AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.4.1.2

Speed

Past-paper questions

Tier	**Higher**
Question groups	**29**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

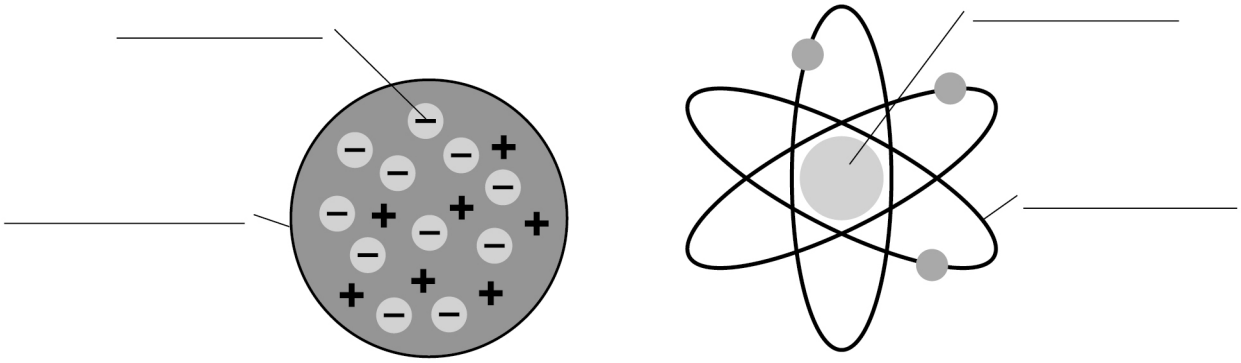
6.5.4.1.2 Speed

Question 01

June 2018 | 8464/P/1H | Original Q1

0 1 **Figure 1** shows two models of the atom.

Figure 1



Plum pudding model

Nuclear model

0 1 . 1 Write the labels on **Figure 1**

Choose the answers from the box.

[4 marks]

atom	**electron**	**nucleus**
neutron	**orbit**	**proton**

0 1 . 2 Explain why the total positive charge in every atom of an element is always the same.

[2 marks]

6.5.4.1.2 Speed

Question 01 · continued

0 1 . 3 The results from the alpha particle scattering experiment led to the nuclear model.

Alpha particles were fired at a thin film of gold at a speed of 7% of the speed of light.

Determine the speed of the alpha particles.

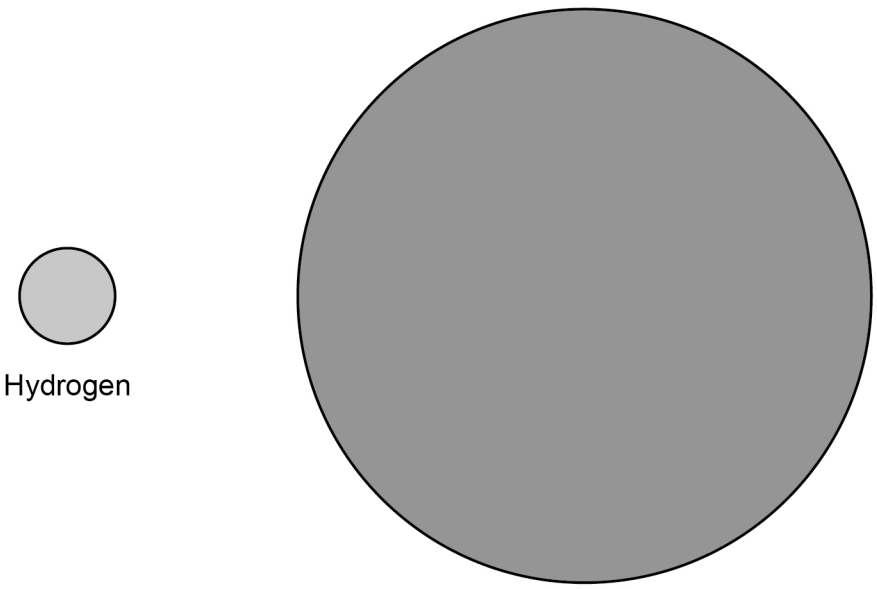
Speed of light = 300 000 000 m/s

[2 marks]

Speed = _____ m/s

0 1 . 4 **Figure 2** shows two atoms represented as solid spheres.

Figure 2



A hydrogen atom has a radius of 2.5×10^{-11} m

Determine the radius of a magnesium atom.

Use measurements from **Figure 2**

[2 marks]

Radius = _____ m

10

6.5.4.1.2 Speed

Question 02

June 2018 | 8464/P/2H | Original Q5

0 5 A car aerial receives radio waves from a radio transmitter.

Radio waves are transverse waves.

Sound waves are longitudinal waves.

0 5 . 1 Describe the difference between transverse waves and longitudinal waves.

[2 marks]

0 5 . 2 The radio waves have a frequency of 4.8×10^9 Hz

Wave speed of electromagnetic waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give your answer to 2 significant figures.

[3 marks]

Wavelength = _____ m

Question 5 continues on the next page

6.5.4.1.2 Speed

Question 02 · continued

0 5 . 3 Describe how the radio waves reaching the car aerial produce signals in the electrical circuit of the car radio.

[3 marks]

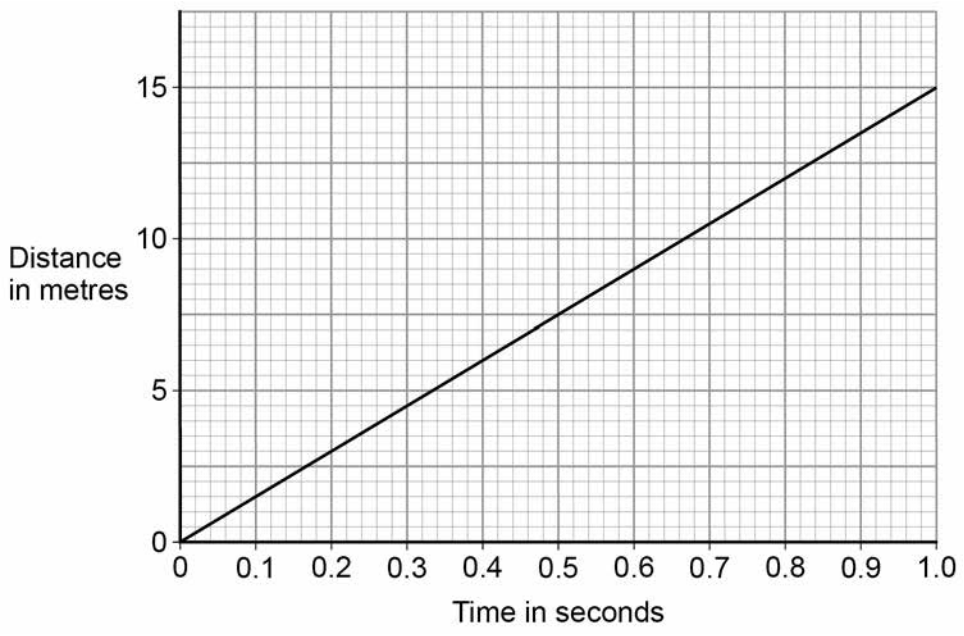
8

6.5.4.1.2 Speed

Question 03

0 6 . 1 **Figure 8** shows the distance-time graph for a car travelling at 15 m/s

Figure 8



When the driver is tired, his reaction time increases from 0.50 seconds to 0.82 seconds.

Determine the **extra** distance the car would travel before the driver starts braking.

[2 marks]

Distance = _____ m

0 6 . 2 When the brakes are used, the temperature of the brakes increases.

Explain why. Use ideas about energy in your explanation.

[2 marks]

Question 6 continues on the next page

6.5.4.1.2 Speed

Question 03 · continued

0 6 . 3 A lorry travels 84 m with a constant acceleration of 2.0 m/s^2 to reach a velocity of 19 m/s

Calculate the initial velocity of the lorry.

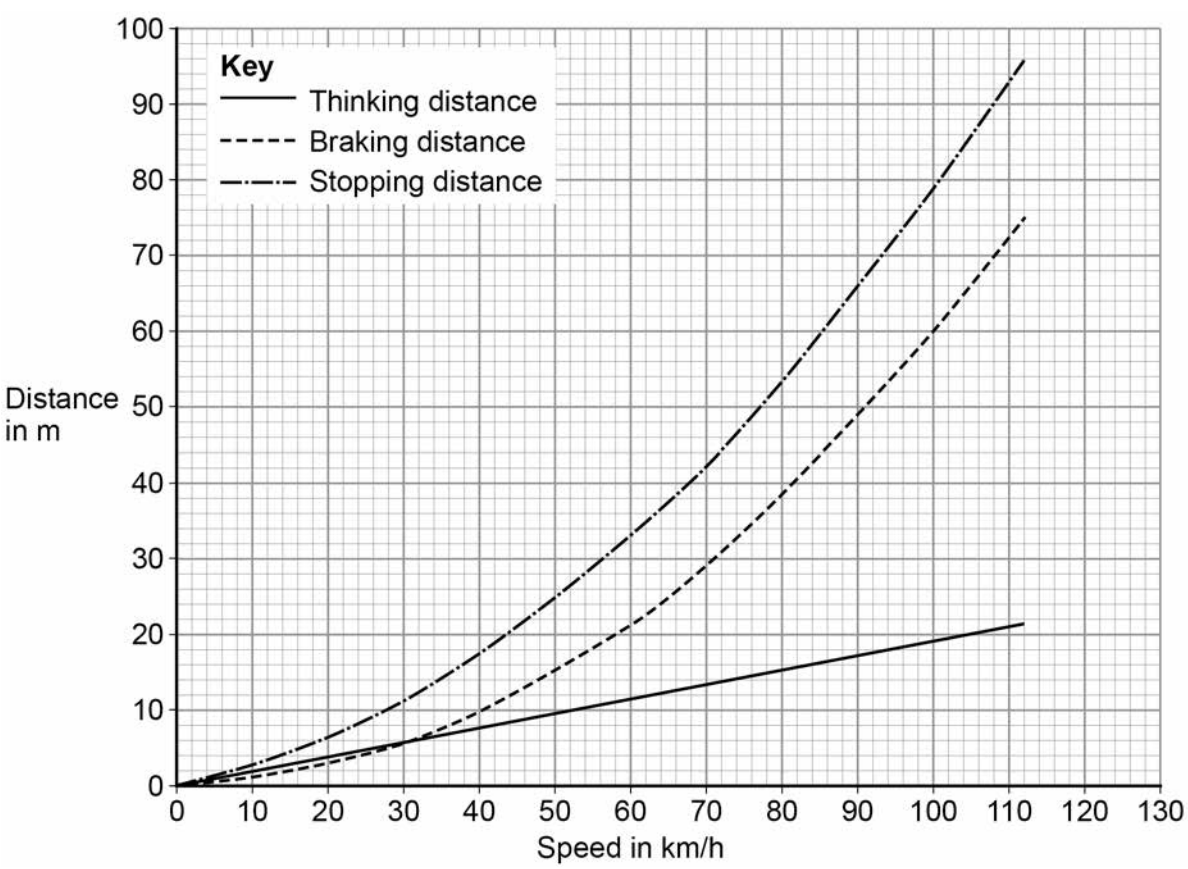
Use the Physics Equations Sheet.

[3 marks]

Initial velocity = _____ m/s

0 6 . 4 **Figure 9** shows how the thinking distance, braking distance and stopping distance for a car vary with the speed of the car.

Figure 9



6.5.4.1.2 Speed

Question 03 · continued

Describe the relationships shown in **Figure 9**

You should include factors that would affect the gradient of the lines.

[6 marks]

13

6.5.4.1.2 Speed

Question 04

June 2019 | 8464/P/2H | Original Q1

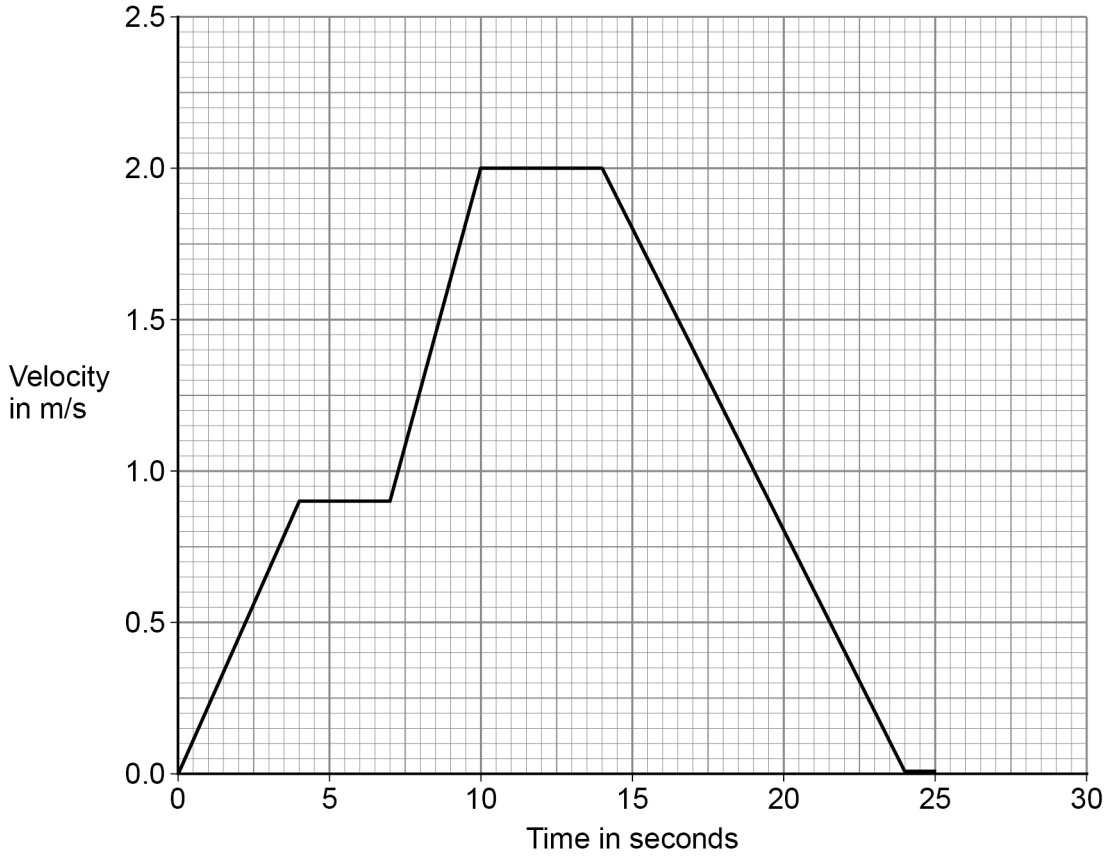
0 1 **Figure 1** shows a runner using a smart watch and a mobile phone to monitor her run.

Figure 1



Figure 2 is a velocity–time graph for part of the runner's warm-up.

Figure 2



6.5.4.1.2 Speed

Question 04 · continued

0 1 . 1 Determine the total time for which the velocity of the runner was increasing.

[2 marks]

Time = _____ s

0 1 . 2 Determine the deceleration of the runner.

[2 marks]

Deceleration = _____ m/s^2

Question 1 continues on the next page

6.5.4.1.2 Speed

Question 04 · continued

The smart watch and mobile phone are connected to each other by a system called Bluetooth.

Bluetooth is wireless and uses electromagnetic waves for communication.

0 1 . 3 Suggest why the phone and watch being connected by a wireless system is an advantage when running.

[1 mark]

0 1 . 4 Write down the equation that links frequency, wave speed and wavelength.

[1 mark]

0 1 . 5 The electromagnetic waves have a frequency of 2 400 000 000 Hz

The speed of electromagnetic waves is 300 000 000 m/s

Calculate the wavelength of the electromagnetic waves.

[3 marks]

Wavelength = _____ m

6.5.4.1.2 Speed

Question 04 · continued

0 1 . 6 **Table 1** shows some information about four types of Bluetooth.

Table 1

Type	Power in milliwatts	Range in metres
1	100	100
2	2.50	10.0
3	1.00	1.00
4	0.50	0.50

Mobile phones use type **2** Bluetooth to communicate with other devices.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

11

6.5.4.1.2 Speed

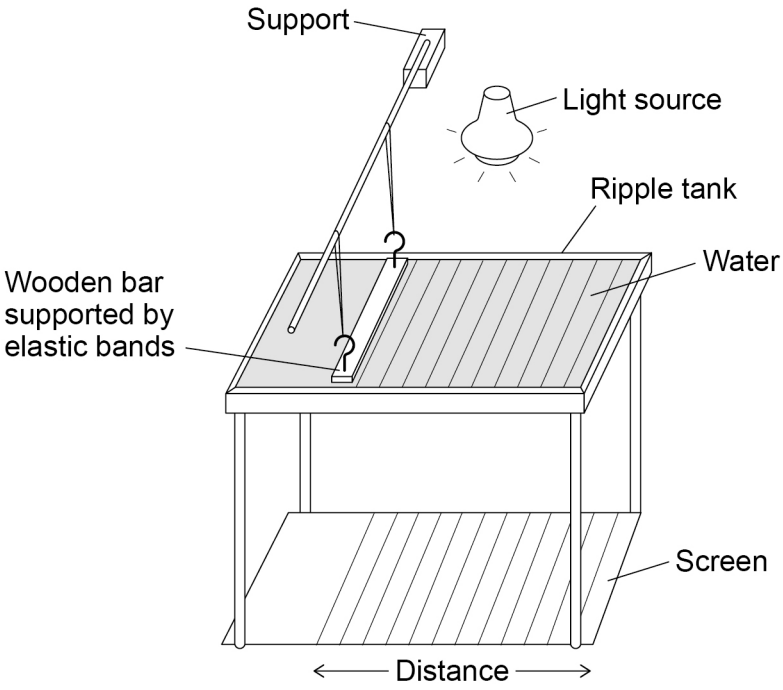
Question 05

0 2 **Figure 3** shows the equipment a teacher used to determine the speed of a water wave.

The equipment includes:

- a ripple tank filled with water
- a wooden bar that creates ripples on the surface of the water
- a light source which causes a shadow of the ripples on the screen.

Figure 3



0 2 . 1 Describe how equipment in **Figure 3** can be used to measure the wavelength, frequency and speed of a water wave.

[6 marks]

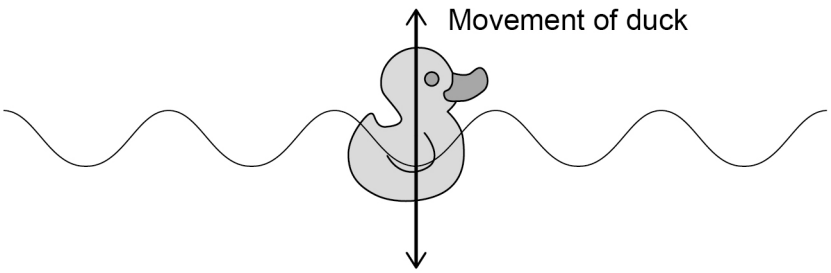
6.5.4.1.2 Speed

Question 05 · continued

The teacher put a plastic duck in the ripple tank as shown in **Figure 4**.

The plastic duck moved up and down as the waves in the water passed.

Figure 4



0 2 . 2 How does the movement of the plastic duck in **Figure 4** demonstrate that water waves are transverse?

[1 mark]

Question 2 continues on the next page

6.5.4.1.2 Speed

Question 05 · continued

0 2 . 3 The teacher measured the maximum height and the minimum height of the plastic duck above the screen as the wave passed.

The teacher repeated his measurements.

Table 2 shows the teacher's measurements.

Table 2

Maximum height in mm	509	513	511
Minimum height in mm	503	498	499

Calculate the mean amplitude of the water wave.

[3 marks]

Mean amplitude = _____ mm

10

6.5.4.1.2 Speed

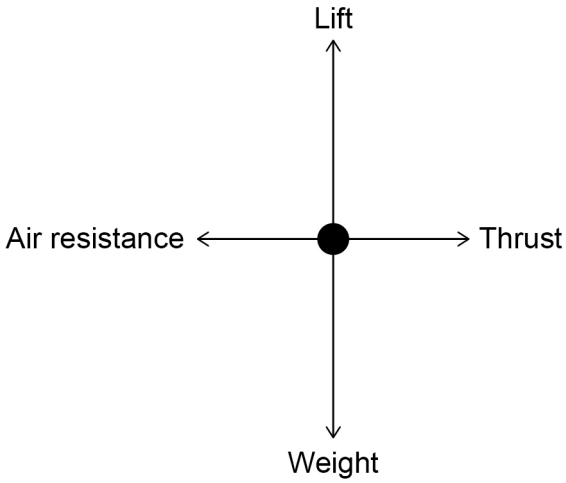
Question 06

June 2019 | 8464/P/2H | Original Q6

0 6 **Figure 9** shows a free body diagram for an aeroplane flying at a constant speed and at a constant height.

The speed of the aeroplane is much greater than the speed at which the aeroplane lands.

Figure 9



0 6 . 1 Explain how the forces need to change so the aeroplane can land.

[4 marks]

Question 6 continues on the next page

6.5.4.1.2 Speed

Question 06 · continued

0 6 . 2 The aeroplane lands at a speed of 80 m/s

After landing, the aeroplane takes 28 s to decelerate to a speed of 10 m/s

The mean resultant force on the aeroplane as it decelerates is 750 000 N

Calculate the mass of the aeroplane.

[5 marks]

Mass = _____ kg

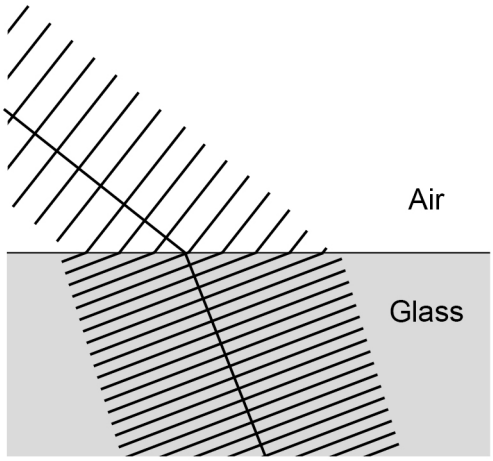
9

6.5.4.1.2 Speed

Question 07

0 7 Wave front diagrams are used to explain why light refracts when it passes from air into glass.

Figure 10



0 7 . 1 Explain why the light refracts as it passes from air into glass.

[3 marks]

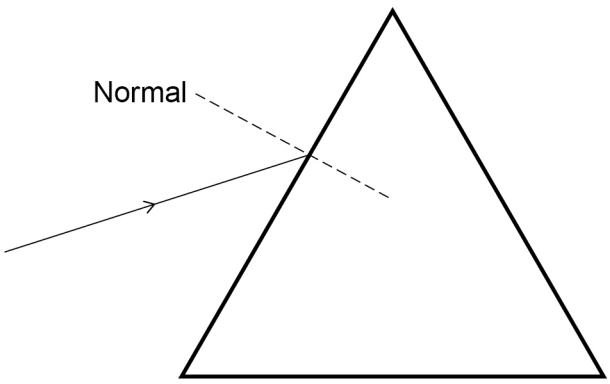
Question 7 continues on the next page

6.5.4.1.2 Speed

Question 07 · continued

0 7 . 2 **Figure 11** shows a ray of red light entering a glass prism.

Figure 11



Complete the ray diagram to show the ray emerging from the glass prism.

[3 marks]

6.5.4.1.2 Speed

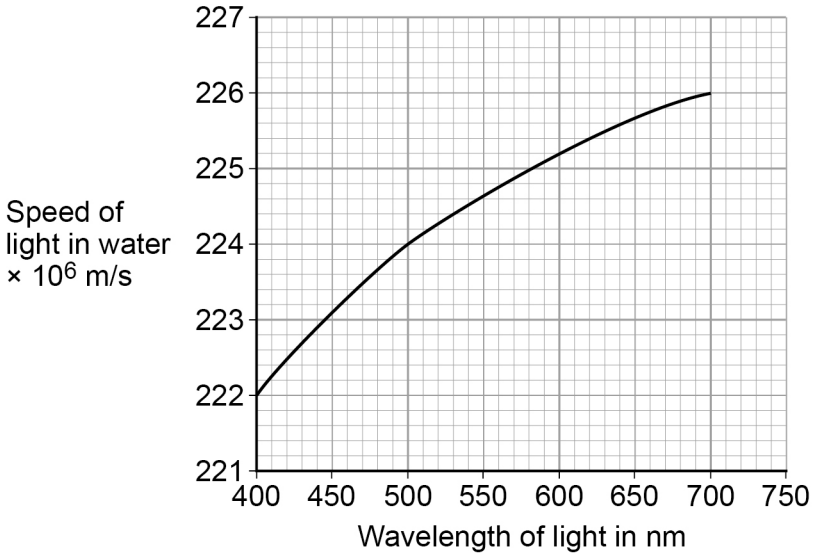
Question 07 · continued

0 7 . 3 White light is made up of a continuous spectrum of different wavelengths that all travel at 3×10^8 m/s in air.

Rainbows are produced because different wavelengths of light travel at different speeds in water.

Figure 12 shows the speed of different wavelengths of light in water.

Figure 12



Explain why violet light is refracted the most as it enters water.

[3 marks]

9

6.5.4.1.2 Speed

Question 08

0 7 Kangaroos are large animals that travel by jumping.

Figure 8 shows a kangaroo.

Figure 8



Each leg of a kangaroo has a tendon connected to a muscle. Each tendon can be modelled as a spring.

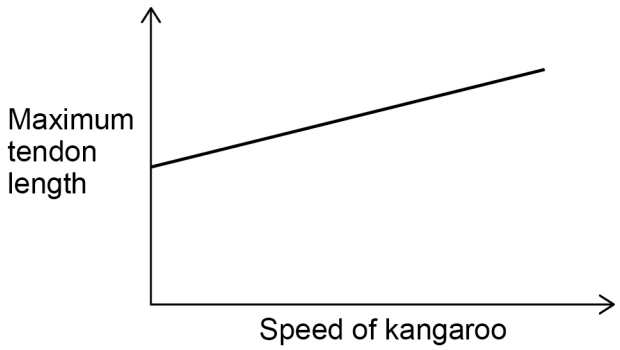
When a jumping kangaroo lands on the ground, the tendons stretch.

6.5.4.1.2 Speed

Question 08 · continued

0 7 . 1 **Figure 9** shows a sketch graph of how the maximum tendon length during a jump changes with the speed of the kangaroo.

Figure 9



Explain why a kangaroo can jump higher as its speed increases.

[3 marks]

Question 7 continues on the next page

6.5.4.1.2 Speed

Question 08 · continued

0 7 . 2 A kangaroo has a maximum gravitational potential energy during one jump of 770 J

When the kangaroo lands on the ground 14% of the maximum gravitational potential energy is transferred to elastic potential energy in one tendon.

The tendon has an unstretched length of 35.0 cm

When the kangaroo lands on the ground the tendon stretches to a length of 42.0 cm

Calculate the spring constant of the tendon.

[5 marks]

Spring constant = _____ N/m

8

6.5.4.1.2 Speed

Question 09

0 4 **Figure 8** shows a girl bowling a ball along a ten-pin bowling lane.

Figure 8



The girl is trying to knock down the ten pins at the end of the bowling lane.

0 4 . 1 Velocity is a vector quantity, speed is a scalar quantity.

Describe what is meant by a vector quantity and a scalar quantity.

[2 marks]

Vector quantity _____

_____

Scalar quantity _____

_____

0 4 . 2 The bowling lane is horizontal.

Explain why the bowling ball decelerates as it travels along the lane.

[2 marks]

_____

_____

_____

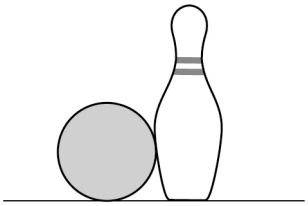
_____

6.5.4.1.2 Speed

Question 09 · continued

Figure 9 shows the bowling ball hitting one of the pins.

Figure 9



0 4 . 3 Write down the equation that links mass (*m*), momentum (*p*) and velocity (*v*).

[1 mark]

0 4 . 4 The bowling ball has a velocity of 5.0 m/s when it hits the pin.

The momentum of the bowling ball is 26 kg m/s

Calculate the mass of the bowling ball.

[3 marks]

Mass = _____ kg

Question 4 continues on the next page

6.5.4.1.2 Speed

Question 09 · continued

0 4 . 5 Explain why the bowling ball slows down when it hits the pin.

You should use ideas about momentum in your answer.

[3 marks]

11

6.5.4.1.2 Speed

Question 10

November 2020 | 8464/P/2H | Original Q6

0 6 The speed limit on many roads in towns is 13.5 m/s

Outside schools this speed limit is often **reduced by** one-third.

0 6 . 1 Calculate the reduced speed limit.

[2 marks]

Reduced speed limit = _____ m/s

0 6 . 2 A reduced speed limit may reduce air pollution.

Explain **one** other advantage of a reduced speed limit.

[2 marks]

Question 6 continues on the next page

6.5.4.1.2 Speed

Question 10 · continued

0 6 . 3 **Figure 11** shows a car being driven at a constant speed past a speed camera.

Figure 11



The camera recorded two images of the car 0.70 s apart.

The car travelled 14 m between the two images being taken.

The maximum deceleration of the car is 6.25 m/s^2

Calculate the minimum braking distance for the car at the speed it passed the speed camera.

[6 marks]

Minimum braking distance = _____ m

6.5.4.1.2 Speed

Question 10 · continued

0 6 . 4 **Figure 12** shows a delivery van full of packages.

Figure 12



The driver delivers all the packages.

The empty van has a shorter stopping distance than the full van when driven at the same speed.

Explain why.

[3 marks]

13

6.5.4.1.2 Speed

Question 11

November 2021 | 8464/P/1H | Original Q3

0 3 **Figure 4** shows a sailing boat crossing an ocean.

Figure 4



There is a wind turbine on the boat.

0 3 . 1 The wind turbine generates electricity to charge a battery on the boat.

Name one **other** renewable energy resource that could be used on the boat to generate electricity.

[1 mark]

_____

0 3 . 2 The boat also has a generator that burns a fossil fuel.

The battery can be charged by either the wind turbine **or** the generator.

Give **two** reasons why this is useful.

[2 marks]

1 _____

_____

2 _____

_____

6.5.4.1.2 Speed

Question 11 · continued

0 3 . 3 Explain **one** environmental impact of using fossil fuels to generate electricity.

[2 marks]

0 3 . 4 The kinetic energy of the boat is 81 kJ.

mass of boat = 8000 kg

Calculate the speed of the boat.

[4 marks]

Speed = _____ m/s

Question 3 continues on the next page

6.5.4.1.2 Speed

Question 11 · continued

0 3 . 5 As the boat passes over a wave, the gravitational potential energy of the boat increases by 19 600 J.

mass of boat = 8000 kg

gravitational field strength = 9.8 N/kg

Calculate the change in height of the centre of mass of the boat as it passes over the wave.

[3 marks]

Change in height = _____ m

12

6.5.4.1.2 Speed

Question 12

November 2021 | 8464/P/2H | Original Q3

0 3 A student made water waves in a ripple tank.

0 3 . 1 Describe how the frequency and wavelength of the water waves in the ripple tank can be measured accurately.

[4 marks]

The student recorded values for the frequency and the wavelength of waves in the ripple tank.

Table 1 and **Table 2** show the results.

Table 1

Reading	**1**	**2**	**3**
Frequency in hertz	9.8	9.4	9.3

Table 2

Reading	**1**	**2**	**3**
Wavelength in cm	1.7	2.2	2.1

6.5.4.1.2 Speed

Question 12 · continued

0 3 . 2 Determine the mean wave speed.

[4 marks]

Mean wave speed = _____ m/s

0 3 . 3 What is the advantage of taking repeat readings and then calculating a mean?

[1 mark]

0 3 . 4 The speed of the wave is affected by the depth of the water in the ripple tank.

The deeper the water the faster the wave.

Explain how the depth of the water affects the wavelength of the wave if the frequency is constant.

[2 marks]

11

6.5.4.1.2 Speed

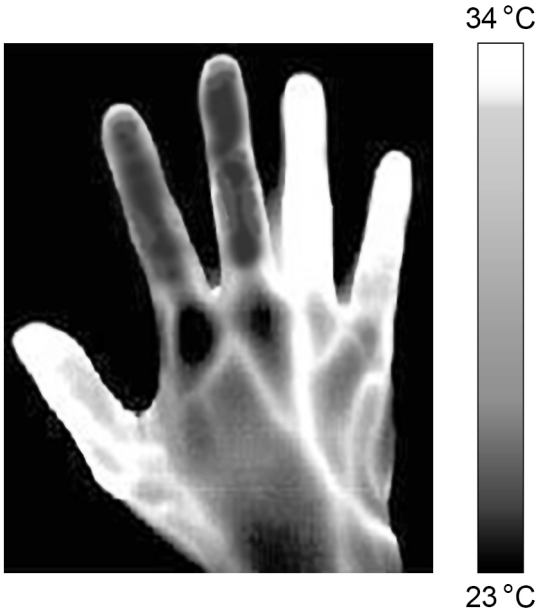
Question 13

November 2021 | 8464/P/2H | Original Q5

0 5 Different parts of the electromagnetic spectrum are used in medical imaging.

Figure 8 shows an image of a person's hand taken with an infrared camera.

Figure 8



0 5 . 1 Explain why the infrared camera is able to show that parts of the hand are at different temperatures.

[2 marks]

Question 5 continues on the next page

6.5.4.1.2 Speed

Question 13 · continued

0 5 . 2 Infrared has a range of wavelengths from 700 nm to 1 mm.

Which part of the electromagnetic spectrum would have waves with a wavelength of 6.5×10^{-7} m?

[1 mark]

Tick (✓) **one** box.

Infrared ☐

Microwaves ☐

Radio waves ☐

Visible light ☐

6.5.4.1.2 Speed

Question 13 · continued

0 5 . 3 **Figure 9** shows X-rays and gamma rays being used for medical imaging.

Figure 9

X-rays **Gamma rays**



To use X-rays for medical imaging, a machine produces a very brief burst of X-rays.

To use gamma rays for medical imaging, a radioactive isotope is injected into the patient's blood. The isotope is circulated around the body in the blood. The isotope emits gamma rays.

Compare the potential risks to a patient of using X-rays and gamma rays for medical imaging.

[4 marks]

Question 5 continues on the next page

6.5.4.1.2 Speed

Question 13 · continued

X-rays are produced by colliding high-energy electrons into a metal target.

The electrons have high energy because they are accelerated to high speeds.

Only a small proportion of the kinetic energy of an electron is converted into an X-ray when it collides with the metal target.

0 5 . 4 An electron is accelerated through a distance of 15 mm.

The work done on the electron is 1.2×10^{-13} J.

Calculate the force on the electron.

[3 marks]

Force = _____ N

0 5 . 5 The metal target is made from tungsten.

Tungsten has the highest melting point of any metal.

Explain why using tungsten as the metal target enables the X-ray machine to be more powerful.

[3 marks]

13

6.5.4.1.2 Speed

Question 14

November 2021 | 8464/P/2H | Original Q6

0 6 Scientists are developing a hypersonic aeroplane that will travel much faster than normal aeroplanes.

0 6 . 1 An aeroplane accelerates from a low speed to a high speed with the engines at maximum power.

Explain why the acceleration is **not** constant.

[5 marks]

Question 6 continues on the next page

6.5.4.1.2 Speed

Question 14 · continued

0 6 . 2 The hypersonic aeroplane will have jet engines and a rocket engine.

The speed of aeroplanes can be measured on a uniform scale called the Mach scale.

Mach 1 = 330 m/s

The jet engines will accelerate the aeroplane to Mach 5.5.

The rocket engine will accelerate the aeroplane from Mach 5.5 to Mach 25.5 in 300 s.

The average resultant force on the aeroplane when the rocket engine is used will be 630 000 N.

Calculate the mass of the hypersonic aeroplane.

Give your answer to 2 significant figures.

[6 marks]

Mass (2 significant figures) = _____ kg

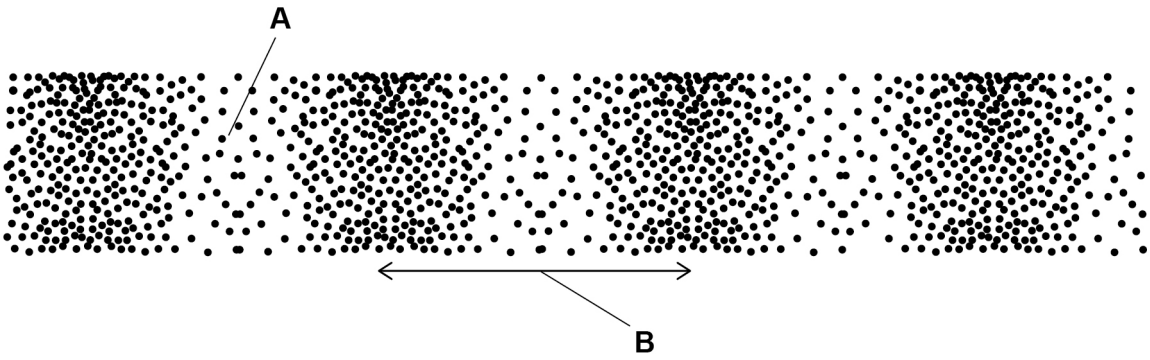
11

6.5.4.1.2 Speed

Question 15

0 1 **Figure 1** shows a longitudinal wave.

Figure 1



0 1 . 1 What do the labels **A** and **B** on **Figure 1** represent?

Choose answers from the box.

[2 marks]

amplitude	**frequency**	**rarefaction**	**reflection**	**wavelength**

A _____

B _____

6.5.4.1.2 Speed

Question 15 · continued

0 1 . 2 The wave shown in **Figure 1** has a frequency of 4.0 kHz

Calculate the period of the wave.

Use the Physics Equations Sheet.

Give the unit.

[4 marks]

Period = _____ Unit _____

Question 1 continues on the next page

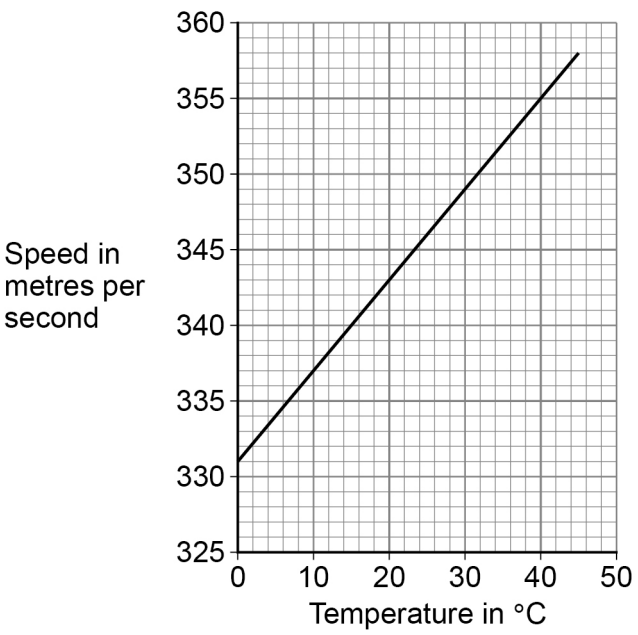
6.5.4.1.2 Speed

Question 15 · continued

Sound waves are longitudinal.

Figure 2 shows how the speed of sound varies with the temperature of the air.

Figure 2



6.5.4.1.2 Speed

Question 15 · continued

Use the Physics Equations Sheet to answer questions **01.3** and **01.4**.

0 1 . 3 Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

[1 mark]

0 1 . 4 A sound wave with a frequency of 300 Hz travels through the air.

The air has a temperature of 28.0 °C

Determine the wavelength of the sound wave.

Use **Figure 2**.

[4 marks]

Wavelength = _____ m

11

6.5.4.1.2 Speed

Question 16

0 2 **Figure 3** shows competitors in the wheelchair race at the London Marathon.

The distance of the London Marathon is 42 000 m

Figure 3



6.5.4.1.2 Speed

Question 16 · continued

Use the Physics Equations Sheet to answer questions **02.1** and **02.2**.

0 2 . 1 Write down the equation that links distance (*s*), force (*F*) and work done (*W*).

[1 mark]

0 2 . 2 During the race competitors work against air resistance.

The work done against air resistance by the winner of the race was 3 360 000 J

Calculate the average air resistance acting on the winner of the race.

[3 marks]

Average air resistance = _____ N

Question 2 continues on the next page

6.5.4.1.2 Speed

Question 16 · continued

Use the Physics Equations Sheet to answer questions **02.3** and **02.4**.

0 2 . 3 Which equation links distance travelled, speed and time?

[1 mark]

Tick (✓) **one** box.

distance travelled = speed × time ☐

time = distance travelled × speed ☐

speed = distance travelled × time ☐

0 2 . 4 The distance of the London Marathon is 42 000 m

The winning time for the race was 5600 seconds.

Calculate the average speed of the winner of the race.

[3 marks]

Average speed = _____ m/s

6.5.4.1.2 Speed

Question 16 · continued

0 2 . 5 Explain why the speed of a competitor changes during the race.

[4 marks]

12

Turn over for the next question

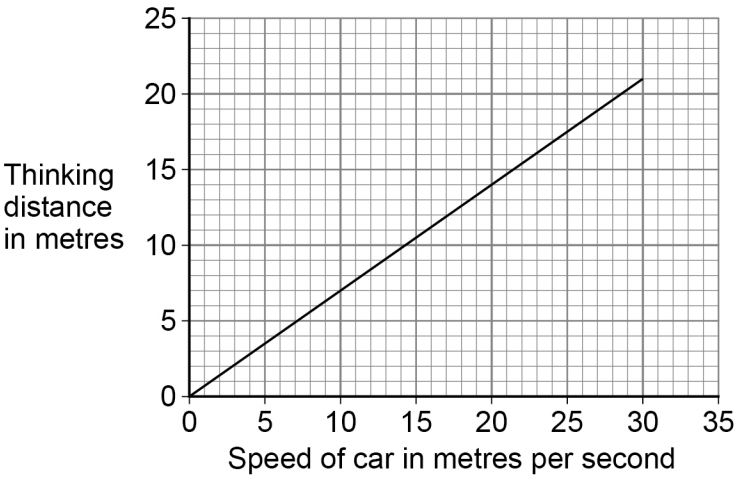
6.5.4.1.2 Speed

Question 17

0 6 The distance a car travels during the driver's reaction time is called the thinking distance.

0 6 . 1 **Figure 9** shows how thinking distance depends on speed for a car.

Figure 9



Determine the driver's reaction time.

Use the Physics Equations Sheet.

[3 marks]

Reaction time = _____ s

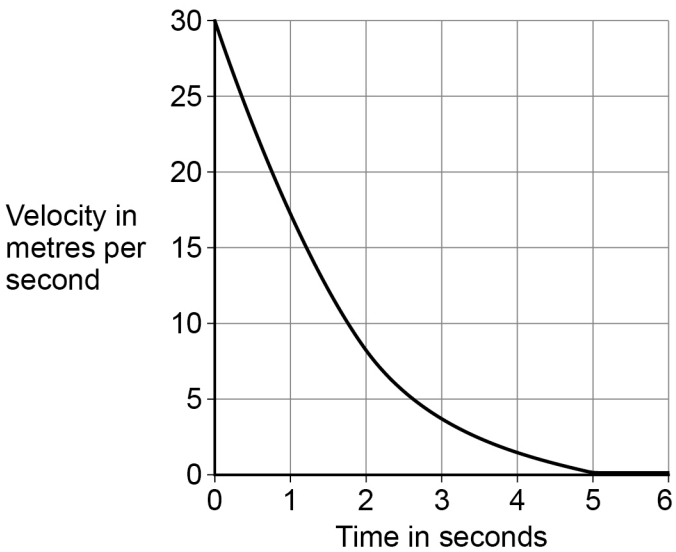
Question 6 continues on the next page

6.5.4.1.2 Speed

Question 17 · continued

0 6 . 2 **Figure 10** shows how the velocity of a car changes during braking.

Figure 10



Determine the braking distance of the car.

[3 marks]

Braking distance = _____ m

6.5.4.1.2 Speed

Question 17 · continued

0 6 . 3 Explain how the gradient of the line on **Figure 10** shows that the resultant force on the car was **not** constant.

[3 marks]

9

Turn over for the next question

6.5.4.1.2 Speed

Question 18

June 2023 | 8464/P/1H | Original Q4

0 4 A scientist investigated a sample of a radioactive material to determine if it would be suitable for medical use.

0 4 . 1 The method, results and conclusions of the scientist will need to be checked by other scientists before the results of the investigation are published.

What name is given to this checking process?

[1 mark]

0 4 . 2 There is an increased risk of cancer if the scientist is irradiated by nuclear radiation.

What property of nuclear radiation causes the increased risk of cancer?

[1 mark]

0 4 . 3 The activity of a radioactive source is the rate at which the nuclei of the source decay.

What is the unit for the activity of a radioactive source?

[1 mark]

0 4 . 4 The scientist placed a radiation detector near the sample and measured the count-rate.

Explain why the count-rate is less than the activity of the sample.

[2 marks]

6.5.4.1.2 Speed

Question 18 · continued

0 4 . 5 The scientist recorded the count-rate from the sample with the radiation detector at different distances from the sample.

Table 2 shows the results.

Table 2

Distance between the sample and the detector in centimetres	Count-rate in counts/second
2.0	300
5.0	24
10.0	0

Explain which type of radiation was emitted by the sample.

[2 marks]

Question 4 continues on the next page

6.5.4.1.2 Speed

Question 18 · continued

0 4 . 6 The scientist moved the detector closer to the sample and started a stopwatch.

The scientist measured the count-rate from the sample at different times.

Table 3 shows some of the results.

Table 3

Time in minutes	Count-rate in counts/second
0	1568
30	**X**
60	98

The scientist realised that 30 minutes is a whole number of half-lives.

Calculate the value of **X** in **Table 3**.

[3 marks]

X = _____ counts/second

6.5.4.1.2 Speed

Question 18 · continued

0 4 . 7 The scientist had a second sample of the radioactive material.

The scientist made appropriate measurements, then calculated the half-life of each sample.

Why was the half-life calculated from the second sample slightly different from the half-life calculated from the first sample?

[1 mark]

Tick (✓) **one** box.

Radioactive decay is a random process. ☐

The count-rate from a radioactive sample is predictable. ☐

The samples were at different temperatures. ☐

The size of each sample was different. ☐

11

Turn over for the next question

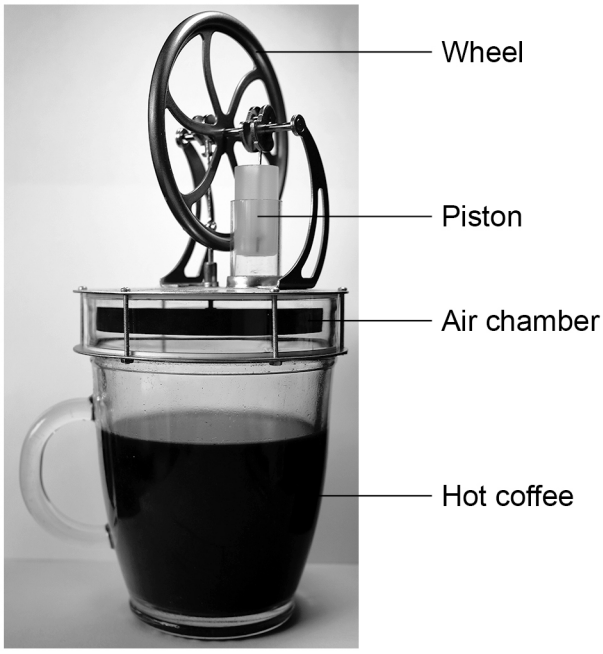
6.5.4.1.2 Speed

Question 19

June 2023 | 8464/P/1H | Original Q6

0 6 **Figure 12** shows a device that uses a mug of hot coffee to turn a wheel.

Figure 12



0 6 . 1 The hot coffee increases the temperature of the air in the chamber.

Explain how the pressure in the chamber changes.

[3 marks]

Question 6 continues on the next page

6.5.4.1.2 Speed

Question 19 · continued

0 6 . 2 For the device to work, the air in the chamber must increase in temperature quickly.

Explain why the bottom of the air chamber is made of metal rather than plastic.

[2 marks]

0 6 . 3 The mass of air in the chamber is constant.

What property of air allows a small change in internal energy to cause a large temperature change to the air in the chamber?

[1 mark]

0 6 . 4 The changes in pressure in the air chamber cause the wheel to turn.

Suggest **one** way to increase the speed at which the wheel turns.

[1 mark]

6.5.4.1.2 Speed

Question 19 · continued

0 6 . 5 The temperature of the coffee decreases as the device is used.

The initial temperature of the coffee was 76 °C.

The internal energy of the coffee decreased by 15 kJ.

density of coffee = 1.1×10^{3} kg/m^{3}

volume of coffee = 1.9×10^{-4} m^{3}

specific heat capacity of coffee = 4200 J/kg °C

Calculate the final temperature of the coffee.

Use the Physics Equations Sheet.

[6 marks]

Final temperature of the coffee = _____ °C

13

6.5.4.1.2 Speed

Question 20

June 2023 | 8464/P/2H | Original Q1

0 1 The Sun emits a continuous spectrum of electromagnetic waves.

Figure 1 names some of the groups of waves in the electromagnetic spectrum.

Figure 1

A	**B**	Infrared	Visible light	Ultraviolet	**C**	Gamma rays

0 1 . 1 Name groups **A**, **B** and **C** in **Figure 1**.

[2 marks]

A _____

B _____

C _____

0 1 . 2 Give **one** similarity and **one** difference between the properties of ultraviolet waves and gamma rays.

[2 marks]

Similarity _____

_____

Difference _____

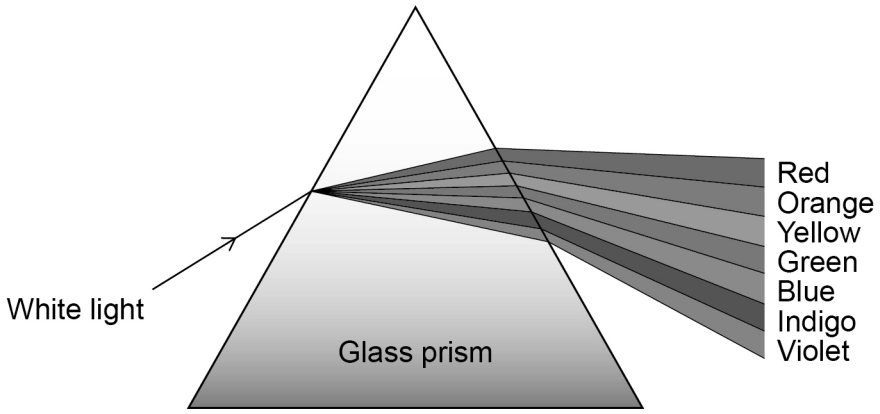
_____

6.5.4.1.2 Speed

Question 20 · continued

Figure 2 shows white light split into a spectrum of different colours by a glass prism.

Figure 2



0 1 . 3 Light changes direction when it enters the glass prism.

What name is given to this process?

[1 mark]

Question 1 continues on the next page

6.5.4.1.2 Speed

Question 20 · continued

Use the Physics Equations Sheet to answer questions **01.4** and **01.5**.

0 1 . 4 Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

[1 mark]

0 1 . 5 The wave in the middle of the spectrum has a wavelength of 5.0×10^{-7} m.

wave speed of light = 3.0×10^{8} m/s

Calculate the frequency of the wave.

[3 marks]

Frequency = _____ Hz

9

6.5.4.1.2 Speed

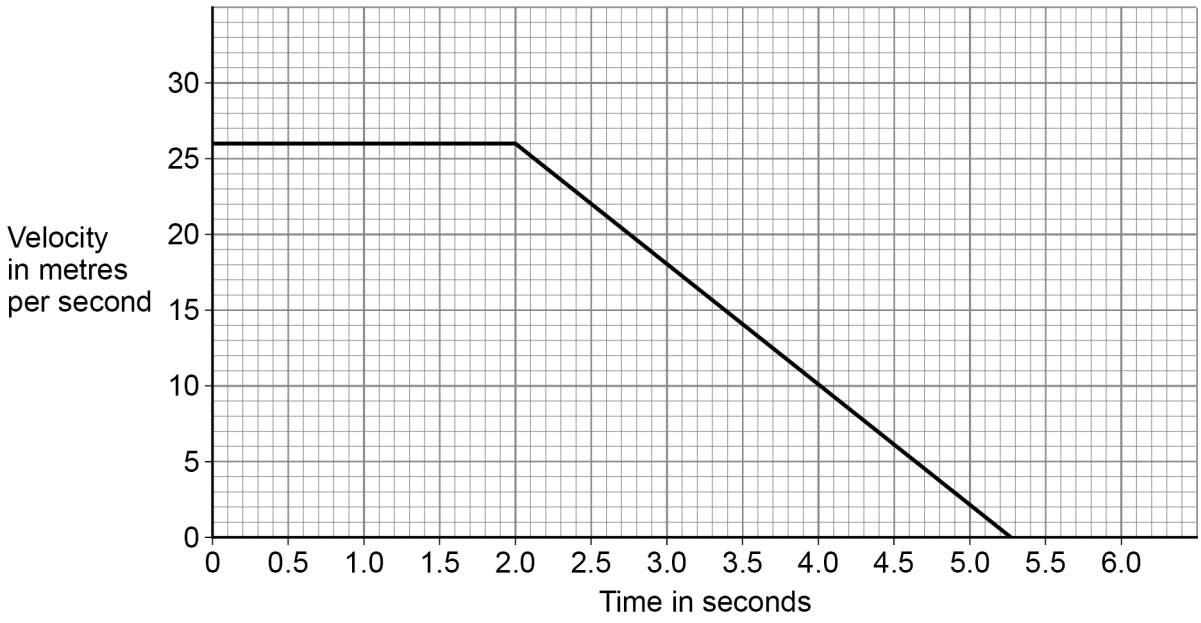
Question 21

0 7 A car contains a device called a black box. The black box records the velocity and acceleration of the car.

The car was travelling at a constant velocity. The driver then reacted to a hazard.

Figure 11 shows the velocity–time graph for the car.

Figure 11



0 7 . 1 Determine the deceleration of the car.

Give the unit.

[3 marks]

Deceleration = _____ Unit _____

6.5.4.1.2 Speed

Question 21 · continued

0 7 . 2 The driver of the car has a reaction time of 0.75 s.

Determine the stopping distance of the car.

Use the Physics Equations Sheet.

Use **Figure 11**.

[5 marks]

Stopping distance = _____ m

0 7 . 3 If the black box records large decelerations, it identifies that the driving may be dangerous.

Explain why large decelerations may be dangerous.

[2 marks]

10

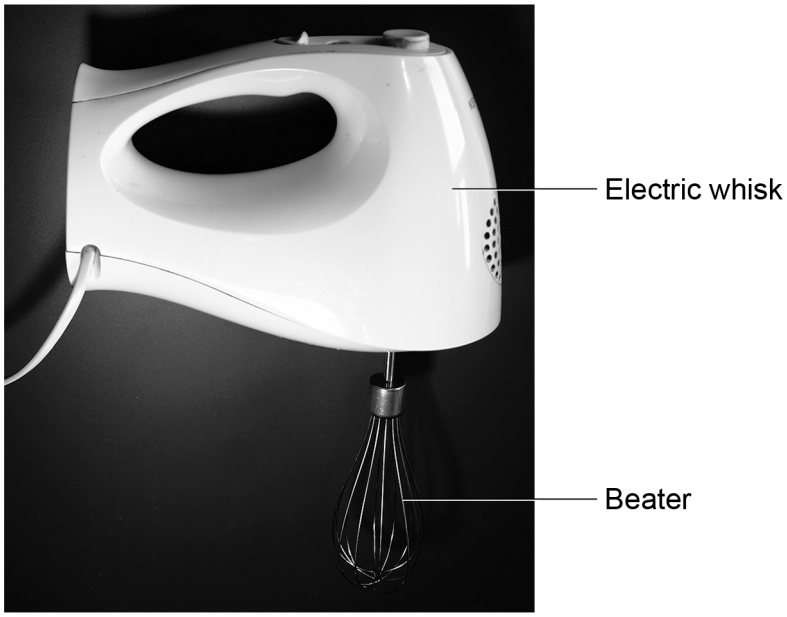
6.5.4.1.2 Speed

Question 22

0 1 **Figure 1** shows an electric whisk that plugs into the mains electricity supply.

The whisk can mix food by spinning a beater.

Figure 1



0 1 . 1 Give **two** energy stores that increase when the whisk is switched on.

[2 marks]

1 _____

_____

2 _____

_____

6.5.4.1.2 Speed

Question 22 · continued

Use the Physics Equations Sheet to answer questions **01.2** and **01.3**.

0 1 . 2 Work is done by the whisk when it is used to mix food.

Write down the equation that links power (P), time (t) and work done (W).

[1 mark]

0 1 . 3 The power output of the whisk is 92 W.

Calculate the time for the whisk to do 23 000 J of work.

[3 marks]

Time = _____ s

Question 1 continues on the next page

6.5.4.1.2 Speed

Question 22 · continued

Use the Physics Equations Sheet to answer questions **01.4** and **01.5**.

0 1 . 4 Which equation links current (I), power (P) and resistance (R)?

[1 mark]

Tick (✓) **one** box.

$P = \frac{I}{R^2}$ ☐

$P = I R^2$ ☐

$P = \frac{I^2}{R}$ ☐

$P = I^2 R$ ☐

0 1 . 5 The current in the whisk is 500 mA.

The resistance of the whisk is 640 Ω.

Calculate the power of the whisk.

[3 marks]

Power = _____ W

6.5.4.1.2 Speed

Question 22 · continued

The whisk has several settings that allow the beater to spin at different speeds.

A faster beater speed needs a greater power input from the mains electricity supply.

0 1 . 6 What is the potential difference between the live wire and neutral wire in the mains electricity supply?

[1 mark]

_____ V

0 1 . 7 Changing the beater speed does **not** change the potential difference between the live wire and neutral wire.

The power input to the whisk changes because the current in the whisk changes.

Complete the sentence.

[1 mark]

When the beater speed increases, the current in the whisk increases because the resistance of the whisk _____.

12

6.5.4.1.2 Speed

Question 23

June 2024 | 8464/P/1H | Original Q4

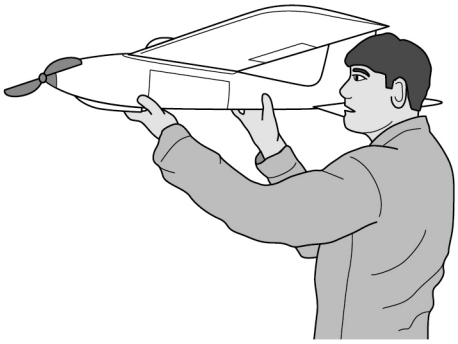
0 4 A drone is a miniature aircraft that has a remote control.

An inventor designed a battery powered drone.

The inventor tested what would happen if the battery runs out of charge during a flight.

Figure 5 shows the inventor about to launch the drone.

Figure 5



0 4 . 1 After the drone was launched, it moved at a constant speed and gained height.

The thermal stores of energy of the drone increased.

Describe **two** other changes to the energy stores of the drone as it moved at a constant speed and gained height.

[2 marks]

1 _____

_____

2 _____

_____

Question 4 continues on the next page

6.5.4.1.2 Speed

Question 23 · continued

When the drone reached a height of 840 m the motor was switched off.

The motor was switched back on after a short time, when the drone had fallen to a lower height above the ground.

The change in gravitational potential energy of the drone during the fall to this lower height was 3920 J.

The mass of the drone is 2.5 kg.

gravitational field strength = 9.8 N/kg

0 4 . 2 Calculate the height above the ground of the drone when the motor was switched back on.

Use the Physics Equations Sheet.

[4 marks]

Height above ground = _____ m

6.5.4.1.2 Speed

Question 23 · continued

0 4 . 3 When the motor was switched off, the kinetic energy of the drone was 150 J.

Calculate the maximum possible speed of the drone when the motor was switched back on.

Use the Physics Equations Sheet.

Give your answer in km/s.

[5 marks]

Maximum possible speed of drone = _____ km/s

11

6.5.4.1.2 Speed

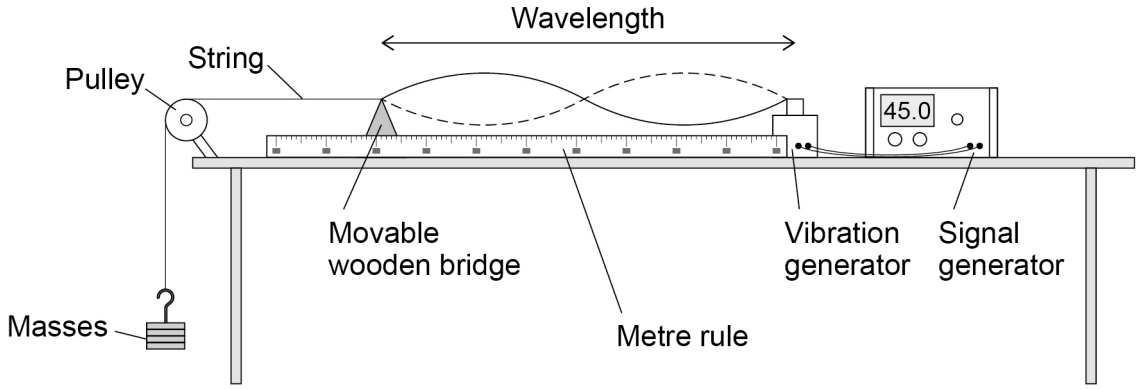
Question 24

June 2024 | 8464/P/2H | Original Q1

0 1 A teacher demonstrated how the frequency of a wave on a string affects the wavelength of the wave.

Figure 1 shows the equipment used.

Figure 1



The frequency of the signal generator is adjusted so that the wave shown in **Figure 1** is seen.

At this frequency the string vibrates between the two positions shown in **Figure 1**.

0 1 . 1 Describe a method the teacher could use to investigate how the frequency of the wave affects the wavelength.

[4 marks]

6.5.4.1.2 Speed

Question 24 · continued

Use the Physics Equations Sheet to answer questions **01.2** and **01.3**.

0 1 . 2 Which equation links frequency (f), wavelength (λ) and wave speed (v)?

[1 mark]

Tick (✓) **one** box.

$f = \lambda \times v$ ☐

$\lambda = f \times v$ ☐

$v = f \times \lambda$ ☐

0 1 . 3 The wave on the string has a frequency of 45.0 Hz.

The wave speed is 35.1 m/s.

Calculate the wavelength of the wave.

[3 marks]

Wavelength = _____ m

8

6.5.4.1.2 Speed

Question 25

0 5 A safety test was carried out to determine how the speed of a car affects the stopping distance of the car.

0 5 . 1 At the start of the test the car was moving slowly.

Then the car accelerated at 5.8 m/s^2 for 2.5 s.

The final velocity of the car was 20 m/s.

Calculate the initial velocity of the car.

Use the Physics Equations Sheet.

[4 marks]

Initial velocity = _____ m/s

0 5 . 2 The reaction time of the driver was measured.

How can the reaction time of the driver be used to calculate the thinking distance?

[1 mark]

Question 5 continues on the next page

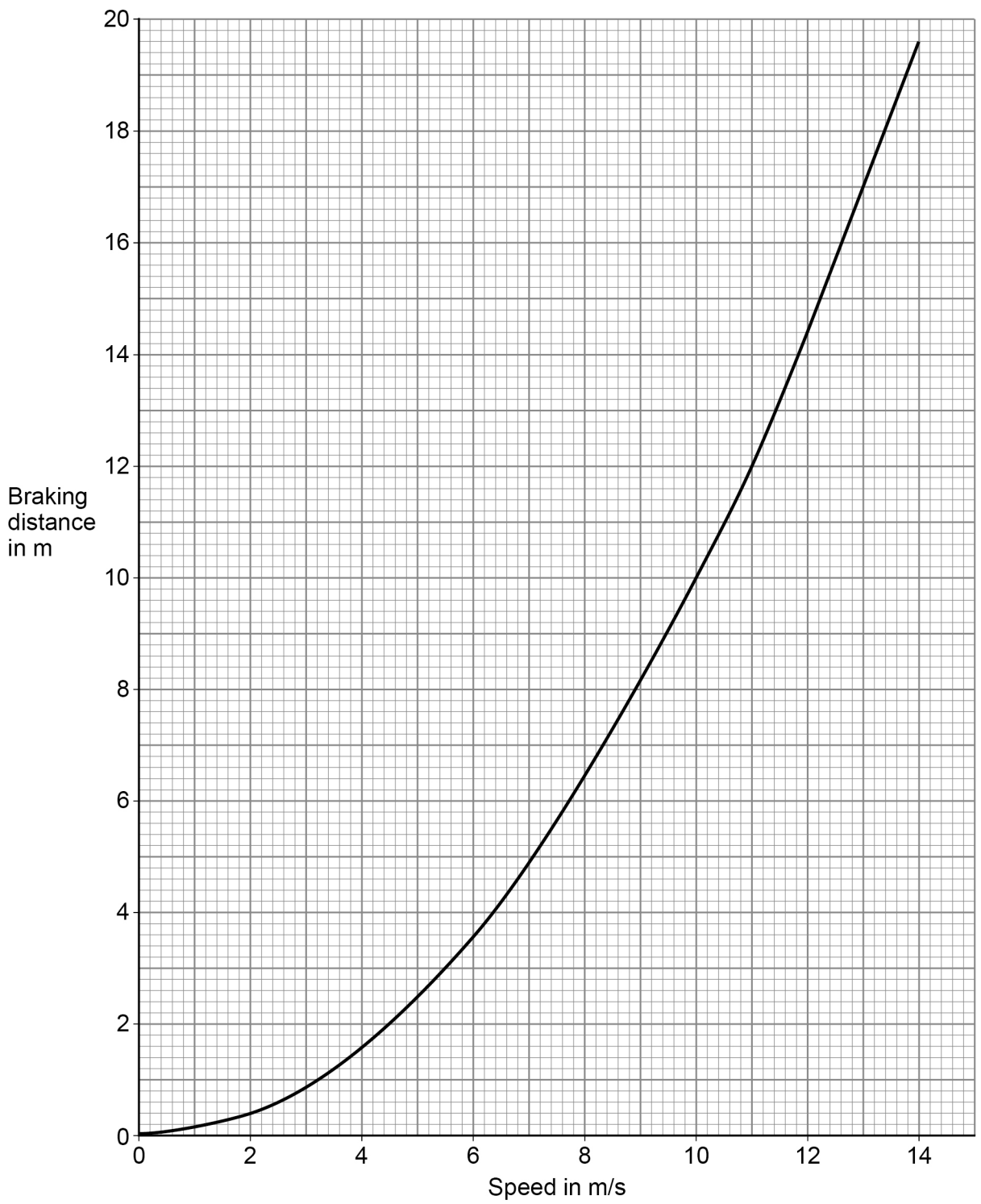
Question 25 · continued

The car was driven at a constant speed. The driver applied the maximum braking force, and the braking distance was measured.

The test was repeated at different speeds.

Figure 8 shows the results.

Figure 8



6.5.4.1.2 Speed

Question 25 · continued

0 5 . 3 Which of the following gives the relationship between the speed and the braking distance?

[1 mark]

Tick (✓) **one** box.

braking distance $\propto \frac{1}{\text{speed}}$ ☐

braking distance $\propto$ speed ☐

braking distance $\propto$ speed^2 ☐

0 5 . 4 During one test the brakes were applied with a force of 6250 N.

The deceleration of the car was 5.0 m/s^2.

The braking distance of the car was 14.4 m.

Determine the momentum of the car before the brakes were applied.

Use the Physics Equations Sheet.

Use **Figure 8**.

[6 marks]

Momentum = _____ kg m/s

12

6.5.4.1.2 Speed

Question 26

0 1 In a dog-sled race, a team of dogs pull on a rope attached to a sled.

Figure 1 shows a dog-sled team.

Figure 1



Use the Physics Equations Sheet to answer questions **01.1** and **01.2**.

0 1 . 1 What equation links distance travelled, speed and time?

[1 mark]

Tick (✓) **one** box.

distance travelled = speed × time ☐

speed = time × distance travelled ☐

time = distance travelled × speed ☐

6.5.4.1.2 Speed

Question 26 · continued

0 1 . 2 The longest dog-sled race in the world covers a distance of 1 500 000 m.

One team finished the race in a time of 670 000 s.

Calculate the average speed of this team during the race.

[3 marks]

Average speed = _____ m/s

0 1 . 3 At the start of the race, 6 dogs pulled on the rope.

The average forward force on the sled from **each** dog was 370 N.

The backwards force on the sled from friction was 520 N.

Calculate the resultant force on the sled.

[2 marks]

Resultant force = _____ N

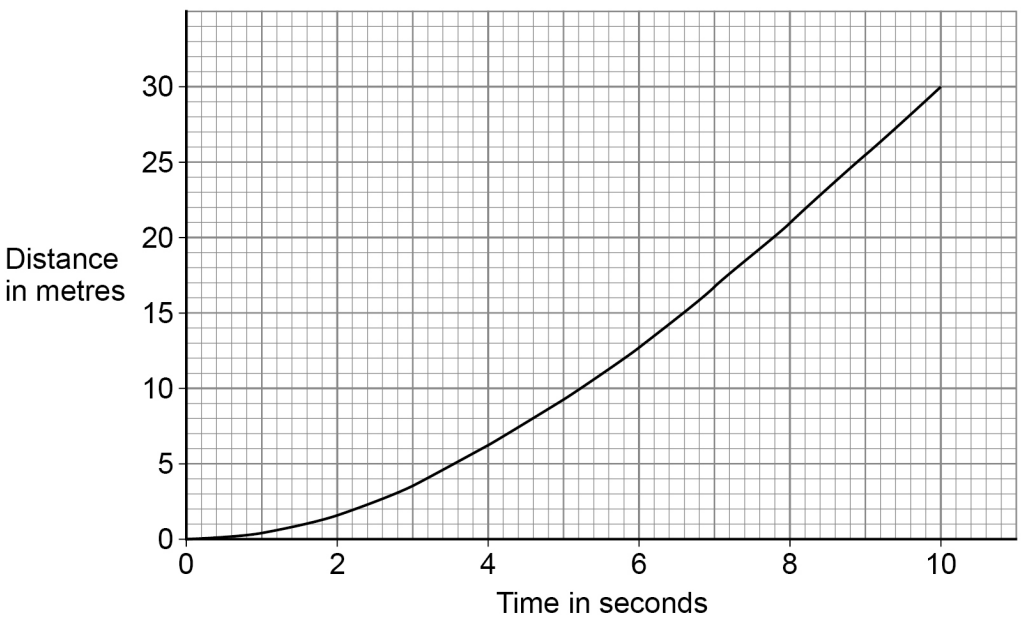
Question 1 continues on the next page

6.5.4.1.2 Speed

Question 26 · continued

Figure 2 shows a distance–time graph for the sled at the start of the race.

Figure 2



0 1 . 4 What does the gradient of the graph in **Figure 2** represent?

[1 mark]

6.5.4.1.2 Speed

Question 26 · continued

0 1 . 5 Later in the race, the sled moved at a constant speed along a flat, horizontal path.

What was the relationship between the size of the horizontal forces acting when the sled moved at a constant speed?

[1 mark]

Tick (✓) **one** box.

friction + air resistance < pull of the rope on the sled ☐

friction + air resistance = pull of the rope on the sled ☐

friction + air resistance > pull of the rope on the sled ☐

0 1 . 6 The rope exerted a force on the sled when the sled was moving.

What is the Newton's Third Law pair to the force of the rope on the sled?

[1 mark]

Tick (✓) **one** box.

The force of friction on the sled ☐

The force of the dogs on the rope ☐

The force of the sled on the rope ☐

9

6.5.4.1.2 Speed

Question 27

0 2 The stopping distance of a car is affected by the condition of the brakes and tyres.

A car is being driven around a corner when the driver sees some roadworks.

0 2 . 1 The driver applies the brakes when the car is 24 m away from the roadworks.

The velocity of the car changes from 18 m/s to 0 m/s.

Calculate the constant deceleration needed to stop the car in a distance of 24 m.

Use the Physics Equations Sheet.

[3 marks]

Deceleration = _____ m/s^2

6.5.4.1.2 Speed

Question 27 · continued

0 2 . 2 As a safety measure, the speed limit on the road was reduced.

Explain how the safety of road users is affected by:

- the condition of the brakes and tyres
- reduced speed.

You should refer to thinking distance and braking distance.

[6 marks]

Extra space

Question 2 continues on the next page

6.5.4.1.2 Speed

Question 27 · continued

0 2 . 3 Two identical cars were driven along a straight, level road.

One car had a greater speed than the other car.

The driver of each car applied the brakes until the cars stopped.

Both cars travelled the same distance while braking.

Explain how braking from a greater speed affected the risk of the brakes overheating.

[3 marks]

12

6.5.4.1.2 Speed

Question 28

0 3 A pair of sunglasses has lenses that absorb all ultraviolet and some visible light.

0 3 . 1 Ultraviolet and visible light are both transverse waves.

What is meant by 'transverse waves'?

[2 marks]

0 3 . 2 Ultraviolet can cause sunburn and eye damage.

Give **one** other risk to health from exposure to ultraviolet.

[1 mark]

0 3 . 3 Complete the sentence.

[1 mark]

Compared with the wavelength of visible light, the wavelength of ultraviolet is _____.

Question 3 continues on the next page

6.5.4.1.2 Speed

Question 28 · continued

0 3 . 4 A wave of visible light has a frequency of 6.25×10^{14} Hz.

speed of light = 3.00×10^{8} m/s

Calculate the wavelength of this light.

Use the Physics Equations Sheet.

Give your answer in nanometres (nm).

[4 marks]

Wavelength = _____ nm

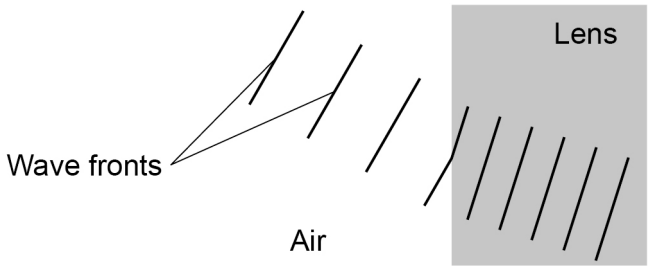
6.5.4.1.2 Speed

Question 28 · continued

0 3 . 5 A ray of visible light incident on the lens in a pair of sunglasses is refracted.

Figure 3 shows a wave front diagram for visible light incident on the lens.

Figure 3



For each wave front, one end of the wave front enters the lens before the other end.

Explain why the light refracts as it enters the lens.

[2 marks]

Question 3 continues on the next page

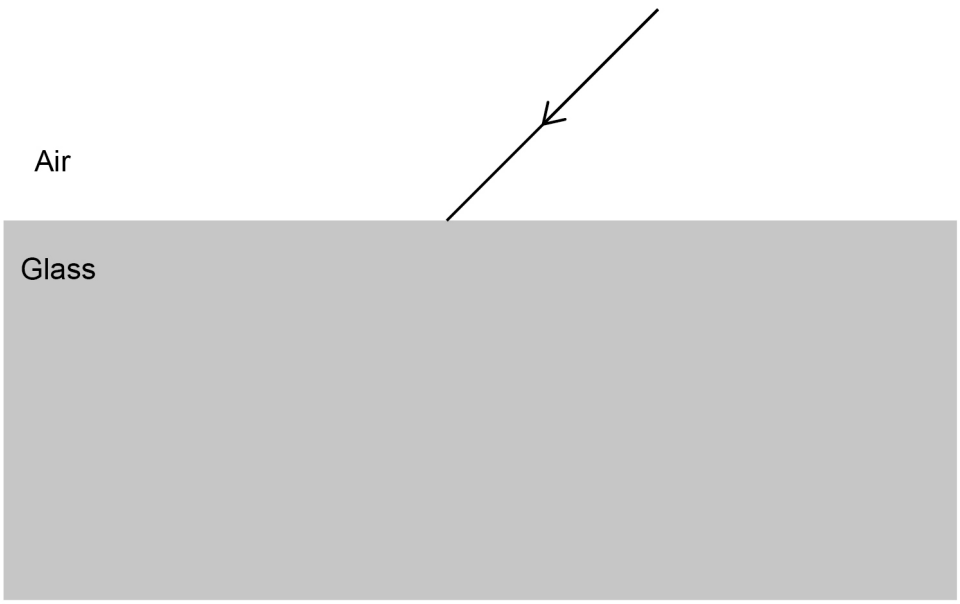
6.5.4.1.2 Speed

Question 28 · continued

0 3 . 6 **Figure 4** shows a ray of visible light incident on glass.

The angle of incidence is 45°.

Figure 4



The angle of refraction of the ray in the glass is 28°.

Complete the ray diagram in **Figure 4** to show the path of the ray in the glass.

You should:

- draw the normal line
- draw the refracted ray in the glass.

You do **not** need to draw the ray leaving the glass.

[2 marks]

12

6.5.4.1.2 Speed

Question 29

June 2025 | 8464/P/2H | Original Q6

0 6 A triathlon race consists of swimming, cycling and running.

0 6 . 1 One athlete in a triathlon swims at a speed of 1.5 m/s.

How does the athlete's swimming speed compare with the typical speed of a person walking?

[1 mark]

Tick (✓) **one** box.

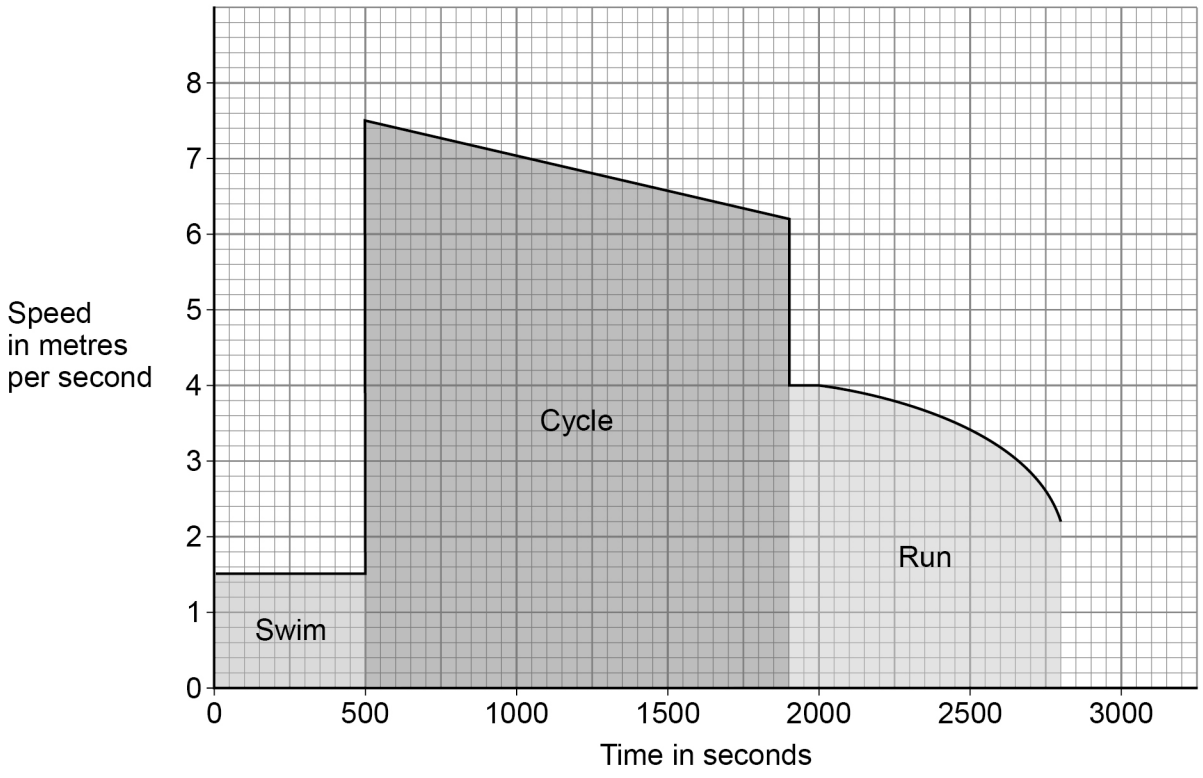
athlete's swimming speed > typical walking speed ☐

athlete's swimming speed = typical walking speed ☐

athlete's swimming speed < typical walking speed ☐

Figure 8 shows a speed–time graph for the athlete for the whole triathlon.

Figure 8



Question 29 · continued

0 6 . 2 The cycling part of the race was on a straight road.

The work done by the forward force on the bicycle was 110 000 J.

Determine the mean forward force on the bicycle.

Use the Physics Equations Sheet.

[6 marks]

Mean forward force = _____ N

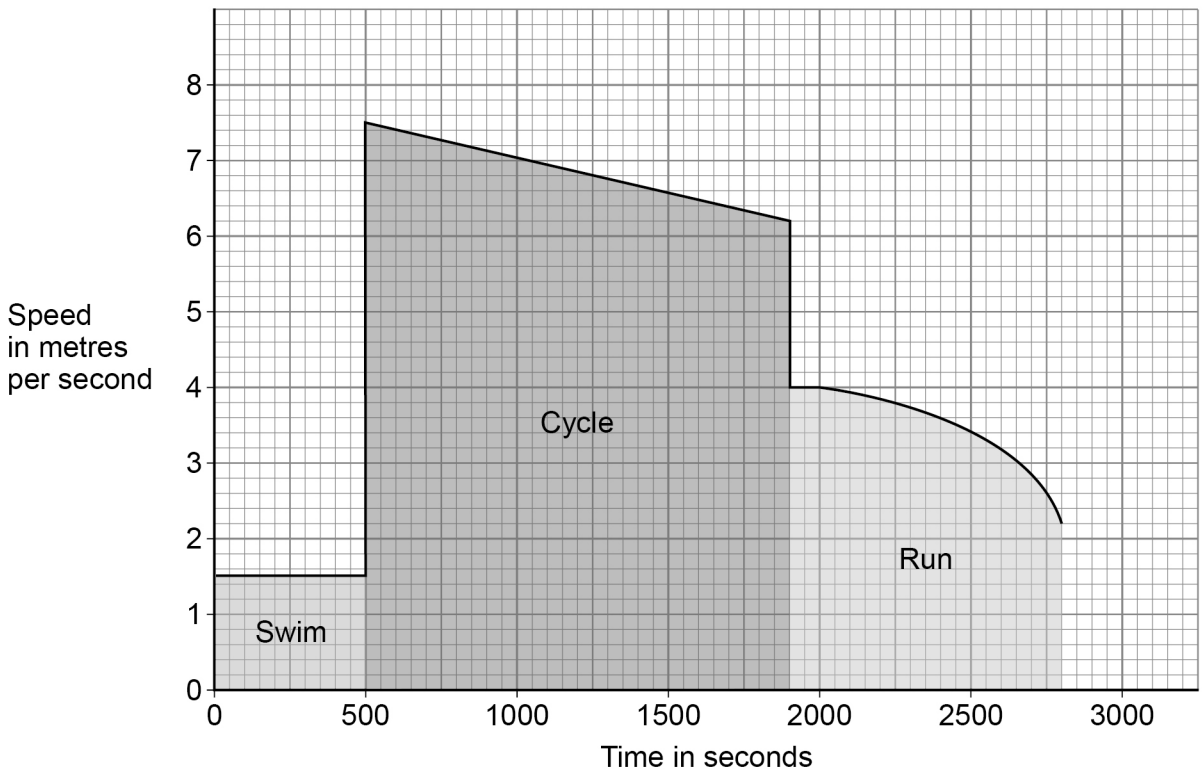
Question 6 continues on the next page

6.5.4.1.2 Speed

Question 29 · continued

Figure 8 is repeated below.

Figure 8



0 6 . 3 The first part of the **run** was on a circular track.

The time taken for the athlete to run round the track was 100 s.

Describe the velocity of the athlete during the first 100 s of the **run**.

Use **Figure 8**.

[2 marks]

6.5.4.1.2 Speed

Question 29 · continued

0 6 . 4 After running round the track once, the rest of the run was on a straight, horizontal road.

Explain how **Figure 8** shows that the magnitude of the deceleration of the athlete increased.

[2 marks]

11