
SILICON
VALLEY
DAYS HOURS MIN SEC
1656 07:44:43

1
00:00:00,000 --> 00:00:03,350
[Music]

2
00:00:03,360 --> 00:00:06,470
wow

3
00:00:06,480 --> 00:00:17,750
[Music]

4
00:00:17,760 --> 00:00:23,720
wow

5
00:00:36,630 --> 00:00:35,590
[Music]

6
00:00:37,590 --> 00:00:36,640
10

7
00:00:38,549 --> 00:00:37,600
9

8
00:00:39,510 --> 00:00:38,559
8

9
00:00:40,549 --> 00:00:39,520
7

10
00:00:41,510 --> 00:00:40,559
6

11
00:00:42,549 --> 00:00:41,520
5

12
00:00:43,590 --> 00:00:42,559
4

13
00:00:44,549 --> 00:00:43,600

3

14
00:00:46,580 --> 00:00:44,559
two

15
00:01:00,090 --> 00:00:46,590
one

16
00:01:04,229 --> 00:01:03,430
[Music]

17
00:01:06,870 --> 00:01:04,239
hey

18
00:01:09,510 --> 00:01:06,880
what's up everybody welcome welcome

19
00:01:10,550 --> 00:01:09,520
welcome back to nasa in silicon valley

20
00:01:13,510 --> 00:01:10,560
live

21
00:01:15,429 --> 00:01:13,520
if this is your first time with the show

22
00:01:17,670 --> 00:01:15,439
nasa and silicon valley live is a

23
00:01:19,510 --> 00:01:17,680
conversational show out of nasa's ames

24
00:01:21,429 --> 00:01:19,520
research center where we talk about all

25
00:01:24,630 --> 00:01:21,439
the nerdy nasa news you need to know

26
00:01:27,030 --> 00:01:24,640
about i'm your host today abby tabor

27
00:01:29,429 --> 00:01:27,040
and i have with me the extraordinary

28
00:01:32,310 --> 00:01:29,439
danielle carmichael

29
00:01:35,190 --> 00:01:32,320
hi everybody i am your co-host danielle

30
00:01:37,190 --> 00:01:35,200
carmichael and it is great to be back if

31
00:01:41,109 --> 00:01:37,200
you don't know we are simultaneously

32
00:01:43,350 --> 00:01:41,119
live on twitch youtube face facebook and

33
00:01:45,030 --> 00:01:43,360
periscope but if you want to participate

34
00:01:46,870 --> 00:01:45,040
in the chat and ask our guests some

35
00:01:49,469 --> 00:01:46,880
questions there's only one place to do

36
00:01:55,190 --> 00:01:52,389
www.twitch.tv backslash nasa

37
00:01:57,429 --> 00:01:55,200
okay so speaking of nasa news we have a

38
00:01:58,870 --> 00:01:57,439

really big announcement to make today

39
00:02:01,670 --> 00:01:58,880
are you guys ready

40
00:02:04,550 --> 00:02:01,680
are you ready okay so the news is that

41
00:02:06,389 --> 00:02:04,560
we are returning astronauts to the moon

42
00:02:08,389 --> 00:02:06,399
and this is really exciting so we have

43
00:02:09,749 --> 00:02:08,399
for you today two of our experts we're

44
00:02:12,949 --> 00:02:09,759
going to talk about some of the plans

45
00:02:15,350 --> 00:02:12,959
that nasa has for returning to the moon

46
00:02:18,309 --> 00:02:15,360
so let me introduce you to tony and

47
00:02:20,070 --> 00:02:18,319
kimberly so why don't you two

48
00:02:22,309 --> 00:02:20,080
tell the audience who you are a little

49
00:02:24,710 --> 00:02:22,319
bit about yourselves kimberly i'm

50
00:02:26,949 --> 00:02:24,720
kimberly ennico smith i'm a research

51
00:02:29,190 --> 00:02:26,959
astrophysicist here at nasa ames

52
00:02:31,750 --> 00:02:29,200
research center in silicon valley and i

53
00:02:32,949 --> 00:02:31,760
work on space missions fabulous

54
00:02:35,750 --> 00:02:32,959
thanks

55
00:02:37,509 --> 00:02:35,760
i'm tony culprite i'm also here at nasa

56
00:02:39,350 --> 00:02:37,519
ames research center i'm a planetary

57
00:02:41,910 --> 00:02:39,360
scientist and

58
00:02:44,869 --> 00:02:41,920
work on space instruments space missions

59
00:02:46,470 --> 00:02:44,879
uh things like that that right

60
00:02:48,309 --> 00:02:46,480
instruments too so

61
00:02:49,670 --> 00:02:48,319
we do a lot of similar stuff yeah we

62
00:02:51,190 --> 00:02:49,680
spent a lot of time in

63
00:02:53,509 --> 00:02:51,200

clean rooms

64
00:02:55,990 --> 00:02:53,519
five chambers thermal back chambers but

65
00:02:58,470 --> 00:02:56,000
not inside but not inside no no you

66
00:03:00,390 --> 00:02:58,480
don't undergo vacuum tests okay not on

67
00:03:02,949 --> 00:03:00,400
purpose yeah all right cool so let's

68
00:03:04,790 --> 00:03:02,959
start with the basics of returning

69
00:03:07,509 --> 00:03:04,800
humans to the moon when's this going to

70
00:03:11,430 --> 00:03:09,110
the clock i think up in front says

71
00:03:13,190 --> 00:03:11,440
something yeah yeah yes

72
00:03:15,910 --> 00:03:13,200
so quick do the math

73
00:03:18,470 --> 00:03:15,920
in 1656 days

74
00:03:20,229 --> 00:03:18,480
exactly eight hours 46 minutes to be

75
00:03:22,309 --> 00:03:20,239
precise that's right yeah

76
00:03:24,309 --> 00:03:22,319
counting in league years exactly this is

77
00:03:26,390 --> 00:03:24,319
not the doomsday clock

78
00:03:29,589 --> 00:03:26,400
this new clock of hours is counting down

79
00:03:31,110 --> 00:03:29,599
the days until the year 2024 which is

80
00:03:33,670 --> 00:03:31,120
when the

81
00:03:36,229 --> 00:03:33,680
first woman and the next person

82
00:03:37,990 --> 00:03:36,239
perhaps it's a man perhaps a woman will

83
00:03:39,750 --> 00:03:38,000
set foot on the moon right that's right

84
00:03:41,750 --> 00:03:39,760
that's a be a historic

85
00:03:43,910 --> 00:03:41,760
historic moment exactly yeah so let's

86
00:03:46,390 --> 00:03:43,920
talk about this mission let everybody

87
00:03:50,070 --> 00:03:46,400
know what it's called to start us off

88
00:03:51,589 --> 00:03:50,080

well um we're calling it artemis right

89
00:03:53,429 --> 00:03:51,599
so who like

90
00:03:55,509 --> 00:03:53,439
why why artemis like what's so

91
00:03:57,670 --> 00:03:55,519
significant about that name

92
00:03:58,789 --> 00:03:57,680
well she's a if you know your greek

93
00:04:01,830 --> 00:03:58,799
mythology

94
00:04:05,110 --> 00:04:01,840
because we are slowly talking great

95
00:04:06,630 --> 00:04:05,120
mythology um artemis is the twin sister

96
00:04:09,030 --> 00:04:06,640
of apollo

97
00:04:11,429 --> 00:04:09,040
that is and only appropriate yeah you

98
00:04:13,110 --> 00:04:11,439
see the connection

99
00:04:15,270 --> 00:04:13,120
for those who know about the apollo

100
00:04:17,590 --> 00:04:15,280
program that's when we did send the

101
00:04:19,509 --> 00:04:17,600
first humans um to set foot on the moon

102
00:04:21,590 --> 00:04:19,519
right exactly so the next are going

103
00:04:23,510 --> 00:04:21,600
under the artemis mission and i might

104
00:04:26,550 --> 00:04:23,520
add that when i was in fifth grade we

105
00:04:27,909 --> 00:04:26,560
did greek mythology and my goddess was

106
00:04:29,749 --> 00:04:27,919
artemis

107
00:04:31,430 --> 00:04:29,759
i'm pretty sure that played into the

108
00:04:34,150 --> 00:04:31,440
choice of the name for the missions and

109
00:04:35,749 --> 00:04:34,160
she's also a great goddess your destiny

110
00:04:37,110 --> 00:04:35,759
it was right that's right i'm very

111
00:04:40,390 --> 00:04:37,120
excited for this

112
00:04:42,310 --> 00:04:40,400
so why the moon what is so exciting for

113
00:04:44,870 --> 00:04:42,320

a couple of scientists about going back

114
00:04:49,110 --> 00:04:44,880
to the moon oh boy where to start

115
00:04:51,510 --> 00:04:49,120
um the moon is a spectacular place it's

116
00:04:53,350 --> 00:04:51,520
it's our nearest neighbor it's a

117
00:04:55,110 --> 00:04:53,360
treasure trove of science

118
00:04:56,390 --> 00:04:55,120
of exploration it's it's a place where

119
00:04:58,070 --> 00:04:56,400
we can learn about

120
00:05:01,189 --> 00:04:58,080
the history of the earth in our solar

121
00:05:03,749 --> 00:05:01,199
system it's also uh really a launching

122
00:05:04,629 --> 00:05:03,759
pad in terms of our exploration beyond

123
00:05:06,550 --> 00:05:04,639
earth

124
00:05:08,710 --> 00:05:06,560
there's uh resources there we can

125
00:05:11,430 --> 00:05:08,720
utilize to explore

126
00:05:12,390 --> 00:05:11,440
but there's also just the opportunity

127
00:05:15,270 --> 00:05:12,400
to

128
00:05:18,390 --> 00:05:15,280
test our abilities our technologies our

129
00:05:20,150 --> 00:05:18,400
processes for extended missions beyond

130
00:05:22,710 --> 00:05:20,160
the moon to mars for example that's the

131
00:05:24,790 --> 00:05:22,720
ultimate destination beyond

132
00:05:27,830 --> 00:05:24,800
the moon right now but even beyond that

133
00:05:30,230 --> 00:05:27,840
asteroids and other places wow so it's a

134
00:05:33,270 --> 00:05:30,240
it's a huge sandbox if you will to

135
00:05:36,150 --> 00:05:33,280
really learn in and and and demonstrate

136
00:05:38,390 --> 00:05:36,160
what we can do to explore yeah well said

137
00:05:40,230 --> 00:05:38,400
yeah and also um looking at just the

138
00:05:42,950 --> 00:05:40,240

moon itself um

139
00:05:44,870 --> 00:05:42,960
we know a lot about it but

140
00:05:47,990 --> 00:05:44,880
we've not really visited

141
00:05:49,590 --> 00:05:48,000
a lot fraction of the surface or even

142
00:05:50,950 --> 00:05:49,600
the environment of the moon okay so

143
00:05:53,270 --> 00:05:50,960
there's a lot of mysteries still yet to

144
00:05:55,350 --> 00:05:53,280
be uncovered yeah just on the surface

145
00:05:57,430 --> 00:05:55,360
and underneath the surface okay

146
00:05:58,390 --> 00:05:57,440
and yeah absolutely and

147
00:05:59,909 --> 00:05:58,400
you know we

148
00:06:02,309 --> 00:05:59,919
mentioned the apollo program we've been

149
00:06:04,390 --> 00:06:02,319
there robotically we have a robot

150
00:06:06,309 --> 00:06:04,400
spacecraft orbiting it now

151
00:06:08,309 --> 00:06:06,319
but we've only barely scratched the

152
00:06:10,230 --> 00:06:08,319
surface in terms of the amount of area

153
00:06:12,390 --> 00:06:10,240
we've explored on the moon there's so

154
00:06:14,870 --> 00:06:12,400
much more to learn imagine awesome all

155
00:06:15,909 --> 00:06:14,880
right so you were anxiously anticipating

156
00:06:17,870 --> 00:06:15,919
very

157
00:06:20,790 --> 00:06:17,880
uh

158
00:06:22,390 --> 00:06:20,800
656 days from now

159
00:06:24,309 --> 00:06:22,400
you'll be watching that clock closely i

160
00:06:26,150 --> 00:06:24,319
guess all right so tell us a little bit

161
00:06:28,390 --> 00:06:26,160
more specifically where are we sending

162
00:06:30,550 --> 00:06:28,400
astronauts in 2024

163
00:06:32,550 --> 00:06:30,560

well this is what i was gonna actually

164
00:06:34,070 --> 00:06:32,560
just say was what's really really

165
00:06:35,830 --> 00:06:34,080
exciting is where we are going where

166
00:06:37,590 --> 00:06:35,840
we've never been before and that's to

167
00:06:40,070 --> 00:06:37,600
one of the poles of the moon and very

168
00:06:41,909 --> 00:06:40,080
specifically the south pole of the moon

169
00:06:43,029 --> 00:06:41,919
which is my favorite pole it is if you

170
00:06:45,029 --> 00:06:43,039
have to have a favorite pole that's my

171
00:06:47,270 --> 00:06:45,039
favorite i hope it doesn't yeah

172
00:06:48,950 --> 00:06:47,280
exactly and and it's it's an incredible

173
00:06:51,510 --> 00:06:48,960
place um

174
00:06:52,390 --> 00:06:51,520
and we can talk about that as we go but

175
00:06:58,950 --> 00:06:52,400
uh

176
00:07:00,830 --> 00:06:58,960
moving shadows extreme temperatures it's

177
00:07:02,469 --> 00:07:00,840
it's unlike anywhere we've ever

178
00:07:03,670 --> 00:07:02,479
visited so cool in the solar system and

179
00:07:05,749 --> 00:07:03,680
we are going to talk all about that

180
00:07:08,230 --> 00:07:05,759
later i'm excited for that um but you

181
00:07:09,990 --> 00:07:08,240
mentioned resources now there's water

182
00:07:13,430 --> 00:07:10,000
there isn't there

183
00:07:17,670 --> 00:07:15,990
true statement okay so why why is that

184
00:07:19,749 --> 00:07:17,680
so important obviously i know humans

185
00:07:21,749 --> 00:07:19,759
need water to survive but but what do

186
00:07:24,150 --> 00:07:21,759
you see us using that for

187
00:07:25,110 --> 00:07:24,160
lots of other purposes right yeah

188
00:07:27,909 --> 00:07:25,120

um

189
00:07:30,390 --> 00:07:27,919
well water is is key in the

190
00:07:32,550 --> 00:07:30,400
water is so important for two different

191
00:07:34,230 --> 00:07:32,560
reasons one it's it's incredibly

192
00:07:36,070 --> 00:07:34,240
scientifically interesting

193
00:07:37,749 --> 00:07:36,080
and understanding the water that we now

194
00:07:39,670 --> 00:07:37,759
know exists on the moon is really

195
00:07:40,950 --> 00:07:39,680
important to understanding the processes

196
00:07:42,629 --> 00:07:40,960
that have acted on the moon and the

197
00:07:45,189 --> 00:07:42,639
earth over the last several billion

198
00:07:47,029 --> 00:07:45,199
years oh wow yeah and i like to think of

199
00:07:48,869 --> 00:07:47,039
the ice at the poles as almost like ice

200
00:07:50,629 --> 00:07:48,879
cores here on earth if we can examine

201
00:07:53,270 --> 00:07:50,639
that water ice we can actually look back

202
00:07:56,469 --> 00:07:53,280
into the history of the solar system

203
00:07:58,950 --> 00:07:56,479
uh but also just as important it is a

204
00:07:59,909 --> 00:07:58,960
valuable resource and

205
00:08:02,710 --> 00:07:59,919
as

206
00:08:05,909 --> 00:08:02,720
we probably all know water contains

207
00:08:06,790 --> 00:08:05,919
two hydrogen and an oxygen right atom

208
00:08:10,869 --> 00:08:06,800
and

209
00:08:13,110 --> 00:08:10,879
ingredients that go into rocket fuel

210
00:08:15,189 --> 00:08:13,120
and rather than spending lots of rocket

211
00:08:17,430 --> 00:08:15,199
fuel to bring rocket fuel into space

212
00:08:18,950 --> 00:08:17,440
which is what we do now right it'd be

213
00:08:21,749 --> 00:08:18,960

great if we could actually find a

214
00:08:23,990 --> 00:08:21,759
resource and produce rocket fuel outside

215
00:08:25,670 --> 00:08:24,000
the gravity well of earth that would not

216
00:08:27,350 --> 00:08:25,680
only make things more affordable it's

217
00:08:29,909 --> 00:08:27,360
actually could be enabling of new

218
00:08:32,310 --> 00:08:29,919
architectures uh for exploring mars and

219
00:08:35,350 --> 00:08:32,320
beyond yeah well and then

220
00:08:37,269 --> 00:08:35,360
the oxygen in itself is what we breathe

221
00:08:39,670 --> 00:08:37,279
yeah of course yeah and

222
00:08:41,430 --> 00:08:39,680
the the techniques and the approach to

223
00:08:43,029 --> 00:08:41,440
how we excavate

224
00:08:46,150 --> 00:08:43,039
water on the moon

225
00:08:49,190 --> 00:08:46,160
is applicable to even doing it on mars

226
00:08:51,750 --> 00:08:49,200
so if you're looking for long-term

227
00:08:54,550 --> 00:08:51,760
human presence on other worlds and truly

228
00:08:56,389 --> 00:08:54,560
becoming interplanetary species

229
00:08:58,070 --> 00:08:56,399
we can be creating the oxygen that we

230
00:09:00,630 --> 00:08:58,080
breathe and the habitats in which we're

231
00:09:02,070 --> 00:09:00,640
living in off world wow

232
00:09:04,389 --> 00:09:02,080
that's so amazing that we're actually

233
00:09:08,550 --> 00:09:04,399
talking about that you know as a future

234
00:09:12,790 --> 00:09:10,150
i actually have a couple of shout outs

235
00:09:14,710 --> 00:09:12,800
so super snail says that the earth and

236
00:09:17,190 --> 00:09:14,720
moon shirt is awesome

237
00:09:19,190 --> 00:09:17,200
and also uh

238
00:09:20,350 --> 00:09:19,200

said it's great to see tony and kimberly

239
00:09:24,630 --> 00:09:20,360
again

240
00:09:27,829 --> 00:09:24,640
[Music]

241
00:09:30,550 --> 00:09:27,839
outstanding wow all right

242
00:09:31,590 --> 00:09:30,560
do you have any questions yet danielle

243
00:09:32,790 --> 00:09:31,600
i do

244
00:09:33,670 --> 00:09:32,800
um so

245
00:09:34,389 --> 00:09:33,680
moon

246
00:09:36,550 --> 00:09:34,399
uh

247
00:09:39,350 --> 00:09:36,560
momestrites wants to know like what's

248
00:09:40,470 --> 00:09:39,360
the end long-term goal of the artemis

249
00:09:42,790 --> 00:09:40,480
mission

250
00:09:44,310 --> 00:09:42,800
because we've been talking it up but

251
00:09:45,190 --> 00:09:44,320
yeah that's a great question you wanna

252
00:09:47,750 --> 00:09:45,200
yeah

253
00:09:50,630 --> 00:09:47,760
so artemis is a term to describe in a

254
00:09:52,630 --> 00:09:50,640
whole series of missions to the lunar

255
00:09:55,030 --> 00:09:52,640
surface and using

256
00:09:56,790 --> 00:09:55,040
an orbital uh tugboat interplanetary

257
00:09:58,630 --> 00:09:56,800
spaceship called the gateway it's a big

258
00:10:00,870 --> 00:09:58,640
architecture but in the long term

259
00:10:03,030 --> 00:10:00,880
opening it up with many partners along

260
00:10:07,030 --> 00:10:03,040
on this journey we have a sustainable

261
00:10:08,790 --> 00:10:07,040
presence on the moon where we are

262
00:10:10,870 --> 00:10:08,800
you know providing the infrastructure

263
00:10:13,430 --> 00:10:10,880

for us to stay there

264
00:10:15,670 --> 00:10:13,440
for building materials to creating the

265
00:10:17,590 --> 00:10:15,680
rocket fuel to

266
00:10:20,470 --> 00:10:17,600
exploring areas that we've never been

267
00:10:22,230 --> 00:10:20,480
before the you know actually going into

268
00:10:24,310 --> 00:10:22,240
the the depths of craters that we

269
00:10:26,550 --> 00:10:24,320
haven't explored yet um and pieces of

270
00:10:28,470 --> 00:10:26,560
moon we don't see so that long-term

271
00:10:30,069 --> 00:10:28,480
presence on the moon but while we're

272
00:10:32,230 --> 00:10:30,079
using those techniques those become

273
00:10:34,710 --> 00:10:32,240
applicable for to that next step you

274
00:10:35,590 --> 00:10:34,720
know we're living off earth on another

275
00:10:37,910 --> 00:10:35,600
world

276
00:10:39,590 --> 00:10:37,920
in a harsh environment and learning to

277
00:10:41,590 --> 00:10:39,600
deal with those challenges and solving

278
00:10:43,910 --> 00:10:41,600
those challenges and once we've got that

279
00:10:45,590 --> 00:10:43,920
under our belt and we've understood our

280
00:10:46,949 --> 00:10:45,600
neighborhood background

281
00:10:49,269 --> 00:10:46,959
our backyard

282
00:10:51,590 --> 00:10:49,279
we can take that easily to mars yeah so

283
00:10:52,949 --> 00:10:51,600
cool i see lots of other great questions

284
00:10:55,190 --> 00:10:52,959
but i know that some of them are going

285
00:10:57,910 --> 00:10:55,200
to answer yes in the next few minutes so

286
00:10:59,990 --> 00:10:57,920
let's keep going i just want to touch

287
00:11:02,069 --> 00:11:00,000
back on the water a little bit how much

288
00:11:04,069 --> 00:11:02,079

are we actually talking about i know you

289
00:11:08,150 --> 00:11:04,079
two have worked together on a past

290
00:11:10,069 --> 00:11:08,160
mission that found some water

291
00:11:11,509 --> 00:11:10,079
tell us a little bit about that launched

292
00:11:13,400 --> 00:11:11,519
ten years ago

293
00:11:17,509 --> 00:11:13,410
yesterday yesterday

294
00:11:19,990 --> 00:11:17,519
[Music]

295
00:11:22,230 --> 00:11:20,000
and and the mission we launched with lro

296
00:11:24,389 --> 00:11:22,240
the lunar reconnaissance orbiter is

297
00:11:25,829 --> 00:11:24,399
still in orbit around the moon

298
00:11:27,670 --> 00:11:25,839
still collecting data

299
00:11:29,190 --> 00:11:27,680
and making fantastic maps of the lunar

300
00:11:31,350 --> 00:11:29,200
surface which actually was really

301
00:11:32,310 --> 00:11:31,360
enabling of artemis it's what's making

302
00:11:34,710 --> 00:11:32,320
it

303
00:11:37,030 --> 00:11:34,720
able to go forward awesome yeah yeah so

304
00:11:39,269 --> 00:11:37,040
the uh yeah kim and i were both part of

305
00:11:41,110 --> 00:11:39,279
the l cross mission which was

306
00:11:43,269 --> 00:11:41,120
a mission that crashed a spent upper

307
00:11:44,790 --> 00:11:43,279
stage of a rocket into a permanently

308
00:11:47,670 --> 00:11:44,800
shadowed crater at the south pole of the

309
00:11:50,470 --> 00:11:47,680
moon and the purpose was to understand

310
00:11:52,629 --> 00:11:50,480
the nature of hydrogen we had measured

311
00:11:54,470 --> 00:11:52,639
there prior with a different mission

312
00:11:56,470 --> 00:11:54,480
and saw an excess of this hydrogen we

313
00:11:58,470 --> 00:11:56,480

didn't know if the hydrogen was water or

314
00:12:00,710 --> 00:11:58,480
just soil protons which is hydrogen

315
00:12:03,350 --> 00:12:00,720
atoms it's trapped in the soil or what

316
00:12:05,350 --> 00:12:03,360
and and our job was to actually uh

317
00:12:07,430 --> 00:12:05,360
understand it to see if it could

318
00:12:08,949 --> 00:12:07,440
potentially be a resource so it was a

319
00:12:10,870 --> 00:12:08,959
very targeted

320
00:12:12,310 --> 00:12:10,880
mission see what that water

321
00:12:14,790 --> 00:12:12,320
i actually want to back up a little bit

322
00:12:16,550 --> 00:12:14,800
like what is a permanently shattered

323
00:12:18,629 --> 00:12:16,560
crater

324
00:12:21,110 --> 00:12:18,639
good question

325
00:12:23,910 --> 00:12:21,120
doesn't everybody know

326
00:12:26,069 --> 00:12:23,920
well with the tilt of the moon and the

327
00:12:27,829 --> 00:12:26,079
illumination of the sun

328
00:12:30,150 --> 00:12:27,839
there are places at both poles of the

329
00:12:32,150 --> 00:12:30,160
moon where the extreme topography the

330
00:12:33,990 --> 00:12:32,160
rims of the craters of the moon

331
00:12:37,030 --> 00:12:34,000
the sun didn't does not get above those

332
00:12:38,790 --> 00:12:37,040
rims so the basins of those craters are

333
00:12:40,790 --> 00:12:38,800
in permanent shadow and they have been

334
00:12:42,470 --> 00:12:40,800
in permanent shadow for you know four

335
00:12:44,710 --> 00:12:42,480
billion years wow

336
00:12:46,870 --> 00:12:44,720
and being in the shadows if you remember

337
00:12:48,949 --> 00:12:46,880
if you're out in a hot day

338
00:12:50,790 --> 00:12:48,959

and you go underneath the shadow of a

339
00:12:52,949 --> 00:12:50,800
tree you'll notice that things get a

340
00:12:54,710 --> 00:12:52,959
little cooler well and if you're in a

341
00:12:56,710 --> 00:12:54,720
permanently shadowed place on the moon

342
00:12:59,430 --> 00:12:56,720
things get really really cold

343
00:13:01,430 --> 00:12:59,440
so um these these what was interesting

344
00:13:03,269 --> 00:13:01,440
about tony was mentioning this orbiter

345
00:13:05,350 --> 00:13:03,279
mission that had found hydrogen it was

346
00:13:07,110 --> 00:13:05,360
concentrated at the poles

347
00:13:08,629 --> 00:13:07,120
and there was a correlation with the

348
00:13:09,829 --> 00:13:08,639
permanently shadowed craters so there

349
00:13:11,509 --> 00:13:09,839
was this

350
00:13:13,509 --> 00:13:11,519
connection between lots amounts of

351
00:13:16,310 --> 00:13:13,519
hydrogen in very cold places that had

352
00:13:17,670 --> 00:13:16,320
never seen sunlight okay and actually it

353
00:13:19,990 --> 00:13:17,680
was

354
00:13:22,870 --> 00:13:20,000
theorized that these craters would have

355
00:13:25,750 --> 00:13:22,880
cold bottoms and could hold water as

356
00:13:27,350 --> 00:13:25,760
early as 1961. oh really first we're

357
00:13:30,230 --> 00:13:27,360
really understanding the topography even

358
00:13:33,269 --> 00:13:30,240
before the apollo program really got

359
00:13:35,269 --> 00:13:33,279
you know off and running wow and so uh

360
00:13:37,509 --> 00:13:35,279
it wasn't though until

361
00:13:39,350 --> 00:13:37,519
10 years ago uh we

362
00:13:41,910 --> 00:13:39,360
verified the form of that hydrogen in

363
00:13:44,150 --> 00:13:41,920

one of these cold craters as water ice

364
00:13:46,550 --> 00:13:44,160
so let's review now that was l cross

365
00:13:48,470 --> 00:13:46,560
which is the loon

366
00:13:50,470 --> 00:13:48,480
crater observation and sensing

367
00:13:52,629 --> 00:13:50,480
satellites yes okay all right okay and

368
00:13:54,310 --> 00:13:52,639
we we hit a crater at the lunar south

369
00:13:56,310 --> 00:13:54,320
pole and that's why south poles is

370
00:13:58,069 --> 00:13:56,320
tony's favorite right right okay and

371
00:14:00,949 --> 00:13:58,079
where the future astronauts will be

372
00:14:03,509 --> 00:14:00,959
landing exactly okay and do you remember

373
00:14:05,590 --> 00:14:03,519
how much water l cross saw yeah so it

374
00:14:09,189 --> 00:14:05,600
was just like a point measurement right

375
00:14:12,069 --> 00:14:09,199
it made a crater about 35 meters across

376
00:14:14,230 --> 00:14:12,079
um half a football field or so across

377
00:14:17,269 --> 00:14:14,240
and so yeah pretty big hole but you'll

378
00:14:21,910 --> 00:14:17,279
never see it in the dark yeah

379
00:14:25,910 --> 00:14:23,430
but uh

380
00:14:27,829 --> 00:14:25,920
it brought ejecta up into sunlight so we

381
00:14:29,990 --> 00:14:27,839
could examine it and it

382
00:14:31,750 --> 00:14:30,000
threw the soil up the soil

383
00:14:33,350 --> 00:14:31,760
out of shadow until eventually reaches

384
00:14:35,910 --> 00:14:33,360
sunlight and what's i always like to

385
00:14:37,430 --> 00:14:35,920
think about that that's that soil hadn't

386
00:14:39,030 --> 00:14:37,440
seen sunlight in billions of years

387
00:14:41,350 --> 00:14:39,040
that's crazy yeah

388
00:14:43,670 --> 00:14:41,360

and in just the dirt we threw up into

389
00:14:47,590 --> 00:14:43,680
the cloud or into the sun sorry we saw

390
00:14:48,550 --> 00:14:47,600
about 152 gallons of water okay okay and

391
00:14:49,430 --> 00:14:48,560
if you

392
00:14:51,189 --> 00:14:49,440
uh

393
00:14:52,710 --> 00:14:51,199
take all if you take that measurement

394
00:14:55,189 --> 00:14:52,720
and all the other measurements we have

395
00:14:57,910 --> 00:14:55,199
of hydrogen at the poles

396
00:15:00,069 --> 00:14:57,920
and uh make some assumptions about how

397
00:15:03,509 --> 00:15:00,079
it's distributed with depth we're

398
00:15:05,110 --> 00:15:03,519
talking 10 million uh potentially up to

399
00:15:08,230 --> 00:15:05,120
100 million

400
00:15:10,790 --> 00:15:08,240
tons metric tons oh wow of water ice a

401
00:15:12,629 --> 00:15:10,800
lot of water ice it's a lot i think so

402
00:15:14,470 --> 00:15:12,639
it would make a big ice cube i think kim

403
00:15:17,030 --> 00:15:14,480
and i were talking beforehand and it was

404
00:15:20,150 --> 00:15:17,040
about a hundred and thirty 130 meters

405
00:15:23,990 --> 00:15:20,160
130 meter on the side ice cube

406
00:15:25,509 --> 00:15:24,000
stadium for the football stadium

407
00:15:28,310 --> 00:15:25,519
yeah

408
00:15:30,790 --> 00:15:28,320
important science there

409
00:15:32,629 --> 00:15:30,800
the moon's ice cube and yeah to be clear

410
00:15:35,189 --> 00:15:32,639
none of this is flowing liquid water

411
00:15:38,150 --> 00:15:35,199
this is crystals

412
00:15:38,870 --> 00:15:38,160
the temperatures are about minus 200 and

413
00:15:42,550 --> 00:15:38,880

uh

414
00:15:44,470 --> 00:15:42,560
to minus 240 or so below zero centigrade

415
00:15:46,310 --> 00:15:44,480
okay and this was the first time we ever

416
00:15:48,470 --> 00:15:46,320
sampled the bottom of a permanently

417
00:15:50,470 --> 00:15:48,480
shadowed crater i mean since then this

418
00:15:53,030 --> 00:15:50,480
has experiment has been repeated okay

419
00:15:54,389 --> 00:15:53,040
and um in not only did we find water but

420
00:15:56,710 --> 00:15:54,399
there was a bunch of other things that

421
00:15:59,110 --> 00:15:56,720
were excavated as well

422
00:16:02,150 --> 00:15:59,120
gold mercury argon

423
00:16:04,310 --> 00:16:02,160
carbon monoxide and so it's opening up

424
00:16:06,150 --> 00:16:04,320
these questions um when we're going to

425
00:16:08,230 --> 00:16:06,160
have humans and robots going to the

426
00:16:10,949 --> 00:16:08,240
poles of the south pole the moon we're

427
00:16:13,509 --> 00:16:10,959
gonna get the boots on ground the wheels

428
00:16:15,269 --> 00:16:13,519
on ground and really understand what's

429
00:16:17,110 --> 00:16:15,279
there because we've never been there

430
00:16:19,189 --> 00:16:17,120
before we just have this you know simple

431
00:16:20,550 --> 00:16:19,199
impactor experiment that opened more

432
00:16:22,150 --> 00:16:20,560
questions than it answered but it

433
00:16:23,670 --> 00:16:22,160
answered one particular one right the

434
00:16:26,710 --> 00:16:23,680
hydrogen is definitely in the form of

435
00:16:29,269 --> 00:16:26,720
water ice and enough such that there is

436
00:16:31,430 --> 00:16:29,279
the resources to enable the exploration

437
00:16:33,269 --> 00:16:31,440
exciting yeah another good way to put in

438
00:16:35,749 --> 00:16:33,279

perspective is el cross about five

439
00:16:37,749 --> 00:16:35,759
percent by weight water water in the

440
00:16:39,670 --> 00:16:37,759
regolith in the dirt regulators lunar

441
00:16:42,069 --> 00:16:39,680
dirt for comparison that's about what

442
00:16:43,749 --> 00:16:42,079
you have in the sahara yeah oh okay

443
00:16:45,430 --> 00:16:43,759
let's give you some the wettest places

444
00:16:51,030 --> 00:16:45,440
on the moon is as wet as the driest

445
00:16:54,150 --> 00:16:52,470
that's the engineering challenge ahead

446
00:16:55,749 --> 00:16:54,160
that we will solve to excavate it

447
00:16:57,990 --> 00:16:55,759
because we know it's there and we can

448
00:17:00,069 --> 00:16:58,000
extract um you know water has been

449
00:17:02,389 --> 00:17:00,079
extracted from very dry places okay yes

450
00:17:05,829 --> 00:17:02,399
yeah that can be done it can and we will

451
00:17:07,909 --> 00:17:05,839
do it how exciting awesome so

452
00:17:09,270 --> 00:17:07,919
i want to know then what's next okay we

453
00:17:10,789 --> 00:17:09,280
know that people will we'll get there

454
00:17:13,189 --> 00:17:10,799
we're going to send people there let's

455
00:17:15,510 --> 00:17:13,199
talk about how so what's the rocket

456
00:17:18,390 --> 00:17:15,520
that's going to take people on the f on

457
00:17:19,590 --> 00:17:18,400
the artemis missions to the moon who

458
00:17:22,390 --> 00:17:19,600
wants to take that

459
00:17:24,150 --> 00:17:22,400
space launch system that's it the sls

460
00:17:27,350 --> 00:17:24,160
yeah we have an animation i think of it

461
00:17:30,830 --> 00:17:27,360
too that's right yes um there it is

462
00:17:33,110 --> 00:17:30,840
largest rocket ever built

463
00:17:35,590 --> 00:17:33,120

um and uh

464
00:17:38,150 --> 00:17:35,600
it's to bring humans not only to the

465
00:17:39,990 --> 00:17:38,160
moon but actually beyond too they're uh

466
00:17:41,750 --> 00:17:40,000
it carries them

467
00:17:44,150 --> 00:17:41,760
in a capsule that's on the very tip of

468
00:17:46,630 --> 00:17:44,160
that that just went past the frame

469
00:17:48,230 --> 00:17:46,640
called the orion capsule very small

470
00:17:50,150 --> 00:17:48,240
capsule up there

471
00:17:52,150 --> 00:17:50,160
but uh that capsule

472
00:17:54,470 --> 00:17:52,160
uh you'll see a little yeah yeah we have

473
00:17:56,710 --> 00:17:54,480
an animation for that after the sls

474
00:17:59,029 --> 00:17:56,720
it is very powerful in fact it um is

475
00:18:02,230 --> 00:17:59,039
designed to take an incredible amount of

476
00:18:04,950 --> 00:18:02,240
material to you know deep space okay um

477
00:18:07,110 --> 00:18:04,960
so it is servicing moon and mars and

478
00:18:09,190 --> 00:18:07,120
also elsewhere i mean it also has

479
00:18:10,630 --> 00:18:09,200
amazing commercial spin-offs as well

480
00:18:12,630 --> 00:18:10,640
because you can actually put up a

481
00:18:15,029 --> 00:18:12,640
replacements of say the gps satellites

482
00:18:16,950 --> 00:18:15,039
in a single sls launch rocket it has a

483
00:18:19,750 --> 00:18:16,960
huge capacity

484
00:18:21,510 --> 00:18:19,760
and it could transform the way we do

485
00:18:24,470 --> 00:18:21,520
other types of things in the agency so

486
00:18:26,870 --> 00:18:24,480
it's one of many uses of a large rocket

487
00:18:29,110 --> 00:18:26,880
that's been you know uh can be utilized

488
00:18:31,350 --> 00:18:29,120

how awesome it's pretty awesome

489
00:18:33,029 --> 00:18:31,360
danielle you jump in whenever you have

490
00:18:34,870 --> 00:18:33,039
to with a question but otherwise we're

491
00:18:37,830 --> 00:18:34,880
going to keep talking about uh so that

492
00:18:41,190 --> 00:18:37,840
was sls the rocket and tony pointed out

493
00:18:42,710 --> 00:18:41,200
the capsule yeah so let's see the orion

494
00:18:45,669 --> 00:18:42,720
capsule animation and tell us a little

495
00:18:46,789 --> 00:18:45,679
bit about so ryan is uh either it is a

496
00:18:48,789 --> 00:18:46,799
the capsule that will bring the

497
00:18:51,190 --> 00:18:48,799
astronauts wherever they're going to go

498
00:18:54,630 --> 00:18:51,200
and and this indeed can go not just to

499
00:18:57,190 --> 00:18:54,640
the moon but also beyond the mars

500
00:18:59,830 --> 00:18:57,200
and after you know a lot of analysis and

501
00:19:00,710 --> 00:18:59,840
study uh it was eventually concluded

502
00:19:03,270 --> 00:19:00,720
that

503
00:19:05,830 --> 00:19:03,280
the the apollo shape the blunt nose

504
00:19:09,430 --> 00:19:05,840
reentry system that paul used is still

505
00:19:11,270 --> 00:19:09,440
the best way to go forward um however

506
00:19:13,029 --> 00:19:11,280
look how roomy if you're looking into

507
00:19:16,230 --> 00:19:13,039
this video how look how roomy this one

508
00:19:17,590 --> 00:19:16,240
is compared to the apollo um

509
00:19:18,950 --> 00:19:17,600
have anyone seen the apollo 11

510
00:19:20,789 --> 00:19:18,960
documentary that's out in the movie

511
00:19:22,230 --> 00:19:20,799
theaters you get a feel for how tight

512
00:19:23,350 --> 00:19:22,240
apollo is

513
00:19:26,230 --> 00:19:23,360

four

514
00:19:28,390 --> 00:19:26,240
and uh it's a lot more powerful in every

515
00:19:32,470 --> 00:19:28,400
single way from uh

516
00:19:35,270 --> 00:19:32,480
information systems guidance uh payload

517
00:19:37,029 --> 00:19:35,280
everything and and and it's meant to be

518
00:19:39,350 --> 00:19:37,039
able to carry humans

519
00:19:42,549 --> 00:19:39,360
longer distance way beyond the moon okay

520
00:19:44,390 --> 00:19:42,559
so uh it is really is apollo on steroids

521
00:19:47,750 --> 00:19:44,400
i like to say yeah that's awesome i love

522
00:19:51,029 --> 00:19:47,760
that it's kept some of the same designs

523
00:19:52,549 --> 00:19:51,039
way to go apollo engineers

524
00:19:53,669 --> 00:19:52,559
they solved some pretty tough challenges

525
00:19:55,830 --> 00:19:53,679
and they made it happen so because we

526
00:19:58,630 --> 00:19:55,840
know we can do this so they actually

527
00:20:00,390 --> 00:19:58,640
have a question from digital don donger

528
00:20:02,870 --> 00:20:00,400
who wants to know um are you using

529
00:20:05,029 --> 00:20:02,880
specifically any apollo era research or

530
00:20:07,830 --> 00:20:05,039
tech on the quest to return back to the

531
00:20:09,190 --> 00:20:07,840
moon well the the shape that i just

532
00:20:10,950 --> 00:20:09,200
mentioned is

533
00:20:13,110 --> 00:20:10,960
really was derived originally through

534
00:20:15,510 --> 00:20:13,120
the apollo program the shape of that

535
00:20:17,510 --> 00:20:15,520
capsule is very critical

536
00:20:19,669 --> 00:20:17,520
to enabling the reentry

537
00:20:22,789 --> 00:20:19,679
and and and this capsule is meant to

538
00:20:25,510 --> 00:20:22,799

reenter parachute and splash down in in

539
00:20:27,510 --> 00:20:25,520
the ocean just like the apollo program

540
00:20:30,390 --> 00:20:27,520
did and speaking of re-entry here at

541
00:20:32,070 --> 00:20:30,400
nasa ames um we developed and tested the

542
00:20:34,710 --> 00:20:32,080
thermal reentry

543
00:20:36,390 --> 00:20:34,720
materials and for the apollo program is

544
00:20:37,669 --> 00:20:36,400
a chemist a chemical compound called

545
00:20:39,029 --> 00:20:37,679
avcoat

546
00:20:40,470 --> 00:20:39,039
and their heat shield the heat shield

547
00:20:42,310 --> 00:20:40,480
for the heat so that re-entry through

548
00:20:44,230 --> 00:20:42,320
the atmosphere and they would ablate so

549
00:20:45,750 --> 00:20:44,240
they would absorb the heat and then you

550
00:20:47,350 --> 00:20:45,760
know protect the capsules with

551
00:20:49,830 --> 00:20:47,360
successfully returned

552
00:20:53,110 --> 00:20:49,840
um to preparation for orion

553
00:20:55,190 --> 00:20:53,120
engineers uh looked at avcote and

554
00:20:57,430 --> 00:20:55,200
modified the chemistry of that and did a

555
00:20:59,590 --> 00:20:57,440
lot of the testing so there's a direct

556
00:21:02,470 --> 00:20:59,600
connection even with the materials that

557
00:21:04,390 --> 00:21:02,480
were used during apollo pretty cool

558
00:21:07,110 --> 00:21:04,400
and just modified for the the the shape

559
00:21:09,669 --> 00:21:07,120
of the capsule but for to and to support

560
00:21:11,350 --> 00:21:09,679
um even re-entry from um further

561
00:21:12,789 --> 00:21:11,360
destinations say you're coming back from

562
00:21:14,830 --> 00:21:12,799
an asteroid or say you're coming back

563
00:21:17,510 --> 00:21:14,840

from mars orbit or something like

564
00:21:21,270 --> 00:21:17,520
that speeds can be hard

565
00:21:23,190 --> 00:21:21,280
so um it's smarter yeah all around i

566
00:21:25,110 --> 00:21:23,200
love that excellent and i i love these

567
00:21:27,909 --> 00:21:25,120
apollo connections but then on the flip

568
00:21:30,630 --> 00:21:27,919
side how is the artemis program

569
00:21:33,029 --> 00:21:30,640
different from apollo

570
00:21:34,870 --> 00:21:33,039
you want to take this no adventure one

571
00:21:38,149 --> 00:21:34,880
an element that we um that i mentioned

572
00:21:39,510 --> 00:21:38,159
briefly sorry about the spoilers is they

573
00:21:41,430 --> 00:21:39,520
is actually

574
00:21:43,350 --> 00:21:41,440
one of the cooler parts of the artemis

575
00:21:46,390 --> 00:21:43,360
program it's this this object called the

576
00:21:47,270 --> 00:21:46,400
gateway okay and the gateway

577
00:21:49,990 --> 00:21:47,280
is

578
00:21:51,270 --> 00:21:50,000
a for our first interplanetary spaceship

579
00:21:53,190 --> 00:21:51,280
and this is something that nasa has

580
00:21:55,830 --> 00:21:53,200
never really built before

581
00:21:57,590 --> 00:21:55,840
and that's why in a sense is exciting i

582
00:22:01,110 --> 00:21:57,600
mean this um

583
00:22:03,590 --> 00:22:01,120
space module sometimes we call spaceship

584
00:22:05,990 --> 00:22:03,600
will be in lunar orbit

585
00:22:08,549 --> 00:22:06,000
and it will provide the way to access

586
00:22:09,750 --> 00:22:08,559
all different parts of the moon

587
00:22:12,630 --> 00:22:09,760
and

588
00:22:13,830 --> 00:22:12,640

it's also going to be crude but not 100

589
00:22:16,070 --> 00:22:13,840
of the time

590
00:22:18,230 --> 00:22:16,080
so it has to be autonomous it'll have a

591
00:22:20,950 --> 00:22:18,240
lot of autonomy in it and it

592
00:22:22,950 --> 00:22:20,960
also would be providing a way to be a

593
00:22:25,590 --> 00:22:22,960
space laboratory so we can put

594
00:22:28,549 --> 00:22:25,600
experiments on board for understanding

595
00:22:31,029 --> 00:22:28,559
biology outside our magnetosphere

596
00:22:33,190 --> 00:22:31,039
it also can dock with all the different

597
00:22:35,270 --> 00:22:33,200
commercial and

598
00:22:37,750 --> 00:22:35,280
international partners it has an open

599
00:22:39,270 --> 00:22:37,760
architecture the port designs are going

600
00:22:41,110 --> 00:22:39,280
to be available for anyone who wants to

601
00:22:43,909 --> 00:22:41,120
build things that connect to it the

602
00:22:45,350 --> 00:22:43,919
apollo will connect apollo orion will

603
00:22:49,669 --> 00:22:45,360
connect to it

604
00:22:51,270 --> 00:22:49,679
service modules but it has the ability

605
00:22:53,350 --> 00:22:51,280
to change its orbit

606
00:22:55,430 --> 00:22:53,360
so it can also become this

607
00:22:57,430 --> 00:22:55,440
interplanetary tugboat because it can

608
00:22:59,590 --> 00:22:57,440
move things around and first enable

609
00:23:01,909 --> 00:22:59,600
travel i mean it's the transportation

610
00:23:03,750 --> 00:23:01,919
backbone for mars exploration oh wow

611
00:23:05,909 --> 00:23:03,760
okay and again this is gateway this is

612
00:23:08,470 --> 00:23:05,919
gateway it's called gateway and we're

613
00:23:09,350 --> 00:23:08,480

going to um this space

614
00:23:11,430 --> 00:23:09,360
ship

615
00:23:13,029 --> 00:23:11,440
um we'll oh and we have an animation

616
00:23:14,870 --> 00:23:13,039
showing of this orbit in which the

617
00:23:16,310 --> 00:23:14,880
gateway for the lunar exploration will

618
00:23:19,029 --> 00:23:16,320
have

619
00:23:21,190 --> 00:23:19,039
really is enabling and this is the part

620
00:23:23,110 --> 00:23:21,200
of the artemis program that's very this

621
00:23:24,870 --> 00:23:23,120
is apollo didn't do this apollo took

622
00:23:25,750 --> 00:23:24,880
everything with them and everything came

623
00:23:28,390 --> 00:23:25,760
back

624
00:23:31,990 --> 00:23:28,400
so um artemis is is building up a

625
00:23:34,230 --> 00:23:32,000
sustainable presence and this uh gateway

626
00:23:36,070 --> 00:23:34,240
is key to that yeah and one one one part

627
00:23:37,590 --> 00:23:36,080
that i'd like to emphasize that kim

628
00:23:40,549 --> 00:23:37,600
mentioned that is really different from

629
00:23:43,590 --> 00:23:40,559
apollo is this open architecture aspect

630
00:23:46,310 --> 00:23:43,600
is nasa's not doing this alone and it's

631
00:23:48,230 --> 00:23:46,320
and it's even beyond what we did for the

632
00:23:49,830 --> 00:23:48,240
international space station where we had

633
00:23:50,789 --> 00:23:49,840
lots of other government agencies

634
00:23:53,110 --> 00:23:50,799
involved

635
00:23:54,630 --> 00:23:53,120
there is a huge involvement from the

636
00:23:57,029 --> 00:23:54,640
private commercial

637
00:23:58,549 --> 00:23:57,039
sector that's involved in all parts of

638
00:24:01,190 --> 00:23:58,559

this so

639
00:24:03,190 --> 00:24:01,200
this artemis program and lunar

640
00:24:05,669 --> 00:24:03,200
exploration going forward

641
00:24:07,350 --> 00:24:05,679
has got a commercial element a private

642
00:24:09,350 --> 00:24:07,360
sector commercial element a lot of

643
00:24:11,830 --> 00:24:09,360
people call it new space

644
00:24:14,710 --> 00:24:11,840
part of it that didn't exist during

645
00:24:18,390 --> 00:24:14,720
apollo so we are really i think

646
00:24:21,830 --> 00:24:18,400
at the you know at the dawn of a new age

647
00:24:22,870 --> 00:24:21,840
of exploration uh and in space beyond

648
00:24:24,230 --> 00:24:22,880
leo

649
00:24:26,149 --> 00:24:24,240
and the low earth orbit lower

650
00:24:28,310 --> 00:24:26,159
authorities are going farther out yeah

651
00:24:29,830 --> 00:24:28,320
and also as tony was saying about this

652
00:24:30,950 --> 00:24:29,840
it's sort of a space economy have a lot

653
00:24:31,909 --> 00:24:30,960
of partners

654
00:24:34,070 --> 00:24:31,919
um

655
00:24:35,590 --> 00:24:34,080
we're on the verge of you know if you

656
00:24:37,190 --> 00:24:35,600
were to go back in time and ask the

657
00:24:38,950 --> 00:24:37,200
wright brothers to look at modern day

658
00:24:40,630 --> 00:24:38,960
today and see that oh i can fly from

659
00:24:42,630 --> 00:24:40,640
place to place on this planet using an

660
00:24:44,390 --> 00:24:42,640
airplane that they did this

661
00:24:46,310 --> 00:24:44,400
or go back and talk to alexander graham

662
00:24:47,830 --> 00:24:46,320
bell invented the telephone and we all

663
00:24:49,110 --> 00:24:47,840

look at using our smartphones to

664
00:24:51,909 --> 00:24:49,120
communicate

665
00:24:54,549 --> 00:24:51,919
we have no clue what the future of space

666
00:24:56,870 --> 00:24:54,559
will be when we involve the commercial

667
00:24:58,789 --> 00:24:56,880
aspect of it wow it is really an

668
00:25:01,510 --> 00:24:58,799
unbounded future

669
00:25:03,669 --> 00:25:01,520
that's monumental yeah i'm excited this

670
00:25:06,310 --> 00:25:03,679
is why it's different than a place right

671
00:25:08,149 --> 00:25:06,320
if you ask a simple question you get a

672
00:25:09,430 --> 00:25:08,159
pretty profound answer yeah from the

673
00:25:10,710 --> 00:25:09,440
science point of view tony and everybody

674
00:25:12,149 --> 00:25:10,720
else excited about the science but it

675
00:25:13,669 --> 00:25:12,159
has a lot of it's much bigger than once

676
00:25:15,029 --> 00:25:13,679
and then it will enable a lot of that

677
00:25:16,630 --> 00:25:15,039
science and we'll be able to do things

678
00:25:19,909 --> 00:25:16,640
we could never have done before before

679
00:25:21,909 --> 00:25:19,919
yeah yeah wow okay how long how long 1

680
00:25:24,390 --> 00:25:21,919
656 days

681
00:25:27,510 --> 00:25:24,400
well let's move into our rapid fire

682
00:25:28,950 --> 00:25:27,520
section so i'm not going to give any

683
00:25:30,470 --> 00:25:28,960
usernames but i'm just going to go ahead

684
00:25:36,310 --> 00:25:30,480
and just

685
00:25:40,870 --> 00:25:37,909
what is the long-term effect of the

686
00:25:42,470 --> 00:25:40,880
human body on the moon

687
00:25:44,070 --> 00:25:42,480
long-term effect of the human body on

688
00:25:45,269 --> 00:25:44,080

the moon or the environment on the human

689
00:25:48,070 --> 00:25:45,279
body

690
00:25:50,070 --> 00:25:48,080
oh i understand the environment so it

691
00:25:51,510 --> 00:25:50,080
goes both ways so and that's actually a

692
00:25:53,590 --> 00:25:51,520
really interesting question from the

693
00:25:55,029 --> 00:25:53,600
science standpoint in particular these

694
00:25:57,350 --> 00:25:55,039
cold areas

695
00:25:59,909 --> 00:25:57,360
these uh in the craters are what are

696
00:26:02,470 --> 00:25:59,919
called cold traps they're so cold any

697
00:26:04,789 --> 00:26:02,480
molecules that get in there freeze out

698
00:26:07,110 --> 00:26:04,799
so every time we've gone to the moon

699
00:26:08,950 --> 00:26:07,120
and the astronauts vented

700
00:26:11,190 --> 00:26:08,960
water or vented other things or

701
00:26:13,269 --> 00:26:11,200
outgassed outcasts mean stuff

702
00:26:15,669 --> 00:26:13,279
subliming off of equipment

703
00:26:17,430 --> 00:26:15,679
those molecules some of those molecules

704
00:26:19,669 --> 00:26:17,440
very likely found their ways to the

705
00:26:21,590 --> 00:26:19,679
poles of the moon and froze out

706
00:26:23,750 --> 00:26:21,600
and they're there now forever until a

707
00:26:27,269 --> 00:26:23,760
meteorite might release them

708
00:26:29,909 --> 00:26:27,279
if we go once we go exploring

709
00:26:31,909 --> 00:26:29,919
not just we nasa but the world

710
00:26:33,750 --> 00:26:31,919
uh we'll bring more and more of these

711
00:26:35,269 --> 00:26:33,760
volatiles and other materials to the

712
00:26:37,350 --> 00:26:35,279
moon that will be trapped in the cold

713
00:26:39,510 --> 00:26:37,360

trap so if you're trying to understand

714
00:26:42,630 --> 00:26:39,520
some pristine environments to understand

715
00:26:44,230 --> 00:26:42,640
the history the last three billion years

716
00:26:45,990 --> 00:26:44,240
you you want to do it in a way that you

717
00:26:47,590 --> 00:26:46,000
can understand what contaminants you've

718
00:26:50,830 --> 00:26:47,600
brought there yourself

719
00:26:53,669 --> 00:26:50,840
and we actually we nasa ames

720
00:26:55,669 --> 00:26:53,679
uh flew a mission not long

721
00:26:57,830 --> 00:26:55,679
long ago called lady the lunar

722
00:26:59,510 --> 00:26:57,840
atmospheric dust environment explorer

723
00:27:01,750 --> 00:26:59,520
and its principal purpose was actually

724
00:27:02,950 --> 00:27:01,760
to understand the lunar atmosphere the

725
00:27:04,870 --> 00:27:02,960
exosphere

726
00:27:06,390 --> 00:27:04,880
in its pristine state with the

727
00:27:08,149 --> 00:27:06,400
anticipation that more and more

728
00:27:10,630 --> 00:27:08,159
countries and commercial peoples would

729
00:27:12,230 --> 00:27:10,640
be going to the moon and so we wanted to

730
00:27:14,630 --> 00:27:12,240
get kind of a background before we

731
00:27:16,950 --> 00:27:14,640
started impacting right yeah yeah the

732
00:27:18,230 --> 00:27:16,960
baseline before we touched it right

733
00:27:19,269 --> 00:27:18,240
right interesting

734
00:27:21,110 --> 00:27:19,279
from a

735
00:27:23,029 --> 00:27:21,120
impact on the human body radiation is

736
00:27:25,110 --> 00:27:23,039
one of the principal concerns

737
00:27:27,029 --> 00:27:25,120
and there's a lot of very clever

738
00:27:28,950 --> 00:27:27,039

solutions being looked at

739
00:27:30,710 --> 00:27:28,960
uh in terms of shielding and and we talk

740
00:27:32,710 --> 00:27:30,720
about water as a resource

741
00:27:34,389 --> 00:27:32,720
there's lots of other resources

742
00:27:35,909 --> 00:27:34,399
at the moon and

743
00:27:36,870 --> 00:27:35,919
especially at the poles including

744
00:27:39,029 --> 00:27:36,880
lighting

745
00:27:41,110 --> 00:27:39,039
for the solar power but also the dirt

746
00:27:44,630 --> 00:27:41,120
itself the regolith can be an excellent

747
00:27:46,070 --> 00:27:44,640
insulator oh okay so uh as kimberly was

748
00:27:47,990 --> 00:27:46,080
talking about living off the land

749
00:27:49,430 --> 00:27:48,000
involves using whatever you have

750
00:27:51,510 --> 00:27:49,440
whatever you have to

751
00:27:53,830 --> 00:27:51,520
make your situation better

752
00:27:55,590 --> 00:27:53,840
yeah excellent okay next question how

753
00:27:56,549 --> 00:27:55,600
many launches until the first base is

754
00:27:58,549 --> 00:27:56,559
set up

755
00:28:09,750 --> 00:27:58,559
um

756
00:28:12,389 --> 00:28:09,760
that's the 2024 milestone and then

757
00:28:14,149 --> 00:28:12,399
there's a later milestone in 2028 where

758
00:28:17,510 --> 00:28:14,159
we have a more established presence

759
00:28:19,190 --> 00:28:17,520
there um prior to um the first humans

760
00:28:21,350 --> 00:28:19,200
going on on the moon we'll have the

761
00:28:23,029 --> 00:28:21,360
first launch of artemis artemis one

762
00:28:25,110 --> 00:28:23,039
which will not have humans on board but

763
00:28:27,029 --> 00:28:25,120

we'll carry uh space satellites and

764
00:28:27,909 --> 00:28:27,039
robots and the like some will go to deep

765
00:28:30,230 --> 00:28:27,919
space

766
00:28:31,909 --> 00:28:30,240
a second artemis mission will actually

767
00:28:34,310 --> 00:28:31,919
go to the moon or in orbit around the

768
00:28:36,710 --> 00:28:34,320
moon it's on that third launch of the

769
00:28:39,269 --> 00:28:36,720
sls um that we would be carrying the

770
00:28:41,990 --> 00:28:39,279
humans and that's the 2024 milestone so

771
00:28:44,470 --> 00:28:42,000
we should see a sequence of incremental

772
00:28:46,630 --> 00:28:44,480
steps towards proving out the new launch

773
00:28:49,110 --> 00:28:46,640
system and the new capabilities in

774
00:28:51,269 --> 00:28:49,120
addition the first module of the gateway

775
00:28:53,350 --> 00:28:51,279
which is the solar propulsion element

776
00:28:55,750 --> 00:28:53,360
which is a really cool technology

777
00:28:58,310 --> 00:28:55,760
advancement we've never seen an engine

778
00:28:59,430 --> 00:28:58,320
like this on a spaceship before that's

779
00:29:01,029 --> 00:28:59,440
going to be launched by a commercial

780
00:29:01,990 --> 00:29:01,039
rocket and so that's you know we're

781
00:29:04,310 --> 00:29:02,000
going to be having all these different

782
00:29:06,230 --> 00:29:04,320
types of infrastructures getting us all

783
00:29:07,430 --> 00:29:06,240
part of the artemis program and that's

784
00:29:08,870 --> 00:29:07,440
it this

785
00:29:09,990 --> 00:29:08,880
really brings an important point it's

786
00:29:11,669 --> 00:29:10,000
not a

787
00:29:14,470 --> 00:29:11,679
it will be done by this date it will be

788
00:29:16,950 --> 00:29:14,480

a continuous development and build up of

789
00:29:17,990 --> 00:29:16,960
in a to reach an eventual sustained

790
00:29:21,110 --> 00:29:18,000
presence

791
00:29:22,870 --> 00:29:21,120
and so the exact date when it becomes a

792
00:29:30,230 --> 00:29:22,880
base or whatever you want to call it

793
00:29:33,750 --> 00:29:31,669
when that exactly happens it's kind of

794
00:29:36,630 --> 00:29:33,760
ill-defined because it's really building

795
00:29:39,590 --> 00:29:36,640
up of capabilities over time

796
00:29:40,950 --> 00:29:39,600
there will be longer and longer stays as

797
00:29:43,669 --> 00:29:40,960
they move through these various phases

798
00:29:46,070 --> 00:29:43,679
as kimberly stayed as mentioned

799
00:29:48,389 --> 00:29:46,080
um for the astronauts on the surface so

800
00:29:49,909 --> 00:29:48,399
okay so we have time for two short

801
00:29:52,149 --> 00:29:49,919
questions i hope

802
00:29:53,430 --> 00:29:52,159
so how long is this gateway going to be

803
00:29:55,350 --> 00:29:53,440
inhabited by astronauts when it's

804
00:29:56,630 --> 00:29:55,360
finished that's a good question i mean

805
00:29:59,669 --> 00:29:56,640
it's variable

806
00:30:01,510 --> 00:29:59,679
um the the key point is that that

807
00:30:02,950 --> 00:30:01,520
spaceship needs to be able to operate

808
00:30:04,870 --> 00:30:02,960
without humans because there will be

809
00:30:07,830 --> 00:30:04,880
prairies in which humans aren't on board

810
00:30:08,950 --> 00:30:07,840
um so don't know the exact fraction of

811
00:30:10,310 --> 00:30:08,960
it but it's going to have two different

812
00:30:12,230 --> 00:30:10,320
modes when the humans are on board and

813
00:30:13,350 --> 00:30:12,240

when they're not yeah i've heard numbers

814
00:30:15,669 --> 00:30:13,360
uh

815
00:30:17,350 --> 00:30:15,679
up to 30 days at a time okay so they're

816
00:30:19,029 --> 00:30:17,360
not going to be up there for a year like

817
00:30:20,470 --> 00:30:19,039
we do on space station they'll go up

818
00:30:22,389 --> 00:30:20,480
there

819
00:30:23,830 --> 00:30:22,399
and then come back in in a month or two

820
00:30:25,669 --> 00:30:23,840
um and so that's to

821
00:30:27,590 --> 00:30:25,679
kimberly's point is a lot of the time

822
00:30:30,950 --> 00:30:27,600
you'll have to have robots running the

823
00:30:32,950 --> 00:30:30,960
house okay so last question

824
00:30:36,630 --> 00:30:32,960
uh someone wants to know like what's the

825
00:30:38,950 --> 00:30:36,640
coolest thing about gateway

826
00:30:43,190 --> 00:30:38,960
i've heard you vote for this power well

827
00:30:47,510 --> 00:30:45,510
i call it the tugboat this is electric

828
00:30:49,510 --> 00:30:47,520
propulsion system

829
00:30:51,909 --> 00:30:49,520
and it's at a power level we've never

830
00:30:53,669 --> 00:30:51,919
built before really and what's neat is

831
00:30:55,269 --> 00:30:53,679
it allows it to change its orbit around

832
00:30:57,350 --> 00:30:55,279
the moon so it is really a spaceship

833
00:31:00,070 --> 00:30:57,360
it's not just going in an orbit it can

834
00:31:01,909 --> 00:31:00,080
actually steer this entire space station

835
00:31:03,029 --> 00:31:01,919
size kind of thing

836
00:31:05,669 --> 00:31:03,039
in space

837
00:31:07,269 --> 00:31:05,679
and and then ultimately it's it's the

838
00:31:10,070 --> 00:31:07,279

kind of engine that's going to be used

839
00:31:12,789 --> 00:31:10,080
to bring us to mars and asteroids into

840
00:31:13,909 --> 00:31:12,799
wherever else so okay and now it's a

841
00:31:15,029 --> 00:31:13,919
slow

842
00:31:16,789 --> 00:31:15,039
ride

843
00:31:18,789 --> 00:31:16,799
slow acceleration

844
00:31:20,230 --> 00:31:18,799
acceleration it

845
00:31:21,830 --> 00:31:20,240
is slow but

846
00:31:23,669 --> 00:31:21,840
it's powerful it allows you to get to

847
00:31:25,350 --> 00:31:23,679
the kinds of velocities with a lot of

848
00:31:27,110 --> 00:31:25,360
mass that you need to to do

849
00:31:30,230 --> 00:31:27,120
interplanetary travel okay and i like

850
00:31:31,830 --> 00:31:30,240
the open architecture i don't think

851
00:31:34,789 --> 00:31:31,840
all the engineers have figured out all

852
00:31:36,149 --> 00:31:34,799
the wonderful uses of gateway

853
00:31:37,669 --> 00:31:36,159
because it's a little i mean it's going

854
00:31:39,430 --> 00:31:37,679
to be designed for a certain purpose and

855
00:31:41,669 --> 00:31:39,440
will achieve those purposes

856
00:31:43,669 --> 00:31:41,679
allowing the docking of multiple

857
00:31:44,870 --> 00:31:43,679
vehicles from different countries and

858
00:31:46,549 --> 00:31:44,880
companies

859
00:31:48,310 --> 00:31:46,559
allowing astronauts to stay for periods

860
00:31:49,990 --> 00:31:48,320
of days months

861
00:31:51,909 --> 00:31:50,000
being in constant communication with the

862
00:31:53,750 --> 00:31:51,919
earth being in communication with the

863
00:31:55,269 --> 00:31:53,760

surface of the moon being able to

864
00:31:57,669 --> 00:31:55,279
deliver things to the surface of the

865
00:31:59,430 --> 00:31:57,679
moon at different latitudes i mean it's

866
00:32:01,669 --> 00:31:59,440
very versatile

867
00:32:03,990 --> 00:32:01,679
but it could also be a test bed for

868
00:32:06,630 --> 00:32:04,000
testing um other types of vehicles that

869
00:32:08,389 --> 00:32:06,640
actually might be made in space someday

870
00:32:11,430 --> 00:32:08,399
and then launch them from there i mean

871
00:32:14,630 --> 00:32:11,440
it has a lifetime that will keep giving

872
00:32:17,590 --> 00:32:14,640
we're only thinking about how to uh you

873
00:32:19,430 --> 00:32:17,600
know do that first step is the the first

874
00:32:21,750 --> 00:32:19,440
step in the return to the moon the

875
00:32:23,350 --> 00:32:21,760
forward to the moon part um

876
00:32:26,389 --> 00:32:23,360
but there's a lot more than it can give

877
00:32:27,990 --> 00:32:26,399
okay yeah you you both keep mentioning

878
00:32:29,830 --> 00:32:28,000
learning at the moon and then we'll go

879
00:32:31,590 --> 00:32:29,840
on and you know sls could take us to

880
00:32:34,149 --> 00:32:31,600
mars let's talk really quickly a little

881
00:32:36,070 --> 00:32:34,159
bit about mars so what are some favorite

882
00:32:38,310 --> 00:32:36,080
fun facts about mars that you can share

883
00:32:40,630 --> 00:32:38,320
with us okay well we have a picture of

884
00:32:41,590 --> 00:32:40,640
mars to cue people and what mars looks

885
00:32:43,430 --> 00:32:41,600
like

886
00:32:44,710 --> 00:32:43,440
it's um it's the fourth planet around

887
00:32:47,430 --> 00:32:44,720
the sun

888
00:32:49,669 --> 00:32:47,440

it's a red planet the red is um

889
00:32:52,710 --> 00:32:49,679
primarily due to iron in the um the

890
00:32:53,909 --> 00:32:52,720
rocks on the surface of mars

891
00:32:56,230 --> 00:32:53,919
mars

892
00:32:58,310 --> 00:32:56,240
has polar caps it has you know it's one

893
00:33:00,870 --> 00:32:58,320
of the other bodies besides the earth

894
00:33:03,190 --> 00:33:00,880
that has um frozen

895
00:33:05,350 --> 00:33:03,200
um ice it's water ice and carbon dioxide

896
00:33:07,669 --> 00:33:05,360
ice at the polar poles

897
00:33:09,430 --> 00:33:07,679
um it's uh

898
00:33:10,789 --> 00:33:09,440
it has an atmosphere

899
00:33:12,549 --> 00:33:10,799
but its atmosphere is different than

900
00:33:13,990 --> 00:33:12,559
earth's um it's probably made of carbon

901
00:33:15,590 --> 00:33:14,000
dioxide whereas our atmosphere is

902
00:33:17,590 --> 00:33:15,600
nitrogen based

903
00:33:19,430 --> 00:33:17,600
um and uh

904
00:33:21,110 --> 00:33:19,440
if you it's the for where the earth is

905
00:33:22,830 --> 00:33:21,120
the third planet and mars is the fourth

906
00:33:26,070 --> 00:33:22,840
planet we're both circling around the

907
00:33:27,909 --> 00:33:26,080
sun um if you imagine racetrack cars on

908
00:33:30,630 --> 00:33:27,919
a racetrack um

909
00:33:33,110 --> 00:33:30,640
so at our closest distance between the

910
00:33:35,669 --> 00:33:33,120
earth and mars is about 34 million miles

911
00:33:37,909 --> 00:33:35,679
and that happens every 26 months

912
00:33:40,389 --> 00:33:37,919
otherwise we're doing laps um right

913
00:33:42,070 --> 00:33:40,399

there we're moving at different speeds

914
00:33:44,389 --> 00:33:42,080
around the racetrack yeah so this is a

915
00:33:47,029 --> 00:33:44,399
reason why when we launch our you know

916
00:33:49,590 --> 00:33:47,039
robots to mars and in the future the

917
00:33:52,870 --> 00:33:49,600
human the crude missions to mars uh

918
00:33:56,230 --> 00:33:52,880
taking advantage of the close that 26

919
00:33:57,909 --> 00:33:56,240
month period of uh of alignment okay

920
00:34:00,230 --> 00:33:57,919
help shorten the distance because even

921
00:34:02,470 --> 00:34:00,240
at that shortest distance the trip is

922
00:34:03,909 --> 00:34:02,480
still about six to nine months yeah okay

923
00:34:06,789 --> 00:34:03,919
still a long way do you want to take

924
00:34:09,030 --> 00:34:06,799
advantage of that yeah excellent all

925
00:34:11,109 --> 00:34:09,040
right and the moon you say is going to

926
00:34:13,750 --> 00:34:11,119
help us practice for what we might do

927
00:34:16,310 --> 00:34:13,760
when we reach everything

928
00:34:18,790 --> 00:34:16,320
so much of what we will be doing on

929
00:34:21,190 --> 00:34:18,800
the moon is extensible

930
00:34:22,950 --> 00:34:21,200
to to mars and and everything from the

931
00:34:25,030 --> 00:34:22,960
kinds of tools we use

932
00:34:26,790 --> 00:34:25,040
to the procedures and processes and the

933
00:34:29,430 --> 00:34:26,800
technologies

934
00:34:32,069 --> 00:34:29,440
learning to uh really work

935
00:34:34,149 --> 00:34:32,079
and and build and construct and uh

936
00:34:36,710 --> 00:34:34,159
different environments that the moon and

937
00:34:39,190 --> 00:34:36,720
mars everything from gravity to low

938
00:34:41,589 --> 00:34:39,200

little to no atmosphere etc

939
00:34:44,389 --> 00:34:41,599
um is really important and and bring it

940
00:34:45,829 --> 00:34:44,399
back to water as kimberly mentioned mars

941
00:34:47,589 --> 00:34:45,839
has got water we've known that for a

942
00:34:49,190 --> 00:34:47,599
while it's got a lot more water than the

943
00:34:50,069 --> 00:34:49,200
moon

944
00:34:51,750 --> 00:34:50,079
and

945
00:34:54,069 --> 00:34:51,760
but that is the one of the key

946
00:34:56,310 --> 00:34:54,079
connections between the moon and mars is

947
00:34:59,349 --> 00:34:56,320
as we learn to utilize

948
00:35:00,790 --> 00:34:59,359
water on the moon everything from

949
00:35:03,190 --> 00:35:00,800
locating it

950
00:35:03,910 --> 00:35:03,200
excavating it processing it all that can

951
00:35:06,150 --> 00:35:03,920
be

952
00:35:08,390 --> 00:35:06,160
carried over and applied to how we do

953
00:35:09,510 --> 00:35:08,400
that on mars which we want to do we want

954
00:35:15,829 --> 00:35:09,520
to

955
00:35:18,390 --> 00:35:15,839
eventually we will of course the first

956
00:35:20,710 --> 00:35:18,400
few times but you can't it's too far

957
00:35:22,870 --> 00:35:20,720
away yeah all right let's just say i was

958
00:35:25,270 --> 00:35:22,880
mentioning earlier is once we're really

959
00:35:27,430 --> 00:35:25,280
comfortable with this whole approach on

960
00:35:29,510 --> 00:35:27,440
excavating the water and processing the

961
00:35:32,390 --> 00:35:29,520
water and transferring it to rocket fuel

962
00:35:34,390 --> 00:35:32,400
or oxygen or other utilizations because

963
00:35:37,190 --> 00:35:34,400

water can be used in many different ways

964
00:35:38,550 --> 00:35:37,200
um that's a totally applicable system

965
00:35:40,470 --> 00:35:38,560
for mars

966
00:35:42,550 --> 00:35:40,480
um you know directly

967
00:35:44,630 --> 00:35:42,560
and also though most likely there will

968
00:35:46,230 --> 00:35:44,640
be wonderful spin-offs that can be used

969
00:35:47,750 --> 00:35:46,240
back here on earth oh yeah i mean

970
00:35:50,790 --> 00:35:47,760
anything to do with things in a closed

971
00:35:52,150 --> 00:35:50,800
system is uh usually very power

972
00:35:54,069 --> 00:35:52,160
conscious you're not using a lot of

973
00:35:56,069 --> 00:35:54,079
energy

974
00:35:57,829 --> 00:35:56,079
recycling a lot of things

975
00:36:00,150 --> 00:35:57,839
will have you know very improved

976
00:36:01,750 --> 00:36:00,160
technology uh who knows what we're doing

977
00:36:03,910 --> 00:36:01,760
actually i have a question from the chat

978
00:36:05,430 --> 00:36:03,920
looks like king goldboygamer wants to

979
00:36:08,950 --> 00:36:05,440
know like when are we actually going to

980
00:36:15,349 --> 00:36:09,670
i

981
00:36:18,550 --> 00:36:15,359
the top of my head

982
00:36:21,030 --> 00:36:18,560
but it would be uh

983
00:36:22,470 --> 00:36:21,040
you know a couple decades

984
00:36:24,069 --> 00:36:22,480
it's still a little ways out so first

985
00:36:25,510 --> 00:36:24,079
we're going to the moon we're going to

986
00:36:27,910 --> 00:36:25,520
practice we're going to learn to

987
00:36:28,950 --> 00:36:27,920
excavate water and process it and all

988
00:36:31,670 --> 00:36:28,960

that

989
00:36:33,349 --> 00:36:31,680
and also um the most fragile part in

990
00:36:35,270 --> 00:36:33,359
this whole uh

991
00:36:38,230 --> 00:36:35,280
amazing exploration adventure is the

992
00:36:40,150 --> 00:36:38,240
human body wow the human body outside

993
00:36:43,190 --> 00:36:40,160
the magnetosphere you know we've had

994
00:36:45,030 --> 00:36:43,200
only um 24 individuals who've been

995
00:36:47,430 --> 00:36:45,040
outside that we are now going to have

996
00:36:49,510 --> 00:36:47,440
the ability to really study biology and

997
00:36:51,829 --> 00:36:49,520
how the human body is reacting this this

998
00:36:53,270 --> 00:36:51,839
will make us totally prepared for that

999
00:36:54,870 --> 00:36:53,280
long trip to mars

1000
00:36:57,270 --> 00:36:54,880
because a mission to the moon is three

1001
00:36:59,990 --> 00:36:57,280
days and you're on the surface for weeks

1002
00:37:00,950 --> 00:37:00,000
months come back but you're you're close

1003
00:37:02,390 --> 00:37:00,960
to home

1004
00:37:04,790 --> 00:37:02,400
when you go to mars we're talking a

1005
00:37:06,310 --> 00:37:04,800
two-year and how is the bot you know

1006
00:37:07,349 --> 00:37:06,320
it's like a six months nine months to

1007
00:37:08,470 --> 00:37:07,359
get there you're gonna be there for a

1008
00:37:10,950 --> 00:37:08,480
few months you come back you want to

1009
00:37:12,310 --> 00:37:10,960
take advantage of the sure close by so

1010
00:37:14,150 --> 00:37:12,320
you're going to be on a sort of a

1011
00:37:16,790 --> 00:37:14,160
two-year time scale right

1012
00:37:18,870 --> 00:37:16,800
just think about it um you know

1013
00:37:20,950 --> 00:37:18,880

what we're going to learn to protect the

1014
00:37:23,670 --> 00:37:20,960
human body

1015
00:37:24,950 --> 00:37:23,680
and uh you know enable

1016
00:37:27,109 --> 00:37:24,960
all the infrastructure to allow the

1017
00:37:29,349 --> 00:37:27,119
human body to survive and thrive we'll

1018
00:37:30,069 --> 00:37:29,359
solve that by being on the moon yeah

1019
00:37:33,030 --> 00:37:30,079
cool

1020
00:37:34,950 --> 00:37:33,040
so tell me quickly so so i want to know

1021
00:37:37,030 --> 00:37:34,960
what's coming up then you know

1022
00:37:39,829 --> 00:37:37,040
what's what's in the news coming up next

1023
00:37:41,430 --> 00:37:39,839
in the process so um human landers will

1024
00:37:44,390 --> 00:37:41,440
be built

1025
00:37:46,470 --> 00:37:44,400
uh by by nasa by partners what do you

1026
00:37:47,829 --> 00:37:46,480
guys know about that

1027
00:37:49,109 --> 00:37:47,839
there was a i believe there was a bid

1028
00:37:52,310 --> 00:37:49,119
that went out on the street for

1029
00:37:54,310 --> 00:37:52,320
companies to um provide lunar landers um

1030
00:37:56,069 --> 00:37:54,320
and docking with the gateway or not

1031
00:37:58,870 --> 00:37:56,079
because it's an open it's a different

1032
00:38:01,510 --> 00:37:58,880
type of architecture you can use um but

1033
00:38:03,270 --> 00:38:01,520
yeah okay yeah there's and there's a

1034
00:38:05,589 --> 00:38:03,280
variety of landers being

1035
00:38:06,630 --> 00:38:05,599
pursued with the commercial sector with

1036
00:38:09,670 --> 00:38:06,640
nasa

1037
00:38:13,349 --> 00:38:09,680
and there are smaller landers

1038
00:38:16,550 --> 00:38:13,359

being built now and we've actually

1039
00:38:18,790 --> 00:38:16,560
nasa just recently selected three to be

1040
00:38:20,630 --> 00:38:18,800
carrying nasa payloads

1041
00:38:22,390 --> 00:38:20,640
so instruments and things before the

1042
00:38:24,710 --> 00:38:22,400
people go exactly it would land next

1043
00:38:27,829 --> 00:38:24,720
year next year already as soon as next

1044
00:38:31,430 --> 00:38:27,839
year and and a couple in in the summer

1045
00:38:32,550 --> 00:38:31,440
21 july 2021 and what's really neat is

1046
00:38:35,589 --> 00:38:32,560
these these

1047
00:38:37,349 --> 00:38:35,599
um companies are providing nasa a

1048
00:38:39,510 --> 00:38:37,359
delivery surface

1049
00:38:41,270 --> 00:38:39,520
it's not nasa telling them we need a

1050
00:38:43,510 --> 00:38:41,280
lander like this

1051
00:38:45,190 --> 00:38:43,520
no it's they're building a lander that

1052
00:38:48,069 --> 00:38:45,200
provides a service

1053
00:38:50,310 --> 00:38:48,079
and selling that service then okay nasa

1054
00:38:52,710 --> 00:38:50,320
here's an example of one on the screen

1055
00:38:55,030 --> 00:38:52,720
of one of these small commercial landers

1056
00:38:57,829 --> 00:38:55,040
and these companies then have plans to

1057
00:38:59,589 --> 00:38:57,839
increase the the scale and the scope of

1058
00:39:02,470 --> 00:38:59,599
these landers so they can carry more and

1059
00:39:03,349 --> 00:39:02,480
more to the surface so the human landers

1060
00:39:05,430 --> 00:39:03,359
are

1061
00:39:07,510 --> 00:39:05,440
like as kimberly said right now being

1062
00:39:08,230 --> 00:39:07,520
discussed with commercial companies as

1063
00:39:12,470 --> 00:39:08,240

to

1064
00:39:13,829 --> 00:39:12,480
build them going forward

1065
00:39:16,950 --> 00:39:13,839
it's really kind of exciting because

1066
00:39:19,349 --> 00:39:16,960
again this is a totally new paradigm we

1067
00:39:22,150 --> 00:39:19,359
nasa's always built

1068
00:39:24,310 --> 00:39:22,160
the landers with commercial companies

1069
00:39:27,030 --> 00:39:24,320
but they've done it in a

1070
00:39:29,349 --> 00:39:27,040
very much requirement driven process

1071
00:39:30,150 --> 00:39:29,359
we need you to build this for us okay

1072
00:39:31,910 --> 00:39:30,160
all right

1073
00:39:34,470 --> 00:39:31,920
this is very different this is i'm

1074
00:39:36,069 --> 00:39:34,480
buying my airline ticket to fly across

1075
00:39:37,750 --> 00:39:36,079
the country i'm not telling you how to

1076
00:39:39,990 --> 00:39:37,760
build your airplane right right you get

1077
00:39:42,630 --> 00:39:40,000
me there somehow exactly and that's what

1078
00:39:43,990 --> 00:39:42,640
we're doing now and um other um other

1079
00:39:46,710 --> 00:39:44,000
folks can

1080
00:39:48,670 --> 00:39:46,720
pay to use the services so it's um it

1081
00:39:51,430 --> 00:39:48,680
opens up the

1082
00:39:52,310 --> 00:39:51,440
accessibility of the moon

1083
00:39:59,430 --> 00:39:52,320
okay

1084
00:40:00,950 --> 00:39:59,440
chat a space space tv net wants to know

1085
00:40:03,190 --> 00:40:00,960
are any of these vehicles going to be

1086
00:40:05,589 --> 00:40:03,200
like the lunar roving vehicle

1087
00:40:07,910 --> 00:40:05,599
yeah there's actually commercial rovers

1088
00:40:09,829 --> 00:40:07,920

actually being discussed too so

1089
00:40:12,550 --> 00:40:09,839
nasa is working on some rovers as well

1090
00:40:14,309 --> 00:40:12,560
but uh and rovers come in all shapes and

1091
00:40:16,950 --> 00:40:14,319
sizes exactly

1092
00:40:19,030 --> 00:40:16,960
robotic but also for the uh humans

1093
00:40:21,270 --> 00:40:19,040
beyond 2024

1094
00:40:23,349 --> 00:40:21,280
uh there's definitely plans for large

1095
00:40:25,750 --> 00:40:23,359
even pressurized rovers that they would

1096
00:40:28,069 --> 00:40:25,760
go in so i see way beyond what we did in

1097
00:40:29,510 --> 00:40:28,079
the apollo era um i think the martian

1098
00:40:31,510 --> 00:40:29,520
remember the

1099
00:40:33,270 --> 00:40:31,520
pressure so but some of these commercial

1100
00:40:35,750 --> 00:40:33,280
landers the ones going in the next year

1101
00:40:37,030 --> 00:40:35,760
and a half or so are carrying very small

1102
00:40:43,990 --> 00:40:37,040
rovers

1103
00:40:46,069 --> 00:40:44,000
providing a service so

1104
00:40:47,910 --> 00:40:46,079
the landers provide the landed service

1105
00:40:49,990 --> 00:40:47,920
and commercial rovers can provide a

1106
00:40:52,710 --> 00:40:50,000
roving service okay so i can put my

1107
00:40:55,109 --> 00:40:52,720
instrument on a rover that

1108
00:40:56,870 --> 00:40:55,119
we can buy space on rather than nasa

1109
00:40:59,030 --> 00:40:56,880
having to build all that okay now

1110
00:41:02,150 --> 00:40:59,040
speaking of your instrument i know that

1111
00:41:04,230 --> 00:41:02,160
you have a good segue

1112
00:41:05,829 --> 00:41:04,240
that was perfect thanks tony

1113
00:41:08,230 --> 00:41:05,839

did you bring it today well i brought

1114
00:41:09,910 --> 00:41:08,240
part of it all right can you show us and

1115
00:41:12,470 --> 00:41:09,920
tell us what it's going to do up there i

1116
00:41:14,950 --> 00:41:12,480
don't drop it so something like this is

1117
00:41:18,390 --> 00:41:14,960
flying to the moon in the next year or

1118
00:41:20,870 --> 00:41:18,400
two yeah so this was selected to fly on

1119
00:41:22,710 --> 00:41:20,880
one of the three landers that is going

1120
00:41:24,150 --> 00:41:22,720
to the moon in the next few uh next

1121
00:41:26,950 --> 00:41:24,160
couple of years

1122
00:41:28,870 --> 00:41:26,960
and this is uh it's called nervous

1123
00:41:32,150 --> 00:41:28,880
nervous terrible

1124
00:41:37,270 --> 00:41:34,470
near infrared volatile spectrometer

1125
00:41:39,349 --> 00:41:37,280
system okay and what it does is it finds

1126
00:41:42,150 --> 00:41:39,359
water that's its principal purpose is to

1127
00:41:43,990 --> 00:41:42,160
find volatiles but especially water okay

1128
00:41:45,030 --> 00:41:44,000
so it's a prospecting instrument if you

1129
00:41:46,870 --> 00:41:45,040
think about

1130
00:41:48,790 --> 00:41:46,880
uh when we look for minerals and

1131
00:41:49,910 --> 00:41:48,800
resources on earth you prospect you go

1132
00:41:52,230 --> 00:41:49,920
and look at this is what this

1133
00:41:55,190 --> 00:41:52,240
instruments meant yeah yeah sniffing out

1134
00:41:56,870 --> 00:41:55,200
where the water is exactly and and this

1135
00:42:00,470 --> 00:41:56,880
is an engineering unit this is a unit

1136
00:42:02,150 --> 00:42:00,480
that we use to develop uh the technology

1137
00:42:04,630 --> 00:42:02,160
make sure we can make the measurements

1138
00:42:06,710 --> 00:42:04,640

and and meet the goals we want to meet

1139
00:42:08,069 --> 00:42:06,720
and then we then test it

1140
00:42:09,910 --> 00:42:08,079
in the similar environments it's going

1141
00:42:12,630 --> 00:42:09,920
to see for example it has to survive

1142
00:42:14,950 --> 00:42:12,640
launch landing oh yeah vacuum radiation

1143
00:42:16,870 --> 00:42:14,960
et cetera

1144
00:42:17,990 --> 00:42:16,880
test all that make sure it works and and

1145
00:42:20,230 --> 00:42:18,000
you can see it's just got a bunch of

1146
00:42:23,670 --> 00:42:20,240
eyes on it yeah

1147
00:42:25,829 --> 00:42:23,680
what else is going on there yeah so um

1148
00:42:28,309 --> 00:42:25,839
what what it's meant to an important

1149
00:42:30,150 --> 00:42:28,319
aspect of this is is it needs to work

1150
00:42:31,990 --> 00:42:30,160
both in sunlight and in darkness just

1151
00:42:33,589 --> 00:42:32,000
like kimberly was saying these are dark

1152
00:42:35,190 --> 00:42:33,599
craters some we're really interested in

1153
00:42:36,790 --> 00:42:35,200
because there's that correlation but we

1154
00:42:38,150 --> 00:42:36,800
yeah we have to go down there and we

1155
00:42:38,950 --> 00:42:38,160
have to look at the scales we're going

1156
00:42:40,550 --> 00:42:38,960
to

1157
00:42:42,390 --> 00:42:40,560
work out

1158
00:42:44,390 --> 00:42:42,400
because the data from orbit is giving us

1159
00:42:46,710 --> 00:42:44,400
hundreds of meter kind of footprints of

1160
00:42:48,710 --> 00:42:46,720
where the water is yeah this is going to

1161
00:42:50,710 --> 00:42:48,720
give us human scale you know things on

1162
00:42:53,829 --> 00:42:50,720
the meter and that's an unknown you know

1163
00:42:56,069 --> 00:42:53,839

so we do need to exactly that's exciting

1164
00:42:57,829 --> 00:42:56,079
so real quick this this if

1165
00:43:00,230 --> 00:42:57,839
this little guy right here i can't get

1166
00:43:03,109 --> 00:43:00,240
the nice blue shine of it that's this is

1167
00:43:05,030 --> 00:43:03,119
an infrared lamp oh yeah um and and the

1168
00:43:05,990 --> 00:43:05,040
intent of this is to actually

1169
00:43:07,670 --> 00:43:06,000
provide

1170
00:43:09,430 --> 00:43:07,680
infrared light for the other instruments

1171
00:43:11,750 --> 00:43:09,440
so it can see in the dark

1172
00:43:13,750 --> 00:43:11,760
likewise all these things over here

1173
00:43:15,270 --> 00:43:13,760
these little guys those are leds of

1174
00:43:16,790 --> 00:43:15,280
various colors

1175
00:43:18,710 --> 00:43:16,800
so they provide

1176
00:43:21,589 --> 00:43:18,720
illumination from the ultraviolet to the

1177
00:43:23,109 --> 00:43:21,599
near infrared uh for our camera system

1178
00:43:25,270 --> 00:43:23,119
which is right here this is a lens to

1179
00:43:28,069 --> 00:43:25,280
the camera system this black thing this

1180
00:43:29,990 --> 00:43:28,079
allows us to image the area at very high

1181
00:43:32,870 --> 00:43:30,000
resolution understand the chemical

1182
00:43:34,870 --> 00:43:32,880
makeup the mineralogy the morphology

1183
00:43:36,870 --> 00:43:34,880
and things like that and the last thing

1184
00:43:38,470 --> 00:43:36,880
are the four sensors right underneath uh

1185
00:43:39,670 --> 00:43:38,480
the camera these four right here this is

1186
00:43:41,510 --> 00:43:39,680
really hard to do it's like doing it in

1187
00:43:43,589 --> 00:43:41,520
the mirror

1188
00:43:44,870 --> 00:43:43,599

those are thermal sensors it's a thermal

1189
00:43:47,349 --> 00:43:44,880
radiometer

1190
00:43:48,870 --> 00:43:47,359
and what that does is allows us to

1191
00:43:50,790 --> 00:43:48,880
measure temperatures of the scene we're

1192
00:43:53,349 --> 00:43:50,800
looking at because we're interested in

1193
00:43:54,790 --> 00:43:53,359
not only understanding if water is there

1194
00:43:56,790 --> 00:43:54,800
but we don't want to understand the

1195
00:43:58,710 --> 00:43:56,800
environment we are finding water or not

1196
00:44:00,630 --> 00:43:58,720
finding water because ultimately we will

1197
00:44:02,150 --> 00:44:00,640
use this data to build what is called a

1198
00:44:03,670 --> 00:44:02,160
resource map on earth we call them a

1199
00:44:07,190 --> 00:44:03,680
mineral mineral map that's what the

1200
00:44:08,710 --> 00:44:07,200
united states geological survey provides

1201
00:44:10,870 --> 00:44:08,720
to a company that's interested in

1202
00:44:12,790 --> 00:44:10,880
finding minerals and and we're going to

1203
00:44:15,750 --> 00:44:12,800
do this on the moon basically build

1204
00:44:17,510 --> 00:44:15,760
these maps and understand the location

1205
00:44:19,349 --> 00:44:17,520
this is one instrument of several that

1206
00:44:21,910 --> 00:44:19,359
is dedicated to do this kind of work oh

1207
00:44:23,910 --> 00:44:21,920
yeah yeah all working in tandem and yeah

1208
00:44:27,109 --> 00:44:23,920
exactly together a map together maybe

1209
00:44:28,710 --> 00:44:27,119
yeah yeah exactly i see that makes sense

1210
00:44:30,550 --> 00:44:28,720
and i'm trying to convince tony that the

1211
00:44:32,390 --> 00:44:30,560
next iteration of this is to be handheld

1212
00:44:34,470 --> 00:44:32,400
by the astronauts

1213
00:44:42,470 --> 00:44:34,480

the astronauts go and look at like okay

1214
00:44:47,430 --> 00:44:45,990
it's on all right do you have a question

1215
00:44:49,750 --> 00:44:47,440
so

1216
00:44:51,430 --> 00:44:49,760
guard chose wants to know how is nasa

1217
00:44:53,190 --> 00:44:51,440
going to protect these rovers from lunar

1218
00:44:57,030 --> 00:44:53,200
dust

1219
00:44:59,030 --> 00:44:57,040
it is

1220
00:45:00,550 --> 00:44:59,040
and it's really is unique in that it's

1221
00:45:01,829 --> 00:45:00,560
only generated because of the

1222
00:45:04,309 --> 00:45:01,839
environment on the moon it's generated

1223
00:45:06,150 --> 00:45:04,319
through the impact processes and so the

1224
00:45:08,550 --> 00:45:06,160
dust and it's never eroded there's no

1225
00:45:11,190 --> 00:45:08,560
way there's no there's no wind to make

1226
00:45:14,309 --> 00:45:11,200
or water or flowing liquid water to

1227
00:45:17,030 --> 00:45:14,319
smooth things out so it's jagged and

1228
00:45:18,870 --> 00:45:17,040
jagged it locks in place

1229
00:45:20,390 --> 00:45:18,880
and the apollo astronauts you know

1230
00:45:22,550 --> 00:45:20,400
complained about you know got into their

1231
00:45:24,790 --> 00:45:22,560
lungs and they scratched their suits the

1232
00:45:27,510 --> 00:45:24,800
suits were all ripped to shreds

1233
00:45:29,109 --> 00:45:27,520
so it is it is a beast

1234
00:45:30,710 --> 00:45:29,119
and the way you protect there's a lot of

1235
00:45:32,309 --> 00:45:30,720
ways you can protect it everything from

1236
00:45:33,430 --> 00:45:32,319
electrostatic barriers they're working

1237
00:45:36,309 --> 00:45:33,440
on so

1238
00:45:38,710 --> 00:45:36,319

one nice thing about the uh a lot of the

1239
00:45:41,910 --> 00:45:38,720
lunar dust is it has a magnetic property

1240
00:45:44,230 --> 00:45:41,920
to it it's got some uh ferric iron in it

1241
00:45:46,710 --> 00:45:44,240
nanophase iron and so you can actually

1242
00:45:53,589 --> 00:45:46,720
repulse it with electric fields um you

1243
00:45:57,750 --> 00:45:55,829
and also a number of other mechanical

1244
00:45:59,670 --> 00:45:57,760
gasket materials basically things that

1245
00:46:00,630 --> 00:45:59,680
go between bearings on wheels and

1246
00:46:03,349 --> 00:46:00,640
whatnot

1247
00:46:04,230 --> 00:46:03,359
that make it very diff difficult for the

1248
00:46:06,309 --> 00:46:04,240
dust

1249
00:46:07,829 --> 00:46:06,319
to get to the bearings of the the the

1250
00:46:09,910 --> 00:46:07,839
delicate parts these are kind of

1251
00:46:11,670 --> 00:46:09,920
torturous paths it has to follow and

1252
00:46:13,670 --> 00:46:11,680
we're fortunate that there's been a

1253
00:46:15,510 --> 00:46:13,680
couple of lunar simulants that have been

1254
00:46:17,990 --> 00:46:15,520
made modeled on the regular that was

1255
00:46:19,030 --> 00:46:18,000
brought by the apollo astronauts and so

1256
00:46:20,630 --> 00:46:19,040
um

1257
00:46:23,030 --> 00:46:20,640
companies and engineers who are looking

1258
00:46:24,790 --> 00:46:23,040
at wheel design and rover design they

1259
00:46:26,710 --> 00:46:24,800
can test out

1260
00:46:28,630 --> 00:46:26,720
their designs as best as possible with

1261
00:46:29,990 --> 00:46:28,640
this kind of jagged kind of stimulant i

1262
00:46:31,190 --> 00:46:30,000
mean obviously it's not a one-to-one

1263
00:46:33,270 --> 00:46:31,200

connection in fact one of the big

1264
00:46:34,790 --> 00:46:33,280
mysteries about

1265
00:46:37,670 --> 00:46:34,800
the um

1266
00:46:39,349 --> 00:46:37,680
permanently shadow regions um when rl

1267
00:46:42,230 --> 00:46:39,359
cross experiment that we did it a decade

1268
00:46:44,150 --> 00:46:42,240
ago finding water in cabela's um it

1269
00:46:45,349 --> 00:46:44,160
revealed that perhaps the the regolith

1270
00:46:46,630 --> 00:46:45,359
and those permanently shallow craters

1271
00:46:48,470 --> 00:46:46,640
are actually different than the

1272
00:46:50,309 --> 00:46:48,480
regulator that was found on the apollo

1273
00:46:51,670 --> 00:46:50,319
sites oh it's different so

1274
00:46:53,589 --> 00:46:51,680
there's going to be some learning to be

1275
00:46:55,589 --> 00:46:53,599
done so the engineers will do the best

1276
00:46:57,670 --> 00:46:55,599
knowledge they have now using a simulant

1277
00:46:59,589 --> 00:46:57,680
designing the wheels and the excavation

1278
00:47:01,190 --> 00:46:59,599
we're gonna have challenges with drills

1279
00:47:02,870 --> 00:47:01,200
and scoops and all that the same thing

1280
00:47:04,870 --> 00:47:02,880
to deal with the beast that is the dust

1281
00:47:07,589 --> 00:47:04,880
yes but we'll overcome those but we're

1282
00:47:09,190 --> 00:47:07,599
gonna have to get there on the scene at

1283
00:47:11,190 --> 00:47:09,200
the south pole

1284
00:47:12,950 --> 00:47:11,200
and the polar regions and go hmm that

1285
00:47:14,790 --> 00:47:12,960
dust is different yeah that's what we're

1286
00:47:17,510 --> 00:47:14,800
going to do next time all right

1287
00:47:19,750 --> 00:47:17,520
that question foreshadowed

1288
00:47:21,109 --> 00:47:19,760

my favorite section of the day uh you

1289
00:47:22,790 --> 00:47:21,119
guys described the south pole as

1290
00:47:24,710 --> 00:47:22,800
unexplored territory and you keep

1291
00:47:26,950 --> 00:47:24,720
referencing that it's really extreme

1292
00:47:28,470 --> 00:47:26,960
it's going to be tough so let's go

1293
00:47:30,230 --> 00:47:28,480
through some of those specific

1294
00:47:31,030 --> 00:47:30,240
challenges i mean it's it's like you

1295
00:47:32,950 --> 00:47:31,040
know

1296
00:47:35,190 --> 00:47:32,960
wanting to go in the deepest minds on

1297
00:47:37,670 --> 00:47:35,200
earth oh really and the deep you know

1298
00:47:39,430 --> 00:47:37,680
the deepest undersea exploration you

1299
00:47:40,870 --> 00:47:39,440
know it is because it's so different

1300
00:47:41,910 --> 00:47:40,880
from what we're used to or is it really

1301
00:47:46,549 --> 00:47:41,920
deep

1302
00:47:48,390 --> 00:47:46,559
is extreme it's completely

1303
00:47:51,190 --> 00:47:48,400
unlike a lot of the department who saw

1304
00:47:53,589 --> 00:47:51,200
the lower latitudes they landed in flat

1305
00:47:55,270 --> 00:47:53,599
areas okay nice pristine that's when i

1306
00:47:57,910 --> 00:47:55,280
picture the moon and

1307
00:47:59,829 --> 00:47:57,920
will be landing perhaps in areas that

1308
00:48:02,470 --> 00:47:59,839
are ridges that are sitting on top of a

1309
00:48:06,309 --> 00:48:02,480
crater that looks down into a

1310
00:48:09,349 --> 00:48:06,319
six kilometer hole so i was like that's

1311
00:48:10,790 --> 00:48:09,359
yeah exactly about three miles down and

1312
00:48:13,270 --> 00:48:10,800
and you can stay they'll be standing on

1313
00:48:16,390 --> 00:48:13,280

the edge of these vistas overlooking wow

1314
00:48:18,230 --> 00:48:16,400
mountains that are many miles high wow

1315
00:48:21,270 --> 00:48:18,240
into craters that are

1316
00:48:23,190 --> 00:48:21,280
uh 10 miles across and

1317
00:48:24,470 --> 00:48:23,200
three miles deep i never knew it was

1318
00:48:26,790 --> 00:48:24,480
that extreme and then the lighting

1319
00:48:28,950 --> 00:48:26,800
conditions um because of the low angle

1320
00:48:31,750 --> 00:48:28,960
of the sun you can have shadows that are

1321
00:48:33,750 --> 00:48:31,760
being cast from a ridge of a crater

1322
00:48:35,829 --> 00:48:33,760
that's hundreds of kilometers away

1323
00:48:38,549 --> 00:48:35,839
really and the shadows will be sweeping

1324
00:48:40,309 --> 00:48:38,559
across you over time skills of hours and

1325
00:48:42,549 --> 00:48:40,319
as we mentioned earlier when you're in

1326
00:48:43,750 --> 00:48:42,559
shadow your temperature drops and so

1327
00:48:45,030 --> 00:48:43,760
you're going to be experienced of course

1328
00:48:47,910 --> 00:48:45,040
you're in a

1329
00:48:49,589 --> 00:48:47,920
suit that's keeping you regulated but if

1330
00:48:51,670 --> 00:48:49,599
you think about it the whole

1331
00:48:53,589 --> 00:48:51,680
lighting condition the whole dealing

1332
00:48:56,309 --> 00:48:53,599
with the swing of temperatures is going

1333
00:48:57,829 --> 00:48:56,319
to stress out your system so

1334
00:48:59,750 --> 00:48:57,839
your equipment your machine and

1335
00:49:01,750 --> 00:48:59,760
everything and there are areas where

1336
00:49:03,109 --> 00:49:01,760
there's this permanent shadow darkness

1337
00:49:05,109 --> 00:49:03,119
is prone to darkness but there's also

1338
00:49:07,510 --> 00:49:05,119

areas that have what i like to say

1339
00:49:09,589 --> 00:49:07,520
persistent sunlight so there are some of

1340
00:49:11,750 --> 00:49:09,599
these peaks because they're so extreme

1341
00:49:14,150 --> 00:49:11,760
that no matter what time it

1342
00:49:17,109 --> 00:49:14,160
year it is it has

1343
00:49:18,950 --> 00:49:17,119
very often sunlight at it so it's often

1344
00:49:20,950 --> 00:49:18,960
at the rims or or crests of some of

1345
00:49:22,069 --> 00:49:20,960
these ridges near these craters and so

1346
00:49:23,829 --> 00:49:22,079
those are very attractive for the

1347
00:49:25,589 --> 00:49:23,839
reasons kim said is you won't be getting

1348
00:49:28,230 --> 00:49:25,599
these deep shadows sweeping across you

1349
00:49:29,670 --> 00:49:28,240
all that often right and when they do it

1350
00:49:32,710 --> 00:49:29,680
might just be for

1351
00:49:35,109 --> 00:49:32,720
five six seven days as opposed to

1352
00:49:36,150 --> 00:49:35,119
you know three months and something like

1353
00:49:37,990 --> 00:49:36,160
that so

1354
00:49:40,230 --> 00:49:38,000
so these are uh and they're great places

1355
00:49:42,150 --> 00:49:40,240
to put your power station exactly

1356
00:49:44,069 --> 00:49:42,160
and have some of your infrastructure

1357
00:49:45,910 --> 00:49:44,079
again it's sort of you know if you're

1358
00:49:47,589 --> 00:49:45,920
going to explore and you you're learning

1359
00:49:49,109 --> 00:49:47,599
about where you're exploring take

1360
00:49:50,710 --> 00:49:49,119
advantage of

1361
00:49:52,390 --> 00:49:50,720
the gifts that were given to you by

1362
00:49:54,870 --> 00:49:52,400
nature

1363
00:49:57,190 --> 00:49:54,880

and also be aware of the dangers you

1364
00:49:58,950 --> 00:49:57,200
know of course so you keep talking about

1365
00:50:01,349 --> 00:49:58,960
those the polls we actually have this

1366
00:50:03,750 --> 00:50:01,359
really cool anime our video

1367
00:50:06,309 --> 00:50:03,760
showing uh some light cycles at the moon

1368
00:50:07,910 --> 00:50:06,319
south pole exactly right yeah yeah

1369
00:50:09,270 --> 00:50:07,920
so can you tell us what we're seeing

1370
00:50:09,890 --> 00:50:09,280
this is

1371
00:50:11,589 --> 00:50:09,900
light falling

1372
00:50:14,470 --> 00:50:11,599
[Music]

1373
00:50:16,150 --> 00:50:14,480
we started at a low um latitudes looking

1374
00:50:18,710 --> 00:50:16,160
at the moon as we see the moon and what

1375
00:50:21,670 --> 00:50:18,720
you saw was the the sun moving

1376
00:50:23,270 --> 00:50:21,680
across the face of the moon there is no

1377
00:50:25,270 --> 00:50:23,280
dark side of the moon

1378
00:50:27,430 --> 00:50:25,280
every side of the moon gets sunlight

1379
00:50:29,349 --> 00:50:27,440
at some point we get 14 days of sunlight

1380
00:50:31,109 --> 00:50:29,359
14 days of darkness and we just don't

1381
00:50:33,670 --> 00:50:31,119
see that we just don't see that because

1382
00:50:35,109 --> 00:50:33,680
we always see the near side now this

1383
00:50:37,030 --> 00:50:35,119
what's done is this

1384
00:50:39,109 --> 00:50:37,040
movie's swung down so you're looking at

1385
00:50:41,030 --> 00:50:39,119
the south pole of the moon that crater

1386
00:50:43,589 --> 00:50:41,040
nice circular one right in the middle

1387
00:50:45,349 --> 00:50:43,599
that shackleton crater is almost exactly

1388
00:50:47,990 --> 00:50:45,359

at the south pole of the moon

1389
00:50:49,829 --> 00:50:48,000
it is about 15 miles across and about

1390
00:50:52,150 --> 00:50:49,839
four miles deep

1391
00:50:53,990 --> 00:50:52,160
and what you see are these shadows that

1392
00:50:57,109 --> 00:50:54,000
are sweeping across and it's because

1393
00:50:59,190 --> 00:50:57,119
again as kim kimberly explained earlier

1394
00:51:01,109 --> 00:50:59,200
the tilt of the moon on its axis is very

1395
00:51:03,030 --> 00:51:01,119
small so

1396
00:51:05,750 --> 00:51:03,040
the sun's always just hugging the

1397
00:51:07,829 --> 00:51:05,760
horizon creating these shadows

1398
00:51:10,309 --> 00:51:07,839
and and you can see in some of these

1399
00:51:12,470 --> 00:51:10,319
craters like the big shackleton itself

1400
00:51:14,390 --> 00:51:12,480
and the larger ones just above it

1401
00:51:16,309 --> 00:51:14,400
the floors of those craters never get

1402
00:51:17,910 --> 00:51:16,319
sunlight they are in permanent shadow

1403
00:51:18,549 --> 00:51:17,920
they just say dark you can just stare at

1404
00:51:30,720 --> 00:51:18,559
a

1405
00:51:32,150 --> 00:51:30,730
sunlight

1406
00:51:34,630 --> 00:51:32,160
[Music]

1407
00:51:36,150 --> 00:51:34,640
they stayed light yeah yeah so extreme

1408
00:51:38,230 --> 00:51:36,160
so lighting conditions are extreme

1409
00:51:40,630 --> 00:51:38,240
topography is extreme temperatures are

1410
00:51:43,510 --> 00:51:40,640
extreme the dust we sort of know what

1411
00:51:44,790 --> 00:51:43,520
it's made of but maybe not um

1412
00:51:46,150 --> 00:51:44,800
[Music]

1413
00:51:48,549 --> 00:51:46,160

yeah but it could have some other

1414
00:51:50,230 --> 00:51:48,559
benefits too we just have to we haven't

1415
00:51:52,870 --> 00:51:50,240
explored it mm-hmm and we haven't

1416
00:51:54,950 --> 00:51:52,880
explored it with robots yet either so

1417
00:51:56,549 --> 00:51:54,960
and humans and somebody's boots on the

1418
00:51:58,870 --> 00:51:56,559
ground and in general we see this

1419
00:52:00,950 --> 00:51:58,880
increase of hydrogen at the poles

1420
00:52:04,309 --> 00:52:00,960
and we've seen increase in hydration of

1421
00:52:06,630 --> 00:52:04,319
the soils meaning hydroxyl oh or water

1422
00:52:08,710 --> 00:52:06,640
molecules bound to the soils even in

1423
00:52:10,950 --> 00:52:08,720
sunlight right in

1424
00:52:13,829 --> 00:52:10,960
increased amounts towards the poles

1425
00:52:15,349 --> 00:52:13,839
so just the composition and even in the

1426
00:52:17,510 --> 00:52:15,359
sunlight areas is going to be different

1427
00:52:19,030 --> 00:52:17,520
from anything we've ever seen before wow

1428
00:52:20,549 --> 00:52:19,040
and um that's going to just make the

1429
00:52:21,990 --> 00:52:20,559
modelers go crazy because we're going to

1430
00:52:23,829 --> 00:52:22,000
have a lot of a lot of tony's types of

1431
00:52:25,109 --> 00:52:23,839
instruments you know looking for the

1432
00:52:26,309 --> 00:52:25,119
water on these scales and then we're

1433
00:52:27,750 --> 00:52:26,319
going to try to piece together quite a

1434
00:52:29,430 --> 00:52:27,760
complex puzzle

1435
00:52:32,549 --> 00:52:29,440
um but it's a nice it's an interesting

1436
00:52:35,430 --> 00:52:32,559
puzzle to have i mean we're going

1437
00:52:37,990 --> 00:52:35,440
on the moon it's only been 10 years now

1438
00:52:39,510 --> 00:52:38,000

10 years is a it's not a long time but

1439
00:52:41,270 --> 00:52:39,520
it's long enough for like to realize

1440
00:52:42,710 --> 00:52:41,280
that you know this moon is a place that

1441
00:52:44,470 --> 00:52:42,720
we have full of things that we don't

1442
00:52:46,790 --> 00:52:44,480
know what's going on

1443
00:52:49,030 --> 00:52:46,800
it's more active than i ever it is it's

1444
00:52:50,309 --> 00:52:49,040
very active and more extreme especially

1445
00:52:52,790 --> 00:52:50,319
at the polls kind of picked a better

1446
00:52:55,270 --> 00:52:52,800
place to go exciting yeah you know

1447
00:52:57,829 --> 00:52:55,280
speaking of that uh you guys don't

1448
00:52:59,910 --> 00:52:57,839
forget if you do have any questions

1449
00:53:01,150 --> 00:52:59,920
please type them into the twitch chat

1450
00:53:05,349 --> 00:53:01,160
it's

1451
00:53:06,950 --> 00:53:05,359
www.twitch.nas twitch.tv backslash nasa

1452
00:53:08,230 --> 00:53:06,960
so we're going to move into our rapid

1453
00:53:09,870 --> 00:53:08,240
fire section

1454
00:53:12,309 --> 00:53:09,880
so uh

1455
00:53:14,710 --> 00:53:12,319
jesta578 wants to know about the nervous

1456
00:53:16,230 --> 00:53:14,720
instrument is it ultrasound ir and

1457
00:53:19,109 --> 00:53:16,240
visual

1458
00:53:20,630 --> 00:53:19,119
uh it is a little bit of everything so i

1459
00:53:21,910 --> 00:53:20,640
always like to say we go in with our

1460
00:53:23,670 --> 00:53:21,920
eyes wide open

1461
00:53:25,030 --> 00:53:23,680
for all the reasons kim just said

1462
00:53:26,309 --> 00:53:25,040
because you don't exactly know what

1463
00:53:27,190 --> 00:53:26,319

you're going to see

1464
00:53:28,790 --> 00:53:27,200
so

1465
00:53:31,190 --> 00:53:28,800
it is actually

1466
00:53:33,190 --> 00:53:31,200
a combination of near-infrared and for

1467
00:53:35,670 --> 00:53:33,200
you geeks out there that's between about

1468
00:53:38,549 --> 00:53:35,680
1.2 and 4 microns

1469
00:53:40,630 --> 00:53:38,559
thermal infrared that's between about 8

1470
00:53:43,030 --> 00:53:40,640
and 25 microns

1471
00:53:46,549 --> 00:53:43,040
and ultraviolet visible which is a we

1472
00:53:48,870 --> 00:53:46,559
run about um 0.35 to

1473
00:53:50,150 --> 00:53:48,880
0.94 microns

1474
00:53:51,990 --> 00:53:50,160
okay so

1475
00:53:54,230 --> 00:53:52,000
ultraviolet

1476
00:53:57,349 --> 00:53:54,240
colors that are below what we can see in

1477
00:53:59,910 --> 00:53:57,359
terms of our visual spectrum and

1478
00:54:01,990 --> 00:53:59,920
and energy is beyond what we can see in

1479
00:54:03,589 --> 00:54:02,000
into the thermal infrared yeah and then

1480
00:54:05,349 --> 00:54:03,599
what dona dunny had mentioned is that

1481
00:54:08,309 --> 00:54:05,359
this this this is the front end with the

1482
00:54:09,990 --> 00:54:08,319
cameras but the infrared um is going to

1483
00:54:11,670 --> 00:54:10,000
be connected to a spectrometer on the

1484
00:54:13,109 --> 00:54:11,680
back end okay because it's from the

1485
00:54:14,710 --> 00:54:13,119
spectrometer spreading the light out

1486
00:54:15,990 --> 00:54:14,720
into different wavelengths and it's over

1487
00:54:17,829 --> 00:54:16,000
the infrared that you're going to see

1488
00:54:20,069 --> 00:54:17,839

the water signature or the hydroxyl

1489
00:54:22,230 --> 00:54:20,079
signature and the minerals yeah and so

1490
00:54:24,390 --> 00:54:22,240
this is a very it's a compact instrument

1491
00:54:25,510 --> 00:54:24,400
with both cameras and thermal sensors to

1492
00:54:27,910 --> 00:54:25,520
get the temperature plus the

1493
00:54:29,190 --> 00:54:27,920
spectrometer to get the amount of

1494
00:54:30,950 --> 00:54:29,200
composition

1495
00:54:32,950 --> 00:54:30,960
yeah what things are made out of all

1496
00:54:35,990 --> 00:54:32,960
right so let's see

1497
00:54:38,789 --> 00:54:36,000
dude is dudette wants to know is there a

1498
00:54:41,510 --> 00:54:38,799
sample return plan for lunar water

1499
00:54:43,589 --> 00:54:41,520
yeah that's uh absolutely

1500
00:54:45,510 --> 00:54:43,599
they do want to return uh yeah but the

1501
00:54:47,750 --> 00:54:45,520
question is will it happen

1502
00:54:48,789 --> 00:54:47,760
it will happen with the humans going in

1503
00:54:50,150 --> 00:54:48,799
2024 because they're going to bring

1504
00:54:51,829 --> 00:54:50,160
samples back okay don't worry we're

1505
00:54:53,750 --> 00:54:51,839
going to be so excited that

1506
00:54:55,430 --> 00:54:53,760
question is will we get a rover to get

1507
00:54:58,069 --> 00:54:55,440
us a sample return before the humans

1508
00:55:00,230 --> 00:54:58,079
don't know yet that would be awesome too

1509
00:55:01,589 --> 00:55:00,240
um but yeah we're certainly going to get

1510
00:55:03,109 --> 00:55:01,599
something we're going to get something

1511
00:55:04,630 --> 00:55:03,119
and specifically there's a lot of

1512
00:55:06,549 --> 00:55:04,640
discussion about

1513
00:55:08,950 --> 00:55:06,559

cryogenic sampling because when you

1514
00:55:10,950 --> 00:55:08,960
sample something that's at minus 230

1515
00:55:12,230 --> 00:55:10,960
degrees below centigrade

1516
00:55:13,430 --> 00:55:12,240
uh

1517
00:55:14,710 --> 00:55:13,440
there's a lot of debate right now

1518
00:55:16,950 --> 00:55:14,720
whether or not you need to keep it that

1519
00:55:18,950 --> 00:55:16,960
cold yeah or do you just need to seal it

1520
00:55:20,870 --> 00:55:18,960
and make sure you don't lose as it

1521
00:55:23,030 --> 00:55:20,880
sublimes as it warms and the ice is

1522
00:55:25,109 --> 00:55:23,040
sublime yeah i was on a mission concept

1523
00:55:26,549 --> 00:55:25,119
for sampling off a comet and we had that

1524
00:55:27,990 --> 00:55:26,559
same debate because we're going to bring

1525
00:55:30,150 --> 00:55:28,000
it back to the earth the question is you

1526
00:55:31,030 --> 00:55:30,160
keep it in cryo storage or do you allow

1527
00:55:32,710 --> 00:55:31,040
it to

1528
00:55:34,470 --> 00:55:32,720
come up to room temperature but then

1529
00:55:35,589 --> 00:55:34,480
you've lost some information but you're

1530
00:55:36,789 --> 00:55:35,599
right they're gonna have to solve that

1531
00:55:38,150 --> 00:55:36,799
issue i never thought about that you're

1532
00:55:39,430 --> 00:55:38,160
right yeah we're gonna bring back our

1533
00:55:40,870 --> 00:55:39,440
water samples from the moon we're gonna

1534
00:55:42,630 --> 00:55:40,880
have to have something cold you need a

1535
00:55:46,950 --> 00:55:42,640
couple years definitely yeah get me a

1536
00:55:52,950 --> 00:55:50,470
as yeah so it looks like grundian wants

1537
00:55:54,630 --> 00:55:52,960
to know he wonders what is the moon

1538
00:55:56,630 --> 00:55:54,640

smelling what does the air smell like on

1539
00:55:58,150 --> 00:55:56,640
the moon good question

1540
00:56:00,069 --> 00:55:58,160
well we don't know but according to the

1541
00:56:02,630 --> 00:56:00,079
apollo tapes they smell they said it

1542
00:56:04,549 --> 00:56:02,640
smelled like gun powder gun powder that

1543
00:56:06,470 --> 00:56:04,559
was the the it's reported by several of

1544
00:56:07,829 --> 00:56:06,480
the astronauts um so my husband and i

1545
00:56:10,590 --> 00:56:07,839
are geeks we kind of listen to the audio

1546
00:56:14,230 --> 00:56:10,600
tapes of all the apologies

1547
00:56:17,589 --> 00:56:15,829
and more than once they would say it

1548
00:56:19,349 --> 00:56:17,599
smelled like gunpowder i have no idea

1549
00:56:20,710 --> 00:56:19,359
whether that would be true i mean it

1550
00:56:22,069 --> 00:56:20,720
just and that's error to be clear

1551
00:56:23,430 --> 00:56:22,079
there's air in the capsule that's the

1552
00:56:25,109 --> 00:56:23,440
air in the capsule when they got in

1553
00:56:26,470 --> 00:56:25,119
after their evas is extra vehicle

1554
00:56:27,829 --> 00:56:26,480
activity and are romping around on the

1555
00:56:29,430 --> 00:56:27,839
surface and they're coming back in and

1556
00:56:32,950 --> 00:56:29,440
they're taking off their coat that's

1557
00:56:34,950 --> 00:56:32,960
when they smell it because you know um

1558
00:56:35,990 --> 00:56:34,960
yeah they needed the atmosphere but

1559
00:56:37,589 --> 00:56:36,000
they're also in a pure oxidative

1560
00:56:39,190 --> 00:56:37,599
atmosphere i don't know if that changed

1561
00:56:41,109 --> 00:56:39,200
anything maybe it has something to do

1562
00:56:42,630 --> 00:56:41,119
with the dust they think it's because

1563
00:56:46,309 --> 00:56:42,640

again this dust is very unique it's

1564
00:56:49,109 --> 00:56:46,319
never been as it gets fractured and and

1565
00:56:50,549 --> 00:56:49,119
melted and re-solidified by impacts on

1566
00:56:53,109 --> 00:56:50,559
the surface it creates what are called

1567
00:56:54,710 --> 00:56:53,119
very um open active sites on the

1568
00:56:56,390 --> 00:56:54,720
surfaces that

1569
00:57:00,069 --> 00:56:56,400
again on earth we have all this oxygen

1570
00:57:04,069 --> 00:57:01,750
very very very little atmosphere it's

1571
00:57:06,390 --> 00:57:04,079
called an exosphere meaning a molecule

1572
00:57:08,390 --> 00:57:06,400
can leave the surface of the moon and

1573
00:57:09,990 --> 00:57:08,400
never encounter another another molecule

1574
00:57:24,390 --> 00:57:10,000
as long as it lives

1575
00:57:28,950 --> 00:57:26,150
and then somehow a hook up to it some

1576
00:57:32,230 --> 00:57:28,960
sniffing instrument that will

1577
00:57:33,750 --> 00:57:32,240
knows what molecules are in women

1578
00:57:35,270 --> 00:57:33,760
there's instruments with the nanotubes

1579
00:57:37,750 --> 00:57:35,280
that measure can measure specific

1580
00:57:39,349 --> 00:57:37,760
chemicals right right as they reach so

1581
00:57:41,190 --> 00:57:39,359
it's kind of like a smell

1582
00:57:42,549 --> 00:57:41,200
but then to extrapolate it to what we

1583
00:57:44,390 --> 00:57:42,559
would experience

1584
00:57:46,150 --> 00:57:44,400
yes that's very subjective yeah so the

1585
00:57:47,829 --> 00:57:46,160
dust has these open surfaces and reacts

1586
00:57:49,349 --> 00:57:47,839
with the oxygen in the capsule i was

1587
00:57:51,190 --> 00:57:49,359
wondering whether that made it that's

1588
00:57:52,950 --> 00:57:51,200

the comment that was made and that's our

1589
00:57:55,030 --> 00:57:52,960
only one data point right

1590
00:57:58,150 --> 00:57:55,040
so we're looking forward to more data

1591
00:58:03,270 --> 00:58:01,270
so sun cricket wants to know um will new

1592
00:58:05,430 --> 00:58:03,280
suits be made specifically for longer

1593
00:58:08,789 --> 00:58:05,440
stays on the martian surface

1594
00:58:11,030 --> 00:58:08,799
or sorry the moon surface

1595
00:58:13,030 --> 00:58:11,040
they are working on the next generation

1596
00:58:14,870 --> 00:58:13,040
suit and i'm afraid i don't know the

1597
00:58:16,950 --> 00:58:14,880
name of it the designation of it but

1598
00:58:18,950 --> 00:58:16,960
they are working on a new generation

1599
00:58:19,750 --> 00:58:18,960
suit that is meant to be

1600
00:58:23,270 --> 00:58:19,760
uh

1601
00:58:26,470 --> 00:58:23,280
more mobile a lot more mobility to it

1602
00:58:28,549 --> 00:58:26,480
um and to allow the astronauts to

1603
00:58:30,390 --> 00:58:28,559
uh be able to do things like that they

1604
00:58:33,349 --> 00:58:30,400
couldn't do on apollo for example if you

1605
00:58:34,870 --> 00:58:33,359
saw an astronaut fall over on apollo

1606
00:58:36,230 --> 00:58:34,880
they would have to do a push-up to get

1607
00:58:38,870 --> 00:58:36,240
themselves up they couldn't bend the

1608
00:58:41,510 --> 00:58:38,880
knees well enough to actually stand so

1609
00:58:43,190 --> 00:58:41,520
they'd have to do a push-up a few times

1610
00:58:50,420 --> 00:58:43,200
until they got enough momentum to get

1611
00:58:54,230 --> 00:58:52,150
[Music]

1612
00:58:56,150 --> 00:58:54,240
the fingernails of the astronauts were

1613
00:58:58,789 --> 00:58:56,160

crushed up against the edges of the

1614
00:59:00,069 --> 00:58:58,799
gloves and they were all bruised and

1615
00:59:02,150 --> 00:59:00,079
everything so

1616
00:59:03,910 --> 00:59:02,160
we want are the astronauts on the moon

1617
00:59:05,910 --> 00:59:03,920
to be very physically active excavating

1618
00:59:08,390 --> 00:59:05,920
all this water for us and building off

1619
00:59:09,349 --> 00:59:08,400
habitats and doing that so the new suits

1620
00:59:14,390 --> 00:59:09,359
are

1621
00:59:17,829 --> 00:59:14,400
here's a good one can i jump in with it

1622
00:59:19,670 --> 00:59:17,839
go for it terminus 1961. how do you

1623
00:59:21,829 --> 00:59:19,680
communicate with a probe down in the

1624
00:59:23,990 --> 00:59:21,839
crater what are the challenges

1625
00:59:26,870 --> 00:59:24,000
so this is kind of really interesting uh

1626
00:59:28,950 --> 00:59:26,880
point a a dark crater does not mean we

1627
00:59:32,150 --> 00:59:28,960
can't see into the crater from earth

1628
00:59:33,349 --> 00:59:32,160
uh-huh good point so um in one instance

1629
00:59:35,030 --> 00:59:33,359
you can use what's called direct to

1630
00:59:37,030 --> 00:59:35,040
earth communications that's where is

1631
00:59:40,950 --> 00:59:37,040
what we did in apollo or in this case

1632
00:59:44,789 --> 00:59:42,549
or depending on the geometry exactly

1633
00:59:47,349 --> 00:59:44,799
right right so in some instances yes you

1634
00:59:48,710 --> 00:59:47,359
can see earth from a psr from the floor

1635
00:59:49,670 --> 00:59:48,720
of a permanently shadowed region or

1636
00:59:51,109 --> 00:59:49,680
crater

1637
00:59:52,870 --> 00:59:51,119
other instances you'll be able to look

1638
00:59:54,470 --> 00:59:52,880

up overhead and see gateway

1639
00:59:57,270 --> 00:59:54,480
so you can relay you can look straight

1640
00:59:58,549 --> 00:59:57,280
up and talk to a relay satellite or

1641
01:00:00,069 --> 00:59:58,559
gateway

1642
01:00:01,750 --> 01:00:00,079
but they've also talked about having

1643
01:00:02,789 --> 01:00:01,760
repeaters yeah so some of these

1644
01:00:04,710 --> 01:00:02,799
commercial

1645
01:00:07,109 --> 01:00:04,720
service providers aren't just talking

1646
01:00:09,670 --> 01:00:07,119
about providing landed services i can

1647
01:00:11,430 --> 01:00:09,680
take you uh to the moon but they're also

1648
01:00:17,030 --> 01:00:11,440
talking about setting up infrastructure

1649
01:00:21,430 --> 01:00:19,670
the commercial uh landers that are going

1650
01:00:23,750 --> 01:00:21,440
actually will communicate with the small

1651
01:00:25,589 --> 01:00:23,760
rovers and whatnot with wi-fi okay and

1652
01:00:27,990 --> 01:00:25,599
they're actually talking about uh both

1653
01:00:29,349 --> 01:00:28,000
communication power all kinds of relay

1654
01:00:30,950 --> 01:00:29,359
systems building infrastructure to

1655
01:00:32,150 --> 01:00:30,960
actually assist in the exploration and

1656
01:00:34,390 --> 01:00:32,160
science and

1657
01:00:36,390 --> 01:00:34,400
build up that's cool yeah and that helps

1658
01:00:37,510 --> 01:00:36,400
me picture better the creator and

1659
01:00:38,789 --> 01:00:37,520
communicating

1660
01:00:40,230 --> 01:00:38,799
i mean if you're really deep in you're

1661
01:00:41,270 --> 01:00:40,240
going to have to go up but if you're you

1662
01:00:43,750 --> 01:00:41,280
know it depends on where you can put a

1663
01:00:46,230 --> 01:00:43,760

repeater true cool okay so i have

1664
01:00:47,829 --> 01:00:46,240
another question uh calcu's wants to

1665
01:00:49,670 --> 01:00:47,839
know are you going to send rovers to

1666
01:00:52,789 --> 01:00:49,680
these craters first

1667
01:00:56,630 --> 01:00:52,799
before we eventually send the next woman

1668
01:00:58,390 --> 01:00:56,640
or like the next person and if so when

1669
01:01:01,349 --> 01:00:58,400
uh we really want to

1670
01:01:03,109 --> 01:01:01,359
and uh we're working on plans along

1671
01:01:07,190 --> 01:01:03,119
those lines that

1672
01:01:09,829 --> 01:01:07,200
still are being formulated so um yes uh

1673
01:01:11,829 --> 01:01:09,839
you need mobility to really understand

1674
01:01:13,670 --> 01:01:11,839
the distribution of water

1675
01:01:15,430 --> 01:01:13,680
and and i think everyone appreciates

1676
01:01:17,109 --> 01:01:15,440
that so um

1677
01:01:18,549 --> 01:01:17,119
that is one of the higher priorities

1678
01:01:21,030 --> 01:01:18,559
right now to understand the resources at

1679
01:01:22,230 --> 01:01:21,040
the polls is to get a rover at the polls

1680
01:01:24,069 --> 01:01:22,240
at least one

1681
01:01:25,910 --> 01:01:24,079
and more you really probably want more

1682
01:01:27,510 --> 01:01:25,920
and to start prospecting and

1683
01:01:29,750 --> 01:01:27,520
characterizing and identifying and

1684
01:01:31,829 --> 01:01:29,760
that's the instrument i showed was built

1685
01:01:34,150 --> 01:01:31,839
specifically to go on a rover just like

1686
01:01:36,870 --> 01:01:34,160
that oh yeah yeah and so hopefully

1687
01:01:39,109 --> 01:01:36,880
before 2024. okay

1688
01:01:40,950 --> 01:01:39,119

i mean that's an ideal

1689
01:01:43,510 --> 01:01:40,960
situation but there's also alternative i

1690
01:01:44,789 --> 01:01:43,520
mean if if if we get the human uh

1691
01:01:47,030 --> 01:01:44,799
visiting the moon before we get the

1692
01:01:49,030 --> 01:01:47,040
rovers the rovers will go hand in hand i

1693
01:01:51,030 --> 01:01:49,040
mean it doesn't it doesn't slow down no

1694
01:01:53,589 --> 01:01:51,040
it's a whole architecture to get humans

1695
01:01:55,670 --> 01:01:53,599
2024 does not depend at all

1696
01:01:58,069 --> 01:01:55,680
because wherever the the astronauts are

1697
01:01:59,910 --> 01:01:58,079
going to land is unexplored territory

1698
01:02:01,510 --> 01:01:59,920
non-stop you know and they're going to

1699
01:02:02,870 --> 01:02:01,520
make so many discoveries they're going

1700
01:02:04,549 --> 01:02:02,880
to make so many discoveries and they're

1701
01:02:06,069 --> 01:02:04,559
going to be like we're going to do this

1702
01:02:07,510 --> 01:02:06,079
slightly different less i mean that's

1703
01:02:09,910 --> 01:02:07,520
exactly what happened on apollo with the

1704
01:02:12,150 --> 01:02:09,920
six landed missions each of them built

1705
01:02:13,670 --> 01:02:12,160
upon the experience of the prior oh yeah

1706
01:02:15,270 --> 01:02:13,680
and we all do that in science and in

1707
01:02:18,069 --> 01:02:15,280
engineering we learn what works what

1708
01:02:19,990 --> 01:02:18,079
doesn't work and we we expand

1709
01:02:21,589 --> 01:02:20,000
in fact perhaps we might have a scenario

1710
01:02:23,190 --> 01:02:21,599
where the humans get first men they're

1711
01:02:23,990 --> 01:02:23,200
going to like i want a rover to go over

1712
01:02:25,430 --> 01:02:24,000
there

1713
01:02:28,069 --> 01:02:25,440

because you know what i haven't yet

1714
01:02:29,829 --> 01:02:28,079
developed my harness to do repelling off

1715
01:02:31,750 --> 01:02:29,839
of cliff

1716
01:02:33,349 --> 01:02:31,760
but i know a rover can do it with you

1717
01:02:34,710 --> 01:02:33,359
know some sort of design and then you

1718
01:02:36,630 --> 01:02:34,720
know a couple years later i've got my

1719
01:02:38,870 --> 01:02:36,640
repelling harness ready to go so you

1720
01:02:40,950 --> 01:02:38,880
know okay could be that all right yeah a

1721
01:02:42,470 --> 01:02:40,960
little better so we have time for one

1722
01:02:44,630 --> 01:02:42,480
last question

1723
01:02:49,670 --> 01:02:44,640
uh so

1724
01:02:52,230 --> 01:02:49,680
triple x y h v h triple x wants to know

1725
01:02:54,150 --> 01:02:52,240
um is radioactivity uh really a major

1726
01:02:55,829 --> 01:02:54,160
concern when traveling to and from earth

1727
01:02:58,309 --> 01:02:55,839
and how does this radiation affect your

1728
01:03:00,230 --> 01:02:58,319
instruments

1729
01:03:01,510 --> 01:03:00,240
it is it absolutely is and it needs to

1730
01:03:02,549 --> 01:03:01,520
be designed

1731
01:03:04,549 --> 01:03:02,559
into

1732
01:03:06,710 --> 01:03:04,559
all your considerations both for the

1733
01:03:07,589 --> 01:03:06,720
instruments and for humans

1734
01:03:09,109 --> 01:03:07,599
and so

1735
01:03:11,349 --> 01:03:09,119
our instrument

1736
01:03:13,190 --> 01:03:11,359
uses components and electronic parts

1737
01:03:15,190 --> 01:03:13,200
that are what was called flight

1738
01:03:17,510 --> 01:03:15,200

qualified for flight and what the what

1739
01:03:19,829 --> 01:03:17,520
that means is they've undergone testing

1740
01:03:22,309 --> 01:03:19,839
to show that radiation doesn't affect

1741
01:03:24,630 --> 01:03:22,319
them okay and for electronics we've been

1742
01:03:25,990 --> 01:03:24,640
sending probes to pluto and the voyagers

1743
01:03:27,430 --> 01:03:26,000
have left the syst you know the solar

1744
01:03:29,109 --> 01:03:27,440
system time and space so from an

1745
01:03:31,670 --> 01:03:29,119
electronics point of view we're kind of

1746
01:03:32,710 --> 01:03:31,680
smart on making things robust i mean the

1747
01:03:34,549 --> 01:03:32,720
challenges are when you have new

1748
01:03:35,829 --> 01:03:34,559
materials and really smaller transistors

1749
01:03:38,069 --> 01:03:35,839
transistors and the like that you'll

1750
01:03:41,029 --> 01:03:38,079
have to do but we have facilities here

1751
01:03:43,430 --> 01:03:41,039
to test them okay so um for that for the

1752
01:03:44,549 --> 01:03:43,440
the biology is the the other yeah so the

1753
01:03:46,470 --> 01:03:44,559
biology is the one that we're going to

1754
01:03:48,710 --> 01:03:46,480
have to be learning and adapting and

1755
01:03:49,670 --> 01:03:48,720
reacting to and being proactive as we go

1756
01:03:51,270 --> 01:03:49,680
forward

1757
01:03:53,589 --> 01:03:51,280
and also we're going to be wanting to

1758
01:03:54,549 --> 01:03:53,599
monitor um when the big solar storms

1759
01:03:56,309 --> 01:03:54,559
come

1760
01:03:58,069 --> 01:03:56,319
our understanding i mean we have

1761
01:04:00,870 --> 01:03:58,079
sentinels out in space right now that

1762
01:04:02,549 --> 01:04:00,880
are monitoring the solar um behavior and

1763
01:04:04,230 --> 01:04:02,559

whenever we get these solar storms that

1764
01:04:05,270 --> 01:04:04,240
could you know uh

1765
01:04:06,309 --> 01:04:05,280
you know when it happens and our

1766
01:04:09,270 --> 01:04:06,319
astronauts are on the international

1767
01:04:11,109 --> 01:04:09,280
space station um they go to a certain

1768
01:04:13,109 --> 01:04:11,119
part of the space station that's more

1769
01:04:15,349 --> 01:04:13,119
safer a safer place we're going to have

1770
01:04:17,029 --> 01:04:15,359
scenarios like that with our humans on

1771
01:04:20,230 --> 01:04:17,039
the moon as well and on you know

1772
01:04:22,789 --> 01:04:20,240
wherever they are next uh so uh it is a

1773
01:04:24,309 --> 01:04:22,799
concern but it's it's uh we're gonna

1774
01:04:26,549 --> 01:04:24,319
learn and we're gonna adapt and we're

1775
01:04:28,710 --> 01:04:26,559
gonna um you know

1776
01:04:30,950 --> 01:04:28,720
react and be also preventing things

1777
01:04:32,950 --> 01:04:30,960
the only thing i'll add is uh another

1778
01:04:34,470 --> 01:04:32,960
great use of water is radiation

1779
01:04:36,710 --> 01:04:34,480
shielding one of the best radiation

1780
01:04:38,710 --> 01:04:36,720
shields there is is water so there are

1781
01:04:40,470 --> 01:04:38,720
discussions about using regolith but

1782
01:04:42,390 --> 01:04:40,480
also in the safe room where you really

1783
01:04:44,230 --> 01:04:42,400
need extra protection

1784
01:04:45,029 --> 01:04:44,240
you have a layer of water that you find

1785
01:04:54,789 --> 01:04:45,039
on

1786
01:04:56,069 --> 01:04:54,799
for the last ten years um

1787
01:04:58,230 --> 01:04:56,079
uh

1788
01:05:00,710 --> 01:04:58,240

has you know uncovered these places that

1789
01:05:01,990 --> 01:05:00,720
are lava tubes these underground caverns

1790
01:05:03,990 --> 01:05:02,000
in the moon

1791
01:05:04,870 --> 01:05:04,000
and they're also places that we have to

1792
01:05:07,190 --> 01:05:04,880
explore

1793
01:05:08,789 --> 01:05:07,200
they're not quite at the poles but once

1794
01:05:10,549 --> 01:05:08,799
we've set up this infrastructure to

1795
01:05:13,029 --> 01:05:10,559
allow us to go anywhere on the lunar

1796
01:05:14,870 --> 01:05:13,039
surface yeah i bet you an early

1797
01:05:16,470 --> 01:05:14,880
destination after going to the polls

1798
01:05:17,910 --> 01:05:16,480
will be good to explore the underground

1799
01:05:20,470 --> 01:05:17,920
caverns

1800
01:05:21,349 --> 01:05:20,480
and that's also a place for potentially

1801
01:05:23,430 --> 01:05:21,359
uh

1802
01:05:26,630 --> 01:05:23,440
you could take advantage of the you know

1803
01:05:28,630 --> 01:05:26,640
what nature gave you as a shield right

1804
01:05:30,710 --> 01:05:28,640
go underground or underground exactly

1805
01:05:32,549 --> 01:05:30,720
excellent very cool so maybe there's

1806
01:05:34,230 --> 01:05:32,559
lava tubes on mars too so that's right

1807
01:05:35,349 --> 01:05:34,240
so you can figure out if you can work

1808
01:05:38,150 --> 01:05:35,359
this whole thing out on the moon you've

1809
01:05:40,630 --> 01:05:38,160
got it sorted from mars excellent

1810
01:05:42,630 --> 01:05:40,640
we got it all figured out

1811
01:05:44,230 --> 01:05:42,640
we have to go and do it yeah

1812
01:05:47,510 --> 01:05:44,240
it's all we're all talk right now once

1813
01:05:51,750 --> 01:05:47,520

we do it right then we can say

1814
01:05:53,349 --> 01:05:51,760
we're ready we've got 1656 days to do it

1815
01:05:55,829 --> 01:05:53,359
yeah i was just going to say before we

1816
01:05:58,150 --> 01:05:55,839
have to wind up we've been talking about

1817
01:05:59,349 --> 01:05:58,160
all these challenges and you guys sound

1818
01:06:00,470 --> 01:05:59,359
confident that we're going to figure it

1819
01:06:02,230 --> 01:06:00,480
out but we're going to need a lot of

1820
01:06:05,109 --> 01:06:02,240
help right so there might be people

1821
01:06:07,190 --> 01:06:05,119
listening who want to get in on that so

1822
01:06:09,589 --> 01:06:07,200
do you guys have an answer for

1823
01:06:11,349 --> 01:06:09,599
what's a what's a good way to prepare to

1824
01:06:12,470 --> 01:06:11,359
help nasa tackle these challenges down

1825
01:06:14,630 --> 01:06:12,480
the road

1826
01:06:16,390 --> 01:06:14,640
are there particular you know majors in

1827
01:06:17,589 --> 01:06:16,400
college you would do or skills you would

1828
01:06:20,309 --> 01:06:17,599
develop

1829
01:06:22,470 --> 01:06:20,319
one thing is it's important to note that

1830
01:06:24,870 --> 01:06:22,480
this isn't going back to put a new

1831
01:06:26,390 --> 01:06:24,880
footprint on the moon and then come home

1832
01:06:28,789 --> 01:06:26,400
it really is

1833
01:06:31,349 --> 01:06:28,799
to be a sustained presence

1834
01:06:32,710 --> 01:06:31,359
that is

1835
01:06:34,470 --> 01:06:32,720
with within open architectures can

1836
01:06:36,309 --> 01:06:34,480
really describe so it's involving

1837
01:06:39,670 --> 01:06:36,319
everybody from the commercial side to

1838
01:06:42,069 --> 01:06:39,680

industry to governments foreign nasa

1839
01:06:44,309 --> 01:06:42,079
agencies all nasa agencies

1840
01:06:46,549 --> 01:06:44,319
so uh

1841
01:06:48,710 --> 01:06:46,559
i really do think we're at a

1842
01:06:51,029 --> 01:06:48,720
dawn of a new age of exploration

1843
01:06:53,109 --> 01:06:51,039
and so the opportunities are going to be

1844
01:06:54,950 --> 01:06:53,119
incredible and vast in terms of being

1845
01:06:57,430 --> 01:06:54,960
able to participate

1846
01:06:59,750 --> 01:06:57,440
uh not only within a government agency

1847
01:07:02,390 --> 01:06:59,760
to get into space but you can now go

1848
01:07:05,910 --> 01:07:02,400
work at a company and get into space

1849
01:07:08,470 --> 01:07:05,920
yeah and eventually i do not doubt that

1850
01:07:09,670 --> 01:07:08,480
there won't only be nasa astronauts

1851
01:07:12,069 --> 01:07:09,680
there will be

1852
01:07:13,190 --> 01:07:12,079
corporate astronauts interesting we're

1853
01:07:17,430 --> 01:07:13,200
gonna need people who know how to build

1854
01:07:19,430 --> 01:07:17,440
things and fix things and improve things

1855
01:07:21,829 --> 01:07:19,440
and keep an infrastructure going so

1856
01:07:24,309 --> 01:07:21,839
basically saying you can do anything

1857
01:07:34,870 --> 01:07:24,319
just anywhere from business to

1858
01:07:41,190 --> 01:07:37,510
of international law

1859
01:07:43,430 --> 01:07:41,200
interplanetary law fascinating that we

1860
01:07:44,710 --> 01:07:43,440
haven't even begun to scratch really and

1861
01:07:47,190 --> 01:07:44,720
it's the basis of becoming a

1862
01:07:49,750 --> 01:07:47,200
space-faring civilization yeah that's

1863
01:07:51,910 --> 01:07:49,760

what's next yep we're there

1864
01:07:53,670 --> 01:07:51,920
we're there all right

1865
01:07:56,230 --> 01:07:53,680
well that is all the time we have for

1866
01:07:57,910 --> 01:07:56,240
today so a huge thanks to you guys our

1867
01:07:59,190 --> 01:07:57,920
guests and to everyone who joined us in

1868
01:08:00,150 --> 01:07:59,200
the twitch chat with your amazing

1869
01:08:03,190 --> 01:08:00,160
questions

1870
01:08:05,029 --> 01:08:03,200
we will be back on thursday july 18th

1871
01:08:07,990 --> 01:08:05,039
when we talk about the 50th anniversary

1872
01:08:09,510 --> 01:08:08,000
of the apollo moon landing and then tune

1873
01:08:12,390 --> 01:08:09,520
in the next day

1874
01:08:14,470 --> 01:08:12,400
friday july 19th for a special live

1875
01:08:16,789 --> 01:08:14,480
broadcast from nasa centers across the

1876
01:08:19,590 --> 01:08:16,799
country celebrating the apollo 50th as

1877
01:08:23,269 --> 01:08:19,600
we go forward to the moon so for more

1878
01:08:26,390 --> 01:08:23,279
info on that go to www.nasa.gov

1879
01:08:35,370 --> 01:08:26,400
apollo50 and we will see you next time