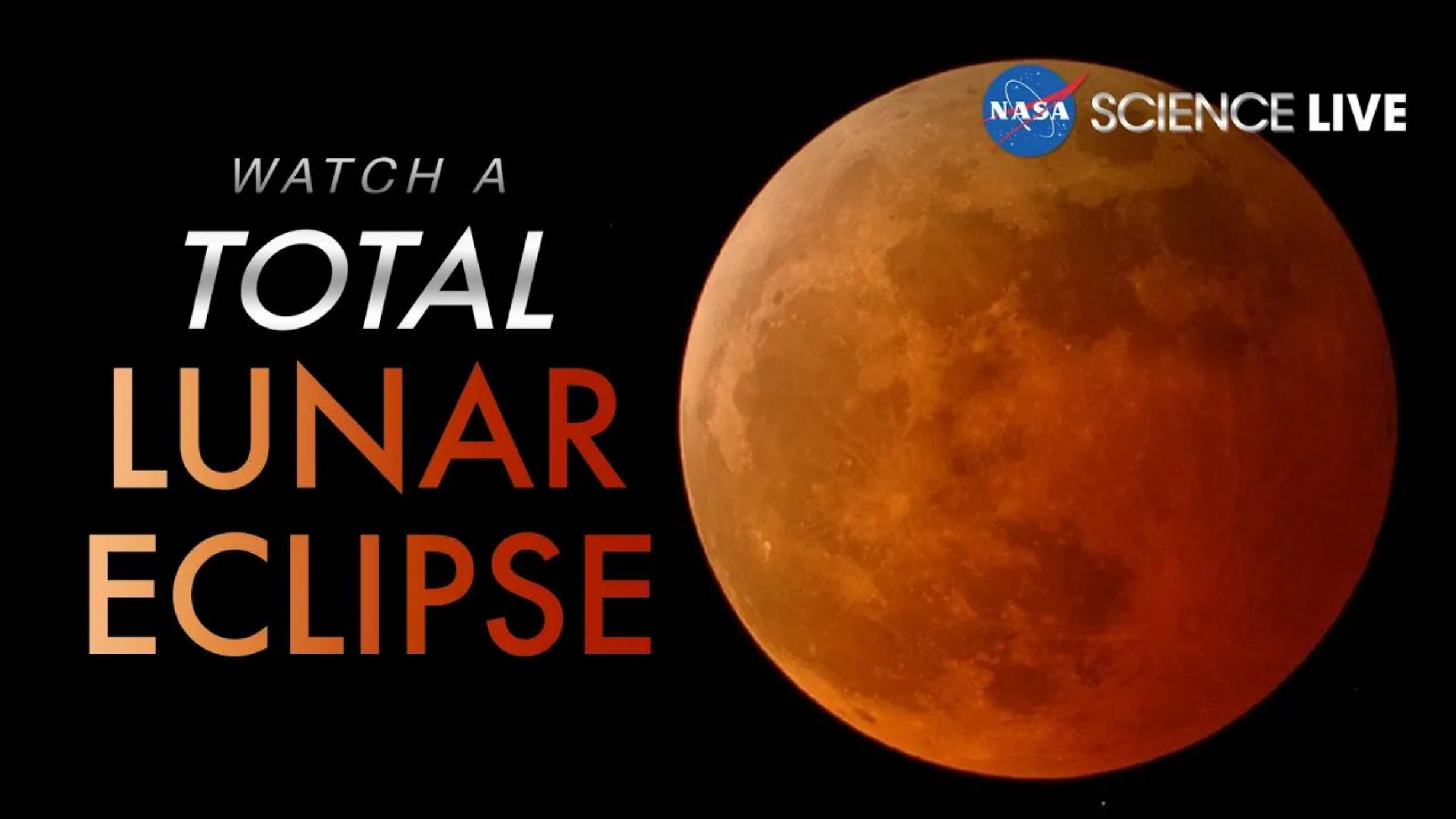
NASA SCIENCE LIVE
WATCH A
TOTAL
LUNAR
ECLIPSE

1
00:00:28,970 --> 00:00:02,570
[Music]

2
00:00:35,090 --> 00:00:32,330
hello and welcome to another episode of

3
00:00:37,310 --> 00:00:35,100
NASA science live an opportunity for you

4
00:00:38,930 --> 00:00:37,320
to interact with NASA scientists and

5
00:00:41,750 --> 00:00:38,940
have your questions answered in real

6
00:00:43,670 --> 00:00:41,760
time I'm your host joyung and tonight we

7
00:00:46,549 --> 00:00:43,680
are live at NASA's Goddard space flight

8
00:00:49,069 --> 00:00:46,559
center as the total lunar eclipse is

9
00:00:51,290 --> 00:00:49,079
nearing totality so it's a little bit

10
00:00:52,670 --> 00:00:51,300
overcast here right now but luckily

11
00:00:54,410 --> 00:00:52,680
we're going to be taking you to

12
00:00:56,750 --> 00:00:54,420
different locations with clear skies

13
00:00:58,729 --> 00:00:56,760

throughout the show so if you have any

14
00:01:01,130 --> 00:00:58,739
questions at all about the total lunar

15
00:01:03,410 --> 00:01:01,140
eclipse all by NASA is heading back to

16
00:01:05,810 --> 00:01:03,420
the Moon send your questions in using

17
00:01:07,969 --> 00:01:05,820
the hashtag asknassa or wherever you're

18
00:01:10,490 --> 00:01:07,979
watching the show today and as you can

19
00:01:12,530 --> 00:01:10,500
see we will have a constant live feed of

20
00:01:14,090 --> 00:01:12,540
the lunar eclipse so thank you so much

21
00:01:16,490 --> 00:01:14,100
to our friends at time and date for

22
00:01:18,230 --> 00:01:16,500
providing that feed so as you can see

23
00:01:20,870 --> 00:01:18,240
there's a lot of excitement in the air

24
00:01:22,609 --> 00:01:20,880
and we have a lot in store for you as we

25
00:01:24,530 --> 00:01:22,619
track the lunar eclipse from North and

26
00:01:26,450 --> 00:01:24,540
South America and parts of Europe as

27
00:01:28,609 --> 00:01:26,460
well we have NASA scientists answering

28
00:01:30,530 --> 00:01:28,619
your questions and we also have feeds of

29
00:01:32,810 --> 00:01:30,540
tell us Scopes dotted all around the

30
00:01:34,969 --> 00:01:32,820
world that are fixated on tonight's

31
00:01:37,190 --> 00:01:34,979
Celestial event and there's a chance

32
00:01:39,830 --> 00:01:37,200
that you too can see the lunar eclipse

33
00:01:41,810 --> 00:01:39,840
as well so if you do snap a photo and

34
00:01:42,889 --> 00:01:41,820
start with us on social media or

35
00:01:44,569 --> 00:01:42,899
wherever you're watching tonight's

36
00:01:47,270 --> 00:01:44,579
episode

37
00:01:48,950 --> 00:01:47,280
um so there's yeah

38
00:01:50,450 --> 00:01:48,960

uh there's a lot to talk about and we

39
00:01:52,910 --> 00:01:50,460
have a lot of questions coming in online

40
00:01:55,429 --> 00:01:52,920
but first let's go over to my co-host

41
00:01:57,469 --> 00:01:55,439
James traily who can tell us where we

42
00:01:59,810 --> 00:01:57,479
are on the eclipse right now and what's

43
00:02:01,910 --> 00:01:59,820
in store for us in tonight's total lunar

44
00:02:04,010 --> 00:02:01,920
eclipse hey James how's it going over

45
00:02:05,389 --> 00:02:04,020
there good there are some extreme micro

46
00:02:07,010 --> 00:02:05,399
climates out there but unfortunately

47
00:02:08,389 --> 00:02:07,020
just a couple feet away from you and the

48
00:02:11,390 --> 00:02:08,399
other side of the building it's also

49
00:02:13,070 --> 00:02:11,400
overcast and rainy so not holding out

50
00:02:14,690 --> 00:02:13,080
you know for a good view from here

51
00:02:16,130 --> 00:02:14,700
release but we're tracking it all across

52
00:02:18,290 --> 00:02:16,140
the world the view behind me right here

53
00:02:19,729 --> 00:02:18,300
is from Cartersville Georgia where

54
00:02:21,350 --> 00:02:19,739
there's a little bit of cloud cover but

55
00:02:23,270 --> 00:02:21,360
we've got a really nice view coming into

56
00:02:24,410 --> 00:02:23,280
Focus tracking this from around the

57
00:02:27,050 --> 00:02:24,420
world as well we got some feeds from

58
00:02:28,490 --> 00:02:27,060
Morocco all over Spain and it's just

59
00:02:30,949 --> 00:02:28,500
going to be a phenomenal show to view

60
00:02:32,630 --> 00:02:30,959
from there so is this your first ever

61
00:02:37,430 --> 00:02:32,640
eclipse

62
00:02:39,890 --> 00:02:37,440
in 2019 in uh Mexico City actually and

63
00:02:42,650 --> 00:02:39,900

it was an amazing experience what about

64
00:02:44,150 --> 00:02:42,660
yourself it's been I think at least a

65
00:02:45,229 --> 00:02:44,160
decade for me it's been a really long

66
00:02:47,210 --> 00:02:45,239
time and I guess I'm gonna have to keep

67
00:02:48,830 --> 00:02:47,220
waiting as well but live vicariously

68
00:02:51,530 --> 00:02:48,840
through the amazing fees that we've got

69
00:02:53,570 --> 00:02:51,540
out here as well so how many feeds do we

70
00:02:55,309 --> 00:02:53,580
have tonight yeah quite a few I think

71
00:02:56,330 --> 00:02:55,319
I'm tracking at least eight here so far

72
00:02:58,130 --> 00:02:56,340
there's some that are kind of cycling

73
00:02:59,930 --> 00:02:58,140
through for me as well too from parts of

74
00:03:01,490 --> 00:02:59,940
the west coast of the United States out

75
00:03:03,589 --> 00:03:01,500
in La we've got a really cool view from

76
00:03:05,089 --> 00:03:03,599
Ontario Canada as well a lot of places

77
00:03:06,290 --> 00:03:05,099
are fighting with a little bit of cloud

78
00:03:08,210 --> 00:03:06,300
cover so we'll kind of see how that

79
00:03:09,410 --> 00:03:08,220
develops over the night as well one of

80
00:03:11,210 --> 00:03:09,420
the views I'm tracking as well is from

81
00:03:12,589 --> 00:03:11,220
Rome Italy where as the night goes on

82
00:03:14,630 --> 00:03:12,599
the moon is going to get lower and lower

83
00:03:16,009 --> 00:03:14,640
and the Horizon we might even get a view

84
00:03:18,170 --> 00:03:16,019
of the Coliseum as well which would be

85
00:03:19,309 --> 00:03:18,180
fantastic as well but at least for right

86
00:03:22,430 --> 00:03:19,319
now let's learn a little bit more about

87
00:03:24,229 --> 00:03:22,440
the science behind a lunar eclipse

88
00:03:25,729 --> 00:03:24,239

if you looked at the Moon over the

89
00:03:26,990 --> 00:03:25,739
course of a few weeks you'd probably

90
00:03:29,570 --> 00:03:27,000
notice that it looks slightly different

91
00:03:31,250 --> 00:03:29,580
every day the change in its shadow is

92
00:03:33,229 --> 00:03:31,260
based on where the Moon is in its orbit

93
00:03:35,030 --> 00:03:33,239
we call this cycle the phases of the

94
00:03:37,490 --> 00:03:35,040
moon and it occurs roughly once a month

95
00:03:39,830 --> 00:03:37,500
at least twice a year however something

96
00:03:41,089 --> 00:03:39,840
quite different happens the moon passes

97
00:03:43,190 --> 00:03:41,099
through the shadow cast by the Earth

98
00:03:45,229 --> 00:03:43,200
causing it to look extremely unusual for

99
00:03:47,149 --> 00:03:45,239
a short period of time from the earth

100
00:03:48,830 --> 00:03:47,159
the moon will appear to darken and turn

101
00:03:50,990 --> 00:03:48,840
a deep red before eventually returning

102
00:03:52,850 --> 00:03:51,000
to normal this is called a lunar eclipse

103
00:03:54,470 --> 00:03:52,860
if we were to look at what happens from

104
00:03:56,690 --> 00:03:54,480
space during an eclipse it would go

105
00:03:57,710 --> 00:03:56,700
something like this first the moon

106
00:03:59,509 --> 00:03:57,720
passes through What's called the

107
00:04:01,970 --> 00:03:59,519
penumbra where the Sun's light is only

108
00:04:03,649 --> 00:04:01,980
partially obscured this results in only

109
00:04:05,449 --> 00:04:03,659
a slight darkening of the Moon

110
00:04:07,070 --> 00:04:05,459
as the moon continues along its path

111
00:04:08,509 --> 00:04:07,080
however it enters What's called the

112
00:04:10,850 --> 00:04:08,519
Umbra where all direct light from the

113
00:04:12,710 --> 00:04:10,860

sun is blocked but if the Sun is blocked

114
00:04:14,390 --> 00:04:12,720
why does the moon turn red

115
00:04:16,069 --> 00:04:14,400
when light from the sun goes by the side

116
00:04:17,990 --> 00:04:16,079
of the earth it passes through a long

117
00:04:19,789 --> 00:04:18,000
and thick layer of Earth's atmosphere

118
00:04:22,069 --> 00:04:19,799
shorter wavelengths of sunlight like

119
00:04:23,450 --> 00:04:22,079
blue are scattered by the atmosphere so

120
00:04:25,010 --> 00:04:23,460
by the time the light has finished its

121
00:04:27,650 --> 00:04:25,020
trip to the moon more of the longer

122
00:04:29,150 --> 00:04:27,660
wavelengths like red are left over on

123
00:04:30,650 --> 00:04:29,160
the earth the same thing happens at

124
00:04:32,990 --> 00:04:30,660
Sunset as the ground you stand on

125
00:04:34,730 --> 00:04:33,000
gradually passes in tonight as the

126
00:04:36,770 --> 00:04:34,740
eclipse ends the moon leaves the Umbra

127
00:04:38,450 --> 00:04:36,780
returns to its normal color and then

128
00:04:41,210 --> 00:04:38,460
leaves the pen number of brightening and

129
00:04:42,650 --> 00:04:41,220
resuming its original cycle overall the

130
00:04:44,330 --> 00:04:42,660
whole process lasts only from a few

131
00:04:46,610 --> 00:04:44,340
minutes to a few hours so you'll have to

132
00:04:47,749 --> 00:04:46,620
be quick if you want to see it but as

133
00:04:49,430 --> 00:04:47,759
long as you're willing to stay awake

134
00:04:52,370 --> 00:04:49,440
you'll catch the moon as you won't see

135
00:04:56,330 --> 00:04:54,170
so right now I'm joined by science

136
00:04:58,370 --> 00:04:56,340
visualizer and our telescope Guru for

137
00:04:59,629 --> 00:04:58,380
tonight's events Ernie Wright hi James

138
00:05:01,129 --> 00:04:59,639

Ernie thanks so much for joining us uh

139
00:05:02,510 --> 00:05:01,139
it's a pleasure to be here it's a little

140
00:05:03,710 --> 00:05:02,520
bit of a cloudy night but we're still

141
00:05:05,029 --> 00:05:03,720
you know tracking this from across the

142
00:05:06,710 --> 00:05:05,039
world here right now we can actually see

143
00:05:08,210 --> 00:05:06,720
a shadow starting to creep a little bit

144
00:05:09,770 --> 00:05:08,220
across the moon can you tell us where we

145
00:05:11,090 --> 00:05:09,780
are right now in the process right I

146
00:05:13,730 --> 00:05:11,100
mean we're a little bit more than 50

147
00:05:16,129 --> 00:05:13,740
covered in the partial phase and this is

148
00:05:17,930 --> 00:05:16,139
where the Umbra is starting to track

149
00:05:20,510 --> 00:05:17,940
across the moon

150
00:05:22,249 --> 00:05:20,520
um in this view it's a little bit dark a

151
00:05:25,129 --> 00:05:22,259
little bit farther out because of the

152
00:05:26,990 --> 00:05:25,139
exposure that they're using um but over

153
00:05:29,450 --> 00:05:27,000
the next half hour or so we should

154
00:05:32,029 --> 00:05:29,460
expect this Darkness to completely

155
00:05:33,890 --> 00:05:32,039
spread across the moon uh and then when

156
00:05:36,290 --> 00:05:33,900
they change the exposure because the

157
00:05:38,150 --> 00:05:36,300
moon's so dim during totality hopefully

158
00:05:39,529 --> 00:05:38,160
we'll see some red color there too very

159
00:05:41,029 --> 00:05:39,539
excited about that and if you're keeping

160
00:05:42,529 --> 00:05:41,039
score from home and you want to sync up

161
00:05:43,670 --> 00:05:42,539
your events you're outside at the right

162
00:05:44,930 --> 00:05:43,680
moment there's a good chance that you

163
00:05:46,550 --> 00:05:44,940

can capture this from your own backyard

164
00:05:47,810 --> 00:05:46,560
so we want you out there sharing your

165
00:05:48,950 --> 00:05:47,820
picks with us as well we've got the

166
00:05:50,270 --> 00:05:48,960
schedule up here could you just kind of

167
00:05:53,749 --> 00:05:50,280
walk us through some of the highlights

168
00:05:55,430 --> 00:05:53,759
right so um before we came on even

169
00:05:57,890 --> 00:05:55,440
um the partial began and that's the

170
00:05:59,390 --> 00:05:57,900
point where the Umbra is starting to

171
00:06:01,370 --> 00:05:59,400
cover the moon

172
00:06:04,010 --> 00:06:01,380
um about halfway through our program at

173
00:06:06,230 --> 00:06:04,020
11 29 uh totality will begin and that's

174
00:06:07,969 --> 00:06:06,240
when the moon all the brightness will

175
00:06:11,590 --> 00:06:07,979
stop dazzling your eyes and you can see

176
00:06:15,290 --> 00:06:11,600
sort of that dark red color at 11 29

177
00:06:17,510 --> 00:06:15,300
maximum eclipse this is when the moon is

178
00:06:19,070 --> 00:06:17,520
in the middle of the shadow in the

179
00:06:20,809 --> 00:06:19,080
deepest part of the shadow that occurs

180
00:06:24,650 --> 00:06:20,819
about 10 minutes after we're done here

181
00:06:27,350 --> 00:06:24,660
at 12 11 Eastern and the eclipse

182
00:06:29,450 --> 00:06:27,360
continues for another 45 minutes or so

183
00:06:31,129 --> 00:06:29,460
yeah so it's a longer one 85 minutes or

184
00:06:32,330 --> 00:06:31,139
so this is not usually the case usually

185
00:06:33,650 --> 00:06:32,340
they're pretty short so you got some

186
00:06:35,510 --> 00:06:33,660
time to grab a coffee get your camera

187
00:06:36,770 --> 00:06:35,520
set up you know why is why is this one

188
00:06:38,390 --> 00:06:36,780

different I guess from the rest in terms

189
00:06:39,469 --> 00:06:38,400
of length uh it has a lot to do with

190
00:06:41,629 --> 00:06:39,479
whether or not it's going through the

191
00:06:44,450 --> 00:06:41,639
middle of the Shadow or kind of skimming

192
00:06:47,510 --> 00:06:44,460
along the edge this eclipse is in the

193
00:06:50,150 --> 00:06:47,520
top 25 percent of eclipses for duration

194
00:06:51,770 --> 00:06:50,160
so we're pretty close to the middle it

195
00:06:53,689 --> 00:06:51,780
gives everybody lots of chances to go

196
00:06:55,730 --> 00:06:53,699
outside if it's cloudy where you are

197
00:06:57,890 --> 00:06:55,740
right now wait a couple of minutes and

198
00:06:59,510 --> 00:06:57,900
try again yes we're just tracking this

199
00:07:00,710 --> 00:06:59,520
now the conditions are changing so

200
00:07:02,330 --> 00:07:00,720
quickly the cloud cover is kind of

201
00:07:03,950 --> 00:07:02,340
moving over and as I mentioned we really

202
00:07:05,990 --> 00:07:03,960
do want you to capture this moment for

203
00:07:07,309 --> 00:07:06,000
us as well from your own backyard what

204
00:07:08,689 --> 00:07:07,319
are some tips for people to get that

205
00:07:09,950 --> 00:07:08,699
Best Shot you know with whatever camera

206
00:07:12,890 --> 00:07:09,960
they're using you know even their cell

207
00:07:14,270 --> 00:07:12,900
phone right I mean for for one thing it

208
00:07:15,830 --> 00:07:14,280
should be pointed out that we don't need

209
00:07:17,930 --> 00:07:15,840
any special equipment to see it you can

210
00:07:19,730 --> 00:07:17,940
go outside with your naked eye and you

211
00:07:22,010 --> 00:07:19,740
can also see it with binoculars but if

212
00:07:23,890 --> 00:07:22,020
you want to take a photograph you'll

213
00:07:26,510 --> 00:07:23,900

need longer exposure

214
00:07:28,730 --> 00:07:26,520
and you'll want to probably set your

215
00:07:29,990 --> 00:07:28,740
camera not to night mode because if you

216
00:07:31,850 --> 00:07:30,000
set it to night mode it will try to

217
00:07:33,890 --> 00:07:31,860
brighten everything and you're only

218
00:07:36,290 --> 00:07:33,900
trying to take a picture of the Moon if

219
00:07:38,809 --> 00:07:36,300
you're able to zoom you should do that

220
00:07:40,550 --> 00:07:38,819
the Moon is surprisingly small in these

221
00:07:42,170 --> 00:07:40,560
pictures so if you just take a regular

222
00:07:44,330 --> 00:07:42,180
photograph you'll get three pixels of

223
00:07:46,189 --> 00:07:44,340
moon and lots of dark sky

224
00:07:47,930 --> 00:07:46,199
so right now you have your telescope

225
00:07:50,089 --> 00:07:47,940
with us which is getting a great shot of

226
00:07:51,350 --> 00:07:50,099
the studio lights but you know what is

227
00:07:52,430 --> 00:07:51,360
it actually what would it be doing out

228
00:07:54,950 --> 00:07:52,440
in the field if you're actually having

229
00:07:57,350 --> 00:07:54,960
out there right and I brought this in um

230
00:08:00,770 --> 00:07:57,360
so that if we had clear skies we could

231
00:08:03,350 --> 00:08:00,780
actually get a feed from here but this

232
00:08:05,689 --> 00:08:03,360
is just a three inch refractor there are

233
00:08:07,790 --> 00:08:05,699
two basic kinds of telescope a refractor

234
00:08:11,029 --> 00:08:07,800
has a big lens for Gathering light and a

235
00:08:13,490 --> 00:08:11,039
reflector has a big mirror and then I've

236
00:08:17,390 --> 00:08:13,500
attached to the telescope just a regular

237
00:08:19,909 --> 00:08:17,400
DSLR and there's a special bit that

238
00:08:21,830 --> 00:08:19,919

mates them together but this allows the

239
00:08:23,570 --> 00:08:21,840
camera to look through the telescope as

240
00:08:25,850 --> 00:08:23,580
if the telescope were a big telephoto

241
00:08:28,249 --> 00:08:25,860
lens and

242
00:08:30,950 --> 00:08:28,259
what we were planning to do if we had

243
00:08:34,370 --> 00:08:30,960
clear skies was use the Live View mode

244
00:08:37,310 --> 00:08:34,380
on the camera and the camera has HDMI

245
00:08:39,230 --> 00:08:37,320
out and so if you had a crowd and you

246
00:08:41,449 --> 00:08:39,240
didn't want to line them all up and look

247
00:08:43,909 --> 00:08:41,459
through it individually you could put a

248
00:08:45,530 --> 00:08:43,919
TV right next to the telescope and and

249
00:08:47,329 --> 00:08:45,540
everybody could see it simultaneously

250
00:08:48,710 --> 00:08:47,339
just like we're looking at it here yeah

251
00:08:50,030 --> 00:08:48,720
and stuff is really starting to move a

252
00:08:51,350 --> 00:08:50,040
little bit more here now even since we

253
00:08:52,490 --> 00:08:51,360
started talking it seems like there's a

254
00:08:56,329 --> 00:08:52,500
little bit more coverage as well too

255
00:08:58,370 --> 00:08:56,339
yeah um and in fact as time goes on uh

256
00:09:01,490 --> 00:08:58,380
from minute to minute you should be able

257
00:09:03,590 --> 00:09:01,500
to see some changes in the shadow it's

258
00:09:06,889 --> 00:09:03,600
going to move very quickly particularly

259
00:09:08,269 --> 00:09:06,899
when we get close to 11 29 you know the

260
00:09:10,550 --> 00:09:08,279
last little bit of bright moon will be

261
00:09:12,170 --> 00:09:10,560
there and as you're watching it you can

262
00:09:14,030 --> 00:09:12,180
see it being covered up which is pretty

263
00:09:15,530 --> 00:09:14,040

cool what can we expect some of the kind

264
00:09:16,790 --> 00:09:15,540
of reddish color to start creeping in

265
00:09:20,210 --> 00:09:16,800
here as well

266
00:09:21,829 --> 00:09:20,220
um almost before totality starts what

267
00:09:23,210 --> 00:09:21,839
you really need to do is kind of get rid

268
00:09:25,490 --> 00:09:23,220
of all that very bright moon because

269
00:09:28,730 --> 00:09:25,500
that sort of dazzling your eye

270
00:09:31,790 --> 00:09:28,740
um this is thousands of times dimmer but

271
00:09:34,310 --> 00:09:31,800
once you get into totality your eye will

272
00:09:36,290 --> 00:09:34,320
adjust you know your eye has this sort

273
00:09:38,329 --> 00:09:36,300
of automatic exposure control and you'll

274
00:09:40,550 --> 00:09:38,339
be able to see that red color amazing

275
00:09:42,889 --> 00:09:40,560
and what is the next one as well next

276
00:09:45,230 --> 00:09:42,899
lunar eclipse here from November so

277
00:09:47,030 --> 00:09:45,240
anybody who's missing out

278
00:09:48,650 --> 00:09:47,040
um you know six months from now we'll

279
00:09:50,030 --> 00:09:48,660
have another one to look forward to

280
00:09:52,130 --> 00:09:50,040
plenty of time for this one tonight

281
00:09:53,930 --> 00:09:52,140
still too like we said 85 minutes for

282
00:09:55,190 --> 00:09:53,940
you to be able to view this one so a

283
00:09:56,449 --> 00:09:55,200
really good window for you to get you

284
00:09:57,710 --> 00:09:56,459
know nice coffee it's a little bit late

285
00:09:59,509 --> 00:09:57,720
here maybe bundle up a little bit if

286
00:10:00,949 --> 00:09:59,519
it's cold where you are but in the

287
00:10:02,569 --> 00:10:00,959
meantime I understand that Joy has some

288
00:10:04,550 --> 00:10:02,579

members of the Artemis program with her

289
00:10:06,949 --> 00:10:04,560
to talk a bit more about our next

290
00:10:10,490 --> 00:10:06,959
mission to the Moon

291
00:10:12,889 --> 00:10:10,500
hi yes so Earth's moon is the only place

292
00:10:15,769 --> 00:10:12,899
beyond Earth that humans have set foot

293
00:10:17,690 --> 00:10:15,779
on and with NASA's Artemis program we're

294
00:10:19,370 --> 00:10:17,700
planning to take the first woman a first

295
00:10:21,470 --> 00:10:19,380
person of color back to the lunar

296
00:10:24,110 --> 00:10:21,480
surface so to tell us more about that

297
00:10:26,630 --> 00:10:24,120
I'm joined by two with two NASA experts

298
00:10:29,090 --> 00:10:26,640
uh Dr Ryan Watkins who is a program

299
00:10:31,370 --> 00:10:29,100
scientist at NASA headquarters and Dr

300
00:10:33,710 --> 00:10:31,380
Vishnu vishwanathan who is a research

301
00:10:35,449 --> 00:10:33,720
scientist at Nasa Goddard thank you both

302
00:10:37,790 --> 00:10:35,459
so much for joining us today thanks for

303
00:10:39,290 --> 00:10:37,800
having us yeah thanks so can you tell us

304
00:10:41,810 --> 00:10:39,300
a little bit about your roles and what

305
00:10:43,610 --> 00:10:41,820
you do at NASA yeah I'll just start off

306
00:10:45,889 --> 00:10:43,620
by saying it's a very exciting time to

307
00:10:48,050 --> 00:10:45,899
be a lunar scientist at Nasa so at

308
00:10:49,970 --> 00:10:48,060
headquarters um in my office we manage

309
00:10:53,449 --> 00:10:49,980
the lunar Discovery and exploration

310
00:10:55,069 --> 00:10:53,459
program and so under this program Falls

311
00:10:57,590 --> 00:10:55,079
um the various programs that are sending

312
00:10:59,569 --> 00:10:57,600
scientific and Technology development

313
00:11:01,550 --> 00:10:59,579

instruments to the Moon via commercial

314
00:11:03,530 --> 00:11:01,560
Partners as well as on various

315
00:11:04,850 --> 00:11:03,540
International missions we also do all

316
00:11:08,389 --> 00:11:04,860
the integration of Artemis science

317
00:11:10,130 --> 00:11:08,399
within NASA's directorates and yeah so

318
00:11:11,930 --> 00:11:10,140
for my role specifically one of the

319
00:11:13,670 --> 00:11:11,940
things I do is just make sure that our

320
00:11:14,990 --> 00:11:13,680
scientific instruments can meet their

321
00:11:17,090 --> 00:11:15,000
science objectives and have everything

322
00:11:18,829 --> 00:11:17,100
they need to do that it's one of many

323
00:11:20,210 --> 00:11:18,839
many things we do but yeah so getting

324
00:11:22,550 --> 00:11:20,220
science instruments to the moon and

325
00:11:25,550 --> 00:11:22,560
Artemis is a large part of what we do

326
00:11:28,670 --> 00:11:25,560
hey um I'm a research scientist here at

327
00:11:31,130 --> 00:11:28,680
Nasa got it and I primarily use

328
00:11:32,810 --> 00:11:31,140
um like the data sets that are obtained

329
00:11:34,970 --> 00:11:32,820
from Sonic scientific instruments that

330
00:11:36,230 --> 00:11:34,980
we have sent to space primarily to

331
00:11:38,509 --> 00:11:36,240
understand

332
00:11:40,250 --> 00:11:38,519
um the interior structure of planetary

333
00:11:42,530 --> 00:11:40,260
bodies especially the moon and other

334
00:11:46,370 --> 00:11:42,540
planetary bodies as well to put together

335
00:11:49,250 --> 00:11:46,380
a puzzle regarding uh you know how

336
00:11:51,350 --> 00:11:49,260
regarding the evolution and formation of

337
00:11:54,530 --> 00:11:51,360
the solar system in general uh you know

338
00:11:57,590 --> 00:11:54,540

I asked several questions like uh uh

339
00:12:00,170 --> 00:11:57,600
like you know how is uh the moon like

340
00:12:02,030 --> 00:12:00,180
was the moon always uh how it is as we

341
00:12:03,829 --> 00:12:02,040
see it in the sky today or was it

342
00:12:06,590 --> 00:12:03,839
oriented in a different manner compared

343
00:12:08,210 --> 00:12:06,600
to you know several billion years ago or

344
00:12:10,310 --> 00:12:08,220
you know like you know does it have a

345
00:12:13,910 --> 00:12:10,320
solid inner core within it like like we

346
00:12:15,889 --> 00:12:13,920
know for the Earth and um so I I'm

347
00:12:18,530 --> 00:12:15,899
facilitated by several data sets that

348
00:12:21,110 --> 00:12:18,540
we've collected such as the Luna laser

349
00:12:25,310 --> 00:12:21,120
ranging data where we fire lasers to

350
00:12:27,350 --> 00:12:25,320
these mirrors that were left over on the

351
00:12:30,470 --> 00:12:27,360
um you know the lunar surface the new

352
00:12:33,590 --> 00:12:30,480
the lunar near Side by our astronauts

353
00:12:35,870 --> 00:12:33,600
and some of the Rovers and

354
00:12:37,310 --> 00:12:35,880
um as well as the gravity field of the

355
00:12:40,610 --> 00:12:37,320
Moon that was mapped in high resolution

356
00:12:43,449 --> 00:12:40,620
by um in the NASA Grail Mission as well

357
00:12:46,310 --> 00:12:43,459
as lunar topography data for example

358
00:12:49,310 --> 00:12:46,320
that's obtained from the laser ultimate

359
00:12:52,670 --> 00:12:49,320
on the the lro spacecraft which is now

360
00:12:54,410 --> 00:12:52,680
in orbit for like what 13 years now so

361
00:12:56,210 --> 00:12:54,420
yeah this is just a great time as she

362
00:12:58,670 --> 00:12:56,220
said to be a lunar scientist and I'm

363
00:13:00,829 --> 00:12:58,680

really excited to be here

364
00:13:02,389 --> 00:13:00,839
so can we talk a bit about what NASA's

365
00:13:04,069 --> 00:13:02,399
plans are for back so we're going back

366
00:13:07,009 --> 00:13:04,079
to the moon so we're taking science

367
00:13:08,210 --> 00:13:07,019
instruments a river and then humans yeah

368
00:13:09,710 --> 00:13:08,220
so we're actually doing a lot to get

369
00:13:11,150 --> 00:13:09,720
ready to go back to the Moon right now

370
00:13:14,210 --> 00:13:11,160
um like you said one of the first things

371
00:13:15,710 --> 00:13:14,220
we're doing um besides lro is is sending

372
00:13:17,930 --> 00:13:15,720
scientific instruments as well as

373
00:13:20,329 --> 00:13:17,940
technology demonstrations to the Moon

374
00:13:22,910 --> 00:13:20,339
via the commercial lunar payload

375
00:13:24,769 --> 00:13:22,920
Services Program or eclipse for short

376
00:13:27,170 --> 00:13:24,779
um and so this is um NASA's way of

377
00:13:30,230 --> 00:13:27,180
rapidly acquiring commercial delivery

378
00:13:31,790 --> 00:13:30,240
services to the lunar surface so we have

379
00:13:33,769 --> 00:13:31,800
about seven of these on Deck right now

380
00:13:35,750 --> 00:13:33,779
with over 40 instruments that it will be

381
00:13:37,910 --> 00:13:35,760
flying to the moon and it's part of this

382
00:13:40,310 --> 00:13:37,920
is the Rover you mentioned Viper so

383
00:13:42,590 --> 00:13:40,320
Viper will be roving around looking for

384
00:13:44,990 --> 00:13:42,600
volatiles specifically things such as

385
00:13:46,670 --> 00:13:45,000
water ice and permanently shadowed

386
00:13:48,470 --> 00:13:46,680
regions on the moon so these are areas

387
00:13:50,389 --> 00:13:48,480
that either neither or never get

388
00:13:52,250 --> 00:13:50,399

sunlight or rarely get any sunlight so

389
00:13:54,350 --> 00:13:52,260
good places for water ice to to be

390
00:13:55,850 --> 00:13:54,360
contained so it will be prospecting for

391
00:13:58,189 --> 00:13:55,860
for these areas you know how much is

392
00:13:59,810 --> 00:13:58,199
there what type of deposits do we see

393
00:14:02,090 --> 00:13:59,820
and then how could we possibly use that

394
00:14:03,530 --> 00:14:02,100
for for future human missions to the

395
00:14:05,449 --> 00:14:03,540
Moon yes and then culminating with

396
00:14:06,829 --> 00:14:05,459
Artemis and in our first woman and first

397
00:14:07,910 --> 00:14:06,839
person of color back to the surface of

398
00:14:09,710 --> 00:14:07,920
the Moon

399
00:14:12,590 --> 00:14:09,720
and this is a question for you Vishnu so

400
00:14:15,050 --> 00:14:12,600
you study the Moon from Earth is

401
00:14:16,910 --> 00:14:15,060
studying uh the Moon from Earth during

402
00:14:18,650 --> 00:14:16,920
the lunar eclipse particularly exciting

403
00:14:20,269 --> 00:14:18,660
for your type of research oh yes

404
00:14:22,250 --> 00:14:20,279
absolutely

405
00:14:24,530 --> 00:14:22,260
um so for example right now like during

406
00:14:26,810 --> 00:14:24,540
the full moon phase right uh the surface

407
00:14:29,569 --> 00:14:26,820
of the Moon is really hot it gets heated

408
00:14:32,389 --> 00:14:29,579
up something like 250 degrees Fahrenheit

409
00:14:35,389 --> 00:14:32,399
or you know comparatively like or 120

410
00:14:37,490 --> 00:14:35,399
degrees Celsius so uh these mirrors that

411
00:14:39,050 --> 00:14:37,500
I was talking about on the moon these

412
00:14:42,590 --> 00:14:39,060
are not optimal temperatures for you

413
00:14:44,150 --> 00:14:42,600

know the moon to operate in and so we so

414
00:14:46,910 --> 00:14:44,160
the performance of these the optical

415
00:14:48,350 --> 00:14:46,920
performance of these retro reflectors as

416
00:14:51,470 --> 00:14:48,360
they're called

417
00:14:54,290 --> 00:14:51,480
um they diminished with time right so we

418
00:14:56,930 --> 00:14:54,300
want this kind of a window this Eclipse

419
00:14:59,210 --> 00:14:56,940
offers us this time window wherein you

420
00:15:01,310 --> 00:14:59,220
know the moon passes through the shadow

421
00:15:03,050 --> 00:15:01,320
of the earth so which gives you know

422
00:15:05,810 --> 00:15:03,060
these Optical instruments to kind of

423
00:15:07,850 --> 00:15:05,820
cool down and this enables us to make

424
00:15:10,250 --> 00:15:07,860
measurements right and so what science

425
00:15:12,350 --> 00:15:10,260
we can do from that is that you know

426
00:15:13,970 --> 00:15:12,360
when when when this particular

427
00:15:16,189 --> 00:15:13,980
configuration that we are in right now

428
00:15:19,069 --> 00:15:16,199
which is you know the sun earth and the

429
00:15:21,110 --> 00:15:19,079
moon this enables us to make very high

430
00:15:22,790 --> 00:15:21,120
Precision tests of

431
00:15:26,449 --> 00:15:22,800
um you know the universality of free

432
00:15:27,290 --> 00:15:26,459
fall uh so um during the Apollo 15 I

433
00:15:30,170 --> 00:15:27,300
believe

434
00:15:33,170 --> 00:15:30,180
um the commander uh David Scott he he

435
00:15:36,350 --> 00:15:33,180
dropped um a feather and a hammer at the

436
00:15:38,030 --> 00:15:36,360
same time to demonstrate that uh to show

437
00:15:40,310 --> 00:15:38,040
that you know all objects fall in the

438
00:15:42,470 --> 00:15:40,320

external gravitational field at the same

439
00:15:44,930 --> 00:15:42,480
time and similarly what we're doing here

440
00:15:47,990 --> 00:15:44,940
with this laser ranging measurements is

441
00:15:50,329 --> 00:15:48,000
that uh we're trying to make use of the

442
00:15:53,629 --> 00:15:50,339
Moon and the Earth as test bodies in

443
00:15:56,810 --> 00:15:53,639
this gravitational field and uh so as to

444
00:15:58,790 --> 00:15:56,820
measure the falling of you know this

445
00:16:01,430 --> 00:15:58,800
Earth and Moon system into the

446
00:16:03,769 --> 00:16:01,440
gravitational field of the Sun so by

447
00:16:05,870 --> 00:16:03,779
measuring and comparing uh what we

448
00:16:07,370 --> 00:16:05,880
predict with Theory versus what we

449
00:16:09,650 --> 00:16:07,380
observe with these laser ranging

450
00:16:13,430 --> 00:16:09,660
observations we are able to put a number

451
00:16:15,590 --> 00:16:13,440
to those limits on how accurately was

452
00:16:17,090 --> 00:16:15,600
you know the theory of universality of

453
00:16:19,790 --> 00:16:17,100
free fall based on which you know

454
00:16:22,069 --> 00:16:19,800
Einstein formulated his uh theory of

455
00:16:24,530 --> 00:16:22,079
General Nativity so this is really a

456
00:16:28,610 --> 00:16:24,540
fascinating time and I I just spoke with

457
00:16:31,730 --> 00:16:28,620
one of the um uh one of The Observers in

458
00:16:33,470 --> 00:16:31,740
Grass Station in France and uh if the

459
00:16:35,150 --> 00:16:33,480
weather is clear there they might be

460
00:16:37,670 --> 00:16:35,160
collecting some amazing data for us to

461
00:16:38,810 --> 00:16:37,680
analyze yeah I think Vishnu will if you

462
00:16:40,249 --> 00:16:38,820
don't already know I'll be very excited

463
00:16:42,470 --> 00:16:40,259

to know that we're sending more of these

464
00:16:43,550 --> 00:16:42,480
retro reflectors before the eclipse so

465
00:16:45,230 --> 00:16:43,560
you're going to have lots more science

466
00:16:47,449 --> 00:16:45,240
oh yeah they're not really excited about

467
00:16:49,850 --> 00:16:47,459
that opportunity great that's fantastic

468
00:16:52,370 --> 00:16:49,860
so the last time we set a crude mission

469
00:16:54,230 --> 00:16:52,380
to the moon was about 50 years ago so

470
00:16:56,569 --> 00:16:54,240
why is it important that we send humans

471
00:16:58,069 --> 00:16:56,579
back to the Moon yeah there's a lot of

472
00:16:59,449 --> 00:16:58,079
really important reasons to send humans

473
00:17:01,430 --> 00:16:59,459
back so the last time we were there was

474
00:17:02,629 --> 00:17:01,440
with Apollo and most of the Apollo or

475
00:17:04,189 --> 00:17:02,639
sorry all of the Apollo missions were

476
00:17:06,529 --> 00:17:04,199
kind of in the equatorial region of the

477
00:17:08,809 --> 00:17:06,539
moon so with Artemis we'll be going down

478
00:17:10,069 --> 00:17:08,819
to the South polar region and much like

479
00:17:12,169 --> 00:17:10,079
on Earth if you travel to another

480
00:17:13,189 --> 00:17:12,179
country you know often you know the

481
00:17:15,890 --> 00:17:13,199
Rocks there are completely different

482
00:17:17,449 --> 00:17:15,900
there's just a whole new area so also on

483
00:17:18,590 --> 00:17:17,459
the moon you go down to the South Pole

484
00:17:20,329 --> 00:17:18,600
there's only rocks of different

485
00:17:22,970 --> 00:17:20,339
compositions it's going to be possibly

486
00:17:24,230 --> 00:17:22,980
colder in some areas there's a lot of um

487
00:17:26,449 --> 00:17:24,240
different types of science questions

488
00:17:28,250 --> 00:17:26,459

that we will answer there also we'll

489
00:17:30,289 --> 00:17:28,260
just be developing the the Technologies

490
00:17:32,570 --> 00:17:30,299
and demonstrating the things we need to

491
00:17:34,490 --> 00:17:32,580
to live for longer periods of time on

492
00:17:37,190 --> 00:17:34,500
another planetary body and really

493
00:17:38,810 --> 00:17:37,200
helping prepare ourselves to go to Mars

494
00:17:41,090 --> 00:17:38,820
so talking about

495
00:17:42,610 --> 00:17:41,100
um long-term space travel we had some

496
00:17:45,590 --> 00:17:42,620
really exciting news the other day

497
00:17:48,529 --> 00:17:45,600
scientists had successfully grown plants

498
00:17:50,150 --> 00:17:48,539
from regolith which is lunar soil what

499
00:17:51,710 --> 00:17:50,160
does that mean for future astronauts

500
00:17:53,570 --> 00:17:51,720
yeah yeah so for those who didn't hear

501
00:17:54,890 --> 00:17:53,580
we grew our first plants in lunar

502
00:17:57,289 --> 00:17:54,900
regolith and this is really exciting

503
00:17:58,789 --> 00:17:57,299
scientists hadn't done this before lunar

504
00:18:00,529 --> 00:17:58,799
regolith doesn't have nutrients and

505
00:18:02,390 --> 00:18:00,539
water like like we have here on Earth so

506
00:18:03,470 --> 00:18:02,400
to readily grow plants so there's still

507
00:18:05,390 --> 00:18:03,480
some work we have to do to understand

508
00:18:07,909 --> 00:18:05,400
why the plants grew differently than

509
00:18:10,190 --> 00:18:07,919
they did in you know typical Earth-like

510
00:18:11,810 --> 00:18:10,200
conditions but yeah it's really exciting

511
00:18:13,190 --> 00:18:11,820
it could open up a lot of possibilities

512
00:18:15,650 --> 00:18:13,200
for us to potentially grow our own

513
00:18:17,750 --> 00:18:15,660

plants when we get back to the Moon

514
00:18:20,090 --> 00:18:17,760
so we're nearing totality um have either

515
00:18:22,010 --> 00:18:20,100
of you seen a lunar eclipse before not

516
00:18:24,110 --> 00:18:22,020
that I can remember no I have not either

517
00:18:26,810 --> 00:18:24,120
so it's really really we're all really

518
00:18:28,490 --> 00:18:26,820
excited in the studio today so let's dig

519
00:18:30,950 --> 00:18:28,500
into some questions we're getting online

520
00:18:33,590 --> 00:18:30,960
on social media

521
00:18:35,870 --> 00:18:33,600
um so let's uh see who we what questions

522
00:18:38,090 --> 00:18:35,880
we have uh we have a question from A

523
00:18:40,610 --> 00:18:38,100
Midsummer on Twitter and they ask is

524
00:18:42,590 --> 00:18:40,620
there a delay in real time for data from

525
00:18:45,890 --> 00:18:42,600
the Moon like how there is an eight

526
00:18:49,130 --> 00:18:45,900
million minute delay from the Sun

527
00:18:51,230 --> 00:18:49,140
um yes and um so this is precisely the

528
00:18:56,090 --> 00:18:51,240
time that we measure with the laser data

529
00:18:58,789 --> 00:18:56,100
right so it takes 2.5 ish seconds uh for

530
00:19:01,250 --> 00:18:58,799
a light beam to go from Earth bounce

531
00:19:03,770 --> 00:19:01,260
back the um you know these mirrors and

532
00:19:05,390 --> 00:19:03,780
come back uh to those telescopes so

533
00:19:08,450 --> 00:19:05,400
which means that you know one way would

534
00:19:09,669 --> 00:19:08,460
be like half of that value 1.25

535
00:19:12,289 --> 00:19:09,679
um seconds

536
00:19:15,350 --> 00:19:12,299
wow pretty fast compared to you know the

537
00:19:17,029 --> 00:19:15,360
eight minute yeah much faster

538
00:19:19,070 --> 00:19:17,039

and so on the next we have a next

539
00:19:21,529 --> 00:19:19,080
question from Trevor on Twitter and they

540
00:19:22,789 --> 00:19:21,539
asked why does the moon turn red during

541
00:19:24,770 --> 00:19:22,799
an eclipse

542
00:19:26,510 --> 00:19:24,780
yeah so the moon we call this a blood

543
00:19:28,789 --> 00:19:26,520
moon when it turns red during an eclipse

544
00:19:30,710 --> 00:19:28,799
and this is because as as the Earth is

545
00:19:32,450 --> 00:19:30,720
blocking the Sun's light the sun's

546
00:19:34,490 --> 00:19:32,460
sunlight is still passing through

547
00:19:36,169 --> 00:19:34,500
Earth's atmosphere and when this happens

548
00:19:37,610 --> 00:19:36,179
you're kind of Bluer wavelengths of

549
00:19:39,529 --> 00:19:37,620
light gets scattered by Earth's

550
00:19:41,029 --> 00:19:39,539
atmosphere but the red wavelengths of

551
00:19:42,049 --> 00:19:41,039
light still pass through and that's the

552
00:19:43,610 --> 00:19:42,059
wavelength of light you're seeing

553
00:19:45,590 --> 00:19:43,620
reflected off the surface of the Moon

554
00:19:48,710 --> 00:19:45,600
it's much like reflecting back Earth's

555
00:19:50,570 --> 00:19:48,720
sunrises and sunsets in a sense

556
00:19:53,150 --> 00:19:50,580
okay so our next question is from

557
00:19:55,669 --> 00:19:53,160
musical wolves on YouTube and they ask

558
00:19:57,770 --> 00:19:55,679
why does a total lunar eclipse sorry

559
00:19:59,210 --> 00:19:57,780
what does a total lunar eclipse look

560
00:20:02,029 --> 00:19:59,220
like from the International Space

561
00:20:06,649 --> 00:20:04,490
well I think they will definitely enjoy

562
00:20:08,330 --> 00:20:06,659
a more clearer view because you know

563
00:20:10,370 --> 00:20:08,340

there's no atmosphere up there right

564
00:20:13,010 --> 00:20:10,380
from the uh International Space Station

565
00:20:15,230 --> 00:20:13,020
so I think it's going to look like how

566
00:20:17,450 --> 00:20:15,240
we see it on Earth but just beautiful

567
00:20:19,970 --> 00:20:17,460
much more prettier because you know it's

568
00:20:21,289 --> 00:20:19,980
without without all the atmosphere in

569
00:20:24,110 --> 00:20:21,299
between all the clouds like we have

570
00:20:29,810 --> 00:20:28,010
uh and Sydney asks um why are we going

571
00:20:31,850 --> 00:20:29,820
back to the Moon

572
00:20:33,289 --> 00:20:31,860
that's a great question um some of the

573
00:20:34,490 --> 00:20:33,299
reasons I mentioned before um the

574
00:20:36,169 --> 00:20:34,500
different variety of science questions

575
00:20:37,730 --> 00:20:36,179
that we can answer

576
00:20:39,289 --> 00:20:37,740
um you know the moon hasn't really I've

577
00:20:41,330 --> 00:20:39,299
been there done that place um the South

578
00:20:43,250 --> 00:20:41,340
polar region is is a whole new area we

579
00:20:44,810 --> 00:20:43,260
haven't explored yet there are resources

580
00:20:46,730 --> 00:20:44,820
there that weren't really available to

581
00:20:48,830 --> 00:20:46,740
us um for the Apollo missions again

582
00:20:51,470 --> 00:20:48,840
because of the presence of water ice in

583
00:20:52,850 --> 00:20:51,480
the South polar area so we can really

584
00:20:55,250 --> 00:20:52,860
demonstrate how we can pull out these

585
00:20:57,049 --> 00:20:55,260
resources and use them for for water or

586
00:20:59,149 --> 00:20:57,059
even for making Rocket Fuel that can

587
00:21:00,590 --> 00:20:59,159
then send us onto Mars but but yeah so a

588
00:21:02,090 --> 00:21:00,600

lot of it is is you know the science and

589
00:21:03,710 --> 00:21:02,100
then also just developing these

590
00:21:05,330 --> 00:21:03,720
Technologies and getting that experience

591
00:21:08,029 --> 00:21:05,340
we need in order to go on to places like

592
00:21:10,789 --> 00:21:08,039
Mars and Beyond

593
00:21:12,830 --> 00:21:10,799
okay so our next question is from Denise

594
00:21:14,750 --> 00:21:12,840
Wright an Earth and space science

595
00:21:17,029 --> 00:21:14,760
teacher from Myrtle Beach in South

596
00:21:19,370 --> 00:21:17,039
Carolina and they ask how much does the

597
00:21:21,169 --> 00:21:19,380
surface temperature of the Moon drop on

598
00:21:22,970 --> 00:21:21,179
that side that we are seeing during this

599
00:21:24,409 --> 00:21:22,980
eclipse

600
00:21:25,190 --> 00:21:24,419
oh okay

601
00:21:28,549 --> 00:21:25,200
um

602
00:21:30,409 --> 00:21:28,559
I think it's about a few uh tens of uh

603
00:21:32,690 --> 00:21:30,419
Calvin

604
00:21:35,690 --> 00:21:32,700
um at least you'll get that duration

605
00:21:38,029 --> 00:21:35,700
over which um you know I know the the

606
00:21:40,490 --> 00:21:38,039
entire it takes about when during a full

607
00:21:42,710 --> 00:21:40,500
moon phase it goes up to like 250 degree

608
00:21:46,190 --> 00:21:42,720
Fahrenheit or which is you know it's

609
00:21:47,750 --> 00:21:46,200
like um 120 Celsius but I think yeah I'm

610
00:21:49,850 --> 00:21:47,760
not very familiar with the exact value

611
00:21:51,409 --> 00:21:49,860
because you know we this is a very long

612
00:21:53,450 --> 00:21:51,419
Eclipse which means like you know it's

613
00:21:55,850 --> 00:21:53,460

it has sufficient time to cool down but

614
00:21:57,649 --> 00:21:55,860
the the it takes time for the lunar

615
00:22:00,710 --> 00:21:57,659
regolith to respond to it you know

616
00:22:03,409 --> 00:22:00,720
there's some thermal inertia to it so um

617
00:22:04,610 --> 00:22:03,419
yeah I'd say a couple of degrees to as a

618
00:22:07,610 --> 00:22:04,620
guess yeah

619
00:22:10,370 --> 00:22:07,620
I don't have a better guess

620
00:22:13,490 --> 00:22:10,380
okay so we have a question from Trevor

621
00:22:14,750 --> 00:22:13,500
polinga on Twitter uh and they are

622
00:22:17,270 --> 00:22:14,760
asking on behalf of the pulling good

623
00:22:19,669 --> 00:22:17,280
kids has anyone ever been on the moon

624
00:22:21,289 --> 00:22:19,679
during a lunar eclipse

625
00:22:22,850 --> 00:22:21,299
great question I believe the answer is

626
00:22:24,409 --> 00:22:22,860
no I don't I don't know if one happened

627
00:22:26,570 --> 00:22:24,419
during Apollo or not I'd actually I'm

628
00:22:27,470 --> 00:22:26,580
not entirely sure but I imagine if if

629
00:22:29,090 --> 00:22:27,480
they had been they probably would have

630
00:22:30,710 --> 00:22:29,100
gotten a good image for us

631
00:22:32,810 --> 00:22:30,720
I think um you know what what they would

632
00:22:34,909 --> 00:22:32,820
be seeing if during the lunar eclipse is

633
00:22:36,710 --> 00:22:34,919
like uh just like during the solar

634
00:22:38,810 --> 00:22:36,720
eclipse you know when when you get the

635
00:22:42,110 --> 00:22:38,820
totality we see that annular ring around

636
00:22:44,570 --> 00:22:42,120
the Moon similarly you can expect you

637
00:22:45,890 --> 00:22:44,580
know when we during a lunar eclipse if

638
00:22:48,289 --> 00:22:45,900

you were to be on the surface of the

639
00:22:50,090 --> 00:22:48,299
Moon looking at the Earth it would be

640
00:22:53,029 --> 00:22:50,100
such a fantastic view because you'll see

641
00:22:55,490 --> 00:22:53,039
uh you know not that Horizon Sunset that

642
00:22:57,950 --> 00:22:55,500
we we see on Earth but you know it'd be

643
00:23:00,350 --> 00:22:57,960
like a ring of sunset right around

644
00:23:01,610 --> 00:23:00,360
around the around the earth with you

645
00:23:03,590 --> 00:23:01,620
know the sun in the background I think

646
00:23:05,750 --> 00:23:03,600
it's a spectacular view I'd you know I'd

647
00:23:07,970 --> 00:23:05,760
I'd love to be there in that place to

648
00:23:09,890 --> 00:23:07,980
see that view yeah so that would be so

649
00:23:11,570 --> 00:23:09,900
that would be like a red ring around

650
00:23:13,310 --> 00:23:11,580
Earth is that what you mean yes I think

651
00:23:16,430 --> 00:23:13,320
so yeah that's how it would look like I

652
00:23:18,710 --> 00:23:16,440
believe um only right you know at

653
00:23:21,049 --> 00:23:18,720
Goddard wood you know I'm sure he has

654
00:23:22,610 --> 00:23:21,059
made a simulation on this that shows

655
00:23:24,049 --> 00:23:22,620
that particular video you know check

656
00:23:29,270 --> 00:23:24,059
that out

657
00:23:34,370 --> 00:23:32,029
um when we go back to the moon will we

658
00:23:36,110 --> 00:23:34,380
set it up as a permanent settlement

659
00:23:38,149 --> 00:23:36,120
yeah so so we are looking at

660
00:23:40,370 --> 00:23:38,159
establishing a lunar base on the moon

661
00:23:42,409 --> 00:23:40,380
you know having more you know permanent

662
00:23:44,750 --> 00:23:42,419
or semi-permanent architecture uh that

663
00:23:46,549 --> 00:23:44,760

we can um then go to at a more frequent

664
00:23:48,830 --> 00:23:46,559
basis you know send or you know cruise

665
00:23:50,570 --> 00:23:48,840
on a regular basis to habitats and then

666
00:23:51,710 --> 00:23:50,580
have long duration Rovers and things

667
00:23:53,510 --> 00:23:51,720
like that so yes it's definitely

668
00:23:56,450 --> 00:23:53,520
something that NASA is working towards

669
00:23:59,870 --> 00:23:56,460
oh fantastic okay so our next question

670
00:24:02,450 --> 00:23:59,880
is from anab on Twitter and they ask is

671
00:24:03,710 --> 00:24:02,460
a lunar Mission launch possible during a

672
00:24:05,450 --> 00:24:03,720
lunar eclipse

673
00:24:07,549 --> 00:24:05,460
I mean not during the launch but while

674
00:24:10,490 --> 00:24:07,559
it's in orbit and maneuvering to get

675
00:24:14,149 --> 00:24:10,500
into the lunar orbits

676
00:24:16,190 --> 00:24:14,159
I don't see uh a reason why not

677
00:24:17,570 --> 00:24:16,200
um yeah yeah I mean I think

678
00:24:19,010 --> 00:24:17,580
communication with Earth is one of the

679
00:24:21,289 --> 00:24:19,020
most important things and then good

680
00:24:22,250 --> 00:24:21,299
conditions to launch offers so the lunar

681
00:24:23,269 --> 00:24:22,260
eclipse shouldn't affect those things

682
00:24:24,950 --> 00:24:23,279
yeah

683
00:24:27,409 --> 00:24:24,960
so do you think there's a chance um

684
00:24:28,549 --> 00:24:27,419
finding future lunar missions to do for

685
00:24:30,169 --> 00:24:28,559
that to happen

686
00:24:32,029 --> 00:24:30,179
yeah I think it'd be really exciting I

687
00:24:33,470 --> 00:24:32,039
mean yeah you know there's cool visuals

688
00:24:36,710 --> 00:24:33,480

and probably in school science you know

689
00:24:40,789 --> 00:24:38,870
okay so our next question is from snazzy

690
00:24:42,110 --> 00:24:40,799
zazzy on Twitter and they ask with the

691
00:24:43,909 --> 00:24:42,120
awesomest crew deal with any

692
00:24:46,430 --> 00:24:43,919
abnormalities if they were on the moon

693
00:24:49,730 --> 00:24:46,440
during a lunar eclipse for example extra

694
00:24:52,610 --> 00:24:50,570
um

695
00:24:54,710 --> 00:24:52,620
I think one of the difficulties that

696
00:24:56,990 --> 00:24:54,720
they would potentially face is you know

697
00:24:59,570 --> 00:24:57,000
the lack of light right because you know

698
00:25:00,830 --> 00:24:59,580
you have a good amount of sunlight

699
00:25:02,630 --> 00:25:00,840
coming in

700
00:25:05,330 --> 00:25:02,640
um if they were to be in the you know in

701
00:25:07,970 --> 00:25:05,340
your side and suddenly it would be like

702
00:25:09,470 --> 00:25:07,980
a you know a diminished light or a much

703
00:25:11,810 --> 00:25:09,480
dimmer light than you know they are

704
00:25:14,149 --> 00:25:11,820
enjoying too and I just hope they're not

705
00:25:17,029 --> 00:25:14,159
in one of those abundantly shattered

706
00:25:20,029 --> 00:25:17,039
reasons when well you know when you're

707
00:25:21,710 --> 00:25:20,039
doing that so but I think I think that's

708
00:25:23,029 --> 00:25:21,720
that's about it yeah and I think one

709
00:25:24,350 --> 00:25:23,039
thing one thing to remember too is that

710
00:25:26,149 --> 00:25:24,360
generally these eclipses are not very

711
00:25:28,490 --> 00:25:26,159
long you're the one tonight is is quite

712
00:25:30,289 --> 00:25:28,500
a bit longer than what we typically see

713
00:25:32,390 --> 00:25:30,299

but usually they're on the order of a

714
00:25:33,830 --> 00:25:32,400
few minutes so you know even again yeah

715
00:25:35,269 --> 00:25:33,840
light the lack of light could be

716
00:25:37,130 --> 00:25:35,279
probably the biggest issue to be

717
00:25:38,870 --> 00:25:37,140
concerned with

718
00:25:41,149 --> 00:25:38,880
okay so we're going to be taking more of

719
00:25:43,070 --> 00:25:41,159
your questions later on in the show but

720
00:25:45,169 --> 00:25:43,080
we are nearing totality now which is

721
00:25:47,269 --> 00:25:45,179
really really exciting so let's head

722
00:25:48,649 --> 00:25:47,279
back to James to see where we are what

723
00:25:50,510 --> 00:25:48,659
we're seeing on the feeds and what other

724
00:25:52,370 --> 00:25:50,520
people around the world are seeing

725
00:25:53,750 --> 00:25:52,380
yeah Joy this is the big moment you know

726
00:25:55,130 --> 00:25:53,760
if you're keeping score at home or just

727
00:25:57,230 --> 00:25:55,140
about four minutes away from the main

728
00:25:58,970 --> 00:25:57,240
event totality and if I swipe back to

729
00:26:00,350 --> 00:25:58,980
the screen here we've been tracking this

730
00:26:02,450 --> 00:26:00,360
View for the past couple minutes here in

731
00:26:03,710 --> 00:26:02,460
orzazat Morocco they have a beautiful

732
00:26:05,990 --> 00:26:03,720
clear night there in the desert right

733
00:26:07,970 --> 00:26:06,000
now you can see just the last little

734
00:26:09,950 --> 00:26:07,980
sliver of brightness here before the

735
00:26:11,090 --> 00:26:09,960
Moon is eclipsed here for us and we're

736
00:26:12,590 --> 00:26:11,100
starting to get some really interesting

737
00:26:13,669 --> 00:26:12,600
reddish color creeping across and just

738
00:26:15,529 --> 00:26:13,679

before we went on you're telling me

739
00:26:17,630 --> 00:26:15,539
something interesting about the times

740
00:26:18,769 --> 00:26:17,640
that we're displaying there there's you

741
00:26:20,149 --> 00:26:18,779
know they're not down to the exact

742
00:26:23,750 --> 00:26:20,159
second you know we have them at like 11

743
00:26:25,549 --> 00:26:23,760
29. why is that you know not precise for

744
00:26:27,169 --> 00:26:25,559
us right you would think that we know

745
00:26:28,669 --> 00:26:27,179
the geometry of the Shadow and we can

746
00:26:31,210 --> 00:26:28,679
just figure that out but it turns out

747
00:26:33,590 --> 00:26:31,220
that the width of the Shadow at the Moon

748
00:26:35,210 --> 00:26:33,600
is affected by the atmosphere and of

749
00:26:37,010 --> 00:26:35,220
course the atmosphere on Earth is

750
00:26:39,169 --> 00:26:37,020
constantly changing

751
00:26:41,810 --> 00:26:39,179
um it enlarges the Shadow by about one

752
00:26:44,149 --> 00:26:41,820
to two percent but for each Eclipse it's

753
00:26:46,850 --> 00:26:44,159
a little bit different so when we do the

754
00:26:50,750 --> 00:26:46,860
calculations we use an average value but

755
00:26:52,310 --> 00:26:50,760
um we don't know precisely what that

756
00:26:54,230 --> 00:26:52,320
number is going to be until it actually

757
00:26:57,950 --> 00:26:54,240
happens and this is actually something

758
00:27:01,370 --> 00:26:57,960
that um citizen scientists can help with

759
00:27:04,430 --> 00:27:01,380
um while the shadow is moving across you

760
00:27:06,649 --> 00:27:04,440
can time when that edge hits each crater

761
00:27:10,070 --> 00:27:06,659
and you can do that at the end of

762
00:27:13,970 --> 00:27:10,080
totality as well and this sort of pins

763
00:27:15,830 --> 00:27:13,980

down the size of that shadow and so I

764
00:27:17,690 --> 00:27:15,840
mean I think it's probably surprising to

765
00:27:19,310 --> 00:27:17,700
people that we were not certain to the

766
00:27:22,190 --> 00:27:19,320
millisecond when these things are going

767
00:27:24,590 --> 00:27:22,200
to happen but you know uh science is a

768
00:27:26,630 --> 00:27:24,600
little bit messy sometimes and and we

769
00:27:28,669 --> 00:27:26,640
don't even fully understand all of the

770
00:27:30,590 --> 00:27:28,679
effects that are changing the size of

771
00:27:32,029 --> 00:27:30,600
that shadow so it's it's an ongoing

772
00:27:33,529 --> 00:27:32,039
question yeah and we've been watching

773
00:27:34,669 --> 00:27:33,539
them kind of adjusting the exposure a

774
00:27:36,289 --> 00:27:34,679
bit of the camera here to get this

775
00:27:37,370 --> 00:27:36,299
really dark area of the Moon and a

776
00:27:38,690 --> 00:27:37,380
couple of our other feeds as well have

777
00:27:40,190 --> 00:27:38,700
been kind of doing the same pattern as

778
00:27:41,630 --> 00:27:40,200
well here too can you tell us a little

779
00:27:42,590 --> 00:27:41,640
bit about this red color we're seeing

780
00:27:43,610 --> 00:27:42,600
starting to come up here if I'm

781
00:27:45,470 --> 00:27:43,620
understanding correctly it's a

782
00:27:48,350 --> 00:27:45,480
projection of all the sunrises and

783
00:27:50,090 --> 00:27:48,360
sunsets it absolutely is um imagine how

784
00:27:52,789 --> 00:27:50,100
beautiful that would be to be on the

785
00:27:54,409 --> 00:27:52,799
moon and see it um yeah this is a color

786
00:27:56,510 --> 00:27:54,419
that's coming from all the sunrises and

787
00:27:58,010 --> 00:27:56,520
sunsets it's the it's the light filtered

788
00:27:59,510 --> 00:27:58,020

through the atmosphere

789
00:28:01,669 --> 00:27:59,520
um all the blue light is scattered away

790
00:28:03,409 --> 00:28:01,679
the red light is sort of refracted into

791
00:28:05,269 --> 00:28:03,419
that total shadow

792
00:28:07,789 --> 00:28:05,279
um and so that's why it's appearing red

793
00:28:09,289 --> 00:28:07,799
it's very possible that the color of

794
00:28:12,470 --> 00:28:09,299
this eclipse is somewhat darker than

795
00:28:15,289 --> 00:28:12,480
usual because of an eruption in Tonga in

796
00:28:17,210 --> 00:28:15,299
December and January the number of

797
00:28:19,970 --> 00:28:17,220
aerosols of particles in the atmosphere

798
00:28:22,850 --> 00:28:19,980
can affect the darkness and so there's a

799
00:28:24,769 --> 00:28:22,860
scale that we rate the darkness the

800
00:28:26,630 --> 00:28:24,779
scale goes from zero to four the scale

801
00:28:28,610 --> 00:28:26,640
was invented by an astronomer named

802
00:28:30,649 --> 00:28:28,620
danjon right

803
00:28:32,149 --> 00:28:30,659
um and so that's another thing that

804
00:28:33,590 --> 00:28:32,159
people can do they can go outside and

805
00:28:35,269 --> 00:28:33,600
sort of Judge the darkness of this

806
00:28:37,789 --> 00:28:35,279
compared to other eclipses and this

807
00:28:39,470 --> 00:28:37,799
one's looking a little dark yeah if

808
00:28:40,909 --> 00:28:39,480
you're a bit luckier than us at home and

809
00:28:41,990 --> 00:28:40,919
you don't have cloud cover what kind of

810
00:28:43,070 --> 00:28:42,000
things can you see with the naked eye

811
00:28:45,350 --> 00:28:43,080
just looking up at the moon at this

812
00:28:46,970 --> 00:28:45,360
point right you know I I think even with

813
00:28:48,769 --> 00:28:46,980

the naked eye you can distinguish the

814
00:28:51,769 --> 00:28:48,779
dark parts of the Moon from the brighter

815
00:28:53,990 --> 00:28:51,779
Parts the dark parts are called Mare and

816
00:28:57,409 --> 00:28:54,000
these are places where lava has infilled

817
00:28:59,750 --> 00:28:57,419
large depressions so this is tranquility

818
00:29:04,010 --> 00:28:59,760
where Apollo 11 landed and serenity is

819
00:29:06,169 --> 00:29:04,020
next to it and Ibrahim is up here these

820
00:29:07,970 --> 00:29:06,179
are basalts these are like volcanic

821
00:29:11,690 --> 00:29:07,980
rocks and they're very dark you think of

822
00:29:13,549 --> 00:29:11,700
uh black beaches in Hawaii so you have a

823
00:29:15,769 --> 00:29:13,559
geology background you know about this

824
00:29:17,690 --> 00:29:15,779
um and then the the lighter parts are

825
00:29:20,389 --> 00:29:17,700
called Highlands and these are older

826
00:29:22,730 --> 00:29:20,399
they're more heavily cratered but

827
00:29:24,230 --> 00:29:22,740
they're not filled with lava and so

828
00:29:26,029 --> 00:29:24,240
that's something you can notice right

829
00:29:28,370 --> 00:29:26,039
away just with the naked eye and looking

830
00:29:29,990 --> 00:29:28,380
at my watch right now it is 11 29 here

831
00:29:31,669 --> 00:29:30,000
on the East Coast this is the moment

832
00:29:33,769 --> 00:29:31,679
we've all been waiting for totality here

833
00:29:35,210 --> 00:29:33,779
there's just that last little bit of

834
00:29:36,830 --> 00:29:35,220
sliver of light here so we're just gonna

835
00:29:38,570 --> 00:29:36,840
sit back and watch this moment happen

836
00:29:40,490 --> 00:29:38,580
wish we could be doing this from outside

837
00:29:42,049 --> 00:29:40,500
here in the rocket oh my God it would be

838
00:29:43,730 --> 00:29:42,059

really nice but you know this is still

839
00:29:45,110 --> 00:29:43,740
an incredible view here from orzazad

840
00:29:46,970 --> 00:29:45,120
well and one of the things that you'll

841
00:29:48,889 --> 00:29:46,980
notice I mean this bright part is just

842
00:29:50,810 --> 00:29:48,899
because the difference in exposure so

843
00:29:52,549 --> 00:29:50,820
this part of the moon right here is

844
00:29:54,350 --> 00:29:52,559
closer to the center of the Shadow and

845
00:29:55,850 --> 00:29:54,360
that's where it's darker so throughout

846
00:29:58,310 --> 00:29:55,860
totality you're going to see the sort of

847
00:29:59,630 --> 00:29:58,320
gradient from one side to the other and

848
00:30:01,010 --> 00:29:59,640
so if you're at home you know this is

849
00:30:02,090 --> 00:30:01,020
the moment to run outside keep us in

850
00:30:03,350 --> 00:30:02,100
your back pocket listening on your

851
00:30:05,330 --> 00:30:03,360
headphones as you run out there to take

852
00:30:06,529 --> 00:30:05,340
some pictures for some play-by-play but

853
00:30:07,850 --> 00:30:06,539
what are some tips for this moment you

854
00:30:09,169 --> 00:30:07,860
kind of went over some earlier here but

855
00:30:10,310 --> 00:30:09,179
you know this is the moment to take a

856
00:30:11,930 --> 00:30:10,320
picture and share with us wherever

857
00:30:13,669 --> 00:30:11,940
you're watching this right well and the

858
00:30:15,230 --> 00:30:13,679
lovely thing about a total lunar eclipse

859
00:30:17,090 --> 00:30:15,240
is that it lasts for a little while so

860
00:30:18,230 --> 00:30:17,100
this is an opportunity just to get

861
00:30:20,930 --> 00:30:18,240
outside

862
00:30:23,029 --> 00:30:20,940
um it's an outdoor activity you bring a

863
00:30:25,070 --> 00:30:23,039

lawn chair and you kind of sit back and

864
00:30:28,310 --> 00:30:25,080
you think about the fact that we're in

865
00:30:30,950 --> 00:30:28,320
the earth's Shadow every night but this

866
00:30:32,330 --> 00:30:30,960
night you are sharing that shadow with a

867
00:30:34,490 --> 00:30:32,340
body that's a quarter of a million miles

868
00:30:35,870 --> 00:30:34,500
away it's the same Shadow which is kind

869
00:30:37,430 --> 00:30:35,880
of cool and I can't help but think about

870
00:30:38,690 --> 00:30:37,440
what that view would look like on the

871
00:30:40,970 --> 00:30:38,700
moon you know imagine if you're an

872
00:30:42,529 --> 00:30:40,980
astronaut up there observing that I I

873
00:30:44,090 --> 00:30:42,539
yeah I would love that I think it was

874
00:30:46,730 --> 00:30:44,100
mentioned a little earlier

875
00:30:49,250 --> 00:30:46,740
um a question came in about whether or

876
00:30:52,370 --> 00:30:49,260
not Apollo follow or or any astronaut

877
00:30:54,169 --> 00:30:52,380
had seen a total solar total lunar

878
00:30:55,610 --> 00:30:54,179
eclipse from the Moon

879
00:30:58,370 --> 00:30:55,620
almost

880
00:31:01,430 --> 00:30:58,380
um a plan for one of the Apollo missions

881
00:31:04,370 --> 00:31:01,440
was to leave the TV camera pointed at

882
00:31:06,230 --> 00:31:04,380
the Earth and an eclipse is going to

883
00:31:08,210 --> 00:31:06,240
take place a few days later but the

884
00:31:11,630 --> 00:31:08,220
camera malfunctioned and that didn't

885
00:31:13,730 --> 00:31:11,640
have that opportunity so it's another of

886
00:31:15,889 --> 00:31:13,740
the thousand reasons to go back

887
00:31:17,990 --> 00:31:15,899
um I I think the opportunity to see it

888
00:31:19,370 --> 00:31:18,000

from there would just be amazing yeah

889
00:31:21,409 --> 00:31:19,380
and some questions are coming in from

890
00:31:23,570 --> 00:31:21,419
social media here as well too James itso

891
00:31:26,810 --> 00:31:23,580
on Twitter asks how often does this type

892
00:31:28,730 --> 00:31:26,820
of lunar eclipse occur so total lunar

893
00:31:30,409 --> 00:31:28,740
eclipses happen about every six months

894
00:31:32,570 --> 00:31:30,419
but they're not always visible from

895
00:31:34,310 --> 00:31:32,580
where you are the nice thing about lunar

896
00:31:36,049 --> 00:31:34,320
eclipses is that half the Earth can see

897
00:31:37,570 --> 00:31:36,059
them but it might not be the half you

898
00:31:41,649 --> 00:31:37,580
happen to be in

899
00:31:43,970 --> 00:31:41,659
so mostly every six months sometimes

900
00:31:48,169 --> 00:31:43,980
it's five months in between and

901
00:31:50,810 --> 00:31:48,179
sometimes you can have two in a row and

902
00:31:52,370 --> 00:31:50,820
occasionally that six month pattern is

903
00:31:54,169 --> 00:31:52,380
sort of broken and what you get is sort

904
00:31:56,169 --> 00:31:54,179
of partial and penumbral and less

905
00:31:58,250 --> 00:31:56,179
interesting eclipses for a little while

906
00:32:00,289 --> 00:31:58,260
and then suddenly you get a string of

907
00:32:02,029 --> 00:32:00,299
totals again amazing and you've had a

908
00:32:03,889 --> 00:32:02,039
chance to really study the Moon up close

909
00:32:05,810 --> 00:32:03,899
with some of the missions from NASA like

910
00:32:07,310 --> 00:32:05,820
the lunar reconnaissance Orbiter to get

911
00:32:08,269 --> 00:32:07,320
some really cool visualizations can you

912
00:32:09,710 --> 00:32:08,279
tell us a bit more about some of those

913
00:32:11,690 --> 00:32:09,720

types of things right so this is

914
00:32:13,250 --> 00:32:11,700
actually what I do here I've been

915
00:32:17,269 --> 00:32:13,260
working with lunar Constance Orbiter

916
00:32:19,789 --> 00:32:17,279
data since it launched in 2009 and lro

917
00:32:22,310 --> 00:32:19,799
is creating global maps of the Moon that

918
00:32:24,350 --> 00:32:22,320
are way more detailed than anything we

919
00:32:26,630 --> 00:32:24,360
had before I think people had the

920
00:32:27,950 --> 00:32:26,640
impression that since Apollo we had the

921
00:32:29,930 --> 00:32:27,960
moon all figured out and we actually

922
00:32:32,750 --> 00:32:29,940
knew almost nothing about it I mean we

923
00:32:35,210 --> 00:32:32,760
we landed in six pinpoints on the

924
00:32:38,630 --> 00:32:35,220
surface and that's what we got from

925
00:32:39,850 --> 00:32:38,640
Apollo um but lro has been mapping the

926
00:32:42,649 --> 00:32:39,860
entire Moon

927
00:32:45,710 --> 00:32:42,659
we have millions of pictures of the

928
00:32:48,889 --> 00:32:45,720
surface we have a very detailed shape of

929
00:32:50,509 --> 00:32:48,899
the surface we have a record of how the

930
00:32:52,490 --> 00:32:50,519
temperature changes on the surface and

931
00:32:54,169 --> 00:32:52,500
this also tells us something about we

932
00:32:55,549 --> 00:32:54,179
got another oh wow yeah yeah movies

933
00:32:57,169 --> 00:32:55,559
coming in here this is from San Diego

934
00:32:59,029 --> 00:32:57,179
looks like a beautiful clear night there

935
00:33:00,409 --> 00:32:59,039
as well too which you know we got some

936
00:33:02,330 --> 00:33:00,419
questions here on social media Robert

937
00:33:03,950 --> 00:33:02,340
Schloss is asking does you know this

938
00:33:05,090 --> 00:33:03,960

Eclipse here affect the tide San Diego

939
00:33:06,649 --> 00:33:05,100
they'd be concerned about without Wilson

940
00:33:08,029 --> 00:33:06,659
surfing you know how's that going to

941
00:33:10,009 --> 00:33:08,039
affect their their surface occasionally

942
00:33:11,330 --> 00:33:10,019
I mean there are there are King tides

943
00:33:13,669 --> 00:33:11,340
and these are things that happen during

944
00:33:15,950 --> 00:33:13,679
full moons and new moons um

945
00:33:17,630 --> 00:33:15,960
the eclipse isn't special in that in

946
00:33:19,669 --> 00:33:17,640
that respect but it is one of those

947
00:33:21,649 --> 00:33:19,679
times where you might get a little bit

948
00:33:24,289 --> 00:33:21,659
of a title effect but it won't be

949
00:33:26,269 --> 00:33:24,299
enormous you don't have to worry about

950
00:33:28,250 --> 00:33:26,279
um you know tidal waves or anything uh

951
00:33:29,389 --> 00:33:28,260
silly like that yeah yeah let's check

952
00:33:30,769 --> 00:33:29,399
out some of the other fees here too so

953
00:33:32,990 --> 00:33:30,779
this is San Diego I'm going to check

954
00:33:34,070 --> 00:33:33,000
back on Rome which they look like they

955
00:33:35,029 --> 00:33:34,080
have a little bit of cloud cover we've

956
00:33:37,070 --> 00:33:35,039
got some buildings there you're

957
00:33:38,330 --> 00:33:37,080
mentioning that if this was a little bit

958
00:33:40,250 --> 00:33:38,340
clearer you'd be able to see the moon

959
00:33:42,350 --> 00:33:40,260
you know perched right there yeah

960
00:33:44,509 --> 00:33:42,360
because the Moon is setting in Rome um

961
00:33:46,970 --> 00:33:44,519
it would be low in the sky and so that

962
00:33:49,250 --> 00:33:46,980
was an opportunity to maybe catch the

963
00:33:50,870 --> 00:33:49,260

moon with

964
00:33:52,190 --> 00:33:50,880
all of this beautiful architecture yeah

965
00:33:53,570 --> 00:33:52,200
they're adjusting a little bit maybe

966
00:33:55,190 --> 00:33:53,580
it'll come into Focus here in a second

967
00:33:56,389 --> 00:33:55,200
while they're doing that let's let's

968
00:33:57,409 --> 00:33:56,399
scroll down here and check out some of

969
00:33:59,149 --> 00:33:57,419
the other ones here this is one from

970
00:34:00,470 --> 00:33:59,159
Cartersville Georgia the first one we I

971
00:34:02,870 --> 00:34:00,480
opened with tonight here too they got

972
00:34:04,310 --> 00:34:02,880
some beautiful red color here too and so

973
00:34:05,450 --> 00:34:04,320
there's quite a gradient of the color

974
00:34:08,569 --> 00:34:05,460
here as well you're mentioning that

975
00:34:10,669 --> 00:34:08,579
scale the digital scale as well right

976
00:34:12,409 --> 00:34:10,679
um yeah and um so you can tell right

977
00:34:14,329 --> 00:34:12,419
away that the part of the Moon that's

978
00:34:15,889 --> 00:34:14,339
deepest in the shadow is over on this

979
00:34:17,990 --> 00:34:15,899
side this is something else that you can

980
00:34:19,790 --> 00:34:18,000
see with the naked eye and it

981
00:34:21,109 --> 00:34:19,800
um you know the feeds don't fully

982
00:34:22,849 --> 00:34:21,119
capture it if you're able to go outside

983
00:34:25,129 --> 00:34:22,859
and see it with your naked eye the color

984
00:34:26,450 --> 00:34:25,139
is amazing um something I've noticed

985
00:34:28,849 --> 00:34:26,460
with a couple of these total lunar

986
00:34:30,950 --> 00:34:28,859
eclipses is that the Moon looks weirdly

987
00:34:33,169 --> 00:34:30,960
almost transparent it looks like you can

988
00:34:35,629 --> 00:34:33,179

see space behind it it's not really but

989
00:34:38,270 --> 00:34:35,639
it's an effect of that sort of color

990
00:34:39,950 --> 00:34:38,280
gradient and the dark red and the

991
00:34:42,710 --> 00:34:39,960
surprising darkness of the Moon I mean

992
00:34:43,730 --> 00:34:42,720
this is Right Way darker than a normal

993
00:34:45,470 --> 00:34:43,740
full moon

994
00:34:46,609 --> 00:34:45,480
um so it just looks weird and yeah

995
00:34:48,470 --> 00:34:46,619
that's one of the things that's fun

996
00:34:49,790 --> 00:34:48,480
about it exactly yeah it's different

997
00:34:50,990 --> 00:34:49,800
every time and we were like we were

998
00:34:52,069 --> 00:34:51,000
saying we were noticing the settings of

999
00:34:53,389 --> 00:34:52,079
people's cameras kind of changing here

1000
00:34:54,589 --> 00:34:53,399
to capture that Darkness it was really

1001
00:34:56,629 --> 00:34:54,599
Stark I mean there's parts that were

1002
00:34:59,870 --> 00:34:56,639
just completely blown out just to really

1003
00:35:01,790 --> 00:34:59,880
capture you know the darkness right

1004
00:35:02,810 --> 00:35:01,800
and so let's check back on that room and

1005
00:35:04,550 --> 00:35:02,820
see if they've kind of pulled this up

1006
00:35:05,750 --> 00:35:04,560
again still looks a little bit cloudy

1007
00:35:07,790 --> 00:35:05,760
here but we're back to the Morocco one

1008
00:35:09,170 --> 00:35:07,800
here which this has been kind of the the

1009
00:35:10,609 --> 00:35:09,180
winner of the night for me I've I've

1010
00:35:12,710 --> 00:35:10,619
really love this view that it really has

1011
00:35:14,569 --> 00:35:12,720
really beautiful weather yeah um Taiko

1012
00:35:17,089 --> 00:35:14,579
is very visible right here um this is a

1013
00:35:18,410 --> 00:35:17,099

crater this is a young crater um in the

1014
00:35:21,290 --> 00:35:18,420
southern hemisphere of the Moon and you

1015
00:35:23,690 --> 00:35:21,300
can see the Rays in full moon but during

1016
00:35:25,250 --> 00:35:23,700
a total eclipse they look even more

1017
00:35:27,589 --> 00:35:25,260
spectacular I think

1018
00:35:30,050 --> 00:35:27,599
so a question on Twitter which is kind

1019
00:35:33,230 --> 00:35:30,060
of a tricky question here so Abby asks

1020
00:35:34,310 --> 00:35:33,240
what's the rarest moon event that's the

1021
00:35:35,990 --> 00:35:34,320
kind of thing that you want to go back

1022
00:35:38,569 --> 00:35:36,000
in the almanac and sort of check through

1023
00:35:39,890 --> 00:35:38,579
it um but a kind of unusual thing

1024
00:35:42,890 --> 00:35:39,900
happened just six months ago the

1025
00:35:45,170 --> 00:35:42,900
November Eclipse was a 99 partial oh wow

1026
00:35:47,150 --> 00:35:45,180
it was so close yeah um just edging it

1027
00:35:48,950 --> 00:35:47,160
there just getting over to the edge so

1028
00:35:51,770 --> 00:35:48,960
it would have looked like this but with

1029
00:35:53,390 --> 00:35:51,780
a bright sort of limb there and it never

1030
00:35:55,069 --> 00:35:53,400
quite made it into the shadow that's

1031
00:35:57,230 --> 00:35:55,079
pretty unusual

1032
00:35:59,569 --> 00:35:57,240
um you know certain solar eclipses are

1033
00:36:01,130 --> 00:35:59,579
unusual too but to really answer that

1034
00:36:03,530 --> 00:36:01,140
question we'd have to go back to the

1035
00:36:06,230 --> 00:36:03,540
records and and find out what the

1036
00:36:07,730 --> 00:36:06,240
craziest thing was yeah yeah one more

1037
00:36:09,710 --> 00:36:07,740
question here from from Twitter as well

1038
00:36:11,690 --> 00:36:09,720

here Amber asks have there ever been

1039
00:36:14,329 --> 00:36:11,700
both solar and lunar eclipses in the

1040
00:36:16,430 --> 00:36:14,339
same year yes absolutely in fact that's

1041
00:36:19,250 --> 00:36:16,440
not uncommon at all

1042
00:36:22,190 --> 00:36:19,260
um the every six months is actually uh

1043
00:36:24,349 --> 00:36:22,200
when we're in Eclipse seasons and so

1044
00:36:26,450 --> 00:36:24,359
both solar and lunar eclipses can happen

1045
00:36:28,730 --> 00:36:26,460
there was a partial solar eclipse just

1046
00:36:30,470 --> 00:36:28,740
two weeks ago okay and that was visible

1047
00:36:33,290 --> 00:36:30,480
in the southern hemisphere if I remember

1048
00:36:35,750 --> 00:36:33,300
correctly but

1049
00:36:37,310 --> 00:36:35,760
That's Not Unusual at all in fact it's

1050
00:36:39,170 --> 00:36:37,320
very common to have them paired together

1051
00:36:41,329 --> 00:36:39,180
so solar eclipse either two weeks before

1052
00:36:42,589 --> 00:36:41,339
or two weeks after a total lunar eclipse

1053
00:36:43,670 --> 00:36:42,599
and we've been talking about the moon

1054
00:36:45,410 --> 00:36:43,680
quite a bit obviously throughout the

1055
00:36:46,730 --> 00:36:45,420
night here but let's learn a bit more

1056
00:36:48,950 --> 00:36:46,740
about why we're going to be going back

1057
00:36:51,550 --> 00:36:48,960
to the Moon just to study so much more

1058
00:36:58,670 --> 00:36:55,089
we are going

1059
00:37:01,490 --> 00:36:58,680
the history of this agency is marked

1060
00:37:02,829 --> 00:37:01,500
with broken barriers once viewed as

1061
00:37:07,010 --> 00:37:02,839
impossible

1062
00:37:09,950 --> 00:37:07,020
with science fiction turned reality with

1063
00:37:11,990 --> 00:37:09,960

innovations that have spun Industries

1064
00:37:16,730 --> 00:37:12,000
all their own

1065
00:37:19,670 --> 00:37:16,740
and with demonstrations of Peace for all

1066
00:37:27,829 --> 00:37:24,470
we soar in the skies of our home planet

1067
00:37:31,310 --> 00:37:27,839
we maintain a human presence just

1068
00:37:35,270 --> 00:37:31,320
outside of gravity and we touch points

1069
00:37:37,490 --> 00:37:35,280
all across the solar system and beyond

1070
00:37:39,970 --> 00:37:37,500
we're going back to the Moon

1071
00:37:42,650 --> 00:37:39,980
if this is why

1072
00:37:45,470 --> 00:37:42,660
the Moon is a treasure Trove of science

1073
00:37:48,230 --> 00:37:45,480
it holds opportunities for us to make

1074
00:37:51,349 --> 00:37:48,240
discoveries about our home planet about

1075
00:37:52,849 --> 00:37:51,359
our sun and a better solar system the

1076
00:37:55,069 --> 00:37:52,859
wealth of knowledge that he gleaned from

1077
00:37:58,430 --> 00:37:55,079
the moon will inspire a new generation

1078
00:38:00,710 --> 00:37:58,440
of thought and action without fail every

1079
00:38:03,050 --> 00:38:00,720
major program and mission NASA has

1080
00:38:04,790 --> 00:38:03,060
invested in has led to Technologies and

1081
00:38:07,130 --> 00:38:04,800
capabilities that have shaped our

1082
00:38:09,950 --> 00:38:07,140
culture the breakthroughs of the Artemis

1083
00:38:11,569 --> 00:38:09,960
era will Define Our Generation and the

1084
00:38:14,089 --> 00:38:11,579
generations to follow

1085
00:38:16,430 --> 00:38:14,099
the tens of thousands of jobs associated

1086
00:38:18,530 --> 00:38:16,440
with propelling us to the Moon today are

1087
00:38:20,990 --> 00:38:18,540
just the beginning of a lunar economy

1088
00:38:23,990 --> 00:38:21,000

that will see hundreds of thousands of

1089
00:38:26,030 --> 00:38:24,000
new jobs developed around the world this

1090
00:38:28,609 --> 00:38:26,040
is not an ambition of one entity or one

1091
00:38:31,609 --> 00:38:28,619
country the exploration of the moon is a

1092
00:38:33,829 --> 00:38:31,619
shared effort woven together by a desire

1093
00:38:36,650 --> 00:38:33,839
for the greater good why the moon

1094
00:38:38,990 --> 00:38:36,660
because the missions of Tomorrow Will Be

1095
00:38:41,810 --> 00:38:39,000
sparked by the accomplishments of the

1096
00:38:45,170 --> 00:38:41,820
Artemis generation today because the

1097
00:38:47,150 --> 00:38:45,180
ambition to go has already begun and

1098
00:38:48,589 --> 00:38:47,160
because Mars is calling we need to learn

1099
00:38:51,470 --> 00:38:48,599
what it takes to establish a community

1100
00:38:54,650 --> 00:38:51,480
on another Cosmic Shore so let's Camp

1101
00:38:58,430 --> 00:38:54,660
close before pushing out

1102
00:39:02,150 --> 00:38:58,440
and so we go to the moon now not as a

1103
00:39:08,690 --> 00:39:05,329
but to build a community on and around

1104
00:39:15,829 --> 00:39:08,700
the Moon capable of proving how to live

1105
00:39:21,050 --> 00:39:17,810
we'll use some lessons for more than 50

1106
00:39:23,089 --> 00:39:21,060
years of peaceful exploration to send a

1107
00:39:25,430 --> 00:39:23,099
new generation to the lunar surface to

1108
00:39:27,290 --> 00:39:25,440
stay we will anchor our efforts on the

1109
00:39:29,450 --> 00:39:27,300
lunar South Pole to establish the

1110
00:39:32,210 --> 00:39:29,460
artemis-based camp positioning us for

1111
00:39:34,730 --> 00:39:32,220
long-term science and exploration of the

1112
00:39:37,430 --> 00:39:34,740
lunar surface we will prove what it

1113
00:39:40,370 --> 00:39:37,440

takes to assemble a complex ship in deep

1114
00:39:42,770 --> 00:39:40,380
space we will perfect descending the

1115
00:39:45,410 --> 00:39:42,780
option and returning from a distance

1116
00:39:47,990 --> 00:39:45,420
service we will learn how humans can

1117
00:39:49,310 --> 00:39:48,000
survive and thrive in a partial gravity

1118
00:39:51,170 --> 00:39:49,320
environment

1119
00:39:53,510 --> 00:39:51,180
improve spacesuit designs mobile

1120
00:39:57,230 --> 00:39:53,520
habitats and with reconnaissance robots

1121
00:39:59,510 --> 00:39:57,240
pre-positioning and relocating supplies

1122
00:40:01,730 --> 00:39:59,520
the resources we find on this other

1123
00:40:04,190 --> 00:40:01,740
worlds starting with finding water reps

1124
00:40:06,410 --> 00:40:04,200
and purifying it to drinkable water and

1125
00:40:07,730 --> 00:40:06,420
find that into hydrogen fulfilled and

1126
00:40:10,609 --> 00:40:07,740
oxygen degree

1127
00:40:13,130 --> 00:40:10,619
we will establish fission power plants

1128
00:40:14,870 --> 00:40:13,140
on the surface of the Moon capable of

1129
00:40:17,690 --> 00:40:14,880
supporting a growing community of

1130
00:40:19,910 --> 00:40:17,700
efforts and we will expand the logistics

1131
00:40:22,430 --> 00:40:19,920
supply chain to enable commercial and

1132
00:40:26,630 --> 00:40:22,440
international Partners to resupply and

1133
00:40:28,970 --> 00:40:26,640
refuel deep space outposts

1134
00:40:36,849 --> 00:40:28,980
none of this is

1135
00:40:42,410 --> 00:40:40,130
again thanks a lot this kind of

1136
00:40:45,410 --> 00:40:42,420
continuous lunar presence is a natural

1137
00:40:47,230 --> 00:40:45,420
extension of all that we've learned in

1138
00:40:50,510 --> 00:40:47,240

low earth orbit

1139
00:40:53,270 --> 00:40:50,520
and what we will accomplish there will

1140
00:40:56,150 --> 00:40:53,280
ensure the Monumental missions to Mars

1141
00:40:59,270 --> 00:40:56,160
are within reach

1142
00:41:01,069 --> 00:40:59,280
as we ready the launch of the first

1143
00:41:03,410 --> 00:41:01,079
Artemis mission

1144
00:41:06,109 --> 00:41:03,420
and as commercial companies ready their

1145
00:41:08,089 --> 00:41:06,119
lunar Landers for the first private

1146
00:41:13,130 --> 00:41:08,099
payload deliveries

1147
00:41:16,720 --> 00:41:13,140
we have already begun to take the next

1148
00:41:16,730 --> 00:41:26,210
[Music]

1149
00:41:31,490 --> 00:41:28,910
hello so we just had a look at all the

1150
00:41:33,230 --> 00:41:31,500
feeds and the total lunar eclipse looks

1151
00:41:35,930 --> 00:41:33,240
absolutely stunning what did you guys

1152
00:41:38,390 --> 00:41:35,940
think it was amazing I guess oh I think

1153
00:41:40,490 --> 00:41:38,400
when I first saw Morocco the defeats

1154
00:41:42,650 --> 00:41:40,500
coming into Morocco I was like okay this

1155
00:41:44,809 --> 00:41:42,660
is the winner for today but you just

1156
00:41:46,069 --> 00:41:44,819
showed me another image from Rome and

1157
00:41:49,010 --> 00:41:46,079
they just changed my mind and that's

1158
00:41:50,390 --> 00:41:49,020
like really a reddish nice Hue across

1159
00:41:51,710 --> 00:41:50,400
the entire Moon and such beautiful

1160
00:41:53,210 --> 00:41:51,720
images

1161
00:41:56,450 --> 00:41:53,220
yeah so we have a lot of questions

1162
00:41:58,250 --> 00:41:56,460
online so let's dig in

1163
00:42:00,290 --> 00:41:58,260

um let's see so we have a viewer who

1164
00:42:02,569 --> 00:42:00,300
asks what kind of new and better

1165
00:42:04,730 --> 00:42:02,579
equipment do you need to have to return

1166
00:42:06,290 --> 00:42:04,740
to the moon and when will astronauts

1167
00:42:08,690 --> 00:42:06,300
arrive on it

1168
00:42:11,150 --> 00:42:08,700
yeah there's um a lot of different and

1169
00:42:12,829 --> 00:42:11,160
new equipment or improved equipment that

1170
00:42:14,150 --> 00:42:12,839
we're looking at for the moon

1171
00:42:15,890 --> 00:42:14,160
um one of which I think I've mentioned a

1172
00:42:17,390 --> 00:42:15,900
few times is that we're looking at using

1173
00:42:19,550 --> 00:42:17,400
the resources that are on the moon we

1174
00:42:21,470 --> 00:42:19,560
haven't done this before so all sorts of

1175
00:42:24,109 --> 00:42:21,480
new technologies whether it's drills or

1176
00:42:25,790 --> 00:42:24,119
just systems that can extract oxygen and

1177
00:42:28,010 --> 00:42:25,800
water and things from the from the lunar

1178
00:42:29,089 --> 00:42:28,020
regulator these are all new systems uh

1179
00:42:30,410 --> 00:42:29,099
we're improving things like our

1180
00:42:31,849 --> 00:42:30,420
Precision Landing you know how

1181
00:42:33,050 --> 00:42:31,859
accurately can you land where you want

1182
00:42:34,730 --> 00:42:33,060
to land

1183
00:42:37,010 --> 00:42:34,740
um and how how well can you avoid

1184
00:42:38,270 --> 00:42:37,020
obstacles like craters and boulders and

1185
00:42:39,650 --> 00:42:38,280
things um so those are some things

1186
00:42:41,750 --> 00:42:39,660
really The Landing but yeah different

1187
00:42:44,089 --> 00:42:41,760
sampling techniques for the astronauts

1188
00:42:45,770 --> 00:42:44,099

all sorts of new technologies um which

1189
00:42:47,870 --> 00:42:45,780
is really exciting because these will be

1190
00:42:48,950 --> 00:42:47,880
useful for Mars and also for our lives

1191
00:42:50,510 --> 00:42:48,960
on Earth

1192
00:42:52,430 --> 00:42:50,520
um as far as when they're getting there

1193
00:42:53,690 --> 00:42:52,440
um NASA's targeting 2025 for our first

1194
00:42:55,730 --> 00:42:53,700
grouped mission

1195
00:42:58,190 --> 00:42:55,740
and so you mentioned it will be useful

1196
00:43:00,530 --> 00:42:58,200
for us on Earth um could you tell us

1197
00:43:01,970 --> 00:43:00,540
more yeah um I mean I don't have a lot

1198
00:43:03,470 --> 00:43:01,980
of specific examples off the top of my

1199
00:43:04,970 --> 00:43:03,480
head but um you know for the Apollo

1200
00:43:06,710 --> 00:43:04,980
program for example we call them

1201
00:43:08,510 --> 00:43:06,720
spin-offs or all these technologies that

1202
00:43:10,069 --> 00:43:08,520
NASA developed for the the lunar program

1203
00:43:11,210 --> 00:43:10,079
uh that then became useful and

1204
00:43:13,130 --> 00:43:11,220
everything tennis shoes are a good

1205
00:43:14,630 --> 00:43:13,140
example of one I don't know if you have

1206
00:43:16,550 --> 00:43:14,640
any other examples you can think of off

1207
00:43:18,890 --> 00:43:16,560
the top of your head something right now

1208
00:43:21,230 --> 00:43:18,900
but yeah I think so

1209
00:43:23,270 --> 00:43:21,240
um I think the the Tamil blankets that

1210
00:43:25,609 --> 00:43:23,280
were used first the entire during the

1211
00:43:28,069 --> 00:43:25,619
Apollo space program and the spaceways

1212
00:43:30,109 --> 00:43:28,079
are being heavily used on Earth for a

1213
00:43:33,050 --> 00:43:30,119

variety of purposes

1214
00:43:34,910 --> 00:43:33,060
um and even these retro reflectors I'm

1215
00:43:37,250 --> 00:43:34,920
sorry I keep going back to those Eternal

1216
00:43:39,829 --> 00:43:37,260
reflectors that's what I do for work

1217
00:43:42,890 --> 00:43:39,839
um so I uh you know when I explain it to

1218
00:43:45,109 --> 00:43:42,900
some like a child what do I do I I I

1219
00:43:47,809 --> 00:43:45,119
make them look at you know all these uh

1220
00:43:49,970 --> 00:43:47,819
you know on the road as you travel when

1221
00:43:52,010 --> 00:43:49,980
you shine your headlight at them it

1222
00:43:53,690 --> 00:43:52,020
comes back right at you and those those

1223
00:43:55,430 --> 00:43:53,700
are Miniature versions of the same thing

1224
00:43:56,870 --> 00:43:55,440
but just that they're not space grade

1225
00:44:00,230 --> 00:43:56,880
right they're not ready to go to space

1226
00:44:01,849 --> 00:44:00,240
but yeah there's a whole lot of um you

1227
00:44:04,790 --> 00:44:01,859
know equipments which were developed

1228
00:44:08,510 --> 00:44:04,800
during the Space Race uh and uh you know

1229
00:44:10,970 --> 00:44:08,520
the Apollo era which uh is being used

1230
00:44:12,650 --> 00:44:10,980
right now on on Earth for to make our

1231
00:44:14,329 --> 00:44:12,660
lives better

1232
00:44:16,790 --> 00:44:14,339
fantastic so we have a question from

1233
00:44:18,470 --> 00:44:16,800
Charlie couch from YouTube and they

1234
00:44:22,069 --> 00:44:18,480
asked can you tell us the difference

1235
00:44:25,309 --> 00:44:22,079
between a solar and lunar eclipse

1236
00:44:28,550 --> 00:44:25,319
of course um so during a lunar eclipse

1237
00:44:32,150 --> 00:44:28,560
what comes between uh you know the uh

1238
00:44:33,470 --> 00:44:32,160

the Sun and the Moon is is the Earth so

1239
00:44:36,230 --> 00:44:33,480
you know dude that's what we're

1240
00:44:37,730 --> 00:44:36,240
witnessing today and similarly for the

1241
00:44:40,490 --> 00:44:37,740
solar eclipse what we have in between

1242
00:44:43,970 --> 00:44:40,500
the object in between is the moon

1243
00:44:46,849 --> 00:44:43,980
um and it's not safe to look at

1244
00:44:48,890 --> 00:44:46,859
um you know by eye uh the the solar

1245
00:44:50,390 --> 00:44:48,900
eclipse but you know it's very safe to

1246
00:44:51,770 --> 00:44:50,400
look at the moon so I encourage you all

1247
00:44:54,170 --> 00:44:51,780
to go out and look at the Moon if you

1248
00:44:55,609 --> 00:44:54,180
get a chance to yeah and what are the

1249
00:44:57,770 --> 00:44:55,619
differences when you when you look in

1250
00:44:58,849 --> 00:44:57,780
the sky because they look pretty they

1251
00:45:01,130 --> 00:44:58,859
look pretty different

1252
00:45:03,050 --> 00:45:01,140
right in in one of them you know you

1253
00:45:04,730 --> 00:45:03,060
have the sun in the background so it

1254
00:45:07,370 --> 00:45:04,740
could be a you know during the daylight

1255
00:45:10,010 --> 00:45:07,380
right and then suddenly it goes all dim

1256
00:45:12,170 --> 00:45:10,020
here on on earth when this is the solar

1257
00:45:13,069 --> 00:45:12,180
eclipse and

1258
00:45:17,569 --> 00:45:13,079
um

1259
00:45:19,849 --> 00:45:17,579
mean to have a lunar eclipse you need a

1260
00:45:22,130 --> 00:45:19,859
full moon uh right uh to get that

1261
00:45:24,170 --> 00:45:22,140
configuration for that eclipse and so

1262
00:45:25,490 --> 00:45:24,180
these are typically visible at night so

1263
00:45:26,870 --> 00:45:25,500

that's one of the differences I can

1264
00:45:29,510 --> 00:45:26,880
think of

1265
00:45:32,510 --> 00:45:29,520
okay so we have a question from Jack

1266
00:45:34,670 --> 00:45:32,520
and he asks how much do we know about

1267
00:45:37,190 --> 00:45:34,680
The Far Side of the Moon mapping

1268
00:45:39,050 --> 00:45:37,200
geography Etc has a satellite sustained

1269
00:45:41,089 --> 00:45:39,060
a durable orbit around the moon in order

1270
00:45:42,170 --> 00:45:41,099
to map the surface and has that ever

1271
00:45:44,690 --> 00:45:42,180
been done

1272
00:45:46,430 --> 00:45:44,700
uh yes great question uh so yes um

1273
00:45:49,130 --> 00:45:46,440
Apollo obviously that those were all

1274
00:45:50,630 --> 00:45:49,140
near side missions but we do know a lot

1275
00:45:52,730 --> 00:45:50,640
about the far side as well we have the

1276
00:45:54,530 --> 00:45:52,740
lunar reconnaissance Orbiter lro has

1277
00:45:55,790 --> 00:45:54,540
been orbiting the moon for almost 13

1278
00:45:57,050 --> 00:45:55,800
years now

1279
00:45:58,490 --> 00:45:57,060
um and yeah doing a lot of the mapping

1280
00:46:00,710 --> 00:45:58,500
that was that was asked about mapping

1281
00:46:03,109 --> 00:46:00,720
topography we had Grail that mapped the

1282
00:46:04,670 --> 00:46:03,119
gravity data of the moon so we don't

1283
00:46:06,770 --> 00:46:04,680
have you know we haven't had any surface

1284
00:46:07,910 --> 00:46:06,780
missions from the US to The Far Side of

1285
00:46:09,530 --> 00:46:07,920
the Moon we haven't returned those

1286
00:46:11,089 --> 00:46:09,540
samples we have a lot of really great

1287
00:46:12,950 --> 00:46:11,099
orbital instruments that tell us things

1288
00:46:14,750 --> 00:46:12,960

about about the composition and the

1289
00:46:16,190 --> 00:46:14,760
again the topography we know that

1290
00:46:18,589 --> 00:46:16,200
there's not as many

1291
00:46:21,050 --> 00:46:18,599
um uh volcanic areas on The Far Side of

1292
00:46:22,130 --> 00:46:21,060
the Moon we know the crust is thicker uh

1293
00:46:23,450 --> 00:46:22,140
I think the composition is a bit

1294
00:46:25,490 --> 00:46:23,460
different but we don't really know why

1295
00:46:28,609 --> 00:46:25,500
so there's a lot of good reasons to go

1296
00:46:32,270 --> 00:46:28,619
go explore the far side as well

1297
00:46:34,910 --> 00:46:32,280
okay and so Kelsey on Twitter asks my

1298
00:46:36,770 --> 00:46:34,920
eight-year-old Nico is asking when is

1299
00:46:39,829 --> 00:46:36,780
the Artemis Mission going to the moon

1300
00:46:40,970 --> 00:46:39,839
great question Nico yeah so like depends

1301
00:46:42,530 --> 00:46:40,980
on which art in this Mission you're

1302
00:46:45,109 --> 00:46:42,540
talking about we'll have our our

1303
00:46:46,910 --> 00:46:45,119
uncrewed demo um this year uh and then

1304
00:46:50,030 --> 00:46:46,920
our our first astronauts will hopefully

1305
00:46:52,730 --> 00:46:50,040
be on the surface in 2025.

1306
00:46:54,410 --> 00:46:52,740
okay so our next question is from

1307
00:46:56,750 --> 00:46:54,420
Tiffany on Twitter

1308
00:47:01,130 --> 00:46:56,760
and they asked what is the Moon's core

1309
00:47:04,609 --> 00:47:01,140
made of oh so

1310
00:47:06,410 --> 00:47:04,619
um you know the moon score so if you it

1311
00:47:10,309 --> 00:47:06,420
depends on how deep you're going right

1312
00:47:13,550 --> 00:47:10,319
so we know from uh initially from again

1313
00:47:16,309 --> 00:47:13,560

lunar laser ranging data uh by looking

1314
00:47:18,650 --> 00:47:16,319
at orientation in space we kind of

1315
00:47:20,390 --> 00:47:18,660
figured out uh by you know monitoring

1316
00:47:22,849 --> 00:47:20,400
these retro reflectors we have about

1317
00:47:24,589 --> 00:47:22,859
five of them we've been monitoring them

1318
00:47:27,710 --> 00:47:24,599
very closely over a long period of time

1319
00:47:29,750 --> 00:47:27,720
and we were able to you know reconstruct

1320
00:47:31,730 --> 00:47:29,760
the orientation of the Moon predict it

1321
00:47:34,630 --> 00:47:31,740
and compare with observations so when

1322
00:47:37,670 --> 00:47:34,640
you stick in a liquid core in that model

1323
00:47:40,069 --> 00:47:37,680
it it very well agrees with the data set

1324
00:47:41,990 --> 00:47:40,079
and this is one of the

1325
00:47:43,549 --> 00:47:42,000
um you know findings from lunar

1326
00:47:45,770 --> 00:47:43,559
initially from the lunar laser ranging

1327
00:47:48,770 --> 00:47:45,780
data but it was also later confirmed by

1328
00:47:51,470 --> 00:47:48,780
you know re-analysis of seismic data

1329
00:47:52,609 --> 00:47:51,480
that was collected from the Apollo

1330
00:47:55,970 --> 00:47:52,619
Mission

1331
00:47:58,790 --> 00:47:55,980
um so indeed it's made out of a liquid

1332
00:48:01,490 --> 00:47:58,800
core but there is a

1333
00:48:04,670 --> 00:48:01,500
um an expectation that there could

1334
00:48:07,490 --> 00:48:04,680
potentially be also a solid inner core

1335
00:48:11,450 --> 00:48:07,500
within that liquid core just like for

1336
00:48:15,109 --> 00:48:11,460
the Earth and this is a currently you

1337
00:48:17,809 --> 00:48:15,119
know uh in research and we still don't

1338
00:48:20,390 --> 00:48:17,819

have a very strong evidence

1339
00:48:23,809 --> 00:48:20,400
um uh suggesting that the moon has a

1340
00:48:25,730 --> 00:48:23,819
solid core but some of the samples that

1341
00:48:27,890 --> 00:48:25,740
were returned from you know the moon

1342
00:48:30,910 --> 00:48:27,900
during the Apollo missions

1343
00:48:33,890 --> 00:48:30,920
um they had Remnant magnetism in them

1344
00:48:36,349 --> 00:48:33,900
and you know those are signs that at

1345
00:48:39,770 --> 00:48:36,359
some point in time the moon had you know

1346
00:48:41,990 --> 00:48:39,780
an active magnetic field and so that

1347
00:48:43,790 --> 00:48:42,000
potentially magnetized these rocks that

1348
00:48:45,950 --> 00:48:43,800
were returned but currently we know that

1349
00:48:48,950 --> 00:48:45,960
there's no magnetization uh you know

1350
00:48:51,290 --> 00:48:48,960
there's no active magnetic field so you

1351
00:48:53,950 --> 00:48:51,300
know it's uh which suggests that there's

1352
00:48:56,650 --> 00:48:53,960
a potentially as maybe a very small

1353
00:49:00,589 --> 00:48:56,660
solid intercore which is you know

1354
00:49:03,170 --> 00:49:00,599
so it it's definitely an active topic of

1355
00:49:04,970 --> 00:49:03,180
research and we are seeking answers to

1356
00:49:08,089 --> 00:49:04,980
this via you know several of those

1357
00:49:10,790 --> 00:49:08,099
missions that Ryan was talking about so

1358
00:49:13,130 --> 00:49:10,800
yeah it's we know for sure there's a

1359
00:49:15,829 --> 00:49:13,140
liquid core but a solid core

1360
00:49:17,329 --> 00:49:15,839
I I my bed is indeed there is but you

1361
00:49:19,490 --> 00:49:17,339
know we want evidence for It We Are

1362
00:49:21,290 --> 00:49:19,500
Scientists so we want evidence

1363
00:49:22,910 --> 00:49:21,300

that's fascinating so we have a lot more

1364
00:49:25,370 --> 00:49:22,920
questions to get to later on in the show

1365
00:49:27,589 --> 00:49:25,380
but let's go back to James and Ernie

1366
00:49:30,710 --> 00:49:27,599
right now to see what the lunar eclipse

1367
00:49:32,329 --> 00:49:30,720
intertality looks like around the world

1368
00:49:33,770 --> 00:49:32,339
yeah thanks so much Joey we were just

1369
00:49:35,809 --> 00:49:33,780
looking at a feed from Nebraska a second

1370
00:49:37,970 --> 00:49:35,819
ago just switched off but they had the

1371
00:49:39,770 --> 00:49:37,980
most red looking Moon it was incredible

1372
00:49:41,089 --> 00:49:39,780
it was beautiful wasn't it yeah we were

1373
00:49:42,290 --> 00:49:41,099
tracking this earlier the weather looked

1374
00:49:43,970 --> 00:49:42,300
really nice from Nebraska so they must

1375
00:49:45,829 --> 00:49:43,980
have had a beautiful clear night there

1376
00:49:47,390 --> 00:49:45,839
yeah in fact I was saying earlier

1377
00:49:48,530 --> 00:49:47,400
tonight that that's that's the clear

1378
00:49:50,390 --> 00:49:48,540
part of the country that's the part

1379
00:49:51,770 --> 00:49:50,400
that's not affected by clouds and and it

1380
00:49:54,170 --> 00:49:51,780
turned out somebody was there watching

1381
00:49:55,549 --> 00:49:54,180
this amazing yeah and so a couple

1382
00:49:56,930 --> 00:49:55,559
questions have come in on Twitter as

1383
00:49:58,970 --> 00:49:56,940
well here too and I think you can really

1384
00:50:01,370 --> 00:49:58,980
speak to these very well Karthik asks

1385
00:50:03,470 --> 00:50:01,380
why do lunar eclipses happen rarely and

1386
00:50:05,030 --> 00:50:03,480
not every 28 days right that's a great

1387
00:50:07,730 --> 00:50:05,040
question and it's because the moon's

1388
00:50:09,410 --> 00:50:07,740

orbit is slightly tilted so

1389
00:50:10,970 --> 00:50:09,420
um five out of the six months the moon

1390
00:50:14,270 --> 00:50:10,980
is going to pass either underneath the

1391
00:50:16,190 --> 00:50:14,280
Shadow or above it uh it's only when you

1392
00:50:18,049 --> 00:50:16,200
get that tilt oriented just right so

1393
00:50:20,750 --> 00:50:18,059
that the moon is going

1394
00:50:23,089 --> 00:50:20,760
um right along that line that connects

1395
00:50:24,849 --> 00:50:23,099
the Earth and the Sun that you get lunar

1396
00:50:28,069 --> 00:50:24,859
eclipses and solar eclipses as well

1397
00:50:29,569 --> 00:50:28,079
those are related so a lunar eclipse is

1398
00:50:30,650 --> 00:50:29,579
always the full moon solar eclipse is

1399
00:50:32,750 --> 00:50:30,660
always the new moon so they're at

1400
00:50:34,370 --> 00:50:32,760
opposite ends of the orbit but that's

1401
00:50:36,890 --> 00:50:34,380
what Eclipse season really means it's

1402
00:50:38,510 --> 00:50:36,900
when that tilt is oriented in such a way

1403
00:50:40,730 --> 00:50:38,520
that it's sort of Crossing through the

1404
00:50:42,530 --> 00:50:40,740
center line got it amazing and you know

1405
00:50:44,329 --> 00:50:42,540
if you're just tuning in too this is

1406
00:50:46,250 --> 00:50:44,339
really going on quite a bit longer after

1407
00:50:48,049 --> 00:50:46,260
our broadcast here as well too so you

1408
00:50:49,309 --> 00:50:48,059
know stick around put on another pot of

1409
00:50:50,870 --> 00:50:49,319
coffee if it's getting late for you

1410
00:50:52,790 --> 00:50:50,880
wherever you are in the world and just

1411
00:50:55,069 --> 00:50:52,800
take your time to observe and really

1412
00:50:57,589 --> 00:50:55,079
enjoy this view here too another

1413
00:50:59,569 --> 00:50:57,599

question from Twitter from Lucas he asks

1414
00:51:01,370 --> 00:50:59,579
how do you calculate the next lunar

1415
00:51:02,930 --> 00:51:01,380
eclipse or any eclipse for that matter

1416
00:51:06,049 --> 00:51:02,940
so

1417
00:51:07,690 --> 00:51:06,059
gotten very good at

1418
00:51:10,490 --> 00:51:07,700
um the the

1419
00:51:12,410 --> 00:51:10,500
calculation of the position of the Moon

1420
00:51:13,970 --> 00:51:12,420
the Earth and the Sun and these are the

1421
00:51:15,530 --> 00:51:13,980
critical elements that you need in order

1422
00:51:18,589 --> 00:51:15,540
to understand when an eclipse is going

1423
00:51:21,470 --> 00:51:18,599
to happen we can predict those 100 100

1424
00:51:23,210 --> 00:51:21,480
or more years into the future and what

1425
00:51:24,230 --> 00:51:23,220
you need to do is just roll that clock

1426
00:51:25,549 --> 00:51:24,240
forward while you're doing the

1427
00:51:27,829 --> 00:51:25,559
calculation and find out where

1428
00:51:30,349 --> 00:51:27,839
everything lines up again and that's

1429
00:51:33,410 --> 00:51:30,359
basically how you do it uh

1430
00:51:36,650 --> 00:51:33,420
a little bit dark here San Diego oh

1431
00:51:38,990 --> 00:51:36,660
there's the fee this is the one up yeah

1432
00:51:40,370 --> 00:51:39,000
this is an absolutely stunning view out

1433
00:51:42,109 --> 00:51:40,380
in the plains of Nebraska a gorgeous

1434
00:51:43,970 --> 00:51:42,119
gorgeous shot here of the moon really

1435
00:51:45,770 --> 00:51:43,980
love this one as well and so

1436
00:51:48,109 --> 00:51:45,780
unfortunately here it stayed cloudy for

1437
00:51:50,329 --> 00:51:48,119
us a lot of thunderstorms but I was

1438
00:51:52,069 --> 00:51:50,339

actually able to visit the Moon from our

1439
00:51:53,990 --> 00:51:52,079
own Goddard Visitor Center it was a lot

1440
00:51:56,030 --> 00:51:54,000
of fun you know we got a nice close-up

1441
00:51:57,829 --> 00:51:56,040
view of it here hoping for a bit better

1442
00:51:59,390 --> 00:51:57,839
weather you know for the next lunar

1443
00:52:01,490 --> 00:51:59,400
eclipse down the line here as well so

1444
00:52:04,210 --> 00:52:01,500
we'll see how that goes as well uh Joy

1445
00:52:07,730 --> 00:52:04,220
how was your trip up the space today

1446
00:52:10,430 --> 00:52:07,740
yes I highly recommend going to NASA's

1447
00:52:12,890 --> 00:52:10,440
Visitor Center in Greenback Maryland to

1448
00:52:15,049 --> 00:52:12,900
go to the Moon yourself as well so we

1449
00:52:18,829 --> 00:52:15,059
have a lot more questions from social

1450
00:52:21,770 --> 00:52:18,839
media so let's let's get chatting

1451
00:52:24,650 --> 00:52:21,780
um we have a question from TJ on Twitter

1452
00:52:27,170 --> 00:52:24,660
and they ask why do we have to wear

1453
00:52:30,770 --> 00:52:27,180
special glasses during a solar eclipse

1454
00:52:35,030 --> 00:52:30,780
but not during a lunar eclipse

1455
00:52:36,829 --> 00:52:35,040
well um you know the solar eclipse in

1456
00:52:38,990 --> 00:52:36,839
during solar eclipse looking at you know

1457
00:52:40,910 --> 00:52:39,000
the sun and the sky and you really you

1458
00:52:43,430 --> 00:52:40,920
don't want to look at the sun directly

1459
00:52:46,010 --> 00:52:43,440
because of all the harmful radiation

1460
00:52:47,690 --> 00:52:46,020
such as like UV light Etc that's coming

1461
00:52:50,450 --> 00:52:47,700
in at all times you should never look at

1462
00:52:51,890 --> 00:52:50,460
the sun right so even during the solar

1463
00:52:55,010 --> 00:52:51,900

eclipse what happens is you know you get

1464
00:52:56,569 --> 00:52:55,020
that really drop in uh you know sunlight

1465
00:52:59,750 --> 00:52:56,579
and so you have

1466
00:53:01,910 --> 00:52:59,760
um you have a very really dark place and

1467
00:53:04,910 --> 00:53:01,920
suddenly when the moon

1468
00:53:06,770 --> 00:53:04,920
um you know moves away uh you get this

1469
00:53:08,930 --> 00:53:06,780
Saturn bright so which can damage your

1470
00:53:13,670 --> 00:53:08,940
eye so that's why they recommend you to

1471
00:53:15,770 --> 00:53:13,680
wear a filter whereas for the lunar

1472
00:53:17,870 --> 00:53:15,780
eclipse you're looking at

1473
00:53:21,430 --> 00:53:17,880
um just like looking at a moon during a

1474
00:53:24,170 --> 00:53:21,440
full moon or a a waiting or a you know

1475
00:53:26,630 --> 00:53:24,180
during the other phases of the moon uh

1476
00:53:28,790 --> 00:53:26,640
is that is the the light which is

1477
00:53:31,970 --> 00:53:28,800
bounced off from the Sun and then coming

1478
00:53:34,130 --> 00:53:31,980
to you so that's much less bright and

1479
00:53:38,030 --> 00:53:34,140
you know they're not as harmful as that

1480
00:53:41,030 --> 00:53:38,040
looking at the solar eclipse

1481
00:53:44,089 --> 00:53:41,040
so we have a question from nip per on

1482
00:53:46,130 --> 00:53:44,099
NASA Moon Facebook and they ask with the

1483
00:53:49,250 --> 00:53:46,140
moon receding from the earth about two

1484
00:53:52,549 --> 00:53:49,260
centimeters per year how long will it be

1485
00:53:54,890 --> 00:53:52,559
until there will be no total eclipses or

1486
00:53:57,190 --> 00:53:54,900
by Mega coincidence will the sun shrink

1487
00:53:59,870 --> 00:53:57,200
at the same ratio

1488
00:54:01,370 --> 00:53:59,880

really great question and I don't know

1489
00:54:02,829 --> 00:54:01,380
that I know the answer can we shout that

1490
00:54:06,170 --> 00:54:02,839
one over to Ernie

1491
00:54:08,210 --> 00:54:06,180
I think uh I mean it's we can make that

1492
00:54:10,430 --> 00:54:08,220
calculation uh because you know we have

1493
00:54:13,010 --> 00:54:10,440
the models that can extrapolate it based

1494
00:54:16,670 --> 00:54:13,020
on the current data sets that we have to

1495
00:54:19,430 --> 00:54:16,680
the Future uh but you know at some point

1496
00:54:20,829 --> 00:54:19,440
we we're not going to be able to witness

1497
00:54:25,010 --> 00:54:20,839
like

1498
00:54:27,290 --> 00:54:25,020
a total uh you know solar eclipse either

1499
00:54:29,030 --> 00:54:27,300
because you know we'll we'll have the

1500
00:54:31,190 --> 00:54:29,040
moon becoming smaller and small as it

1501
00:54:32,510 --> 00:54:31,200
goes away but it's a calculation that

1502
00:54:35,710 --> 00:54:32,520
needs to be done before it can be

1503
00:54:39,109 --> 00:54:35,720
answered it won't be in our lifetimes

1504
00:54:42,589 --> 00:54:39,119
okay so we have another question

1505
00:54:44,690 --> 00:54:42,599
um marisota electronic on YouTube asks

1506
00:54:46,970 --> 00:54:44,700
is there gravity on the moon

1507
00:54:49,190 --> 00:54:46,980
yes the gravity on the moon is one-sixth

1508
00:54:50,690 --> 00:54:49,200
that of Earth so um that's why if you

1509
00:54:51,770 --> 00:54:50,700
see videos of the Apollo Astronauts they

1510
00:54:53,329 --> 00:54:51,780
can look like they're hopping around

1511
00:54:54,770 --> 00:54:53,339
kind of almost in slow motion like

1512
00:54:57,950 --> 00:54:54,780
because there there is gravity it's just

1513
00:55:00,349 --> 00:54:57,960

not quite as quite as strong as hers

1514
00:55:02,750 --> 00:55:00,359
okay so we have um Loudoun on Twitter

1515
00:55:06,170 --> 00:55:02,760
and they ask why are lunar eclipses only

1516
00:55:10,970 --> 00:55:06,180
visible from certain locations

1517
00:55:13,849 --> 00:55:10,980
oh I think uh um so it to be in that

1518
00:55:16,250 --> 00:55:13,859
shadowed region right so um the the

1519
00:55:17,990 --> 00:55:16,260
moon's orbit is slightly inclined so

1520
00:55:20,210 --> 00:55:18,000
what happens is there are only specific

1521
00:55:22,970 --> 00:55:20,220
points in the orbit where you can have

1522
00:55:26,030 --> 00:55:22,980
that shadow so as long as uh you know

1523
00:55:28,549 --> 00:55:26,040
you the Moon is visible in the sky when

1524
00:55:30,770 --> 00:55:28,559
the moon is passing through that uh you

1525
00:55:34,250 --> 00:55:30,780
know shadow of the earth you'll be able

1526
00:55:35,990 --> 00:55:34,260
to be able to see that and that's

1527
00:55:38,870 --> 00:55:36,000
probably why

1528
00:55:41,089 --> 00:55:38,880
okay so that is all we have time for

1529
00:55:42,410 --> 00:55:41,099
today thank you both so much for

1530
00:55:45,530 --> 00:55:42,420
answering everyone's questions online

1531
00:55:47,450 --> 00:55:45,540
thanks for having us yeah pleasure and

1532
00:55:50,150 --> 00:55:47,460
thank you to everyone joining us at home

1533
00:55:53,690 --> 00:55:50,160
for this remarkable experience remember

1534
00:55:56,089 --> 00:55:53,700
totality ends at 12 54 a.m eastern time

1535
00:55:58,069 --> 00:55:56,099
so if it's not cloudy where you are I

1536
00:56:00,470 --> 00:55:58,079
recommend you head outside and check out

1537
00:56:02,710 --> 00:56:00,480
the red moon if you want to learn more

1538
00:56:04,670 --> 00:56:02,720

about the moon head to

1539
00:56:06,349 --> 00:56:04,680
moon.nasa.gov and if you want to learn

1540
00:56:09,109 --> 00:56:06,359
about NASA's latest research around the

1541
00:56:12,770 --> 00:56:09,119
Moon follow us on NASA Moon on Facebook

1542
00:56:15,370 --> 00:56:12,780
and Twitter and we will be continuing to

1543
00:56:17,510 --> 00:56:15,380
stream the lunar eclipse on

1544
00:56:19,069 --> 00:56:17,520
moon.natural.gov so head over there so

1545
00:56:21,530 --> 00:56:19,079
you can check out the lunar eclipse at

1546
00:56:23,329 --> 00:56:21,540
different locations across the world and

1547
00:56:25,670 --> 00:56:23,339
mark your calendars for the next lunar

1548
00:56:28,549 --> 00:56:25,680
eclipse which will be on November 8th

1549
00:56:31,920 --> 00:56:28,559
until then see you next time

1550
00:57:12,950 --> 00:56:45,650
[Music]

1551
00:57:12,960 --> 00:57:16,550
foreign

1552
00:58:06,670 --> 00:57:22,960
[Music]

1553
00:58:10,329 --> 00:58:06,680
[Applause]

1554
00:58:10,339 --> 00:58:15,049
thank you