
STEMonstrations
NEWTON'S FIRST LAW
STEMonstrations
NASA
SUNI WILLIAMS

1
00:00:01,260 --> 00:00:21,800
[Music]

2
00:00:24,160 --> 00:00:24,479
Hi

3
00:00:24,480 --> 00:00:26,799
I'm Suni Williams and I'm an astronaut

4
00:00:26,800 --> 00:00:28,239
who's lived and worked aboard the

5
00:00:28,240 --> 00:00:29,999
International Space Station,

6
00:00:30,000 --> 00:00:32,238
an amazing research laboratory that's

7
00:00:32,239 --> 00:00:34,879
orbiting the earth about 250 miles above

8
00:00:34,880 --> 00:00:35,919
us.

9
00:00:35,920 --> 00:00:37,679
While we're at the space station we

10
00:00:37,680 --> 00:00:39,119
astronauts live

11
00:00:39,120 --> 00:00:42,159
and work in a microgravity environment.

12
00:00:42,160 --> 00:00:44,159
Do you think the laws of physics will

13
00:00:44,160 --> 00:00:45,999

hold up in the space station while

14
00:00:46,000 --> 00:00:48,238
experiencing microgravity?

15
00:00:48,239 --> 00:00:50,238
Let's check with nasa astronaut Mark

16
00:00:50,239 --> 00:00:52,398
Vande Hei on the International Space Station

17
00:00:52,399 --> 00:00:58,319
to find out.

18
00:00:58,320 --> 00:01:00,398
Newton's first law of motion says an

19
00:01:00,399 --> 00:01:01,358
object at rest

20
00:01:01,359 --> 00:01:03,759
tends to stay at rest unless acted on by

21
00:01:03,760 --> 00:01:04,659
an outside force.

22
00:01:04,660 --> 00:01:06,559
[Music]

23
00:01:06,560 --> 00:01:10,239
Also, an object in motion

24
00:01:10,240 --> 00:01:12,639
tends to stay in motion unless acted on

25
00:01:12,640 --> 00:01:14,798
by an outside force

26
00:01:14,799 --> 00:01:17,439
like my finger.

27
00:01:20,159 --> 00:01:22,478
Let's look at this from another angle.

28
00:01:22,479 --> 00:01:24,239
Over time the International Space

29
00:01:24,240 --> 00:01:26,478
Station slows down from experiencing a

30
00:01:26,479 --> 00:01:28,639
very small amount of drag,

31
00:01:28,640 --> 00:01:32,239
or force from a tiny amount of atomic

32
00:01:32,240 --> 00:01:33,999
oxygen in space.

33
00:01:34,000 --> 00:01:36,319
This is like the force you feel from the

34
00:01:36,320 --> 00:01:38,399
air if you stick your hand out of a

35
00:01:38,400 --> 00:01:39,599
moving car.

36
00:01:39,600 --> 00:01:42,158
Because of this the space station does

37
00:01:42,159 --> 00:01:44,398
what we call a re-boost.

38
00:01:44,399 --> 00:01:46,798

A reboost uses rocket engines to put a

39
00:01:46,799 --> 00:01:48,798
force on the space station.

40
00:01:48,799 --> 00:01:51,679
This allows it to speed up just a little

41
00:01:51,680 --> 00:01:54,239
to remain in orbit around the earth.

42
00:01:54,240 --> 00:01:56,478
Let's join nasa astronaut Jeff Williams

43
00:01:56,479 --> 00:01:58,559
to check out what happens to the objects

44
00:01:58,560 --> 00:02:00,078
inside the space station

45
00:02:00,079 --> 00:02:03,039
when it begins. Now the way i'm going to

46
00:02:03,040 --> 00:02:04,798
demonstrate the acceleration that comes

47
00:02:04,799 --> 00:02:06,559
during the reboost is by using this

48
00:02:06,560 --> 00:02:07,359
camera

49
00:02:07,360 --> 00:02:09,839
uh 800 millimeter lens. So it's it's

50
00:02:09,840 --> 00:02:10,878
pretty massive

51
00:02:10,879 --> 00:02:13,999
actually and you can see i can float it

52
00:02:18,879 --> 00:02:17,520
here

53
00:02:17,520 --> 00:02:18,878
now so the camera's not going to go

54
00:02:18,879 --> 00:02:20,639
anywhere. It's just going to slowly drift

55
00:02:20,640 --> 00:02:23,119
due to the ventilation or or if i put

56
00:02:23,120 --> 00:02:23,919
any

57
00:02:23,920 --> 00:02:26,238
uh velocity into it it'll drift out of

58
00:02:26,239 --> 00:02:27,598
the scene. But i'm going to try to hold

59
00:02:27,599 --> 00:02:28,639
it here steady

60
00:02:28,640 --> 00:02:30,559
and you can see that it stays very

61
00:02:30,560 --> 00:02:31,919
steady.

62
00:02:31,920 --> 00:02:34,839
There's my camera I'm setting it up for

63
00:02:34,840 --> 00:02:35,999

ignition.

64
00:02:36,000 --> 00:02:38,238
There it goes it actually came a little

65
00:02:38,239 --> 00:02:40,238
bit early.

66
00:02:40,239 --> 00:02:42,719
Now watch the camera accelerate toward

67
00:02:42,720 --> 00:02:43,759
you.

68
00:02:43,760 --> 00:02:45,199
There it goes i'm going to reach out and

69
00:02:45,200 --> 00:02:47,199
grab it and bring it back

70
00:02:47,200 --> 00:02:50,479
in the view here and i'm holding it i'm

71
00:02:50,480 --> 00:02:52,479
actually feeling the acceleration

72
00:02:52,480 --> 00:02:55,039
i'm gonna let go again and here it goes.

73
00:02:55,040 --> 00:02:57,840
It's gonna take off.

74
00:02:58,640 --> 00:03:00,829
I'll try not to let it hit you.

75
00:03:00,830 --> 00:03:03,279
[Music]

76
00:03:03,280 --> 00:03:06,239
Just going to miss you.

77
00:03:07,280 --> 00:03:09,919
Yeah i'm going to let go now and here i

78
00:03:09,920 --> 00:03:11,518
go drifting back toward you again.

79
00:03:11,519 --> 00:03:13,389
So the acceleration applies to me too.

80
00:03:13,390 --> 00:03:16,639
[Music]

81
00:03:16,640 --> 00:03:19,598
Reached our 2.7 meters per second that

82
00:03:19,599 --> 00:03:20,079
we

83
00:03:20,080 --> 00:03:21,839
desired and now if i let go of the

84
00:03:21,840 --> 00:03:24,479
camera it's not going anywhere so the

85
00:03:24,480 --> 00:03:25,999
burn is over.

86
00:03:26,000 --> 00:03:28,399
Reboost complete. We'll stay in orbit for

87
00:03:28,400 --> 00:03:30,399
a little while longer.

88
00:03:30,400 --> 00:03:32,158

Can you use Newton's first law to

89
00:03:32,159 --> 00:03:34,238
explain why the camera began moving

90
00:03:34,239 --> 00:03:36,158
without an astronaut putting a force

91
00:03:36,159 --> 00:03:38,079
directly on it?

92
00:03:38,080 --> 00:03:40,479
I'm going to send you back to class so

93
00:03:40,480 --> 00:03:42,639
you can start to investigate this with

94
00:03:42,640 --> 00:03:44,158
the classroom connection

95
00:03:44,159 --> 00:03:47,359
found at nasa.gov/stemonstrations.

96
00:03:47,360 --> 00:03:49,279
Thanks for exploring a little physics on

97
00:03:49,280 --> 00:03:51,199
the space station with us today.