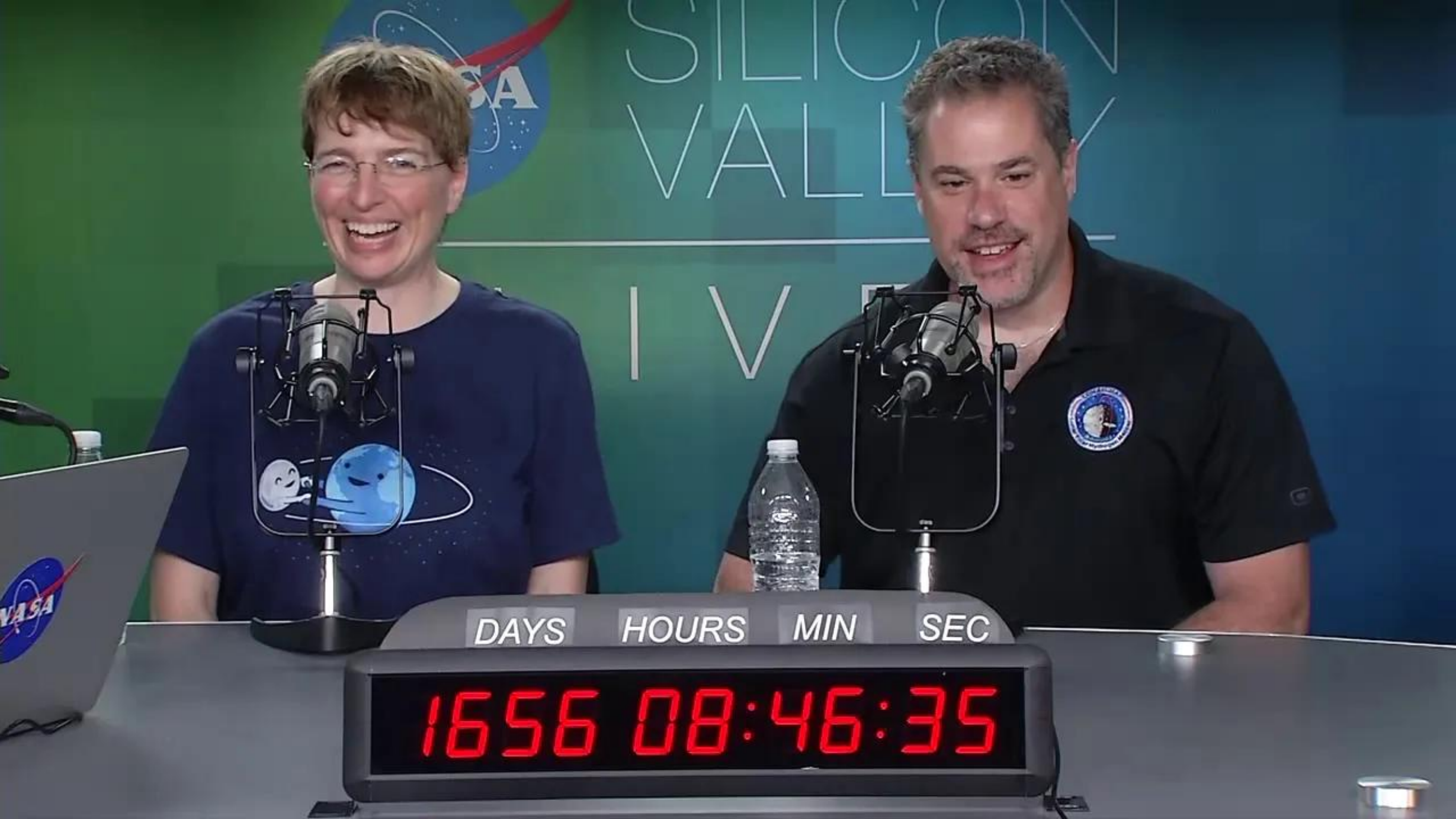
SILICON
VALLEY
DAYS HOURS MIN SEC
1656 08:46:35

1
00:00:23,689 --> 00:00:17,070
[Music]

2
00:00:26,060 --> 00:00:23,699
hey what's up everybody welcome welcome

3
00:00:30,290 --> 00:00:26,070
welcome back to NASA in Silicon Valley

4
00:00:32,269 --> 00:00:30,300
live if this is your first time with the

5
00:00:34,579 --> 00:00:32,279
show NASA and Silicon Valley live is a

6
00:00:36,350 --> 00:00:34,589
conversational show out of NASA's Ames

7
00:00:38,329 --> 00:00:36,360
Research Center where we talk about all

8
00:00:38,930 --> 00:00:38,339
the nerdy NASA news you need to know

9
00:00:42,139 --> 00:00:38,940
about

10
00:00:44,540 --> 00:00:42,149
I'm your host today Abby Tabor and I

11
00:00:47,450 --> 00:00:44,550
have with me the extraordinary Daniel

12
00:00:50,000 --> 00:00:47,460
Carmichael hi everybody

13
00:00:52,429 --> 00:00:50,010

I am your co-host Danielle Carmichael

14
00:00:54,859 --> 00:00:52,439
and it is great to be back if you don't

15
00:00:57,799 --> 00:00:54,869
know we are simultaneously live on

16
00:00:59,990 --> 00:00:57,809
twitch YouTube face Facebook and

17
00:01:01,999 --> 00:01:00,000
periscope but if you want to participate

18
00:01:03,890 --> 00:01:02,009
in the chat and ask our guest some

19
00:01:09,800 --> 00:01:03,900
questions there's only one place to do

20
00:01:12,170 --> 00:01:09,810
that and that's a www.twitch.tv/esa okay

21
00:01:13,700 --> 00:01:12,180
so speaking of NASA news we have a

22
00:01:18,920 --> 00:01:13,710
really big announcement to make today

23
00:01:21,649 --> 00:01:18,930
are you guys ready are you ready okay we

24
00:01:23,660 --> 00:01:21,659
are returning astronauts to the moon and

25
00:01:24,230 --> 00:01:23,670
this is really exciting so we have for

26
00:01:25,760 --> 00:01:24,240
you today

27
00:01:27,440 --> 00:01:25,770
two of our experts we're going to talk

28
00:01:30,560 --> 00:01:27,450
about some of the plans that NASA has

29
00:01:33,590 --> 00:01:30,570
for returning to the moon so let me

30
00:01:36,620 --> 00:01:33,600
introduce you to Tony and Kimberly so

31
00:01:37,850 --> 00:01:36,630
why don't you two tell the audience who

32
00:01:40,039 --> 00:01:37,860
you are a little bit about yourselves

33
00:01:41,660 --> 00:01:40,049
Kimberly I'm Kimberly

34
00:01:43,700 --> 00:01:41,670
Anika Smith I am a research

35
00:01:46,310 --> 00:01:43,710
astrophysicist here at NASA Ames

36
00:01:47,360 --> 00:01:46,320
Research Center in Silicon Valley and I

37
00:01:51,620 --> 00:01:47,370
work on space missions

38
00:01:53,960 --> 00:01:51,630

Aeolus thanks I'm Tony Cole pre I'm also

39
00:01:57,350 --> 00:01:53,970
here at NASA Ames Research Center I'm a

40
00:01:59,990 --> 00:01:57,360
planetary scientist and work on space

41
00:02:18,050 --> 00:02:00,000
instruments space missions things like

42
00:02:20,809 --> 00:02:18,060
that all right cool so let's start with

43
00:02:24,979 --> 00:02:20,819
the basics of returning humans to the

44
00:02:26,980 --> 00:02:24,989
moon when's this gonna happen the clock

45
00:02:28,089 --> 00:02:26,990
I think of in front says yeah

46
00:02:43,460 --> 00:02:28,099
[Music]

47
00:02:46,850 --> 00:02:43,470
do the math 656 days counting down the

48
00:02:49,960 --> 00:02:46,860
days until the Year 2024 which is when

49
00:02:53,210 --> 00:02:49,970
the first woman and the next person

50
00:02:54,800 --> 00:02:53,220
perhaps it's a man perhaps a woman will

51
00:02:57,500 --> 00:02:54,810
set foot on the moon right that's right

52
00:02:59,780 --> 00:02:57,510
that's a be a historic historic moment

53
00:03:01,940 --> 00:02:59,790
exactly so let's talk about this mission

54
00:03:04,490 --> 00:03:01,950
let everybody know what it's called to

55
00:03:05,300 --> 00:03:04,500
start us off well we're calling it

56
00:03:12,830 --> 00:03:05,310
Artemis

57
00:03:18,009 --> 00:03:12,840
so significant about that name well

58
00:03:30,349 --> 00:03:22,130
mythology Artemis is the twin sister of

59
00:03:32,960 --> 00:03:30,359
Apollo you know about the Apollo program

60
00:03:35,750 --> 00:03:32,970
that's when we did send the first humans

61
00:03:37,190 --> 00:03:35,760
to set foot on the moon right exactly so

62
00:03:39,319 --> 00:03:37,200
the next are going under the Artemis

63
00:03:41,569 --> 00:03:39,329

mission and I might add that when I was

64
00:03:54,349 --> 00:03:41,579
in fifth grade we did Greek mythology

65
00:03:57,349 --> 00:03:54,359
and My Goddess very excited for this so

66
00:03:59,390 --> 00:03:57,359
why the moon what is so exciting for a

67
00:04:02,689 --> 00:03:59,400
couple of scientists about going back to

68
00:04:06,530 --> 00:04:02,699
the moon oh boy where to start the moon

69
00:04:08,990 --> 00:04:06,540
is a spectacular place it's it's her

70
00:04:12,020 --> 00:04:09,000
nearest neighbor it's a treasure trove

71
00:04:14,000 --> 00:04:12,030
of science of exploration its place

72
00:04:16,539 --> 00:04:14,010
where we can learn about the history of

73
00:04:19,310 --> 00:04:16,549
the earth in our solar system it's also

74
00:04:22,029 --> 00:04:19,320
really a launching pad in terms of our

75
00:04:24,589 --> 00:04:22,039
exploration beyond Earth there's

76
00:04:26,990 --> 00:04:24,599
resources there we can utilize to

77
00:04:31,250 --> 00:04:27,000
explore but there's also just the

78
00:04:34,520 --> 00:04:31,260
opportunity to test our abilities or

79
00:04:36,589 --> 00:04:34,530
technologies or processes for extended

80
00:04:38,630 --> 00:04:36,599
missions beyond the moon to Mars for

81
00:04:40,999 --> 00:04:38,640
example that's the ultimate destination

82
00:04:43,010 --> 00:04:41,009
beyond me the moon right now but

83
00:04:46,100 --> 00:04:43,020
and beyond that to asteroids and other

84
00:04:48,499 --> 00:04:46,110
places Wow so it's a it's a huge sandbox

85
00:04:51,469 --> 00:04:48,509
if you will have really learned in and

86
00:04:54,040 --> 00:04:51,479
and and demonstrate what we can do to

87
00:04:57,679 --> 00:04:54,050
explore yeah well said yeah and also

88
00:05:00,769 --> 00:04:57,689

looking at just the moon itself we know

89
00:05:04,609 --> 00:05:00,779
a lot about it but we've not really

90
00:05:06,589 --> 00:05:04,619
visited a lot fraction of the surface or

91
00:05:07,939 --> 00:05:06,599
even the environment of the moon okay so

92
00:05:10,339 --> 00:05:07,949
there's a lot of mysteries you still yet

93
00:05:12,889 --> 00:05:10,349
to be uncovered yeah yes on the surface

94
00:05:15,950 --> 00:05:12,899
and underneath the surface okay and yeah

95
00:05:17,149 --> 00:05:15,960
absolutely and you know mention the

96
00:05:19,939 --> 00:05:17,159
Apollo program we've been there

97
00:05:20,929 --> 00:05:19,949
robotically we have a robot spacecraft

98
00:05:23,299 --> 00:05:20,939
orbiting it now

99
00:05:25,279 --> 00:05:23,309
but we've only barely scratched the

100
00:05:27,320 --> 00:05:25,289
surface in terms of the amount of area

101
00:05:29,510 --> 00:05:27,330
we've explored on the moon there's so

102
00:05:31,459 --> 00:05:29,520
much more to learn imagine awesome all

103
00:05:38,089 --> 00:05:31,469
right so you were anxiously anticipating

104
00:05:40,040 --> 00:05:38,099
very 1656 days from now you'll be

105
00:05:41,510 --> 00:05:40,050
watching that clock closely I guess yeah

106
00:05:43,129 --> 00:05:41,520
all right so tell us a little bit more

107
00:05:46,100 --> 00:05:43,139
specifically where are we sending

108
00:05:48,469 --> 00:05:46,110
astronauts in 2024 well this is what I

109
00:05:50,540 --> 00:05:48,479
was gonna actually just say was what's

110
00:05:52,489 --> 00:05:50,550
really really exciting is where you are

111
00:05:53,869 --> 00:05:52,499
going where we've never been before and

112
00:05:56,269 --> 00:05:53,879
that's to one of the poles of the Moon

113
00:06:03,079 --> 00:05:56,279

and very specifically the South Pole or

114
00:06:06,559 --> 00:06:03,089
the moon which is my favorite pole and

115
00:06:10,369 --> 00:06:06,569
it's it's an incredible place and we can

116
00:06:13,999 --> 00:06:10,379
talk about that as we go but it's full

117
00:06:16,610 --> 00:06:14,009
of spectacular topography moving shadows

118
00:06:19,850 --> 00:06:16,620
extreme temperatures it's unlike

119
00:06:21,499 --> 00:06:19,860
anywhere we've ever visited and we are

120
00:06:21,829 --> 00:06:21,509
gonna talk about that later I'm excited

121
00:06:24,619 --> 00:06:21,839
for that

122
00:06:30,709 --> 00:06:24,629
but you mentioned resources now there's

123
00:06:33,230 --> 00:06:30,719
water there isn't there yes true

124
00:06:34,909 --> 00:06:33,240
statement okay so why is that so

125
00:06:37,279 --> 00:06:34,919
important obviously I know humans need

126
00:06:39,799 --> 00:06:37,289
water to survive but but what do you see

127
00:06:44,199 --> 00:06:39,809
us using that for lots of other purposes

128
00:06:47,360 --> 00:06:44,209
right yeah well water is key in the

129
00:06:49,519 --> 00:06:47,370
water is so important for two different

130
00:06:51,290 --> 00:06:49,529
reasons one it's it's an incredibly

131
00:06:52,879 --> 00:06:51,300
scientifically interesting and

132
00:06:54,679 --> 00:06:52,889
understanding the water the

133
00:06:56,600 --> 00:06:54,689
now no exists on the moon is really

134
00:06:58,010 --> 00:06:56,610
important to understanding the processes

135
00:06:59,689 --> 00:06:58,020
that have acted on the moon and the

136
00:07:00,559 --> 00:06:59,699
earth over the last several billion

137
00:07:02,839 --> 00:07:00,569
years Wow

138
00:07:04,399 --> 00:07:02,849

yeah and I like to think of the ice at

139
00:07:06,140 --> 00:07:04,409
the poles is almost like ice quarters

140
00:07:07,820 --> 00:07:06,150
here on earth if we can examine that

141
00:07:11,209 --> 00:07:07,830
water ice we can actually look back into

142
00:07:13,879 --> 00:07:11,219
the history of the solar system but also

143
00:07:17,719 --> 00:07:13,889
just as important it is a valuable

144
00:07:20,749 --> 00:07:17,729
resource and as we probably all know

145
00:07:25,040 --> 00:07:20,759
water contains two hydrogen and an

146
00:07:26,510 --> 00:07:25,050
oxygen atom and hydrogen and oxygen are

147
00:07:28,999 --> 00:07:26,520
exactly the ingredients that go into

148
00:07:31,550 --> 00:07:29,009
rocket fuel and rather than spending

149
00:07:32,929 --> 00:07:31,560
lots of rocket fuels to bring rocket

150
00:07:35,119 --> 00:07:32,939
fuel into space which is what would be

151
00:07:37,010 --> 00:07:35,129
now right it'd be great if we could

152
00:07:38,089 --> 00:07:37,020
actually find a resource and produce

153
00:07:40,519 --> 00:07:38,099
rocket fuel

154
00:07:41,959 --> 00:07:40,529
outside the gravity well of Earth that

155
00:07:43,399 --> 00:07:41,969
would not only make things more

156
00:07:46,040 --> 00:07:43,409
affordable it's actually it could be

157
00:07:50,540 --> 00:07:46,050
enabling of new architectures for

158
00:07:52,939 --> 00:07:50,550
exploring Mars and beyond the oxygen in

159
00:07:56,510 --> 00:07:52,949
itself is what we breathe yeah of course

160
00:07:59,800 --> 00:07:56,520
and the the techniques and the approach

161
00:08:03,379 --> 00:07:59,810
to how we excavate water on the moon is

162
00:08:06,649 --> 00:08:03,389
applicable to even doing it on Mars so

163
00:08:08,869 --> 00:08:06,659

if you're looking for long-term human

164
00:08:12,019 --> 00:08:08,879
presence on other worlds and truly

165
00:08:13,490 --> 00:08:12,029
becoming interplanetary species we can

166
00:08:15,529 --> 00:08:13,500
be creating the oxygen that we breathe

167
00:08:19,490 --> 00:08:15,539
in the habitats in which we're living in

168
00:08:22,279 --> 00:08:19,500
off world we're actually talking about

169
00:08:26,420 --> 00:08:22,289
that you know is it future reality not

170
00:08:29,510 --> 00:08:26,430
just a plotline I actually have a couple

171
00:08:34,430 --> 00:08:29,520
of shout outs so snail says that the

172
00:08:36,199 --> 00:08:34,440
Earth and Moon shirt is awesome said

173
00:08:37,340 --> 00:08:36,209
it's great to see Tony and Kimberly

174
00:08:41,480 --> 00:08:37,350
again yeah

175
00:08:45,240 --> 00:08:41,490
[Music]

176
00:08:50,210 --> 00:08:45,250
outstanding Wow all right do you have

177
00:08:53,490 --> 00:08:50,220
any questions yet Daniella I do so moon

178
00:08:56,249 --> 00:08:53,500
mo most writes wants to know like what's

179
00:08:59,009 --> 00:08:56,259
the end long-term goal of the Artemis

180
00:09:01,110 --> 00:08:59,019
mission because we've been talking it up

181
00:09:04,079 --> 00:09:01,120
but yeah that's a great question you

182
00:09:07,350 --> 00:09:04,089
want to so Artemis is a term to describe

183
00:09:10,199 --> 00:09:07,360
it a whole series of missions to the

184
00:09:12,600 --> 00:09:10,209
lunar surface and using a an orbital

185
00:09:14,670 --> 00:09:12,610
tugboat interplanetary spaceship called

186
00:09:16,949 --> 00:09:14,680
the Gateway it's a big architecture but

187
00:09:19,050 --> 00:09:16,959
in the long term opening it up with many

188
00:09:21,059 --> 00:09:19,060

partners are long on this journey we

189
00:09:25,170 --> 00:09:21,069
have a sustainable presence on the moon

190
00:09:28,139 --> 00:09:25,180
where we are you know providing the

191
00:09:30,540 --> 00:09:28,149
infrastructure for us to stay there for

192
00:09:34,079 --> 00:09:30,550
building materials to creating the

193
00:09:36,059 --> 00:09:34,089
rocket fuel to exploring areas that

194
00:09:38,610 --> 00:09:36,069
we've never been before the you know

195
00:09:41,040 --> 00:09:38,620
actually going into the the depths of

196
00:09:42,809 --> 00:09:41,050
craters that we haven't explored yet and

197
00:09:45,210 --> 00:09:42,819
pieces of the moon we don't see so that

198
00:09:46,679 --> 00:09:45,220
long-term presence on the moon but while

199
00:09:48,540 --> 00:09:46,689
we're using those techniques that's

200
00:09:50,999 --> 00:09:48,550
become applicable for it to that next

201
00:09:54,240 --> 00:09:51,009
step you know we're living off Earth on

202
00:09:55,620 --> 00:09:54,250
another world in a harsh environment and

203
00:09:57,809 --> 00:09:55,630
learning to deal with those challenges

204
00:10:00,030 --> 00:09:57,819
and solving those challenges and once

205
00:10:02,040 --> 00:10:00,040
we've got that under our belt and we've

206
00:10:05,160 --> 00:10:02,050
understood our neighborhood background

207
00:10:06,840 --> 00:10:05,170
our backyard we can take that easily to

208
00:10:08,730 --> 00:10:06,850
Mars yeah oh cool

209
00:10:10,139 --> 00:10:08,740
I see lots of other great questions but

210
00:10:11,519 --> 00:10:10,149
I know that some of them are going to

211
00:10:13,079 --> 00:10:11,529
answer yes see in the next few minutes

212
00:10:15,780 --> 00:10:13,089
so let's keep going

213
00:10:17,460 --> 00:10:15,790

I just want to touch back on the water a

214
00:10:20,100 --> 00:10:17,470
little bit how much are we actually

215
00:10:22,679 --> 00:10:20,110
talking about I know you two have worked

216
00:10:25,790 --> 00:10:22,689
together on a past mission that found

217
00:10:30,390 --> 00:10:29,100
launched 10 years ago yesterday

218
00:10:33,579 --> 00:10:30,400
yesterday

219
00:10:36,980 --> 00:10:33,589
[Music]

220
00:10:39,079 --> 00:10:36,990
and and the mission we launched with LRO

221
00:10:41,660 --> 00:10:39,089
the Lunar Reconnaissance Orbiter is

222
00:10:43,699 --> 00:10:41,670
still in orbit around moon still

223
00:10:45,559 --> 00:10:43,709
collecting data and making fantastic

224
00:10:49,819 --> 00:10:45,569
maps of the lunar surface which actually

225
00:10:51,169 --> 00:10:49,829
was really enabling of Artemis able to

226
00:10:53,689 --> 00:10:51,179
go forward awesome yeah

227
00:10:56,030 --> 00:10:53,699
yeah so the yeah Kim and I were both

228
00:10:58,340 --> 00:10:56,040
part of the L cross mission which was a

229
00:11:00,530 --> 00:10:58,350
mission that crashed a spent upper stage

230
00:11:02,359 --> 00:11:00,540
of rocket into a permanently shadowed

231
00:11:05,119 --> 00:11:02,369
crater at the South Pole of the moon and

232
00:11:08,030 --> 00:11:05,129
the purpose was to understand the nature

233
00:11:10,189 --> 00:11:08,040
of hydrogen we had measured there prior

234
00:11:11,869 --> 00:11:10,199
with a different mission and saw an

235
00:11:13,999 --> 00:11:11,879
excess of this hydrogen we didn't know

236
00:11:15,799 --> 00:11:14,009
if the hydrogen was water or just sort

237
00:11:18,410 --> 00:11:15,809
of protons which is hydrogen atoms

238
00:11:21,769 --> 00:11:18,420

trapped in the soil or what and and our

239
00:11:24,290 --> 00:11:21,779
job was to actually understand it to see

240
00:11:26,869 --> 00:11:24,300
if it could potentially be a resource so

241
00:11:29,569 --> 00:11:26,879
it was a very targeted mission see what

242
00:11:32,829 --> 00:11:29,579
that water actually a little bit like

243
00:11:41,840 --> 00:11:32,839
what is a permanently shadowed crater

244
00:11:44,509 --> 00:11:41,850
good question and the illumination of

245
00:11:47,090 --> 00:11:44,519
the Sun there are places at both poles

246
00:11:49,400 --> 00:11:47,100
of the moon where the extreme topography

247
00:11:51,259 --> 00:11:49,410
the rims of the craters of the moon the

248
00:11:54,199 --> 00:11:51,269
Sun didn't does not get above those rims

249
00:11:55,970 --> 00:11:54,209
so the basin's of those craters are in

250
00:11:57,889 --> 00:11:55,980
permanent shadow and they have been in

251
00:12:00,619 --> 00:11:57,899
permanent shadow for you know four

252
00:12:02,239 --> 00:12:00,629
billion years Wow and being in the

253
00:12:05,509 --> 00:12:02,249
shadows if you remember if you were out

254
00:12:07,160 --> 00:12:05,519
in a hot day and you go underneath the

255
00:12:09,769 --> 00:12:07,170
shadow of a tree you'll notice that

256
00:12:10,910 --> 00:12:09,779
things get a little cooler well and if

257
00:12:12,679 --> 00:12:10,920
you're in a permanently shadowed place

258
00:12:16,519 --> 00:12:12,689
on the moon things get really really

259
00:12:18,499 --> 00:12:16,529
cold so these these what was interesting

260
00:12:20,269 --> 00:12:18,509
about a Tony was mentioning this orbiter

261
00:12:22,999 --> 00:12:20,279
mission that had found hydrogen it was

262
00:12:24,650 --> 00:12:23,009
concentrated at the poles and there was

263
00:12:26,470 --> 00:12:24,660

a correlation with the permanently

264
00:12:28,579 --> 00:12:26,480
shadowed craters so there was this

265
00:12:30,619 --> 00:12:28,589
connection between lots amounts of

266
00:12:33,559 --> 00:12:30,629
hydrogen in very cold places that had

267
00:12:37,039 --> 00:12:33,569
never seen sunlight and actually it was

268
00:12:39,350 --> 00:12:37,049
a theorize that these craters would have

269
00:12:42,590 --> 00:12:39,360
cold bottoms and could hold water as

270
00:12:44,180 --> 00:12:42,600
early as 1961 oh really when we first

271
00:12:46,400 --> 00:12:44,190
were really understanding topography

272
00:12:50,390 --> 00:12:46,410
even before the Apollo program really

273
00:12:54,130 --> 00:12:50,400
got you know off and running and so it

274
00:12:56,600 --> 00:12:54,140
wasn't though until 10 years ago we

275
00:12:59,150 --> 00:12:56,610
verified the form of that hydrogen one

276
00:12:59,930 --> 00:12:59,160
of these cold craters as water ice so

277
00:13:03,790 --> 00:12:59,940
let's review

278
00:13:07,400 --> 00:13:06,230
observation and sensing satellite yes

279
00:13:09,860 --> 00:13:07,410
okay all right okay

280
00:13:13,790 --> 00:13:09,870
we hit a crater at the Lunar South Pole

281
00:13:15,530 --> 00:13:13,800
and that's Tony's favorite and where the

282
00:13:17,540 --> 00:13:15,540
future astronauts will be landing

283
00:13:21,920 --> 00:13:17,550
exactly wait okay and do you remember

284
00:13:23,840 --> 00:13:21,930
how much water L cross saw yes point

285
00:13:27,410 --> 00:13:23,850
measurement right it made a crater about

286
00:13:41,870 --> 00:13:27,420
35 meters across half a football field

287
00:13:44,120 --> 00:13:41,880
or so across and it brought ejecta up

288
00:13:49,220 --> 00:13:44,130

into sunlight so we could examine it and

289
00:13:50,840 --> 00:13:49,230
its shadow eventually reaches sunlight

290
00:13:53,450 --> 00:13:50,850
and what I always like to think about

291
00:13:55,520 --> 00:13:53,460
that that's that soil and seen sunlight

292
00:13:58,460 --> 00:13:55,530
in billions of years it's crazy yeah

293
00:14:00,620 --> 00:13:58,470
and in just the dirt we threw up into

294
00:14:04,790 --> 00:14:00,630
the cloud or into the Sun sorry we saw

295
00:14:07,670 --> 00:14:04,800
about 152 gallons of water okay and if

296
00:14:08,810 --> 00:14:07,680
you take all if you take that

297
00:14:10,880 --> 00:14:08,820
measurement and all the other

298
00:14:14,600 --> 00:14:10,890
measurements we have of hydrogen at the

299
00:14:17,030 --> 00:14:14,610
poles and make some assumptions about

300
00:14:20,600 --> 00:14:17,040
how its distributed with depth we're

301
00:14:23,900 --> 00:14:20,610
talking 10 million potentially up to a

302
00:14:29,480 --> 00:14:23,910
hundred million tons metric tons of

303
00:14:31,310 --> 00:14:29,490
water ice it's a lot I think so I think

304
00:14:41,950 --> 00:14:31,320
Kim and I were talking beforehand and it

305
00:14:50,060 --> 00:14:48,200
important science to be clear none of

306
00:14:56,120 --> 00:14:50,070
this is flowing liquid water this is

307
00:14:59,000 --> 00:14:56,130
crystal temperatures are about minus 202

308
00:15:01,100 --> 00:14:59,010
minus 240 or so below zero centigrade

309
00:15:03,380 --> 00:15:01,110
okay and this was the first time we ever

310
00:15:05,510 --> 00:15:03,390
sampled the bottom of a permanently

311
00:15:06,530 --> 00:15:05,520
shadowed crater I mean since then this

312
00:15:09,890 --> 00:15:06,540
has the experiment has been repeated

313
00:15:11,150 --> 00:15:09,900

okay and and not only did we find water

314
00:15:14,900 --> 00:15:11,160
but there was a bunch of other things

315
00:15:18,770 --> 00:15:14,910
that were excavated as well gold mercury

316
00:15:21,170 --> 00:15:18,780
argon carbon monoxide and so it's

317
00:15:23,000 --> 00:15:21,180
opening up these questions when we're

318
00:15:24,920 --> 00:15:23,010
gonna have humans and robots going to

319
00:15:27,650 --> 00:15:24,930
the polls of their South Poles of Moon

320
00:15:29,690 --> 00:15:27,660
we're gonna get the boots on ground the

321
00:15:32,120 --> 00:15:29,700
wheels on ground and really understand

322
00:15:33,680 --> 00:15:32,130
what's there because we've never been

323
00:15:35,390 --> 00:15:33,690
there before and we just have this you

324
00:15:37,460 --> 00:15:35,400
know simple impactor experiment that

325
00:15:39,230 --> 00:15:37,470
open more questions than it answered but

326
00:15:40,730 --> 00:15:39,240
it answered one particular one right the

327
00:15:43,460 --> 00:15:40,740
hydrogen is definitely in the form of

328
00:15:46,250 --> 00:15:43,470
water ice and enough such that there is

329
00:15:48,470 --> 00:15:46,260
the resources to enable the exploration

330
00:15:50,960 --> 00:15:48,480
exciting yeah another good way to put in

331
00:15:51,590 --> 00:15:50,970
perspective is El cross about 5% by

332
00:15:53,630 --> 00:15:51,600
weight

333
00:15:55,640 --> 00:15:53,640
water water in the regolith in the dirt

334
00:15:57,170 --> 00:15:55,650
and regular this lunar dirt for

335
00:16:00,980 --> 00:15:57,180
comparison that's about what you have it

336
00:16:02,960 --> 00:16:00,990
in the Sahara ok wettest places on the

337
00:16:08,810 --> 00:16:02,970
moon is as wet as the driest places on

338
00:16:10,580 --> 00:16:08,820

earth okay that's the engineering

339
00:16:12,140 --> 00:16:10,590
challenge ahead that we will solve it

340
00:16:15,050 --> 00:16:12,150
excavate it because we know it's there

341
00:16:17,030 --> 00:16:15,060
we can extract you know water has been

342
00:16:19,700 --> 00:16:17,040
extracted from very dry places okay yes

343
00:16:23,510 --> 00:16:19,710
yeah that can be done can we will do it

344
00:16:25,490 --> 00:16:23,520
how exciting awesome so I want to know

345
00:16:26,840 --> 00:16:25,500
then what's next okay we know the people

346
00:16:28,910 --> 00:16:26,850
will we'll get there we're gonna send

347
00:16:31,580 --> 00:16:28,920
people there let's talk about how so

348
00:16:33,050 --> 00:16:31,590
what's the rocket that's going to take

349
00:16:35,690 --> 00:16:33,060
people on the fur on the art herbs

350
00:16:38,450 --> 00:16:35,700
Artemis missions to the moon who wants

351
00:16:41,030 --> 00:16:38,460
to take that Space Launch System that's

352
00:16:43,690 --> 00:16:41,040
it the SLS yeah an animation I think of

353
00:16:48,889 --> 00:16:43,700
it too that's right yes there it is

354
00:16:55,369 --> 00:16:52,609
and it's to bring humans not only to the

355
00:16:58,249 --> 00:16:55,379
moon but actually beyond to their it

356
00:17:00,199 --> 00:16:58,259
carries them in a capsule that's on the

357
00:17:03,410 --> 00:17:00,209
very tip of that that just went past the

358
00:17:06,669 --> 00:17:03,420
frame called the Orion capsule very

359
00:17:14,990 --> 00:17:06,679
small capsule up there but that capsule

360
00:17:17,899 --> 00:17:15,000
you'll see them is designed to take an

361
00:17:20,990 --> 00:17:17,909
incredible amount of material to you

362
00:17:23,809 --> 00:17:21,000
know deep space so it is servicing Moon

363
00:17:26,149 --> 00:17:23,819

and Mars and also elsewhere I mean it

364
00:17:27,620 --> 00:17:26,159
also has amazing commercial spin-offs as

365
00:17:29,659 --> 00:17:27,630
well because you can actually put up a

366
00:17:35,510 --> 00:17:29,669
replacement so say the GPS satellites

367
00:17:37,880 --> 00:17:35,520
and in a single SLS rocket it's the way

368
00:17:41,000 --> 00:17:37,890
we do other types of things in the

369
00:17:43,250 --> 00:17:41,010
agency so it's one of many uses of a

370
00:17:47,120 --> 00:17:43,260
large rocket that's been you know can be

371
00:17:49,639 --> 00:17:47,130
utilized how awesome Danielle you jump

372
00:17:50,510 --> 00:17:49,649
in whenever you have to the question but

373
00:17:56,750 --> 00:17:50,520
otherwise you're gonna keep talking

374
00:17:59,149 --> 00:17:56,760
about so that was SLS the rocket and so

375
00:18:00,889 --> 00:17:59,159
let's see the Orion capsule animation

376
00:18:03,500 --> 00:18:00,899
and tell us a little bit about so Ryan

377
00:18:05,210 --> 00:18:03,510
is there it is a the capsule that will

378
00:18:08,120 --> 00:18:05,220
bring the astronauts wherever they're

379
00:18:11,810 --> 00:18:08,130
gonna go and this indeed can go not just

380
00:18:14,299 --> 00:18:11,820
to the moon but also beyond the Mars and

381
00:18:17,060 --> 00:18:14,309
after you know a lot of analysis and

382
00:18:20,269 --> 00:18:17,070
study it was eventually concluded that

383
00:18:22,880 --> 00:18:20,279
the the Apollo shape the blunt-nosed

384
00:18:25,970 --> 00:18:22,890
reentry system that Apollo used is still

385
00:18:28,190 --> 00:18:25,980
a best way to go forward

386
00:18:30,230 --> 00:18:28,200
look how roomy if you're looking into

387
00:18:35,389 --> 00:18:30,240
this video look how roomy this one is

388
00:18:37,370 --> 00:18:35,399

compared to the Apollo documentary the

389
00:18:42,289 --> 00:18:37,380
movie theaters you get a feel for how

390
00:18:45,010 --> 00:18:42,299
tight the whole sits for and it's a lot

391
00:18:49,000 --> 00:18:45,020
more powerful in every single way from

392
00:18:52,340 --> 00:18:49,010
information systems guidance payload

393
00:18:55,220 --> 00:18:52,350
everything and and and it's meant to be

394
00:18:58,070 --> 00:18:55,230
able to carry humans longer distance way

395
00:19:00,260 --> 00:18:58,080
beyond the moon okay so it is really is

396
00:19:01,050 --> 00:19:00,270
Apollo on steroids I'd like to say

397
00:19:03,630 --> 00:19:01,060
that's

398
00:19:05,730 --> 00:19:03,640
I love that it's kept some of the same

399
00:19:09,030 --> 00:19:05,740
design as Apollo way to go Apollo

400
00:19:10,590 --> 00:19:09,040
engineers these are some pretty tough

401
00:19:13,050 --> 00:19:10,600
challenges and they made happens I guess

402
00:19:15,870 --> 00:19:13,060
we know we can do this actually have a

403
00:19:18,000 --> 00:19:15,880
question from digital dawn dawn sure it

404
00:19:20,640 --> 00:19:18,010
wants to know are you using specifically

405
00:19:23,280 --> 00:19:20,650
any Apollo era research or tech on the

406
00:19:25,890 --> 00:19:23,290
quest to return back to the moon well

407
00:19:28,140 --> 00:19:25,900
the the shape I just mentioned is really

408
00:19:30,630 --> 00:19:28,150
was derived originally through the

409
00:19:34,080 --> 00:19:30,640
Apollo program the shape of that capsule

410
00:19:36,660 --> 00:19:34,090
is very critical to enabling the reentry

411
00:19:39,240 --> 00:19:36,670
and and and this capsule is meant to

412
00:19:42,240 --> 00:19:39,250
re-enter parachute and splashdown and

413
00:19:44,250 --> 00:19:42,250

the ocean just like the Apollo program

414
00:19:47,100 --> 00:19:44,260
did and speaking of reentry

415
00:19:50,610 --> 00:19:47,110
here at NASA Ames we develop and test

416
00:19:52,350 --> 00:19:50,620
the thermal reentry materials and for

417
00:19:55,730 --> 00:19:52,360
the Apollo program as chemists a

418
00:19:57,690 --> 00:19:55,740
chemical compound called avcoat and

419
00:19:59,400 --> 00:19:57,700
therefore that re-entry through the

420
00:20:01,260 --> 00:19:59,410
atmosphere and they would have blade so

421
00:20:02,820 --> 00:20:01,270
they would absorb the heat and then you

422
00:20:05,820 --> 00:20:02,830
know protect the capsule to a

423
00:20:09,990 --> 00:20:05,830
successfully return to preparation for

424
00:20:12,120 --> 00:20:10,000
Orion engineers looked at F coat and he

425
00:20:14,490 --> 00:20:12,130
modified the chemistry of that and did a

426
00:20:16,740 --> 00:20:14,500
lot of the testing so there's a direct

427
00:20:19,800 --> 00:20:16,750
connection even with the materials that

428
00:20:22,080 --> 00:20:19,810
were used during Apollo and he's

429
00:20:25,230 --> 00:20:22,090
modified for the shape of the capsule

430
00:20:27,870 --> 00:20:25,240
but for to and to support even re-entry

431
00:20:29,340 --> 00:20:27,880
from further destinations say you're

432
00:20:30,900 --> 00:20:29,350
coming back from an asteroid or say

433
00:20:34,790 --> 00:20:30,910
you're coming back from Mars orbit or

434
00:20:38,760 --> 00:20:34,800
something like that to be different so

435
00:20:40,530 --> 00:20:38,770
it's smarter yeah all around I love that

436
00:20:42,150 --> 00:20:40,540
excellent and I love these apollo

437
00:20:45,300 --> 00:20:42,160
connections but then on the flip side

438
00:20:51,540 --> 00:20:45,310

how is the Artemis program different

439
00:20:52,830 --> 00:20:51,550
from Apollo well an element that we that

440
00:20:56,910 --> 00:20:52,840
I've mentioned briefly sorry about the

441
00:20:59,070 --> 00:20:56,920
spoilers is a is actually one of the

442
00:21:01,410 --> 00:20:59,080
cooler parts of the Artemis program it's

443
00:21:05,280 --> 00:21:01,420
this this object called the Gateway okay

444
00:21:07,470 --> 00:21:05,290
and the Gateway is our first

445
00:21:08,820 --> 00:21:07,480
interplanetary spaceship and this is

446
00:21:10,500 --> 00:21:08,830
something that NASA has never really

447
00:21:12,659 --> 00:21:10,510
built before hmm

448
00:21:16,260 --> 00:21:12,669
and that's why in a sense it's exciting

449
00:21:19,700 --> 00:21:16,270
I mean this space module sometimes we

450
00:21:22,919 --> 00:21:19,710
call spaceship will be in lunar orbit

451
00:21:26,909 --> 00:21:22,929
and it will provide the way to access

452
00:21:29,789 --> 00:21:26,919
all different parts of the Moon and it's

453
00:21:32,430 --> 00:21:29,799
also going to be crude but not 100% of

454
00:21:34,260 --> 00:21:32,440
the time so it has to be autonomous

455
00:21:37,770 --> 00:21:34,270
it'll have a lot of autonomy in it and

456
00:21:39,990 --> 00:21:37,780
it also would be providing a way to be a

457
00:21:42,659 --> 00:21:40,000
space laboratory so we can put

458
00:21:45,150 --> 00:21:42,669
experiments on board for understanding

459
00:21:47,659 --> 00:21:45,160
biology outside our magnetosphere

460
00:21:51,690 --> 00:21:47,669
it also can dock with all the different

461
00:21:53,880 --> 00:21:51,700
commercial and international partners it

462
00:21:55,590 --> 00:21:53,890
has an open architecture the port

463
00:21:57,000 --> 00:21:55,600

designs are gonna be available for

464
00:21:59,100 --> 00:21:57,010
anyone who wants to build things that

465
00:22:04,409 --> 00:21:59,110
connect to it the Apollo will connect

466
00:22:06,810 --> 00:22:04,419
Apollo will collect connect to and

467
00:22:08,880 --> 00:22:06,820
service modules but it has ability to

468
00:22:11,700 --> 00:22:08,890
change its orbit mm-hmm so it can also

469
00:22:13,230 --> 00:22:11,710
become this interplanetary tugboat

470
00:22:15,690 --> 00:22:13,240
because it can move things around and

471
00:22:17,850 --> 00:22:15,700
first enable travel I mean it's the

472
00:22:24,060 --> 00:22:17,860
transportation backbone for Mars

473
00:22:27,900 --> 00:22:24,070
exploration and we're going to this

474
00:22:29,909 --> 00:22:27,910
space ship will oh and we have an

475
00:22:31,710 --> 00:22:29,919
animation showing of this orbit in which

476
00:22:35,340 --> 00:22:31,720
the Gateway for the lunar exploration

477
00:22:37,260 --> 00:22:35,350
will have really is enabling and this is

478
00:22:39,630 --> 00:22:37,270
the part of the Artemis program it's

479
00:22:41,400 --> 00:22:39,640
very this is Apollo didn't do this so

480
00:22:44,549 --> 00:22:41,410
Paula took everything with them and

481
00:22:47,580 --> 00:22:44,559
everything came back so Artemis is is

482
00:22:50,400 --> 00:22:47,590
building up a sustainable presence and

483
00:22:52,470 --> 00:22:50,410
this gateway is key to that yeah and one

484
00:22:54,570 --> 00:22:52,480
one part that I'd like to emphasize that

485
00:22:56,820 --> 00:22:54,580
can mention as is really different from

486
00:23:00,150 --> 00:22:56,830
Apollo is this open architecture aspect

487
00:23:03,060 --> 00:23:00,160
is NASA's not doing this alone and it's

488
00:23:05,280 --> 00:23:03,070

and it's even beyond what we did for the

489
00:23:06,810 --> 00:23:05,290
International Space Station where we had

490
00:23:09,360 --> 00:23:06,820
lots of other government agencies

491
00:23:12,060 --> 00:23:09,370
involved there is a huge involvement

492
00:23:14,400 --> 00:23:12,070
from the private commercial sector

493
00:23:18,270 --> 00:23:14,410
that's involved in all parts of this

494
00:23:20,909 --> 00:23:18,280
so this Artemis program and lunar

495
00:23:23,100 --> 00:23:20,919
exploration going forward is got a

496
00:23:23,850 --> 00:23:23,110
commercial element a private sector

497
00:23:26,700 --> 00:23:23,860
commercial

498
00:23:29,850 --> 00:23:26,710
a lot of people call it new space part

499
00:23:33,270 --> 00:23:29,860
of it that didn't exist during Apollo so

500
00:23:37,220 --> 00:23:33,280
we are really I think at the you know at

501
00:23:44,610 --> 00:23:37,230
the dawn of a new age of exploration and

502
00:23:46,560 --> 00:23:44,620
space beyond leo as tony was saying

503
00:23:49,620 --> 00:23:46,570
about this it's sort of a space economy

504
00:23:51,539 --> 00:23:49,630
have a lot of partners we're on the

505
00:23:53,430 --> 00:23:51,549
verge of you know if you were to go back

506
00:23:55,140 --> 00:23:53,440
in time and ask the wright brothers to

507
00:23:56,880 --> 00:23:55,150
look at modern-day today and see that oh

508
00:23:58,919 --> 00:23:56,890
i can fly from place to place on this

509
00:24:00,690 --> 00:23:58,929
planet using an airplane that they did

510
00:24:02,520 --> 00:24:00,700
the center or go back and talk to

511
00:24:04,080 --> 00:24:02,530
Alexander Graham Bell invented the

512
00:24:06,900 --> 00:24:04,090
telephone and we all look at using our

513
00:24:09,299 --> 00:24:06,910

smart phones to communicate we have no

514
00:24:12,180 --> 00:24:09,309
clue what the future of space will be

515
00:24:16,080 --> 00:24:12,190
when we involve the commercial aspect of

516
00:24:32,220 --> 00:24:16,090
it is really unbounded future that's

517
00:24:39,180 --> 00:24:32,230
monumental we'll be able to do things we

518
00:24:41,820 --> 00:24:39,190
could never have done before before well

519
00:24:45,299 --> 00:24:41,830
let's move into our rapid-fire section

520
00:24:47,850 --> 00:24:45,309
so I'm not gonna give any user names but

521
00:24:55,260 --> 00:24:47,860
I'm just gonna go ahead and just spit

522
00:24:58,799 --> 00:24:55,270
out some questions rapidly the human

523
00:25:00,120 --> 00:24:58,809
body on the moon long-term effect of the

524
00:25:06,750 --> 00:25:00,130
human body on the moon or the

525
00:25:07,980 --> 00:25:06,760
environment on the human body it's

526
00:25:09,450 --> 00:25:07,990
actually a really interesting question

527
00:25:12,210 --> 00:25:09,460
from the science standpoint in

528
00:25:14,940 --> 00:25:12,220
particular these cold air because these

529
00:25:17,669 --> 00:25:14,950
in the craters are what are called cold

530
00:25:20,250 --> 00:25:17,679
traps they're so cold any molecules that

531
00:25:22,169 --> 00:25:20,260
get in there freeze out so every time

532
00:25:25,320 --> 00:25:22,179
we've gone to the moon and the

533
00:25:26,700 --> 00:25:25,330
astronauts vented water or vented other

534
00:25:29,220 --> 00:25:26,710
things or outgassed

535
00:25:31,560 --> 00:25:29,230
outcasts mean stuff subliming off of

536
00:25:34,140 --> 00:25:31,570
equipment those molecules some of those

537
00:25:35,660 --> 00:25:34,150
molecules very likely found their ways

538
00:25:37,310 --> 00:25:35,670

to the poles of the moon

539
00:25:39,380 --> 00:25:37,320
froze out hoping they're there now

540
00:25:42,230 --> 00:25:39,390
forever until the meteorite might

541
00:25:43,510 --> 00:25:42,240
release them if we go once we go

542
00:25:47,390 --> 00:25:43,520
exploring

543
00:25:49,490 --> 00:25:47,400
not just we NASA but the world will

544
00:25:51,200 --> 00:25:49,500
bring more and more of these volatiles

545
00:25:52,910 --> 00:25:51,210
and other materials to the moon that

546
00:25:54,650 --> 00:25:52,920
will be trapped in the coal trap so if

547
00:25:56,720 --> 00:25:54,660
you're trying to understand some

548
00:25:59,840 --> 00:25:56,730
pristine environments to understand the

549
00:26:01,400 --> 00:25:59,850
history the last three billion years you

550
00:26:02,810 --> 00:26:01,410
you want to do it in a way that you can

551
00:26:05,270 --> 00:26:02,820
understand what contaminants

552
00:26:09,680 --> 00:26:05,280
you've brought there yourself and we

553
00:26:12,020 --> 00:26:09,690
actually we NASA Ames flew of mission

554
00:26:13,730 --> 00:26:12,030
not long ago long ago called laddy

555
00:26:16,310 --> 00:26:13,740
the lunar atmospheric dust environment

556
00:26:17,900 --> 00:26:16,320
Explorer and its principal purpose was

557
00:26:20,570 --> 00:26:17,910
actually to understand the lunar

558
00:26:23,270 --> 00:26:20,580
atmosphere of exosphere in its pristine

559
00:26:24,560 --> 00:26:23,280
state with the anticipation that more

560
00:26:27,020 --> 00:26:24,570
and more countries and commercial

561
00:26:28,400 --> 00:26:27,030
people's would be going to the moon and

562
00:26:32,180 --> 00:26:28,410
so we wanted to get kind of a background

563
00:26:34,940 --> 00:26:32,190

before we start impacting the baseline

564
00:26:37,490 --> 00:26:34,950
before we touched it right right

565
00:26:38,990 --> 00:26:37,500
from a impact on the human body

566
00:26:41,510 --> 00:26:39,000
radiation is one of the principal

567
00:26:44,450 --> 00:26:41,520
concerns and there's a lot of very

568
00:26:46,040 --> 00:26:44,460
clever solutions being looked at in

569
00:26:48,260 --> 00:26:46,050
terms of shielding and and we talked

570
00:26:50,960 --> 00:26:48,270
about water as a resource there's lots

571
00:26:52,880 --> 00:26:50,970
of other resources at the moon and

572
00:26:55,580 --> 00:26:52,890
especially at the poles including

573
00:26:57,620 --> 00:26:55,590
lighting for the solar power but also

574
00:27:01,430 --> 00:26:57,630
the dirt itself the regular can be an

575
00:27:02,930 --> 00:27:01,440
excellent insulator okay so as Kimberly

576
00:27:04,910 --> 00:27:02,940
was talking about living off the land

577
00:27:08,750 --> 00:27:04,920
involves using whatever you got at

578
00:27:10,970 --> 00:27:08,760
whatever your situation better yeah

579
00:27:13,210 --> 00:27:10,980
excellent next question how many

580
00:27:17,450 --> 00:27:13,220
launches until the first base is set up

581
00:27:20,270 --> 00:27:17,460
mmm that's a good question well we're

582
00:27:23,210 --> 00:27:20,280
not about a base so there's two phases

583
00:27:25,730 --> 00:27:23,220
to the Artemis the one is the the return

584
00:27:27,350 --> 00:27:25,740
of the first humans and that's the 2024

585
00:27:30,020 --> 00:27:27,360
milestone and then there's a later

586
00:27:33,680 --> 00:27:30,030
milestone 2028 where we have a more

587
00:27:35,870 --> 00:27:33,690
established presence there prior to the

588
00:27:38,030 --> 00:27:35,880

first humans going on on the moon will

589
00:27:39,890 --> 00:27:38,040
have the first launch of Artemis Artemis

590
00:27:42,200 --> 00:27:39,900
one which will not have humans on board

591
00:27:44,030 --> 00:27:42,210
but will carry space satellites and

592
00:27:46,820 --> 00:27:44,040
robots in the light some will go to deep

593
00:27:48,620 --> 00:27:46,830
space a second Artemis mission will

594
00:27:49,070 --> 00:27:48,630
actually go to the moon or in orbit

595
00:27:51,850 --> 00:27:49,080
around the

596
00:27:54,320 --> 00:27:51,860
it's on that third launch of the SLS

597
00:27:56,720 --> 00:27:54,330
that we would be carrying the humans and

598
00:27:59,360 --> 00:27:56,730
that's the 2024 milestone so we should

599
00:28:01,400 --> 00:27:59,370
see a sequence of incremental steps

600
00:28:03,410 --> 00:28:01,410
towards proving out the new launch

601
00:28:05,750 --> 00:28:03,420
system and the new capabilities in

602
00:28:08,360 --> 00:28:05,760
addition the first module of the Gateway

603
00:28:10,130 --> 00:28:08,370
which is the solar propulsion element

604
00:28:12,770 --> 00:28:10,140
which is a really cool technology

605
00:28:15,380 --> 00:28:12,780
advancement we've never seen an engine

606
00:28:16,850 --> 00:28:15,390
like this on a spaceship before that's

607
00:28:18,380 --> 00:28:16,860
gonna be launched by a commercial rocket

608
00:28:19,400 --> 00:28:18,390
and so that's you know we're gonna be

609
00:28:21,860 --> 00:28:19,410
having all these different types of

610
00:28:23,870 --> 00:28:21,870
infrastructures getting us all part of

611
00:28:25,940 --> 00:28:23,880
the Artemis program and that's it this

612
00:28:28,460 --> 00:28:25,950
really brings up an important point it's

613
00:28:30,020 --> 00:28:28,470

not a it will be done by this date it

614
00:28:33,260 --> 00:28:30,030
will be a continuous development and

615
00:28:36,260 --> 00:28:33,270
build up in a to reach a an eventual

616
00:28:39,080 --> 00:28:36,270
sustained presence and so the exact date

617
00:28:49,430 --> 00:28:39,090
when that becomes a base or whatever you

618
00:28:51,710 --> 00:28:49,440
want to call it isn't defined because

619
00:28:55,040 --> 00:28:51,720
it's really building up of capabilities

620
00:28:57,290 --> 00:28:55,050
over time there will be longer and

621
00:28:59,090 --> 00:28:57,300
longer stays as they move through these

622
00:29:02,240 --> 00:28:59,100
various phases as Kimberly stayed as

623
00:29:04,520 --> 00:29:02,250
just mentioned for the astronauts on the

624
00:29:09,170 --> 00:29:04,530
surface okay so we have time for two

625
00:29:10,490 --> 00:29:09,180
short questions this gateway gonna be

626
00:29:10,970 --> 00:29:10,500
inhabited by astronauts when it's

627
00:29:12,590 --> 00:29:10,980
finished

628
00:29:16,180 --> 00:29:12,600
that's a good question I mean it's

629
00:29:18,530 --> 00:29:16,190
variable the the key point is that that

630
00:29:20,210 --> 00:29:18,540
spaceship needs to be able to operate

631
00:29:22,610 --> 00:29:20,220
without humans because it will be pers

632
00:29:25,130 --> 00:29:22,620
and which humans aren't on board so

633
00:29:26,150 --> 00:29:25,140
don't know the exact fraction of it but

634
00:29:27,560 --> 00:29:26,160
it's going to be had two different modes

635
00:29:30,440 --> 00:29:27,570
when the humans are on board and when

636
00:29:32,810 --> 00:29:30,450
they're not yeah I've heard numbers up

637
00:29:34,670 --> 00:29:32,820
to 30 days at a time okay so they're not

638
00:29:37,490 --> 00:29:34,680

gonna be up there for a year like we do

639
00:29:40,070 --> 00:29:37,500
on space station they'll go up there and

640
00:29:42,140 --> 00:29:40,080
then come back in a month or two and so

641
00:29:43,730 --> 00:29:42,150
that's to Kimberly's point is a lot of

642
00:29:47,890 --> 00:29:43,740
the time you don't have to have robots

643
00:29:50,030 --> 00:29:47,900
running the house so last question

644
00:29:54,050 --> 00:29:50,040
someone wants to know like what's the

645
00:29:55,760 --> 00:29:54,060
coolest thing about Gateway I've heard

646
00:29:57,660 --> 00:29:55,770
you vote for this power

647
00:30:02,310 --> 00:29:57,670
well Kim

648
00:30:05,550 --> 00:30:02,320
I call it the tugboat this is electric

649
00:30:08,160 --> 00:30:05,560
propulsion system and it's at a power

650
00:30:09,990 --> 00:30:08,170
level we've never built before and

651
00:30:11,640 --> 00:30:10,000
what's neat is it allows it to change

652
00:30:13,020 --> 00:30:11,650
its orbit around the moon so it is

653
00:30:15,210 --> 00:30:13,030
really a spaceship it's not just going

654
00:30:18,060 --> 00:30:15,220
in an orbit it can actually steer this

655
00:30:21,960 --> 00:30:18,070
entire space station size kind of thing

656
00:30:24,060 --> 00:30:21,970
on in space okay and then ultimately

657
00:30:27,000 --> 00:30:24,070
it's the kind of engine that's gonna be

658
00:30:29,760 --> 00:30:27,010
used to bring us to Mars and - droids in

659
00:30:35,000 --> 00:30:29,770
- whatever else so okay you know it's a

660
00:30:38,640 --> 00:30:35,010
slow ride acceleration acceleration it

661
00:30:40,320 --> 00:30:38,650
is slow but as powerful it allows you to

662
00:30:41,990 --> 00:30:40,330
get to the kinds of velocities with a

663
00:30:44,340 --> 00:30:42,000

lot of mass and you need to do

664
00:30:47,400 --> 00:30:44,350
interplanetary travel and I like the

665
00:30:49,080 --> 00:30:47,410
open architecture I don't think all the

666
00:30:52,080 --> 00:30:49,090
engineers have figure out all the

667
00:30:53,370 --> 00:30:52,090
wonderful uses of gateway mm-hmm because

668
00:30:54,870 --> 00:30:53,380
it's a little I mean it's gonna be

669
00:30:57,090 --> 00:30:54,880
designed for a certain purpose and we'll

670
00:30:59,550 --> 00:30:57,100
achieve those purposes allowing the

671
00:31:01,220 --> 00:30:59,560
docking of multiple vehicles from

672
00:31:03,540 --> 00:31:01,230
different countries and companies

673
00:31:06,150 --> 00:31:03,550
allowing astronauts to stay for periods

674
00:31:08,010 --> 00:31:06,160
of days months being in constant

675
00:31:09,570 --> 00:31:08,020
communication with the earth being in

676
00:31:11,880 --> 00:31:09,580
communication with the surface of the

677
00:31:13,080 --> 00:31:11,890
Moon being able to deliver things to the

678
00:31:16,680 --> 00:31:13,090
surface of the Moon at different

679
00:31:19,140 --> 00:31:16,690
latitudes I mean it's very versatile but

680
00:31:21,360 --> 00:31:19,150
they could also be a testbed for testing

681
00:31:23,760 --> 00:31:21,370
other types of vehicles that actually

682
00:31:25,740 --> 00:31:23,770
might be made in space someday and then

683
00:31:28,680 --> 00:31:25,750
watch them from there I mean it has a

684
00:31:32,250 --> 00:31:28,690
lifetime that will keep giving we're

685
00:31:35,070 --> 00:31:32,260
only thinking about how to you know do

686
00:31:36,900 --> 00:31:35,080
that first step is the first step and

687
00:31:39,420 --> 00:31:36,910
the return to the moon the forward to

688
00:31:42,120 --> 00:31:39,430

the moon part but there's a lot more

689
00:31:44,700 --> 00:31:42,130
than it can get okay you you both keep

690
00:31:46,680 --> 00:31:44,710
mentioning learning at the moon and then

691
00:31:48,300 --> 00:31:46,690
we'll go on and you know SLS could take

692
00:31:50,370 --> 00:31:48,310
us to Mars so let's talk really quickly

693
00:31:52,950 --> 00:31:50,380
a little bit about Mars so what are some

694
00:31:54,930 --> 00:31:52,960
favorite fun facts about Mars you can

695
00:31:57,030 --> 00:31:54,940
share with us okay well we've we have a

696
00:31:59,910 --> 00:31:57,040
picture of Mars took you people and what

697
00:32:03,270 --> 00:31:59,920
Mars looks like it's what's the fourth

698
00:32:06,090 --> 00:32:03,280
planet around the Sun it's a red planet

699
00:32:10,100 --> 00:32:06,100
the red is primarily due to iron in

700
00:32:13,320 --> 00:32:10,110
the rocks on the surface of Mars Mars

701
00:32:15,510 --> 00:32:13,330
has polar caps it has you know it's one

702
00:32:19,830 --> 00:32:15,520
the other bodies besides the earth that

703
00:32:24,810 --> 00:32:19,840
has frozen ice it's water ice and carbon

704
00:32:27,360 --> 00:32:24,820
dioxide ice at the polar poles it's it

705
00:32:29,159 --> 00:32:27,370
has an atmosphere but its atmosphere is

706
00:32:30,539 --> 00:32:29,169
different than Earth's it's probably

707
00:32:35,070 --> 00:32:30,549
made of carbon dioxide where's our

708
00:32:36,630 --> 00:32:35,080
atmosphere is nitrogen raised and if you

709
00:32:38,159 --> 00:32:36,640
its support where the earth is the third

710
00:32:41,250 --> 00:32:38,169
planet and Mars is the fourth planet

711
00:32:43,140 --> 00:32:41,260
we're both circling around the Sun if

712
00:32:46,529 --> 00:32:43,150
you imagine racetrack writ cars on a

713
00:32:49,409 --> 00:32:46,539

racetrack um so at our closest distance

714
00:32:51,720 --> 00:32:49,419
between the Earth and Mars is about 34

715
00:32:57,710 --> 00:32:51,730
million miles and that happens every 26

716
00:33:03,330 --> 00:33:00,779
so this is a reason why when we launch

717
00:33:05,399 --> 00:33:03,340
our you know robots to Mars and few in

718
00:33:08,640 --> 00:33:05,409
the future the human the crude missions

719
00:33:11,610 --> 00:33:08,650
to Mars taking advantage of the close

720
00:33:14,070 --> 00:33:11,620
that twenty six month period of of

721
00:33:15,870 --> 00:33:14,080
alignment okay crazy helps shorten the

722
00:33:18,180 --> 00:33:15,880
distance cuz even at that shortest

723
00:33:24,930 --> 00:33:18,190
distance the trip is still about six or

724
00:33:27,090 --> 00:33:24,940
nine months okay all right and the moon

725
00:33:31,710 --> 00:33:27,100
you say is gonna help us practice for

726
00:33:34,890 --> 00:33:31,720
what we might do yeah so much of what we

727
00:33:38,250 --> 00:33:34,900
will be doing on the moon is extensible

728
00:33:41,010 --> 00:33:38,260
to to Mars and and everything from the

729
00:33:43,190 --> 00:33:41,020
kinds of tools we use to the procedures

730
00:33:47,399 --> 00:33:43,200
and processes and the technologies

731
00:33:49,890 --> 00:33:47,409
learning to really work and build and

732
00:33:51,779 --> 00:33:49,900
construct and different environments

733
00:33:54,060 --> 00:33:51,789
that the Moon and Mars

734
00:33:56,820 --> 00:33:54,070
everything from gravity to low up little

735
00:33:59,580 --> 00:33:56,830
to no atmosphere etc it's really

736
00:34:01,950 --> 00:33:59,590
important and bring it back to water and

737
00:34:03,630 --> 00:34:01,960
as kimberly mentioned mars has got water

738
00:34:05,880 --> 00:34:03,640

we've known that for a while it's got a

739
00:34:08,820 --> 00:34:05,890
lot more water than the moon okay

740
00:34:11,010 --> 00:34:08,830
and but that is the one of the key

741
00:34:14,579 --> 00:34:11,020
connections between the moon and mars is

742
00:34:18,480 --> 00:34:14,589
as we learn to utilize water on the moon

743
00:34:19,830 --> 00:34:18,490
everything from locating it excavating

744
00:34:22,650 --> 00:34:19,840
it processing it

745
00:34:24,900 --> 00:34:22,660
that can be carried over and applied to

746
00:34:27,720 --> 00:34:24,910
how we do that on Mars which we want to

747
00:34:29,310 --> 00:34:27,730
do we want to excuse me live off the

748
00:34:32,100 --> 00:34:29,320
land at Mars - we don't want to bring

749
00:34:33,960 --> 00:34:32,110
everything with us to Mars eventually we

750
00:34:37,500 --> 00:34:33,970
will of course the first few times but

751
00:34:39,480 --> 00:34:37,510
you can't it's too far away all right I

752
00:34:41,220 --> 00:34:39,490
was mentioning earlier is months were

753
00:34:43,800 --> 00:34:41,230
really comfortable with this whole

754
00:34:45,900 --> 00:34:43,810
approach on excavating the water and

755
00:34:48,200 --> 00:34:45,910
processing ordering and transferring it

756
00:34:50,010 --> 00:34:48,210
to rocket fuel or oxygen or other

757
00:34:51,210 --> 00:34:50,020
utilizations because water can be used

758
00:34:54,450 --> 00:34:51,220
in many different ways

759
00:34:58,380 --> 00:34:54,460
that's totally applicable system for

760
00:35:00,360 --> 00:34:58,390
Mars you know directly and also though

761
00:35:02,130 --> 00:35:00,370
most likely there will be wonderful

762
00:35:04,470 --> 00:35:02,140
spin-offs that can be used back here in

763
00:35:07,680 --> 00:35:04,480

ours oh yeah I mean any things in a

764
00:35:09,120 --> 00:35:07,690
closed system is usually very power

765
00:35:13,950 --> 00:35:09,130
conscious you're not using a lot of

766
00:35:18,450 --> 00:35:13,960
energy a lot of things will have you

767
00:35:20,880 --> 00:35:18,460
know very improved technology from the

768
00:35:22,440 --> 00:35:20,890
chat looks like king gold boy gamer ones

769
00:35:33,770 --> 00:35:22,450
you know like when are we actually going

770
00:35:40,890 --> 00:35:33,780
to go to Mars my head but it would be

771
00:35:42,600 --> 00:35:40,900
and you know a couple decades we're

772
00:35:44,880 --> 00:35:42,610
gonna practice we're gonna learn to

773
00:35:48,690 --> 00:35:44,890
excavate water and process it and all

774
00:35:51,840 --> 00:35:48,700
that and also the most fragile part in

775
00:35:54,720 --> 00:35:51,850
this whole amazing exploration adventure

776
00:35:57,000 --> 00:35:54,730
is the human body the human body outside

777
00:36:00,600 --> 00:35:57,010
the magnetosphere you know we've had

778
00:36:02,220 --> 00:36:00,610
only 24 individuals who've been outside

779
00:36:04,650 --> 00:36:02,230
that we are now going to have the

780
00:36:06,510 --> 00:36:04,660
ability to really study biology and how

781
00:36:08,850 --> 00:36:06,520
the human body is reacting this this

782
00:36:11,250 --> 00:36:08,860
will make us totally prepared for that

783
00:36:12,930 --> 00:36:11,260
long trip to Mars because a mission to

784
00:36:16,110 --> 00:36:12,940
the moon is three days and you're on the

785
00:36:18,270 --> 00:36:16,120
surface for weeks months come back but

786
00:36:20,010 --> 00:36:18,280
you're you're close to home mm-hmm when

787
00:36:22,200 --> 00:36:20,020
you go to Mars we're talking a two-year

788
00:36:23,700 --> 00:36:22,210

and how is the bond you know it's like

789
00:36:25,110 --> 00:36:23,710
is six months and I wants to get there

790
00:36:26,460 --> 00:36:25,120
gonna be there for a few months you come

791
00:36:28,620 --> 00:36:26,470
back you want to take advantage of the

792
00:36:31,590 --> 00:36:28,630
shirt close by so you're gonna be on a

793
00:36:32,690 --> 00:36:31,600
sort of a two year time scale just think

794
00:36:35,120 --> 00:36:32,700
about it

795
00:36:39,440 --> 00:36:35,130
you know what we're going to learn to

796
00:36:41,810 --> 00:36:39,450
protect the human body and you know

797
00:36:44,060 --> 00:36:41,820
enable all the infrastructure to allow

798
00:36:46,300 --> 00:36:44,070
the human body to survive and thrive we

799
00:36:49,609 --> 00:36:46,310
all saw that by being on the moon yeah

800
00:36:52,250 --> 00:36:49,619
so tell me quickly so so I want to know

801
00:36:54,260 --> 00:36:52,260
what's coming up then you know what's

802
00:36:58,000 --> 00:36:54,270
what's in the news coming up next in the

803
00:37:01,550 --> 00:36:58,010
process so human Landers will be built

804
00:37:04,430 --> 00:37:01,560
by by NASA by partners what do you guys

805
00:37:05,570 --> 00:37:04,440
know about that there was a believe

806
00:37:08,210 --> 00:37:05,580
there was a bid that went out on the

807
00:37:10,880 --> 00:37:08,220
street for companies to provide lunar

808
00:37:12,770 --> 00:37:10,890
landers and docking with the Gateway or

809
00:37:14,210 --> 00:37:12,780
not because there it's an open it's a

810
00:37:17,510 --> 00:37:14,220
different type of architecture you can

811
00:37:19,730 --> 00:37:17,520
use but yeah okay yeah there's and

812
00:37:22,609 --> 00:37:19,740
there's a variety of Landers being

813
00:37:26,930 --> 00:37:22,619

pursued with the commercial sector with

814
00:37:31,040 --> 00:37:26,940
NASA and there are smaller Landers being

815
00:37:34,040 --> 00:37:31,050
built now and we've actually NASA just

816
00:37:40,660 --> 00:37:34,050
recently selected three to be carrying

817
00:37:47,960 --> 00:37:44,690
next year and and a couple in the summer

818
00:37:51,050 --> 00:37:47,970
of twenty one 2021 and what's really

819
00:37:54,530 --> 00:37:51,060
neat is these these companies are

820
00:37:56,960 --> 00:37:54,540
providing NASA a delivery surface it's

821
00:37:59,810 --> 00:37:56,970
not NASA telling them we need a lander

822
00:38:02,109 --> 00:37:59,820
like this no it's they're building a

823
00:38:05,329 --> 00:38:02,119
lander that provides a service and

824
00:38:07,670 --> 00:38:05,339
selling that service then ok NASA here's

825
00:38:09,380 --> 00:38:07,680
an example of one on the screen of one

826
00:38:11,410 --> 00:38:09,390
of these small commercial Landers and

827
00:38:14,540 --> 00:38:11,420
these companies and have plans to

828
00:38:16,250 --> 00:38:14,550
increase this the the scale and the

829
00:38:18,530 --> 00:38:16,260
scope of these Landers so they can carry

830
00:38:21,260 --> 00:38:18,540
more and more to the surface so the

831
00:38:23,060 --> 00:38:21,270
human Landers are discriminately said

832
00:38:26,020 --> 00:38:23,070
right now being discussed with

833
00:38:28,820 --> 00:38:26,030
commercial companies as to who's gonna

834
00:38:30,710 --> 00:38:28,830
participate and build them going forward

835
00:38:33,500 --> 00:38:30,720
and surely kind of exciting because

836
00:38:37,339 --> 00:38:33,510
again this is a totally new paradigm we

837
00:38:39,950 --> 00:38:37,349
NASA's always built the Landers with

838
00:38:42,859 --> 00:38:39,960

commercial companies but they've done it

839
00:38:45,690 --> 00:38:42,869
in a very much requirement driven

840
00:38:47,670 --> 00:38:45,700
process we need you to build this for

841
00:38:49,740 --> 00:38:47,680
okay let's see yeah this is very

842
00:38:52,470 --> 00:38:49,750
different this is I'm buying my airline

843
00:38:55,460 --> 00:38:52,480
ticket to fly across the country I'm not

844
00:38:57,870 --> 00:38:55,470
telling you how to build your everybody

845
00:39:01,710 --> 00:38:57,880
exactly and that's what we're doing and

846
00:39:05,630 --> 00:39:01,720
other other folks can pay to use the

847
00:39:12,109 --> 00:39:05,640
services so it's opens up the

848
00:39:17,130 --> 00:39:15,569
from the chat a spaced space T being

849
00:39:19,049 --> 00:39:17,140
that wants to know are any of these

850
00:39:20,910 --> 00:39:19,059
vehicles gonna be like the lunar roving

851
00:39:23,250 --> 00:39:20,920
vehicle hmm yeah there's actually

852
00:39:25,890 --> 00:39:23,260
commercial Rovers actually being

853
00:39:29,130 --> 00:39:25,900
discussed - so NASA is working on some

854
00:39:33,030 --> 00:39:29,140
Rovers as well but and Rovers come in

855
00:39:37,079 --> 00:39:33,040
all shapes and sizes but also for the

856
00:39:39,630 --> 00:39:37,089
humans beyond 2024 there's definitely

857
00:39:41,730 --> 00:39:39,640
plans for large even pressurized Rovers

858
00:39:43,680 --> 00:39:41,740
that they would go in so I think way

859
00:39:48,000 --> 00:39:43,690
beyond what we did in other Apollo era

860
00:39:49,380 --> 00:39:48,010
I think the Martian remember but some of

861
00:39:51,270 --> 00:39:49,390
these commercial Landers the ones going

862
00:39:54,809 --> 00:39:51,280
in the next year and a half or so are

863
00:39:57,720 --> 00:39:54,819

carrying very small Rovers five kilogram

864
00:40:00,120 --> 00:39:57,730
10 kilogram motors and eventually those

865
00:40:02,640 --> 00:40:00,130
Rovers will be also providing a service

866
00:40:04,230 --> 00:40:02,650
so the Landers provide the landed

867
00:40:06,930 --> 00:40:04,240
service and commercial Rovers can

868
00:40:10,319 --> 00:40:06,940
provide a roving service so I can put my

869
00:40:12,480 --> 00:40:10,329
instrument on a rover that we can buy

870
00:40:13,589 --> 00:40:12,490
space on rather than NASA having to

871
00:40:15,630 --> 00:40:13,599
build all that okay

872
00:40:22,170 --> 00:40:15,640
now speaking of your instrument I know

873
00:40:26,339 --> 00:40:22,180
that you have did you bring it today

874
00:40:28,799 --> 00:40:26,349
part of it and tell us what its gonna do

875
00:40:31,380 --> 00:40:28,809
up there I don't drop it so something

876
00:40:32,160 --> 00:40:31,390
like this is flying to the moon in the

877
00:40:35,640 --> 00:40:32,170
next year or two

878
00:40:38,069 --> 00:40:35,650
yes so this was selected to fly on one

879
00:40:40,109 --> 00:40:38,079
of the three Landers that is going to

880
00:40:45,970 --> 00:40:40,119
the moon in the next few next couple

881
00:40:52,810 --> 00:40:49,810
it is of course an acronym near-infrared

882
00:40:55,180 --> 00:40:52,820
volatile spectrometer system okay and

883
00:40:56,650 --> 00:40:55,190
what it does is it finds water that's

884
00:40:59,260 --> 00:40:56,660
its principal purpose is to find

885
00:41:01,030 --> 00:40:59,270
volatiles but especially water okay so

886
00:41:03,760 --> 00:41:01,040
it's a prospecting instrument if you

887
00:41:05,800 --> 00:41:03,770
think about when we look for minerals

888
00:41:06,940 --> 00:41:05,810

and resources an earthy prospect to go

889
00:41:09,520 --> 00:41:06,950
and look at this is what this

890
00:41:12,490 --> 00:41:09,530
instruments mean yeah sniffing out where

891
00:41:14,530 --> 00:41:12,500
the water is exactly and this is an

892
00:41:17,920 --> 00:41:14,540
engineering unit this is a unit that we

893
00:41:20,050 --> 00:41:17,930
use to develop the technology make sure

894
00:41:22,120 --> 00:41:20,060
we can make the measurements and meet

895
00:41:24,910 --> 00:41:22,130
the goals we want to meet and then we

896
00:41:26,590 --> 00:41:24,920
then test it in the similar environments

897
00:41:29,109 --> 00:41:26,600
it's going to see for example it has to

898
00:41:34,060 --> 00:41:29,119
survive launch landing oh yeah vacuum

899
00:41:35,470 --> 00:41:34,070
radiation etc make sure it works and you

900
00:41:39,930 --> 00:41:35,480
can see it's just got a bunch of eyes on

901
00:41:45,700 --> 00:41:43,150
what it's meant to an important aspect

902
00:41:47,380 --> 00:41:45,710
of this is is it needs to work both in

903
00:41:49,000 --> 00:41:47,390
sunlight and in darkness just like

904
00:41:53,680 --> 00:41:49,010
Kimberly was saying these are dark

905
00:41:55,090 --> 00:41:53,690
craters so yeah we have to go down there

906
00:41:58,750 --> 00:41:55,100
and we have to look at the scales we're

907
00:42:00,760 --> 00:41:58,760
gonna yeah because the data from orbit

908
00:42:02,770 --> 00:42:00,770
is giving us hundreds of meter kind of

909
00:42:04,780 --> 00:42:02,780
footprints of where the the resolution

910
00:42:06,490 --> 00:42:04,790
yeah this is gonna give us human scale

911
00:42:08,410 --> 00:42:06,500
you know right on the meter and that's

912
00:42:13,359 --> 00:42:08,420
an unknown you know so we do need to

913
00:42:15,190 --> 00:42:13,369

exactly so real quick this this if this

914
00:42:17,770 --> 00:42:15,200
little guy right here can't get the nice

915
00:42:21,250 --> 00:42:17,780
blue shine of it this is an infrared

916
00:42:24,160 --> 00:42:21,260
lamp yeah and and then ten of this is to

917
00:42:25,510 --> 00:42:24,170
actually provide infrared light for the

918
00:42:28,270 --> 00:42:25,520
other instruments so it can see in the

919
00:42:30,609 --> 00:42:28,280
dark likewise all these things over here

920
00:42:33,150 --> 00:42:30,619
these little guys those are LEDs of

921
00:42:35,830 --> 00:42:33,160
various colors so they provide

922
00:42:38,650 --> 00:42:35,840
illumination from the ultraviolet to the

923
00:42:40,270 --> 00:42:38,660
near-infrared for a camera system which

924
00:42:42,310 --> 00:42:40,280
is right here this is a lens to the

925
00:42:44,530 --> 00:42:42,320
camera system this black thing this

926
00:42:46,960 --> 00:42:44,540
allows us to image the area very

927
00:42:49,780 --> 00:42:46,970
high-resolution understand the chemical

928
00:42:52,060 --> 00:42:49,790
makeup the mineralogy the morphology and

929
00:42:54,130 --> 00:42:52,070
things like that and the last thing are

930
00:42:55,540 --> 00:42:54,140
the four sensors right underneath the

931
00:42:56,710 --> 00:42:55,550
camera these four right here that's

932
00:42:57,220 --> 00:42:56,720
really hard to do it's like doing it in

933
00:43:00,010 --> 00:42:57,230
a mirror

934
00:43:02,500 --> 00:43:00,020
before there those are thermal sensors

935
00:43:04,570 --> 00:43:02,510
it's a thermal radiometer and what that

936
00:43:06,220 --> 00:43:04,580
does it allows us to measure

937
00:43:08,380 --> 00:43:06,230
temperatures of the scene we're looking

938
00:43:10,750 --> 00:43:08,390

at because we're interested in not only

939
00:43:11,830 --> 00:43:10,760
understanding if water is there but we

940
00:43:13,780 --> 00:43:11,840
aren't want to understand the

941
00:43:15,760 --> 00:43:13,790
environment we are finding water or not

942
00:43:17,710 --> 00:43:15,770
finding water because ultimately we will

943
00:43:19,180 --> 00:43:17,720
use this data to build what is called a

944
00:43:21,130 --> 00:43:19,190
resource map on earth we call them a

945
00:43:24,490 --> 00:43:21,140
mineral mineral map so if the United

946
00:43:26,140 --> 00:43:24,500
States Geological Survey provides to a

947
00:43:28,300 --> 00:43:26,150
company that's interested in finding

948
00:43:30,340 --> 00:43:28,310
minerals and and we're going to do this

949
00:43:33,280 --> 00:43:30,350
on the moon basically build these maps

950
00:43:35,350 --> 00:43:33,290
and understand the location this is one

951
00:43:37,210 --> 00:43:35,360
instrument of several that is dedicated

952
00:43:46,330 --> 00:43:37,220
to do this kind of work oh yeah yeah all

953
00:43:47,800 --> 00:43:46,340
working in tandem and the next iteration

954
00:44:06,250 --> 00:43:47,810
of this has to be hand held by the

955
00:44:07,990 --> 00:44:06,260
astronauts guard shows wants to know how

956
00:44:14,260 --> 00:44:08,000
is NASA going to protect these Rovers

957
00:44:16,390 --> 00:44:14,270
from lunar dust is a unique beast and

958
00:44:18,160 --> 00:44:16,400
it's really is unique in that it's only

959
00:44:19,450 --> 00:44:18,170
generated because of the environment on

960
00:44:22,540 --> 00:44:19,460
the moon is generated through the impact

961
00:44:24,730 --> 00:44:22,550
processes and so the dust and is never

962
00:44:27,730 --> 00:44:24,740
eroded there's no work there's no wind

963
00:44:30,430 --> 00:44:27,740

to make warm water flowing liquid water

964
00:44:35,380 --> 00:44:30,440
to have smooth things out so it's jagged

965
00:44:37,090 --> 00:44:35,390
and jagged it locks in place and it's

966
00:44:38,890 --> 00:44:37,100
you know complain about you know got

967
00:44:40,690 --> 00:44:38,900
into their lungs and they scratch their

968
00:44:45,970 --> 00:44:40,700
suits the suits were all ripped to

969
00:44:47,290 --> 00:44:45,980
shreds and the way you protect there's a

970
00:44:48,970 --> 00:44:47,300
lot of ways you can protect it

971
00:44:51,150 --> 00:44:48,980
everything from electrostatic barriers

972
00:44:54,850 --> 00:44:51,160
are working on so one nice thing about

973
00:44:57,060 --> 00:44:54,860
the lot of the lunar dust is it has a

974
00:44:58,720 --> 00:44:57,070
magnetic property to it it's got some

975
00:45:00,850 --> 00:44:58,730
ferric iron in it

976
00:45:03,850 --> 00:45:00,860
nano phase iron and so you can actually

977
00:45:09,720 --> 00:45:03,860
repulse it with electric fields you can

978
00:45:14,740 --> 00:45:12,850
and also number of other mechanical

979
00:45:16,810 --> 00:45:14,750
gasket materials basically things that

980
00:45:19,810 --> 00:45:16,820
go between bearings on wheels and

981
00:45:22,810 --> 00:45:19,820
whatnot that make it very difficult for

982
00:45:24,850 --> 00:45:22,820
the dust to get to the bearings that the

983
00:45:27,760 --> 00:45:24,860
delicate parts these are kind of

984
00:45:29,440 --> 00:45:27,770
torturous past and we're fortunate that

985
00:45:30,910 --> 00:45:29,450
there's been a couple of lunar

986
00:45:32,740 --> 00:45:30,920
settlement simulants that have been made

987
00:45:35,520 --> 00:45:32,750
modeled on the Regulus that was brought

988
00:45:37,660 --> 00:45:35,530

back the Apollo astronauts and so

989
00:45:40,060 --> 00:45:37,670
companies and engineers who are looking

990
00:45:43,000 --> 00:45:40,070
at wheel design and rover design they

991
00:45:44,950 --> 00:45:43,010
can test out their designs as best as

992
00:45:47,950 --> 00:45:44,960
possible with this kind of jagged kind

993
00:45:51,240 --> 00:45:47,960
of cylinder one connection in fact one

994
00:45:54,670 --> 00:45:51,250
of the big mysteries about the

995
00:45:56,470 --> 00:45:54,680
permanently shadowed regions when RL

996
00:45:58,900 --> 00:45:56,480
cross experiment that we did it a decade

997
00:46:01,360 --> 00:45:58,910
ago finding water and caballos it

998
00:46:02,500 --> 00:46:01,370
revealed that perhaps the Regulus and

999
00:46:06,010 --> 00:46:02,510
those permanently shadowed craters are

1000
00:46:11,230 --> 00:46:06,020
actually different than the Apollo sites

1001
00:46:13,630 --> 00:46:11,240
oh it's do the best knowledge they have

1002
00:46:15,190 --> 00:46:13,640
now using a simulant designing the reels

1003
00:46:17,380 --> 00:46:15,200
and the excavation we're gonna have

1004
00:46:18,850 --> 00:46:17,390
challenges with drills and scoops and

1005
00:46:20,740 --> 00:46:18,860
all that the same thing to do with the

1006
00:46:22,450 --> 00:46:20,750
beast that is the dust yes but we'll

1007
00:46:25,060 --> 00:46:22,460
overcome those but we're gonna have to

1008
00:46:28,300 --> 00:46:25,070
get there on the scene at the South Pole

1009
00:46:35,650 --> 00:46:28,310
and the polar regions and go hmm that

1010
00:46:37,930 --> 00:46:35,660
just is different my favorite section of

1011
00:46:39,730 --> 00:46:37,940
the day you guys describe the South Pole

1012
00:46:41,650 --> 00:46:39,740
as unexplored territory and you keep

1013
00:46:44,260 --> 00:46:41,660

referencing that it's really extreme

1014
00:46:47,500 --> 00:46:44,270
it's gonna be tough so let's go through

1015
00:46:49,960 --> 00:46:47,510
some of those challenges like you know

1016
00:46:52,240 --> 00:46:49,970
wanting to go in the deepest minds on

1017
00:46:54,730 --> 00:46:52,250
earth oh really and the deep you know

1018
00:46:56,320 --> 00:46:54,740
the deepest undersea exploration you

1019
00:46:57,850 --> 00:46:56,330
know it is because it's so different

1020
00:47:01,060 --> 00:46:57,860
from what we're used to or is it really

1021
00:47:04,660 --> 00:47:01,070
deep really deep right so the topography

1022
00:47:06,190 --> 00:47:04,670
is extreme it's completely unlike a lava

1023
00:47:11,720 --> 00:47:06,200
to part of your solid power at lower

1024
00:47:16,520 --> 00:47:14,599
and we'll be landing perhaps in areas

1025
00:47:19,790 --> 00:47:16,530
that are ridges that are sitting on top

1026
00:47:22,250 --> 00:47:19,800
a crater that looks down into a six

1027
00:47:24,830 --> 00:47:22,260
kilometre hole so I was like that's like

1028
00:47:27,320 --> 00:47:24,840
three miles yeah exactly about three

1029
00:47:29,060 --> 00:47:27,330
miles down and and you can stay they'll

1030
00:47:31,790 --> 00:47:29,070
be standing on the edge of these vistas

1031
00:47:35,990 --> 00:47:31,800
overlooking Wow mountains that are many

1032
00:47:39,410 --> 00:47:36,000
miles high into craters that are ten

1033
00:47:41,210 --> 00:47:39,420
miles across and three miles deep I

1034
00:47:43,490 --> 00:47:41,220
never knew is that extreme then the

1035
00:47:45,380 --> 00:47:43,500
lighting conditions because of the low

1036
00:47:48,500 --> 00:47:45,390
angle of the Sun you can have shadows

1037
00:47:50,180 --> 00:47:48,510
that are being cast from a ridge of a

1038
00:47:52,849 --> 00:47:50,190

crater that's hundreds of kilometers

1039
00:47:55,280 --> 00:47:52,859
away really the shadows will be sweeping

1040
00:47:57,320 --> 00:47:55,290
across you overtime skills of ours and

1041
00:47:59,540 --> 00:47:57,330
as we mentioned earlier when you're in

1042
00:48:00,830 --> 00:47:59,550
shadow your temperature drops uh-huh and

1043
00:48:03,380 --> 00:48:00,840
so you're gonna be experienced of course

1044
00:48:05,570 --> 00:48:03,390
you're in though a suit that's keeping

1045
00:48:07,760 --> 00:48:05,580
you regulated but it didn't think about

1046
00:48:09,620 --> 00:48:07,770
it the whole lighting condition the

1047
00:48:11,690 --> 00:48:09,630
whole dealing with the swing of

1048
00:48:17,000 --> 00:48:11,700
temperatures is gonna stress out your

1049
00:48:18,230 --> 00:48:17,010
systems and there are areas where the

1050
00:48:19,790 --> 00:48:18,240
reserves of this permanent shadow

1051
00:48:21,620 --> 00:48:19,800
darkness is permanent darkness but

1052
00:48:24,349 --> 00:48:21,630
there's also areas that have what I like

1053
00:48:25,520 --> 00:48:24,359
to say persistent sunlight so there are

1054
00:48:29,150 --> 00:48:25,530
some of these Peaks because they're so

1055
00:48:32,960 --> 00:48:29,160
extreme that no matter what time it year

1056
00:48:35,840 --> 00:48:32,970
it is it has a very often sunlight at it

1057
00:48:37,099 --> 00:48:35,850
so it's often at the rims or crests of

1058
00:48:39,170 --> 00:48:37,109
some of these ridges near these craters

1059
00:48:40,970 --> 00:48:39,180
and so those are very attractive for the

1060
00:48:42,440 --> 00:48:40,980
reasons Kim said is you won't be getting

1061
00:48:45,500 --> 00:48:42,450
these deep shadows sweeping across you

1062
00:48:48,440 --> 00:48:45,510
all that often and when they do it might

1063
00:48:51,500 --> 00:48:48,450

just be four of five six seven days as

1064
00:48:54,020 --> 00:48:51,510
opposed to you know three months and yet

1065
00:48:59,210 --> 00:48:54,030
something like that so so these are

1066
00:49:01,160 --> 00:48:59,220
great places to put your power structure

1067
00:49:02,990 --> 00:49:01,170
again it's sort of you know if you're

1068
00:49:04,640 --> 00:49:03,000
going to explore and you you're learning

1069
00:49:07,010 --> 00:49:04,650
about where you're exploring take

1070
00:49:09,539 --> 00:49:07,020
advantage of the gifts that were given

1071
00:49:12,419 --> 00:49:09,549
to you by Nature

1072
00:49:14,489 --> 00:49:12,429
be aware of the dangers you know of

1073
00:49:16,019 --> 00:49:14,499
course so you keep talking about those

1074
00:49:19,620 --> 00:49:16,029
the polls we actually have this really

1075
00:49:22,229 --> 00:49:19,630
cool anime video showing some light

1076
00:49:24,749 --> 00:49:22,239
cycles at that South Pole exactly right

1077
00:49:30,169 --> 00:49:24,759
yeah so can tell us what we're seeing

1078
00:49:32,489 --> 00:49:30,179
this is falling we we started at a low

1079
00:49:34,409 --> 00:49:32,499
latitudes looking at the moon as we see

1080
00:49:37,049 --> 00:49:34,419
the moon and what you saw was the the

1081
00:49:40,620 --> 00:49:37,059
Sun moving across the face of the Moon

1082
00:49:43,769 --> 00:49:40,630
there is no Dark Side of the Moon every

1083
00:49:46,049 --> 00:49:43,779
side of the Moon gets some point 14 days

1084
00:49:47,909 --> 00:49:46,059
of sunlight 14 days of darkness and we

1085
00:49:49,559 --> 00:49:47,919
just don't see that we just see that

1086
00:49:52,469 --> 00:49:49,569
because we always see the nearside

1087
00:49:54,239 --> 00:49:52,479
now this what's done is this movies

1088
00:49:56,399 --> 00:49:54,249

swung down so you're looking at the

1089
00:49:58,039 --> 00:49:56,409
South Pole of the moon that crater nice

1090
00:50:00,809 --> 00:49:58,049
circular one right in the middle that

1091
00:50:02,969 --> 00:50:00,819
Shackleton crater it's almost exactly at

1092
00:50:05,549 --> 00:50:02,979
the South Pole of the moon it is about

1093
00:50:08,789 --> 00:50:05,559
15 miles across and about four miles

1094
00:50:10,589 --> 00:50:08,799
deep and what you see are these shadows

1095
00:50:12,329 --> 00:50:10,599
that are sweeping across and it's

1096
00:50:15,059 --> 00:50:12,339
because again as Kim kimberleigh

1097
00:50:18,719 --> 00:50:15,069
explained earlier the tilt to the moon

1098
00:50:21,419 --> 00:50:18,729
on its axis is very small so the sun's

1099
00:50:24,329 --> 00:50:21,429
always just hugging the horizon creating

1100
00:50:26,039 --> 00:50:24,339
these shadows and and you can see in

1101
00:50:28,139 --> 00:50:26,049
some of these craters like the big

1102
00:50:30,299 --> 00:50:28,149
Shackleton itself and the larger ones

1103
00:50:32,399 --> 00:50:30,309
just above it the floors of those

1104
00:50:34,229 --> 00:50:32,409
craters never get some like they are in

1105
00:50:36,299 --> 00:50:34,239
permanent shadow they just stay dark you

1106
00:50:38,189 --> 00:50:36,309
can just stare at a piece of the you

1107
00:50:40,319 --> 00:50:38,199
know pick out a point in the video and

1108
00:50:42,179 --> 00:50:40,329
look at it and you can see over the

1109
00:50:44,519 --> 00:50:42,189
course of the shadow pattern what gets

1110
00:50:52,289 --> 00:50:44,529
light or not and then you also saw there

1111
00:50:53,879 --> 00:50:52,299
were these rims extreme so lighting

1112
00:50:56,459 --> 00:50:53,889
conditions are extreme topographies

1113
00:50:58,139 --> 00:50:56,469

extreme temperatures are extreme the

1114
00:51:02,789 --> 00:50:58,149
dust we sort of know what it's made of

1115
00:51:04,919 --> 00:51:02,799
but maybe not yeah but it could have

1116
00:51:06,929 --> 00:51:04,929
some other benefits too we just have to

1117
00:51:08,129 --> 00:51:06,939
we haven't explored it mm-hmm

1118
00:51:13,499 --> 00:51:08,139
and we haven't explored it with robots

1119
00:51:15,809 --> 00:51:13,509
yet either so and in general we see this

1120
00:51:18,059 --> 00:51:15,819
increase of hydrogen at the poles and

1121
00:51:21,089 --> 00:51:18,069
we've seen an increase in hydration of

1122
00:51:22,680 --> 00:51:21,099
the soils meaning hydroxyl OAH or water

1123
00:51:25,130 --> 00:51:22,690
molecules bound

1124
00:51:28,200 --> 00:51:25,140
to the soils even in sunlight and

1125
00:51:30,930 --> 00:51:28,210
increased amounts towards the poles so

1126
00:51:32,339 --> 00:51:30,940
just the composition and even in the

1127
00:51:34,050 --> 00:51:32,349
sunlight areas it's gonna be different

1128
00:51:36,480 --> 00:51:34,060
from anything you've ever seen before

1129
00:51:37,890 --> 00:51:36,490
and that's gonna just make the modelers

1130
00:51:39,660 --> 00:51:37,900
go crazy because we're gonna have a lot

1131
00:51:41,460 --> 00:51:39,670
of lot of Toni's types of instruments

1132
00:51:42,750 --> 00:51:41,470
you know looking for the water on these

1133
00:51:45,059 --> 00:51:42,760
scales and then we're gonna try to piece

1134
00:51:46,319 --> 00:51:45,069
together quite a complex puzzle mm-hm

1135
00:51:51,450 --> 00:51:46,329
but it's a nice it's an interesting

1136
00:51:54,720 --> 00:51:51,460
puzzle to have I mean it's only been 10

1137
00:51:56,550 --> 00:51:54,730
years now 10 years is not a long time

1138
00:51:58,260 --> 00:51:56,560

but it's long enough for like to realize

1139
00:51:59,790 --> 00:51:58,270
that you know this moon is a place that

1140
00:52:02,400 --> 00:51:59,800
we have full of things that we don't

1141
00:52:04,950 --> 00:52:02,410
know what's going on it's more active

1142
00:52:06,870 --> 00:52:04,960
than it is it's very active and more

1143
00:52:09,660 --> 00:52:06,880
extreme especially at the poles going to

1144
00:52:12,690 --> 00:52:09,670
picked a better place to go you know

1145
00:52:15,510 --> 00:52:12,700
speaking of that you guys don't forget

1146
00:52:19,079 --> 00:52:15,520
if you do have any questions please type

1147
00:52:22,800 --> 00:52:19,089
them into the twitch chat it's www.hs

1148
00:52:24,690 --> 00:52:22,810
which dot TV backslash nasa so we're

1149
00:52:28,950 --> 00:52:24,700
gonna move into our rapid-fire section

1150
00:52:31,140 --> 00:52:28,960
so just a 5 7 8 wants to know about the

1151
00:52:35,130 --> 00:52:31,150
nervous instrument is it ultrasound

1152
00:52:37,260 --> 00:52:35,140
ir in visual it is a little bit of

1153
00:52:39,510 --> 00:52:37,270
everything so I always like to say we go

1154
00:52:41,190 --> 00:52:39,520
in with our eyes wide open for all the

1155
00:52:44,280 --> 00:52:41,200
reasons you just said because I don't

1156
00:52:46,680 --> 00:52:44,290
exactly know what you're gonna see so it

1157
00:52:48,839 --> 00:52:46,690
is actually a combination of

1158
00:52:51,300 --> 00:52:48,849
near-infrared and for you geeks out

1159
00:52:54,870 --> 00:52:51,310
there that's between about 1.2 and 4

1160
00:52:58,559 --> 00:52:54,880
microns thermal infrared that's between

1161
00:53:03,470 --> 00:52:58,569
about 8 and 25 microns and ultraviolet

1162
00:53:05,400 --> 00:53:03,480
visible which is we run about 0.35 to

1163
00:53:09,780 --> 00:53:05,410

0.94 microns

1164
00:53:12,329 --> 00:53:09,790
okay so ultraviolet colors that are

1165
00:53:15,990 --> 00:53:12,339
below but we can see if it's a visual

1166
00:53:19,309 --> 00:53:16,000
spectrum and and energy is beyond what

1167
00:53:21,599 --> 00:53:19,319
we can see into the thermal infrared I

1168
00:53:23,490 --> 00:53:21,609
mentioned is that business like this is

1169
00:53:25,950 --> 00:53:23,500
a front end with the cameras but the

1170
00:53:28,020 --> 00:53:25,960
infrared is gonna be connected to a

1171
00:53:29,400 --> 00:53:28,030
spectrometer on the back end okay

1172
00:53:30,690 --> 00:53:29,410
because it's from the spectrometer

1173
00:53:32,520 --> 00:53:30,700
spreading the light out into different

1174
00:53:33,510 --> 00:53:32,530
wavelengths and it's over the infrared

1175
00:53:35,430 --> 00:53:33,520
that you're gonna see the warder

1176
00:53:36,090 --> 00:53:35,440
signature or the hydroxyl signature in

1177
00:53:38,580 --> 00:53:36,100
the mineral

1178
00:53:40,470 --> 00:53:38,590
yeah and so this is a very it's a

1179
00:53:41,970 --> 00:53:40,480
compact instrument with both cameras and

1180
00:53:44,520 --> 00:53:41,980
thermal sensors to get the temperature

1181
00:53:52,200 --> 00:53:44,530
plus the spectrometer to get the amount

1182
00:53:54,030 --> 00:53:52,210
of compositions dude dudette wants to

1183
00:53:56,760 --> 00:53:54,040
know is there a sample return planner

1184
00:53:57,710 --> 00:53:56,770
for lunar water yeah that's yeah

1185
00:54:04,560 --> 00:53:57,720
absolutely

1186
00:54:05,850 --> 00:54:04,570
they do want to return with the humans

1187
00:54:07,230 --> 00:54:05,860
going in 24 because they're gonna bring

1188
00:54:09,660 --> 00:54:07,240

samples back okay you know where we're

1189
00:54:11,460 --> 00:54:09,670
gonna be so excited question is will we

1190
00:54:13,470 --> 00:54:11,470
get a rover to get us a sample return

1191
00:54:15,480 --> 00:54:13,480
before the humans don't know yet that

1192
00:54:18,810 --> 00:54:15,490
would be awesome too

1193
00:54:20,700 --> 00:54:18,820
but yeah we're gonna get something in

1194
00:54:23,430 --> 00:54:20,710
specifically there's a lot of discussion

1195
00:54:25,890 --> 00:54:23,440
about cryogenic sampling because when

1196
00:54:29,790 --> 00:54:25,900
you sample something that's at minus 230

1197
00:54:31,230 --> 00:54:29,800
degrees below Sun that there's a lot of

1198
00:54:32,880 --> 00:54:31,240
debate right now whether or not you need

1199
00:54:34,800 --> 00:54:32,890
to keep it that cold yeah or do you just

1200
00:54:37,440 --> 00:54:34,810
need to seal it and make sure you don't

1201
00:54:39,750 --> 00:54:37,450
lose as it's sublimes as it warms and

1202
00:54:41,940 --> 00:54:39,760
the ice is sublime yeah it was a mission

1203
00:54:43,320 --> 00:54:41,950
concept for sampling off a comet and we

1204
00:54:44,550 --> 00:54:43,330
have that same debate because we're

1205
00:54:46,170 --> 00:54:44,560
going to bring it back to the earth the

1206
00:54:48,720 --> 00:54:46,180
question is you keep it in cryo storage

1207
00:54:50,430 --> 00:54:48,730
or do you allow it to come up to room

1208
00:54:51,960 --> 00:54:50,440
temperature but then you've lost some

1209
00:54:53,130 --> 00:54:51,970
information but you're right they're

1210
00:54:54,060 --> 00:54:53,140
gonna have to solve that issue I never

1211
00:54:56,010 --> 00:54:54,070
thought about that you're right

1212
00:55:06,030 --> 00:54:56,020
bring back our water samples from the

1213
00:55:08,970 --> 00:55:06,040

moon a good chiller so it looks like

1214
00:55:11,190 --> 00:55:08,980
greg daeun wants to know he wonders what

1215
00:55:13,020 --> 00:55:11,200
is the moon smell like what does it

1216
00:55:15,270 --> 00:55:13,030
smell like on the moon good question

1217
00:55:17,220 --> 00:55:15,280
well we don't know but according to the

1218
00:55:19,470 --> 00:55:17,230
Apollo tapes they smell they said it

1219
00:55:21,390 --> 00:55:19,480
smelled like gunpowder gunpowder

1220
00:55:23,640 --> 00:55:21,400
that was the it's reported by several

1221
00:55:24,900 --> 00:55:23,650
the astronauts so my husband died our

1222
00:55:27,580 --> 00:55:24,910
geeks we kind of listen to the audio

1223
00:55:27,590 --> 00:55:30,819
[Applause]

1224
00:55:35,380 --> 00:55:32,950
and more than once they would say it

1225
00:55:37,420 --> 00:55:35,390
smelled like gunpowder that would be

1226
00:55:39,460 --> 00:55:37,430
true I mean it's just that's error to be

1227
00:55:41,319 --> 00:55:39,470
clear that's air in the caps here on the

1228
00:55:42,880 --> 00:55:41,329
capsule when they got in after their EVs

1229
00:55:44,200 --> 00:55:42,890
this extra vehicle activity and are

1230
00:55:45,400 --> 00:55:44,210
romping around on the surface and I'm

1231
00:55:47,289 --> 00:55:45,410
coming back in and they're taking off

1232
00:55:52,390 --> 00:55:47,299
their coat that's when they smell it

1233
00:55:53,920 --> 00:55:52,400
because you know yeah but there wasn't a

1234
00:55:55,720 --> 00:55:53,930
pure oxygen atmosphere I don't know if

1235
00:55:57,160 --> 00:55:55,730
that changes anything maybe it has

1236
00:55:59,170 --> 00:55:57,170
something to do with the dust they think

1237
00:56:01,059 --> 00:55:59,180
is because again this dust is really

1238
00:56:04,180 --> 00:56:01,069

unique it's never been as it gets

1239
00:56:06,609 --> 00:56:04,190
fractured and and melted and

1240
00:56:09,009 --> 00:56:06,619
re-solidified by impacts on the surface

1241
00:56:10,779 --> 00:56:09,019
it creates what are called very open

1242
00:56:13,029 --> 00:56:10,789
active sites on the surfaces that

1243
00:56:19,569 --> 00:56:13,039
they're again on earth we have all this

1244
00:56:21,999 --> 00:56:19,579
oxygen around us that reacts exosphere

1245
00:56:24,670 --> 00:56:22,009
meaning a molecule can leave the surface

1246
00:56:32,470 --> 00:56:24,680
of the Moon and never encounter a number

1247
00:56:42,789 --> 00:56:32,480
another molecule as long as it lives or

1248
00:56:50,170 --> 00:56:42,799
is that just a human thing hook up to it

1249
00:56:51,759 --> 00:56:50,180
some sniffing instruments with the

1250
00:56:57,910 --> 00:56:51,769
nanotubes that measure can measure

1251
00:57:02,259 --> 00:56:57,920
specific chemicals to extrapolate aside

1252
00:57:07,930 --> 00:57:02,269
what we would experience so there's open

1253
00:57:09,999 --> 00:57:07,940
surfaces and reacts with the oxygen and

1254
00:57:16,660 --> 00:57:10,009
that's our only one data point right so

1255
00:57:19,660 --> 00:57:16,670
we're looking forward to more wants to

1256
00:57:21,630 --> 00:57:19,670
know all new suits be made specifically

1257
00:57:26,200 --> 00:57:21,640
for longer stays on the Martian surface

1258
00:57:28,599 --> 00:57:26,210
or sorry the moon surface they are

1259
00:57:30,640 --> 00:57:28,609
working on the next generation suit and

1260
00:57:32,289 --> 00:57:30,650
I'm afraid I don't know the name of it

1261
00:57:34,660 --> 00:57:32,299
the designation of it but they are

1262
00:57:38,289 --> 00:57:34,670
working on a new generation suit that is

1263
00:57:40,420 --> 00:57:38,299

meant to be more mobile a lot more

1264
00:57:44,200 --> 00:57:40,430
mobility to it

1265
00:57:46,060 --> 00:57:44,210
and to allow the astronauts to be able

1266
00:57:47,620 --> 00:57:46,070
to do things like that they couldn't do

1267
00:57:50,740 --> 00:57:47,630
on Apollo for example if you saw a

1268
00:57:52,150 --> 00:57:50,750
national fall over on Apollo they would

1269
00:57:54,160 --> 00:57:52,160
have to do a push-up to get themselves

1270
00:57:56,920 --> 00:57:54,170
up that couldn't bend the knees will not

1271
00:57:59,380 --> 00:57:56,930
least and so they'd have to do a push-up

1272
00:58:10,210 --> 00:57:59,390
a few times and so they got enough

1273
00:58:12,370 --> 00:58:10,220
momentum to get themselves back up the

1274
00:58:15,520 --> 00:58:12,380
astronauts were crushed up against the

1275
00:58:18,910 --> 00:58:15,530
edges and they're all bruised and

1276
00:58:20,470 --> 00:58:18,920
everything so we want the astronauts on

1277
00:58:21,940 --> 00:58:20,480
the moon to be very physically active

1278
00:58:24,550 --> 00:58:21,950
excavating all this water for us and

1279
00:58:34,750 --> 00:58:24,560
building off habitats and doing that so

1280
00:58:36,730 --> 00:58:34,760
the new suits are 1961 how do you

1281
00:58:39,280 --> 00:58:36,740
communicate with a probe down in the

1282
00:58:41,560 --> 00:58:39,290
crater what are the challenges so this

1283
00:58:44,590 --> 00:58:41,570
is kind of really interesting point a a

1284
00:58:46,780 --> 00:58:44,600
dark crater does not mean we can't see

1285
00:58:49,480 --> 00:58:46,790
into the crater from Earth uh-huh good

1286
00:58:50,560 --> 00:58:49,490
point so in one instance you can use

1287
00:58:52,420 --> 00:58:50,570
what's called direct to earth

1288
00:59:03,190 --> 00:58:52,430

communications that's where is what we

1289
00:59:04,930 --> 00:59:03,200
did to Apollo you can see Earth from a

1290
00:59:06,880 --> 00:59:04,940
PSR from the floor of a permanently

1291
00:59:08,320 --> 00:59:06,890
shadowed region or cradle other

1292
00:59:10,390 --> 00:59:08,330
instances you'll be able to look up

1293
00:59:12,250 --> 00:59:10,400
overhead and see gateway so you can

1294
00:59:15,820 --> 00:59:12,260
relay you can look straight up and talk

1295
00:59:17,020 --> 00:59:15,830
to a relay satellite or Gateway but

1296
00:59:18,760 --> 00:59:17,030
they've also talked about having

1297
00:59:21,610 --> 00:59:18,770
repeaters yeah so some of these

1298
00:59:23,770 --> 00:59:21,620
commercial service providers aren't just

1299
00:59:26,440 --> 00:59:23,780
talking about providing landed services

1300
00:59:27,700 --> 00:59:26,450
I can take you to the moon but they're

1301
00:59:36,010 --> 00:59:27,710
also talking about setting up

1302
00:59:37,630 --> 00:59:36,020
infrastructure on the moon like Landers

1303
00:59:39,310 --> 00:59:37,640
that are going actually will communicate

1304
00:59:41,770 --> 00:59:39,320
with the small Rovers and whatnot with

1305
00:59:44,680 --> 00:59:41,780
Wi-Fi and they're actually talking about

1306
00:59:46,420 --> 00:59:44,690
both communication power all kinds of

1307
00:59:48,040 --> 00:59:46,430
relay systems building infrastructure to

1308
00:59:50,050 --> 00:59:48,050
actually assist in the exploration and

1309
00:59:52,180 --> 00:59:50,060
science and and build-out yeah that's

1310
00:59:54,609 --> 00:59:52,190
cool yeah that helps me picture better

1311
00:59:56,349 --> 00:59:54,619
the crater and communicating

1312
00:59:57,819 --> 00:59:56,359
really deep in you're gonna have to go

1313
00:59:59,710 --> 00:59:57,829

up but if you're you know you depend

1314
01:00:01,779 --> 00:59:59,720
somewhere you can put a repeater cool

1315
01:00:03,880 --> 01:00:01,789
okay so I have another question

1316
01:00:05,910 --> 01:00:03,890
kal coos wants to know are you gonna

1317
01:00:09,549 --> 01:00:05,920
send Rovers to these craters first

1318
01:00:11,920 --> 01:00:09,559
before we eventually send the next woman

1319
01:00:16,960 --> 01:00:11,930
or not the next person and if so when

1320
01:00:19,470 --> 01:00:16,970
mm-hmm we really want to and we're

1321
01:00:24,400 --> 01:00:19,480
working on plans along those lines that

1322
01:00:27,039 --> 01:00:24,410
still are being formulated so yes you

1323
01:00:29,769 --> 01:00:27,049
need mobility to really understand the

1324
01:00:33,039 --> 01:00:29,779
distribution of water and and I think

1325
01:00:34,509 --> 01:00:33,049
everyone appreciates that so that is one

1326
01:00:36,249 --> 01:00:34,519
of the higher priorities right now to

1327
01:00:38,650 --> 01:00:36,259
understand the resources at the poles is

1328
01:00:40,900 --> 01:00:38,660
to get a rover at the poles at least one

1329
01:00:42,880 --> 01:00:40,910
and more you really probably want more

1330
01:00:44,620 --> 01:00:42,890
and to start prospecting and

1331
01:00:46,779 --> 01:00:44,630
characterizing and identifying and

1332
01:00:48,849 --> 01:00:46,789
that's the instrument I showed was built

1333
01:00:50,950 --> 01:00:48,859
specifically to go on a rover just like

1334
01:00:55,450 --> 01:00:50,960
that oh yeah yeah and so hopefully

1335
01:00:58,029 --> 01:00:55,460
before 2024 okay I mean that's an ideal

1336
01:01:00,970 --> 01:00:58,039
situation but there's also alternative I

1337
01:01:02,410 --> 01:01:00,980
mean if if if we get the human visiting

1338
01:01:08,829 --> 01:01:02,420

the moon before we get the Rovers the

1339
01:01:12,729 --> 01:01:08,839
Rovers rule doesn't slow down 24 does

1340
01:01:14,640 --> 01:01:12,739
not depend at all the astronauts are

1341
01:01:21,519 --> 01:01:14,650
gonna land is unexplored territory

1342
01:01:23,109 --> 01:01:21,529
non-stop you know we're gonna do this

1343
01:01:24,609 --> 01:01:23,119
slightly different life I mean that's

1344
01:01:26,829 --> 01:01:24,619
exactly what happened on Apollo with the

1345
01:01:29,049 --> 01:01:26,839
six landed missions each of them built

1346
01:01:30,700 --> 01:01:29,059
upon the experience of the prior oh yeah

1347
01:01:32,349 --> 01:01:30,710
and we all do that in science and in

1348
01:01:35,440 --> 01:01:32,359
engineering we learn what works what

1349
01:01:37,239 --> 01:01:35,450
doesn't work and we we expand in fact

1350
01:01:38,769 --> 01:01:37,249
perhaps we might have a scenario where

1351
01:01:40,420 --> 01:01:38,779
the humans get Firstman they're gonna

1352
01:01:42,430 --> 01:01:40,430
like I want a Rover to go over there

1353
01:01:44,799 --> 01:01:42,440
because you know what I haven't yet

1354
01:01:49,269 --> 01:01:44,809
developed my harness to do rappelling

1355
01:01:50,829 --> 01:01:49,279
off of I can do it with you know some

1356
01:01:52,299 --> 01:01:50,839
sort of design and then a couple years

1357
01:01:57,370 --> 01:01:52,309
later I've got my rappelling harness

1358
01:01:59,220 --> 01:01:57,380
ready to go so you know we have time for

1359
01:02:06,940 --> 01:01:59,230
one last question

1360
01:02:09,670 --> 01:02:06,950
so xxx YHVH triple x1 Stan

1361
01:02:11,499 --> 01:02:09,680
is radioactivity really a major concern

1362
01:02:12,819 --> 01:02:11,509
when traveling to and from earth and how

1363
01:02:14,950 --> 01:02:12,829

does this radiation affect your

1364
01:02:17,410 --> 01:02:14,960
instruments mm-hmm

1365
01:02:20,710 --> 01:02:17,420
it is it absolutely isn't it needs to be

1366
01:02:23,170 --> 01:02:20,720
designed into all your considerations

1367
01:02:27,309 --> 01:02:23,180
both for the instruments and for humans

1368
01:02:29,380 --> 01:02:27,319
and so our instrument uses components

1369
01:02:31,720 --> 01:02:29,390
and electronic parts that are what was

1370
01:02:33,460 --> 01:02:31,730
called flight qualified for flight and

1371
01:02:35,680 --> 01:02:33,470
what that what that means is they've

1372
01:02:39,099 --> 01:02:35,690
undergone testing to show that radiation

1373
01:02:40,779 --> 01:02:39,109
doesn't affect them okay electronics

1374
01:02:42,970 --> 01:02:40,789
we've been sending probes to Pluto and

1375
01:02:45,400 --> 01:02:42,980
the voyagers are left you know the solar

1376
01:02:47,529 --> 01:02:45,410
system time and space electronics point

1377
01:02:49,269 --> 01:02:47,539
of view we're kind of smart on making

1378
01:02:50,650 --> 01:02:49,279
things robust I mean the challenges are

1379
01:02:52,329 --> 01:02:50,660
when you have new materials and really

1380
01:02:54,130 --> 01:02:52,339
smaller transistors transistors and the

1381
01:02:57,339 --> 01:02:54,140
like that you'll have to do but we have

1382
01:03:00,579 --> 01:02:57,349
facilities here to test them so for that

1383
01:03:01,749 --> 01:03:00,589
for the biology is the other yeah so the

1384
01:03:04,120 --> 01:03:01,759
biology is the one that we're gonna have

1385
01:03:06,009 --> 01:03:04,130
to be learning and adapting and reacting

1386
01:03:08,289 --> 01:03:06,019
to and being proactive as we go forward

1387
01:03:10,839 --> 01:03:08,299
and also we're gonna be wanting to

1388
01:03:13,420 --> 01:03:10,849

monitor when the big solar storms come

1389
01:03:15,160 --> 01:03:13,430
our understanding I mean we have

1390
01:03:17,650 --> 01:03:15,170
sentinels out in space right now that

1391
01:03:19,569 --> 01:03:17,660
are monitoring the solar behavior and

1392
01:03:22,180 --> 01:03:19,579
whenever we get these solar storms that

1393
01:03:23,019 --> 01:03:22,190
could you know you know when it happens

1394
01:03:25,809 --> 01:03:23,029
in our astronauts are on the

1395
01:03:27,670 --> 01:03:25,819
International Space Station they go to a

1396
01:03:32,410 --> 01:03:27,680
certain part of the space station that's

1397
01:03:34,059 --> 01:03:32,420
a scenarios like that with our humans on

1398
01:03:37,210 --> 01:03:34,069
the moon as well and on you know

1399
01:03:40,059 --> 01:03:37,220
wherever they are next so it is a

1400
01:03:41,499 --> 01:03:40,069
concern but it's it's we're gonna learn

1401
01:03:44,499 --> 01:03:41,509
and we're gonna adapt and we're gonna

1402
01:03:46,420 --> 01:03:44,509
you know being react and be also

1403
01:03:49,420 --> 01:03:46,430
preventing things I don't anything on

1404
01:03:50,920 --> 01:03:49,430
that is another great use of water is

1405
01:03:53,289 --> 01:03:50,930
radiation shielding one of the best

1406
01:03:55,180 --> 01:03:53,299
radiation shields there is this water so

1407
01:03:57,130 --> 01:03:55,190
there are discussions about using

1408
01:03:59,259 --> 01:03:57,140
Regulus but also in the safe room where

1409
01:04:02,650 --> 01:03:59,269
you really need extra protection well

1410
01:04:05,170 --> 01:04:02,660
you have a layer of water that you and

1411
01:04:06,489 --> 01:04:05,180
then once in other places like when they

1412
01:04:08,950 --> 01:04:06,499
need discoveries that the Lunar

1413
01:04:10,390 --> 01:04:08,960

Reconnaissance Orbiter this is a moon

1414
01:04:14,620 --> 01:04:10,400
spacecraft in orbit on the moon for the

1415
01:04:16,569 --> 01:04:14,630
last 10 years has you know uncovered

1416
01:04:18,370 --> 01:04:16,579
these places that are lava tubes these

1417
01:04:21,100 --> 01:04:18,380
underground caverns in the moon

1418
01:04:23,260 --> 01:04:21,110
and they're also places that we have to

1419
01:04:25,030 --> 01:04:23,270
explore they're not quite at the poles

1420
01:04:26,320 --> 01:04:25,040
but once we've set up this

1421
01:04:28,840 --> 01:04:26,330
infrastructure it'll allow us to go

1422
01:04:31,450 --> 01:04:28,850
anywhere on the lunar surface yeah I bet

1423
01:04:33,070 --> 01:04:31,460
you an early destination after going to

1424
01:04:35,950 --> 01:04:33,080
the poles will be good to explore the

1425
01:04:38,830 --> 01:04:35,960
underground caverns and that's also a

1426
01:04:41,080 --> 01:04:38,840
place for potentially you could take

1427
01:04:43,060 --> 01:04:41,090
advantage of the you know what nature

1428
01:04:49,690 --> 01:04:43,070
gave you as a shield

1429
01:04:51,190 --> 01:04:49,700
right under ground Mars - that's right

1430
01:04:52,390 --> 01:04:51,200
so you can figure out if you can work

1431
01:05:04,860 --> 01:04:52,400
this whole thing out of the moon you've

1432
01:05:12,130 --> 01:05:09,210
sixteen hundred fifty six days did do it

1433
01:05:14,290 --> 01:05:12,140
before we have to wind up we've been

1434
01:05:16,480 --> 01:05:14,300
talking about all these challenges and

1435
01:05:17,950 --> 01:05:16,490
you guys sound confident that we're out

1436
01:05:20,080 --> 01:05:17,960
but we're gonna need a lot of help right

1437
01:05:22,420 --> 01:05:20,090
so there might be people listening who

1438
01:05:24,970 --> 01:05:22,430

want to get in on that so do you do you

1439
01:05:27,070 --> 01:05:24,980
guys have an answer for what's a what's

1440
01:05:28,660 --> 01:05:27,080
a good way to prepare to help NASA

1441
01:05:31,660 --> 01:05:28,670
tackle these challenges down the road

1442
01:05:33,340 --> 01:05:31,670
are there particular you know majors in

1443
01:05:34,480 --> 01:05:33,350
college you would do or skills you

1444
01:05:36,940 --> 01:05:34,490
develop it

1445
01:05:39,520 --> 01:05:36,950
one thing is it's important to note that

1446
01:05:41,410 --> 01:05:39,530
this isn't going back to put a new

1447
01:05:45,100 --> 01:05:41,420
footprint on the moon and then come home

1448
01:05:49,720 --> 01:05:45,110
it really is to be a sustained presence

1449
01:05:51,460 --> 01:05:49,730
that is with an open architectures can

1450
01:05:53,320 --> 01:05:51,470
really describe so it's involving

1451
01:05:56,200 --> 01:05:53,330
everybody from the commercial side to

1452
01:06:00,840 --> 01:05:56,210
industry the government's foreign the

1453
01:06:04,060 --> 01:06:00,850
NASA agencies all NASA agencies so I

1454
01:06:06,280 --> 01:06:04,070
really do think we're at a dawn of a new

1455
01:06:08,710 --> 01:06:06,290
age of exploration and so the

1456
01:06:10,420 --> 01:06:08,720
opportunities are gonna be incredible

1457
01:06:13,720 --> 01:06:10,430
and vast in terms of being able to

1458
01:06:16,450 --> 01:06:13,730
participate not only within a government

1459
01:06:19,240 --> 01:06:16,460
agency to get into space but you can now

1460
01:06:22,630 --> 01:06:19,250
go work at a company and get into space

1461
01:06:25,330 --> 01:06:22,640
yeah and eventually I do not doubt that

1462
01:06:26,880 --> 01:06:25,340
there won't only be NASA astronauts

1463
01:06:30,000 --> 01:06:26,890

there will be

1464
01:06:34,950 --> 01:06:30,010
prett astronauts people who know how to

1465
01:06:37,380 --> 01:06:34,960
build things and fix things keep an

1466
01:06:39,839 --> 01:06:37,390
infrastructure going so basically saying

1467
01:06:43,009 --> 01:06:39,849
you can do anything just come from

1468
01:06:47,640 --> 01:06:43,019
business to engineering to science

1469
01:06:50,190 --> 01:06:47,650
medicine you know philosophy and in the

1470
01:06:54,500 --> 01:06:50,200
law I mean this is opens up an entire

1471
01:06:58,680 --> 01:06:54,510
new area of international law

1472
01:07:00,809 --> 01:06:58,690
interplanetary that we haven't even

1473
01:07:02,120 --> 01:07:00,819
begun to scratch really and it's the

1474
01:07:05,160 --> 01:07:02,130
basis of becoming a spacefaring

1475
01:07:07,710 --> 01:07:05,170
civilization yeah that's what's next

1476
01:07:10,529 --> 01:07:07,720
yep thank you for there we're there all

1477
01:07:12,599 --> 01:07:10,539
right well that is all the time we have

1478
01:07:14,819 --> 01:07:12,609
for today so a huge thanks to you guys

1479
01:07:16,019 --> 01:07:14,829
our guests and to everyone who joined us

1480
01:07:18,660 --> 01:07:16,029
in the twitch chat with your amazing

1481
01:07:21,420 --> 01:07:18,670
questions we will be back on Thursday

1482
01:07:23,460 --> 01:07:21,430
July 18th when we talk about the 50th

1483
01:07:26,849 --> 01:07:23,470
anniversary of the Apollo moon landing

1484
01:07:29,279 --> 01:07:26,859
and then tune in the next day Friday

1485
01:07:31,730 --> 01:07:29,289
July 19th for a special live broadcast

1486
01:07:34,259 --> 01:07:31,740
from NASA centers across the country

1487
01:07:37,079 --> 01:07:34,269
celebrating the Apollo 50s as we go

1488
01:07:41,460 --> 01:07:37,089

forward to the moon so for more info on

1489
01:07:43,740 --> 01:07:41,470
that go to wwsz gov slash Apollo 50 and