Chapter 8: Gravity

8.1 Earth’s gravity pulls objects to the centre of the Earth

Student book answers (pages 144–145)

Check your learning 8.1

Remember and understand

1 What is the difference between mass and weight?

The difference between mass and weight is that mass is a measure of how much matter an object contains and weight is a measure of the gravitational force (or pull) acting on an object. The mass of an object never changes no matter where it is and how strong or weak gravity is. Weight is affected by gravity.

2 Who first described gravity?

Isaac Newton first described gravity in 1665.

3 If a half-full water bottle was dropped from the top of a flight of stairs at the same time as a full bottle of water, which would hit the ground first?

If air resistance is the same on each water bottle, they should hit the ground at the same time.

4 True or false: the pull of gravity is stronger on an elephant than on a feather.

True. The gravitational pull on an object is known as weight and depends on an object’s mass. An elephant has a higher mass than a feather so the weight force acting on the elephant will be stronger than that on the feather. (Gravity acts equally on both if they are in the same location, but weight = mass × gravity.)

Apply and analyse

5 An astronaut on the Moon dropped a feather and a hammer at the same time. There is very little atmosphere on the Moon to slow down objects. Explain why the feather and hammer hit the ground at the same time.

With very little atmosphere there will be very little air resistance. The Moon’s gravity will accelerate both objects equally, so they will hit the ground at the same time. (Note: the weight force on each will be different, but they will fall together because gravity acts equally to speed them up.)

Evaluate and create

6 Building a settlement on the Moon has been suggested several times since Buzz Aldrin first walked on the Moon. What advantages and disadvantages would there be in building such a structure in a low-gravity environment?

Student answers will vary. Humans would have difficulty colonising the Moon because there is no atmosphere, which means humans could not breathe. However, gravity is weak, which means it would be easier to move around.

8.2 Gravity keeps planets in orbit around the Sun

Student book answers (pages 146–147)

Check your learning 8.2

Remember and understand

1 Who was the first scientist to suggest the Earth travelled around the Sun?

Nicolas Copernicus

2 Why was Galileo put under house arrest?

Galileo’s ideas upset the authorities. When he didn’t change his beliefs and published his book, he was placed under house arrest, rather than imprisoned, because of his age.

3 What causes the planets to orbit the Sun?

The gravitational attraction between the Sun and the planets causes them to orbit the Sun.

Apply and analyse

4 ‘The Earth orbits the Moon.’ Explain what is wrong with this statement. Provide evidence to support your view.

Lighter objects orbit the heavier object, so the Moon orbits the Earth.

Evaluate and create

5 Research one possible impact of the Moon no longer orbiting the Earth.

Student answers will vary.

8.3 The Moon’s gravity causes tidal movements

Student book answers (pages 148–149)

Check your learning 8.3

Remember and understand

1 Why does the Moon have a greater effect on the tide levels than the Sun?

The Moon is much closer to the Earth than the Sun, so it has a greater effect on the tide levels than the Sun.

Analyse and apply

2 Referring to Table 8.1, calculate the difference between:

a the last high tide on Saturday and the next one on Sunday

0.07 m (0.82 m – 0.75 m)

b one high tide and the following low tide on Saturday.

0.44 m (0.80 m – 0.36 m) OR 0.56 m (0.75 m – 0.19 m)

3 Can you predict the times and heights of the tides for Monday?

Approximate tide times and heights based on the previous days’ measurements are:

**•** 5.50 am, 0.80 m

**•** 12.20 pm, 0.35 m

**•** 6.15 pm, 0.75 m (the next one is on Tuesday: 12.20 am, 0.2 m)

Evaluate and create

4 For 1 week, graph the high and low tide levels of a beach in your state. Compare this against the times of Moon rise and set. Can you find any correlation between the two? Describe the relationship between Moon’s position and tide levels.

Student answers will vary. The graph should show that between moon rise and moon set (i.e. when the moon is in the sky) there is a high tide between those two times. This is due to the gravitational pull of the moon on the water towards the moon, causing a high tide. Between moon set and the next moon rise (i.e. when the moon is not visible in the sky) there should be another high tide because the moon is on the opposite side of the Earth, pulling on the water again and causing bulges on opposite sides of the Earth, as shown in Figure 8.10 on page 148.

8.4 Science as a human endeavour: Scientists work collaboratively to explore microgravity

Student book answers (pages 150–151)

Extend your learning 8.4

Remember and understand

1 What is microgravity?

Microgravity is the term used to describe situations where people or objects appear not to have much gravity acting on them, such as in orbit around the Earth. Gravity still acts, of course, but they appear to be weightless.

Apply and analyse

2 Why are rockets needed to launch spacecraft?

Rockets are needed to launch spacecraft because a fully fuelled spacecraft is very heavy and requires a lot of force to escape the Earth’s gravity.

3 A student said astronauts are weightless on the space station. Do you agree? Explain your answer.

No, astronauts are not weightless on the space station. They only appear to be weightless. Gravity still acts on both the astronauts and the space station, and both are in freefall towards the Earth (as well as moving forward). There is no force acting between them, so the astronauts appear to float within the space station.

4 Why do you think we send probes into space rather than humans?

Probes were sent into space to prepare for human exploration there. Without the information discovered by the probes, scientists wouldn’t know what the conditions are and therefore wouldn’t be equipped to consider human exploration. The space probes we have sent out have taken many years in some instances to travel into space and are not destined to return to Earth. Therefore, it has not been appropriate to send humans with them.

Evaluate and create

5 What sort of knowledge about our bodies has been discovered as a result of sending astronauts to the space station?

Student answers will vary.

6 What is the benefit of having an International Space Station?

Scientific research is done on the International Space Station in biology, physics, astronomy and meteorology, with the long-term goal being to develop the technology needed for humans to explore and colonise space and the planets.

Review 8

Student book answers (pages 152–153)

Remember and understand

1 Who was Sir Isaac Newton?

Isaac Newton was a young student who first had the idea of gravity.

2 What is the difference between mass and weight?

The difference between mass and weight is that mass is a measure of how much matter an object contains and weight is a measure of the gravitational force (or pull) acting on an object. The mass of an object never changes no matter where it is and how strong or weak gravity is. Weight is affected by gravity.

3 Why did many people originally think the Sun moved around the Earth?

During the day we see the Sun move across the sky so it was natural to think the Sun moved around the Earth.

4 Who was Nicholas Copernicus?

Nicolas Copernicus was a 16th century Polish astronomer who considered that instead of the Sun travelling around the Earth, the Earth travelled around the Sun.

5 What is a gravitational field? How does the gravitational field of the Sun affect the planets?

A gravitational field is the space around any object with mass where other objects are attracted towards it. This gravitational field is really only relevant in the space around very, very large masses, such as our Earth, Sun and the other planets, but all masses have gravity.

6 Your mass at a given time remains the same, regardless of gravity. Your weight, however, changes as a result of gravity.

a Why isn’t the mass of any object changed by gravity?

The mass of an object is not changed by gravity because the mass depends on how much matter an object has. The only way to change an object’s mass is to add more matter to it or to remove some of the matter.

b Why does the weight of an object sometimes change?

The weight of an object is dependent on the strength of gravity and its mass. If the strength of gravity changes, the weight of the object will also change.

7 Why was the Catholic Church upset by Galileo’s claims in the 17th century?

The Catholic Church at the time preferred to consider that humankind was the centre of the universe.

Apply and analyse

8 Our Sun is part of a spiral galaxy that is spinning. Why might scientists think there is a heavy object in the centre of the galaxy?

Student answers will vary. Typically, a heavy object in the centre of the galaxy would have sufficient gravity to keep the stars spinning around it.

9 Imagine life on the Moon. Write a paragraph describing how your day would have been different if you lived on the Moon. Which actions would be easier? Which actions would be harder or impossible?

Student answers will vary, but they should write something about how less gravity would make movements like jumping easier and putting something on the ground, for example, near impossible.

Evaluate and create

10 When sky divers step out of an aeroplane they begin to fall towards the Earth. What causes this?

The downward fall of skydivers after exiting the plane is caused by the gravitational pull of the Earth.

11 Why would animals and plants living near a high tide mark need to be more resilient than those living near a low tide mark?

Animals and plants living near a high tide mark would need to be more resilient than those living near a low tide mark because they wouldn’t be covered with water for as long as those near the low tide mark. They would suffer being dried out and exposed to the Sun much more than those near the low tide mark.

12 An adult male elephant has a mass of 7000 kg. Predict the mass of the elephant if it were:

a in your bedroom

b on top of Mt Everest

c on the Moon

d swimming in the ocean

Mass doesn’t change, therefore the mass of an adult male elephant that is 7000 kg would still be 7000 kg in all four locations. (However, weight does depend on location and the strength of gravity at each location.)

13 You are slightly shorter at the end of the day than when you wake up in the morning. In a small group, design an experiment to test this hypothesis. Conduct the test over a series of days. Compile your results and compare your group’s results with those of other groups in the class. As a group, come up with a conclusion for this experiment that draws on your knowledge of gravity.

a Was your hypothesis supported by the results?

b Did your group work well together?

c How would you change your experiment next time?

d Evaluate your own contribution to this experiment and give yourself a score out of 5 (5 being ‘excellent’, 1 being ‘needs improvement’) for:

i group cooperation

ii listening to other members of the group

iii being reliable

iv doing your homework.

Student answers will vary, but they should be measuring the height of the participants in the morning and again in the afternoon or evening.

14 Write a creative short story called ‘A day without gravity’. You might begin by listing the main activities in your day, then considering how they are affected by gravity. Incorporate as many examples into your story as possible.

Student answers will vary.

15 How is gravity responsible for the Earth’s interactions with the Sun and Moon? How important is this effect of gravity on the ability of the Earth to support life? How have modern technologies improved our understanding of the effects of gravity?

Gravity is responsible for keeping the Earth and the other planets in their orbits around the Sun and for keeping the Moon in its orbit around the Earth. This effect is critical for the ability of the Earth to support life because the orbit of the Earth around the Sun creates the seasons and Earth’s daily rotation gives us day and night. These interactions provide solar energy to the Earth, giving us both heat and light. Without this energy, the Earth would be frozen and unable to support life.

Modern technologies have improved our understanding of the effects of gravity by studying how things operate without much gravity. Astronauts have geminated seeds, grown crystals and studied both bone and blood in orbit, giving us more information about gravity and its effects.