AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.6.1.4

The distance–time relationship

Past-paper questions

Tier	**Higher**
Question groups	**27**
Available paper years	**2004–2023**

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:** _____

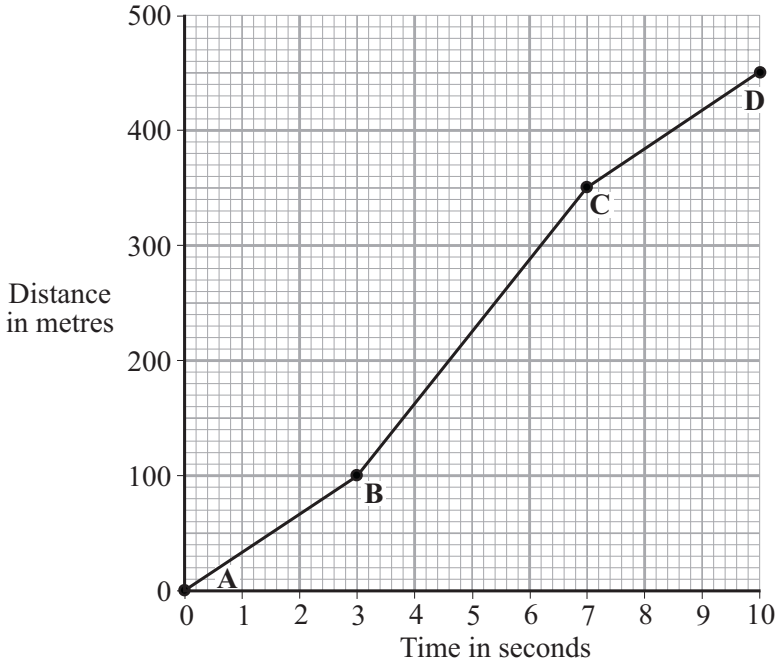
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.5.6.1.4 The distance–time relationship

Question 01

June 2004 | 3451H | Original Q9 | Legacy

9 The distance-time graph represents the motion of a car during a race.



(a) Describe the motion of the car between point **A** and point **D**. You should not carry out any calculations.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

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(3 marks)

(b) Calculate the gradient of the graph between point **B** and point **C**. Show clearly how you get your answer.

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.....

.....

gradient =.....

(3 marks)

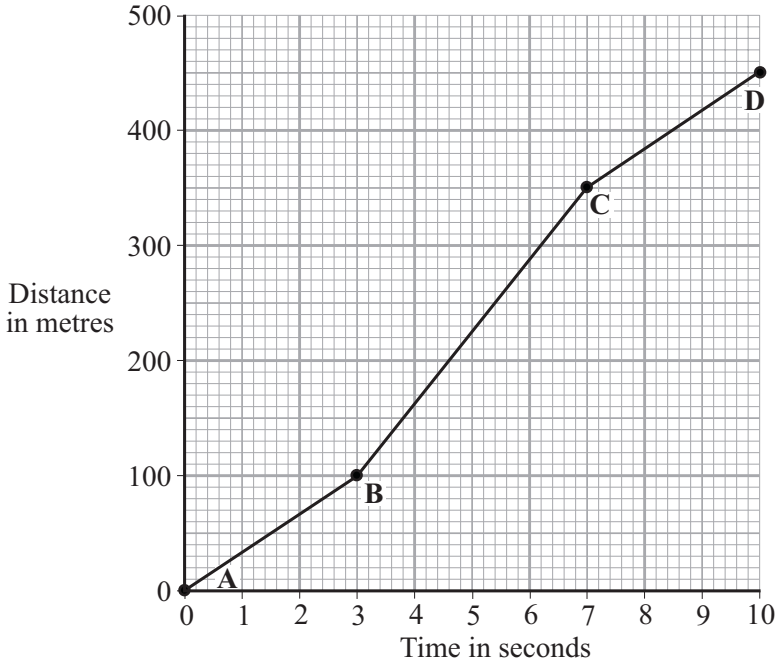
6

4.5.6.1.4 The distance–time relationship

Question 02

June 2004 | 3462H3 | Original Q7 | Legacy

7 The distance-time graph represents the motion of a car during a race.



(a) Describe the motion of the car between point **A** and point **D**. You should not carry out any calculations.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

(3 marks)

(b) Calculate the gradient of the graph between point **B** and point **C**. Show clearly how you get your answer.

.....

.....

.....

gradient =.....

(3 marks)

6

4.5.6.1.4 The distance–time relationship

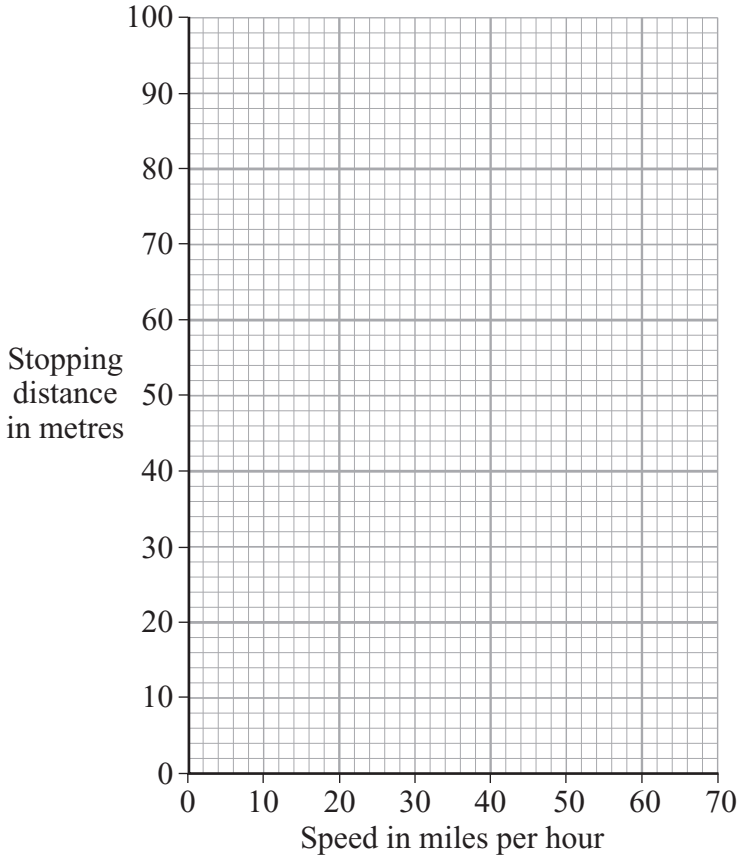
Question 03

June 2006 | 3451 | Original Q4 | Legacy

4 (a) The table shows how the stopping distance of a car, in metres (m), depends on the speed of the car, in miles per hour (mph).

Speed (mph)	20	30	40	50	60	70
Stopping distance (m)	12	23	36	53	73	96

(i) Draw a graph of stopping distance against speed.



(3 marks)

(ii) The speed limit outside a school is 20 mph.

Use the graph to estimate **how much further** a car will travel before it stops when driven at 25 mph instead of 20 mph.

Show clearly how you work out your answer.

.....

.....

(2 marks)

Question 4 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 03 · continued

June 2006 | 3451 | Original Q4 | Legacy

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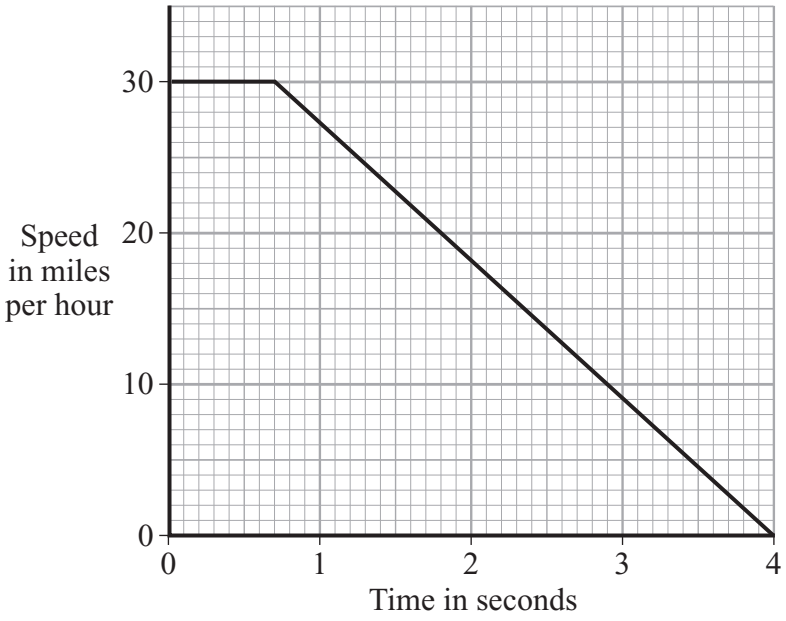
(b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



(i) What was the driver's reaction time?

.....

(1 mark)

(ii) Describe the motion of the car during the first 0.5 seconds.

.....

(1 mark)

(iii) How long did it take the car to stop once the brakes were applied?

.....

(1 mark)

(iv) The drug cannabis makes the reactions of a person slower.

Explain how the stopping distance of the car would change if the driver had been smoking cannabis.

.....

.....

.....

.....

(2 marks)

4.5.6.1.4 The distance–time relationship

Question 03 · continued

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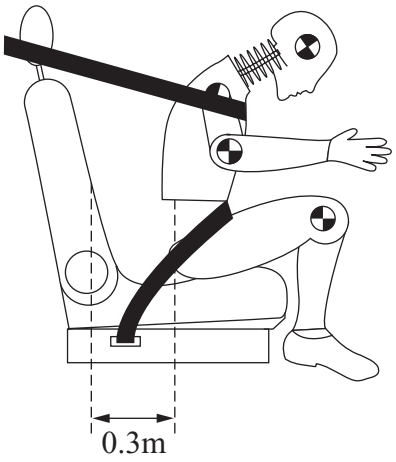
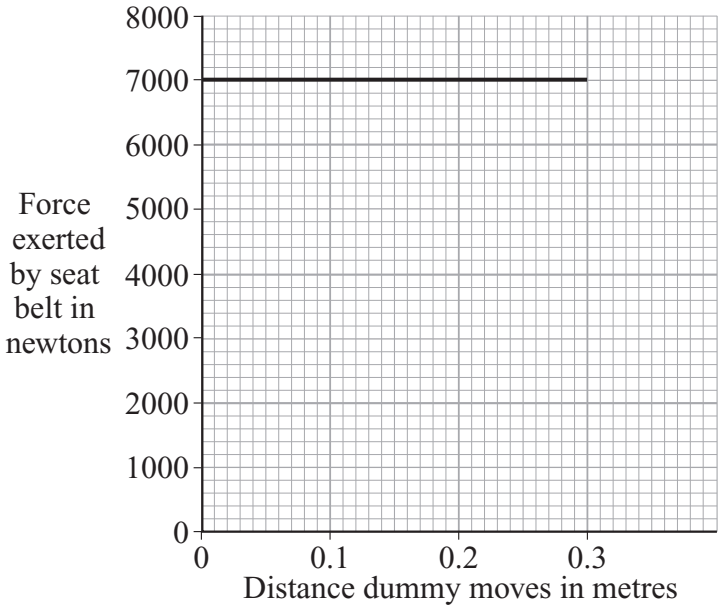
(c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.





(i) Write down the equation that links distance moved, force applied and work done.

.....

(1 mark)

(ii) Calculate the work done to stop the dummy.

Show clearly how you work out your answer.

.....

.....

.....

Work done = ... joules

(2 marks)

(iii) How much energy is transferred from the dummy during the crash?

.....

(1 mark)

14

4.5.6.1.4 The distance–time relationship

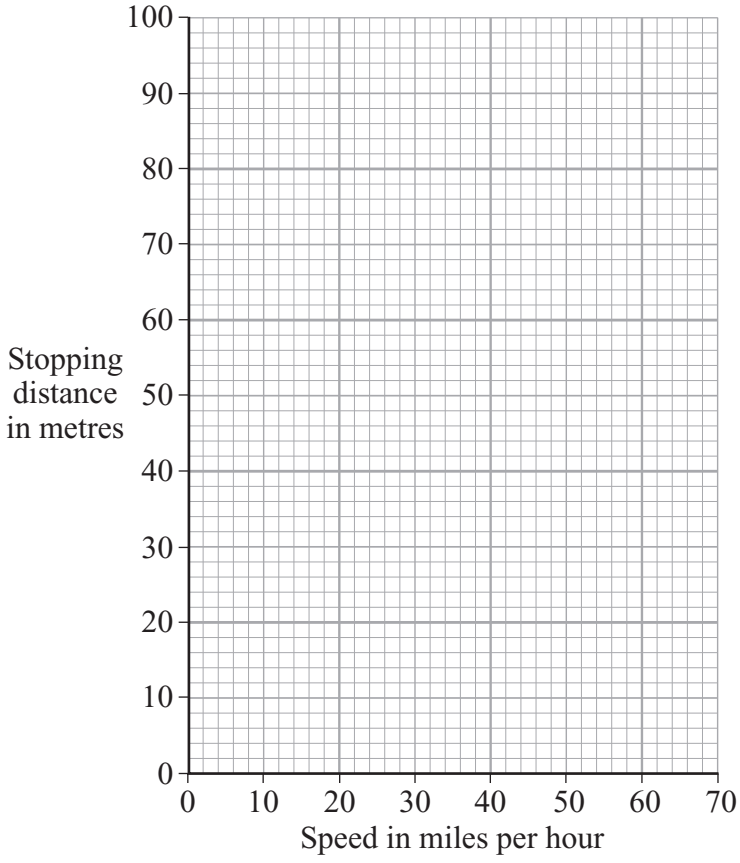
Question 04

June 2006 | 3462 | Original Q4 | Legacy

4 (a) The table shows how the stopping distance of a car, in metres (m), depends on the speed of the car, in miles per hour (mph).

Speed (mph)	20	30	40	50	60	70
Stopping distance (m)	12	23	36	53	73	96

(i) Draw a graph of stopping distance against speed.



(3 marks)

(ii) The speed limit outside a school is 20 mph.

Use the graph to estimate **how much further** a car will travel before it stops when driven at 25 mph instead of 20 mph.

Show clearly how you work out your answer.

.....

.....

(2 marks)

Question 4 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 04 · continued

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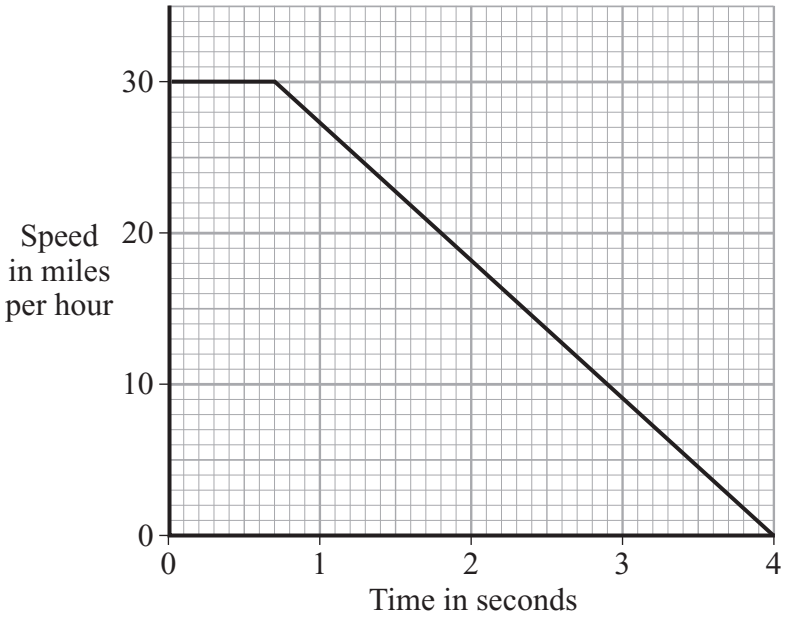
(b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



(i) What was the driver's reaction time?

.....

(1 mark)

(ii) Describe the motion of the car during the first 0.5 seconds.

.....

(1 mark)

(iii) How long did it take the car to stop once the brakes were applied?

.....

(1 mark)

(iv) The drug cannabis makes the reactions of a person slower.

Explain how the stopping distance of the car would change if the driver had been smoking cannabis.

.....

.....

.....

.....

(2 marks)

4.5.6.1.4 The distance–time relationship

Question 04 · continued

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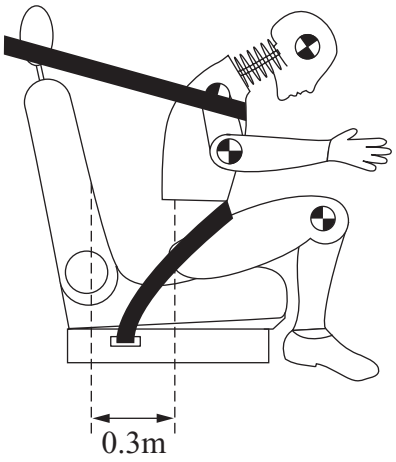
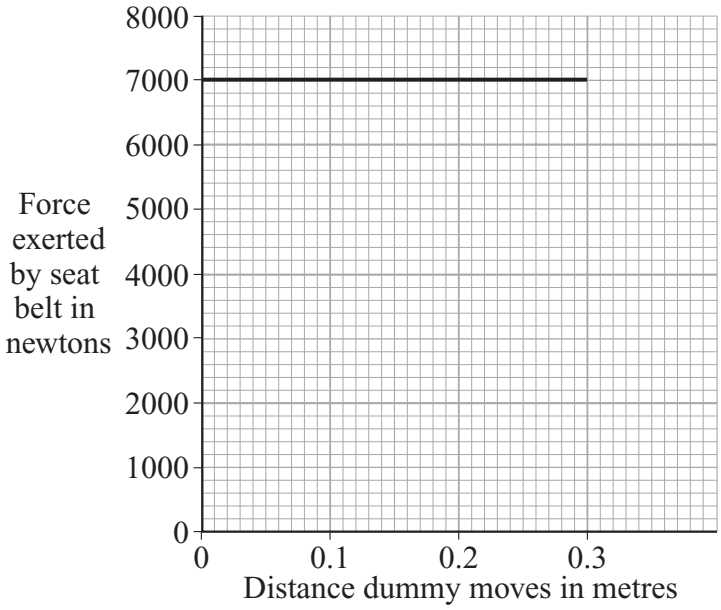
(c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.





(i) Write down the equation that links distance moved, force applied and work done.

.....

(1 mark)

(ii) Calculate the work done to stop the dummy.

Show clearly how you work out your answer.

.....

.....

.....

Work done = ... joules

(2 marks)

(iii) How much energy is transferred from the dummy during the crash?

.....

(1 mark)

14

4.5.6.1.4 The distance–time relationship

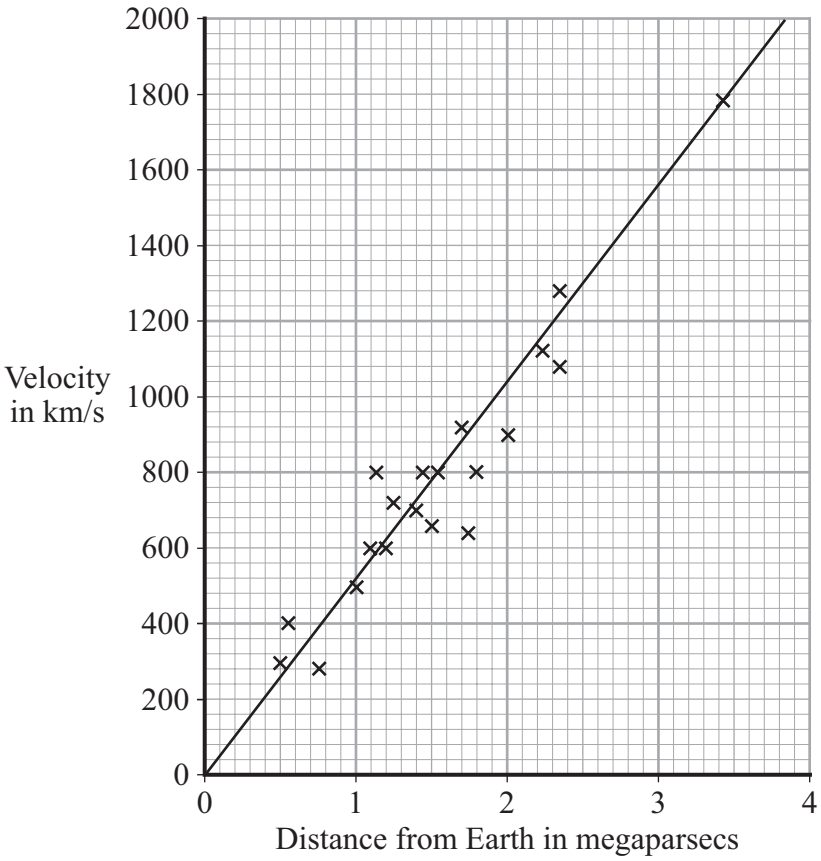
Question 05

November 2007 | PHY1B | Original Q9 | Legacy

QUESTION NINE

The astronomer Hubble calculated the distance of many galaxies from Earth. He also calculated the velocity at which many galaxies are moving away from Earth.

The graph shows some of his results. The distance is given in megaparsecs. One parsec is approximately equal to 30 000 000 000 km.



9A The data in the graph suggests that . . .

1 the further away the galaxy is from Earth, the slower it is moving.

2 all galaxies move at different velocities.

3 the velocity of a galaxy is proportional to its distance away from Earth.

4 there is no relationship between the speed of a galaxy and its distance away from Earth.

4.5.6.1.4 The distance–time relationship

9B The gradient of the line of best fit on the graph is known as the Hubble constant. The Hubble constant can be used to estimate the age of the Universe.

From this data, the approximate value of the Hubble constant in km/s per megaparsec is . . .

1 4.

2 500.

3 1000.

4 2000.

9C Modern astronomers calculate that the **actual** value of the Hubble constant is somewhere between 46 and 80 km/s per megaparsec.

This is very different from the number calculated from the graph.

This is because Hubble's measurements had . . .

1 random errors.

2 systematic errors.

3 zero errors.

4 lack of precision.

9D The Andromeda galaxy is moving towards our own Milky Way galaxy.

This means that, as viewed from Earth, light from the Andromeda galaxy will . . .

1 be shifted towards the red end of the spectrum.

2 show an increase in wavelengths.

3 be shifted towards the blue end of the spectrum.

4 show a decrease in frequencies.

END OF TEST

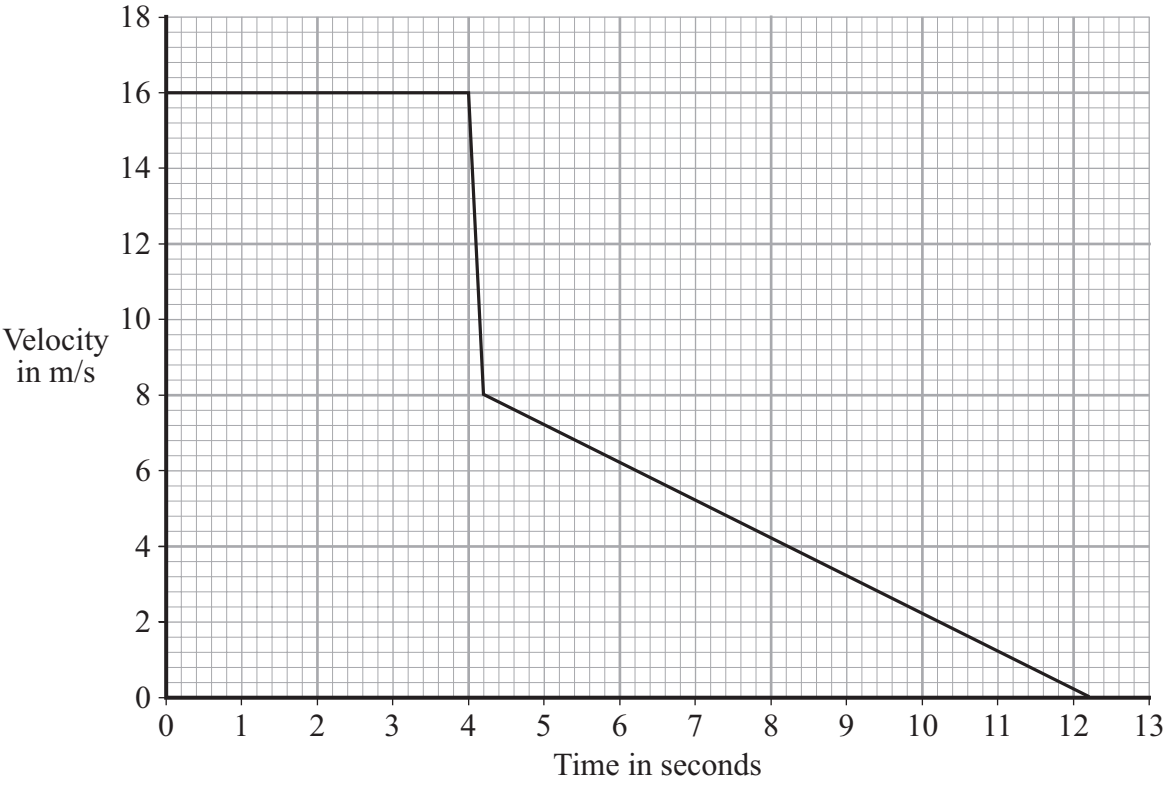
4.5.6.1.4 The distance–time relationship

Question 06

January 2008 | PHY2H | Original Q6 | Legacy

6 In an experiment at an accident research laboratory, a car driven by remote control was crashed into the back of an identical stationary car. On impact the two cars joined together and moved in a straight line.

(a) The graph shows how the *velocity* of the remote-controlled car changed during the experiment.



(i) How is the *velocity* of a car different from the speed of a car?

.....

(1 mark)

(ii) Use the graph to calculate the distance travelled by the remote-controlled car before the collision.

Show clearly how you work out your answer.

.....

.....

Distance = ... m

(2 marks)

4.5.6.1.4 The distance–time relationship

Question 06 · continued

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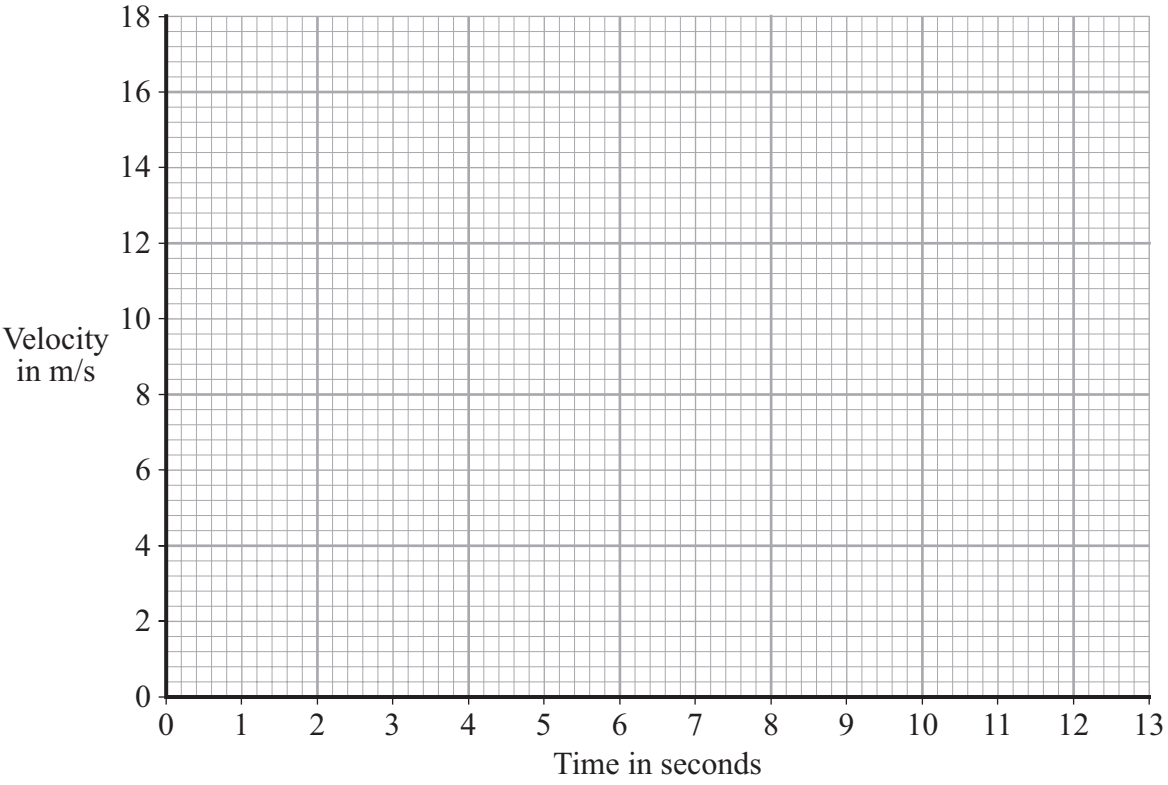
(iii) Draw, on the grid below, a graph to show how the velocity of the second car changed during the experiment.



(2 marks)

(iv) The total momentum of the two cars was not conserved.

What does this statement mean?

.....

.....

(1 mark)

Question 6 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 06 · continued

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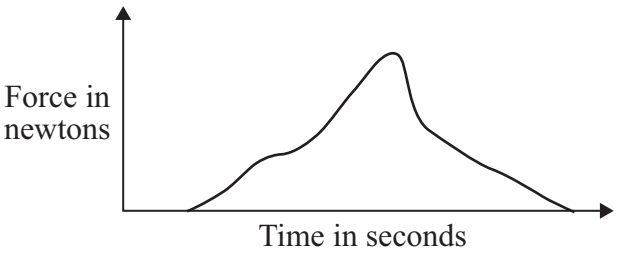
(b) The graph line shows how the force from a seat belt on a car driver changes during a collision.



Scientists at the accident research laboratory want to develop a seat belt that produces a constant force throughout a collision.

Use the idea of momentum to explain why this type of seat belt would be better for a car driver.

.....

.....

.....

.....

(2 marks)

8

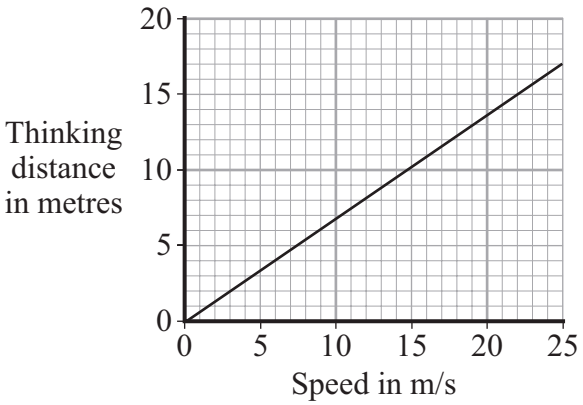
4.5.6.1.4 The distance–time relationship

Question 07

June 2008 | PHY2H | Original Q3 | Legacy

3 (a) A car driver takes a short time to react to an emergency before applying the brakes. The distance the car will travel during this time is called the 'thinking distance'.

The graph shows how the thinking distance of a driver depends on the speed of the car.



3 (a) (i) What is the connection between thinking distance and speed?

.....

(1 mark)

3 (a) (ii) Many people drive while they are tired.

Draw a new line on the graph to show how thinking distance changes with speed for a tired driver.

(1 mark)

3 (a) (iii) The graph was drawn using data given in the Highway Code.

Do you think that the data given in the Highway Code is likely to be reliable?

Draw a ring around your answer.

Yes **No** **Maybe**

Give a reason for your answer.

.....

.....

(1 mark)

Question 3 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 07 · continued

for mark

3 (b) The distance a car travels once the brakes are applied is called the 'braking distance'.

3 (b) (i) What is the relationship between thinking distance, braking distance and stopping distance?

.....

(1 mark)

3 (b) (ii) State **two** factors that could increase the braking distance of a car at a speed of 15 m/s.

1 .....

2 .....

(2 marks)

6

4.5.6.1.4 The distance–time relationship

Question 08

January 2009 | PHY1H | Original Q5 | Legacy

5 (a) Microwaves are one type of electromagnetic wave.

5 (a) (i) Which type of electromagnetic wave has a lower frequency than microwaves?

.....

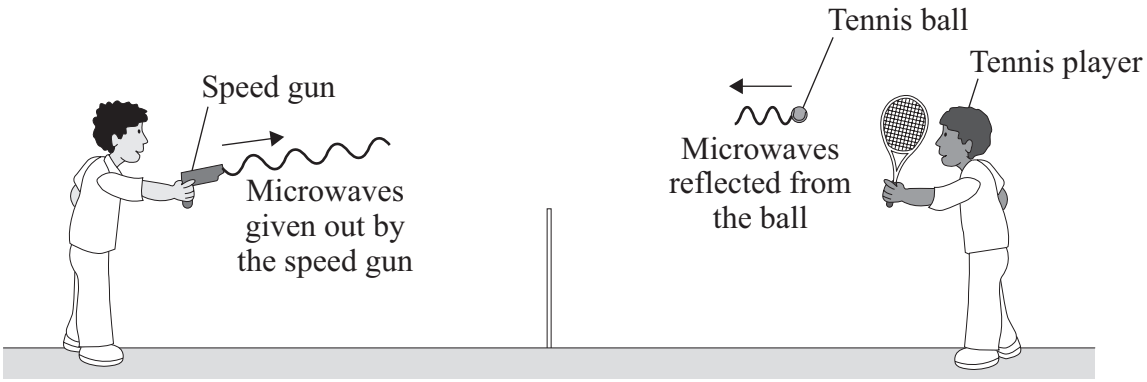
(1 mark)

5 (a) (ii) What do all types of electromagnetic wave transfer from one place to another?

.....

(1 mark)

5 (b) The picture shows a tennis coach using a speed gun to measure how fast the player serves the ball.



5 (b) (i) The microwaves transmitted by the speed gun have a frequency of 24 000 000 000 Hz and travel through the air at 300 000 000 m/s.

Use the equation in the box to calculate the wavelength of the microwaves emitted from the speed gun.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

Wavelength = ... m

(2 marks)

4.5.6.1.4 The distance–time relationship

Question 08 · continued

for mark

5 (b) (ii) Some of the microwaves transmitted by the speed gun are absorbed by the ball.

What effect will the absorbed microwaves have on the ball?

.....

.....

(1 mark)

5 (b) (iii) Some of the microwaves transmitted by the speed gun are reflected from the moving ball back towards the speed gun.

Describe how the wavelength and frequency of the microwaves change as they are reflected from the moving ball.

.....

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.....

.....

(2 marks)

Question 5 continues on the next page

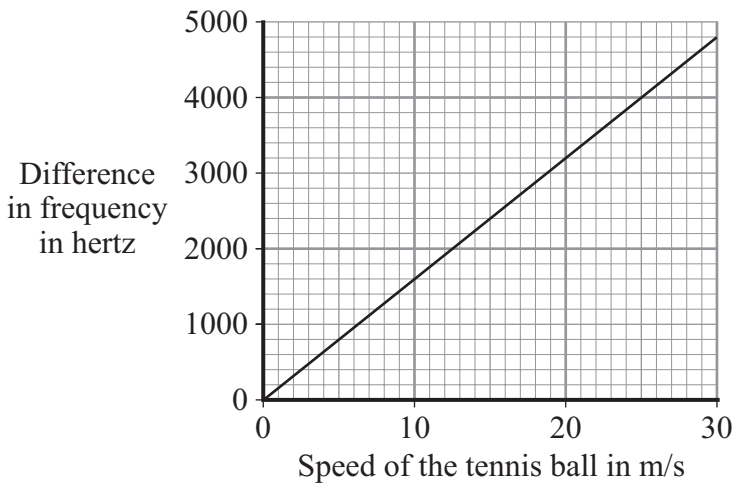
4.5.6.1.4 The distance–time relationship

Question 08 · continued

for mark

5 (c) The difference in frequency between the transmitted and reflected waves is detected by the speed gun. This data is processed by a computer chip inside the speed gun, and then displayed as a speed.

5 (c) (i) The graph shows that the difference in frequency between the transmitted and reflected waves is directly proportional to the speed of the moving ball.



Why has a line graph been used to display the data?

.....

.....

(1 mark)

5 (c) (ii) Is it better to transfer the data to the computer as an analogue signal or as a digital signal?

.....

Give a reason for your answer.

.....

.....

(1 mark)

4.5.6.1.4 The distance–time relationship

Question 08 · continued

for mark

5 (c) (iii) What is the difference between an analogue signal and a digital signal?

You may draw a labelled diagram to help you with your answer.

.....

.....

.....

.....

(2 marks)

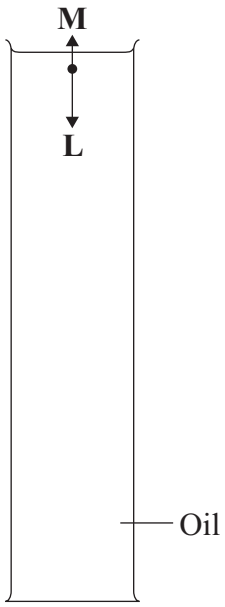
11

4.5.6.1.4 The distance–time relationship

Question 09

June 2009 | PHY2H | Original Q3 | Legacy

3 (a) The diagram shows a steel ball-bearing falling through a tube of oil.
The forces, **L** and **M**, act on the ball-bearing.



What causes force **L**?

.....

(1 mark)

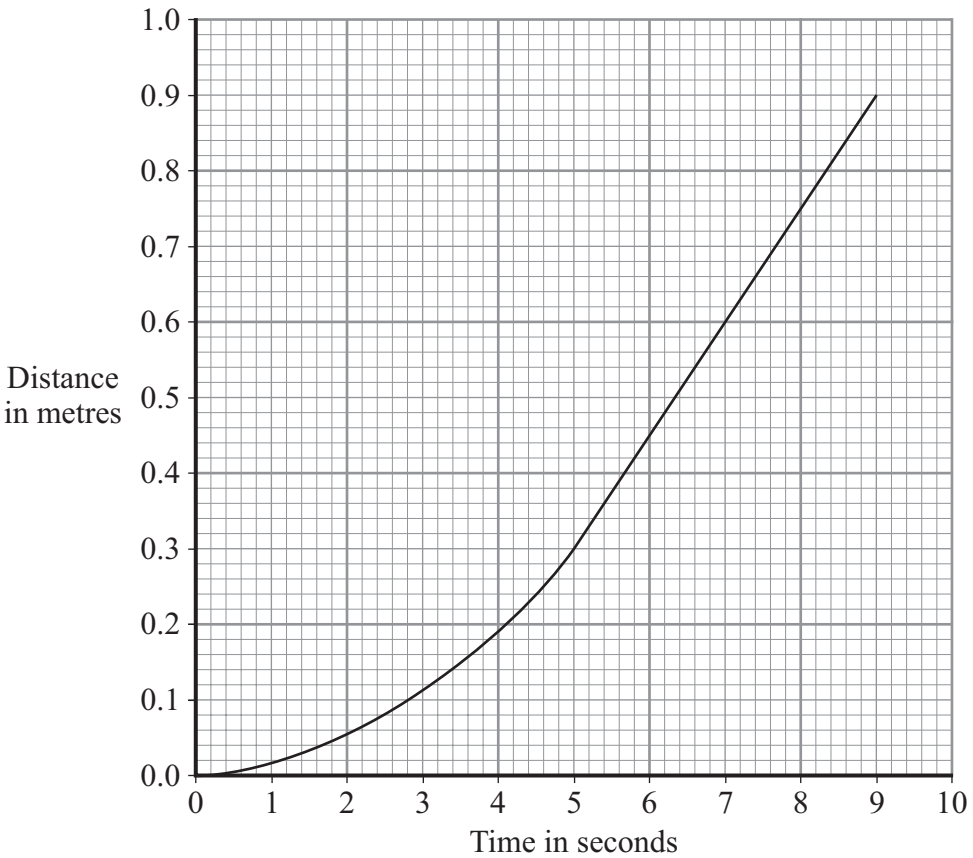
Question 3 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 09 · continued

for mark

3 (b) The distance–time graph represents the motion of the ball-bearing as it falls through the oil.



3 (b) (i) Explain, in terms of the forces, **L** and **M**, why the ball-bearing accelerates at first but then falls at constant speed.

.....

.....

.....

.....

.....

.....

(3 marks)

3 (b) (ii) What name is given to the constant speed reached by the falling ball-bearing?

.....

(1 mark)

4.5.6.1.4 The distance–time relationship

Question 09 · continued

for mark

3 (b) (iii) Calculate the constant speed reached by the ball-bearing.

Show clearly how you use the graph to work out your answer.

.....

.....

.....

Speed = ... m/s

(2 marks)

7

Turn over for the next question

4.5.6.1.4 The distance–time relationship

Question 10

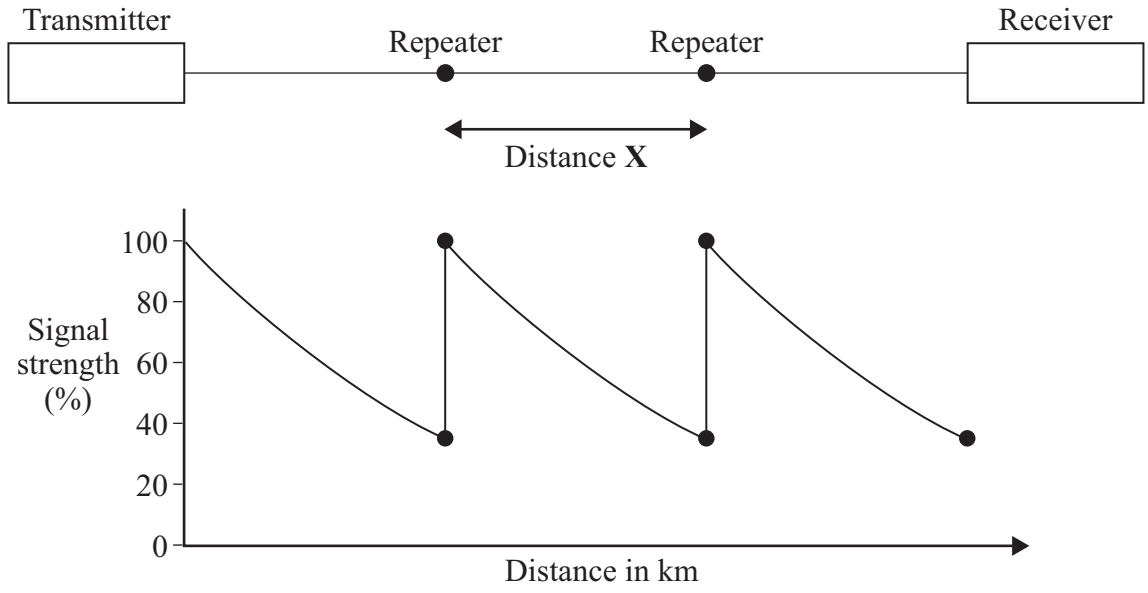
November 2009 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Information can be sent along optical fibres in the form of pulses. These pulses become weaker as they pass along the fibre.

In the early development of the fibres, the signal strength halved every 10 km. To overcome this, devices called 'repeaters' were inserted into the optical fibre system to boost the signal to its original strength.

The diagram shows one of the early systems. The graph shows how the signal strength changes with distance.



8A A signal is transmitted along the optical fibre. The power at the transmitter is 2 mW.

In the absence of any 'repeater', what would the power of the signal be after 30 km?

1 0.000 mW

2 0.125 mW

3 0.250 mW

4 0.333 mW

8B Using the graph, the distance **X** between the 'repeaters' is between . . .

1 0 – 10 km

2 10 – 20 km

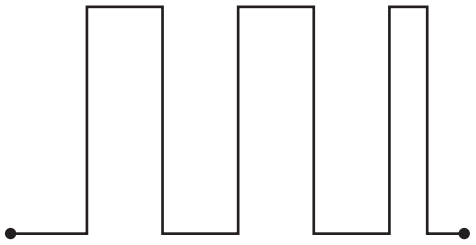
3 20 – 30 km

4 30 – 40 km

4.5.6.1.4 The distance–time relationship

Question 10 · continued

8C The transmitter sends out three pulses as shown. (All diagrams are drawn to the same scale.)

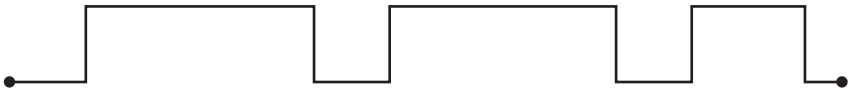


Just before the pulses reach the first 'repeater', they would look like . . .

1



2



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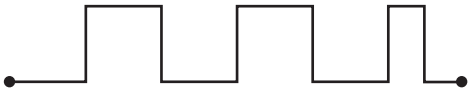

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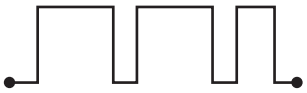


8D The use of optical fibres, between transmitter and receiver, has had a significant effect on the transmission of signals in . . .

1 landline phones.

2 mobile phones.

3 satellite communication.

4 wifi (wireless communication).

4.5.6.1.4 The distance–time relationship

Question 11

1 A cyclist travelling along a straight level road accelerates at 1.2 m/s^2 for 5 seconds. The mass of the cyclist and the bicycle is 80 kg.

1 (a) Use the equation in the box to calculate the resultant force needed to produce this acceleration.

resultant force = mass × acceleration

Show clearly how you work out your answer and give the unit.

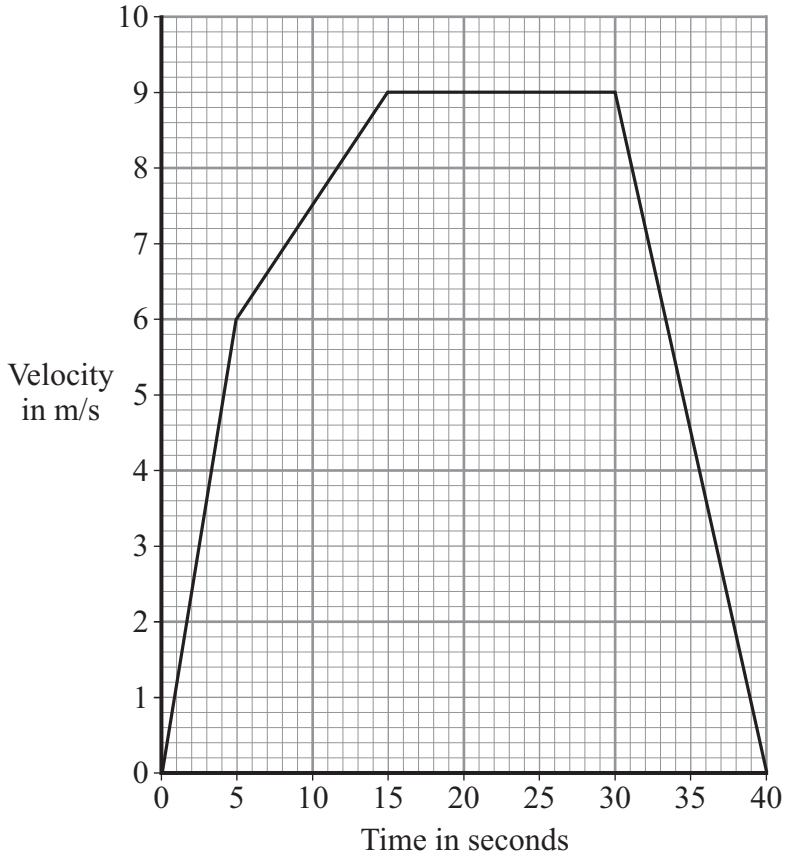
.....

.....

Resultant force = ...

(3 marks)

1 (b) The graph shows how the velocity of the cyclist changes with time.



4.5.6.1.4 The distance–time relationship

Question 11 · continued

for mark

1 (b) (i) Complete the following sentence.

The velocity includes both the speed and the ..... of the cyclist.

(1 mark)

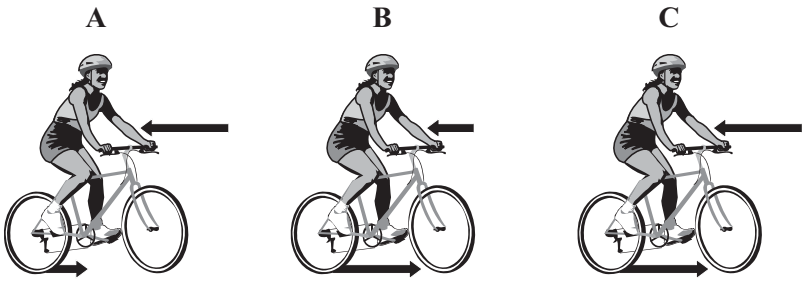
1 (b) (ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

.....

.....

(1 mark)

1 (b) (iii) The diagrams show the horizontal forces acting on the cyclist at three different speeds. The length of an arrow represents the size of the force.



Which **one** of the diagrams, **A**, **B** or **C**, represents the forces acting when the cyclist is travelling at a constant 9 m/s?

.....

Explain the reason for your choice.

.....

.....

.....

.....

.....

.....

(3 marks)

8

4.5.6.1.4 The distance–time relationship

Question 12

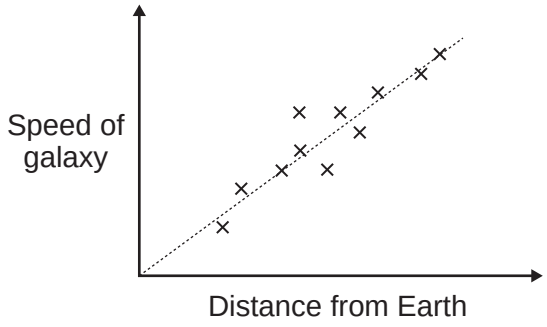
June 2010 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Red-shift measurements can be used to calculate the speed at which a galaxy is moving relative to the Earth.

Astronomers have also measured the distance of some galaxies from the Earth.

They have drawn their results on a graph.



8A The graph shows that . . .

1 all galaxies have the same speed.

2 distant galaxies are moving faster than nearer galaxies.

3 nearer galaxies are moving faster than more distant galaxies.

4 there is no relationship between how far galaxies are from the Earth and how fast they move.

8B Which of the following is the best description of red-shift? . . .

1 The light from galaxies is coloured red.

2 The light from galaxies is mainly at the red end of the spectrum.

3 The wavelength of light from galaxies shows a movement away from the red end of the spectrum.

4 The wavelength of light from galaxies shows a movement towards the red end of the spectrum.

8C Red-shift is described as . . .

1 the increased speed of the electromagnetic radiation as it travels from the galaxy.

2 the observed increase in frequency of the electromagnetic radiation leaving the galaxy.

3 the observed increase in wavelength of the electromagnetic radiation leaving the galaxy.

4 the decreased speed of the electromagnetic radiation as it travels from the galaxy.

4.5.6.1.4 The distance–time relationship

Question 12 · continued June 2010 | PHY1BP | Original Q8 | Legacy

8D The observation of red-shift gives evidence to support the ‘big bang’ theory.

This theory states that . . .

1 the stars in each galaxy are moving further apart.

2 galaxies started to rotate after the ‘big bang’.

3 new galaxies are created by an explosion in space.

4 the universe started from a single initial point.

Turn over for the next question

4.5.6.1.4 The distance–time relationship

Question 13

June 2010 | PHY1H | Original Q6 | Legacy

6 (a) In 1929, the astronomer Edwin Hubble observed that the light from galaxies that are moving away from the Earth showed a *red-shift*.

What is *red-shift*?

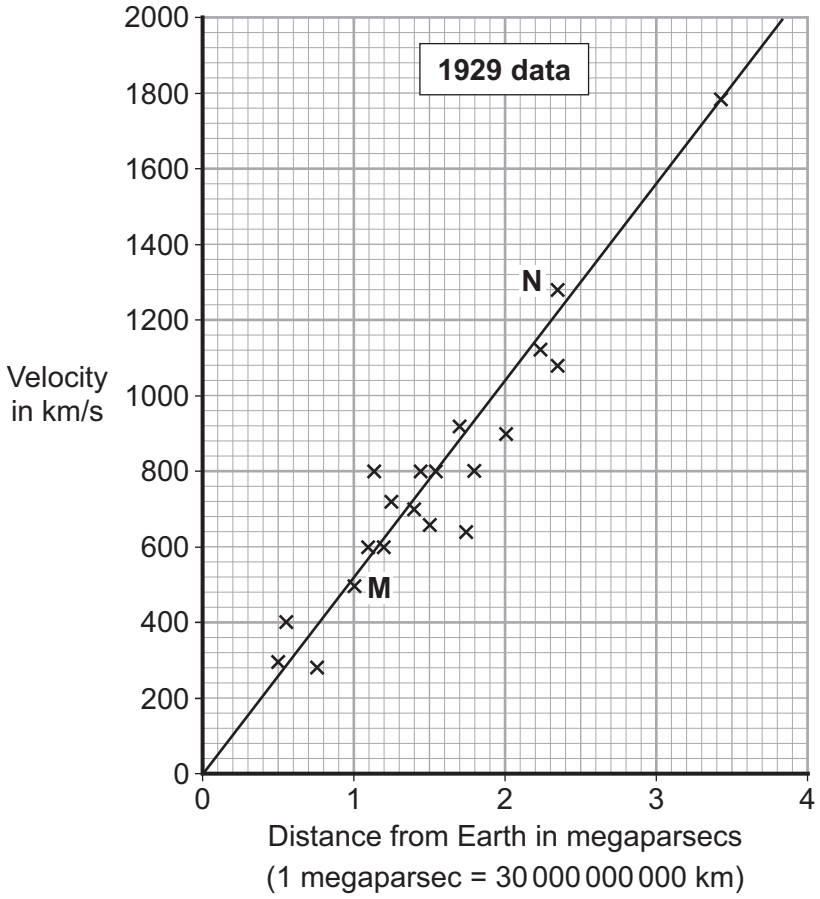
.....

.....

(1 mark)

6 (b) By measuring the red-shift, Hubble was able to calculate the speed at which the galaxies are moving away from the Earth. He was also able to calculate the distance of these galaxies from the Earth.

The graph shows some of the data calculated by Hubble.



4.5.6.1.4 The distance–time relationship

Question 13 · continued June 2010 | PHY1H | Original Q6 | Legacy

6 (b) (i) The data from two galaxies, **M** and **N**, has been included in the graph. The light from galaxy **M** has a smaller red-shift than the light from galaxy **N**.

What does the difference in red-shift tell scientists about the two galaxies, **M** and **N**?

.....

.....

.....

(2 marks)

6 (b) (ii) The gradient of the line drawn on the graph gives a number known as the Hubble constant. The Hubble constant can be used to estimate when the universe began.

Use the graph to calculate the value of the Hubble constant.

Show clearly how you obtained your answer.

.....

.....

Hubble constant = ... km/s per megaparsec

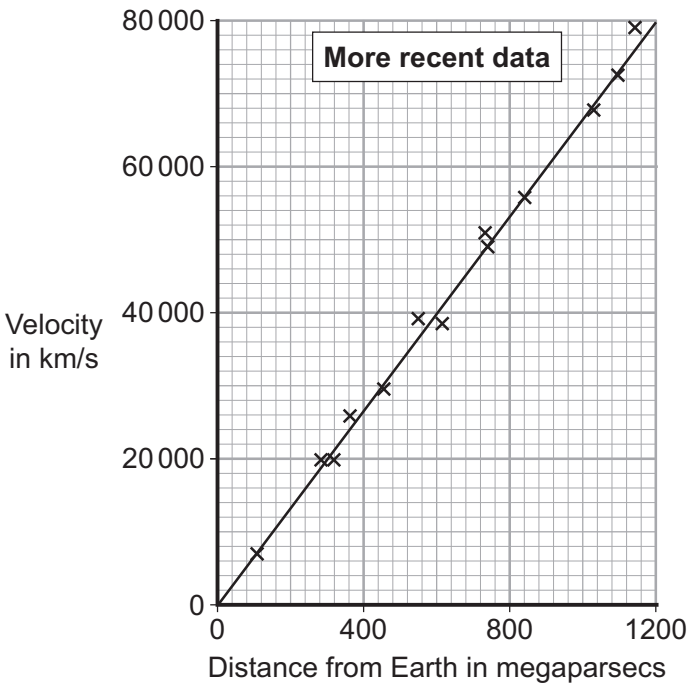
(2 marks)

Question 6 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 13 · continued

6 (b) (iii) More recently, data has been obtained from more distant galaxies.



The results from the more recent data give a totally different value for the Hubble constant to the one calculated from the 1929 data.

Which set of data, the 1929 or the more recent, is most likely to give the value closest to the true value for the Hubble constant?

Draw a ring around your answer.

1929 **more recent**

Give a reason for your answer.

.....

.....

(1 mark)

4.5.6.1.4 The distance–time relationship

Question 13 · continued

6 (c) The Andromeda galaxy is not moving away from the Earth. It is actually moving towards the Earth. This means that the light from Andromeda shows a blue-shift.

How do the wavelength and frequency of the light from Andromeda seem to have changed when viewed from the Earth?

.....

.....

.....

.....

(2 marks)

8

4.5.6.1.4 The distance–time relationship

Question 14

June 2010 | PHY3H | Original Q2 | Legacy

2 (a) Read this passage from a health leaflet.

> Most children can hear the full range of sounds which can be detected by the human ear. But as people get older, they cannot hear the higher frequencies.

2 (a) (i) Complete this statement.

Most children can detect sounds in the frequency range

..... Hz to ..... Hz.

(1 mark)

2 (a) (ii) What word is used to describe sound with a frequency so high that it cannot be heard by humans?

.....

(1 mark)

2 (b) Read this cutting from a newspaper.

> A shopkeeper has fitted a special loudspeaker outside his store.
> "We used to have gangs of young people out there," he said, "but now, when I switch on the special loudspeaker, they hate the sound and go away."
> Older people are not bothered by the sound because the frequency is too high for them to hear it.

Some people support the use of the special loudspeaker but other people do not.

Give **one** reason against its use.

.....

.....

(1 mark)

2 (c) Machines are often very noisy. They transfer energy, and some of the energy is transformed into sound.

What is the cause of the sound?

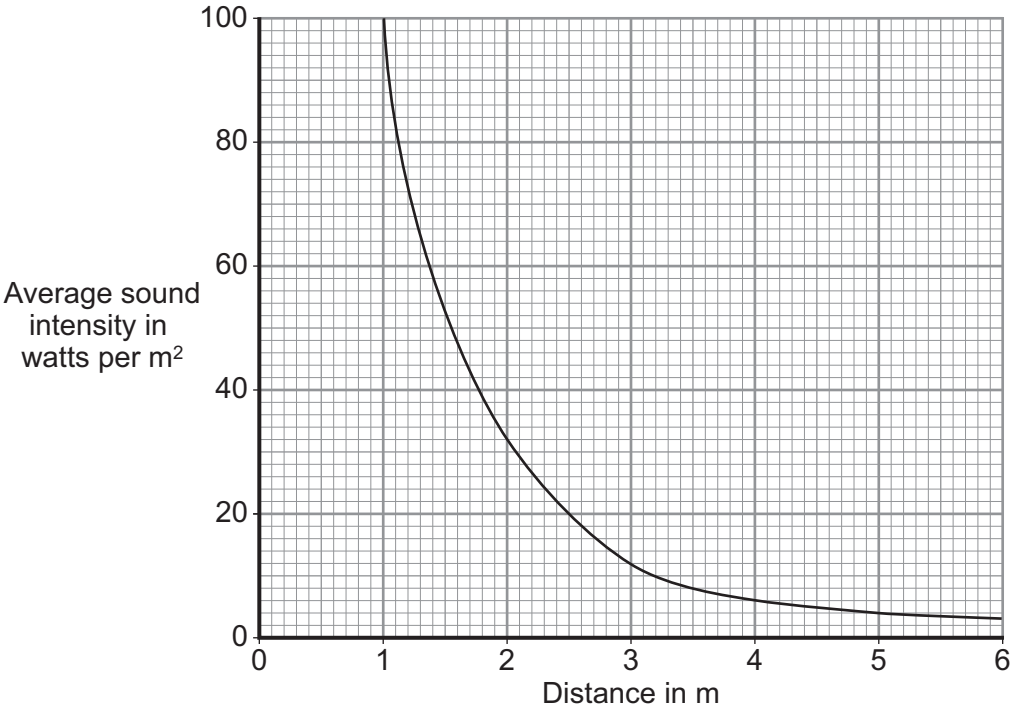
.....

(1 mark)

4.5.6.1.4 The distance–time relationship

Question 14 · continued June 2010 | PHY3H | Original Q2 | Legacy

2 (d) Sound from a machine may damage the hearing of people who work close by. A safety officer measures the sound intensity at different distances from a noisy machine. The average results are shown on the graph.



2 (d) (i) Describe the pattern shown by the graph.

Use one or more examples from the graph to support your description.

.....

.....

.....

.....

(2 marks)

2 (d) (ii) Average results were plotted.

Explain why taking results several times and then calculating average values is more reliable than taking only a single result.

.....

.....

.....

.....

(2 marks)

8

4.5.6.1.4 The distance–time relationship

Question 15

November 2010 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 1927, a scientist proposed that the universe began with an explosion. His proposal came after astronomers had observed red-shift in light from distant galaxies.

7A Red-shift is an apparent . . .

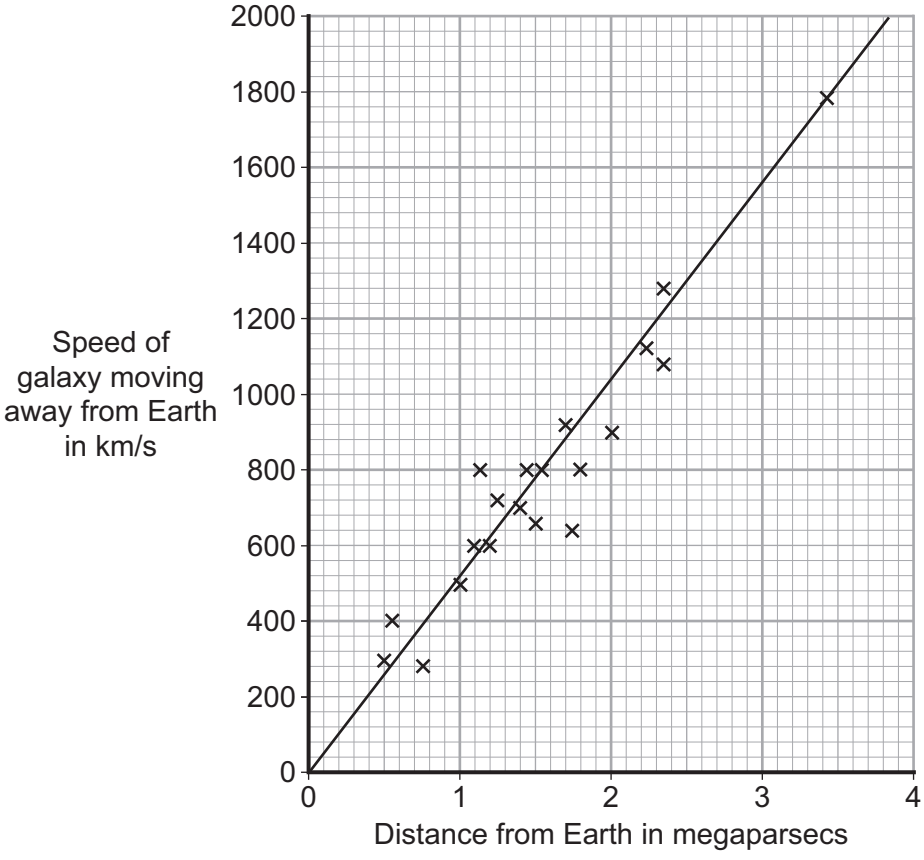
1 decrease in wavelength of the light due to a galaxy moving away from the Earth.

2 increase in wavelength of the light due to a galaxy moving away from the Earth.

3 decrease in wavelength of the light due to a galaxy moving towards the Earth.

4 increase in the wavelength of the light due to a galaxy moving towards the Earth.

The graph shows the results of calculations made by the astronomer Edwin Hubble. He plotted the speed at which the galaxies are moving away from Earth against their distance from Earth. The distance is given in megaparsecs. One parsec is approximately equal to 30 000 000 000 000 km.



4.5.6.1.4 The distance–time relationship

Question 15 · continued November 2010 | PHY1BP | Original Q7 | Legacy

7B Hubble's results suggest that . . .

1 more results are needed before we can say there is a relationship between the speed of a galaxy and the distance of the galaxy from Earth.

2 there is a negative relationship between the speed of a galaxy and the distance of the galaxy from Earth.

3 the speed of a galaxy is directly proportional to the distance of the galaxy from Earth.

4 the graph points are too scattered to give a meaningful relationship.

7C The gradient of the line of best fit on the graph is known as the Hubble constant. The Hubble constant can be used to estimate the age of the universe.

From this data, the approximate value of the Hubble constant in km/s per megaparsec is . . .

1 4

2 500

3 1000

4 2000

7D Hubble's calculations support the 'big bang' theory. The 'big bang' theory says that the universe is expanding.

In 1948, George Gamow predicted that there should be microwave radiation left over from the 'big bang'. This radiation was discovered in the 1960s, and was confirmed by the Cosmic Background Explorer satellite in the early 1990s.

This discovery . . .

1 disproves the involvement of a god in the origin of the universe.

2 gives information to help us know what happened before the 'big bang'.

3 provides evidence which eliminates all other theories of the origin of the universe.

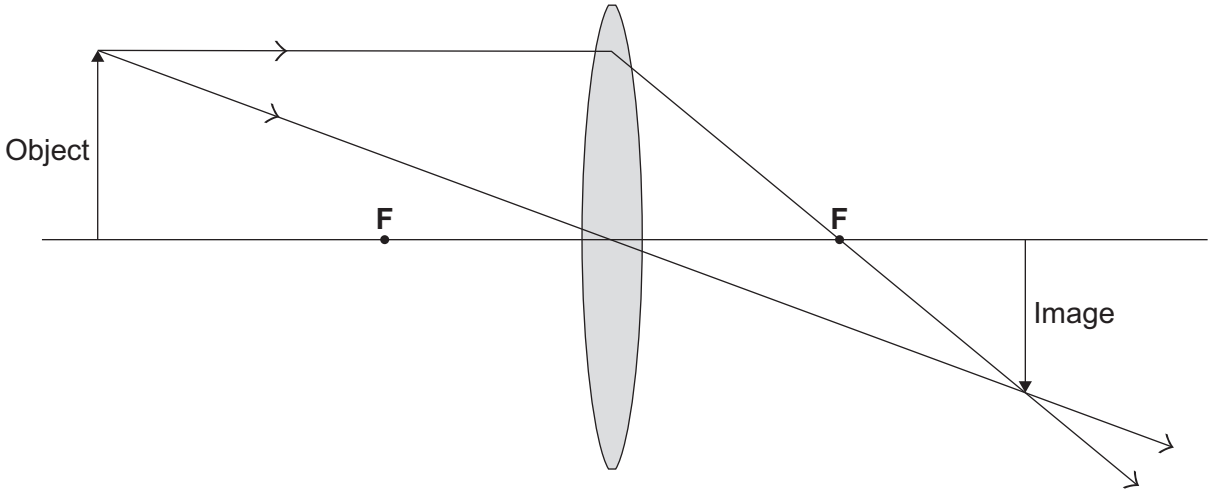
4 provides evidence in support of the 'big bang' theory.

4.5.6.1.4 The distance–time relationship

Question 16

January 2011 | PHY3H | Original Q1 | Legacy

1 The diagram shows a lens, the position of an object and the position of the image of the object.



1 (a) What type of lens is shown?

.....

(1 mark)

1 (b) What is the name of the points, **F**, shown each side of the lens?

.....

(1 mark)

1 (c) (i) The image is real and can be put on a screen.

How can you tell **from the diagram** that the image is real?

.....

.....

(1 mark)

1 (c) (ii) Draw a ring around a word in the box which describes the image produced by the lens.

inverted	**larger**	**upright**

(1 mark)

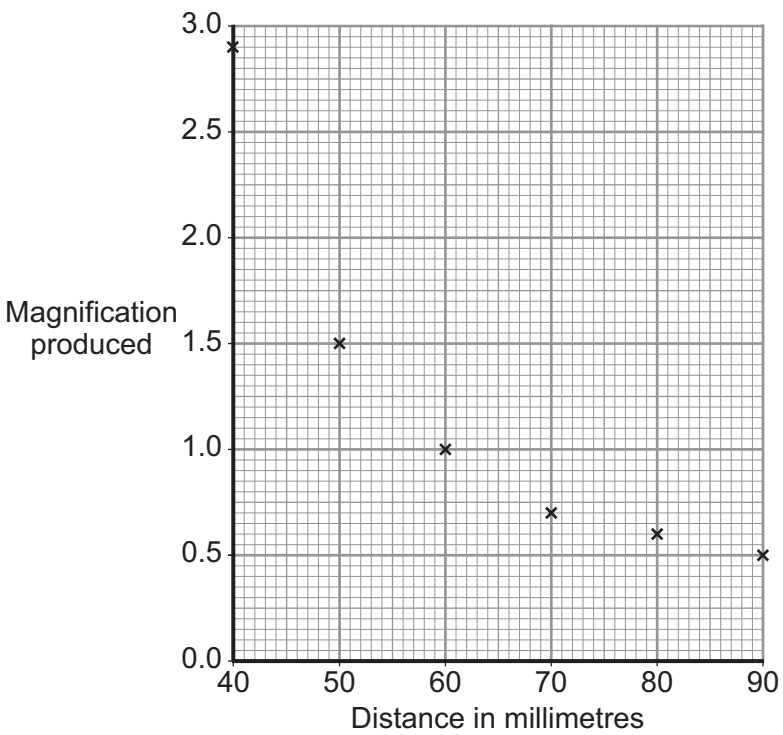
4.5.6.1.4 The distance–time relationship

Question 16 · continued

1 (d) A student investigates the relationship between the distance from the object to the lens and the magnification produced by the lens.
The student's results are given in the table.
The student did not repeat any measurements.

Distance in millimetres	Height of object in millimetres	Height of image in millimetres	Magnification produced
40	20	58	2.9
50	20	30	1.5
60	20	20	1.0
70	20	14	0.7
80	20	12	0.6
90	20	10	0.5

The student plots the points for a graph of *magnification produced* against *distance*.



1 (d) (i) Draw a *line of best fit* for these points.

(1 mark)

4.5.6.1.4 The distance–time relationship

Question 16 · continued

1 (d) (ii) Complete the following sentence by drawing a ring around the correct word in the box.

A line graph has been drawn because both variables are

described as being

categoric.
continuous.
discrete.

(1 mark)

1 (d) (iii) Describe the relationship between *magnification produced* and *distance*.

.....

.....

.....

(2 marks)

8

4.5.6.1.4 The distance–time relationship

Question 17

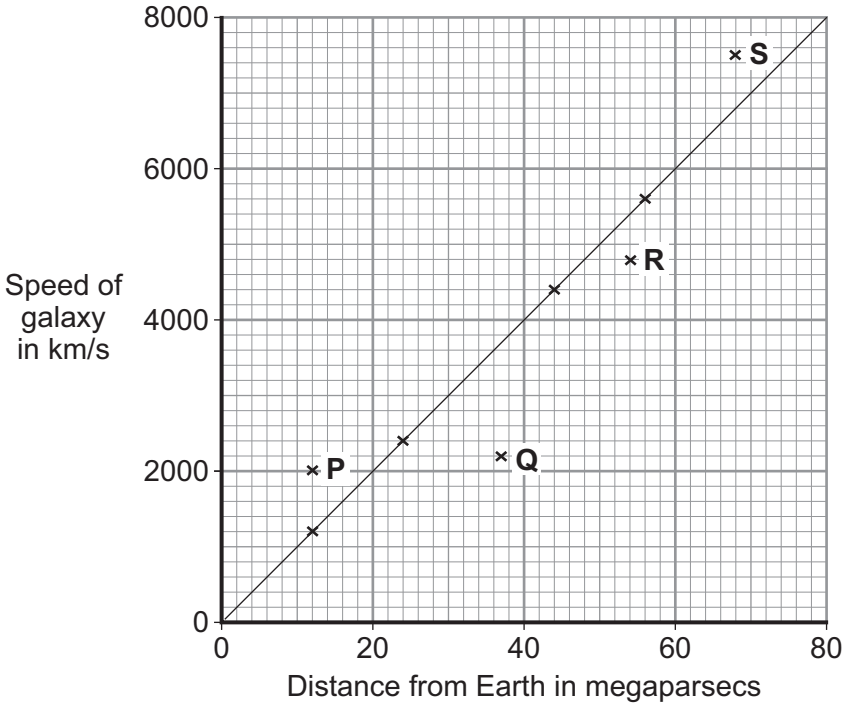
March 2011 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

In the early part of the twentieth century, Edwin Hubble made the discovery that distant galaxies are moving away from Earth.

He calculated the speeds at which the galaxies are moving away from Earth and their distances from Earth.

The graph shows Hubble's results.



A megaparsec is a unit of distance

5A Which one of the following statements describes what the graph shows?

1 All galaxies have different but constant speeds.

2 Galaxies will eventually reach a maximum speed.

3 Nearer galaxies have the highest speeds.

4 The speed of a galaxy is directly proportional to its distance from Earth.

5B What is the approximate speed, in km/s, of a galaxy 120 megaparsecs away from Earth?

1 10 000

2 11 000

3 12 000

4 13 000

4.5.6.1.4 The distance–time relationship

Question 17 · continued

5C The light from four galaxies, **P**, **Q**, **R** and **S**, is examined for red-shift.

Which one of the following statements about the amount of red-shift is correct?

1 **P** produces the biggest red-shift.

2 **P**, **Q**, **R** and **S** produce the same red-shift.

3 **Q** and **R** produce the smallest red-shift.

4 **S** produces the biggest red-shift.

5D Some galaxies show a blue-shift.

These galaxies . . .

1 are the most distant galaxies from the Earth.

2 are stationary.

3 are moving towards the Earth.

4 have only just been formed.

4.5.6.1.4 The distance–time relationship

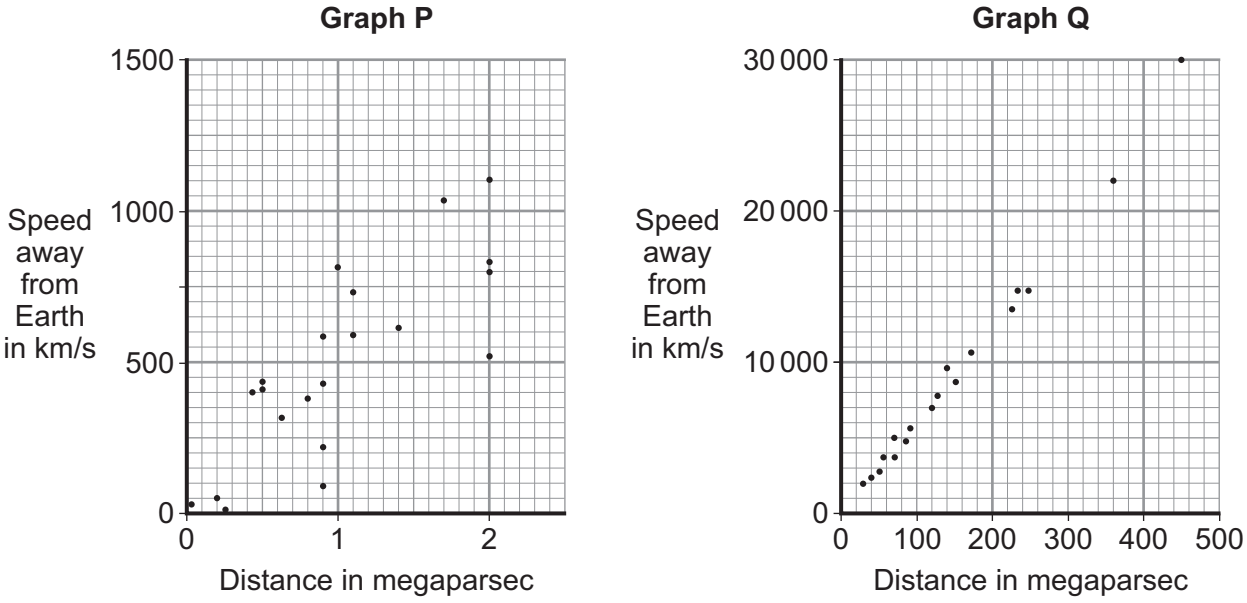
Question 18

June 2011 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Edwin Hubble investigated the relationship between the speed of a galaxy moving away from the Earth and its distance from the Earth.

Graph P shows his results.



A megaparsec is a very large unit of distance used by astronomers.

Other astronomers have confirmed Hubble's results by surveying other galaxies. **Graph Q** shows the other astronomers' results.

9A The data in **Graph P** suggests that . . .

1 there is no relationship between the speed of a galaxy and its distance from Earth.

2 the galaxies closest to Earth move fastest.

3 the further away a galaxy is from Earth, the slower it is moving.

4 the further away a galaxy is from Earth, the faster it is moving.

4.5.6.1.4 The distance–time relationship

Question 18 · continued June 2011 | PHY1BP | Original Q9 | Legacy

The gradient (slope) of the line of best fit is called the Hubble constant. Astronomers have used the value of the Hubble constant to calculate the age of the universe.

9B The value of the Hubble constant obtained from **Graph Q** is thought to be more accurate than Hubble's original value.

This is because . . .

1 the data includes galaxies moving towards the Earth.

2 the data gives a line of best fit passing through the origin, (0,0).

3 the data was obtained from a wide range of galaxies.

4 the data was obtained from only very distant galaxies.

9C From the data in **Graph Q**, an approximate value for the Hubble constant in km/s per megaparsec is . . .

1 0.0017

2 0.017

3 60

4 600

9D A teacher used a balloon to model an expanding universe. Some dots were marked on the balloon, which was then inflated.

Which of the following is **not** a reason for using models in science?

1 They prove a theory is correct.

2 They help us to understand a theory.

3 They give similar results to the real experiment.

4 It is easier to take measurements from a model.

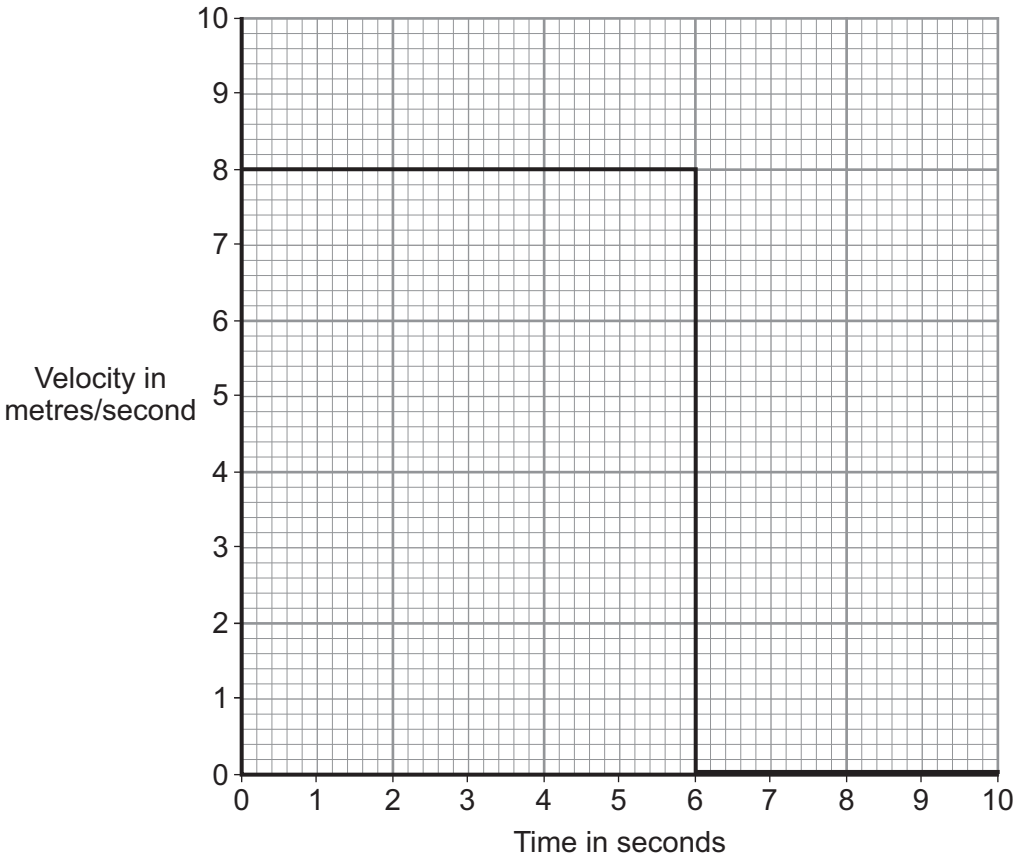
END OF TEST

4.5.6.1.4 The distance–time relationship

Question 19

June 2011 | PHY2H | Original Q5 | Legacy

5 The diagram shows the velocity-time graph for an object over a 10 second period.



5 (a) Use the graph to calculate the distance travelled by the object in 10 seconds.

Show clearly how you work out your answer.

.....

.....

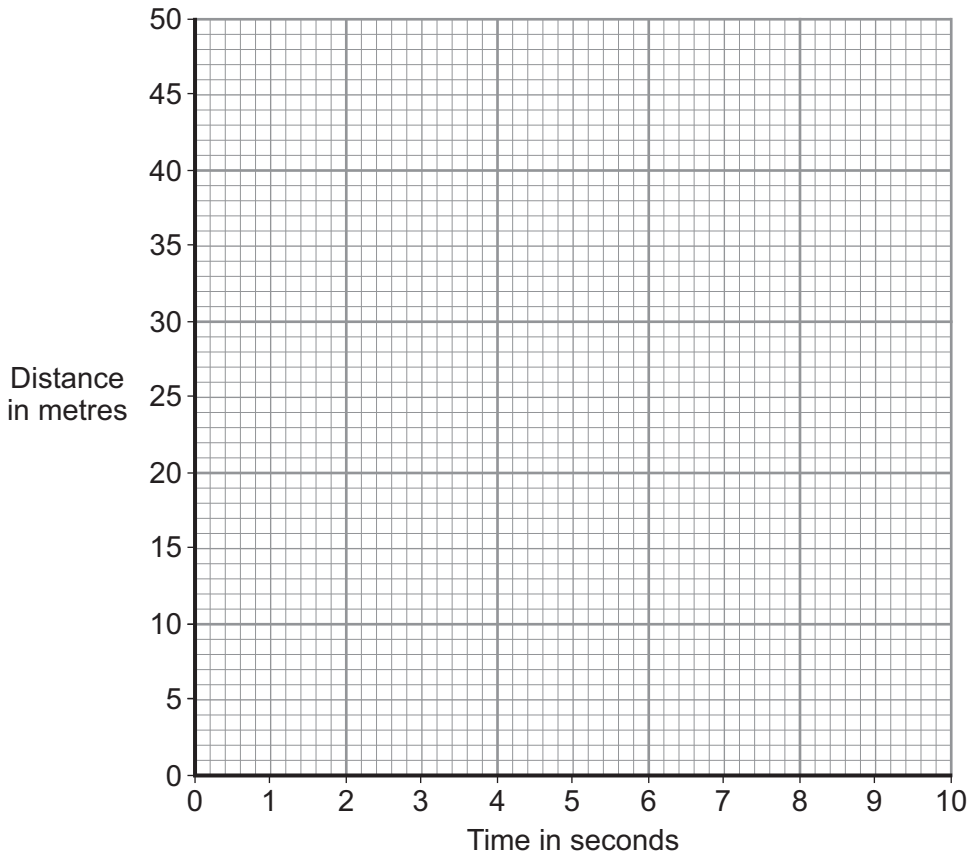
Distance = ... m

(2 marks)

4.5.6.1.4 The distance–time relationship

Question 19 · continued

5 (b) Complete the distance-time graph for the object over the same 10 seconds.



(2 marks)

4

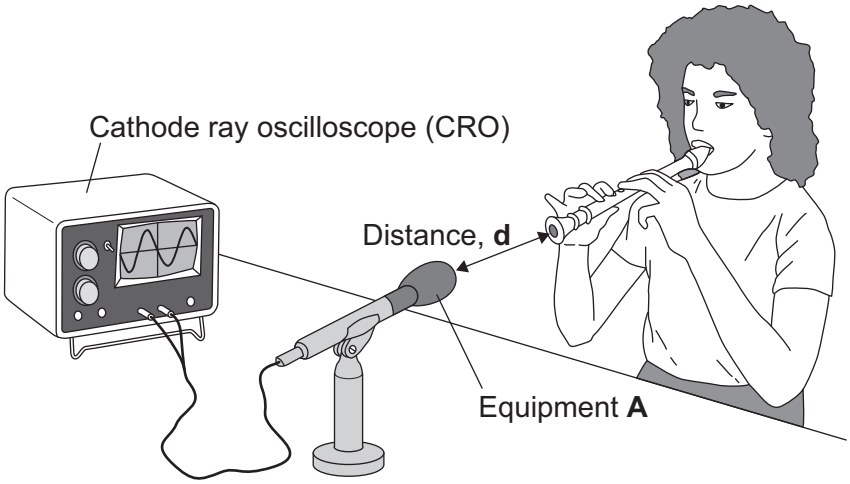
4.5.6.1.4 The distance–time relationship

Question 20

June 2011 | PHY3H | Original Q1 | Legacy

1 A group of students investigates sound waves.

The diagram shows part of their investigation.



1 (a) Identify the equipment labelled **A**.

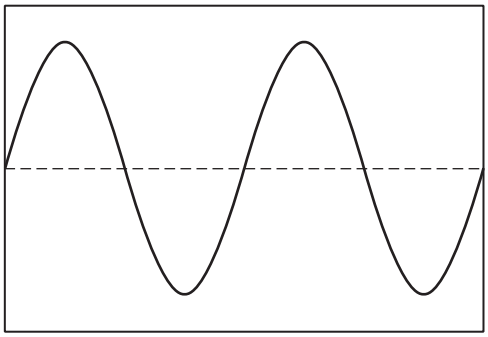
.....

(1 mark)

1 (b) The student plays the same note in the same way at different distances from equipment **A**.

Another student records the amplitude of the wave shown on the cathode ray oscilloscope (CRO).

1 (b) (i) Label this wave to show its amplitude.



(1 mark)

1 (b) (ii) Complete the sentence.

Increasing the amplitude of a sound wave will increase the .....

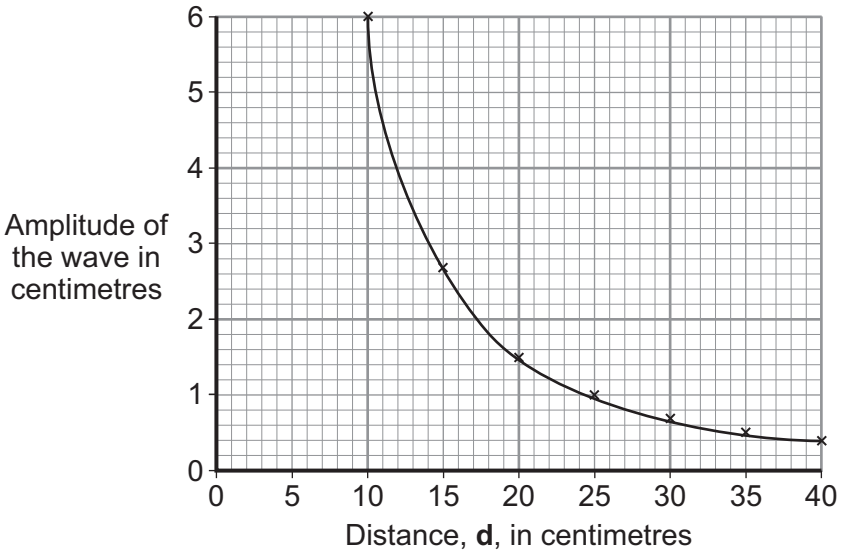
of the sound.

(1 mark)

4.5.6.1.4 The distance–time relationship

Question 20 · continued June 2011 | PHY3H | Original Q1 | Legacy

1 (c) The graph shows the students' average results from several sets of measurements.



Use the graph to find the distance, **d**, in centimetres, at which the average amplitude is likely to be 2 centimetres.

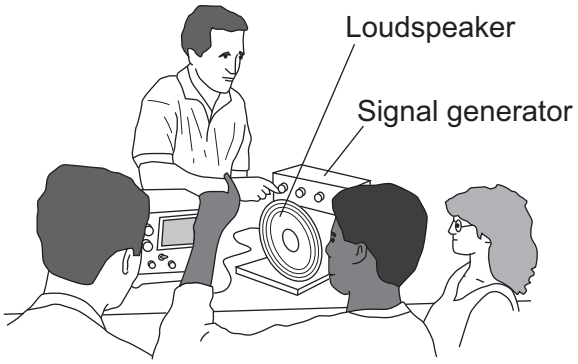
Distance = ... cm.
(1 mark)

1 (d) Write a conclusion for this investigation.

.....

.....
(1 mark)

1 (e) A physics teacher uses a signal generator and a loudspeaker to demonstrate the range of hearing of a group of students.



What is the range of frequencies most humans can hear?

Most humans can hear from ..... Hz to ..... Hz.
(2 marks)

7

4.5.6.1.4 The distance–time relationship

Question 21

November 2011 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

The light given out by distant galaxies has the same features as light from a very hot gas in a laboratory. However, the light from distant galaxies is shifted to longer wavelengths. This is called red-shift.

8A Red-shift occurs because . . .

1 the frequency of light increases as it travels through space.

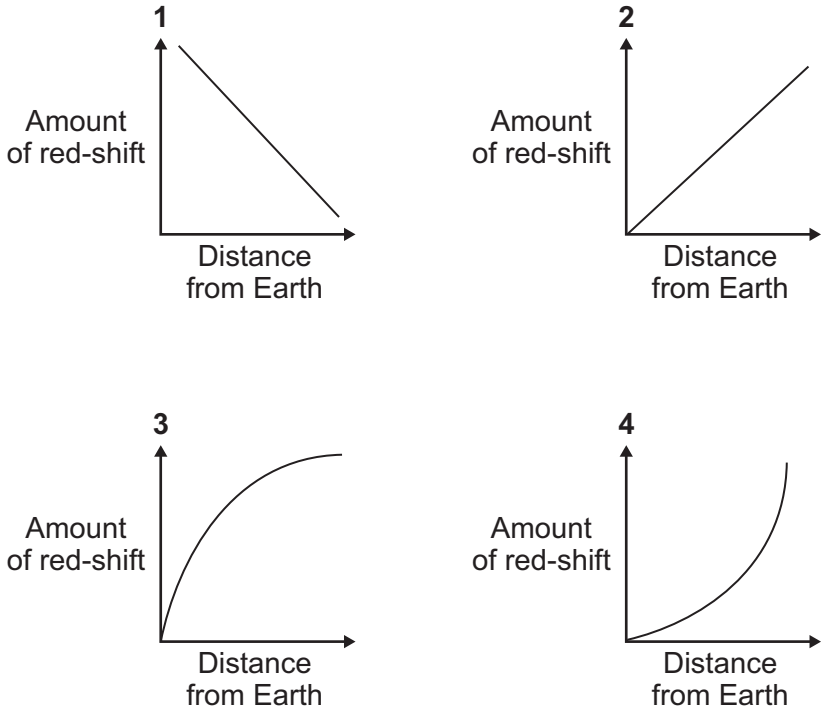
2 the speed of light from galaxies decreases as it travels through space.

3 distant galaxies have a relative movement away from the Earth.

4 distant galaxies have a relative movement towards the Earth.

8B Distant galaxies show an amount of red-shift which is directly proportional to their distance from the Earth.

Which graph shows this relationship?



4.5.6.1.4 The distance–time relationship

Question 21 · continued

8C The amount of red-shift can be used to estimate the speed of a galaxy relative to Earth.

This led to the discovery that distant galaxies are . . .

1 moving faster than nearer galaxies and the universe is contracting.

2 moving faster than nearer galaxies and the universe is expanding.

3 moving slower than nearer galaxies and the universe is contracting.

4 moving slower than nearer galaxies and the universe is expanding.

8D There are some galaxies close to the Earth that are moving towards the Earth.

Light from these galaxies has . . .

1 an observable decrease in its frequency.

2 an observable decrease in its wavelength.

3 smaller red-shifts than distant galaxies.

4 no change in its wavelength.

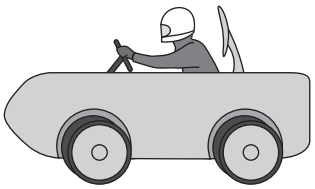
4.5.6.1.4 The distance–time relationship

Question 22

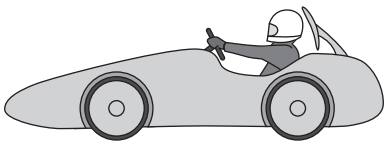
January 2013 | PH2HP | Original Q5 | Legacy

5 (a) Some students have designed and built an electric-powered go-kart. After testing, the students decided to make changes to the design of their go-kart.

First design **X**



Final design **Y**



The go-kart always had the same mass and used the same motor.

The change in shape from the first design (**X**) to the final design (**Y**) will affect the top speed of the go-kart.

Explain why.

.....

.....

.....

.....

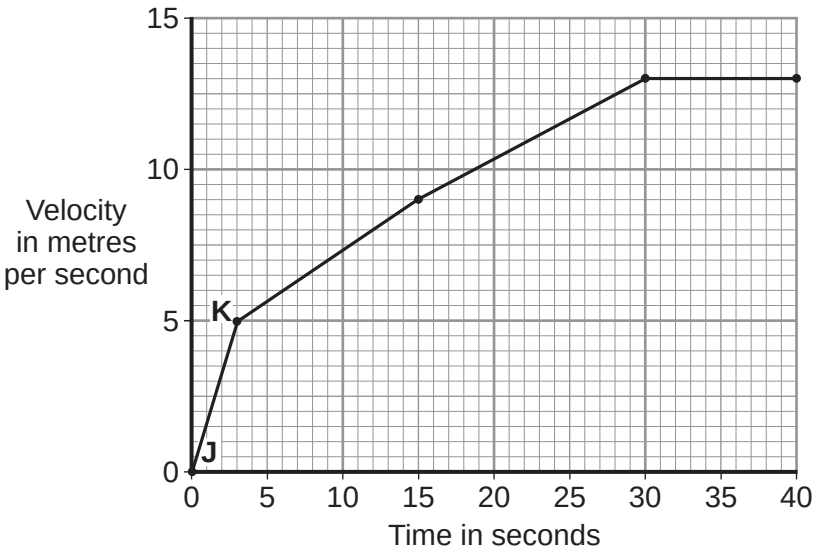
.....

.....

(3 marks)

5 (b) The final design go-kart, **Y**, is entered into a race.

The graph shows how the velocity of the go-kart changes during the first 40 seconds of the race.



4.5.6.1.4 The distance–time relationship

Question 22 · continued

5 (b) (i) Use the graph to calculate the acceleration of the go-kart between points **J** and **K**.

Give your answer to **two** significant figures.

.....

.....

.....

Acceleration = ... m/s^2

(2 marks)

5 (b) (ii) Use the graph to calculate the distance the go-kart travels between points **J** and **K**.

.....

.....

.....

Distance = ... m

(2 marks)

5 (b) (iii) What causes most of the resistive forces acting on the go-kart?

.....

(1 mark)

8

4.5.6.1.4 The distance–time relationship

Question 23

June 2015 | PH2HP | Original Q4 | Legacy

4 (a) A car driver sees the traffic in front is not moving and brakes to stop his car.

The stopping distance of a car is the thinking distance plus the braking distance.

4 (a) (i) What is meant by the 'braking distance'?

[1 mark]

.....

.....

4 (a) (ii) The braking distance of a car depends on the speed of the car and the braking force.

State **one** other factor that affects braking distance.

[1 mark]

.....

.....

4 (a) (iii) How does the braking force needed to stop a car in a particular distance depend on the speed of the car?

[1 mark]

.....

.....

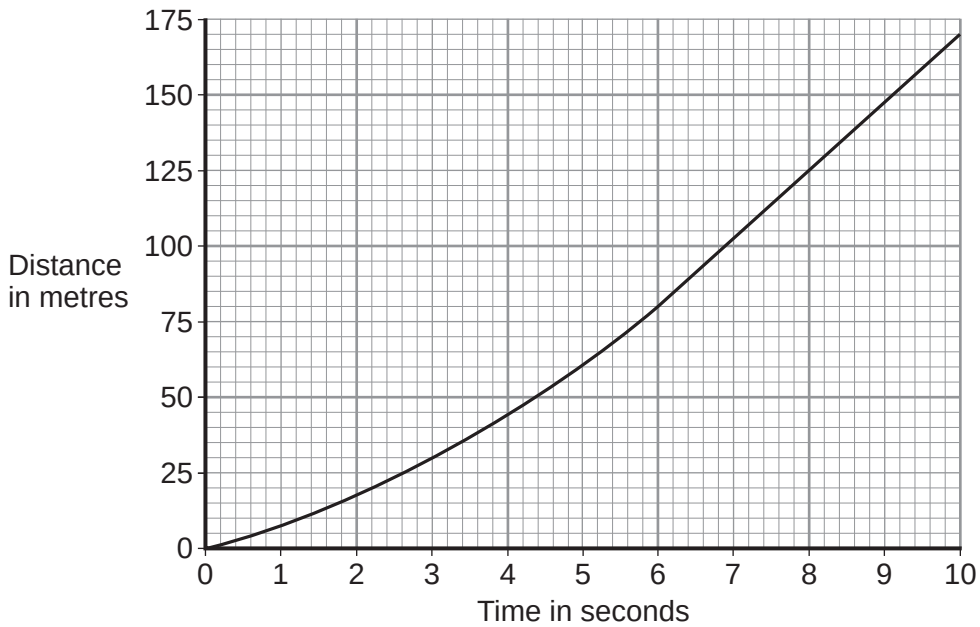
Question 4 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 23 · continued

4 (b) **Figure 4** shows the distance–time graph for the car in the 10 seconds before the driver applied the brakes.

Figure 4



Use **Figure 4** to calculate the maximum speed the car was travelling at.
Show clearly how you work out your answer.

[2 marks]

.....

.....

Maximum speed = ... m/s

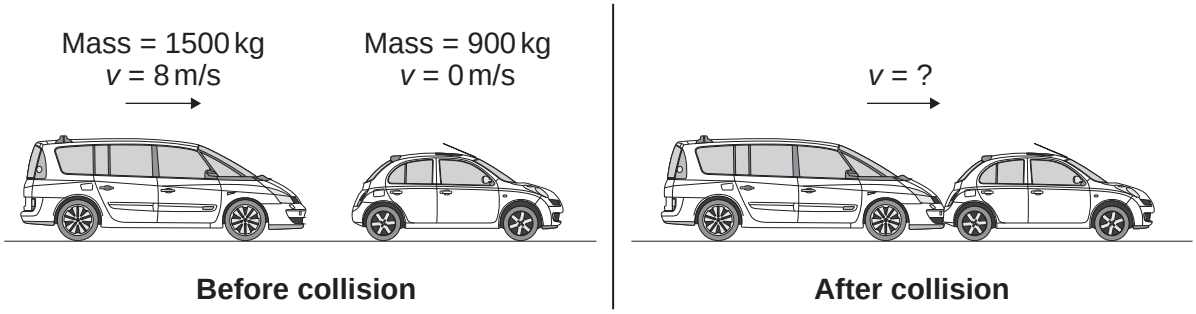
4.5.6.1.4 The distance–time relationship

Question 23 · continued

4 (c) The car did not stop in time. It collided with the stationary car in front, joining the two cars together.

Figure 5 shows both cars, just before and just after the collision.

Figure 5



Before collision **After collision**

4 (c) (i) The momentum of the two cars was conserved.

What is meant by the statement 'momentum is conserved'?

[1 mark]

.....

.....

4 (c) (ii) Calculate the velocity of the two joined cars immediately after the collision.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

.....

.....

Velocity = ... m/s

Question 4 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 23 · continued

4 (d) Since 1965, all cars manufactured for use in the UK must have seat belts.

It is safer for a car driver to be wearing a seat belt, compared with not wearing a seat belt, if the car is involved in a collision.

Explain why.

[4 marks]

.....

.....

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.....

.....

.....

.....

.....

13

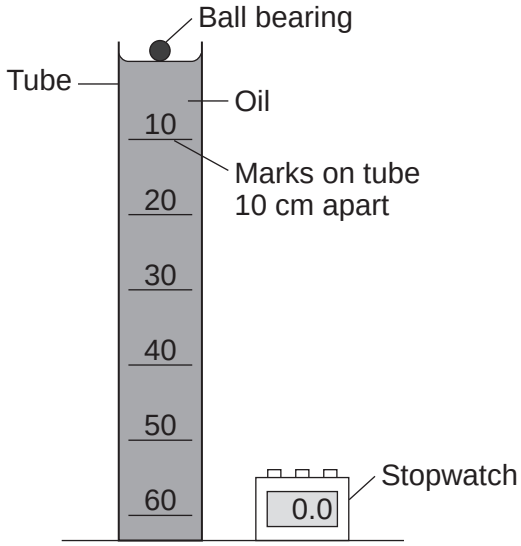
4.5.6.1.4 The distance–time relationship

Question 24

June 2016 | PH2HP | Original Q1 | Legacy

1 A student investigated how the speed of a ball bearing changes as the ball bearing falls through a tube of oil.
Figure 1 shows the equipment the student used.

Figure 1



The student measured the time taken for the ball bearing to fall different distances.
Each distance was measured from the top of the oil.

1 (a) What is likely to have been the main source of error in this investigation?

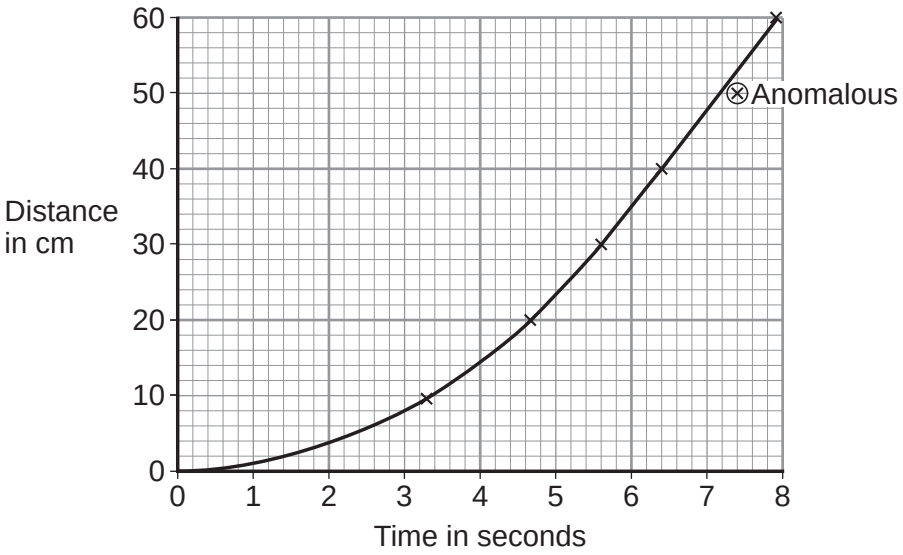
[1 mark]

4.5.6.1.4 The distance–time relationship

Question 24 · continued

1 (b) **Figure 2** shows the student's results plotted as a graph.

Figure 2



1 (b) (i) The student has identified one of the results as being anomalous.

Use the correct answer from the box to complete the sentence.

[1 mark]

after	as	before

The anomalous result was caused by the stopwatch being started _____ the ball bearing was released.

1 (b) (ii) What can you conclude from the graph about the speed of the ball bearing during the first four seconds?

[1 mark]

_____

_____

1 (b) (iii) The graph shows that the ball bearing reached its terminal velocity.

Describe how the graph would be used to calculate the terminal velocity of the ball bearing.

[1 mark]

_____

_____

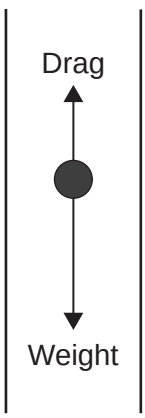
Question 1 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 24 · continued

1 (b) (iv) The directions of the two forces acting on the ball bearing as it falls through the oil are shown in **Figure 3**.

Figure 3



Explain, in terms of the forces shown in **Figure 3**, why the ball bearing reaches its terminal velocity.

[2 marks]

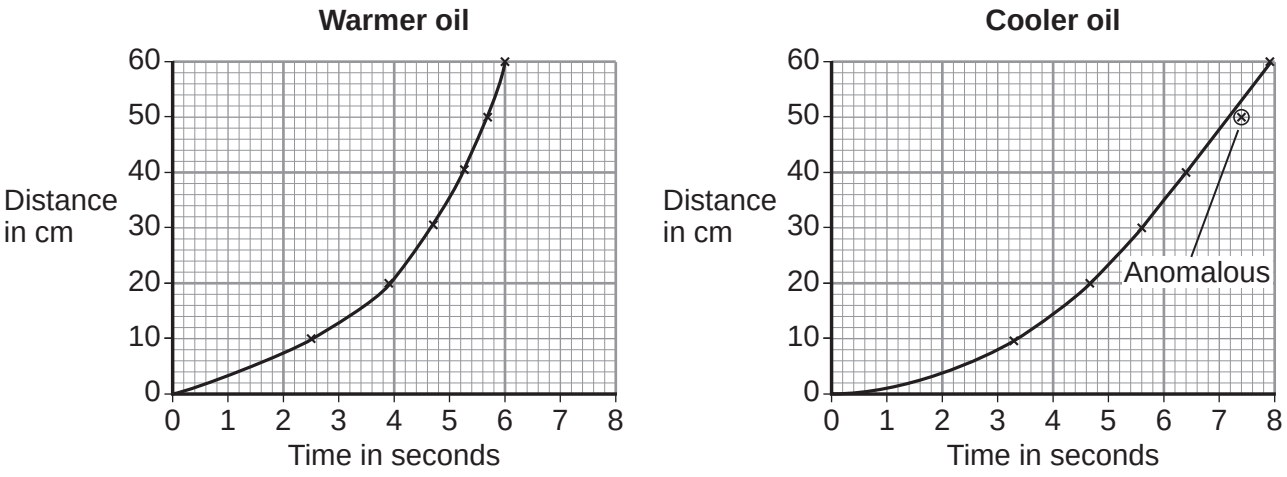
4.5.6.1.4 The distance–time relationship

Question 24 · continued

1 (c) The student repeated the investigation using warmer oil.

Figure 4 shows the set of results using the warmer oil **and** the set of results using the cooler oil.

Figure 4



Compare the two graphs in **Figure 4**.

Use the correct phrase from the box to complete the sentence.

[3 marks]

less than	**equal to**	**greater than**

After falling 40 cm, the drag force on the ball bearing in the warmer oil is

_____ the drag force on the ball bearing in the cooler oil.

Explain the reason for your answer.

_____

_____

_____

_____

9

4.5.6.1.4 The distance–time relationship

Question 25

June 2017 | PH2HP | Original Q4 | Legacy

4 A lorry driver sees the traffic lights at a road junction change to red.
The driver applies the brakes to stop the lorry.

The stopping distance is the thinking distance plus the braking distance.

4 (a) (i) Which statement describes the thinking distance?

[1 mark]

Tick (✓) **one** box.

- The time it takes for the lorry to stop after the brakes are applied. ☐
- The time it takes the driver to react and apply the brakes. ☐
- The distance the lorry travels once the brakes are applied. ☐
- The distance the lorry travels during the driver's reaction time. ☐

4 (a) (ii) How does thinking distance depend on the speed of the lorry?

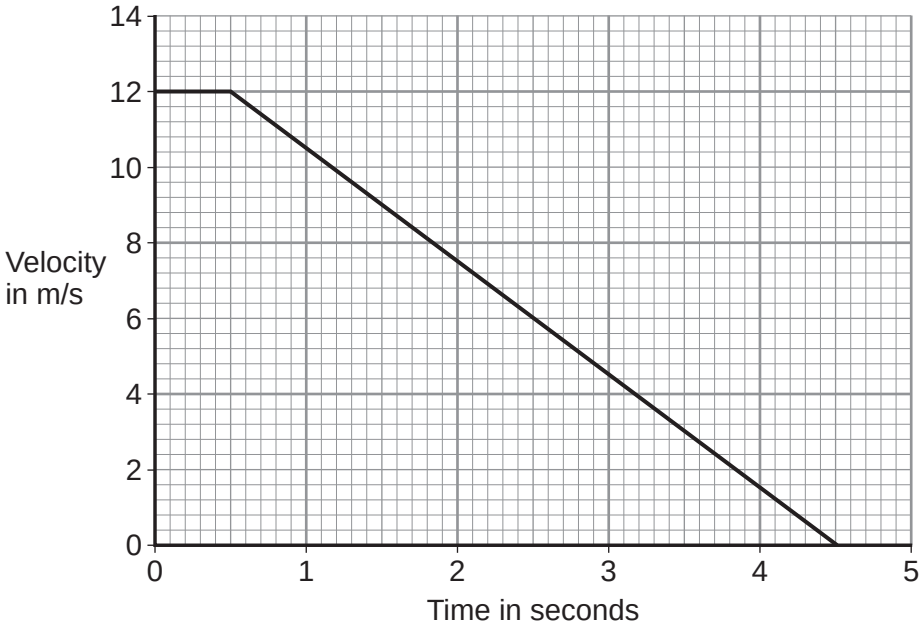
[1 mark]

_____

_____

4 (b) **Figure 3** shows how the velocity of the lorry changes from just after the driver sees the traffic lights change to red.

Figure 3



4.5.6.1.4 The distance–time relationship

Question 25 · continued

4 (b) (i) Calculate the braking distance of the lorry.

Show how you used **Figure 3** to obtain your answer.

[2 marks]

Distance = _____ m

4 (b) (ii) The work done to stop the lorry is 360 kJ

Calculate the braking force used to stop the lorry.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

Braking force = _____ N

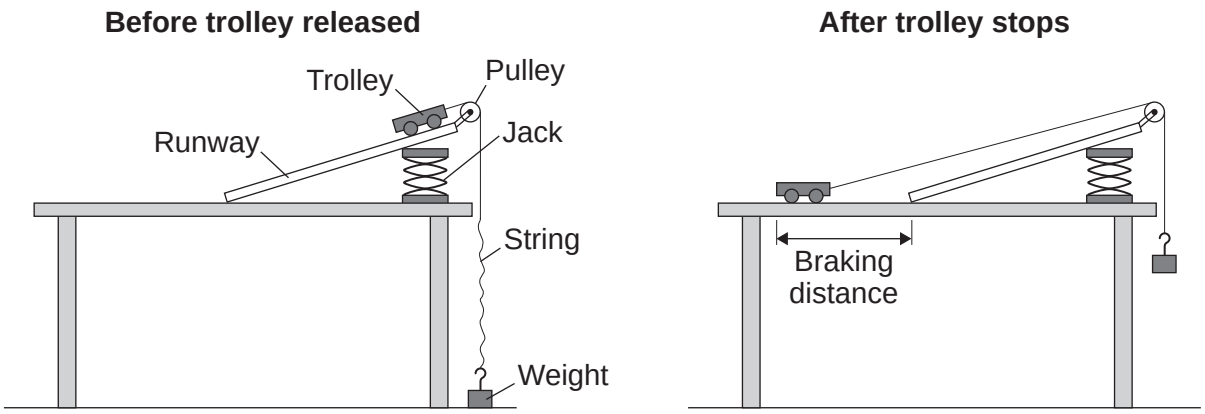
Question 4 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 25 · continued

4 (c) A student investigated how braking distance depends on braking force. The student used the apparatus shown in **Figure 4**.

Figure 4



The student released the trolley from the top of the runway. When the trolley reached the bottom of the runway the string became taut and the trolley started to lift a weight from the floor. The weight being lifted was equal to the braking force on the trolley.

The student changed the weight being lifted and measured the new braking distance.

4 (c) (i) State **one** control variable in this investigation.

[1 mark]

4 (c) (ii) **Figure 4** shows the braking distance measured by the student.

What else could the student have measured that would also have given the braking distance?

[1 mark]

4.5.6.1.4 The distance–time relationship

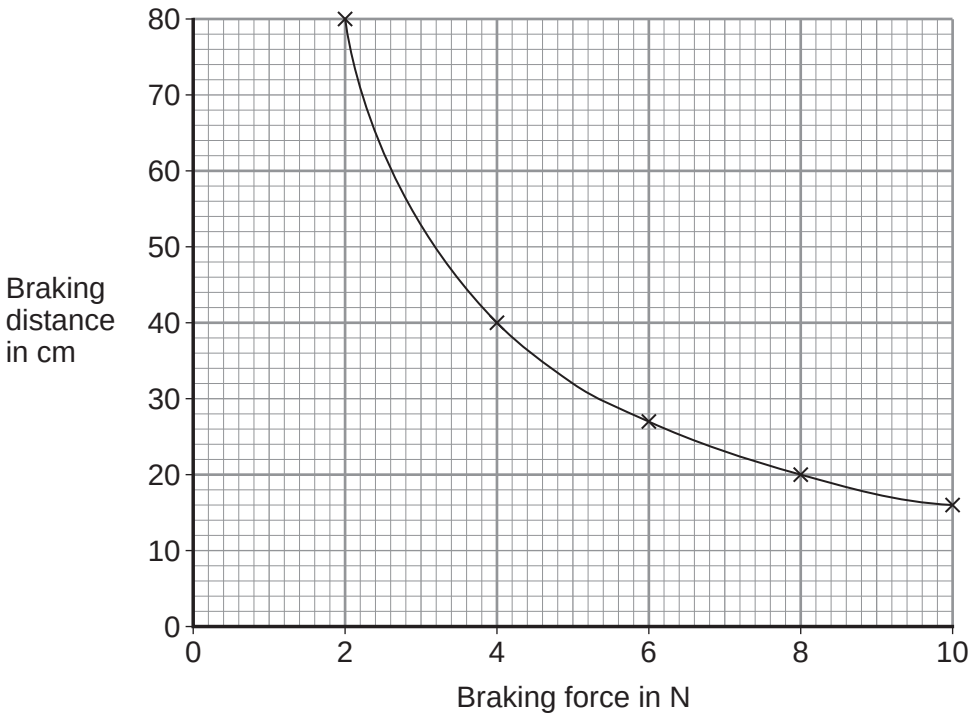
Question 25 · continued

4 (c) (iii) Measuring each braking distance at least twice would improve the investigation. Suggest why.

[2 marks]

4 (c) (iv) The results of the investigation are plotted as a graph in **Figure 5**.

Figure 5



What conclusions should be made from this investigation about the relationship between braking distance and braking force?

Use data from **Figure 5** to justify your conclusion.

[2 marks]

12

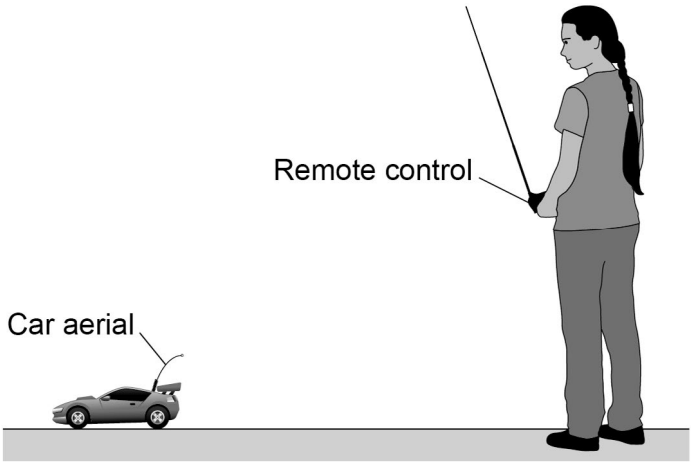
4.5.6.1.4 The distance–time relationship

Question 26

November 2020 | 8463/2H | Original Q6

0 6 **Figure 8** shows a student playing with a remote-controlled car.

Figure 8



0 6 . 1 The remote control transmits radio waves to the car aerial.

The transmitted radio waves have a frequency of 320 MHz.

speed of radio waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give the unit.

[5 marks]

Wavelength = _____ Unit _____

4.5.6.1.4 The distance–time relationship

Question 26 · continued

0 6 . 2 The car aerial is connected to an electrical circuit in the car.

Describe what happens in the electrical circuit when the car aerial absorbs radio waves.

[2 marks]

0 6 . 3 The car produces sound waves.

Give **two** ways in which radio waves are different to sound waves.

[2 marks]

1

2

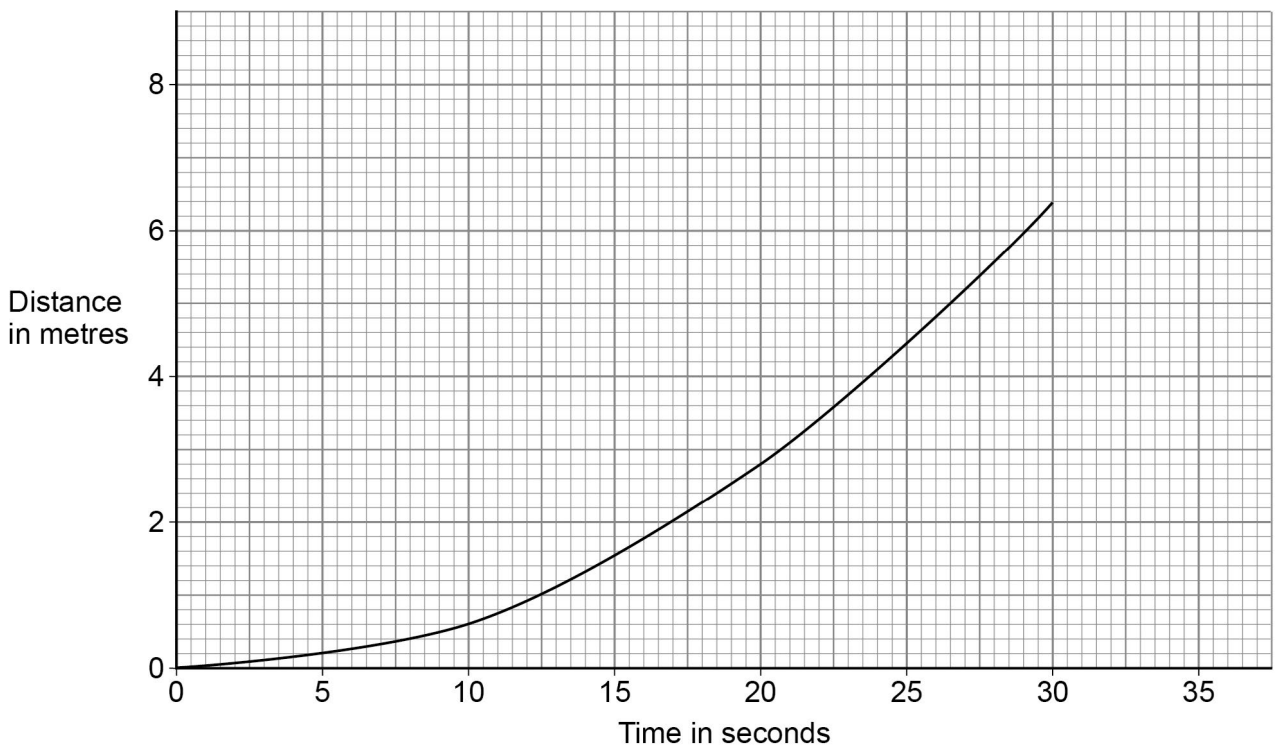
Question 6 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 26 · continued

Figure 9 shows the distance-time graph for the first 30 seconds of the car's motion.

Figure 9



0 6 . 4 Describe the motion of the car during the first 30 seconds.

[1 mark]

0 6 . 5 Determine the speed of the car 20 seconds after it started to move.

[4 marks]

Speed = _____ m/s

4.5.6.1.4 The distance–time relationship

Question 26 · continued

0 6 . 6 A different car accelerated from 0.12 m/s to 0.52 m/s.

The acceleration of the car was 0.040 m/s^2.

The work done to accelerate the car was 0.48 J.

Calculate the resultant force needed to accelerate the car.

[6 marks]

Resultant force = _____ N

0 6 . 7 Explain why the car has a maximum speed.

[4 marks]

24

4.5.6.1.4 The distance–time relationship

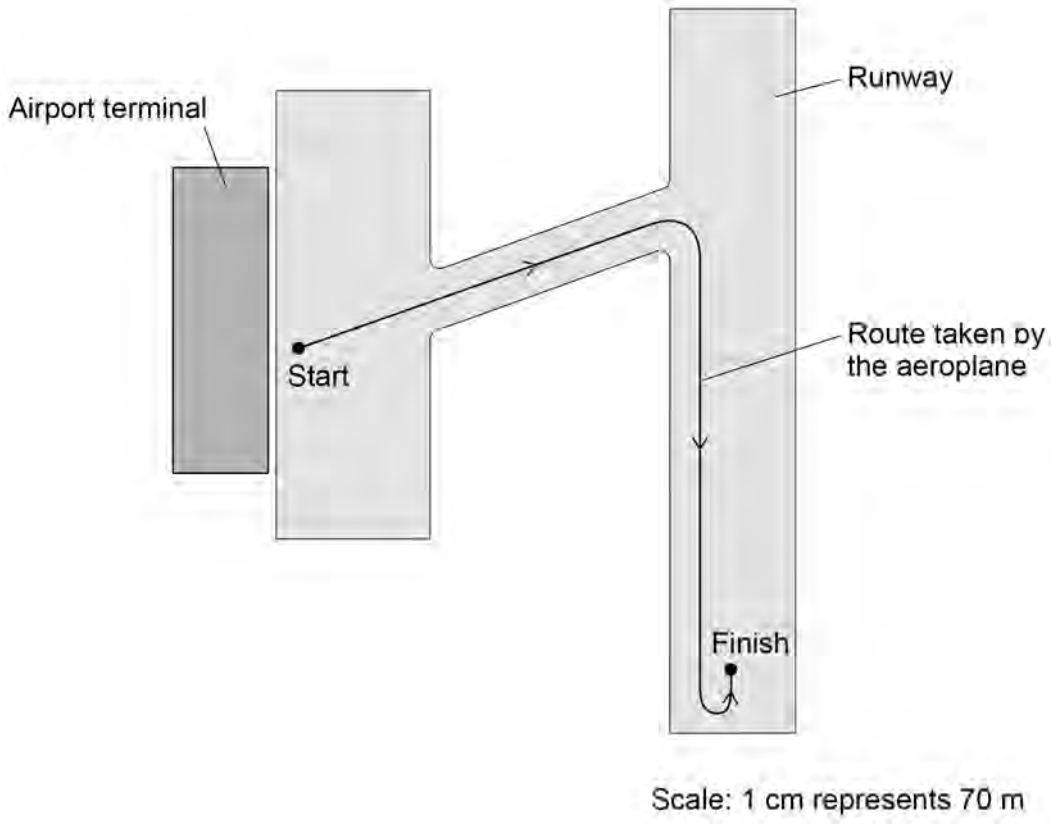
Question 27

June 2023 | 8463/2H | Original Q2

0 2 **Figure 3** shows the route an aeroplane takes as it travels from an airport terminal to the runway.

Figure 3 has been drawn to scale.

Figure 3



0 2 . 1 Determine the magnitude of the aeroplane's displacement from the start point to the finish point on **Figure 3**.

[2 marks]

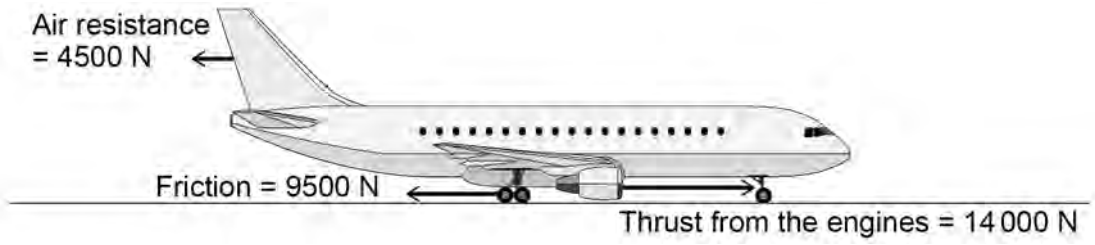
Displacement = _____ m

4.5.6.1.4 The distance–time relationship

Question 27 · continued

Figure 4 shows the direction of the horizontal forces acting on the aeroplane as it moves in a straight line towards the runway.

Figure 4



0 2 . 2 Determine the magnitude of the resultant horizontal force on the aeroplane.

[1 mark]

Resultant horizontal force = _____ N

0 2 . 3 Describe the motion of the aeroplane as it moves towards the runway.

[1 mark]

0 2 . 4 Air resistance and friction are contact forces.

Give **one** other example of a contact force.

[1 mark]

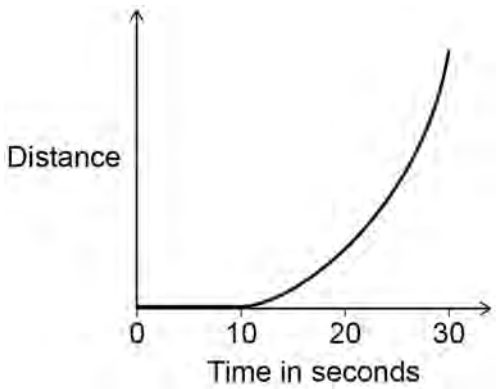
4.5.6.1.4 The distance–time relationship

Question 27 · continued

0 2 . 5 The aeroplane stops for a short time and then accelerates along the runway.

Figure 5 shows a distance–time sketch-graph for this stage of the journey.

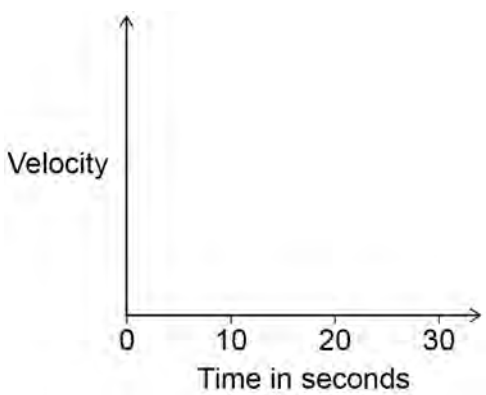
Figure 5



Draw the velocity–time sketch-graph for this stage of the journey on **Figure 6**.

[2 marks]

Figure 6



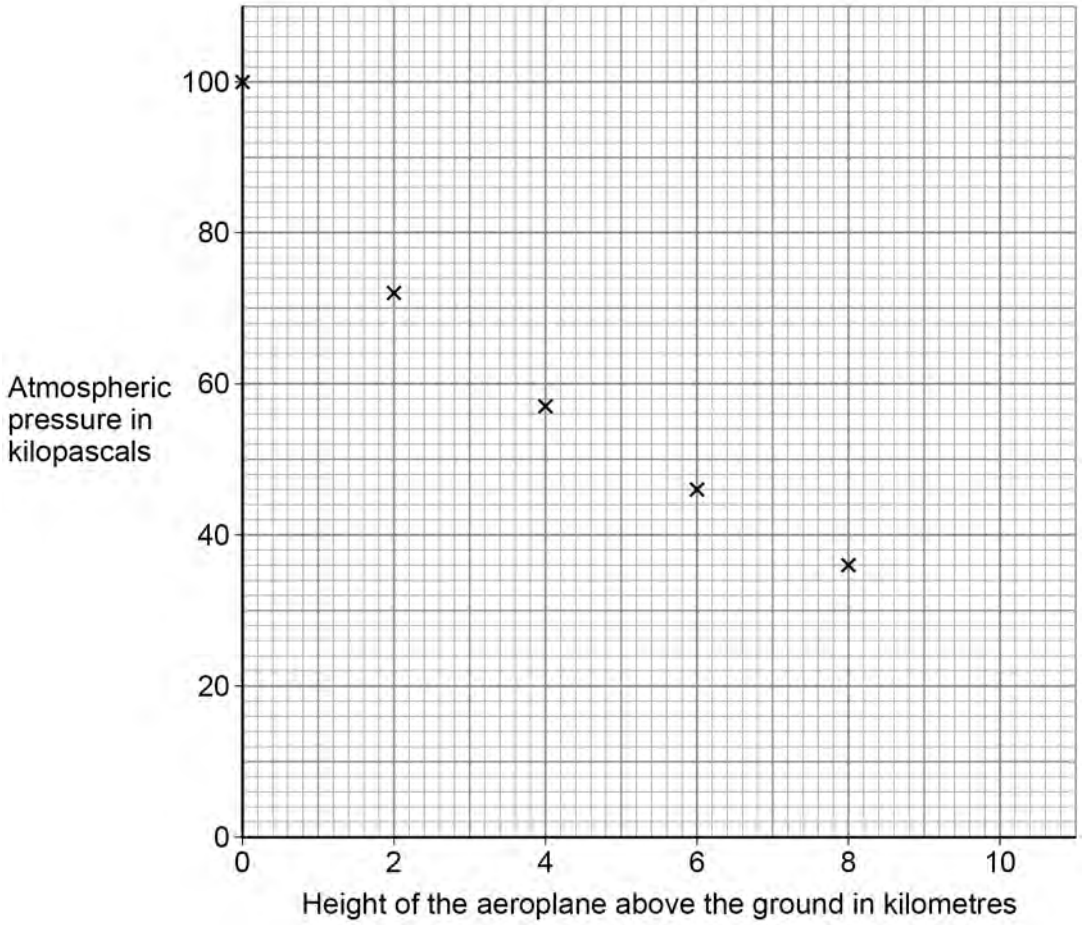
4.5.6.1.4 The distance–time relationship

Question 27 · continued

0 2 . 6 The aeroplane takes off from the runway, so its height above the ground increases.

Figure 7 shows how atmospheric pressure varies with the height of the aeroplane above the ground.

Figure 7



Estimate the atmospheric pressure when the height of the aeroplane above the ground is 10 km.

[2 marks]

Atmospheric pressure = _____ kPa

Question 2 continues on the next page

4.5.6.1.4 The distance–time relationship

Question 27 · continued

0 2 . 7 What happens to the air surrounding the aeroplane as the height of the aeroplane above the ground increases?

[1 mark]

Tick (✓) **one** box.

- The average density of the air above the aeroplane decreases. ☐
- The mass of air above the aeroplane increases. ☐
- The temperature of the air increases. ☐
- The volume of air below the aeroplane decreases. ☐

10