1
00:00:56,559 --> 00:01:02,150
boom

2
00:01:10,789 --> 00:01:04,789
gravity is the force that pulls people

3
00:01:16,870 --> 00:01:13,429
without gravity sitting in a chair or

4
00:01:18,230 --> 00:01:16,880
walking down stairs would be difficult

5
00:01:20,230 --> 00:01:18,240
for example

6
00:01:23,670 --> 00:01:20,240
when you drop a ball at any point on

7
00:01:26,550 --> 00:01:23,680
earth it will always fall straight down

8
00:01:28,789 --> 00:01:26,560
that is gravity at work pulling the ball

9
00:01:30,390 --> 00:01:28,799
towards the earth's surface

10
00:01:33,190 --> 00:01:30,400
but there is a difference between

11
00:01:35,830 --> 00:01:33,200
dropping and throwing a ball

12
00:01:38,310 --> 00:01:35,840
when a ball is thrown it still falls to

13
00:01:40,710 --> 00:01:38,320

earth but lands at a point further away

14
00:01:42,710 --> 00:01:40,720
from where it was thrown

15
00:01:44,390 --> 00:01:42,720
if a ball could be thrown with enough

16
00:01:47,109 --> 00:01:44,400
forward velocity

17
00:01:49,429 --> 00:01:47,119
it would fall around the earth creating

18
00:01:52,069 --> 00:01:49,439
a low earth orbit

19
00:01:54,950 --> 00:01:52,079
like the ball the space shuttle is

20
00:01:56,310 --> 00:01:54,960
actually in a continuous fall around the

21
00:01:58,550 --> 00:01:56,320
earth

22
00:02:01,350 --> 00:01:58,560
astronauts and objects inside the

23
00:02:02,950 --> 00:02:01,360
shuttle are falling at exactly the same

24
00:02:04,709 --> 00:02:02,960
rate as the shuttle

25
00:02:06,630 --> 00:02:04,719
thus creating the effects of

26
00:02:09,190 --> 00:02:06,640
weightlessness

27
00:02:10,630 --> 00:02:09,200
imagine an astronaut in an elevator on

28
00:02:12,630 --> 00:02:10,640
earth

29
00:02:14,710 --> 00:02:12,640
the elevator is going to the top of a

30
00:02:17,430 --> 00:02:14,720
very tall building

31
00:02:18,949 --> 00:02:17,440
suddenly when he reaches the top the

32
00:02:21,430 --> 00:02:18,959
cable breaks

33
00:02:24,150 --> 00:02:21,440
the elevator begins to fall

34
00:02:26,390 --> 00:02:24,160
inside the car the astronaut begins to

35
00:02:29,350 --> 00:02:26,400
float he is weightless

36
00:02:31,830 --> 00:02:29,360
if he had an apple it would float too

37
00:02:34,229 --> 00:02:31,840
that is because the car the astronaut

38
00:02:36,869 --> 00:02:34,239

and the apple are falling at the same

39
00:02:38,790 --> 00:02:36,879
rate of speed

40
00:02:40,790 --> 00:02:38,800
you may have experienced moments on

41
00:02:43,430 --> 00:02:40,800
earth when the effects of gravity seem

42
00:02:47,750 --> 00:02:43,440
to disappear

43
00:02:47,760 --> 00:02:52,790
or crest the hill on a roller coaster

44
00:02:57,430 --> 00:02:54,550
scientists can take advantage of a

45
00:02:59,830 --> 00:02:57,440
reduced gravity environment to isolate

46
00:03:03,190 --> 00:02:59,840
the effects gravity has on physical

47
00:03:04,710 --> 00:03:03,200
chemical and biological processes

48
00:03:07,270 --> 00:03:04,720
a better understanding of these

49
00:03:09,830 --> 00:03:07,280
processes can be achieved by studying

50
00:03:11,830 --> 00:03:09,840
phenomena usually obscured by the

51
00:03:14,949 --> 00:03:11,840
effects of gravity

52
00:03:17,270 --> 00:03:14,959
on earth scientists utilize specialized

53
00:03:19,990 --> 00:03:17,280
facilities such as drop towers and

54
00:03:22,229 --> 00:03:20,000
aircraft in parabolic dive sequences to

55
00:03:24,470 --> 00:03:22,239
test experiments for a few seconds at a

56
00:03:26,790 --> 00:03:24,480
time in an environment which is

57
00:03:28,869 --> 00:03:26,800
approximately 1 100th of the earth's

58
00:03:31,670 --> 00:03:28,879
normal gravity level

59
00:03:34,229 --> 00:03:31,680
however many experiments require even

60
00:03:36,949 --> 00:03:34,239
smaller gravity levels and longer

61
00:03:40,229 --> 00:03:36,959
durations of free fall that cannot be

62
00:03:42,869 --> 00:03:40,239
achieved in these earth-based facilities

63
00:03:44,949 --> 00:03:42,879

in the constant microgravity environment

64
00:03:47,430 --> 00:03:44,959
of low earth orbit

65
00:03:49,190 --> 00:03:47,440
researchers have found that experiments

66
00:03:52,550 --> 00:03:49,200
in biotechnology

67
00:03:54,869 --> 00:03:52,560
fluid dynamics and material science have

68
00:03:57,670 --> 00:03:54,879
produced dramatically different results

69
00:03:59,750 --> 00:03:57,680
than ground-based research

70
00:04:01,509 --> 00:03:59,760
one example of this can be seen by

71
00:04:04,149 --> 00:04:01,519
examining crystals grown in a

72
00:04:06,390 --> 00:04:04,159
microgravity environment

73
00:04:08,229 --> 00:04:06,400
these crystals contain fewer flaws and

74
00:04:09,350 --> 00:04:08,239
imperfections than crystals grown on

75
00:04:10,789 --> 00:04:09,360
earth

76
00:04:13,110 --> 00:04:10,799
the result

77
00:04:15,670 --> 00:04:13,120
higher quality crystals for potential

78
00:04:18,069 --> 00:04:15,680
applications on earth

79
00:04:20,710 --> 00:04:18,079
however even in the microgravity

80
00:04:22,950 --> 00:04:20,720
environment aboard the shuttle there are

81
00:04:25,110 --> 00:04:22,960
other forces that may affect the results

82
00:04:27,670 --> 00:04:25,120
of experiments

83
00:04:29,430 --> 00:04:27,680
disturbances and vibrations caused by

84
00:04:32,310 --> 00:04:29,440
thruster firings

85
00:04:34,550 --> 00:04:32,320
crew movements and equipment operation

86
00:04:36,950 --> 00:04:34,560
can mimic the effects of gravity on

87
00:04:39,110 --> 00:04:36,960
experiment results

88
00:04:41,830 --> 00:04:39,120

disturbances that are significant for

89
00:04:43,830 --> 00:04:41,840
sensitive experiments

90
00:04:46,550 --> 00:04:43,840
that may negatively affect the results

91
00:04:48,629 --> 00:04:46,560
of those experiments

92
00:04:50,790 --> 00:04:48,639
a simple demonstration illustrates how

93
00:04:53,510 --> 00:04:50,800
an outside force can affect the results

94
00:04:55,830 --> 00:04:53,520
of an experiment

95
00:04:59,830 --> 00:04:55,840
the slightest disturbance to just one

96
00:05:02,790 --> 00:04:59,840
domino will cause the others to fall

97
00:05:04,870 --> 00:05:02,800
or try this experiment in your kitchen

98
00:05:07,350 --> 00:05:04,880
the surface tension of a glass of water

99
00:05:09,830 --> 00:05:07,360
will support common paper clips

100
00:05:13,189 --> 00:05:09,840
when the glass is bumped the paper clips

101
00:05:15,430 --> 00:05:13,199
sink to the bottom of the glass

102
00:05:17,110 --> 00:05:15,440
in order to understand the final data

103
00:05:18,710 --> 00:05:17,120
from an experiment conducted in

104
00:05:21,350 --> 00:05:18,720
microgravity

105
00:05:23,510 --> 00:05:21,360
these disturbances and other parameters

106
00:05:25,270 --> 00:05:23,520
such as temperature and pressure need to

107
00:05:27,270 --> 00:05:25,280
be measured

108
00:05:29,590 --> 00:05:27,280
researchers may then use the data to

109
00:05:32,070 --> 00:05:29,600
determine if unexpected results were

110
00:05:37,270 --> 00:05:32,080
caused naturally or by these measured

111
00:05:42,790 --> 00:05:39,430
at nasa's lewis research center in

112
00:05:44,790 --> 00:05:42,800
cleveland ohio scientists and engineers

113
00:05:47,830 --> 00:05:44,800

have developed the space acceleration

114
00:05:50,070 --> 00:05:47,840
measurement system or sams to measure

115
00:05:53,830 --> 00:05:50,080
and record vibrations and disturbances

116
00:05:56,629 --> 00:05:53,840
that may alter experiment results

117
00:05:59,350 --> 00:05:56,639
sams is designed to measure characterize

118
00:06:01,430 --> 00:05:59,360
and record low gravity disturbances on

119
00:06:04,230 --> 00:06:01,440
board the space shuttle

120
00:06:06,870 --> 00:06:04,240
a single sams unit can monitor three

121
00:06:10,230 --> 00:06:06,880
experiments directly as well as other

122
00:06:13,029 --> 00:06:10,240
experiments in close proximity

123
00:06:14,950 --> 00:06:13,039
the sams hardware consists of a main

124
00:06:18,790 --> 00:06:14,960
signal processing unit

125
00:06:21,510 --> 00:06:18,800
and three remote tri-axial sensor heads

126
00:06:23,430 --> 00:06:21,520
the three sensors on each of these heads

127
00:06:25,029 --> 00:06:23,440
detect the different disturbances and

128
00:06:27,510 --> 00:06:25,039
their levels

129
00:06:30,469 --> 00:06:27,520
the data is sent through cables and

130
00:06:34,309 --> 00:06:30,479
stored on disks similar to the compact

131
00:06:37,510 --> 00:06:34,319
discs that are found in homes today the

132
00:06:38,710 --> 00:06:37,520
sensor heads are mounted on or near an

133
00:06:40,950 --> 00:06:38,720
experiment

134
00:06:44,309 --> 00:06:40,960
permitting disturbances affecting that

135
00:06:47,029 --> 00:06:44,319
experiment to be sampled

136
00:06:50,070 --> 00:06:47,039
sams has the ability to collect data up

137
00:06:52,950 --> 00:06:50,080
to 20 feet away from the main unit

138
00:06:55,029 --> 00:06:52,960

this enhances its versatility and allows

139
00:06:57,430 --> 00:06:55,039
it to serve a wide variety of

140
00:06:59,270 --> 00:06:57,440
microgravity science and technology

141
00:07:01,589 --> 00:06:59,280
experiments

142
00:07:03,830 --> 00:07:01,599
sams is scheduled to fly as part of the

143
00:07:05,309 --> 00:07:03,840
second united states microgravity

144
00:07:08,870 --> 00:07:05,319
payload mission

145
00:07:12,309 --> 00:07:08,880
usmp2 aboard the space shuttle columbia

146
00:07:14,790 --> 00:07:12,319
in march of 1994.

147
00:07:17,430 --> 00:07:14,800
during this mission scientists in the

148
00:07:20,070 --> 00:07:17,440
payload operations control center or

149
00:07:22,710 --> 00:07:20,080
park will be able to monitor some of the

150
00:07:24,950 --> 00:07:22,720
data that the sams unit is collecting in

151
00:07:26,629 --> 00:07:24,960
real time as the disturbances are

152
00:07:29,270 --> 00:07:26,639
occurring

153
00:07:31,350 --> 00:07:29,280
scientists can use this information to

154
00:07:33,670 --> 00:07:31,360
determine if adjustments need to be made

155
00:07:36,070 --> 00:07:33,680
to their experiments to avoid any

156
00:07:38,710 --> 00:07:36,080
unacceptable conditions

157
00:07:42,710 --> 00:07:38,720
sams will support four materials science

158
00:07:44,469 --> 00:07:42,720
experiments on the usmp2 mission

159
00:07:46,870 --> 00:07:44,479
three of these experiments were

160
00:07:49,110 --> 00:07:46,880
developed or are managed by the nassau

161
00:07:50,950 --> 00:07:49,120
lewis research center

162
00:07:53,189 --> 00:07:50,960
the data that sams will collect for

163
00:07:55,909 --> 00:07:53,199

these experiments could lead to many

164
00:07:58,550 --> 00:07:55,919
advancements in processed materials such

165
00:08:00,950 --> 00:07:58,560
as improved industrial casting methods

166
00:08:03,110 --> 00:08:00,960
the development of superconductors and

167
00:08:06,150 --> 00:08:03,120
the ability to produce higher quality