Student book answers

7.1 Displacement is change in position with direction

Pages 156–157

Check your learning 7.1

Remember and understand

1 Describe a motion that has zero displacement.

A motion that has zero displacement is any journey where the final location is the same as the initial location.

2 What is the difference between displacement and distance?

Displacement is where the object is located in relation to its starting point. Distance is how far an object moves.

Apply and analyse

3 An object moves 14 metres north and then 14 metres south. What distance has it covered? What is its displacement?

The object has covered a distance of 28 metres and has a displacement of 0 metre.

4 What is the difference between a vector quantity and a scalar quantity?

A vector quantity has size/magnitude and direction, whereas a scalar quantity has size/magnitude only.

5 A person runs 50 metres north, then 20 meters south and then 30 metres west. What is the total distance covered? What is the person's displacement?

The distance covered is 100 metres, and the displacement is 42.4 metres at a bearing of 31° true (or north 45° west).

6 A car starts from rest (stationary) and moves north at a constant rate for 400 metres, then stops for 10 seconds before moving north for another 150 metres. On a piece of paper, draw this movement as a position–time graph.

Students will draw a position–time graph.

7 Consider the graph in Figure 7.3.

a Describe the motion shown.

The object is 20 metres away to the north and stationary for 8 seconds. It then moves south a distance of 20 metres in 4 seconds (speed of 5 metres per second).

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b What is the distance covered in the graph?

20 metres

c What is the displacement shown?

20 metres south

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Student book answers

7.2 Velocity is speed with direction

Pages 158–159

Check your learning 7.2

Remember and understand

1 Is 4 m/s a speed or velocity? Explain your answer.

It is a speed as no direction is provided.

2 Use the average velocity triangle to write the three different formulas.

$d = v_{av} \times t$; $v_{av} = d/t$; $t = d/v_{av}$

3 What does the gradient of a position–time graph indicate?

The speed of an object

4 What does the area under a velocity–time graph indicate?

The distance travelled by the object

Apply and analyse

5 What other units do you know that are used to measure speed?

Kilometres per hour, miles per hour

6 Convert 80 km/h to metres per second.

22 m/s

7 An object travels 40 km in 5 hours. What is its average speed?

8 km/h or 2.22 m/s

Evaluate and create

8 Create a story that describes the motion of a person moving according to the graph in Figure 7.11. Describe their displacement from the point of origin.

Student's answers will vary.

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Student book answers

7.3 Acceleration is change in velocity over time

Pages 160–161

Check your learning 7.3

Remember and understand

1 Use the acceleration triangle to write the three different formulas.

$a = \Delta s/t$; $t = \Delta s/a$; $\Delta s = a \times t$

2 What is meant by the term 'deceleration'?

Deceleration is the rate of decrease in speed or how quickly the object slows down.

3 What is the acceleration of an object if its velocity is constant?

Zero

Apply and analyse

4 Describe the motion of an object with the speed–time graph shown in Figure 7.19.

The object has a constant rate of deceleration from an initial speed to rest.

5 An object starts from rest and accelerates at a rate of 4 m/s^2. State its speed after each second for 5 seconds.

Speed at: 1 s = 4 m/s; 2 s = 8 m/s; 3 s = 12 m/s; 4 s = 16 m/s; 5 s = 20 m/s

6 What do accelerating and decelerating objects have in common?

Both objects are changing speed or acceleration.

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Student book answers

7.4 An object in motion remains in motion until a force acts on it

Pages 162–163

Check your learning 7.4

Remember and understand

1 What is meant by the term ‘net force’?

Net force is the overall effect of all the forces acting on an object.

2 What happens to a stationary object with zero net force acting on it?

It will remain stationary.

3 What happens to a moving object with zero net force acting on it?

It will remain moving in a straight line at the same speed.

4 What is inertia?

A resistance to change in motion.

Apply and analyse

5 Give an example of how inertia affects your motion inside a car, bus, tram or train?

Students’ answers will vary.

6 Why do people lurch backwards in a tram when it starts moving suddenly?

People to not move backwards. Instead, their feet move forwards due to the friction with the floor of the tram, while their head remains still. This feels like lurching backwards.

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7.5 Force equals mass × acceleration

Pages 164–165

Check your learning 7.5

Remember and understand

1 What is meant by the term ‘weight force’?

The force of attraction of the Earth on a mass

2 What happens to a moving object if it is acted on by a net force in the same direction as its motion?

Its velocity will increase.

3 What happens to a moving object if it is acted upon by a net force in the opposite direction to its motion?

It velocity will decrease.

Apply and analyse

4 How does the acceleration of a bus full of passengers compare with that of an empty bus for the same net force?

A bus full of passengers will accelerate slower than an empty bus.

5 Why does a bike slow down on a level road when the rider stops pedalling?

The friction between the road and the bike pushes in the opposite direction to the motion. This slows the bike down.

6 A net force causes a mass of 10 kg to accelerate at 2 m/s^2. What is the magnitude of the net force?

20 N

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Student book answers

7.6 Each action has an equal and opposite reaction

Pages 166–167

Check your learning 7.6

Apply and analyse

1 A person pushes forwards on an object with a force of 30 N. What reaction force acts on the person?

30 N

2 A boy of weight 500 N sits on a chair. What reaction force acts on the boy?

500 N

3 In space, an astronaut pushes on another astronaut with a force of 80 N. What is the reaction force in this case? Why might the second astronaut have a higher acceleration than the first astronaut?

Reaction force is 80 N. If the second astronaut has a lower mass, then their acceleration will be higher.

4 Identify the action–reaction pair when a sprinter uses a set of starting blocks for the start of a sprint race.

The sprinter pushing against the blocks is the action force. The blocks pushing on the sprinter is the reaction force.

5 Identify the action-reaction pair when a softball player hits a home run.

The ball exerts an action force on the bat, and the bat exerts a reaction force on the ball.

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Student book answers

7.7 Momentum is conserved in a collision

Pages 168–169

Check your learning 7.7

Remember and understand

1 What are the units of momentum?

kg m/s or Ns

2 What is the law of conservation of momentum?

In a collision, the total momentum of the objects is conserved.

Apply and analyse

3 Use the momentum triangle to write the three different formulas.

$P = m \times v$; $m = P/v$; $v = P/m$

4 Is it harder to stop a cricket ball or a tennis ball travelling at the same velocity? Why?

A cricket ball has more mass, and therefore more momentum than a tennis ball. Therefore, it is harder to stop a cricket ball.

5 Is it harder to stop a fast-moving tennis ball or a slow-moving tennis ball? Why?

It is harder to stop a fast-moving tennis ball because, despite having the same mass, the fast-moving tennis ball will have more momentum and therefore a larger force is required to reduce its momentum.

6 If a 600 kg golf cart is travelling at 0.8 m/s, what is its momentum?

480 kg m/s

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Student book answers

7.8 Work occurs when an object is moved or rearranged. Energy can be calculated

Pages 170–171

Check your learning 7.8

Remember and understand

1 When is the scientific term ‘work’ done?

‘Work’ is done when a force causes the movement or deformation of an object.

2 Use the work triangle to write the three different formulas.

$W = F \times d$; $F = W/d$; $d = W/F$

Apply and analyse

3 How much work is done if a force of 200 N moves an object 6 m?

1200 J

4 How much work is done if a force of 400 N is applied to a heavy object and it doesn’t move?

No work is done if there is no displacement.

5 How is the kinetic energy of an object affected if its mass decreases and the other variables remain constant?

If mass decreases, its kinetic energy decreases in proportion to the mass.

6 How is the gravitational potential energy of an object affected if its height increases and the other variables remain constant?

If the height of an object increases, its gravitational potential energy increases in proportion to the height.

7 How is the elastic potential energy of an object affected if its stiffness increases and the other variables remain constant?

If the stiffness of an object increases, its elastic potential energy increases in proportion to the stiffness.

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Student book answers

7.9 Energy is always conserved

Pages 172–173

Check your learning 7.9

Remember and understand

1 Explain the law of conservation of energy, using an example of your own.

Energy cannot be created or destroyed. Students' examples will vary.

2 What is waste energy?

The transfer of energy is never 100% efficient. The energy that becomes non-useful heat energy is called waste energy.

Apply and analyse

3 Some people claim energy is lost. Do you agree? Justify your answer using the law of conservation of energy.

The law of conservation of mass states that energy cannot be created or destroyed. This means energy cannot be lost.

4 Describe the conservation of energy that occurs when you use a slinky.

When energy is added to a slinky by stretching it, the energy is stored in the slinky. This energy becomes movement energy that returns the slinky to its original shape.

5 The following statements are incorrect. Rewrite them to make them correct.

a The energy efficiency of all systems is always 100%.

The transformation of energy is never 100% efficient and results in waste energy.

b The law of conservation of energy doesn't always apply.

The law of conservation of energy always applies.

c Pendulums always return to their original height.

Waste energy in a pendulum causes a loss of height with each swing.

d A roller coaster rolling down a ramp will stop at the bottom of the ramp.

A roller coaster at the top of a ramp has gravitational potential energy. As it rolls down the ramp, the gravitational potential energy is converted into kinetic energy that causes the roller coaster to keep moving at the bottom of the ramp.

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Student book answers

7.10 Car safety features require an understanding of Newton's laws and momentum

Pages 174–175

Extend your understanding 7.10

1 Which of Newton's laws are used in the design of seatbelts? Explain your answer.

Newton's second law is used in the design of flexible seatbelts ($F = ma$). A seatbelt that flexes allows more time for the passenger to decelerate, and therefore experiences less force/impact.

2 Which has more momentum; a 5000 kg car travelling at 40 km/h, a 20 000 kg truck travelling at 2 km/h, or a 80 kg minibike travelling at 80 km/h. Provide evidence to support your answer.

Car momentum = 200 000 kg km/s; truck momentum = 40 000 kg km/h; minibike momentum = 6 400 kg km/h; therefore, the car has the greatest momentum.

3 Some early kombi vans had no crumple zone. Instead, drivers were encouraged to store their spare tire at the front of the car. Use Newton's laws to suggest a possible reason for this advice.

A spare tire at the front of the kombi van allows more time for the car to decelerate, and therefore experiences less force/impact.

4 Australasia's New Car Assessment Program (ANCAP) is an independent vehicle safety advocate that tests new cars and advises the public on the safety of their cars. Research what features cars need to achieve a five-star rating. Choose one of these features and apply Newton's laws to explain why this feature increases the safety of the passengers.

Students' answers will vary.

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Review 7

Pages 176–177

Remember and understand

1 Match each word in the left column with its correct meaning in the right column.

vector	speed of an object at a moment in time
average velocity	measures how an object's speed changes
average speed	slope of a graph
acceleration	graph where speed is plotted against time
distance	quantity that has magnitude and direction
instantaneous speed	calculated by dividing distance by time
gradient	measures how far an object has travelled
speed–time graph	calculated by dividing displacement by time

Vector – quantity that has magnitude and direction

Average velocity – calculated by dividing displacement by time

Average speed – calculated by dividing distance by time

Acceleration – measures how fast an object's speed changes

Distance – measures how far an object has travelled

Instantaneous speed – speed of an object at a moment in time

Gradient – slope of a graph

Speed–time graph – graph where speed is plotted against time

2 What happens to an object's speed if it travels with zero acceleration?

The speed will not change.

3 What happens to an object's speed if it travels with constant deceleration?

The speed will decrease by the same amount every second.

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4 Which of the following statements are true and which are false?

A A force will only change an object's speed.

False – an unbalanced force can change an object's speed and/or direction.

B A force is always needed to keep an object in motion.

False – an object will remain in motion until an unbalanced force is applied.

C The quantity of weight is measured in kilograms.

False – weight is measured in newtons.

D A force has magnitude and direction, making it a vector. True

E Acceleration increases if the net force increases and the mass is kept constant. True

F A stationary object can have several forces acting on it. True

G Mass is a measure of how much space an object occupies.

False – mass is a measure of how much matter is inside an object.

5 Show, using the formula for kinetic energy, that if speed is doubled the energy of a car crash would be four times as high.

KE = ½ × m × v^2. If the velocity is doubled, then 2^2 equals 4; as the KE is proportional to v^2, it will be 4 times greater. This can also be shown by inserting numbers and showing that the KE is 4 times greater.

Apply and analyse

6 A car is driven along a straight road. Starting from rest, it takes 10 seconds of steady acceleration for the car to reach a speed of 20 m/s. The car cruises for 60 seconds at 20 m/s, before slowing down to a halt over a period of 30 seconds.

a What is the maximum speed of the car in km/h?

Maximum speed of car = 72 km/h

b Plot a speed–time graph for the car using SI units.

Students will draw a speed–time graph.

c Use the graph to calculate the distance moved in metres and then in kilometres.

Distance moved = 1600 m or 1.6 km

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7 Figure 7.41 shows a rear-end car crash between two dodgem cars. Before the collision, the green car had a velocity of 2.2 m/s and a mass of 140 kg. The blue car had a velocity of 1.7 m/s and a mass of 160 kg.

a Calculate the momentum of each of the two dodgem cars before the collision.

Momentum of green car = 31 080 kg m/s

Momentum of red car = 26 720 kg m/s

b Calculate the total momentum of the two dodgem cars before the collision.

Total momentum of two cars = 57 800 kg m/s

c Calculate the velocity of the two dodgem cars after the collision.

Velocity of two cars = 19.3 m/s (69.4 km/h)

Evaluate and create

8 On a wet Monday morning, a school bus that has to travel 24 km leaves its starting place at 7.35 am and only manages an average speed of 36 km on its trip to school. There is a clear section of the highway when the bus has a speed of 74 km/h. The bus then does various runs during the day and arrives back at school in time to depart at 3.45 pm. It arrived back at exactly at its starting point at 4.25 pm.

a What is the displacement of the bus between 7.35 am and 4.45 pm?

Displacement of bus = 0 metre

b At what time did the bus arrive at school?

The bus will arrive at school at 8.15 am. (The journey takes 40 minutes.)

c What is the average speed of the bus?

Average speed of the bus = 48 km/h

d The bus's average speed on the way to school is 36 km/h, but on one stretch the bus moves at 74 km/h. Use this data to explain the difference between 'average speed' and 'instantaneous speed'.

Average speed is the entire distance travelled divided by the total time. It is a measure of the speed of an object completing this journey at a constant pace. Instantaneous speed is the speed at any moment in time.

9 Renee catches a softball.

a What is the action?

The action force is Renee's hand pushing on the ball.

b What does the action do?

The action force decelerates the ball.

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c What is the reaction?

Reaction force is the ball pushing on Renee's hand.

d What does the reaction do?

The reaction force accelerates Renee's hand backwards.

10 What mass object would accelerate at 3.5 m/s^2 under the influence of a net force of 70 N?

Mass = 20 kg

11 Calculate the acceleration of a 500 g object under the influence of a net force of 500 N.

Acceleration = 1000 m/s^2

Critical and creative thinking

12 Some objects or devices require high accelerations that are many times greater than 9.8 m/s^2, the acceleration due to gravity. Think of an object or device in this category. Does it have an engine or some other propulsion mechanism? What fuel does it use? How does this enable it to achieve such a high acceleration?

Students' answer will vary.

13 Design a poster that explains each of Newton's three laws. Give a detailed example that illustrates each law and is not already mentioned in the text.

Students' answers will vary.

14 Motion is the result of forces acting in different directions. Describe the forces you believe to be acting when an object is stationary, moving, accelerating and changing direction. Which forces are always acting?

Students' answers will vary. Gravity is always acting.

15 Identify the safety features of the car shown in Figure 7.42. Which safety features are missing?

The safety features present include a seatbelt and crumple zone. Those safety features missing are the front and side airbags. In addition, the front windshield pillar frame seems to have failed.

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Research

16 Choose one of the following topics for a research project. Some questions have been included to help you begin your research. Present your report in a format of your own choosing.

Car safety features

Modern cars may be equipped with electronic stability control (ESC), anti-lock braking systems (ABS), electronic brake distribution (EBD), RVC tachometers, traction control systems (TCS) and park assist. Find out about each of these and other car safety features under development. How do they contribute to the safety of passengers?

***g*-forces**

Aircraft pilots flying military jets and those in the Red Bull Air Race commonly experience *g*-forces. A ride at Luna Park is called '*g*-force'. When do pilots experience *g*-forces? What is the human tolerance of *g*-forces and what effect do they have on the body? What other examples are there of theme park rides or situations where people experience *g*-forces?

Movement of aircraft

Aircraft are the second fastest mode of transport, after rockets. Find out about the different types of aircraft and how they move. Explain the interactions between lift, weight, thrust and drag in aircraft movement. What speeds can aircraft attain?

Students' answers will vary.

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