### 7.3.1 Speed

101 minutes

128 marks

Alison has a car. The part of each tyre in contact with the road is flattened.
This is shown in the diagram.

(a) When Alison gets into the car, the force on each tyre increases.

What happens to the area of tyre in contact with the road?
$\qquad$
$\qquad$
1 mark
(b) There is a leak of air from one of the tyres, and the air pressure in the tyre falls. What happens to the area of the tyre in contact with the road?
$\qquad$
$\qquad$
(c) The weight of the car is 8400 N . Each tyre supports a weight of 2100 N . The pressure exerted by each tyre on the road is $20 \mathrm{~N} / \mathrm{cm}^{2}$. Calculate the area of each tyre in contact with the road.
$\qquad$
$\qquad$ $\mathrm{cm}^{2}$
1 mark

Alison goes for a drive on three different days.
(d) Write the missing values in the table.

| day | distance <br> travelled in $\mathbf{k m}$ | time taken in <br> hours | average speed in <br> $\mathbf{k m} / \mathbf{h}$ |
| :---: | :---: | :---: | :---: |
| Monday | 32 | 0.8 |  |
| Wednesday | 8 |  | 16 |
| Friday |  | 2.0 | 70 |

(e) Explain why the calculated car speeds are averages.
$\qquad$
$\qquad$
1 mark Maximum 7 marks

Q2. The graph shows the results of a test in which a car accelerates to its maximum speed.

(a) (i) Describe how the acceleration of the car changes after the car has started to move.
$\qquad$
$\qquad$
(ii) How does the resultant force on the car change?
$\qquad$
$\qquad$

The car has a mass of 1000 kg and the maximum forward force on the car, produced by the engine, is 4000 N .

It is claimed that the car will accelerate from 0 to $24 \mathrm{~m} / \mathrm{s}$ in 6 seconds.
(b) Use calculations, with the correct units, to show that the claim is false.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$

Q3. A spinning mirror can be used to measure the speed of light. The experiment is shown below.


Ray 1 is incident on the spinning mirror.
Ray 2 is the reflection of ray 1 from the spinning mirror.
Ray 3 is the reflection of ray 2 from a small fixed mirror 2.0 m away. It travels back along the same path as ray 2.
(a) Describe how the small fixed mirror is positioned so that the light is reflected back along the same path.
$\qquad$
$\qquad$

When ray 3 reaches the spinning mirror, it is again reflected to form ray 4 . Its path is very close to ray 1 and therefore it has not been drawn on the diagram. Much less light travels along ray 4 than along ray 1 .
(b) Suggest one reason why less light travels along ray 4 than along ray 1.
$\qquad$
$\qquad$

Ray 4 does not travel back along exactly the same path as ray 1 because the spinning mirror has moved between the two reflections.
(c) The spinning mirror rotates 40 times per second.
(i) How long does it take to turn through an angle of $1^{\circ}$ ?

Give the correct units.
$\qquad$
$\qquad$
(ii) The mirror is found to have turned through an angle of $0.0002^{\circ}$ between the two reflections. What is the time interval between the reflections? Give the correct units.
$\qquad$
$\qquad$
(d) The distance between the fixed mirror and the spinning mirror is 2.0 m . What value does this experiment give for the speed of light? Show your working and give the correct units.
$\qquad$
$\qquad$
$\qquad$
$\qquad$

Digital information can be stored on magnetic recording tape in several different ways. One way is shown in the diagram below.


The recording head produces a magnetic field. The magnetic particles in the section of tape under the recording head line up with the field.
(a) As the tape moves past the recording head, different sections of the tape become magnetised. The direction of the current is changed at regular intervals.

How would the pattern on the tape be different if the tape were moved past the recording head more quickly?
$\qquad$
$\qquad$
(b) The direction of the current is changed at regular intervals. The tape is moved past the recording head at a steady speed.

The gap between the poles of the recording head is made much bigger. Suggest two effects this might have on the pattern on the tape.

1 $\qquad$
$\qquad$

2 $\qquad$
$\qquad$
2 marks
Maximum 3 marks

Q5. The graph shows the speed of a ball as it falls from a height and bounces from the floor.

(a) The ball starts to fall and speeds up until it hits the floor.
(i) For how many seconds does the ball fall before it first hits the floor?
$\qquad$
(ii) Calculate the average speed of the ball during its fall.
$\qquad$
$\qquad$
(iii) Calculate the height above the floor from which the ball was dropped.
$\qquad$
$\qquad$
(b) (i) What is happening to the ball in the time between points A and C on the graph?
$\qquad$
$\qquad$
(ii) In which direction is the ball moving between points C and D ?
$\qquad$
(c) Calculate how high the ball bounces back up from the floor.
$\qquad$
$\qquad$
(d) How long after the ball was dropped would you expect it to hit the floor for the second bounce?
$\qquad$
$\qquad$

Q6. (a) The 'two second rule' is a rule for car drivers. The rule is as follows:
'Leave enough space between you and the vehicle in front so that you can pull up safely if it suddenly slows down or stops... A two second time gap may be sufficient... Use stationary objects (eg lamp-posts) to help you keep a two second gap.'
(The Highway Code, 1993)

(i) The traffic is moving at $20 \mathrm{~m} / \mathrm{s}$, and a driver is keeping to the 'two second rule'. What is the distance between the driver and the car in front?
$\qquad$
$\qquad$
(ii) The traffic increases its speed to $25 \mathrm{~m} / \mathrm{s}$, but the driver stays the same distance from the car in front.
She sees the car in front pass a lamp post.
How long will it take her to reach the same lamp post?
$\qquad$
$\qquad$
(b) The driver decides to check her speedometer while driving along a motorway.

She measures how long it takes her to travel 6 km . It takes her exactly 4 minutes.
What was her speed in $\mathbf{k m} / \mathbf{h}$ ? Show your working.
$\qquad$
$\qquad$
$\qquad$ km/h

Q7.


A bell in a church tower is attached to a wheel of radius 0.8 m . The bell is balanced upside down. The bell-ringer pulls the rope with a force of 50 N .
(a) Calculate the moment (turning effect) on the wheel. Give the unit.
$\qquad$
$\qquad$
(b) The bell turns. When the rope is travelling at its highest speed, it moves 0.5 m in 0.04 s . What speed is this? Give the unit.
$\qquad$
$\qquad$
(c) The bell rings twice but the second ring is quieter than the first. Both rings have the same pitch.

Complete the sentences below to compare the two rings.
The amplitude of the second ring was $\qquad$ the amplitude of the first ring.

The frequency of the second ring was $\qquad$ frequency of the first ring.

2 marks
(d) The sound of a bell is within the audible range of most people.

Which is most likely to be the frequency of the sound made by a bell?
Tick the correct box.


1 mark
(e) The energy given out when the bell rings was originally stored in the bell-ringer.

Describe the main sequence of useful energy transfers which take place when a bellringer rings a church bell.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$

On 11th August 1999 there will be an eclipse. The shadow of the Moon will pass over part of the Earth.
(a) The diagram below shows the Moon, the Moon's shadow and the Earth.

not to scale
On the diagram, draw an arrow pointing towards where the Sun must be.
(b) At about midday the Moon's shadow will pass over Cornwall in England.

Where, in the sky, is the Sun at midday?
Tick the correct box.
towards the North

towards the East

towards the South $\square$
(c) The map shows the shape of the Moon's shadow and the path it will take across Cornwall.


The Moon's shadow will take about 2 minutes to move across a house in Falmouth. It will take less than 2 minutes to move across a house in Padstow.

Explain why it will take less time for the Moon's shadow to move across a house in Padstow than to move across one in Falmouth.
$\qquad$
$\qquad$
(d) Why does the Moon's shadow move over the surface of the Earth?
$\qquad$
$\qquad$
1 mark

Q9. The diagram shows a boat using an echo sounder. It sends a pulse of sound waves which is reflected from the sea bottom. The reflected sound waves are detected by a sensitive microphone.


The time between sending and receiving the pulse is 0.005 s . The device calculates the depth of the sea, using the speed of sound in sea water, which is $1500 \mathrm{~m} / \mathrm{s}$.
(a) Calculate the depth of the sea. Show your working.
$\qquad$
$\qquad$
$\qquad$
(b) The boat moves into very deep water. Explain why the reflected pulse is too weak to be detected.
$\qquad$
$\qquad$
(c) The boat's 'echo sounder' could not be used in an aeroplane to measure its height above the ground unless it had been modified.

Explain why the device will not give correct heights above the ground.
$\qquad$
$\qquad$

Q10. Speed cameras are used to detect motorists who break the speed limit. A number of lines 2 m apart are painted on the road. As a speeding car crosses the painted lines, the camera takes two photographs, 0.5 s apart.

(a) (i) How far did the car move between the two photographs?

Give the correct unit.
$\qquad$
$\qquad$
1 mark
(ii) How fast is the car in the photographs moving?
$\qquad$
m/s
1 mark
(b) It takes 0.0002 s to take each photograph.

How far does the car move while the speed camera is taking one photograph?
$\qquad$
(c) The speed camera gives out bright flashes to provide enough light for the photographs.

How does the light from the flash get back to the camera to produce the photographs?
$\qquad$
$\qquad$

Q11. The diagram shows the Sun and the orbits of the five inner planets.
The distances (but not the sizes of the Sun and Jupiter) are to scale.

(a) On the diagram, draw a dot to show the Earth's position when Earth and Jupiter are moving parallel to each other and in the same direction. Label the dot E .
(b) As Jupiter moves in its orbit, it appears to move across the pattern of stars in the background.
When Jupiter and the Earth are moving parallel to each other, Jupiter appears to move backwards across the pattern of stars. Explain why.
$\qquad$
$\qquad$
(c) The light from the Sun takes about 8.3 minutes to reach the Earth.

Using the diagram above, estimate how long it takes for light to travel from Jupiter to the Earth when they are the shortest possible distance apart. Show your working.
$\qquad$
$\qquad$
$\qquad$

Q12. A video recorder is loaded with a tape which plays for 180 minutes.
The length of the tape is 260 m .
(a) (i) Calculate the speed of the tape, in metres per minute.
$\qquad$
$\qquad$
(ii) What is the speed of the tape in metres per second?
$\qquad$
(b) To rewind the tape quickly, a different motor is used, which rewinds the tape at a maximum speed of $1.08 \mathrm{~m} / \mathrm{s}$.
(i) At this speed, how long would it take to rewind the tape completely? Give the units.
$\qquad$
$\qquad$
(ii) In fact, it takes slightly longer than this to rewind the tape. Explain why.
$\qquad$
$\qquad$
1 mark Maximum 4 marks

Q13. The graph shows how the speed of a 0.1 kg mass changes as it falls.

(a) Read from the graph the speed of the mass at 0.4 s and 0.8 s . Use your results to work out the average speed of the mass between 0 and 0.4 s and then between 0 and 0.8 s . Give the units.
(i) final speed at $0.4 \mathrm{~s}=$ $\qquad$
average speed between 0 and $0.4 \mathrm{~s}=$ $\qquad$
(ii) final speed at $0.8 \mathrm{~s}=$ $\qquad$
average speed between 0 and $0.8 \mathrm{~s}=$ $\qquad$
(b) Using the average speeds calculated in (a), work out how far the mass falls in:
(i) 0.4 s
$\qquad$
(ii) 0.8 s
$\qquad$
(c) Complete the sentence:

If the mass falls for double the time, it will fall $\qquad$
times as far
1 mark
Maximum 5 marks

Q14. A remote-controlled car was timed over a period of 10 seconds. A graph of distance against time is shown below.

(a) Describe the motion of the car between:
(i) 2 seconds and 6 seconds;
$\qquad$
(ii) 9 seconds and 10 seconds.
(b) Calculate the average speed of the car between 0 and 10 seconds. Give the unit.
$\qquad$
$\qquad$
(c) The diagram below shows two of the forces acting on the car when it is moving.

(i) When the motor was switched off, the car slowed down and then stopped.

While the car was slowing down, which of the following was true? Tick the correct box.

Friction was zero and the forward force was greater than zero.


The forward force was zero and friction was greater than zero.


Friction was zero and the forward force was zero.


The forward force and friction were both greater than zero.

(ii) Use the graph to find the time when the car started to slow down.

The car started to slow down after $\qquad$ s.

Q15. Thunder and lightning happen at the same time.
(a) We see the flash of lightning before we hear the thunder.

Give the reason for this.
$\qquad$
$\qquad$
(b) Omar investigated the movement of a storm. He measured the time between seeing a flash of lightning and hearing the thunder.
He did this six times. Omar put his results in a table.

| flash of <br> lightning | time between seeing the <br> lightning and hearing the <br> thunder, in seconds |
| :---: | :---: |
| A | 8.0 |
| B | 5.0 |
| C | 3.0 |
| D | 9.0 |
| E | 13.0 |
| F | 16.5 |

Omar drew a bar chart of his results as shown below.

(i) On the bar chart, draw a bar for flash D. Use a ruler.
(ii) Which flash of lightning was closest to Omar? Give the correct letter.
$\qquad$
(iii) Describe how the distance between the storm and Omar changed as the storm moved between flash A and flash F.
$\qquad$
$\qquad$
1 mark
Maximum 4 marks

Q16. (a) Megan was doing time-trials on her bike around a 400 metre horizontal track.
(i) She took 32 seconds to travel 400 m .

What was her average speed? Give the unit.
$\qquad$
$\qquad$
(ii) Compare the forward force on the bike with the backward force on the bike when Megan was travelling at a constant speed.
$\qquad$
$\qquad$
(b) Megan then crouched down over the handlebars to make herself more streamlined, as shown below.
She continued to pedal with the same force as before.


Compare the forward and backward forces on Megan and her bike now.
$\qquad$
$\qquad$

Explain your answer.
$\qquad$
$\qquad$
maximum 4 marks

Q17. (a) Nicola is trying out her new roller blades. Robert is pulling her along with a rope. Arrows A, B, C and D show the directions of four forces acting on Nicola.

(i) Which arrow shows the direction of the force of gravity on Nicola? Give the letter.
$\qquad$
(ii) Which arrow shows the direction of the force of the rope on Nicola? Give the letter.
$\qquad$
1 mark
(b) Robert pulls Nicola at a steady speed of 2 metres per second. How far will Nicola travel in 10 seconds?
$\qquad$ metres
(c) Nicola lets go of the rope and she slows down. Gravity still acts on Nicola.

Give the name of one other force still acting on Nicola after she lets go of the rope.
$\qquad$
1 mark
maximum 4 marks

Q18. Three pupils took part in an investigation into the speed of sound. All three pupils stood 1020 m from an explosion.


- Sylvia wore a blindfold.
- Paul wore ear defenders.
- James wore a blindfold and ear defenders. He rested his head on a wooden stick pushed into the ground so that he could feel vibrations.

The explosion produced sound and light at the same time.
The table shows the speed of sound in two different materials.

| material | Speed of sound (m/s) |
| :---: | :---: |
| air | 340 |
| soil | 3200 |

(a) Use all the information above to help you answer parts (i) and (ii) below.
(i) In which order would the pupils notice the explosion?
first $\qquad$
second $\qquad$
third $\qquad$
1 mark
(ii) From the information given, calculate the time it would take for the sound to travel through the air to Sylvia.
$\qquad$
s
(b) Another pupil, Nasah, stood 2000 m away from the explosion.
(i) The sound heard by Nasah was quieter than the sound heard by Sylvia. The further sound travels the quieter it becomes. Give the reason for this.
$\qquad$
$\qquad$
(ii) The oscilloscope trace below represents the sound Sylvia heard.


Sylvia


Nasah

The sound Nasah heard was quieter but the pitch was the same.
On the right-hand grid, draw the trace to show the pattern of the sound Nasah heard.

2 marks
maximum 5 marks

Q19. The drawing shows a snow-buggy being pulled by a sail.
The buggy rests on three skis on the snow.

(a) The drawing shows four forces that act when the snow-buggy is moving.

Draw a line from each force in the list below to the correct letter from the diagram.
Draw only three lines.

(b) A scientist travelled 80 kilometres (km) each day in the buggy.

How many kilometres did he travel in 10 days?
$\qquad$ km
1 mark
(c) The buggy carried the scientist, food and equipment for the journey.

The table shows how the total mass changed.

|  | total mass at start of <br> journey (kg) | total mass at end of <br> journey (kg) |
| :---: | :---: | :---: |
| mass of buggy, scientist, <br> food and equipment | 295 | 130 |

The buggy sank deeper into the snow at the start of the journey than at the end.
Why did it sink deeper at the start? Use the table to help you.
$\qquad$
$\qquad$
(d) The buggy rests on three skis instead of three wheels.

Why are skis better than wheels for travelling on snow?
$\qquad$
$\qquad$
1 mark
(e) When a bigger sail is used, the buggy goes faster.

How does a bigger sail help the buggy to go faster?
$\qquad$
$\qquad$

Q20. The drawing below shows a space buggy on the surface of Mars.

(a) The distance between Earth and Mars is 192000000 km .

It took a spacecraft 200 days to take the buggy from Earth to Mars.
Calculate the speed at which the spacecraft travelled.
Give the unit.
$\qquad$
$\qquad$
(b) The weight of the buggy was 105 N on Earth and 40 N on Mars.

Why was the weight of the buggy less on Mars than on Earth?
$\qquad$
$\qquad$
(c) The buggy uses solar panels to generate electrical energy.

The solar panels generate less electrical energy on Mars than on Earth.
Give a reason why.
$\qquad$
$\qquad$
(d) The weight of the buggy was 40 N on Mars.

When the buggy landed on Mars it rested on an area of $0.025 \mathrm{~m}^{2}$.
Calculate the pressure exerted by the buggy on the surface of Mars.
Give the unit.
$\qquad$
$\qquad$
(a) Satish poured some water into a long tank in the school laboratory. He used a plunger at one end to make a wave.

(i) The wave travelled to the other end of the tank.

The speed of the wave was $2 \mathrm{~m} / \mathrm{s}$.
How long did the wave take to travel to the other end?
$\qquad$
$\qquad$
(ii) Satish investigated how the depth of water in his tank affected the speed of the waves.
Write a plan to show how he could do this.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(b) Satish found the following information about waves in the sea.

| depth of sea water <br> $(\mathbf{m})$ | speed of wave <br> $(\mathbf{m} / \mathbf{s})$ |
| :---: | :---: |
| 10 | 9.9 |
| 20 | 14.0 |
| 30 | 17.2 |
| 40 | 19.8 |

The diagram below shows how the depth of sea water changes.


Use the information in the table above to help you describe the speed of a wave as it travels from $\mathbf{A}$ to $\mathbf{B}$ and from $\mathbf{B}$ to $\mathbf{C}$.

A to B
1 mark
B to C $\qquad$

Q22. A cyclist and a runner have a race.
The distance-time graph for the race is shown below.


Use the graph to answer the following questions.
(a) (i) How much time did it take the cyclist to travel 100 m ?
$\qquad$ .s
(ii) When the cyclist finished the race how far behind was the runner?
$\qquad$
(iii) How much more time did the runner take compared with the cyclist to complete the race?
........... s
(b) The cyclist is travelling at a constant speed between 3 seconds and 6 seconds.

How does the graph show this?
$\qquad$
$\qquad$
(c) (i) When the race started, a walker set off at a steady speed of $2 \mathrm{~m} / \mathrm{s}$.

Draw a line on the graph on the opposite page to show the distance covered by the walker in the first 15 seconds. Use a ruler.

1 mark
(ii) Calculate how much time it will take for the walker to walk 100 m .
$\qquad$
$\qquad$ s

Q23. The table below shows information about four planets.

| planet | time taken to orbit the Sun <br> (Earth years) | distance from the <br> Sun (million km) |
| :--- | :---: | :---: |
| Mercury | 0.25 | 60 |
| Venus | 0.5 | 108 |
| Earth | 1.0 | 150 |
| Mars | 2.0 | 228 |

The diagram below shows the orbits of the Earth, Mercury, Venus and Mars, and their position at one particular time.
The arrows show the direction in which the planets move.

not to scale
(a) Show the position of each planet six months later by drawing a letter X on the orbit of each planet.
(b) Use the information in the table to calculate the largest and smallest distance between the Earth and Venus.
closest $\qquad$ million km
furthest $\qquad$ million km
(c) The speed of light is $300000 \mathrm{~km} / \mathrm{second}$.

Calculate how long light takes to reach the Earth from the Sun.
$\qquad$
$\qquad$
(d) The diagram below shows the path of an asteroid around the Sun.

not to scale
(i) On the path of the asteroid, draw a letter $S$ to show the position where the asteroid is travelling the slowest.

On the path of the asteroid, draw a letter $F$ to show the position where the asteroid is travelling the fastest.

1 mark
(ii) Explain why the speed of the asteroid changes.
$\qquad$
$\qquad$

Q24. Josh has a helium-filled balloon.

(a) He wants to calculate the speed of his balloon as it rises to the ceiling.
(i) What two measurements should he take to calculate the average speed of his balloon?

1 $\qquad$
$\qquad$
(ii) How can he use these measurements to calculate the speed of his balloon?
$\qquad$
$\qquad$
(b) Josh attached different masses to his balloon. For each mass, he calculated the speed of rise of the balloon. His results are shown below.

| mass <br> $(\mathbf{g})$ | speed of rise <br> $(\mathbf{m m} / \mathbf{s})$ |
| :---: | :---: |
| 0 | 120 |
| 10 | 60 |
| 20 | 40 |
| 30 | -20 |
| 40 | -70 |

(i) How does the table show that the balloon went downwards?
$\qquad$
(ii) Josh plotted two points on the graph as shown.

Complete the graph by plotting the missing points and draw a line of best fit.


2 marks
(iii) From the graph, find the mass needed to keep the balloon floating in one place.
$\qquad$

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