunity

3680

02:51:09,750 --> 02:51:06,319

and

3681

02:51:11,429 --> 02:51:09,760

in fact if you go to the great lakes

3682

02:51:13,590 --> 02:51:11,439

science center

3683

02:51:15,510 --> 02:51:13,600

they have some of nasa's balloons that

3684

02:51:17,269 --> 02:51:15,520

we use successfully to land those rovers

3685

02:51:20,230 --> 02:51:17,279

so you've got an idea most of you have

3686

02:51:23,349 --> 02:51:20,240

an idea that nasa tried as well

3687

02:51:25,349 --> 02:51:23,359

and worked for some payloads

3688

02:51:27,429 --> 02:51:25,359

if we could come back there to everybody

3689

02:51:29,910 --> 02:51:27,439

okay and we could see some more testing

3690

02:51:31,269 --> 02:51:29,920

going on

3691

02:51:32,710 --> 02:51:31,279

some of the things that you may have

3692

02:51:34,950 --> 02:51:32,720

found uh

3693

02:51:37,429 --> 02:51:34,960

are if you use what if you use 30

3694

02:51:38,550 --> 02:51:37,439

balloons

3695

02:51:44,230 --> 02:51:38,560

what do you think what happened if you

3696

02:51:49,590 --> 02:51:46,070

is that that's to be a more complicated

3697

02:51:53,510 --> 02:51:52,070

and it might be kind of heavy

3698

02:51:56,070 --> 02:51:53,520

remember we got to launch this off the

3699

02:51:58,230 --> 02:51:56,080

earth and get it all the way to mars

3700

02:52:01,190 --> 02:51:58,240

so uh that's one things engineers will

3701
02:52:02,309 --> 02:52:01,200
think about okay it's about how heavy it

3702
02:52:05,830 --> 02:52:02,319
might be

3703
02:52:07,830 --> 02:52:05,840
somebody came up saying oh that was a

3704
02:52:10,230 --> 02:52:07,840
good drop i just saw that one go off the

3705
02:52:12,790 --> 02:52:10,240
ladder

3706
02:52:15,349 --> 02:52:12,800
how complex it is to deploy

3707
02:52:17,349 --> 02:52:15,359
the more complicated it is

3708
02:52:20,150 --> 02:52:17,359
the less chance of success you might

3709
02:52:21,910 --> 02:52:20,160
have something go wrong simpler designs

3710
02:52:24,230 --> 02:52:21,920
work better a lot of the times some of

3711
02:52:27,590 --> 02:52:24,240
you had some very good ideas with coffee

3712
02:52:30,790 --> 02:52:27,600
filters with plastic bags grocery bags

3713
02:52:34,790 --> 02:52:30,800

work well because they trap air

3714

02:52:38,469 --> 02:52:36,710

so we've done uh we've done one other

3715

02:52:40,630 --> 02:52:38,479

thing that i wanted to compliment

3716

02:52:43,349 --> 02:52:40,640

everybody on as i watched you know maybe

3717

02:52:45,910 --> 02:52:43,359

tried this at home a lot of people tried

3718

02:52:47,910 --> 02:52:45,920

their designs at their desk they didn't

3719

02:52:49,349 --> 02:52:47,920

go up to the ladder

3720

02:52:50,790 --> 02:52:49,359

so how many of you tried just dropping

3721

02:52:52,630 --> 02:52:50,800

where you were sitting let me see how

3722

02:52:54,469 --> 02:52:52,640

many you actually did try that

3723

02:52:56,630 --> 02:52:54,479

just to see how it's going to work see

3724

02:52:59,030 --> 02:52:56,640

lots of hands guys i watched you do it

3725

02:53:00,790 --> 02:52:59,040

and that's kind of cool because that's

3726

02:53:03,910 --> 02:53:00,800

sort of what nasa does in our wind

3727

02:53:05,910 --> 02:53:03,920

tunnel before we you know do a big huge

3728

02:53:06,870 --> 02:53:05,920

one let's let's try it and see if it's

3729

02:53:08,469 --> 02:53:06,880

going to work

3730

02:53:09,990 --> 02:53:08,479

give us a little idea of whether it's

3731

02:53:12,550 --> 02:53:10,000

going to be successful or not before we

3732

02:53:13,510 --> 02:53:12,560

climb the ladder okay and drop it from

3733

02:53:16,309 --> 02:53:13,520

there

3734

02:53:18,710 --> 02:53:16,319

and that's a good engineering practice

3735

02:53:20,150 --> 02:53:18,720

okay does anybody have some questions

3736

02:53:21,750 --> 02:53:20,160

that they would want to ask before we

3737

02:53:25,510 --> 02:53:21,760

end our session dave we have about seven

3738

02:53:28,950 --> 02:53:27,429

let's see if we have anybody wants to

3739

02:53:30,150 --> 02:53:28,960

come up to the mic or unmute their mic

3740

02:53:32,550 --> 02:53:30,160

raise your hand if you'd like to unmute

3741

02:53:57,670 --> 02:53:32,560

your mic and ask a question

3742

02:53:57,680 --> 02:54:11,990

everybody's continuing to work

3743

02:54:17,110 --> 02:54:15,030

here goes a drop from the ladder

3744

02:54:18,790 --> 02:54:17,120

we've got a question here

3745

02:54:20,309 --> 02:54:18,800

sure

3746

02:54:22,309 --> 02:54:20,319

do you think other life forms could

3747

02:54:23,830 --> 02:54:22,319

exist

3748

02:54:26,630 --> 02:54:23,840

that's one of the big things that

3749

02:54:29,349 --> 02:54:26,640

perseverance is going to look at

3750

02:54:31,830 --> 02:54:29,359

and the the interesting answer is that

3751
02:54:32,950 --> 02:54:31,840
for life forms to exist as we know them

3752
02:54:34,389 --> 02:54:32,960
okay

3753
02:54:35,349 --> 02:54:34,399
they need

3754
02:54:37,349 --> 02:54:35,359
water

3755
02:54:38,469 --> 02:54:37,359
that's the primary thing

3756
02:54:41,670 --> 02:54:38,479
okay

3757
02:54:43,830 --> 02:54:41,680
is is water not everything uh on the

3758
02:54:45,750 --> 02:54:43,840
earth uses oxygen

3759
02:54:47,269 --> 02:54:45,760
there are extremophiles that live by

3760
02:54:50,150 --> 02:54:47,279
volcanic vents in the bottom of the

3761
02:54:52,389 --> 02:54:50,160
ocean that metabolize based on sulfur

3762
02:54:54,950 --> 02:54:52,399
and not oxygen but things have to have

3763
02:54:56,790 --> 02:54:54,960

water so we know there was water on mars

3764

02:54:57,510 --> 02:54:56,800

we see the evidence of it

3765

02:54:59,429 --> 02:54:57,520

and

3766

02:55:01,110 --> 02:54:59,439

so perseverance is going to look more

3767

02:55:04,150 --> 02:55:01,120

deep with that we've got new instruments

3768

02:55:05,510 --> 02:55:04,160

on there to try and give us an idea

3769

02:55:07,510 --> 02:55:05,520

of what

3770

02:55:11,670 --> 02:55:07,520

conditions were and then we might say

3771

02:55:14,550 --> 02:55:11,680

something about life uh on mars today

3772

02:55:17,590 --> 02:55:14,560

uh it'd be happy some tough organism you

3773

02:55:19,510 --> 02:55:17,600

know to survive on mars today

3774

02:55:23,349 --> 02:55:19,520

mars gets a lot of radiation

3775

02:55:26,070 --> 02:55:23,359

mars gets uh a lot of uh solar wind hits

3776

02:55:28,070 --> 02:55:26,080

it and mars gets some very extreme

3777

02:55:29,590 --> 02:55:28,080

temperatures some super cold

3778

02:55:33,269 --> 02:55:29,600

temperatures our coldest temperature

3779

02:55:34,950 --> 02:55:33,279

ever on earth is about minus 126 degrees

3780

02:55:38,630 --> 02:55:34,960

and on mars you get you get down to

3781

02:55:41,510 --> 02:55:38,640

minus 240 degrees 250 260 degrees some

3782

02:55:44,150 --> 02:55:41,520

very super cold temperatures

3783

02:55:46,309 --> 02:55:44,160

although you might have a warm day uh

3784

02:55:47,830 --> 02:55:46,319

and it might be up to 50 degrees but

3785

02:55:49,030 --> 02:55:47,840

that's only going to be as john darn

3786

02:55:50,710 --> 02:55:49,040

said much earlier that's only going to

3787

02:55:52,389 --> 02:55:50,720

be right near the surface

3788

02:55:53,990 --> 02:55:52,399

so your feet might be warm but your head

3789

02:55:55,910 --> 02:55:54,000

is going to be pretty cold

3790

02:55:57,429 --> 02:55:55,920

because that thin atmosphere again

3791

02:56:00,550 --> 02:55:57,439

another question got a hand up here from

3792

02:56:04,230 --> 02:56:02,469

um i don't know if you've already asked

3793

02:56:06,309 --> 02:56:04,240

this but do you know when the rover will

3794

02:56:08,550 --> 02:56:06,319

be launched

3795

02:56:10,070 --> 02:56:08,560

when it's gonna land

3796

02:56:12,870 --> 02:56:10,080

uh yes

3797

02:56:16,710 --> 02:56:12,880

yeah it's gonna land at about 3 20 i

3798

02:56:18,150 --> 02:56:16,720

think so um you want to join the feed uh

3799

02:56:19,349 --> 02:56:18,160

and there's lots of places you can look

3800

02:56:20,870 --> 02:56:19,359

at you stay with the great lakes science

3801
02:56:21,990 --> 02:56:20,880
center john dar is going to talk us

3802
02:56:25,510 --> 02:56:22,000
through that

3803
02:56:28,870 --> 02:56:25,520
you can join nasa on nasa tv

3804
02:56:30,309 --> 02:56:28,880
and uh be there for it but you won't

3805
02:56:32,630 --> 02:56:30,319
know

3806
02:56:34,950 --> 02:56:32,640
if it's when it lands when it lands

3807
02:56:37,750 --> 02:56:34,960
you'll know about 12 minutes later it's

3808
02:56:39,429 --> 02:56:37,760
like if i told you guys to take your

3809
02:56:41,110 --> 02:56:39,439
experiment and climb up on the ladder

3810
02:56:42,150 --> 02:56:41,120
and close your eyes

3811
02:56:43,750 --> 02:56:42,160
okay

3812
02:56:45,590 --> 02:56:43,760
and drop it

3813
02:56:47,110 --> 02:56:45,600

and then 12 minutes later we told you

3814

02:56:48,469 --> 02:56:47,120

whether it was successful or not you

3815

02:56:50,309 --> 02:56:48,479

just had to stay there on top of the

3816

02:56:51,750 --> 02:56:50,319

ladder with your eyes closed for 12

3817

02:56:53,110 --> 02:56:51,760

minutes

3818

02:56:53,910 --> 02:56:53,120

and that's what's going to happen with

3819

02:56:55,110 --> 02:56:53,920

uh

3820

02:56:57,910 --> 02:56:55,120

with

3821

02:57:01,030 --> 02:56:57,920

our landing today okay we won't know

3822

02:57:02,870 --> 02:57:01,040

because mars is so far away uh even at

3823

02:57:05,269 --> 02:57:02,880

the speed of light which is how fast

3824

02:57:06,790 --> 02:57:05,279

signals go it's going to take it 12

3825

02:57:09,750 --> 02:57:06,800

minutes before we get it back to the

3826

02:57:11,750 --> 02:57:09,760

earth so we know what happened

3827

02:57:15,590 --> 02:57:11,760

okay

3828

02:57:18,950 --> 02:57:17,110

so it's still outside the atmosphere

3829

02:57:23,590 --> 02:57:18,960

right now it's close to mars but it

3830

02:57:23,600 --> 02:57:27,990

got a little over an hour to go

3831

02:57:28,000 --> 02:57:32,070

any more questions

3832

02:57:34,830 --> 02:57:34,070

well i see you continuing to work which

3833

02:57:37,590 --> 02:57:34,840

is

3834

02:57:40,710 --> 02:57:37,600

great okay

3835

02:57:43,269 --> 02:57:40,720

and feel free to do that

3836

02:57:44,790 --> 02:57:43,279

engineers always try to improve things

3837

02:57:47,670 --> 02:57:44,800

i see some of you looked at other

3838

02:57:49,590 --> 02:57:47,680

people's ideas and that's good

3839

02:57:50,630 --> 02:57:49,600

one of the things that doesn't happen at

3840

02:57:52,070 --> 02:57:50,640

nasa

3841

02:57:54,630 --> 02:57:52,080

is that people generally don't work

3842

02:57:56,230 --> 02:57:54,640

alone okay they work in groups

3843

02:57:57,990 --> 02:57:56,240

so you guys who are at home had a

3844

02:57:59,030 --> 02:57:58,000

disadvantage today

3845

02:58:02,070 --> 02:57:59,040

okay

3846

02:58:03,670 --> 02:58:02,080

uh you were kind of on your own and uh

3847

02:58:06,469 --> 02:58:03,680

you couldn't see what other people were

3848

02:58:08,469 --> 02:58:06,479

doing or exchange ideas but like i said

3849

02:58:10,710 --> 02:58:08,479

like we say now at nasa people work in

3850

02:58:12,550 --> 02:58:10,720

groups and exchange ideas all the time

3851
02:58:15,110 --> 02:58:12,560
uh you can see how some people thought

3852
02:58:16,870 --> 02:58:15,120
of different things today uh to make

3853
02:58:20,070 --> 02:58:16,880
things work well listen we're gonna have

3854
02:58:23,269 --> 02:58:20,080
to uh to go out so if uh you wanna share

3855
02:58:25,910 --> 02:58:23,279
my screen again back at mission control

3856
02:58:27,269 --> 02:58:25,920
if you people uh you you guys have been

3857
02:58:29,349 --> 02:58:27,279
at home today

3858
02:58:30,790 --> 02:58:29,359
uh we have uh

3859
02:58:32,469 --> 02:58:30,800
uh would like you to share take a

3860
02:58:34,790 --> 02:58:32,479
picture what you did and share it out so

3861
02:58:36,230 --> 02:58:34,800
we can see it

3862
02:58:39,429 --> 02:58:36,240
on twitter

3863
02:58:41,750 --> 02:58:39,439

gl science center on facebook

3864

02:58:44,469 --> 02:58:41,760

at great lakes science center or on

3865

02:58:46,870 --> 02:58:44,479

instagram at great lakes science center

3866

02:58:48,070 --> 02:58:46,880

and don't forget our hashtag countdown

3867

02:58:51,030 --> 02:58:48,080

to mars

3868

02:58:53,030 --> 02:58:51,040

so we would like to uh to have you sip

3869

02:58:55,429 --> 02:58:53,040

those out and we'll repost them

3870

02:58:57,590 --> 02:58:55,439

we'll share your ideas with uh with

3871

02:59:00,389 --> 02:58:57,600

other people and show what a great job

3872

02:59:02,950 --> 02:59:00,399

you did today at making a drag device

3873

02:59:04,230 --> 02:59:02,960

and you can continue to work on that uh

3874

02:59:06,070 --> 02:59:04,240

also

3875

02:59:07,910 --> 02:59:06,080

we would uh

3876

02:59:09,990 --> 02:59:07,920

like you have to try some more nasa

3877

02:59:12,469 --> 02:59:10,000

activities and if you have your uh

3878

02:59:15,670 --> 02:59:12,479

smartphone hold it up to the screen

3879

02:59:18,070 --> 02:59:15,680

take a picture of our hash of our qr

3880

02:59:20,389 --> 02:59:18,080

code today and you can learn more about

3881

02:59:22,790 --> 02:59:20,399

some nasa glenn educational

3882

02:59:24,950 --> 02:59:22,800

opportunities that you can do to learn

3883

02:59:26,550 --> 02:59:24,960

more about uh space

3884

02:59:28,150 --> 02:59:26,560

and about the kinds of things that nasa

3885

02:59:30,710 --> 02:59:28,160

does well thank you so much guys for

3886

02:59:33,750 --> 02:59:30,720

joining with us today it's been great i

3887

02:59:35,670 --> 02:59:33,760

love the creativity i loved how you had

3888

02:59:36,870 --> 02:59:35,680

so many neat ideas

3889

02:59:37,910 --> 02:59:36,880

and uh

3890

02:59:39,269 --> 02:59:37,920

remember when i told you at the

3891

02:59:41,349 --> 02:59:39,279

beginning okay

3892

02:59:43,830 --> 02:59:41,359

that we know that the first martian

3893

02:59:45,910 --> 02:59:43,840

maybe today in the sixth grade fifth

3894

02:59:47,670 --> 02:59:45,920

grade fourth grade seventh grade

3895

02:59:49,349 --> 02:59:47,680

somewhere in there i'm too old to ever

3896

02:59:50,870 --> 02:59:49,359

go to mars but you guys could be the

3897

02:59:51,990 --> 02:59:50,880

very first martians and that would be

3898

02:59:54,389 --> 02:59:52,000

really cool

3899

02:59:55,910 --> 02:59:54,399

so i'm gonna sign off i'm roger storm at

3900

02:59:58,150 --> 02:59:55,920

nasa glenn and thanks for joining with

3901
02:59:59,990 --> 02:59:58,160
us today with nasa glenn on the great

3902
03:00:02,309 --> 03:00:00,000
lakes science center and don't forget to

3903
03:00:03,590 --> 03:00:02,319
tune in okay john dar is going to come

3904
03:00:05,910 --> 03:00:03,600
back and give you some more information

3905
03:00:08,550 --> 03:00:05,920
about that i'm sure but don't forget to

3906
03:00:10,469 --> 03:00:08,560
tune in and watch what happens

3907
03:00:11,750 --> 03:00:10,479
when we finally get to

3908
03:00:13,990 --> 03:00:11,760
wow

3909
03:00:15,510 --> 03:00:14,000
a little over an hour from now

3910
03:00:21,590 --> 03:00:15,520
landing on mars

3911
03:00:26,790 --> 03:00:23,910
roger storm one of the coolest guys that

3912
03:00:28,469 --> 03:00:26,800
i know coming up with a great hands-on

3913
03:00:30,309 --> 03:00:28,479

activity that you can do at home i hope

3914

03:00:32,710 --> 03:00:30,319

that you've had a great time

3915

03:00:34,950 --> 03:00:32,720

doing that experiment and we can't wait

3916

03:00:37,750 --> 03:00:34,960

to see some of your solutions to this

3917

03:00:39,750 --> 03:00:37,760

nasa engineering design challenge thanks

3918

03:00:42,389 --> 03:00:39,760

roger and thanks to all of you for doing

3919

03:00:44,550 --> 03:00:42,399

such a great job so impressed with what

3920

03:00:46,309 --> 03:00:44,560

we've seen so far and i know that many

3921

03:00:49,269 --> 03:00:46,319

of you are continuing to work on those

3922

03:00:51,910 --> 03:00:49,279

projects and uh i can't wait to see how

3923

03:00:53,590 --> 03:00:51,920

you modify your design and make it even

3924

03:00:56,309 --> 03:00:53,600

better that's one of the things that uh

3925

03:00:59,110 --> 03:00:56,319

that engineers just like you do every

3926

03:01:01,590 --> 03:00:59,120

day they they come up with an idea they

3927

03:01:03,830 --> 03:01:01,600

test it out they try to improve it they

3928

03:01:06,790 --> 03:01:03,840

see if they can make it better they test

3929

03:01:09,030 --> 03:01:06,800

it again and then they make even further

3930

03:01:11,110 --> 03:01:09,040

improvements so

3931

03:01:13,190 --> 03:01:11,120

make sure that you take those before and

3932

03:01:15,110 --> 03:01:13,200

after pictures so we can see your

3933

03:01:18,150 --> 03:01:15,120

initial design and see how you've made

3934

03:01:19,910 --> 03:01:18,160

your design better so very very cool uh

3935

03:01:21,750 --> 03:01:19,920

roger was talking a few minutes ago

3936

03:01:24,309 --> 03:01:21,760

about uh about the live coverage coming

3937

03:01:26,950 --> 03:01:24,319

from nasa i'm obliged to share that

3938

03:01:27,990 --> 03:01:26,960

email i'm sorry that uh that uh web

3939

03:01:31,750 --> 03:01:28,000

address with you that will be

3940

03:01:35,750 --> 03:01:34,790

nasa live and you'll be able to follow

3941

03:01:37,349 --> 03:01:35,760

along

3942

03:01:39,990 --> 03:01:37,359

we'll also be carrying that coverage

3943

03:01:41,830 --> 03:01:40,000

live here as well so for those of you

3944

03:01:43,830 --> 03:01:41,840

that want to slip away you're welcome to

3945

03:01:45,590 --> 03:01:43,840

do that but for the rest of you it'll be

3946

03:01:48,150 --> 03:01:45,600

sticking with us we'll continue to

3947

03:01:49,590 --> 03:01:48,160

monitor what happens on that channel and

3948

03:01:52,630 --> 03:01:49,600

we will bring you

3949

03:01:55,349 --> 03:01:52,640

that video uh for when anytime anything

3950

03:01:57,510 --> 03:01:55,359

uh anytime anything significant comes up

3951
03:01:59,990 --> 03:01:57,520
so it's gonna be a great day we've still

3952
03:02:01,830 --> 03:02:00,000
got plenty of time about an hour or so

3953
03:02:03,429 --> 03:02:01,840
before the scheduled touchdown of the

3954
03:02:06,070 --> 03:02:03,439
rover and remember earth and mars are

3955
03:02:08,309 --> 03:02:06,080
about 300 million miles apart it'll take

3956
03:02:10,950 --> 03:02:08,319
about 14 minutes

3957
03:02:13,349 --> 03:02:10,960
for that signal to get from the uh from

3958
03:02:15,750 --> 03:02:13,359
the lander on the surface of mars all

3959
03:02:17,510 --> 03:02:15,760
the way back here to folks on earth

3960
03:02:19,590 --> 03:02:17,520
remember those radio waves are traveling

3961
03:02:23,429 --> 03:02:19,600
at the speed of light so that really

3962
03:02:26,790 --> 03:02:23,439
gives you an idea of just how far away

3963
03:02:28,469 --> 03:02:26,800

uh mars is from the earth right now so

3964

03:02:30,950 --> 03:02:28,479

we'll have word a little bit later on

3965

03:02:33,429 --> 03:02:30,960

today and i am so excited i know that

3966

03:02:35,429 --> 03:02:33,439

you are too we've seen all your

3967

03:02:37,110 --> 03:02:35,439

responses in the chat we know that you

3968

03:02:40,309 --> 03:02:37,120

guys are with us and looking forward to

3969

03:02:45,269 --> 03:02:42,469

so again thanks to roger for that uh

3970

03:02:47,990 --> 03:02:45,279

that great hands-on activity we're so

3971

03:02:49,990 --> 03:02:48,000

excited about that and being able to

3972

03:02:51,830 --> 03:02:50,000

share that and bring that to all of you

3973

03:02:53,910 --> 03:02:51,840

on behalf of the nasa glenn research

3974

03:02:55,750 --> 03:02:53,920

center and those of us here at the great

3975

03:02:57,110 --> 03:02:55,760

lakes science center you know landing on

3976

03:02:59,990 --> 03:02:57,120

mars is hard

3977

03:03:03,510 --> 03:03:00,000

only about 40 percent of the missions

3978

03:03:07,590 --> 03:03:03,520

ever sent to mars by any space agency

3979

03:03:09,990 --> 03:03:07,600

have been successful there are a hundred

3980

03:03:11,349 --> 03:03:10,000

i stand corrected there are hundreds of

3981

03:03:14,070 --> 03:03:11,359

things

3982

03:03:17,349 --> 03:03:14,080

that have to go just right in order to

3983

03:03:19,670 --> 03:03:17,359

successfully land on mars and

3984

03:03:21,590 --> 03:03:19,680

perseverance has got to get through all

3985

03:03:23,190 --> 03:03:21,600

of them all it takes is one thing to go

3986

03:03:25,910 --> 03:03:23,200

wrong and that could scrub the whole

3987

03:03:28,150 --> 03:03:25,920

mission so we've got our fingers crossed

3988

03:03:46,710 --> 03:03:28,160

we're biting our nails we're waiting

3989

03:03:46,720 --> 03:03:50,230

stay with those of you out there

3990

03:03:57,429 --> 03:03:51,670

and it looks like we've got some folks

3991

03:04:03,830 --> 03:04:00,150

again we are broadcasting live from the

3992

03:04:16,309 --> 03:04:05,830

as we await word on the perseverance

3993

03:04:20,389 --> 03:04:18,230

a little bit later on today we'll have a

3994

03:04:23,510 --> 03:04:20,399

lead scientist ken farley

3995

03:04:25,910 --> 03:04:23,520

join us to narrate an animated flyover

3996

03:04:27,750 --> 03:04:25,920

of the martian surface explaining why

3997

03:04:30,230 --> 03:04:27,760

jezreel crater

3998

03:04:32,710 --> 03:04:30,240

is the ideal place for us to land he can

3999

03:04:34,790 --> 03:04:32,720

do a much better job at it than i can

4000

03:04:36,230 --> 03:04:34,800

looking forward to that

4001

03:04:38,630 --> 03:04:36,240

and then uh

4002

03:04:41,190 --> 03:04:38,640

shortly before the scheduled landing

4003

03:04:43,269 --> 03:04:41,200

time we'll hear from uh from three of

4004

03:04:45,429 --> 03:04:43,279

the engineers and scientists who are

4005

03:04:47,510 --> 03:04:45,439

involved with the landing system for

4006

03:04:49,510 --> 03:04:47,520

this vehicle and they'll explain step by

4007

03:04:52,550 --> 03:04:49,520

step what's going to happen with regards

4008

03:04:54,950 --> 03:04:52,560

to the rover during the entry descent

4009

03:04:56,230 --> 03:04:54,960

and landing on the surface of mars you

4010

03:04:58,550 --> 03:04:56,240

don't want to miss that that'll be

4011

03:05:00,230 --> 03:04:58,560

coming up here in just a few minutes and

4012

03:05:02,309 --> 03:05:00,240

of course we'll be here to answer some

4013

03:05:04,150 --> 03:05:02,319

of your questions any of the questions

4014

03:05:06,150 --> 03:05:04,160

that you have that come in uh we're

4015

03:05:09,030 --> 03:05:06,160

anxious to do that you can contact us

4016

03:05:14,790 --> 03:05:09,040

via our social media or right here on

4017

03:05:26,870 --> 03:05:17,590

perseverance is gonna touch down on mars

4018

03:05:29,910 --> 03:05:28,150

so for those of you that are just

4019

03:05:32,230 --> 03:05:29,920

joining us reminding you about the key

4020

03:05:34,790 --> 03:05:32,240

objectives for this mission uh we're

4021

03:05:38,070 --> 03:05:34,800

going to explore an amazing landing site

4022

03:05:41,110 --> 03:05:38,080

that is geologically uh diverse

4023

03:05:43,429 --> 03:05:41,120

uh we'll assess whether or not

4024

03:05:45,830 --> 03:05:43,439

ancient mars was habitable

4025

03:05:48,230 --> 03:05:45,840

uh we'll seek for signs of that ancient

4026

03:05:49,269 --> 03:05:48,240

life using this robot

4027

03:05:55,269 --> 03:05:49,279

and

4028

03:05:57,429 --> 03:05:55,279

for a possible return to earth by a

4029

03:05:59,510 --> 03:05:57,439

future mission and will demonstrate some

4030

03:06:01,910 --> 03:05:59,520

amazing technology

4031

03:06:04,309 --> 03:06:01,920

that is uh being test flown on this

4032

03:06:06,150 --> 03:06:04,319

spacecraft and if it goes well some of

4033

03:06:08,469 --> 03:06:06,160

this technology will end up on

4034

03:06:10,469 --> 03:06:08,479

crew-rated craft that will be carrying

4035

03:06:13,750 --> 03:06:10,479

the first astronauts to the surface of

4036

03:06:15,830 --> 03:06:13,760

mars in the future

4037

03:06:19,110 --> 03:06:15,840

again the vehicles launched last july

4038

03:06:21,990 --> 03:06:19,120

july 30th that took off from the uh

4039

03:06:24,630 --> 03:06:22,000

from cape canaveral air force station

4040

03:06:26,309 --> 03:06:24,640

located there in florida and it was

4041

03:06:28,389 --> 03:06:26,319

launched towards mars it's been in a

4042

03:06:30,150 --> 03:06:28,399

crew space since then it hasn't entered

4043

03:06:33,030 --> 03:06:30,160

the atmosphere so it's still cruising

4044

03:06:35,510 --> 03:06:33,040

towards mars very shortly though

4045

03:06:38,389 --> 03:06:35,520

it will uh it will begin the sequence of

4046

03:06:40,230 --> 03:06:38,399

events that are necessary for it to land

4047

03:06:42,630 --> 03:06:40,240

that will include uh

4048

03:06:44,070 --> 03:06:42,640

shedding the the cruise phase for the

4049

03:06:45,190 --> 03:06:44,080

mission the uh

4050

03:06:49,110 --> 03:06:45,200

and then

4051

03:06:51,590 --> 03:06:49,120

using its heat shield that barrel

4052

03:06:54,230 --> 03:06:51,600

breaking shield to help slow it down for

4053

03:06:56,950 --> 03:06:54,240

a possible landing on the surface again

4054

03:06:59,349 --> 03:06:56,960

our landing site is jezreel crater

4055

03:07:01,590 --> 03:06:59,359

a very interesting place very diverse

4056

03:07:03,990 --> 03:07:01,600

place it was a place that was selected

4057

03:07:05,190 --> 03:07:04,000

out of uh several sites several

4058

03:07:07,590 --> 03:07:05,200

finalists

4059

03:07:09,349 --> 03:07:07,600

across the surface of mars

4060

03:07:12,230 --> 03:07:09,359

we think that this is a location that

4061

03:07:14,630 --> 03:07:12,240

will be perfect for us to land on uh and

4062

03:07:17,269 --> 03:07:14,640

to gather samples that will one day be

4063

03:07:18,950 --> 03:07:17,279

returned to earth so we're excited about

4064

03:07:21,349 --> 03:07:18,960

that

4065

03:07:23,590 --> 03:07:21,359

and of course the the robot is designed

4066

03:07:25,190 --> 03:07:23,600

to operate for two years they're on the

4067

03:07:27,429 --> 03:07:25,200

surface of mars

4068

03:07:28,550 --> 03:07:27,439

that's two earth years again that will

4069

03:07:31,510 --> 03:07:28,560

be one

4070

03:07:33,670 --> 03:07:31,520

martian year again it takes mars twice

4071

03:07:42,309 --> 03:07:33,680

as long to orbit the sun

4072

03:07:46,469 --> 03:07:44,550

seven scientific instruments that are

4073

03:07:49,670 --> 03:07:46,479

that are part of the payload

4074

03:07:52,309 --> 03:07:49,680

uh for the uh for the rover

4075

03:07:54,710 --> 03:07:52,319

from uh rimfax the radar imager from

4076
03:07:57,110 --> 03:07:54,720
mars subsurface experiment that was a

4077
03:07:59,590 --> 03:07:57,120
ground penetrating radar that we talked

4078
03:08:01,429 --> 03:07:59,600
about a short while ago it will actually

4079
03:08:03,750 --> 03:08:01,439
be able to give us a look at what's

4080
03:08:06,550 --> 03:08:03,760
underneath the surface of mars right

4081
03:08:08,230 --> 03:08:06,560
down to a millimeter level and that's

4082
03:08:10,389 --> 03:08:08,240
going to be very exciting for us to

4083
03:08:14,150 --> 03:08:10,399
learn about the sub structure

4084
03:08:18,469 --> 03:08:16,550
mars also has a i'm sorry the rover also

4085
03:08:20,309 --> 03:08:18,479
has a has a

4086
03:08:22,710 --> 03:08:20,319
fantastic weather station that it's

4087
03:08:24,389 --> 03:08:22,720
carrying a board with it a set of unique

4088
03:08:27,269 --> 03:08:24,399

sensors that will provide measurements

4089

03:08:29,349 --> 03:08:27,279

of temperature wind speed and direction

4090

03:08:30,870 --> 03:08:29,359

uh atmospheric pressure relative

4091

03:08:33,030 --> 03:08:30,880

humidity

4092

03:08:36,070 --> 03:08:33,040

it'll even let us know about the dust

4093

03:08:38,070 --> 03:08:36,080

particles size and shape and that will

4094

03:08:40,710 --> 03:08:38,080

be very exciting too that's the mars

4095

03:08:45,670 --> 03:08:40,720

environmental dynamics analyzer

4096

03:08:50,950 --> 03:08:48,710

another scientific instrument is moxie

4097

03:08:55,190 --> 03:08:50,960

that's the mars oxygen incentive

4098

03:08:57,910 --> 03:08:55,200

resource utilization experiment

4099

03:09:00,469 --> 03:08:57,920

this uh technology will be demonstrated

4100

03:09:02,630 --> 03:09:00,479

that will produce oxygen from the

4101
03:09:04,389 --> 03:09:02,640
martian atmosphere

4102
03:09:06,389 --> 03:09:04,399
again that's going to be very exciting

4103
03:09:08,070 --> 03:09:06,399
as we prepare to send a human cruise to

4104
03:09:10,309 --> 03:09:08,080
mars one day

4105
03:09:12,230 --> 03:09:10,319
if this system works well a larger

4106
03:09:15,269 --> 03:09:12,240
system will be employed that will

4107
03:09:18,630 --> 03:09:15,279
actually allow us to generate oxygen for

4108
03:09:19,990 --> 03:09:18,640
those future crews on mars

4109
03:09:20,950 --> 03:09:20,000
sherlock is another one of the great

4110
03:09:22,710 --> 03:09:20,960
tools

4111
03:09:24,950 --> 03:09:22,720
that is on board one of the great

4112
03:09:27,990 --> 03:09:24,960
scientific instruments

4113
03:09:31,269 --> 03:09:28,000

it'll be using a fine scaled imaging

4114

03:09:33,830 --> 03:09:31,279

ultraviolet laser to map mineralogy and

4115

03:09:34,870 --> 03:09:33,840

organic compounds sherlock will be the

4116

03:09:38,469 --> 03:09:34,880

first

4117

03:09:41,590 --> 03:09:38,479

uv spectrometer to fly to the surface of

4118

03:09:42,950 --> 03:09:41,600

mars and it will provide complementary

4119

03:09:45,590 --> 03:09:42,960

measurements to some of the other

4120

03:09:46,630 --> 03:09:45,600

instruments that are included with this

4121

03:09:49,830 --> 03:09:46,640

payload

4122

03:09:52,790 --> 03:09:49,840

again that's sherlock

4123

03:09:55,349 --> 03:09:52,800

pixel is another uh is another

4124

03:09:57,429 --> 03:09:55,359

instrument on board that's a planetary

4125

03:10:00,309 --> 03:09:57,439

instrument for x-ray

4126
03:10:02,389 --> 03:10:00,319
lithochemistry

4127
03:10:05,349 --> 03:10:02,399
it carries an x-ray fluorescence

4128
03:10:07,670 --> 03:10:05,359
spectrometer and high resolution imager

4129
03:10:10,230 --> 03:10:07,680
that will be used to map the fine scale

4130
03:10:12,230 --> 03:10:10,240
element composition on the martian

4131
03:10:14,790 --> 03:10:12,240
surface pixel will provide capabilities

4132
03:10:17,910 --> 03:10:14,800
that will permit more detailed detection

4133
03:10:19,830 --> 03:10:17,920
and analysis of the chemical elements

4134
03:10:23,349 --> 03:10:19,840
much more than ever before that's an

4135
03:10:25,590 --> 03:10:23,359
exciting piece of equipment on board

4136
03:10:27,190 --> 03:10:25,600
super cam that's the instrument that we

4137
03:10:28,150 --> 03:10:27,200
talked about a little while ago that can

4138
03:10:30,950 --> 03:10:28,160

provide

4139

03:10:33,830 --> 03:10:30,960

uh imaging and uh chemical composition

4140

03:10:35,030 --> 03:10:33,840

analysis as well as mineralogy at a

4141

03:10:37,590 --> 03:10:35,040

distance

4142

03:10:39,830 --> 03:10:37,600

and that will be uh that will be

4143

03:10:43,110 --> 03:10:39,840

something that will be extraordinary as

4144

03:10:46,309 --> 03:10:43,120

well and we've talked about mastercam

4145

03:10:49,429 --> 03:10:46,319

the mass cam z is an advanced camera

4146

03:10:52,710 --> 03:10:49,439

system with pano with panoramic and

4147

03:10:55,349 --> 03:10:52,720

stereographic imaging capabilities and

4148

03:10:57,510 --> 03:10:55,359

it has the ability to zoom in to give us

4149

03:11:00,389 --> 03:10:57,520

a closer look so again those are all

4150

03:11:02,630 --> 03:11:00,399

exciting things that will improve rover

4151
03:11:04,389 --> 03:11:02,640
operations that's just

4152
03:11:07,510 --> 03:11:04,399
just amazing

4153
03:11:10,469 --> 03:11:07,520
for this particular piece of equipment

4154
03:11:12,790 --> 03:11:10,479
so again we are still following the the

4155
03:11:15,190 --> 03:11:12,800
progress of the vehicle as it continues

4156
03:11:17,990 --> 03:11:15,200
with its approach to mars ultimately

4157
03:11:20,230 --> 03:11:18,000
it's landing on the surface again a huge

4158
03:11:22,150 --> 03:11:20,240
distance between uh between burke and

4159
03:11:24,630 --> 03:11:22,160
mars so it does take time for those

4160
03:11:26,150 --> 03:11:24,640
signals to reach us but as soon as we

4161
03:11:29,030 --> 03:11:26,160
have them we'll share that information

4162
03:11:30,150 --> 03:11:29,040
with you and that will be very very

4163
03:11:33,590 --> 03:11:30,160

exciting

4164

03:11:38,070 --> 03:11:36,070

mars helicopter is uh is included with

4165

03:11:39,670 --> 03:11:38,080

this uh with this payload package and

4166

03:11:41,670 --> 03:11:39,680

for the first time

4167

03:11:43,590 --> 03:11:41,680

we'll have an aerial drone that will be

4168

03:11:46,550 --> 03:11:43,600

able to fly across the surface of

4169

03:11:48,870 --> 03:11:46,560

another world giving us aerial views

4170

03:11:52,070 --> 03:11:48,880

of the martian surface allowing us to

4171

03:11:53,910 --> 03:11:52,080

see it from a different vantage point

4172

03:11:56,950 --> 03:11:53,920

again we're testing this uh this new

4173

03:12:00,070 --> 03:11:56,960

technology and uh i i've got to tell you

4174

03:12:03,190 --> 03:12:00,080

that i am absolutely excited about this

4175

03:12:05,429 --> 03:12:03,200

the name of the helicopter is ingenuity

4176

03:12:06,950 --> 03:12:05,439

and and that's exactly what it is the

4177

03:12:09,510 --> 03:12:06,960

engineers have

4178

03:12:12,550 --> 03:12:09,520

have developed an ingenious device

4179

03:12:16,630 --> 03:12:12,560

uh robotic vehicle that will be able to

4180

03:12:18,550 --> 03:12:16,640

explore mars from the air

4181

03:12:20,309 --> 03:12:18,560

you know the year on mars is very very

4182

03:12:22,710 --> 03:12:20,319

thin so coming up with a vehicle that

4183

03:12:25,590 --> 03:12:22,720

can do powered flight in that thin

4184

03:12:28,790 --> 03:12:25,600

that thin air is just amazing and it

4185

03:12:30,870 --> 03:12:28,800

will help to inform us decisions uh

4186

03:12:33,349 --> 03:12:30,880

relating to considering other small

4187

03:12:35,269 --> 03:12:33,359

vehicles for a future mars mission

4188

03:12:38,150 --> 03:12:35,279

and they could perform some type of

4189

03:12:40,389 --> 03:12:38,160

supporting role to uh to the other

4190

03:12:42,630 --> 03:12:40,399

vehicles as well these are robotic

4191

03:12:43,750 --> 03:12:42,640

scouts they can survey terrain

4192

03:12:48,870 --> 03:12:43,760

they can

4193

03:12:50,710 --> 03:12:48,880

all of that from above and that's that's

4194

03:12:52,630 --> 03:12:50,720

just amazing

4195

03:12:53,990 --> 03:12:52,640

again this particular project is

4196

03:12:55,750 --> 03:12:54,000

demonstrating

4197

03:12:57,349 --> 03:12:55,760

some new technology

4198

03:12:59,190 --> 03:12:57,359

and

4199

03:13:00,870 --> 03:12:59,200

it wasn't originally designed to support

4200

03:13:03,030 --> 03:13:00,880

the mars mission but

4201

03:13:05,030 --> 03:13:03,040

but it's uh it's some technology that's

4202

03:13:05,830 --> 03:13:05,040

being demonstrated and if it goes well

4203

03:13:12,070 --> 03:13:05,840

then

4204

03:13:16,790 --> 03:13:14,870

a few questions that are coming in

4205

03:13:19,110 --> 03:13:16,800

let's take a look at our social media

4206

03:13:20,550 --> 03:13:19,120

and uh and see who's got a question for

4207

03:13:28,070 --> 03:13:20,560

us

4208

03:13:33,750 --> 03:13:31,269

uh here's a question this is a question

4209

03:13:34,790 --> 03:13:33,760

from jerome hi jerome thanks for joining

4210

03:13:36,550 --> 03:13:34,800

us

4211

03:13:39,510 --> 03:13:36,560

jerome wants to know what does it take

4212

03:13:41,349 --> 03:13:39,520

to get a spacecraft to mars that's uh

4213

03:13:43,510 --> 03:13:41,359

that's a really good question

4214

03:13:45,110 --> 03:13:43,520

it takes careful planning

4215

03:13:46,550 --> 03:13:45,120

and uh

4216

03:13:48,150 --> 03:13:46,560

and that's just part of it you know

4217

03:13:50,710 --> 03:13:48,160

again earth and mars are in different

4218

03:13:52,150 --> 03:13:50,720

orbits they travel at different speeds

4219

03:13:54,309 --> 03:13:52,160

around the sun

4220

03:13:56,309 --> 03:13:54,319

so careful planning of exactly when to

4221

03:13:58,710 --> 03:13:56,319

launch our spacecraft in order to get it

4222

03:14:00,389 --> 03:13:58,720

to uh to mars is very important also we

4223

03:14:02,389 --> 03:14:00,399

have to consider the size of the

4224

03:14:04,790 --> 03:14:02,399

spacecraft depending on what we want to

4225

03:14:06,870 --> 03:14:04,800

launch towards mars it might require a

4226

03:14:08,309 --> 03:14:06,880

larger rocket you know perseverance is

4227

03:14:11,110 --> 03:14:08,319

one of the largest things that we've

4228

03:14:13,750 --> 03:14:11,120

ever sent to mars and we needed an atlas

4229

03:14:16,309 --> 03:14:13,760

v rocket one of our strongest rockets to

4230

03:14:19,349 --> 03:14:16,319

carry such a heavy payload to uh through

4231

03:14:20,710 --> 03:14:19,359

interplanetary space so uh that's one of

4232

03:14:22,630 --> 03:14:20,720

the things that we have to consider when

4233

03:14:24,790 --> 03:14:22,640

we're getting ready to uh to send the

4234

03:14:26,550 --> 03:14:24,800

spacecraft to mars what is it that we

4235

03:14:28,710 --> 03:14:26,560

want to do now one of the other things

4236

03:14:30,630 --> 03:14:28,720

that you want to consider jerome is what

4237

03:14:32,150 --> 03:14:30,640

do you want to do when you get there

4238

03:14:34,309 --> 03:14:32,160

that'll help determine what type of

4239

03:14:35,990 --> 03:14:34,319

chassis or basic frame you're going to

4240

03:14:38,550 --> 03:14:36,000

need for the robot will it be a

4241

03:14:40,710 --> 03:14:38,560

stationary robot will it be a mobile

4242

03:14:42,630 --> 03:14:40,720

robot that will drive around

4243

03:14:44,309 --> 03:14:42,640

those are questions to ask as you help

4244

03:14:46,469 --> 03:14:44,319

to plan and prepare

4245

03:14:48,550 --> 03:14:46,479

for a uh for a potential mission if you

4246

03:14:50,790 --> 03:14:48,560

haven't already done so folks why don't

4247

03:14:52,710 --> 03:14:50,800

you do this as an experiment and it's

4248

03:14:54,309 --> 03:14:52,720

something to think about why don't you

4249

03:14:56,469 --> 03:14:54,319

plan your own

4250

03:14:58,309 --> 03:14:56,479

robotic mission to mars and tell us a

4251

03:15:00,070 --> 03:14:58,319

little bit about the uh about the

4252

03:15:02,790 --> 03:15:00,080

mission that you have planned

4253

03:15:04,630 --> 03:15:02,800

you can also draw pictures and post

4254

03:15:08,070 --> 03:15:04,640

those pictures on social media showing

4255

03:15:10,389 --> 03:15:08,080

you showing us what your uh what your

4256

03:15:12,550 --> 03:15:10,399

your uh your mission vehicle will look

4257

03:15:14,469 --> 03:15:12,560

like and don't forget to tell us what

4258

03:15:16,870 --> 03:15:14,479

it's going to do once it gets tomorrow

4259

03:15:20,950 --> 03:15:16,880

so that's part of your tasking now

4260

03:15:22,469 --> 03:15:20,960

design your own mission to mars

4261

03:15:25,990 --> 03:15:22,479

thanks for that great question jerome

4262

03:15:33,590 --> 03:15:26,000

that was uh that was fantastic

4263

03:15:39,830 --> 03:15:36,389

here's a good one how do rovers drive on

4264

03:15:42,389 --> 03:15:39,840

the surface of mars

4265

03:15:45,269 --> 03:15:42,399

very skillfully again earth and mars are

4266

03:15:47,510 --> 03:15:45,279

very far apart it sends it it takes time

4267

03:15:48,630 --> 03:15:47,520

to send those radio signals back and

4268

03:15:52,150 --> 03:15:48,640

forth so

4269

03:15:54,550 --> 03:15:52,160

uh typically it's not a uh not a a

4270

03:15:57,910 --> 03:15:54,560

remote control like you might be used to

4271

03:16:00,150 --> 03:15:57,920

with a with a toy car or even a a radio

4272

03:16:02,710 --> 03:16:00,160

controlled airplane

4273

03:16:05,990 --> 03:16:02,720

this takes careful planning your robot

4274

03:16:07,830 --> 03:16:06,000

has to do a lot of work on its own so

4275

03:16:09,510 --> 03:16:07,840

that rover will have to have very

4276

03:16:11,349 --> 03:16:09,520

sensitive instruments and excellent

4277

03:16:13,110 --> 03:16:11,359

programming you might know where you

4278

03:16:15,349 --> 03:16:13,120

want the robot to go and you'll send the

4279

03:16:17,510 --> 03:16:15,359

command for it to go there

4280

03:16:20,150 --> 03:16:17,520

but as in the case with pressure with

4281

03:16:22,870 --> 03:16:20,160

perseverance it'll have to figure out on

4282

03:16:24,790 --> 03:16:22,880

its own how to get from point a to point

4283

03:16:27,510 --> 03:16:24,800

b how to get from where it is to where

4284

03:16:29,349 --> 03:16:27,520

you want it to go so some of the sensors

4285

03:16:31,269 --> 03:16:29,359

some of the equipment that's on board

4286

03:16:33,750 --> 03:16:31,279

that are used for navigation are

4287

03:16:35,590 --> 03:16:33,760

designed to be operated just that way

4288

03:16:37,590 --> 03:16:35,600

once it gets here then you can do all

4289

03:16:39,510 --> 03:16:37,600

kinds of thoughts and experiments but

4290

03:16:41,510 --> 03:16:39,520

it's really going to be up to the rover

4291

03:16:43,750 --> 03:16:41,520

and the rovers uh and the rover's

4292

03:16:46,229 --> 03:16:43,760

artificial intelligence to tell it how

4293

03:16:47,990 --> 03:16:46,239

to get to where you wanted to go great

4294

03:16:49,910 --> 03:16:48,000

question again

4295

03:16:54,790 --> 03:16:49,920

where uh

4296

03:16:56,229 --> 03:16:54,800

how do uh how do rovers drive on mars

4297

03:17:00,870 --> 03:16:56,239

check to see if we have any other

4298

03:17:06,150 --> 03:17:04,150

some of these we've already answered

4299

03:17:07,510 --> 03:17:06,160

how long is a year on mars i think we

4300

03:17:08,710 --> 03:17:07,520

we've talked about that a couple of

4301
03:17:10,630 --> 03:17:08,720
times now

4302
03:17:12,630 --> 03:17:10,640
again mars is twice the distance from

4303
03:17:15,590 --> 03:17:12,640
the sun that the earth is so it's going

4304
03:17:19,590 --> 03:17:15,600
to take it twice as long to go around

4305
03:17:22,389 --> 03:17:19,600
the sun as earth does so a year on mars

4306
03:17:24,550 --> 03:17:22,399
is actually two earth years for planets

4307
03:17:26,870 --> 03:17:24,560
that are closer to the sun like venus

4308
03:17:27,670 --> 03:17:26,880
and even mercury they move at a faster

4309
03:17:29,830 --> 03:17:27,680
rate

4310
03:17:32,870 --> 03:17:29,840
and the time it takes them to go around

4311
03:17:34,870 --> 03:17:32,880
the sun a year on those planetary bodies

4312
03:17:37,830 --> 03:17:34,880
is much shorter than a year here on

4313
03:17:41,510 --> 03:17:37,840

earth but for those planets like like

4314

03:17:43,269 --> 03:17:41,520

mars and jupiter and saturn etc they're

4315

03:17:46,150 --> 03:17:43,279

farther away from the sun so it's going

4316

03:17:48,870 --> 03:17:46,160

to take them longer to go around that to

4317

03:17:51,269 --> 03:17:48,880

go around our star

4318

03:17:53,030 --> 03:17:51,279

that that that's a great question and

4319

03:17:54,630 --> 03:17:53,040

hopefully we've answered it for you

4320

03:17:57,269 --> 03:17:54,640

that's a little timmy

4321

03:17:59,349 --> 03:17:57,279

and timmy is from garfield heights thank

4322

03:18:01,429 --> 03:17:59,359

you that was a great question a great

4323

03:18:04,070 --> 03:18:01,439

question

4324

03:18:05,349 --> 03:18:04,080

looking to see if we have any additional

4325

03:18:12,229 --> 03:18:05,359

questions here

4326

03:18:15,510 --> 03:18:13,349

so some of the things that we're going

4327

03:18:17,429 --> 03:18:15,520

to be looking for during the descent and

4328

03:18:19,910 --> 03:18:17,439

the and the landing

4329

03:18:21,590 --> 03:18:19,920

are signals coming from the the vehicle

4330

03:18:24,950 --> 03:18:21,600

itself you know one of the amazing

4331

03:18:29,990 --> 03:18:27,269

excuse me

4332

03:18:32,710 --> 03:18:30,000

once uh once the uh the vehicle enters

4333

03:18:34,870 --> 03:18:32,720

the atmosphere after the after the

4334

03:18:37,750 --> 03:18:34,880

supersonic parachute has been deployed

4335

03:18:39,349 --> 03:18:37,760

and the vehicle slows down substantially

4336

03:18:42,229 --> 03:18:39,359

there is a

4337

03:18:44,150 --> 03:18:42,239

the the the heat shield the lower heat

4338

03:18:46,229 --> 03:18:44,160

shield will be released

4339

03:18:49,429 --> 03:18:46,239

and uh for the first time we'll be able

4340

03:18:51,510 --> 03:18:49,439

to see the uh the surface of the planet

4341

03:18:52,790 --> 03:18:51,520

there are actually two tiny cameras that

4342

03:18:55,269 --> 03:18:52,800

are on board

4343

03:18:57,990 --> 03:18:55,279

that the that the spacecraft is using to

4344

03:18:59,990 --> 03:18:58,000

help it navigate to the touchdown point

4345

03:19:03,030 --> 03:19:00,000

and this will give us the opportunity to

4346

03:19:05,429 --> 03:19:03,040

actually see that landing from the eyes

4347

03:19:06,950 --> 03:19:05,439

of the rover and that's going to be so

4348

03:19:09,429 --> 03:19:06,960

very very cool

4349

03:19:14,710 --> 03:19:09,439

and and hopefully we'll be able to bring

4350

03:19:19,349 --> 03:19:17,510

as the as the vehicle gets closer to the

4351

03:19:20,469 --> 03:19:19,359

surface of mars

4352

03:19:22,550 --> 03:19:20,479

one of the things that we want to be

4353

03:19:24,870 --> 03:19:22,560

very careful of is that we don't want to

4354

03:19:25,750 --> 03:19:24,880

we don't want to kick up a lot of dust

4355

03:19:27,910 --> 03:19:25,760

so

4356

03:19:29,830 --> 03:19:27,920

we've we've entered the atmosphere we've

4357

03:19:32,630 --> 03:19:29,840

used the parachute we've separated from

4358

03:19:34,950 --> 03:19:32,640

the parachute a jet pack will take over

4359

03:19:37,590 --> 03:19:34,960

and that jet pack is going to stop the

4360

03:19:39,349 --> 03:19:37,600

vertical descent of the vehicle

4361

03:19:41,269 --> 03:19:39,359

allow it to hover it's going to move out

4362

03:19:44,229 --> 03:19:41,279

of the way so it doesn't get hit by any

4363

03:19:46,870 --> 03:19:44,239

of the other pieces of the spacecraft as

4364

03:19:48,389 --> 03:19:46,880

it enters the atmosphere but after it's

4365

03:19:50,550 --> 03:19:48,399

moved off to the side it's going to

4366

03:19:52,870 --> 03:19:50,560

steady itself it's going to use its

4367

03:19:54,870 --> 03:19:52,880

onboard sensor system to ease it a

4368

03:19:57,670 --> 03:19:54,880

little bit closer to the to the

4369

03:20:00,229 --> 03:19:57,680

designated landing site in fact

4370

03:20:02,630 --> 03:20:00,239

this spacecraft is so sophisticated it

4371

03:20:04,790 --> 03:20:02,640

can scan the terrain and look for the

4372

03:20:06,630 --> 03:20:04,800

best place in that general facility to

4373

03:20:08,870 --> 03:20:06,640

touch down and that's some neat

4374

03:20:11,510 --> 03:20:08,880

technology that we're going to be seeing

4375

03:20:13,590 --> 03:20:11,520

used on this on this particular mission

4376

03:20:16,150 --> 03:20:13,600

so it will be able to help itself to

4377

03:20:17,990 --> 03:20:16,160

find the best place to land in that

4378

03:20:20,710 --> 03:20:18,000

general area

4379

03:20:22,630 --> 03:20:20,720

it'll hover above that area about 12

4380

03:20:25,910 --> 03:20:22,640

seconds before touchdown

4381

03:20:28,790 --> 03:20:25,920

the uh the rover itself will be lowered

4382

03:20:30,950 --> 03:20:28,800

down from that from that jet pack we

4383

03:20:33,990 --> 03:20:30,960

call this the sky crane maneuver it will

4384

03:20:36,229 --> 03:20:34,000

be lowered down and uh and then once the

4385

03:20:43,110 --> 03:20:36,239

wheels touch down the cables will be

4386

03:20:48,710 --> 03:20:46,070

well folks we understand that uh

4387

03:20:50,469 --> 03:20:48,720

we understand that the uh that nasa

4388

03:20:55,670 --> 03:20:50,479

mission control

4389

03:21:02,309 --> 03:20:59,910

and we are going to join that broadcast

4390

03:21:04,070 --> 03:21:02,319

already in progress you can stay here

4391

03:21:05,990 --> 03:21:04,080

with us or you can switch over to

4392

03:21:08,389 --> 03:21:06,000

nasa.gov

4393

03:21:10,469 --> 03:21:08,399

nasalive but for those of you that are

4394

03:21:12,950 --> 03:21:10,479

staying with us we're going to go ahead

4395

03:21:33,269 --> 03:21:12,960

and tune into that broadcast in real

4396

03:21:38,229 --> 03:21:35,030

once again we're joining uh we're

4397

03:21:41,190 --> 03:21:38,239

joining nasa tv

4398

03:21:44,630 --> 03:21:41,200

as we follow live coverage

4399

03:21:54,710 --> 03:21:46,630

rover

4400

03:21:57,670 --> 03:21:56,150

images that you'll be seeing on the

4401
03:22:01,429 --> 03:21:57,680
screen are coming live from the mission

4402
03:22:05,269 --> 03:22:03,590
robotic missions are primarily handled

4403
03:22:09,830 --> 03:22:05,279
through the jet propulsion laboratory in

4404
03:22:14,630 --> 03:22:11,670
so we'll be able to link up with them

4405
03:22:18,550 --> 03:22:16,229
and we'll continue to provide you with

4406
03:22:24,710 --> 03:22:18,560
commentary

4407
03:22:30,070 --> 03:22:26,710
as a vehicle continues to make it its

4408
03:22:35,429 --> 03:22:32,150
key phases that are that will be coming

4409
03:22:36,870 --> 03:22:35,439
up and the flight

4410
03:22:38,309 --> 03:22:36,880
about 10 minutes before entering the

4411
03:22:40,389 --> 03:22:38,319
atmosphere

4412
03:22:42,469 --> 03:22:40,399
spacecraft is going to shed its cruise

4413
03:22:44,229 --> 03:22:42,479

stage that houses the solar panels

4414

03:22:46,790 --> 03:22:44,239

radios fuel tanks the things that it's

4415

03:22:48,950 --> 03:22:46,800

been using for that interstellar

4416

03:22:55,349 --> 03:22:48,960

cruise

4417

03:23:00,550 --> 03:22:57,990

only the protective aeroshell

4418

03:23:02,550 --> 03:23:00,560

with its rover inside will

4419

03:23:04,550 --> 03:23:02,560

be the descent stage that'll be entering

4420

03:23:05,990 --> 03:23:04,560

the atmosphere and make the trip down to

4421

03:23:07,910 --> 03:23:06,000

the surface happy to have you here

4422

03:23:10,229 --> 03:23:07,920

thanks swati we'll be checking back in

4423

03:23:12,070 --> 03:23:10,239

with you in just a few minutes as

4424

03:23:17,110 --> 03:23:12,080

perseverance approaches its next

4425

03:23:17,120 --> 03:23:23,190

once it lands on mars

4426

03:23:23,200 --> 03:23:35,830

ours is the closest place

4427

03:23:48,630 --> 03:23:44,870

crater

4428

03:23:49,990 --> 03:23:48,640

surface of mars could have hosted

4429

03:23:51,990 --> 03:23:50,000

ancients

4430

03:23:54,229 --> 03:23:52,000

but not every crater that we think had

4431

03:23:56,309 --> 03:23:54,239

only actually preserves evidence that

4432

03:23:58,229 --> 03:23:56,319

that lake was there it had an inflow

4433

03:24:00,070 --> 03:23:58,239

channel and it had an outflow channel

4434

03:24:02,710 --> 03:24:00,080

that means it was filled the crater was

4435

03:24:04,469 --> 03:24:02,720

filled with water in jezreel we have

4436

03:24:08,150 --> 03:24:04,479

probably one of the most beautifully

4437

03:24:09,670 --> 03:24:08,160

preserved delta deposits on mars in that

4438

03:24:15,510 --> 03:24:09,680

crater

4439

03:24:18,389 --> 03:24:17,590

to preserve

4440

03:24:21,990 --> 03:24:18,399

and

4441

03:24:33,780 --> 03:24:23,510

the unique

4442

03:24:33,790 --> 03:24:38,389

[Music]

4443

03:24:38,399 --> 03:24:41,670

and

4444

03:24:44,630 --> 03:24:43,429

life ever existed

4445

03:24:46,309 --> 03:24:44,640

on mars

4446

03:24:49,750 --> 03:24:46,319

the perseverance rover starts with

4447

03:25:06,150 --> 03:24:49,760

design that's very similar to curiosity

4448

03:25:12,630 --> 03:25:09,590

another planet perseverance carries with

4449

03:25:15,510 --> 03:25:12,640

her a grand experiment in space fairing

4450

03:25:19,030 --> 03:25:15,520

technology a helicopter the name of

4451
03:25:21,269 --> 03:25:19,040
which is now ingenuity one of the major

4452
03:25:23,110 --> 03:25:21,279
upgrades that perseverance has from

4453
03:25:26,229 --> 03:25:23,120
curiosity is that it's able to

4454
03:25:29,190 --> 03:25:26,239
self-drive for a distance of up to 200

4455
03:25:31,590 --> 03:25:29,200
meters per day as the rover is driving

4456
03:25:34,469 --> 03:25:31,600
it's literally building the map of the

4457
03:25:36,389 --> 03:25:34,479
road it's driving on on mars

4458
03:25:38,550 --> 03:25:36,399
scientists for years have told us that

4459
03:25:40,070 --> 03:25:38,560
to really unlock

4460
03:25:42,550 --> 03:25:40,080
the secrets of mars we have to bring

4461
03:25:45,990 --> 03:25:42,560
samples from mars back to earth so what

4462
03:25:47,349 --> 03:25:46,000
marsh 2020 is going to do is to

4463
03:25:49,750 --> 03:25:47,359

drill samples

4464

03:25:52,469 --> 03:25:49,760

put them in small tubes we're going to

4465

03:25:54,389 --> 03:25:52,479

seal it in its own individual tube we

4466

03:25:56,950 --> 03:25:54,399

set them on the surface to provide a

4467

03:25:58,710 --> 03:25:56,960

target for the second two missions

4468

03:26:00,150 --> 03:25:58,720

which hopefully will get in development

4469

03:26:01,990 --> 03:26:00,160

in the next several years and could

4470

03:26:06,550 --> 03:26:02,000

potentially get the samples back to

4471

03:26:08,710 --> 03:26:06,560

earth by v31 perseverance is a very very

4472

03:26:11,269 --> 03:26:08,720

profound first step

4473

03:26:12,790 --> 03:26:11,279

in both our understanding

4474

03:26:14,070 --> 03:26:12,800

of our place

4475

03:26:14,950 --> 03:26:14,080

in the universe

4476

03:26:16,550 --> 03:26:14,960

and

4477

03:26:23,429 --> 03:26:16,560

a stepping stone towards human

4478

03:26:27,910 --> 03:26:25,590

you are watching live mars ending

4479

03:26:30,870 --> 03:26:27,920

commentary and perseverance is about to

4480

03:26:32,950 --> 03:26:30,880

reach another important milestone swati

4481

03:26:35,269 --> 03:26:32,960

can you tell us what is happening

4482

03:26:37,990 --> 03:26:35,279

we are at a milestone where the

4483

03:26:39,750 --> 03:26:38,000

operations team determines whether

4484

03:26:42,389 --> 03:26:39,760

they're ready to turn off the

4485

03:26:44,950 --> 03:26:42,399

transmitter and perseverance turning off

4486

03:26:47,429 --> 03:26:44,960

the transmitter is like taking your

4487

03:26:49,670 --> 03:26:47,439

hands off of the wheel at this point

4488

03:26:52,389 --> 03:26:49,680

ford perseverance would be

4489

03:26:55,830 --> 03:26:52,399

on her own to execute entry descent

4490

03:27:00,630 --> 03:26:55,840

landing over 500 000 lines of code let's

4491

03:27:06,950 --> 03:27:04,630

uh folks this is so exciting

4492

03:27:09,349 --> 03:27:06,960

all of that code and it all has to work

4493

03:27:11,510 --> 03:27:09,359

right the first time in order for the

4494

03:27:14,070 --> 03:27:11,520

vehicle to successfully land on the

4495

03:27:16,389 --> 03:27:14,080

surface of mars

4496

03:27:18,190 --> 03:27:16,399

currently the vehicle is cruising at

4497

03:27:20,070 --> 03:27:18,200

near

4498

03:27:24,790 --> 03:27:20,080

2236

4499

03:27:27,590 --> 03:27:24,800

landing site

4500

03:27:29,830 --> 03:27:27,600

velocity is a little more than 10 000

4501
03:27:32,070 --> 03:27:29,840
miles per hour

4502
03:27:33,510 --> 03:27:32,080
propulsion go

4503
03:27:34,469 --> 03:27:33,520
art lead

4504
03:27:35,750 --> 03:27:34,479
go

4505
03:27:36,630 --> 03:27:35,760
team chief

4506
03:27:37,510 --> 03:27:36,640
go

4507
03:27:39,269 --> 03:27:37,520
ace

4508
03:27:41,110 --> 03:27:39,279
go

4509
03:27:43,990 --> 03:27:41,120
launch cruise phase lead

4510
03:27:46,630 --> 03:27:45,429
deputy mission

4511
03:27:48,950 --> 03:27:46,640
go

4512
03:27:51,429 --> 03:27:48,960
edl phase lead

4513
03:27:52,950 --> 03:27:51,439

mission assurance

4514

03:27:58,150 --> 03:27:52,960

let's go

4515

03:28:01,830 --> 03:27:59,830

chief is go

4516

03:28:03,750 --> 03:28:01,840

project manager

4517

03:28:06,070 --> 03:28:03,760

projects go

4518

03:28:08,309 --> 03:28:06,080

mission manager all stations are go for

4519

03:28:14,150 --> 03:28:08,319

transmitter

4520

03:28:20,389 --> 03:28:16,550

we have deemed perseverance ready to

4521

03:28:22,469 --> 03:28:20,399

execute entry descending on her own

4522

03:28:25,110 --> 03:28:22,479

thank you swati as we just heard

4523

03:28:28,550 --> 03:28:25,120

perseverance is now operating on its own

4524

03:28:30,469 --> 03:28:28,560

as it cruises closer to mars to help

4525

03:28:33,830 --> 03:28:30,479

explain what this mission means for the

4526
03:28:35,190 --> 03:28:33,840
agency is nafta's associator thomas

4527
03:28:37,750 --> 03:28:35,200
zurbukin

4528
03:28:40,950 --> 03:28:37,760
thomas this is our fifth rover sent to

4529
03:28:43,190 --> 03:28:40,960
mars since 1997. can you tell us how

4530
03:28:44,309 --> 03:28:43,200
perseverance is going to kick out a new

4531
03:28:47,030 --> 03:28:44,319
era

4532
03:28:49,269 --> 03:28:47,040
wow this is such an important

4533
03:28:51,349 --> 03:28:49,279
and it is the beginning of a new era in

4534
03:28:53,429 --> 03:28:51,359
a sense that we're going from

4535
03:28:57,030 --> 03:28:53,439
exploration you know with

4536
03:28:58,790 --> 03:28:57,040
experiments on rovers looking around

4537
03:29:01,190 --> 03:28:58,800
doing analysis

4538
03:29:04,389 --> 03:29:01,200

to the sample return phase in which

4539

03:29:07,910 --> 03:29:04,399

we're not only looking around looking at

4540

03:29:10,550 --> 03:29:07,920

the geology but really turning our rover

4541

03:29:13,830 --> 03:29:10,560

in exotic geologists and astrobiologists

4542

03:29:15,990 --> 03:29:13,840

collecting samples that we win

4543

03:29:18,229 --> 03:29:16,000

back to earth and for us of course those

4544

03:29:19,990 --> 03:29:18,239

are where the best laboratories are of

4545

03:29:21,990 --> 03:29:20,000

all of humanity some of them still

4546

03:29:24,550 --> 03:29:22,000

remain to be explored by some that are

4547

03:29:26,229 --> 03:29:24,560

not yet in the science community yet and

4548

03:29:28,630 --> 03:29:26,239

that's what we're looking forward to

4549

03:29:30,710 --> 03:29:28,640

it's that new the other element that i

4550

03:29:32,229 --> 03:29:30,720

want to talk about is the amazing

4551
03:29:34,950 --> 03:29:32,239
technologies that are there and of

4552
03:29:37,070 --> 03:29:34,960
course one of my favorites ingenuity

4553
03:29:39,429 --> 03:29:37,080
helicopter this in search of this

4554
03:29:41,670 --> 03:29:39,439
extraterrestrial wright brothers moment

4555
03:29:44,150 --> 03:29:41,680
you know controlled flight for the first

4556
03:29:47,190 --> 03:29:44,160
time elsewhere raquel

4557
03:29:50,790 --> 03:29:47,200
great and we have a student question on

4558
03:29:52,790 --> 03:29:50,800
video for you from macy

4559
03:29:54,630 --> 03:29:52,800
hi my name is dale

4560
03:29:57,030 --> 03:29:54,640
my question is

4561
03:29:59,190 --> 03:29:57,040
is anything alive on mars

4562
03:30:01,750 --> 03:29:59,200
thank you

4563
03:30:04,309 --> 03:30:01,760

well i may see i'm so glad for your

4564

03:30:06,229 --> 03:30:04,319

quest i asked myself is anything alive

4565

03:30:08,309 --> 03:30:06,239

there and frankly at the surface where

4566

03:30:10,950 --> 03:30:08,319

we're going right now with uh

4567

03:30:14,309 --> 03:30:10,960

perseverance we do not believe there's

4568

03:30:16,309 --> 03:30:14,319

anything alive uh right the radiation

4569

03:30:19,670 --> 03:30:16,319

that they're still in cold and there

4570

03:30:21,910 --> 03:30:19,680

ain't no water there guess what

4571

03:30:24,070 --> 03:30:21,920

three billion years ago

4572

03:30:26,550 --> 03:30:24,080

this looked like a stream that you may

4573

03:30:27,990 --> 03:30:26,560

see on earth and frankly a lot more

4574

03:30:29,990 --> 03:30:28,000

similar effects like water with a

4575

03:30:33,750 --> 03:30:30,000

magnetic field just like the earth with

4576

03:30:35,670 --> 03:30:33,760

an atmosphere and the question is

4577

03:30:36,710 --> 03:30:35,680

at that time three billion years ago

4578

03:30:39,349 --> 03:30:36,720

were they

4579

03:30:41,670 --> 03:30:39,359

they're similar forms of the type that

4580

03:30:42,630 --> 03:30:41,680

developed on earth so is there life on

4581

03:30:45,110 --> 03:30:42,640

oh we

4582

03:30:48,790 --> 03:30:45,120

don't know how we're really looking for

4583

03:30:54,229 --> 03:30:51,830

thank you for your time today thomas and

4584

03:30:55,990 --> 03:30:54,239

everyone who has been using the hashtag

4585

03:30:58,550 --> 03:30:56,000

countdown to mars

4586

03:31:01,750 --> 03:30:58,560

here are some of the photos that you've

4587

03:31:05,429 --> 03:31:01,760

sent in so far let's take a look

4588

03:31:10,950 --> 03:31:05,439

now please keep sharing with us how you

4589

03:31:13,750 --> 03:31:12,710

for now let's

4590

03:31:16,469 --> 03:31:13,760

swatch

4591

03:31:19,429 --> 03:31:16,479

an update to what's going on in mission

4592

03:31:21,830 --> 03:31:19,439

control as we get closer to another

4593

03:31:27,510 --> 03:31:21,840

milestone

4594

03:31:30,389 --> 03:31:27,520

communications pool so during landing

4595

03:31:33,190 --> 03:31:30,399

not only universities talk directly to

4596

03:31:35,750 --> 03:31:33,200

earth but we'll also be talking to two

4597

03:31:40,950 --> 03:31:35,760

spacecraft that are currently orbiting

4598

03:31:45,670 --> 03:31:43,030

this pool is to confirm with the mark

4599

03:31:47,670 --> 03:31:45,680

constance orbiter spacecraft and the

4600

03:31:50,870 --> 03:31:47,680

maven spacecraft teams that they are

4601
03:31:52,070 --> 03:31:50,880
ready and on track to support the relay

4602
03:32:19,190 --> 03:31:52,080
from person

4603
03:32:23,429 --> 03:32:21,190
have you performed the contract and

4604
03:32:25,110 --> 03:32:23,439
readiness of the orbiters

4605
03:32:27,590 --> 03:32:25,120
we have performed the voice check and

4606
03:32:29,349 --> 03:32:27,600
the readiness poll and can confirm that

4607
03:32:32,950 --> 03:32:29,359
mro maven

4608
03:32:48,870 --> 03:32:32,960
eda radio science one and two uafbe csn

4609
03:32:54,469 --> 03:32:51,110
from each of the different orbiters and

4610
03:32:56,710 --> 03:32:54,479
all of their on the ground that are and

4611
03:33:02,550 --> 03:32:56,720
uh are on track to support the relay

4612
03:33:07,110 --> 03:33:05,269
great thank you swati and we just heard

4613
03:33:09,030 --> 03:33:07,120

that communications readiness poll which

4614

03:33:10,870 --> 03:33:09,040

means read to relay the data

4615

03:33:13,990 --> 03:33:10,880

perseverance will send

4616

03:33:16,710 --> 03:33:14,000

to get a better idea of what the rover

4617

03:33:19,670 --> 03:33:16,720

looks like as it approaches ours we have

4618

03:33:22,710 --> 03:33:19,680

a nasa program called eyes the

4619

03:33:25,110 --> 03:33:22,720

visualization lets anyone watching track

4620

03:33:27,429 --> 03:33:25,120

perseverance here's how the program

4621

03:33:29,110 --> 03:33:27,439

works

4622

03:33:40,950 --> 03:33:29,120

follow perseverance on its journey to

4623

03:33:47,670 --> 03:33:44,630

in real time through every step of eda

4624

03:33:50,070 --> 03:33:47,680

entry descent and landing

4625

03:33:51,990 --> 03:33:50,080

this interactive experience lets you

4626
03:33:53,590 --> 03:33:52,000
ride along from whatever perspective you

4627
03:33:56,870 --> 03:33:53,600
choose

4628
03:33:58,229 --> 03:33:56,880
click and drag scroll scroll out

4629
03:34:00,469 --> 03:33:58,239
check out the descriptions and

4630
03:34:02,389 --> 03:34:00,479
explanation to increase your edl

4631
03:34:04,389 --> 03:34:02,399
expertise

4632
03:34:05,830 --> 03:34:04,399
experience

4633
03:34:08,070 --> 03:34:05,840
and landing events

4634
03:34:10,790 --> 03:34:08,080
you can design execute

4635
03:34:12,630 --> 03:34:10,800
perseverance beyond mars

4636
03:34:14,950 --> 03:34:12,640
the eyes experience is based on

4637
03:34:16,550 --> 03:34:14,960
predictive data but during this

4638
03:34:19,269 --> 03:34:16,560

broadcast you'll see a different

4639

03:34:21,429 --> 03:34:19,279

visualization called ranger and it's

4640

03:34:23,269 --> 03:34:21,439

based on the real communication the team

4641

03:34:26,070 --> 03:34:23,279

and mission control receives from

4642

03:34:28,469 --> 03:34:26,080

perseverance in near real time

4643

03:34:31,349 --> 03:34:28,479

this is the visualization the team will

4644

03:34:33,110 --> 03:34:31,359

follow as data filters from pray that

4645

03:34:35,190 --> 03:34:33,120

health or perseverance on this

4646

03:34:38,309 --> 03:34:35,200

nerve-wracking course to another

4647

03:34:50,210 --> 03:34:38,319

successful mars landing

4648

03:34:54,710 --> 03:34:52,710

[Music]

4649

03:34:56,870 --> 03:34:54,720

that's a great website if you've if

4650

03:35:00,150 --> 03:34:56,880

you've seen it you should go there it uh

4651
03:35:03,030 --> 03:35:01,349
commentary

4652
03:35:04,950 --> 03:35:03,040
stepping outside

4653
03:35:21,670 --> 03:35:04,960
at mission control to talk

4654
03:35:21,680 --> 03:35:24,870
just

4655
03:35:28,870 --> 03:35:26,469
and tell important things like

4656
03:35:30,710 --> 03:35:28,880
temperatures on the vehicle pressure how

4657
03:35:33,670 --> 03:35:30,720
much fuel we have left and other things

4658
03:35:35,990 --> 03:35:33,680
that we need to understand for uh

4659
03:35:48,469 --> 03:35:36,000
the health and safety

4660
03:35:52,630 --> 03:35:50,950
so velocity is just our speed combined

4661
03:35:55,269 --> 03:35:52,640
with the direction

4662
03:35:57,030 --> 03:35:55,279
and the explosives are sloping blocky so

4663
03:35:58,229 --> 03:35:57,040

we're coming in at uh

4664

03:36:00,469 --> 03:35:58,239

12

4665

03:36:05,030 --> 03:36:00,479

miles

4666

03:36:06,950 --> 03:36:05,040

and that's our deceleration

4667

03:36:09,269 --> 03:36:06,960

uh speaking of landing you may hear a

4668

03:36:11,269 --> 03:36:09,279

couple important terms uh at landing

4669

03:36:13,269 --> 03:36:11,279

itself

4670

03:36:15,429 --> 03:36:13,279

one is

4671

03:36:17,349 --> 03:36:15,439

the mu stable

4672

03:36:23,670 --> 03:36:17,359

so the remu is a device on the rover

4673

03:36:23,680 --> 03:36:31,990

table hopefully uh uh stable refers to

4674

03:36:32,000 --> 03:36:43,750

and

4675

03:36:47,990 --> 03:36:46,150

or touchdown nominal that means we've

4676
03:36:50,790 --> 03:36:48,000
touched down on the surface of mars

4677
03:36:52,469 --> 03:36:50,800
within the expected

4678
03:36:54,469 --> 03:36:52,479
way of

4679
03:36:55,590 --> 03:36:54,479
thanks for that breakdown now

4680
03:36:59,349 --> 03:36:55,600
this

4681
03:37:03,349 --> 03:37:01,990
yeah what am i taking you can

4682
03:37:04,389 --> 03:37:03,359
control when it comes to mars you

4683
03:37:05,349 --> 03:37:04,399
definitely can't

4684
03:37:07,510 --> 03:37:05,359
take

4685
03:37:09,030 --> 03:37:07,520
mars for granted you know we've checked

4686
03:37:11,510 --> 03:37:09,040
checked and double checked and triple

4687
03:37:14,229 --> 03:37:11,520
checked everything and

4688
03:37:17,349 --> 03:37:14,239

even though we've done this once before

4689

03:37:20,469 --> 03:37:18,870

um you know

4690

03:37:22,070 --> 03:37:20,479

i think everyone's going to have their

4691

03:37:23,349 --> 03:37:22,080

uh everyone's going to hold their breath

4692

03:37:24,950 --> 03:37:23,359

until we're on the surface of mars this

4693

03:37:27,190 --> 03:37:24,960

time around

4694

03:37:30,710 --> 03:37:27,200

and we have a social media

4695

03:37:42,870 --> 03:37:30,720

and coming in nor the door on instagram

4696

03:37:48,070 --> 03:37:46,150

timing accuracy and it's the result

4697

03:37:48,600 --> 03:37:48,080

of

4698

03:37:49,910 --> 03:37:48,610

any high

4699

03:37:51,910 --> 03:37:49,920

[Music]

4700

03:37:53,750 --> 03:37:51,920

year's curiosity and then uh improved

4701
03:37:55,990 --> 03:37:53,760
for the perseverance landing today at

4702
03:37:57,670 --> 03:37:56,000
jezreel crater

4703
03:37:58,389 --> 03:37:57,680
thanks for your time today matt and good

4704
03:38:00,710 --> 03:37:58,399
luck

4705
03:38:02,150 --> 03:38:00,720
thanks

4706
03:38:05,349 --> 03:38:02,160
it's hard

4707
03:38:09,750 --> 03:38:07,110
team behind person

4708
03:38:12,550 --> 03:38:09,760
faced one of its biggest challenges when

4709
03:38:16,350 --> 03:38:12,560
the corona virus

4710
03:38:16,360 --> 03:38:22,469
[Music]

4711
03:38:27,429 --> 03:38:25,190
when the dynamic

4712
03:38:29,750 --> 03:38:27,439
the future was certainly unknown it was

4713
03:38:31,429 --> 03:38:29,760

like walking into a blind dark alley you

4714

03:38:32,950 --> 03:38:31,439

didn't know what was there what was in

4715

03:38:35,590 --> 03:38:32,960

front of you what you were going to have

4716

03:38:37,750 --> 03:38:35,600

to deal with

4717

03:38:40,070 --> 03:38:37,760

it's something that nobody expected it's

4718

03:38:41,670 --> 03:38:40,080

something nobody could plan for so we

4719

03:38:43,429 --> 03:38:41,680

all were asked to start working from

4720

03:38:45,910 --> 03:38:43,439

home rather than your first priority

4721

03:38:47,990 --> 03:38:45,920

being mission success and

4722

03:38:50,389 --> 03:38:48,000

getting to the launch pad your first

4723

03:38:52,469 --> 03:38:50,399

priority immediately gets displaced and

4724

03:38:54,710 --> 03:38:52,479

it's now the safety of the people and

4725

03:38:55,990 --> 03:38:54,720

it's like a lot of work to put stuff

4726
03:39:02,469 --> 03:38:56,000
to keep

4727
03:39:05,190 --> 03:39:02,479
project uh not scheduled we called the

4728
03:39:08,309 --> 03:39:05,200
effort march 2020 safe at work and the

4729
03:39:09,990 --> 03:39:08,319
objective was to keep the team as safe

4730
03:39:12,389 --> 03:39:10,000
or safer

4731
03:39:13,990 --> 03:39:12,399
than they would be they were not working

4732
03:39:15,590 --> 03:39:14,000
you know putting a spacecraft together

4733
03:39:17,990 --> 03:39:15,600
that's going to mars

4734
03:39:19,590 --> 03:39:18,000
and not making a mistake it's hard no

4735
03:39:20,950 --> 03:39:19,600
matter what

4736
03:39:22,469 --> 03:39:20,960
trying to do it during the middle of the

4737
03:39:24,870 --> 03:39:22,479
pandemic it's

4738
03:39:27,110 --> 03:39:24,880

it's a lot harder

4739

03:39:28,870 --> 03:39:27,120
and liftoff

4740

03:39:30,710 --> 03:39:28,880
as the countdown to mars continue

4741

03:39:32,870 --> 03:39:30,720
perseverance of humanity launching the

4742

03:39:34,630 --> 03:39:32,880
next generation of robotic explorers to

4743

03:39:35,990 --> 03:39:34,640
the red planet

4744

03:39:37,750 --> 03:39:36,000
certainly i've never done something like

4745

03:39:39,670 --> 03:39:37,760
this before try to lead a team that's

4746

03:39:41,429 --> 03:39:39,680
flying a spacecraft on the way to mars

4747

03:39:44,150 --> 03:39:41,439
while getting ready for landing while

4748

03:39:46,389 --> 03:39:44,160
doing it all from home there's no doubt

4749

03:39:48,550 --> 03:39:46,399
that working

4750

03:39:52,790 --> 03:39:48,560
in

4751
03:39:53,990 --> 03:39:52,800
physical isolation from everyone else is

4752
03:39:55,910 --> 03:39:54,000
a challenge

4753
03:39:58,229 --> 03:39:55,920
we had to

4754
03:40:00,389 --> 03:39:58,239
rethink and redesign

4755
03:40:04,389 --> 03:40:00,399
what it meant to operate

4756
03:40:06,309 --> 03:40:04,399
a spacecraft in flight when we couldn't

4757
03:40:07,429 --> 03:40:06,319
all be in the same room in mission

4758
03:40:09,750 --> 03:40:07,439
control

4759
03:40:12,070 --> 03:40:09,760
seeing the data come down from

4760
03:40:13,990 --> 03:40:12,080
perseverance it was a major change going

4761
03:40:15,670 --> 03:40:14,000
to that you know everyone on a screen

4762
03:40:17,750 --> 03:40:15,680
instead of in person because of the

4763
03:40:19,830 --> 03:40:17,760

pandemic you can't

4764

03:40:21,910 --> 03:40:19,840

you know just pop over your cubicle wall

4765

03:40:23,510 --> 03:40:21,920

and talk to the person next to you it's

4766

03:40:25,990 --> 03:40:23,520

been a challenge to figure out how to

4767

03:40:28,070 --> 03:40:26,000

communicate and get everything done

4768

03:40:28,950 --> 03:40:28,080

remotely but we've managed to make it

4769

03:40:30,309 --> 03:40:28,960

work

4770

03:40:33,590 --> 03:40:30,319

we are

4771

03:40:37,030 --> 03:40:33,600

our job is to go into the unknown

4772

03:40:39,110 --> 03:40:37,040

and this is just another example of

4773

03:40:41,830 --> 03:40:39,120

the unknown we're really

4774

03:40:43,670 --> 03:40:41,840

doing something that's transformative

4775

03:40:45,910 --> 03:40:43,680

and trying to understand whether or not

4776
03:40:48,550 --> 03:40:45,920
life evolved on another plants the

4777
03:40:51,190 --> 03:40:48,560
fundamental objective of this mission

4778
03:40:53,750 --> 03:40:51,200
we're all still connected by this

4779
03:40:55,429 --> 03:40:53,760
incredible mission and this um this

4780
03:40:59,030 --> 03:40:55,439
wonderful team that we need to be a part

4781
03:41:00,630 --> 03:40:59,040
of so that keeps at least me going

4782
03:41:02,950 --> 03:41:00,640
pretty much everybody that i've talked

4783
03:41:05,670 --> 03:41:02,960
to that's associated with the mission

4784
03:41:07,190 --> 03:41:05,680
has has said the same thing which is you

4785
03:41:09,030 --> 03:41:07,200
could not have come up with a better

4786
03:41:11,510 --> 03:41:09,040
name than there is

4787
03:41:14,229 --> 03:41:11,520
it's an amazing serendipity we

4788
03:41:17,020 --> 03:41:14,239

get to persevere through working on

4789

03:41:17,030 --> 03:41:26,630

[Music]

4790

03:41:26,640 --> 03:41:33,590

there's a cool martian pack for you

4791

03:41:36,389 --> 03:41:35,349

well folks we're getting closer and

4792

03:41:38,950 --> 03:41:36,399

closer

4793

03:41:43,670 --> 03:41:38,960

joining us now is perseverance and city

4794

03:41:49,110 --> 03:41:46,070

does this mission

4795

03:41:51,590 --> 03:41:49,120

stay on track with unexpected challenges

4796

03:41:54,469 --> 03:41:51,600

like the pandemic

4797

03:41:57,670 --> 03:41:54,479

well it's a very ambitious mission you

4798

03:41:57,680 --> 03:42:16,630

extremely capable

4799

03:42:16,640 --> 03:43:02,150

easy

4800

03:43:10,790 --> 03:43:02,870

i

4801
03:43:12,870 --> 03:43:10,800
and uh

4802
03:43:15,590 --> 03:43:12,880
you know thanks to a lot of help

4803
03:43:18,150 --> 03:43:15,600
and matt just how large is the team that

4804
03:43:21,269 --> 03:43:18,160
worked on perseverance

4805
04:10:51,269 --> 03:43:21,279
it's a big team a couple thousand people

4806
04:10:55,429 --> 04:10:52,950
hey folks thanks for sticking with us

4807
04:10:56,229 --> 04:10:55,439
we're taking a quick break there from uh

4808
04:10:59,990 --> 04:10:56,239
from

4809
04:11:02,469 --> 04:11:00,000
control center for this particular

4810
04:11:04,550 --> 04:11:02,479
robotic mission thanks again for staying

4811
04:11:07,110 --> 04:11:04,560
with us we're bringing you live coverage

4812
04:11:09,750 --> 04:11:07,120
of the landing of the perseverance rover

4813
04:11:11,990 --> 04:11:09,760

that's scheduled to touch down in only a

4814

04:11:14,630 --> 04:11:12,000

few minutes on the surface of mars

4815

04:11:16,469 --> 04:11:14,640

waiting on confirmation that the vehicle

4816

04:11:18,630 --> 04:11:16,479

has entered the atmosphere and don't

4817

04:11:21,910 --> 04:11:18,640

forget earth and mars are a considerable

4818

04:11:24,870 --> 04:11:21,920

distance apart about 300 million miles

4819

04:11:27,189 --> 04:11:24,880

apart and at that distance it takes the

4820

04:11:30,790 --> 04:11:27,199

signal that radio signal coming from the

4821

04:11:33,830 --> 04:11:30,800

robot to reach mission control nearly 14

4822

04:11:36,790 --> 04:11:33,840

minutes so by the time we get word that

4823

04:11:39,269 --> 04:11:36,800

the robot has entered the atmosphere

4824

04:11:41,830 --> 04:11:39,279

it will already be on the surface of

4825

04:11:44,070 --> 04:11:41,840

mars so as soon as we uh as soon as we

4826

04:11:45,830 --> 04:11:44,080

have that uh that notification we'll let

4827

04:11:48,150 --> 04:11:45,840

you know now there's been a number of

4828

04:11:49,830 --> 04:11:48,160

questions that have come by and uh one

4829

04:11:52,630 --> 04:11:49,840

that keeps coming up and i want to make

4830

04:11:54,550 --> 04:11:52,640

sure that we address that before we move

4831

04:11:56,630 --> 04:11:54,560

any further question came up with

4832

04:11:58,309 --> 04:11:56,640

regards to the wheels on the rover in

4833

04:12:00,229 --> 04:11:58,319

fact one of our viewers wanted to know

4834

04:12:02,950 --> 04:12:00,239

what was the deal about the wheels why

4835

04:12:05,429 --> 04:12:02,960

why are the wheels so important this is

4836

04:12:08,309 --> 04:12:05,439

a mobile rover and again this particular

4837

04:12:10,790 --> 04:12:08,319

vehicle is huge you know spirit and

4838

04:12:13,030 --> 04:12:10,800

opportunity were the size of golf carts

4839

04:12:14,950 --> 04:12:13,040

but curiosity and now the perseverance

4840

04:12:18,070 --> 04:12:14,960

rover well they're much bigger they're

4841

04:12:20,389 --> 04:12:18,080

the size of a small suv now one of the

4842

04:12:22,309 --> 04:12:20,399

problems that we had with the curiosity

4843

04:12:24,630 --> 04:12:22,319

rover that we noticed was that the

4844

04:12:26,630 --> 04:12:24,640

wheels began to break down on the

4845

04:12:29,429 --> 04:12:26,640

vehicle it wasn't something that we had

4846

04:12:31,990 --> 04:12:29,439

anticipated and based on the performance

4847

04:12:35,349 --> 04:12:32,000

of curiosity on the surface of mars

4848

04:12:37,189 --> 04:12:35,359

we've made improvements to those wheels

4849

04:12:38,790 --> 04:12:37,199

think of it this way

4850

04:12:42,469 --> 04:12:38,800

if you're driving in your car and you

4851
04:12:45,269 --> 04:12:42,479
get a flat tire how far does it go

4852
04:12:47,429 --> 04:12:45,279
and how well does it continue to perform

4853
04:12:50,550 --> 04:12:47,439
once once one of those tires has been

4854
04:12:53,349 --> 04:12:50,560
damaged now we have multiple tire wear

4855
04:12:54,950 --> 04:12:53,359
on the curiosity rover right now those

4856
04:12:57,349 --> 04:12:54,960
rocks those boulders and again they're

4857
04:12:59,910 --> 04:12:57,359
screwing all over the surface of mars

4858
04:13:02,790 --> 04:12:59,920
those are uh those are jagged they are

4859
04:13:05,349 --> 04:13:02,800
hazardous and they continue to damage

4860
04:13:07,590 --> 04:13:05,359
those wheels and once a wheel is damaged

4861
04:13:09,750 --> 04:13:07,600
and it becomes locked up now it's not

4862
04:13:12,469 --> 04:13:09,760
helping you to move smoothly across the

4863
04:13:15,269 --> 04:13:12,479

ground it's being drug behind you now

4864

04:13:17,429 --> 04:13:15,279

the rover has six wheels that are on it

4865

04:13:19,990 --> 04:13:17,439

and those wheels have a unique boger

4866

04:13:22,630 --> 04:13:20,000

rocker system bogey rocker system that

4867

04:13:25,189 --> 04:13:22,640

allows it to move over uneven terrain

4868

04:13:27,349 --> 04:13:25,199

but once one of those wheels is damaged

4869

04:13:30,309 --> 04:13:27,359

now it's impediment now it's being drug

4870

04:13:33,030 --> 04:13:30,319

behind and it makes it harder to

4871

04:13:35,670 --> 04:13:33,040

navigate the terrain so the new wheel

4872

04:13:38,389 --> 04:13:35,680

design that that we're using on the

4873

04:13:40,389 --> 04:13:38,399

perseverance rover should perform much

4874

04:13:42,550 --> 04:13:40,399

better and that's uh that's one of the

4875

04:13:44,389 --> 04:13:42,560

key elements of it

4876

04:13:47,910 --> 04:13:44,399

now people have also been asking me

4877

04:13:50,469 --> 04:13:47,920

about the landing site as well and uh we

4878

04:13:52,870 --> 04:13:50,479

put together in fact the video is put

4879

04:13:54,950 --> 04:13:52,880

together by nasa but we found that video

4880

04:13:57,590 --> 04:13:54,960

and uh we want to take a few moments and

4881

04:13:59,830 --> 04:13:57,600

show you give you a guided tour uh an

4882

04:14:01,670 --> 04:13:59,840

animation based on some of the uh some

4883

04:14:04,229 --> 04:14:01,680

of the photographs we've received from

4884

04:14:06,309 --> 04:14:04,239

orbiting spacecraft of what that landing

4885

04:14:08,149 --> 04:14:06,319

site is going to look like give me a

4886

04:14:17,990 --> 04:14:08,159

moment we'll start that video here for

4887

04:14:20,950 --> 04:14:19,510

just when you think you've got it down

4888

04:14:26,950 --> 04:14:20,960

right don't you

4889

04:14:26,960 --> 04:14:31,590

ken foley is the lead scientist

4890

04:14:36,309 --> 04:14:33,750

and he'll narrate this uh this short

4891

04:14:40,149 --> 04:14:36,319

animation for you

4892

04:14:43,510 --> 04:14:42,309

renamed perseverance that's the name of

4893

04:15:03,189 --> 04:14:43,520

our rosary

4894

04:15:35,510 --> 04:15:06,710

and this is the voice of ken farley

4895

04:15:40,790 --> 04:15:38,710

oops looks like we lost our signal here

4896

04:15:51,030 --> 04:15:40,800

well again ken farley was uh explaining

4897

04:15:51,040 --> 04:15:58,630

looks like we lost our audio as well

4898

04:16:27,590 --> 04:16:00,149

we'll see if we can do a better job for

4899

04:16:27,600 --> 04:16:37,349

and we really lost it

4900

04:16:41,510 --> 04:16:39,110

well i apologize for that i thought that

4901

04:16:44,229 --> 04:16:41,520

we that we had that that for you ken

4902

04:16:46,309 --> 04:16:44,239

farley again was a lead scientist

4903

04:16:48,229 --> 04:16:46,319

and was involved with the

4904

04:16:50,550 --> 04:16:48,239

with the selection of the landing site

4905

04:16:52,790 --> 04:16:50,560

and it's a magnificent landing site that

4906

04:16:54,630 --> 04:16:52,800

should provide us with a lot of

4907

04:16:56,389 --> 04:16:54,640

diversity and some of the geological

4908

04:16:58,149 --> 04:16:56,399

specimens that we hope to

4909

04:17:00,309 --> 04:16:58,159

to be able to return both the rock and

4910

04:17:02,469 --> 04:17:00,319

soil samples those core samples that we

4911

04:17:06,070 --> 04:17:02,479

hope for a future mission that will be

4912

04:17:07,750 --> 04:17:06,080

able to return back to uh back to earth

4913

04:17:09,910 --> 04:17:07,760

again we hope we answered that question

4914

04:17:11,670 --> 04:17:09,920

with regards to the wheels on the

4915

04:17:13,189 --> 04:17:11,680

vehicle and the importance of those

4916

04:17:15,189 --> 04:17:13,199

wheels and how those wheels were

4917

04:17:17,189 --> 04:17:15,199

redesigned you know a lot of work is

4918

04:17:19,429 --> 04:17:17,199

being done at the at the nasa glenn

4919

04:17:22,149 --> 04:17:19,439

research center here in cleveland in the

4920

04:17:25,269 --> 04:17:22,159

slope lab where they have a an area with

4921

04:17:27,269 --> 04:17:25,279

simulated lunar and martian soil

4922

04:17:29,590 --> 04:17:27,279

technicians and engineers that are there

4923

04:17:33,189 --> 04:17:29,600

are actually working with uh with

4924

04:17:35,590 --> 04:17:33,199

potential tires for future mars rovers

4925

04:17:37,830 --> 04:17:35,600

and uh they're testing various designs

4926
04:17:40,309 --> 04:17:37,840
seeing which one works the best under a

4927
04:17:42,630 --> 04:17:40,319
variety of conditions in soil that is

4928
04:17:44,229 --> 04:17:42,640
very similar to the moon

4929
04:17:45,750 --> 04:17:44,239
and mars

4930
04:17:47,910 --> 04:17:45,760
once again that's work that's being done

4931
04:17:50,830 --> 04:17:47,920
right here in cleveland at the nasa

4932
04:17:53,429 --> 04:17:50,840
glenn research

4933
04:17:55,030 --> 04:17:53,439
center well again there's a a number of

4934
04:17:56,550 --> 04:17:55,040
things that will need to take place over

4935
04:17:59,110 --> 04:17:56,560
the course of the

4936
04:18:02,469 --> 04:17:59,120
of the next few minutes as we get closer

4937
04:18:05,269 --> 04:18:02,479
and closer to the uh to the uh to the

4938
04:18:06,790 --> 04:18:05,279

time of atmospheric entry about 10

4939

04:18:09,590 --> 04:18:06,800
minutes or so leading up to that

4940

04:18:12,149 --> 04:18:09,600
atmospheric entry the uh

4941

04:18:14,870 --> 04:18:12,159
the uh lander will shed the uh the

4942

04:18:17,030 --> 04:18:14,880
cruise stage of the vehicle that was a

4943

04:18:18,870 --> 04:18:17,040
solar rays that uh

4944

04:18:21,349 --> 04:18:18,880
that helped to power and the fuel that

4945

04:18:22,229 --> 04:18:21,359
helped to to get the spacecraft where it

4946

04:18:24,790 --> 04:18:22,239
is

4947

04:18:27,189 --> 04:18:24,800
once it begins to enter the atmosphere

4948

04:18:29,349 --> 04:18:27,199
the heat shield will begin to uh will

4949

04:18:31,830 --> 04:18:29,359
begin to heat up it will reach maximum

4950

04:18:33,830 --> 04:18:31,840
heating and also there are thruster jets

4951
04:18:36,469 --> 04:18:33,840
that are on the spacecraft itself that

4952
04:18:38,950 --> 04:18:36,479
will help to guide it uh during that

4953
04:18:41,110 --> 04:18:38,960
atmospheric entry now it'll enter the

4954
04:18:43,110 --> 04:18:41,120
atmosphere at an extremely high rate of

4955
04:18:45,750 --> 04:18:43,120
speed a little better than

4956
04:18:47,670 --> 04:18:45,760
1200 miles per hour

4957
04:18:50,070 --> 04:18:47,680
but as it enters the atmosphere the

4958
04:18:52,870 --> 04:18:50,080
blunt side of that heat shield will help

4959
04:18:55,990 --> 04:18:52,880
to slow the spacecraft down it'll get it

4960
04:18:59,429 --> 04:18:56,000
down to around 940

4961
04:19:01,349 --> 04:18:59,439
miles per hour and at that point

4962
04:19:03,670 --> 04:19:01,359
into the descent it'll be moving slow

4963
04:19:06,070 --> 04:19:03,680

enough for the supersonic parachute to

4964

04:19:09,429 --> 04:19:06,080

come out that parachute then will begin

4965

04:19:13,110 --> 04:19:09,439

to slow the spacecraft down even further

4966

04:19:15,910 --> 04:19:13,120

down to around 300 down to 200 miles per

4967

04:19:18,550 --> 04:19:15,920

hour and at that point it'll be

4968

04:19:22,070 --> 04:19:18,560

relatively close to the uh to the target

4969

04:19:23,030 --> 04:19:22,080

landing site and uh then the uh

4970

04:19:25,670 --> 04:19:23,040

the uh

4971

04:19:27,590 --> 04:19:25,680

the bottom the bottom portion of the

4972

04:19:30,790 --> 04:19:27,600

heat shield of that aerobraking shield

4973

04:19:33,349 --> 04:19:30,800

will be removed and then the cameras on

4974

04:19:35,349 --> 04:19:33,359

board the vehicle and its sensors will

4975

04:19:38,070 --> 04:19:35,359

be able to look at the surface for the

4976

04:19:42,229 --> 04:19:38,080

first time figure out where it is it has

4977

04:19:44,389 --> 04:19:42,239

uh it has in its computer memory um

4978

04:19:45,990 --> 04:19:44,399

an image of what the surface should look

4979

04:19:48,630 --> 04:19:46,000

like so we'll have to very quickly

4980

04:19:51,349 --> 04:19:48,640

figure out where it is reorient itself

4981

04:19:53,750 --> 04:19:51,359

uh in order to help guide itself down

4982

04:19:55,030 --> 04:19:53,760

uh at a certain altitude the uh the

4983

04:19:57,110 --> 04:19:55,040

parachute

4984

04:19:59,590 --> 04:19:57,120

and the aerobraking shield will be

4985

04:20:01,910 --> 04:19:59,600

released the vehicle will begin to fall

4986

04:20:04,309 --> 04:20:01,920

the jet pack will turn on and it will

4987

04:20:07,349 --> 04:20:04,319

stop that vertical descent and bring the

4988

04:20:09,910 --> 04:20:07,359

vehicle back up hold it steady and then

4989

04:20:11,510 --> 04:20:09,920

it'll slowly begin to descend once it's

4990

04:20:13,750 --> 04:20:11,520

about uh

4991

04:20:15,990 --> 04:20:13,760

once it's about 60 feet above the above

4992

04:20:16,950 --> 04:20:16,000

the martian surface altimeters will be

4993

04:20:19,590 --> 04:20:16,960

working

4994

04:20:21,349 --> 04:20:19,600

then the rover itself will be lowered

4995

04:20:23,429 --> 04:20:21,359

down from the jet pack using those

4996

04:20:25,590 --> 04:20:23,439

cables and then when the wheels touch

4997

04:20:28,469 --> 04:20:25,600

down the sensors and the wheels as soon

4998

04:20:30,550 --> 04:20:28,479

as it makes contact with the surface the

4999

04:20:32,389 --> 04:20:30,560

cables will automatically be released

5000

04:20:35,189 --> 04:20:32,399

and the jet pack will fly away so it

5001
04:20:37,269 --> 04:20:35,199
doesn't land on top of the vehicle and

5002
04:20:39,750 --> 04:20:37,279
then our rover will be safely on the

5003
04:20:41,670 --> 04:20:39,760
surface of mars it will do a quick self

5004
04:20:44,070 --> 04:20:41,680
diagnostic and then it will send a

5005
04:20:46,309 --> 04:20:44,080
signal back to uh mission control

5006
04:20:48,309 --> 04:20:46,319
letting everyone know that it's safe on

5007
04:20:51,510 --> 04:20:48,319
the surface of another world all of that

5008
04:20:54,070 --> 04:20:51,520
is coming up we're just minutes away

5009
04:20:55,510 --> 04:20:54,080
karen's in our in our studio here we're

5010
04:20:57,750 --> 04:20:55,520
going to try to take care of some of our

5011
04:21:00,870 --> 04:20:57,760
business here on this end let's go ahead

5012
04:21:33,590 --> 04:21:00,880
and rejoin the nasa telecast already in

5013
04:21:33,600 --> 04:21:37,590

thank you

5014

04:21:41,830 --> 04:21:39,030

well folks we've been dealing with that

5015

04:21:44,229 --> 04:21:41,840

winter weather here in ohio it's meant

5016

04:21:46,790 --> 04:21:44,239

that our internet service has gone down

5017

04:21:51,189 --> 04:21:46,800

from time to time hard for us to uh to

5018

04:21:51,199 --> 04:21:55,030

to keep our signal here

5019

04:22:01,349 --> 04:21:57,030

but just like nasa we're doing our best

5020

04:22:07,830 --> 04:22:05,110

and we thank you for bearing with us

5021

04:22:11,830 --> 04:22:07,840

science and space exploration why do you

5022

04:22:13,750 --> 04:22:11,840

think kids are so excited about space

5023

04:22:15,349 --> 04:22:13,760

well i know the reason i'm excited about

5024

04:22:17,269 --> 04:22:15,359

space and i think it's the same reason

5025

04:22:19,349 --> 04:22:17,279

that many others are excited about space

5026

04:22:21,910 --> 04:22:19,359

and it's that the people in the space

5027

04:22:24,229 --> 04:22:21,920

industry work to answer two of the

5028

04:22:27,189 --> 04:22:24,239

biggest questions that humans have ever

5029

04:22:29,429 --> 04:22:27,199

asked are we alone in the universe and

5030

04:22:31,830 --> 04:22:29,439

where did we all come from and by

5031

04:22:34,149 --> 04:22:31,840

sending a rover to mars we are gaining

5032

04:22:35,910 --> 04:22:34,159

evidence for the answers to these

5033

04:22:39,750 --> 04:22:35,920

questions more evidence than we ever had

5034

04:22:41,750 --> 04:22:39,760

before and i think that's so exciting

5035

04:22:43,670 --> 04:22:41,760

it is and i know you get loads of

5036

04:22:46,389 --> 04:22:43,680

interesting questions from kids have you

5037

04:22:48,790 --> 04:22:46,399

gotten any about mars specifically

5038

04:22:51,189 --> 04:22:48,800

oh my gosh yes everybody loves smarts

5039

04:22:52,630 --> 04:22:51,199

it's in movies and books and tv shows

5040

04:22:54,469 --> 04:22:52,640

and everybody loves mars so one of the

5041

04:22:56,630 --> 04:22:54,479

things that i get asked a lot is that

5042

04:22:59,030 --> 04:22:56,640

you know it's called the red planet why

5043

04:23:02,149 --> 04:22:59,040

is it red well it's red because it's

5044

04:23:04,950 --> 04:23:02,159

literally rusty the top layer of soil on

5045

04:23:07,429 --> 04:23:04,960

mars has iron oxide in it or rust and

5046

04:23:09,990 --> 04:23:07,439

rust has that brownish red color so it's

5047

04:23:12,870 --> 04:23:10,000

it's red because it's rusty and also

5048

04:23:15,269 --> 04:23:12,880

because it's red they ask is it red hot

5049

04:23:17,110 --> 04:23:15,279

is it really hot on mars and well no

5050

04:23:18,790 --> 04:23:17,120

actually it's colder than the earth it's

5051
04:23:20,229 --> 04:23:18,800
farther away from the sun so as you

5052
04:23:22,630 --> 04:23:20,239
would imagine it's a little bit colder

5053
04:23:25,269 --> 04:23:22,640
than the earth it also has a really thin

5054
04:23:27,590 --> 04:23:25,279
atmosphere so the heat that it does have

5055
04:23:29,349 --> 04:23:27,600
it has a hard time keeping in

5056
04:23:31,750 --> 04:23:29,359
and so it's a little bit colder but then

5057
04:23:34,309 --> 04:23:31,760
i also get asked what would i weigh on

5058
04:23:36,229 --> 04:23:34,319
mars that's a really fun question so on

5059
04:23:38,070 --> 04:23:36,239
mars it's a little bit smaller than the

5060
04:23:40,229 --> 04:23:38,080
earth so the gravity there is weaker

5061
04:23:41,990 --> 04:23:40,239
it's about 3 8 the gravity that we have

5062
04:23:43,990 --> 04:23:42,000
here on earth so if you weighed 100

5063
04:23:46,070 --> 04:23:44,000

pounds here on earth you weigh 38 pounds

5064

04:23:49,189 --> 04:23:46,080

on mars or 100 kilograms here on earth

5065

04:23:50,870 --> 04:23:49,199

38 kilograms on mars

5066

04:23:52,389 --> 04:23:50,880

those are all super fun i think even

5067

04:23:54,389 --> 04:23:52,399

some adults want to know the answers to

5068

04:23:56,229 --> 04:23:54,399

those questions emily

5069

04:23:58,550 --> 04:23:56,239

now why do you think it's so important

5070

04:24:01,269 --> 04:23:58,560

to educate kids about science and give

5071

04:24:04,309 --> 04:24:01,279

them that great foundation

5072

04:24:06,149 --> 04:24:04,319

well science is the language of nature

5073

04:24:08,630 --> 04:24:06,159

and learning about science and learning

5074

04:24:10,790 --> 04:24:08,640

how to think like a scientist means you

5075

04:24:13,189 --> 04:24:10,800

are learning how to systematically seek

5076

04:24:14,790 --> 04:24:13,199

out truth in the world you are learning

5077

04:24:16,469 --> 04:24:14,800

the scientific method you're learning

5078

04:24:18,469 --> 04:24:16,479

how to be a critical thinker and

5079

04:24:20,070 --> 04:24:18,479

honestly those skills are great for

5080

04:24:21,189 --> 04:24:20,080

whatever you end up wanting to do in

5081

04:24:23,030 --> 04:24:21,199

life

5082

04:24:25,349 --> 04:24:23,040

true if you want to be a scientist or an

5083

04:24:28,070 --> 04:24:25,359

opera singer that holds true what are

5084

04:24:29,110 --> 04:24:28,080

you most excited about today

5085

04:24:31,910 --> 04:24:29,120

i mean

5086

04:24:33,990 --> 04:24:31,920

humans are launching a robot to mars

5087

04:24:35,830 --> 04:24:34,000

that doesn't happen every day i think in

5088

04:24:37,910 --> 04:24:35,840

all of the hecticness that is going on

5089

04:24:40,149 --> 04:24:37,920

today and all of the nerves i just

5090

04:24:42,630 --> 04:24:40,159

everyone can take a moment to sit back

5091

04:24:44,870 --> 04:24:42,640

and remember that we live in a time when

5092

04:24:47,030 --> 04:24:44,880

humans have the ability to send a robot

5093

04:24:49,510 --> 04:24:47,040

to another planet and that is just

5094

04:24:52,309 --> 04:24:49,520

that's so cool to me

5095

04:24:54,469 --> 04:24:52,319

it is very cool emily take a deep breath

5096

04:24:55,830 --> 04:24:54,479

thanks for joining us here

5097

04:24:58,070 --> 04:24:55,840

thanks for having me

5098

04:25:01,349 --> 04:24:58,080

sending it back to you now raquel

5099

04:25:03,830 --> 04:25:01,359

thanks marina we are offering lots of

5100

04:25:06,229 --> 04:25:03,840

ways to ride along with us to mars now

5101
04:25:08,790 --> 04:25:06,239
put yourself right into the action now

5102
04:25:11,030 --> 04:25:08,800
with our perseverance photo booth you

5103
04:25:13,910 --> 04:25:11,040
can pose next to the rover place

5104
04:25:15,510 --> 04:25:13,920
yourself in our mission control and even

5105
04:25:17,750 --> 04:25:15,520
see what you might look like taking a

5106
04:25:19,670 --> 04:25:17,760
selfie on the red planet

5107
04:25:21,990 --> 04:25:19,680
there you'll also have a chance to sign

5108
04:25:24,710 --> 04:25:22,000
up to send your name to mars on nasa's

5109
04:25:26,429 --> 04:25:24,720
next flight to the red planet it's all

5110
04:25:28,309 --> 04:25:26,439
available at

5111
04:25:31,189 --> 04:25:28,319
go.nasa.gov

5112
04:25:35,189 --> 04:25:31,199
mars 2020 toolkit

5113
04:25:38,309 --> 04:25:35,199

and joining us now is jpl chief engineer

5114

04:25:40,309 --> 04:25:38,319

and landing veteran rob manning he will

5115

04:25:42,550 --> 04:25:40,319

be breaking down key moments coming up

5116

04:25:45,269 --> 04:25:42,560

and very few people know more about

5117

04:25:48,790 --> 04:25:45,279

landing on mars than rob going back to

5118

04:25:50,950 --> 04:25:48,800

the pathfinder mission in 1997

5119

04:25:52,710 --> 04:25:50,960

thanks for joining us today rob yeah

5120

04:25:55,030 --> 04:25:52,720

thank you very much rick

5121

04:25:56,229 --> 04:25:55,040

for having me here and what a wonderful

5122

04:25:58,229 --> 04:25:56,239

experience

5123

04:25:59,910 --> 04:25:58,239

what a wonderful day for a beautiful day

5124

04:26:02,309 --> 04:25:59,920

in california

5125

04:26:04,630 --> 04:26:02,319

we we're just so excited here anxious

5126

04:26:06,469 --> 04:26:04,640

worried but very hopeful

5127

04:26:08,870 --> 04:26:06,479

rob i have a question for you there is a

5128

04:26:11,590 --> 04:26:08,880

landing tradition at jpl that involves

5129

04:26:13,269 --> 04:26:11,600

eating peanuts for good luck uh can you

5130

04:26:15,910 --> 04:26:13,279

tell us how did that start

5131

04:26:18,229 --> 04:26:15,920

yes it started in the mid-1960s what

5132

04:26:20,710 --> 04:26:18,239

happened was we had a series of missions

5133

04:26:23,590 --> 04:26:20,720

that had failures the ranger program in

5134

04:26:25,830 --> 04:26:23,600

the early 1960s and one after another

5135

04:26:27,990 --> 04:26:25,840

failed and what happened was one day a

5136

04:26:29,510 --> 04:26:28,000

fellow by their dick wallace on the on

5137

04:26:31,830 --> 04:26:29,520

ranger number 7

5138

04:26:34,389 --> 04:26:31,840

on the seventh attempt decided to bring

5139

04:26:36,550 --> 04:26:34,399

peanuts to the ops area just before the

5140

04:26:38,229 --> 04:26:36,560

before the launch and guess what

5141

04:26:40,389 --> 04:26:38,239

that mission worked now we're not

5142

04:26:42,309 --> 04:26:40,399

supposed to be too super superstitious

5143

04:26:44,149 --> 04:26:42,319

we're engineers and scientists after all

5144

04:26:46,309 --> 04:26:44,159

but we love tradition and ever since

5145

04:26:47,830 --> 04:26:46,319

then before launch and before critical

5146

04:26:49,110 --> 04:26:47,840

events like enter descent landing we

5147

04:26:50,790 --> 04:26:49,120

have brought out peanuts and shared them

5148

04:26:52,950 --> 04:26:50,800

with the team and it's been really a

5149

04:26:54,710 --> 04:26:52,960

wonderful little experience and and so

5150

04:26:57,030 --> 04:26:54,720

this is something we will do we're doing

5151
04:26:58,710 --> 04:26:57,040
right now and uh and it's something that

5152
04:27:01,030 --> 04:26:58,720
we we just can't help ourselves it's

5153
04:27:03,030 --> 04:27:01,040
just part of the experience

5154
04:27:05,110 --> 04:27:03,040
well speaking of the experience how did

5155
04:27:07,269 --> 04:27:05,120
the perseverance team keep the tradition

5156
04:27:09,030 --> 04:27:07,279
alive this year well this year we're

5157
04:27:10,950 --> 04:27:09,040
passed out little package of penis to

5158
04:27:13,349 --> 04:27:10,960
the team and they can sneak a pic one

5159
04:27:15,510 --> 04:27:13,359
peanut in their mouth for uh as part of

5160
04:27:16,950 --> 04:27:15,520
to keep the tradition alive but you know

5161
04:27:19,590 --> 04:27:16,960
this is part of the covet experience but

5162
04:27:21,030 --> 04:27:19,600
we can't leave this one uh undone so

5163
04:27:24,149 --> 04:27:21,040

this is what we're doing and we're and

5164

04:27:25,830 --> 04:27:24,159

uh and this is gonna help us land safely

5165

04:27:27,510 --> 04:27:25,840

all right thanks rob i have some

5166

04:27:29,590 --> 04:27:27,520

questions for you a little later on but

5167

04:27:31,830 --> 04:27:29,600

we are heading back to swati mohan who

5168

04:27:33,990 --> 04:27:31,840

is part of the landing team she'll be

5169

04:27:36,070 --> 04:27:34,000

calling out key milestone and events as

5170

04:27:40,630 --> 04:27:36,080

they happen from mission control so

5171

04:27:44,870 --> 04:27:42,550

so right now we're still about 20

5172

04:27:47,110 --> 04:27:44,880

minutes from entry and the edl phase is

5173

04:27:48,469 --> 04:27:47,120

giving a last minute

5174

04:27:50,309 --> 04:27:48,479

um

5175

04:27:52,309 --> 04:27:50,319

confirmation of what will be

5176
04:27:54,309 --> 04:27:52,319
happening

5177
04:27:56,389 --> 04:27:54,319
in the upcoming

5178
04:27:59,189 --> 04:27:56,399
changes to the vehicle just to remind

5179
04:28:03,670 --> 04:28:02,070
and this will allow us to steer our

5180
04:28:05,189 --> 04:28:03,680
trajectory

5181
04:28:07,030 --> 04:28:05,199
as we make our way through the

5182
04:28:08,630 --> 04:28:07,040
atmosphere

5183
04:28:10,710 --> 04:28:08,640
and uh

5184
04:28:11,830 --> 04:28:10,720
this is one of the things that allowed

5185
04:28:18,469 --> 04:28:11,840
uh

5186
04:28:20,229 --> 04:28:18,479
to land where it did

5187
04:28:22,710 --> 04:28:20,239
and we're depending on the same type of

5188
04:28:26,790 --> 04:28:22,720

entry guidance this time around

5189

04:28:30,550 --> 04:28:28,630

as we make our way

5190

04:28:32,870 --> 04:28:30,560

through entry finish the

5191

04:28:34,710 --> 04:28:32,880

finish our guided entry

5192

04:28:37,110 --> 04:28:34,720

profile

5193

04:28:38,950 --> 04:28:37,120

we'll do a maneuver called heading

5194

04:28:40,070 --> 04:28:38,960

alignment where we point toward the

5195

04:28:42,070 --> 04:28:40,080

target

5196

04:28:43,750 --> 04:28:42,080

and get ready to

5197

04:28:49,269 --> 04:28:43,760

deploy the parachute

5198

04:28:51,429 --> 04:28:49,279

we need to get rid of a

5199

04:28:53,189 --> 04:28:51,439

set of balanced masses

5200

04:28:54,630 --> 04:28:53,199

that have been

5201
04:28:57,910 --> 04:28:54,640
giving us a

5202
04:29:00,389 --> 04:28:57,920
center of gravity or cg offset

5203
04:29:01,990 --> 04:29:00,399
throughout the guided entry phase

5204
04:29:02,950 --> 04:29:02,000
so these are called

5205
04:29:07,349 --> 04:29:02,960
the

5206
04:29:10,149 --> 04:29:07,359
this maneuver

5207
04:29:11,349 --> 04:29:10,159
suffer sufr or straighten up and fly

5208
04:29:14,550 --> 04:29:11,359
right

5209
04:29:16,149 --> 04:29:14,560
so we'll go ahead and eject those masses

5210
04:29:18,950 --> 04:29:16,159
when we get

5211
04:29:21,110 --> 04:29:18,960
a trigger from the gnc system

5212
04:29:23,349 --> 04:29:21,120
telling us that we're at the appropriate

5213
04:29:25,670 --> 04:29:23,359

range to the target to do so

5214

04:29:27,349 --> 04:29:25,680

as soon as we deploy those

5215

04:29:29,910 --> 04:29:27,359

we will

5216

04:29:32,070 --> 04:29:29,920

no longer have a cd offset

5217

04:29:39,189 --> 04:29:32,080

and we'll be ready to deploy the

5218

04:29:42,070 --> 04:29:40,950

right where the perseverance team is

5219

04:29:44,830 --> 04:29:42,080

sitting now

5220

04:29:48,149 --> 04:29:44,840

what's in store for them as we approach

5221

04:29:50,229 --> 04:29:48,159

landing i'm going to hold here for uh

5222

04:29:53,349 --> 04:29:50,239

prep because we're about to start that

5223

04:29:57,030 --> 04:29:55,510

copy piece 2

5224

04:29:58,790 --> 04:29:57,040

an activity please call that out when

5225

04:30:15,670 --> 04:29:58,800

it's ready

5226

04:30:20,309 --> 04:30:18,710

all right now rob uh you've been right

5227

04:30:21,510 --> 04:30:20,319

where the perseverance team is sitting

5228

04:30:23,590 --> 04:30:21,520

now uh

5229

04:30:24,950 --> 04:30:23,600

what's in store for them as we approach

5230

04:30:26,630 --> 04:30:24,960

landing

5231

04:30:28,389 --> 04:30:26,640

well this is the

5232

04:30:29,110 --> 04:30:28,399

this is the nail biting time

5233

04:30:30,550 --> 04:30:29,120

um

5234

04:30:32,309 --> 04:30:30,560

fortunately we still have ones and zeros

5235

04:30:34,389 --> 04:30:32,319

coming but very soon as we approach

5236

04:30:36,309 --> 04:30:34,399

cruise stage separation the the

5237

04:30:37,670 --> 04:30:36,319

transmitter on this rover that's been

5238

04:30:40,389 --> 04:30:37,680

we've been using all the way to get to

5239

04:30:42,149 --> 04:30:40,399

mars is going to be turned off

5240

04:30:43,590 --> 04:30:42,159

um so

5241

04:30:45,189 --> 04:30:43,600

and we will lose our ability to see ones

5242

04:30:46,469 --> 04:30:45,199

and zeros but the good thing is once the

5243

04:30:49,510 --> 04:30:46,479

cruise stage is gone there's another

5244

04:30:50,630 --> 04:30:49,520

radio that will continue transmitting uh

5245

04:30:52,309 --> 04:30:50,640

a tone

5246

04:30:53,910 --> 04:30:52,319

so that like like a flashlight that will

5247

04:30:56,070 --> 04:30:53,920

allow us to see at least see that the

5248

04:30:57,750 --> 04:30:56,080

vehicle is still on and that and then

5249

04:30:59,429 --> 04:30:57,760

and that color of that flashlight tells

5250

04:31:01,990 --> 04:30:59,439

us a little bit what state this the

5251

04:31:04,229 --> 04:31:02,000

rover's in but soon after that um it

5252

04:31:06,389 --> 04:31:04,239

won't be very long before we'll be able

5253

04:31:08,550 --> 04:31:06,399

to hear more ones and zeros coming from

5254

04:31:09,910 --> 04:31:08,560

the spacecraft um so this is a really

5255

04:31:12,309 --> 04:31:09,920

exciting time and and it's just

5256

04:31:13,910 --> 04:31:12,319

important to remind people this is a uh

5257

04:31:15,830 --> 04:31:13,920

there's a lot that can go wrong in a day

5258

04:31:17,590 --> 04:31:15,840

like today there are thousands of things

5259

04:31:19,990 --> 04:31:17,600

that have to go right

5260

04:31:22,309 --> 04:31:20,000

yeah we had success in the past landing

5261

04:31:24,309 --> 04:31:22,319

on mars you think it gets easier but it

5262

04:31:26,950 --> 04:31:24,319

really doesn't why is it still so

5263

04:31:28,550 --> 04:31:26,960

difficult well it's well because it's

5264

04:31:30,070 --> 04:31:28,560

involved thousands and thousands of

5265

04:31:31,030 --> 04:31:30,080

things hundreds of thousands of lines of

5266

04:31:34,070 --> 04:31:31,040

code

5267

04:31:36,630 --> 04:31:34,080

there there is uh there's 79 pyrotechnic

5268

04:31:43,429 --> 04:31:36,640

devices each have to work perfectly

5269

04:31:48,070 --> 04:31:46,229

and so it's you know and and so

5270

04:31:51,110 --> 04:31:48,080

and it's very easy we're human beings

5271

04:31:53,429 --> 04:31:51,120

we're not perfect mistakes can be made

5272

04:31:56,950 --> 04:31:53,439

um we each count on each other to to

5273

04:31:59,269 --> 04:31:56,960

find uh our own mistakes and and we

5274

04:32:01,910 --> 04:31:59,279

work very hard to to

5275

04:32:03,670 --> 04:32:01,920

learn from the mistakes of the past um

5276
04:32:04,550 --> 04:32:03,680
we've had many failures half remind

5277
04:32:05,990 --> 04:32:04,560
people

5278
04:32:07,750 --> 04:32:06,000
roughly half little

5279
04:32:10,790 --> 04:32:07,760
around half of the missions

5280
04:32:12,710 --> 04:32:10,800
to mars over history have failed um and

5281
04:32:14,309 --> 04:32:12,720
so it's it's it's that could happen

5282
04:32:16,469 --> 04:32:14,319
today too even though we've had a nice

5283
04:32:18,149 --> 04:32:16,479
wonderful string of successes in the

5284
04:32:21,349 --> 04:32:18,159
united states it's still

5285
04:32:23,110 --> 04:32:21,359
a a still a bit of a gamble a gamble

5286
04:32:25,670 --> 04:32:23,120
that we've we have hoped that we have we

5287
04:32:27,830 --> 04:32:25,680
have aired in the side of luck and and

5288
04:32:30,630 --> 04:32:27,840

and we've stacked the dice that stacked

5289

04:32:33,590 --> 04:32:30,640

the deck and uh loaded the dice to make

5290

04:32:35,750 --> 04:32:33,600

this thing succeed um but um if we do if

5291

04:32:36,710 --> 04:32:35,760

we do fail and something bad happens

5292

04:32:38,309 --> 04:32:36,720

today

5293

04:32:40,149 --> 04:32:38,319

i can tell you we're going to learn it

5294

04:32:41,910 --> 04:32:40,159

we'll have the data to tell us what

5295

04:32:42,630 --> 04:32:41,920

happened we'll know why we'll figure it

5296

04:32:44,550 --> 04:32:42,640

out

5297

04:32:46,630 --> 04:32:44,560

and and if we

5298

04:32:48,469 --> 04:32:46,640

are allowed we will pick ourselves up

5299

04:32:51,030 --> 04:32:48,479

and get us back on the horse

5300

04:32:52,309 --> 04:32:51,040

and if congress and nasa allow we will

5301
04:32:54,070 --> 04:32:52,319
try again

5302
04:32:55,269 --> 04:32:54,080
as we always do we will learn from our

5303
04:32:55,990 --> 04:32:55,279
mistakes

5304
04:32:58,229 --> 04:32:56,000
and

5305
04:32:59,990 --> 04:32:58,239
what are the possible scenarios we could

5306
04:33:01,110 --> 04:33:00,000
be looking at today

5307
04:33:03,110 --> 04:33:01,120
well there's

5308
04:33:03,910 --> 04:33:03,120
things things like uh you know one of

5309
04:33:05,670 --> 04:33:03,920
the key

5310
04:33:08,070 --> 04:33:05,680
stressful elements for all of us is

5311
04:33:09,670 --> 04:33:08,080
parachute inflation uh but just even

5312
04:33:11,510 --> 04:33:09,680
separating from the cruise stage is a

5313
04:33:13,830 --> 04:33:11,520

pretty major event lots of devices have

5314

04:33:16,470 --> 04:33:13,840

to work properly um certainly on the

5315

04:33:18,310 --> 04:33:16,480

heat shield separation again getting the

5316

04:33:19,990 --> 04:33:18,320

descent engine started there's no less

5317

04:33:22,551 --> 04:33:20,000

than than uh uh

5318

04:33:23,670 --> 04:33:22,561

16 and rocket motors that have to work

5319

04:33:25,830 --> 04:33:23,680

uh one two

5320

04:33:28,150 --> 04:33:25,840

eight to control during entry another

5321

04:33:29,990 --> 04:33:28,160

eight to control it during landing i

5322

04:33:32,150 --> 04:33:30,000

said it's a lot of stuff it all has to

5323

04:33:34,629 --> 04:33:32,160

work and guess what we haven't done this

5324

04:33:37,109 --> 04:33:34,639

before with this vehicle ever this is

5325

04:33:39,510 --> 04:33:37,119

this first attempt to actually land we

5326

04:33:41,109 --> 04:33:39,520

can't try this on earth we can't do we

5327

04:33:43,429 --> 04:33:41,119

don't have test pilots and try it out on

5328

04:33:44,709 --> 04:33:43,439

this planet before the big show so this

5329

04:33:46,070 --> 04:33:44,719

vehicle is doing it for the first time

5330

04:33:48,390 --> 04:33:46,080

we've done the best testing we can do in

5331

04:33:50,949 --> 04:33:48,400

bits and pieces but you know it's it's

5332

04:33:52,949 --> 04:33:50,959

as best as we can do and and uh but i

5333

04:33:54,869 --> 04:33:52,959

think our team is up to it we've this

5334

04:33:57,189 --> 04:33:54,879

team is the best it's a diverse

5335

04:33:58,629 --> 04:33:57,199

intelligent amazing group of people uh

5336

04:34:00,070 --> 04:33:58,639

people from all over the world who

5337

04:34:01,910 --> 04:34:00,080

worked on this not just here in

5338

04:34:04,551 --> 04:34:01,920

california but all over nasa

5339

04:34:06,949 --> 04:34:04,561

contributors from aerospace universities

5340

04:34:08,551 --> 04:34:06,959

countries around the world it is just an

5341

04:34:10,470 --> 04:34:08,561

incredible remarkable engineering

5342

04:34:12,310 --> 04:34:10,480

achievement and i am just so proud of

5343

04:34:14,551 --> 04:34:12,320

this team

5344

04:34:18,310 --> 04:34:14,561

thanks rob now let's listen back into

5345

04:34:22,869 --> 04:34:21,590

right you're about 14 minutes from entry

5346

04:34:24,551 --> 04:34:22,879

interface

5347

04:34:27,109 --> 04:34:24,561

the vehicle is

5348

04:34:29,510 --> 04:34:27,119

currently preparing the heat rejection

5349

04:34:30,949 --> 04:34:29,520

system that has kept the thermal system

5350

04:34:32,709 --> 04:34:30,959

cool inside the aeroshell for about the

5351

04:34:35,109 --> 04:34:32,719

last six months this will allow the

5352

04:35:01,349 --> 04:34:35,119

stiff cuff to more easily cut the line

5353

04:35:05,670 --> 04:35:03,189

with the pyrotechnic system working we

5354

04:35:06,869 --> 04:35:05,680

can you can we can explode the devices

5355

04:35:09,510 --> 04:35:06,879

the vehicle is preparing for the

5356

04:35:12,070 --> 04:35:09,520

upcoming cruise stage duration in about

5357

04:35:14,551 --> 04:35:12,080

3 minutes 15 seconds

5358

04:35:17,109 --> 04:35:14,561

by powering off all the devices on the

5359

04:35:23,349 --> 04:35:17,119

cruise stage in order that take me safe

5360

04:35:27,910 --> 04:35:25,429

yeah this is a this is uh this three

5361

04:35:30,470 --> 04:35:27,920

stage has been very reliable

5362

04:35:33,510 --> 04:35:30,480

we are firing our first pyros to event

5363

04:35:35,269 --> 04:35:33,520

the hrs liquid and gas

5364

04:35:36,629 --> 04:35:35,279

ah this has been the coolant because we

5365

04:35:38,470 --> 04:35:36,639

kept their vehicle from getting too hot

5366

04:35:43,590 --> 04:35:38,480

in the way of mars

5367

04:35:47,590 --> 04:35:46,070

and so this is one of the first uh major

5368

04:35:48,830 --> 04:35:47,600

events that take place as part of entry

5369

04:35:52,390 --> 04:35:48,840

descent

5370

04:35:54,070 --> 04:35:52,400

landing transvent acre is complete

5371

04:35:59,429 --> 04:35:54,080

we will see the next anchor in

5372

04:36:04,390 --> 04:36:01,510

okay we are currently 12 and a half

5373

04:36:06,470 --> 04:36:04,400

minutes from entry interface we are

5374

04:36:10,789 --> 04:36:06,480

coming up on cruise stage separation in

5375

04:36:14,789 --> 04:36:13,029

what's happening now rob

5376

04:36:15,990 --> 04:36:14,799

okay we'll just we're just waiting the

5377

04:36:18,310 --> 04:36:16,000

the

5378

04:36:19,750 --> 04:36:18,320

rover is completely in charge it's doing

5379

04:36:21,189 --> 04:36:19,760

all the things we've taught it how to do

5380

04:36:23,510 --> 04:36:21,199

it's all built into the software we've

5381

04:36:26,629 --> 04:36:23,520

tested it over and over and over again

5382

04:36:29,189 --> 04:36:26,639

this team has spent 24 hours a day seven

5383

04:36:31,750 --> 04:36:29,199

days a week testing this thing for years

5384

04:36:33,830 --> 04:36:31,760

and and and so this is uh this is really

5385

04:36:36,070 --> 04:36:33,840

the culmination of all that work so this

5386

04:36:37,910 --> 04:36:36,080

vehicle is is gonna is getting ready to

5387

04:36:40,789 --> 04:36:37,920

push that cruise stage away

5388

04:36:42,869 --> 04:36:40,799

uh once it gets pushed away um it it

5389

04:36:44,949 --> 04:36:42,879

the entry system with the rover inside

5390

04:36:47,590 --> 04:36:44,959

with the rover is still in charge it's

5391

04:36:49,670 --> 04:36:47,600

to get ready to take the vehicle turn it

5392

04:36:52,629 --> 04:36:49,680

to the right orientation and aim it to

5393

04:36:58,310 --> 04:36:52,639

mars and and uh and prepare for entering

5394

04:37:02,150 --> 04:37:00,470

this won't be long

5395

04:37:04,390 --> 04:37:02,160

um be prepared for this event taking

5396

04:37:07,189 --> 04:37:04,400

about a minute and a half from mistake

5397

04:37:10,949 --> 04:37:07,199

to separation about 11 minutes 20

5398

04:37:14,869 --> 04:37:13,189

okay so it's about 10 minutes from

5399

04:37:16,869 --> 04:37:14,879

cruising separation until it enters the

5400

04:37:18,390 --> 04:37:16,879

top of the atmosphere from then on and

5401
04:37:23,830 --> 04:37:18,400
out things happen

5402
04:37:27,990 --> 04:37:25,429
telecom is confirming that the

5403
04:37:30,789 --> 04:37:28,000
spacecraft has switched to broadcasting

5404
04:37:33,269 --> 04:37:30,799
tones these tones are received directly

5405
04:37:36,150 --> 04:37:33,279
from perseverance but have very limited

5406
04:37:40,310 --> 04:37:36,160
information content we won't receive

5407
04:37:42,230 --> 04:37:40,320
real-time information until about

5408
04:37:44,949 --> 04:37:42,240
9-10 minutes from now once the mars

5409
04:37:46,789 --> 04:37:44,959
reconnaissance orbiter starts relaying

5410
04:37:48,551 --> 04:37:46,799
information from perseverance

5411
04:37:50,629 --> 04:37:48,561
we are under a minute from cruise stage

5412
04:37:53,670 --> 04:37:50,639
separation about ten and a half minutes

5413
04:37:57,429 --> 04:37:55,590

it's getting exciting i have to admit i

5414

04:37:59,510 --> 04:37:57,439

am quite anxious

5415

04:38:00,869 --> 04:37:59,520

uh but very hopeful this machine is

5416

04:38:02,949 --> 04:38:00,879

going to do what we have seen the

5417

04:38:04,789 --> 04:38:02,959

heartbeat terms

5418

04:38:06,230 --> 04:38:04,799

okay that means that there's no more

5419

04:38:17,590 --> 04:38:06,240

ones and zeros coming it's just the

5420

04:38:21,990 --> 04:38:19,510

they're continuing to receive tones from

5421

04:38:42,629 --> 04:38:22,000

perseverance coming standing by for

5422

04:38:46,230 --> 04:38:44,230

i have indication that cruise stage

5423

04:38:51,429 --> 04:38:46,240

separation has been confirmed by the

5424

04:38:55,670 --> 04:38:53,910

we're off on a good start in one minute

5425

04:38:57,510 --> 04:38:55,680

press advances landing software will

5426
04:39:00,470 --> 04:38:57,520
wake up and begin the final preparations

5427
04:39:02,949 --> 04:39:00,480
for entry the first action it will do is

5428
04:39:05,109 --> 04:39:02,959
to fire warm-up pulses with the entry

5429
04:39:07,189 --> 04:39:05,119
thrusters these pulses ensure that the

5430
04:39:09,029 --> 04:39:07,199
spacecraft gets the thrust that it wants

5431
04:39:10,150 --> 04:39:09,039
during entry interface

5432
04:39:17,349 --> 04:39:10,160
we're about

5433
04:39:20,789 --> 04:39:19,269
okay so now the vehicle's on its own

5434
04:39:22,551 --> 04:39:20,799
it's gonna it's turning itself into the

5435
04:39:23,990 --> 04:39:22,561
direction of facing the heat shield

5436
04:39:26,949 --> 04:39:24,000
toward mars

5437
04:39:28,551 --> 04:39:26,959
and uh and we'll eventually uh

5438
04:39:30,551 --> 04:39:28,561

uh hitting the top of the atmosphere

5439

04:39:38,708 --> 04:39:30,561

we're not far away this is gonna go very

5440

04:39:43,430 --> 04:39:40,628

that's confirmation that uh we got

5441

04:39:44,708 --> 04:39:43,440

shadowed by the crew stage

5442

04:39:49,190 --> 04:39:44,718

as it

5443

04:39:53,910 --> 04:39:51,430

telecom indicated actually that we could

5444

04:39:55,190 --> 04:39:53,920

see a signal that the crew stage went

5445

04:39:57,510 --> 04:39:55,200

between

5446

04:39:59,590 --> 04:39:57,520

the perseverance engine capsule and

5447

04:40:01,270 --> 04:39:59,600

earth so we saw a little blip

5448

04:40:02,390 --> 04:40:01,280

uh

5449

04:40:06,550 --> 04:40:02,400

the data stream

5450

04:40:10,230 --> 04:40:08,550

we have confirmation that the vehicle

5451
04:40:11,750 --> 04:40:10,240
has started warming up those entry

5452
04:40:21,350 --> 04:40:11,760
thrusters

5453
04:40:27,110 --> 04:40:23,990
at this point the spacecraft is trying

5454
04:40:29,430 --> 04:40:27,120
to stop its spin from the cruise two

5455
04:40:31,270 --> 04:40:29,440
revolutions per minute down to zero

5456
04:40:33,750 --> 04:40:31,280
and then we'll turn to its desired

5457
04:40:35,030 --> 04:40:33,760
orientation from entry

5458
04:40:37,110 --> 04:40:35,040
it will

5459
04:40:39,030 --> 04:40:37,120
separate the two balanced maps that have

5460
04:40:40,550 --> 04:40:39,040
kept it balanced during all of cruise

5461
04:40:41,750 --> 04:40:40,560
this will allow the entry capsule to

5462
04:40:44,310 --> 04:40:41,760
have lift

5463
04:40:45,510 --> 04:40:44,320

when it enters the atmosphere the

5464

04:40:47,990 --> 04:40:45,520

competition

5465

04:40:50,390 --> 04:40:48,000

has turned to the desire

5466

04:40:51,910 --> 04:40:50,400

entry attitude

5467

04:40:57,190 --> 04:40:51,920

we are about seven and a half minutes

5468

04:41:00,470 --> 04:40:59,270

okay the vehicle is pointed in the right

5469

04:41:01,670 --> 04:41:00,480

direction

5470

04:41:03,910 --> 04:41:01,680

thrusters are

5471

04:41:05,190 --> 04:41:03,920

warmed up and doing their job

5472

04:41:07,430 --> 04:41:05,200

and now

5473

04:41:08,948 --> 04:41:07,440

we've spun down from

5474

04:41:10,550 --> 04:41:08,958

two revolutions per minute that the

5475

04:41:13,110 --> 04:41:10,560

vehicle had the whole way to all the way

5476
04:41:15,030 --> 04:41:13,120
to mars is a spin stabilized spacecraft

5477
04:41:17,030 --> 04:41:15,040
and then from here on out it's going to

5478
04:41:19,030 --> 04:41:17,040
just be a bullet and it's going to

5479
04:41:21,830 --> 04:41:19,040
control its orient orientation and

5480
04:41:23,590 --> 04:41:21,840
attitude via rockets on the back of that

5481
04:41:24,830 --> 04:41:23,600
points carrier lock

5482
04:41:28,628 --> 04:41:24,840
that's

5483
04:41:31,910 --> 04:41:28,638
right dte from radio science from uh

5484
04:41:38,470 --> 04:41:31,920
green bank reports carrier log

5485
04:41:42,868 --> 04:41:40,868
flight level one

5486
04:41:45,750 --> 04:41:42,878
we are continuing to wait for entry

5487
04:41:47,990 --> 04:41:45,760
interface for about six minutes and 45

5488
04:41:50,550 --> 04:41:48,000

seconds from entry interface

5489

04:41:56,708 --> 04:41:50,560

we have confirmation from uh greenback

5490

04:41:59,990 --> 04:41:57,670

the

5491

04:42:02,070 --> 04:42:00,000

spacecraft perseverance is currently

5492

04:42:04,150 --> 04:42:02,080

transmitting heartbeat tones

5493

04:42:06,708 --> 04:42:04,160

these sounds indicate that perseverance

5494

04:42:10,628 --> 04:42:06,718

is operating normally and has nothing

5495

04:42:14,390 --> 04:42:12,390

just as expected

5496

04:42:23,270 --> 04:42:14,400

we're currently just over six minutes

5497

04:42:31,750 --> 04:42:24,868

okay

5498

04:42:35,670 --> 04:42:33,030

as soon as we get to the top of the

5499

04:42:37,670 --> 04:42:35,680

atmosphere the atm will be very quickly

5500

04:42:40,550 --> 04:42:37,680

which is the entry point it won't be

5501
04:42:42,230 --> 04:42:40,560
very long before the the atmosphere will

5502
04:42:44,310 --> 04:42:42,240
start getting thicker and thicker it's

5503
04:42:45,910 --> 04:42:44,320
going very quickly at a fairly steep

5504
04:42:47,350 --> 04:42:45,920
angle of 15 degrees

5505
04:42:49,670 --> 04:42:47,360
into the atmosphere and it starts to

5506
04:42:51,350 --> 04:42:49,680
slow down just under

5507
04:42:52,868 --> 04:42:51,360
about five and a half minutes from entry

5508
04:42:55,350 --> 04:42:52,878
interface

5509
04:42:57,030 --> 04:42:55,360
we're still receiving heartbeat tones

5510
04:42:58,948 --> 04:42:57,040
we expect to continue receiving

5511
04:43:00,230 --> 04:42:58,958
heartbeat tones until about five minutes

5512
04:43:02,310 --> 04:43:00,240
after entry

5513
04:43:04,230 --> 04:43:02,320

at that time perseverance will be no

5514

04:43:05,190 --> 04:43:04,240

longer in view of our antennas here on

5515

04:43:08,230 --> 04:43:05,200

earth

5516

04:43:10,470 --> 04:43:08,240

about 90 seconds prior to entry the mars

5517

04:43:12,868 --> 04:43:10,480

reconnaissance orbiter should begin

5518

04:43:14,948 --> 04:43:12,878

receiving telemetry from perseverance

5519

04:43:16,150 --> 04:43:14,958

and streaming it to earth in near real

5520

04:43:19,430 --> 04:43:16,160

time

5521

04:43:21,670 --> 04:43:19,440

there are a few expected short outages

5522

04:43:24,550 --> 04:43:21,680

such as when we have a plasma back out

5523

04:43:26,310 --> 04:43:24,560

or when we enter the peak heating phase

5524

04:43:28,550 --> 04:43:26,320

aside from these outages caused by the

5525

04:43:30,788 --> 04:43:28,560

plasma blackout antenna switching or

5526
04:43:33,030 --> 04:43:30,798
high dynamic events space type events we

5527
04:43:34,070 --> 04:43:33,040
should have telemetry until about 90

5528
04:43:34,948 --> 04:43:34,080
seconds

5529
04:43:36,708 --> 04:43:34,958
after

5530
04:43:38,310 --> 04:43:36,718
landing

5531
04:43:39,990 --> 04:43:38,320
comprising blackout

5532
04:43:42,788 --> 04:43:40,000
is

5533
04:43:45,350 --> 04:43:42,798
strong enough to make it through the

5534
04:43:47,350 --> 04:43:45,360
superheated super fast air flowing

5535
04:43:49,190 --> 04:43:47,360
around the spacecraft all the way down

5536
04:43:51,110 --> 04:43:49,200
to hertz once the temperature drops

5537
04:43:53,030 --> 04:43:51,120
below that peak heating we do reacquire

5538
04:43:54,708 --> 04:43:53,040

the signal from perseverance

5539

04:43:57,430 --> 04:43:54,718

we are currently about four and a half

5540

04:43:59,030 --> 04:43:57,440

minutes from entry interface

5541

04:44:00,948 --> 04:43:59,040

perseverance continues to report

5542

04:44:03,510 --> 04:44:00,958

heartbeat sounds indicating everything

5543

04:44:04,390 --> 04:44:03,520

is nominal

5544

04:44:06,230 --> 04:44:04,400

okay

5545

04:44:08,230 --> 04:44:06,240

what we wait what we're looking for now

5546

04:44:11,030 --> 04:44:08,240

is where mars reconnaissance orbiter

5547

04:44:13,030 --> 04:44:11,040

should be in view soon of our vehicle

5548

04:44:14,948 --> 04:44:13,040

and be able to listen to ones and zeros

5549

04:44:16,310 --> 04:44:14,958

coming from a separate radio that's

5550

04:44:17,510 --> 04:44:16,320

really designed to talk between

5551

04:44:19,110 --> 04:44:17,520

spacecraft

5552

04:44:20,628 --> 04:44:19,120

camera reports the electric radio is

5553

04:44:22,470 --> 04:44:20,638

powered on ready to receive signals from

5554

04:44:25,110 --> 04:44:22,480

the lander okay

5555

04:44:27,430 --> 04:44:25,120

the mro is ready unless enabled and

5556

04:44:29,350 --> 04:44:27,440

waiting for the to hear from our

5557

04:44:31,670 --> 04:44:29,360

constance's orbiter has reported that

5558

04:44:34,708 --> 04:44:31,680

it's ready to receive the signal from

5559

04:44:37,510 --> 04:44:34,718

perseverance it should be in a few

5560

04:44:41,750 --> 04:44:37,520

minutes here we're just light level one

5561

04:44:45,430 --> 04:44:43,510

four minutes away from landing folks

5562

04:44:48,550 --> 04:44:45,440

four minutes we don't need these ones

5563

04:44:51,190 --> 04:44:48,560

and zeros as swati said um but to land

5564

04:44:51,990 --> 04:44:51,200

safely but we really need it for our own

5565

04:44:53,590 --> 04:44:52,000

uh

5566

04:44:56,230 --> 04:44:53,600

health and well-being today to keep our

5567

04:44:58,550 --> 04:44:56,240

nerves in control around this time a

5568

04:45:00,708 --> 04:44:58,560

second spacecraft maven should begin

5569

04:45:02,390 --> 04:45:00,718

picking up telemetry from perseverance

5570

04:45:04,390 --> 04:45:02,400

and will continue to record that

5571

04:45:05,350 --> 04:45:04,400

telemetry until several minutes post

5572

04:45:08,150 --> 04:45:05,360

landing

5573

04:45:10,470 --> 04:45:08,160

we won't get that data for several hours

5574

04:45:13,830 --> 04:45:10,480

after landing as it's being recorded and

5575

04:45:15,910 --> 04:45:13,840

then will be forwarded to earth later

5576
04:45:16,868 --> 04:45:15,920
we are continuing to receive heartbeat

5577
04:45:18,628 --> 04:45:16,878
tones

5578
04:45:21,190 --> 04:45:18,638
indicating that everything is nominal

5579
04:45:23,510 --> 04:45:21,200
we're currently at about three minutes

5580
04:45:25,350 --> 04:45:23,520
until entry interface

5581
04:45:26,868 --> 04:45:25,360
so far so good we're about three and a

5582
04:45:29,910 --> 04:45:26,878
half minutes away from entering the

5583
04:45:31,510 --> 04:45:29,920
martian atmosphere

5584
04:45:33,670 --> 04:45:31,520
very soon we'll be getting ones and

5585
04:45:38,230 --> 04:45:33,680
zeroes i hope from our radio on the

5586
04:45:42,470 --> 04:45:39,750
making sure that we can establish

5587
04:45:45,590 --> 04:45:42,480
communications all throughout the uh

5588
04:45:47,350 --> 04:45:45,600

throughout the descent as long as we can

5589

04:45:49,030 --> 04:45:47,360

is nothing more than just an arbitrary

5590

04:45:50,470 --> 04:45:49,040

place in the sky that we've defined be

5591

04:45:52,788 --> 04:45:50,480

above the atmosphere

5592

04:45:55,990 --> 04:45:52,798

but once a vehicle enters the atmosphere

5593

04:46:00,150 --> 04:45:56,000

ionized gas as it enters the atmosphere

5594

04:46:06,868 --> 04:46:02,948

will transmit heartbeat tones indicating

5595

04:46:08,390 --> 04:46:06,878

everything is phenomenal

5596

04:46:09,910 --> 04:46:08,400

so far so good

5597

04:46:11,430 --> 04:46:09,920

so the tones can tell us whether

5598

04:46:13,910 --> 04:46:11,440

something's bad or not is happening so

5599

04:46:16,150 --> 04:46:13,920

so far the heartbeat is doing well so

5600

04:46:18,628 --> 04:46:16,160

the vehicle thinks it's how it's in good

5601
04:46:31,910 --> 04:46:18,638
shape to land

5602
04:46:35,830 --> 04:46:33,750
just a little over two minutes away from

5603
04:46:38,070 --> 04:46:35,840
atmospheric entry and again once it

5604
04:46:40,230 --> 04:46:38,080
enters the atmosphere

5605
04:46:42,070 --> 04:46:40,240
spacecraft will use drag to help it slow

5606
04:46:44,628 --> 04:46:42,080
down pressure is actually being pulled

5607
04:46:47,670 --> 04:46:44,638
in by gravity and accelerating by the

5608
04:46:50,470 --> 04:46:47,680
time cartridge reaches entry interface

5609
04:46:52,390 --> 04:46:50,480
so you should be going just under 5.4

5610
04:46:54,150 --> 04:46:52,400
kilometers per second

5611
04:46:56,788 --> 04:46:54,160
we're at about

5612
04:46:58,708 --> 04:46:56,798
90 seconds from entry interface and

5613
04:47:00,230 --> 04:46:58,718

standing by for mars reconnaissance

5614

04:47:03,510 --> 04:47:00,240

orbiter to pick up

5615

04:47:06,708 --> 04:47:05,430

now up until this point the vehicle has

5616

04:47:09,430 --> 04:47:06,718

been using

5617

04:47:11,510 --> 04:47:09,440

uh small thrusters in its back shell to

5618

04:47:14,070 --> 04:47:11,520

reorient itself to make sure that the

5619

04:47:28,150 --> 04:47:14,080

heat shield is in the proper orientation

5620

04:47:38,708 --> 04:47:30,070

mission controllers anxiously looking

5621

04:47:54,150 --> 04:47:41,270

one minute until the vehicle enters the

5622

04:47:54,160 --> 04:48:01,420

is

5623

04:48:01,430 --> 04:48:06,868

[Music]

5624

04:48:06,878 --> 04:48:15,510

above the surface of mars

5625

04:48:21,510 --> 04:48:17,510

one chance to get it right 15 seconds

5626
04:48:21,520 --> 04:48:33,430
five

5627
04:48:37,590 --> 04:48:35,990
here we go folks

5628
04:48:44,708 --> 04:48:37,600
beginning to enter the martian

5629
04:48:50,230 --> 04:48:47,670
i have confirmation of victory interface

5630
04:48:58,470 --> 04:48:50,240
pressure is currently going i made 3d

5631
04:49:02,470 --> 04:49:00,470
so as a spacecraft enters the atmosphere

5632
04:49:05,270 --> 04:49:02,480
the drag producer will dramatically slow

5633
04:49:07,030 --> 04:49:05,280
it down but these forces also heat up

5634
04:49:11,750 --> 04:49:07,040
the spacecraft as well that's why that

5635
04:49:16,230 --> 04:49:14,070
once there is enough atmosphere it will

5636
04:49:20,310 --> 04:49:16,240
start controlling its path to the

5637
04:49:25,830 --> 04:49:22,868
peak heating happens about 90 seconds

5638
04:49:27,670 --> 04:49:25,840

about 80 to 90 seconds after atmosphere

5639

04:49:29,190 --> 04:49:27,680

we can see a little bit

5640

04:49:30,788 --> 04:49:29,200

slow down

5641

04:49:35,190 --> 04:49:30,798

of

5642

04:49:35,200 --> 04:49:36,230

our test anti-capsule

5643

04:49:42,070 --> 04:49:39,270

is about 5.26

5644

04:49:45,670 --> 04:49:42,080

kilometers per second and it helps about

5645

04:49:47,830 --> 04:49:45,680

seven kilometers from the surface

5646

04:49:50,310 --> 04:49:47,840

at peak heating the

5647

04:49:52,868 --> 04:49:50,320

external surface of the heat shield will

5648

04:49:54,868 --> 04:49:52,878

reach temperatures in excess of two

5649

04:49:59,430 --> 04:49:54,878

thousand three hundred and seventy

5650

04:50:04,150 --> 04:50:00,948

turns right now

5651
04:50:04,160 --> 04:50:07,510
president

5652
04:50:10,470 --> 04:50:09,670
we have indications that conference is

5653
04:50:12,550 --> 04:50:10,480
now

5654
04:50:15,510 --> 04:50:12,560
performing bank reversals in the

5655
04:50:17,350 --> 04:50:15,520
atmosphere these are the steps in order

5656
04:50:20,868 --> 04:50:17,360
to control the

5657
04:50:23,190 --> 04:50:20,878
distance to the landing target

5658
04:50:25,510 --> 04:50:23,200
uh president this is passed through the

5659
04:50:28,708 --> 04:50:25,520
point of maximum deceleration and has

5660
04:50:29,830 --> 04:50:28,718
indicated that it felt approximately

5661
04:50:36,868 --> 04:50:29,840
10

5662
04:50:41,190 --> 04:50:39,510
next major milestone will be parachute

5663
04:50:42,868 --> 04:50:41,200

deployment

5664

04:50:45,110 --> 04:50:42,878

of the eu

5665

04:50:46,948 --> 04:50:45,120

from mars reconnaissance earth

5666

04:50:49,510 --> 04:50:46,958

that peak eating phase

5667

04:50:51,190 --> 04:50:49,520

likely caused by

5668

04:50:53,270 --> 04:50:51,200

perseverance is still continuing to

5669

04:50:55,670 --> 04:50:53,280

perform things reversals in the

5670

04:50:56,708 --> 04:50:55,680

atmosphere to control

5671

04:51:13,350 --> 04:50:56,718

its just

5672

04:51:17,430 --> 04:51:16,550

is going about one kilometers per second

5673

04:51:19,830 --> 04:51:17,440

at

5674

04:51:21,510 --> 04:51:19,840

an altitude of 16 kilometers from the

5675

04:51:23,990 --> 04:51:21,520

surface of mars

5676
04:51:26,470 --> 04:51:24,000
we have enz heading alignment

5677
04:51:29,590 --> 04:51:26,480
which means customs is no longer trying

5678
04:51:31,830 --> 04:51:29,600
to control the distance to mars but in

5679
04:51:32,708 --> 04:51:31,840
to the target on mars but instead it's

5680
04:51:36,948 --> 04:51:32,718
flying

5681
04:51:41,590 --> 04:51:39,270
so we're coming back now that the

5682
04:51:43,990 --> 04:51:41,600
spacecraft is

5683
04:51:50,628 --> 04:51:44,000
is on target

5684
04:51:54,708 --> 04:51:52,628
as it enters the atmosphere pockets of

5685
04:51:57,190 --> 04:51:54,718
air can nudge it a little bit

5686
04:51:59,270 --> 04:51:57,200
off course so it's firing thrusters

5687
04:52:01,830 --> 04:51:59,280
during this descent from the back shell

5688
04:52:03,830 --> 04:52:01,840

to the shut to uh

5689

04:52:06,390 --> 04:52:03,840

to direct its uh it's

5690

04:52:09,110 --> 04:52:06,400

its trajectory through this descent so

5691

04:52:11,350 --> 04:52:09,120

far everything is on

5692

04:52:23,750 --> 04:52:11,360

and target meters per second

5693

04:52:28,310 --> 04:52:26,390

we are coming up on this

5694

04:52:29,670 --> 04:52:28,320

we are starting to tighten up and fly

5695

04:52:32,150 --> 04:52:29,680

right maneuver

5696

04:52:34,230 --> 04:52:32,160

where the fist will jettison the entry

5697

04:52:36,550 --> 04:52:34,240

balance process in preparation for

5698

04:52:40,788 --> 04:52:36,560

persons deploy and pull over to give the

5699

04:52:45,750 --> 04:52:43,110

straighten up and fly right gonna

5700

04:52:46,948 --> 04:52:45,760

lose a little ballast on the spacecraft

5701
04:52:48,550 --> 04:52:46,958
and we are seeing significant

5702
04:52:50,628 --> 04:52:48,560
deceleration

5703
04:52:53,430 --> 04:52:50,638
in the velocity our current velocity is

5704
04:52:55,190 --> 04:52:53,440
450 meters per second at an altitude of

5705
04:52:56,628 --> 04:52:55,200
about 12 kilometers from the surface of

5706
04:52:59,990 --> 04:52:56,638
mars

5707
04:53:01,830 --> 04:53:00,000
once again parachute has been deployed

5708
04:53:05,110 --> 04:53:01,840
heat shield has separated from the

5709
04:53:09,350 --> 04:53:06,948
working on a radar lock now that's the

5710
04:53:11,190 --> 04:53:09,360
next major milestone

5711
04:53:12,550 --> 04:53:11,200
and the heat shield has been separated

5712
04:53:14,230 --> 04:53:12,560
this allows

5713
04:53:16,390 --> 04:53:14,240

both the radar and the cameras to get

5714

04:53:19,350 --> 04:53:16,400

their first look at the surface current

5715

04:53:21,910 --> 04:53:19,360

velocity is 145 meters dependent and an

5716

04:53:25,270 --> 04:53:21,920

altitude of about 10 km nine and a half

5717

04:53:25,280 --> 04:53:29,350

so just a little under seven miles

5718

04:53:36,550 --> 04:53:31,990

parachute came out and its velocity was

5719

04:53:51,270 --> 04:53:36,560

right around 940 miles per hour

5720

04:53:56,868 --> 04:53:53,750

outstanding next major milestone has

5721

04:53:58,150 --> 04:53:56,878

been achieved it has radar lock it sees

5722

04:53:59,670 --> 04:53:58,160

where it's at

5723

04:54:05,430 --> 04:53:59,680

and it's guiding itself to where it

5724

04:54:10,070 --> 04:54:08,230

[Music]

5725

04:54:12,310 --> 04:54:10,080

and subsequently the timing of the

5726
04:54:14,550 --> 04:54:12,320
landing engines our current velocity is

5727
04:54:18,550 --> 04:54:14,560
about 90 meters per second

5728
04:54:22,708 --> 04:54:18,560
at an altitude of 4.2 kilometers

5729
04:54:23,910 --> 04:54:22,718
outstanding we're right on track

5730
04:54:26,628 --> 04:54:23,920
we have confirmation that the land

5731
04:54:31,270 --> 04:54:26,638
division has produced a valid solution

5732
04:54:34,550 --> 04:54:33,110
so at this point the vehicle has figured

5733
04:54:36,868 --> 04:54:34,560
out the best way to get to where it

5734
04:54:41,910 --> 04:54:36,878
wants to go and has mapped out the

5735
04:54:46,628 --> 04:54:45,190
is 83 meters per second at about 2.6

5736
04:54:48,628 --> 04:54:46,638
kilometers from

5737
04:54:50,550 --> 04:54:48,638
mars we have confirmation that the back

5738
04:54:51,590 --> 04:54:50,560

shell has separated

5739

04:54:53,670 --> 04:54:51,600

all right

5740

04:54:57,190 --> 04:54:53,680

the diver maneuver current velocity is

5741

04:54:58,948 --> 04:54:57,200

about 75 meters per second and announces

5742

04:55:00,310 --> 04:54:58,958

about a kilometer off the surface of

5743

04:55:01,670 --> 04:55:00,320

mars

5744

04:55:05,190 --> 04:55:01,680

here

5745

04:55:07,110 --> 04:55:05,200

right the backpack that jet pack

5746

04:55:09,350 --> 04:55:07,120

is now operation we've begun power

5747

04:55:12,708 --> 04:55:09,360

descent now 30 meters per second

5748

04:55:15,670 --> 04:55:12,718

altitude of about 300 meters 300 meters

5749

04:55:18,550 --> 04:55:15,680

above the surface next major milestone

5750

04:55:20,390 --> 04:55:18,560

rover will separate from the sky crane

5751
04:55:24,070 --> 04:55:20,400
and begin to lower itself down to the

5752
04:55:25,910 --> 04:55:24,080
surface seconds away from touchdown

5753
04:55:27,750 --> 04:55:25,920
accordion which means we are conducting

5754
04:55:28,868 --> 04:55:27,760
the sky crane

5755
04:55:30,230 --> 04:55:28,878
about to conduct the flight plane

5756
04:55:39,270 --> 04:55:30,240
maneuver

5757
04:55:41,590 --> 04:55:39,280
the vehicle is being lowered down to the

5758
04:55:51,350 --> 04:55:41,600
landing site now about 20 meters off the

5759
04:55:51,360 --> 04:56:11,270
waiting for confirmation for touchdown

5760
04:56:16,390 --> 04:56:13,670
here it is folks confirmation that the

5761
04:56:22,150 --> 04:56:16,400
perseverance rover is now on the surface

5762
04:56:26,550 --> 04:56:24,948
is continuing to transmit

5763
04:56:28,570 --> 04:56:26,560

direct

5764

04:56:30,310 --> 04:56:28,580

through microphonic orbiter to

5765

04:56:32,628 --> 04:56:30,320

[Music]

5766

04:56:34,628 --> 04:56:32,638

congratulations to the team here at the

5767

04:56:36,470 --> 04:56:34,638

jet propulsion laboratory

5768

04:56:38,708 --> 04:56:36,480

to all the men and women of nasa who

5769

04:56:41,270 --> 04:56:38,718

have worked so hard on this project and

5770

04:56:46,230 --> 04:56:41,280

of course our international partners as

5771

04:56:53,750 --> 04:56:49,750

vehicles safely on the surface of

5772

04:56:53,760 --> 04:56:58,310

now the real work will begin

5773

04:56:58,320 --> 04:57:01,750

we're gonna wait for the images

5774

04:57:05,510 --> 04:57:03,430

this is so exciting so folks just so you

5775

04:57:07,750 --> 04:57:05,520

know we're gonna we're gonna stay with

5776

04:57:09,280 --> 04:57:07,760

you until we get the first images back

5777

04:57:13,350 --> 04:57:09,290

from mars

5778

04:57:15,190 --> 04:57:13,360

[Applause]

5779

04:57:22,788 --> 04:57:15,200

this is exciting the rover is on the

5780

04:57:26,230 --> 04:57:25,030

ready to begin all of that great work

5781

04:57:31,990 --> 04:57:26,240

from sample

5782

04:57:35,110 --> 04:57:32,000

surface caching those samples

5783

04:57:38,788 --> 04:57:35,120

we just heard the news that perseverance

5784

04:57:41,350 --> 04:57:38,798

is alive on the surface of mars

5785

04:57:43,910 --> 04:57:41,360

confirmation now that the vehicle is

5786

04:57:47,430 --> 04:57:43,920

functioning on mars again when the first

5787

04:57:49,350 --> 04:57:47,440

task was to do that self diagnostic

5788

04:57:51,190 --> 04:57:49,360

that's been complete

5789

04:57:56,150 --> 04:57:51,200

rover now signaling back to mission

5790

04:58:02,150 --> 04:57:58,310

take a few minutes for the uh for the

5791

04:58:03,830 --> 04:58:02,160

various masks and cameras to deploy

5792

04:58:05,430 --> 04:58:03,840

next major step will be to take it from

5793

04:58:12,470 --> 04:58:05,440

the wrap

5794

04:58:16,708 --> 04:58:14,230

once again folks we want to let you know

5795

04:58:18,788 --> 04:58:16,718

you've been watching live coverage we've

5796

04:58:21,350 --> 04:58:18,798

just heard the news that perseverance is

5797

04:58:23,910 --> 04:58:21,360

alive on the surface of mars

5798

04:58:25,510 --> 04:58:23,920

congratulations to the mission

5799

04:58:26,948 --> 04:58:25,520

and

5800

04:58:30,550 --> 04:58:26,958

looks like we have some more news in it

5801
04:58:33,670 --> 04:58:30,560
looks like we're getting the first image

5802
04:58:35,110 --> 04:58:33,680
here take a look at the first image

5803
04:58:37,270 --> 04:58:35,120
here we go folks some of the first

5804
04:58:39,590 --> 04:58:37,280
images now coming back from the surface

5805
04:58:42,230 --> 04:58:39,600
of mars

5806
04:58:43,350 --> 04:58:42,240
the target point on the map when you are

5807
04:58:54,390 --> 04:58:43,360
ready

5808
04:58:58,720 --> 04:58:56,230
waiting now for some of those first

5809
04:59:12,150 --> 04:58:58,730
images from this new vehicle

5810
04:59:22,390 --> 04:59:13,830
it's like we may have lost our signal

5811
04:59:26,390 --> 04:59:23,990
and it does look like we've lost that

5812
04:59:29,190 --> 04:59:26,400
signal but uh from the engineering

5813
04:59:31,110 --> 04:59:29,200

cameras ah here it is the hazard camera

5814

04:59:33,670 --> 04:59:31,120

uh this camera is mainly used to help

5815

04:59:35,830 --> 04:59:33,680

the rover drive safely around mars and

5816

04:59:38,948 --> 04:59:35,840

we will get higher resolution photos

5817

04:59:41,270 --> 04:59:38,958

later in the day

5818

04:59:43,350 --> 04:59:41,280

there you go that's the first image the

5819

04:59:45,990 --> 04:59:43,360

high resolution images will be coming a

5820

04:59:47,750 --> 04:59:46,000

little bit later on today once again

5821

04:59:50,628 --> 04:59:47,760

congratulations to everybody that was

5822

04:59:53,990 --> 04:59:50,638

involved in this monumental task the

5823

04:59:56,470 --> 04:59:54,000

first step of the of the mission is

5824

04:59:58,070 --> 04:59:56,480

complete that is the completion of the

5825

05:00:00,788 --> 04:59:58,080

journey itself the rover has been

5826
05:00:03,750 --> 05:00:00,798
delivered to mars now the real science

5827
05:00:06,390 --> 05:00:03,760
will begin as a robot readies itself to

5828
05:00:09,190 --> 05:00:06,400
begin traversing the martian landscape

5829
05:00:11,270 --> 05:00:09,200
collecting samples taking measurements

5830
05:00:13,030 --> 05:00:11,280
and sending data

5831
05:00:14,868 --> 05:00:13,040
back to earth on behalf of all of us

5832
05:00:17,670 --> 05:00:14,878
here at the great lakes science center

5833
05:00:19,510 --> 05:00:17,680
and our major sponsor the nasa glenn

5834
05:00:21,590 --> 05:00:19,520
research center here in cleveland we

5835
05:00:24,070 --> 05:00:21,600
want to thank you all for joining us and