



OVERVIEW

In this lesson, students will consider the differences in gravity between the Earth and the Moon and the meaning of mass, weight and gravity.

They will then use stills from footage of the Apollo 17 Lunar lift off to calculate the speed during the initial ascent.

CURRICULUM LINKS

Reading and taking measurements from a graph.

Speed, distance, and time.

Calculating time given a speed and distance.

Making measurements.

Gravity, weight and mass.

WHAT YOU NEED

A14 PowerPoint

14.1 Weight and gravity worksheet

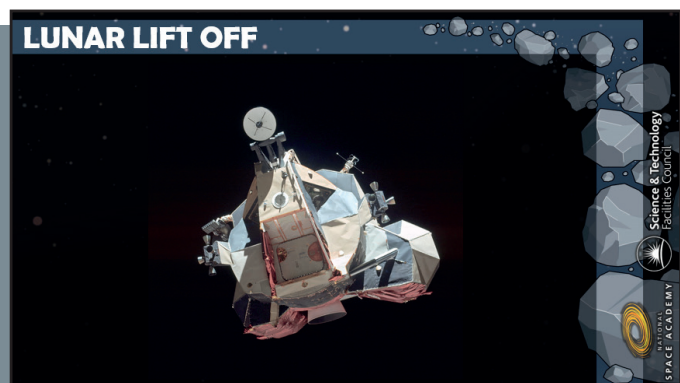
14.2 Lunar lift off worksheet

Optional – empty plastic bottles and scales

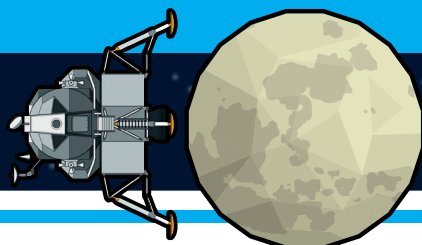


STARTER

Go through the recap slides on mass, weight and gravity on the PowerPoint, asking students what they think the differences will be between the Earth and the Moon.



A14 PowerPoint



MAIN ACTIVITY 1

Hand out sheet 14.1 to students and get them to answer the questions, referring to the information that has just been covered.

Extension activity: Hand students some empty plastic bottles and a set of scales. Get them to fill one of the bottles up with water and weigh it. Then get them to calculate how much water they would need to put in the second bottle to simulate how much lighter this would feel on the Moon. Students can then compare their models.

14.1 WEIGHT AND GRAVITY

You are going to focus on EVA 2. Zoom in on the bottom part of the route using the navigation tools (see Exploring the Moon in Google Earth guide).

Watch the video of astronauts on the Moon - what do you notice about the way that they walk?

What does this suggest about gravity on the Moon compared to on the Earth?

Explaining key terms:
What do we mean by "MASS"?
What do we mean by "WEIGHT"?

Item (one mass in kg)	Weight on Earth in Newtons	Weight on the Moon
Lunar landing Vehicle (2000)		
All the rocks brought back by Apollo missions (3000)		
Apollo 11 landing rovers (2000)		
Golf ball hit during Apollo 14 (0.045)		

Remember: On the Moon, things weigh 1/6 what they weigh on the Earth.

During Apollo 14, astronaut Alan Shepard used a makeshift golf club to hit a golf ball on the Moon. Assuming he hit it with the same force, and at the same angle on the same Earth, how would the time it took for the ball to hit the ground compare?

Explain your answer - you may want to draw a diagram to help!

14.1 Weight and gravity



MAIN ACTIVITY 2

Hand out sheet 14.2 for students to work through. Get them to calculate the average speeds at various points on the Apollo 17 Lunar lift off course.

Extension activity: 14-16 year old students can then plot a graph of average speed against time for each of the intervals. Get them to explain what is happening in terms of acceleration (gradient of the graph) and in terms of the initial explosion to boost the Lunar Module upwards.

14.2 LUNAR LIFT OFF

This is the very last time a human was on the Moon. When Apollo 17 blasted off from the surface, it left in an explosion of bolts! These bolts had to fire to separate the LEM (Lunar Excursion Module) from the descent stage below it. The descent stage was left on the Moon and can still be seen in high resolution images like the one on the right taken by the Lunar Reconnaissance Orbiter. The video shows the LEM lift off slowed down to 1/10 normal speed.

What is the camera doing during this lift off? How can you tell?

After taking this effect into account, the relative position of the LEM over time has been mapped out.

Calculate the average speed of the LEM for each time interval. MEASURE FROM THE BOTTOM OF THE ASCENT STAGE.

Time interval	Distance travelled (m)	Average speed
0-1 s		
1-2 s		
2-3 s		
3-4 s		

Example calculation for first row:
0 is the bottom of the LEM is on 1.9m so height gained = final - original = 1.9 m - 0 m = 1.9 m.

$$\text{speed} = \frac{\text{distance}}{\text{time}} = \frac{1.9}{1} = 1.9 \text{ m/s}$$

What do your results tell you about how the LEM was moving over this time frame?

How do you think this speed would differ if the same force was used to propel the LEM from the surface of the Earth? Explain your answer.

14.2 Lunar lift off



PLENARY

Get students to think about some every day activities that they do on the Earth that would be significantly different in the low gravity environment of the Moon.

Discuss their ideas and make sure that they explain HOW and WHY these would be different.