

PHYSICS



EXAM QUESTION PACK

M4 GRAPHS

SCORE

/168

PERCENTAGE

%

STEMUP

These questions belong to OCR, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by OCR. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with OCR and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. OCR has not endorsed, approved or been involved in the production of it. OCR and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

OCR publishes its past papers, mark schemes and examiner reports. Always check the current specification at ocr.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Gateway Physics A (9-1)

Maths 4: Graphs

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	
-----------------------	--	----------------------	--

Centre number						Candidate number				
---------------	--	--	--	--	--	------------------	--	--	--	--

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

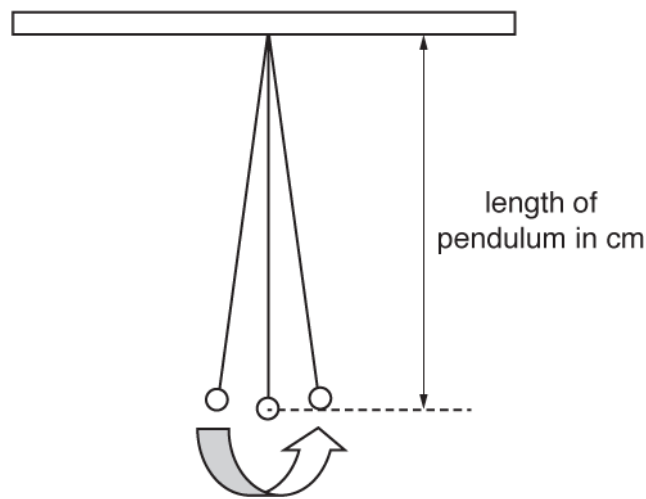
- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **168**.
- The total number of marks may take into account some 'either/or' question choices.

1(a) Helen investigates children’s swings.

She models the swings in the laboratory using weights attached to string.

This type of swing is called a **pendulum**.

She sets up a pendulum and makes it swing.



Helen uses a pendulum that has a length of 50 cm.

She measures the time it takes the pendulum to complete 10 swings.

She repeats this three times, **A**, **B** and **C**.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s			
	A	B	C	Mean (average)
50	14.62	14.78	14.40	

Calculate the mean (average) time for 10 swings.

answer

s [1]

(b) Helen changes the length of the pendulum to 60 cm.

She takes three more measurements and calculates the mean.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s			
	A	B	C	Mean (average)
60	16.35		15.65	16.00

The results table is incomplete.

Use the data to calculate the missing value **B**.

answer -----

s [2]

(c) Helen changes the length of the pendulum to 70 cm.

She takes more measurements and calculates the mean.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s				Mean (average) time for one swing in s
	A	B	C	Mean (average)	
70	17.55	17.65	17.32	17.50666	

Use the data to calculate the mean time for one swing.

Give your answer to 2 decimal places.

answer ----- s [2]

(d) Helen wants to find out about real swings, like those used by children.

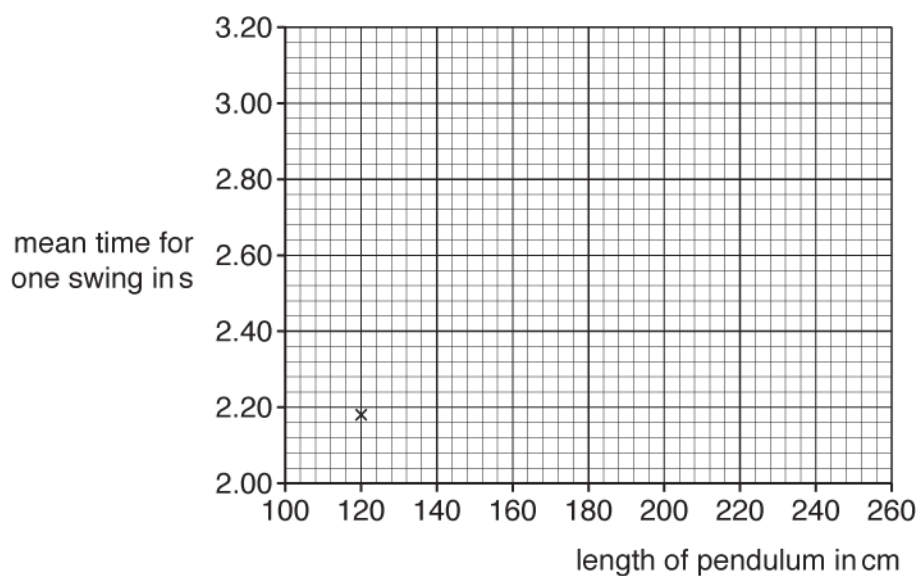
She uses longer pendulums and investigates the effect of changing the length.

Look at the summary of her results.

Length of pendulum in cm	Mean (average) time for one swing in s
100	2.00
120	2.18
150	2.43
190	2.74

- (i) Plot Helen's results onto the graph. One has been plotted for you.

Draw a line of best fit.



[2]

- (ii) Describe the pattern shown by the graph.

[1]

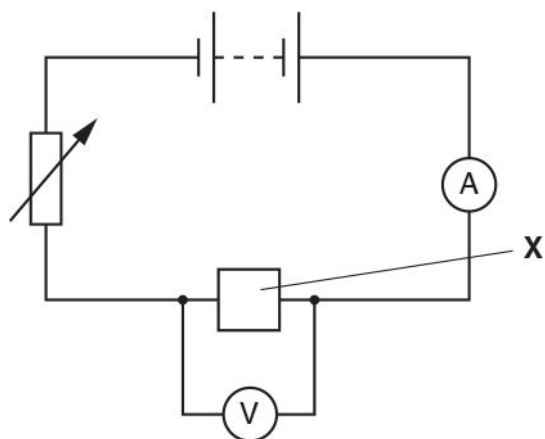
- (iii) Helen wants to make a pendulum that takes 3 s for one complete swing.

Predict the length of this pendulum.

Show your working on the graph.

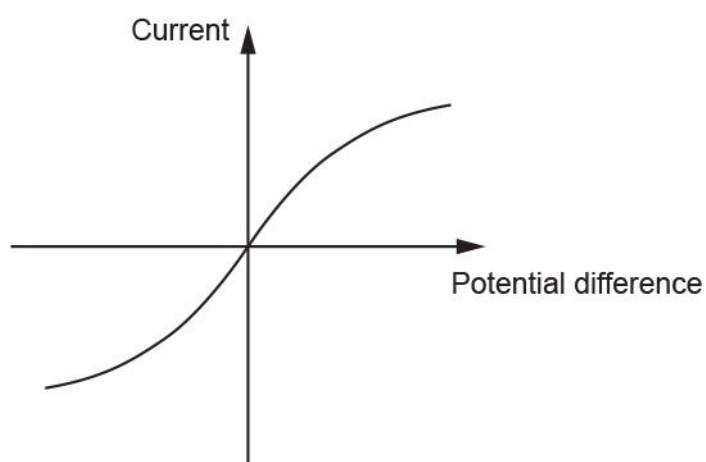
answer ----- cm [2]

2 A student builds a circuit to investigate the resistance of component X.



The student uses the circuit to take current and potential difference readings.

The student plots a graph of her results.



(i) Look at the graph.

What is component X in the circuit?

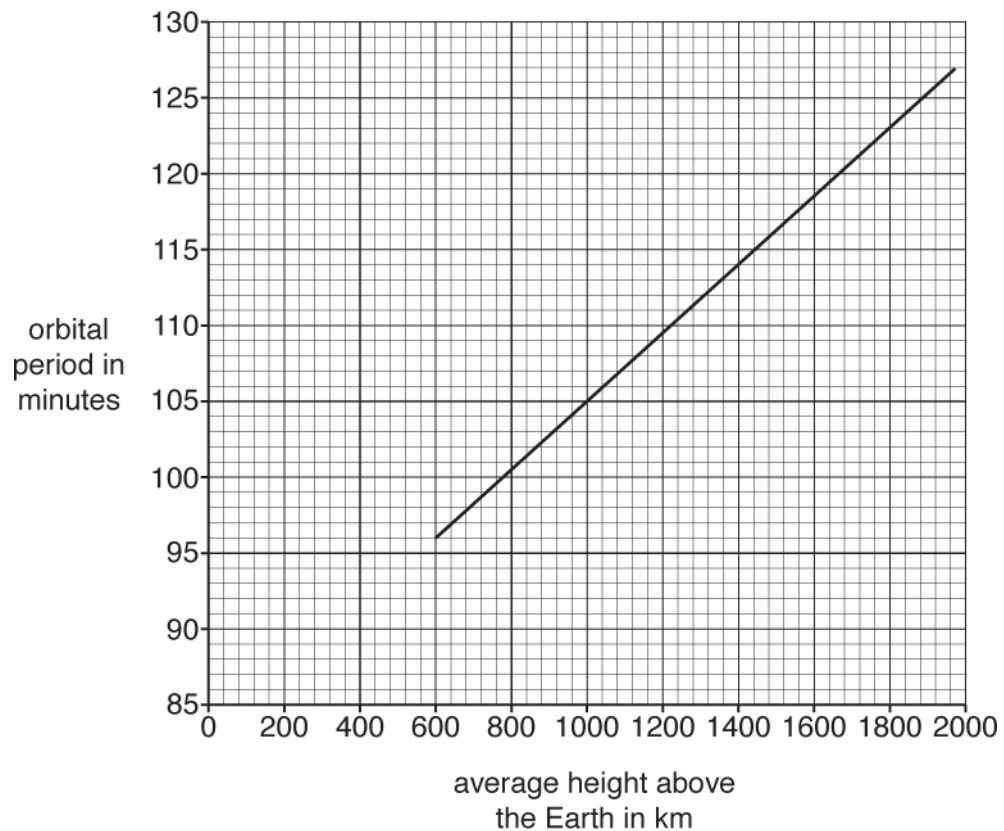
-----[1]

(ii) The resistance of component X varies as the potential difference changes.

Describe **how** the graph shows this and explain **why** this happens.

- 3 Weather forecasting satellites are in a low orbit.

The average height of a satellite above the Earth is linked to its orbital period.



- (i) A scientist suggests that doubling the height above the Earth from 1000 km to 2000 km will double the time period.

Is he correct?

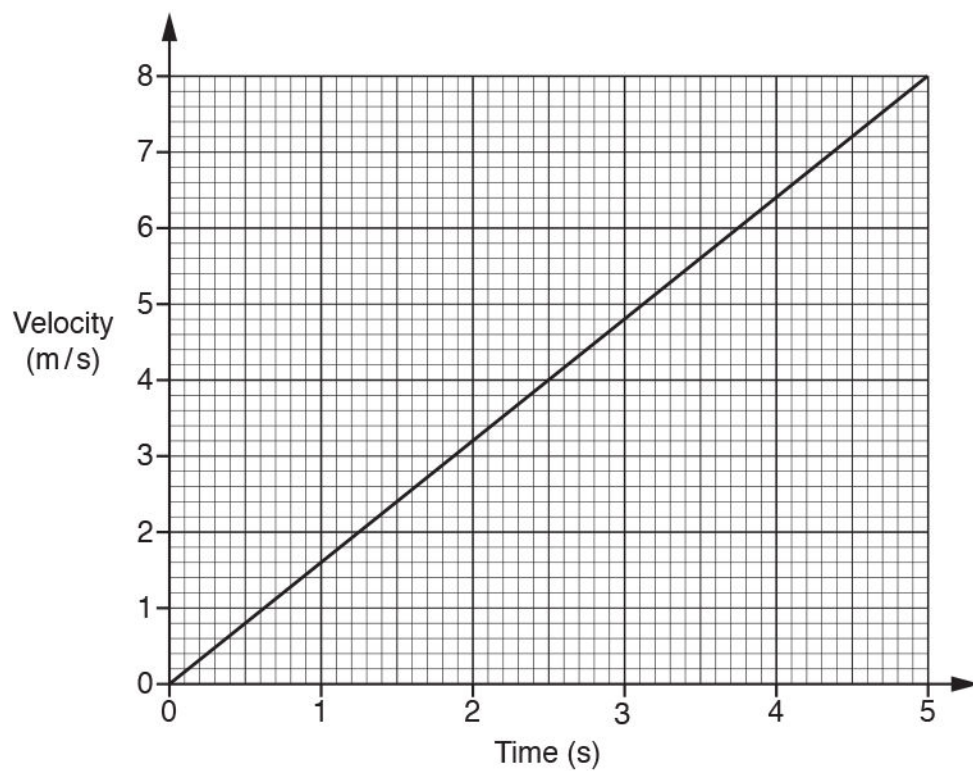
Use calculations in your answer.

----- [2]

(ii) Write down one **advantage** of a low orbit for weather satellites.

----- [1]

4 Look at the velocity-time graph of an object.



What is the distance travelled by the object in 5s?

A 0.63 m

B 1.6 m

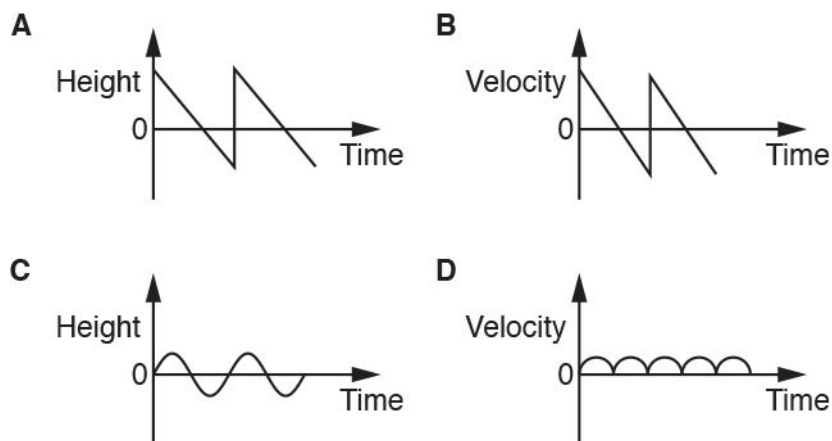
C 20 m

D 40 m

Your answer

[1]

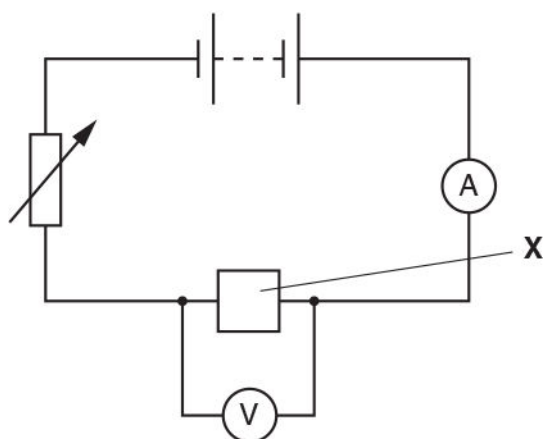
5 Which graph shows a bouncing ball?



Your answer

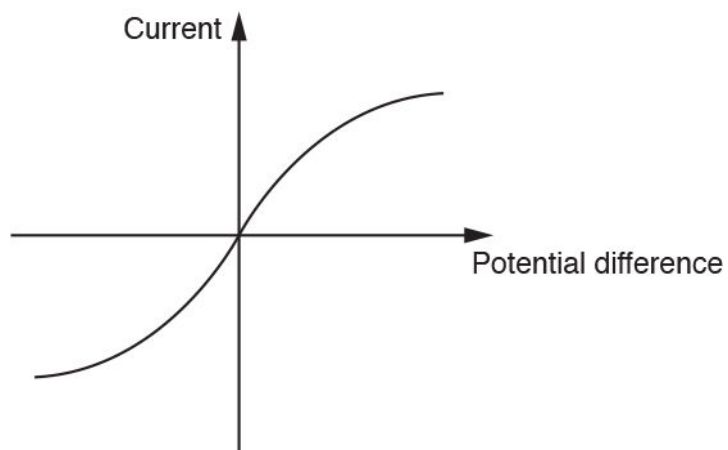
[1]

6 A student builds a circuit to investigate the resistance of component X.



The student uses the circuit to take current and potential difference readings.

The student plots a graph of her results.



- (i) Look at the graph. What is component X in the circuit?

-----[1]

- (ii) The resistance of component X varies as the potential difference changes.

Describe how the graph shows this and explain why this happens.

-----[3]

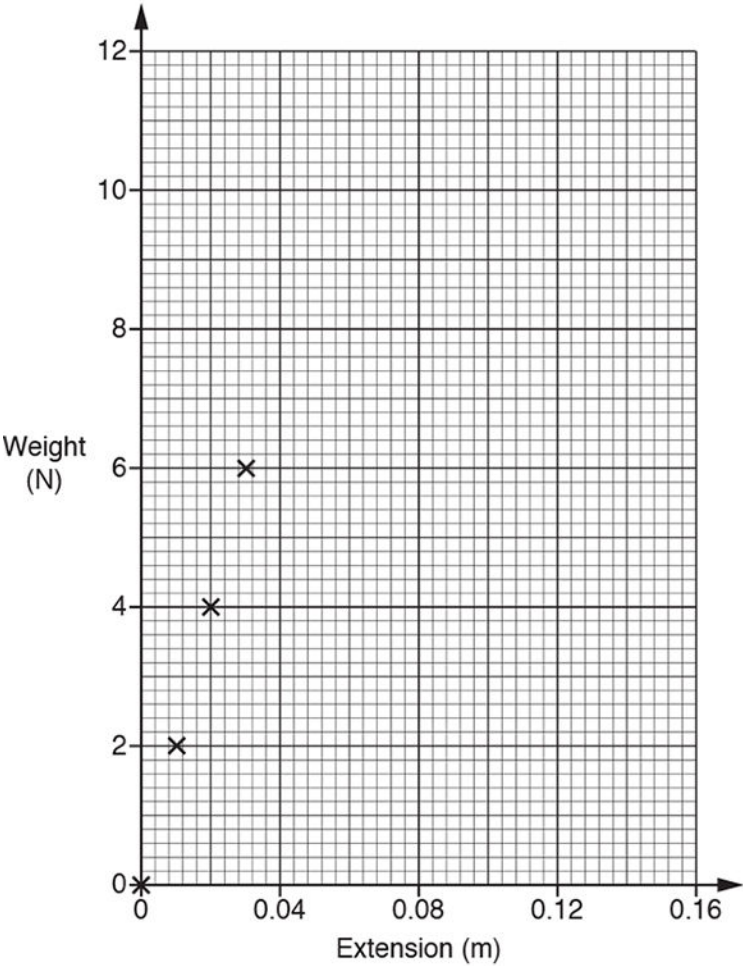
7(a) A student hangs a length of copper wire from the ceiling.

She adds weights to the bottom of the wire and measures the extension of the wire.

Look at a table of some of her results.

Weight (N)	Extension (m)
0	0
2	0.01
4	0.02
6	0.03
8	0.04
10	0.08
12	0.16

(i) Plot the values on the graph. Some have been done for you.



[2]

(ii) Draw a line of best-fit on the graph.

[1]

(iii) Describe **and** explain the shape of the graph.

----- [3]

(b) Calculate the spring constant for the 0 – 6 N part of the graph.

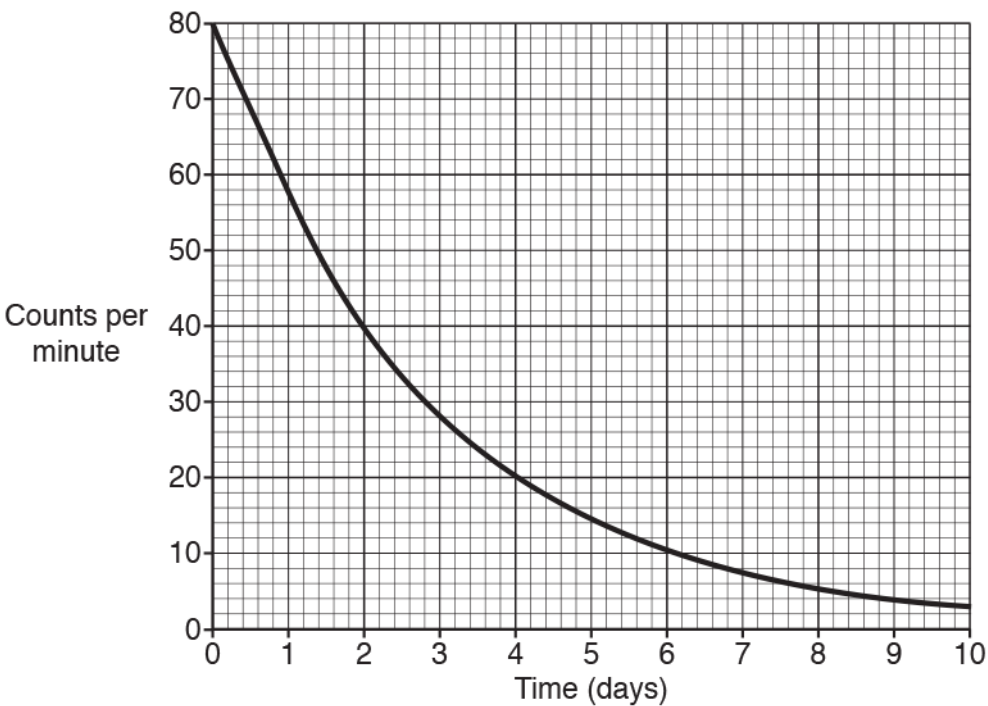
Use the equation: Force = Spring constant $\times$ Extension

Answer = ... N/m [3]

(c) Calculate the work done in stretching the wire to 0.04 m.

Answer = ... J [2]

8 A teacher measures the radiation from a radioactive source for 10 days.



What is the half-life of this radioactive source?

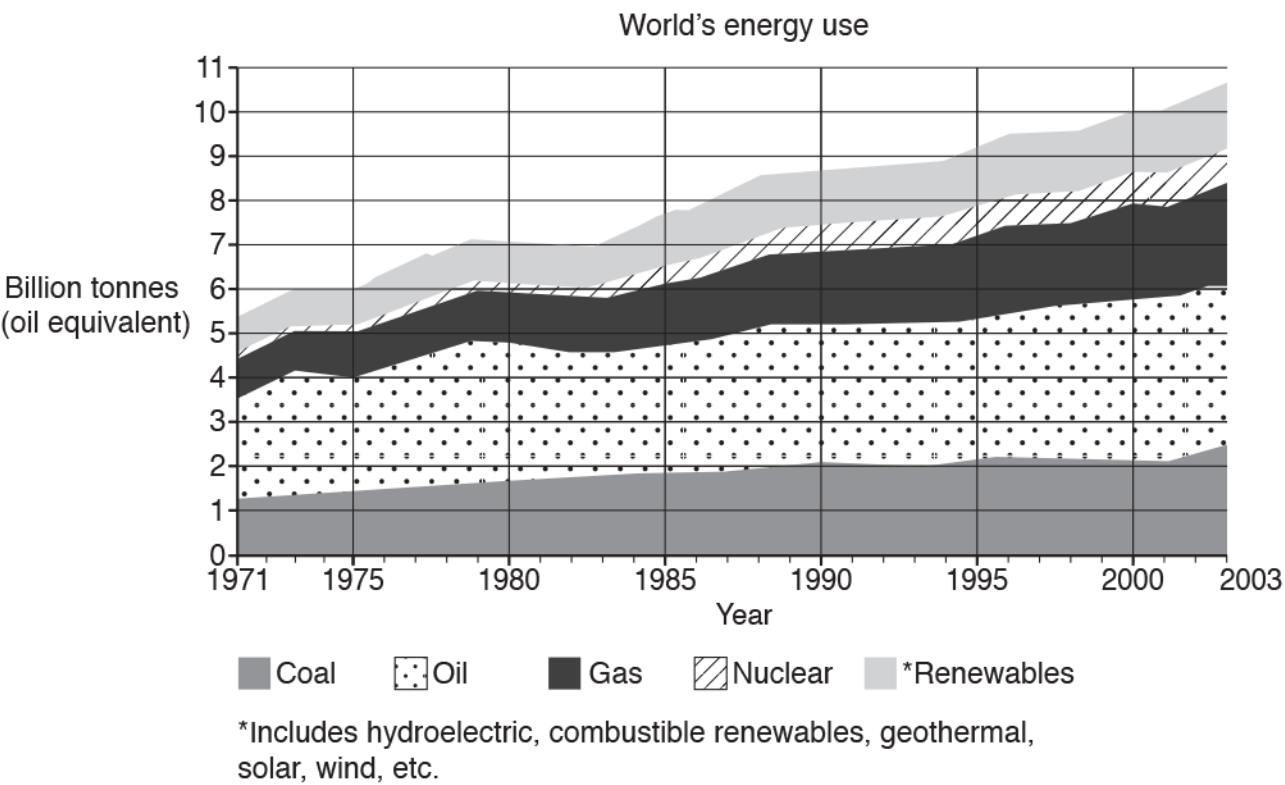
- A 1 day
- B 2 days
- C 4 days
- D 5 days

Your answer

[1]

9(a) The graph shows how the World's energy use has changed from the year 1971 to the year 2003.

It also shows the amount of different energy sources used.



(i) Approximately how much did the total World's energy use increase from the year 1971 to the year 2003?

Answer = ... billion tonnes (oil equivalent) [1]

(ii) Which energy source had the **greatest** use in the year 2003?

..... [1]

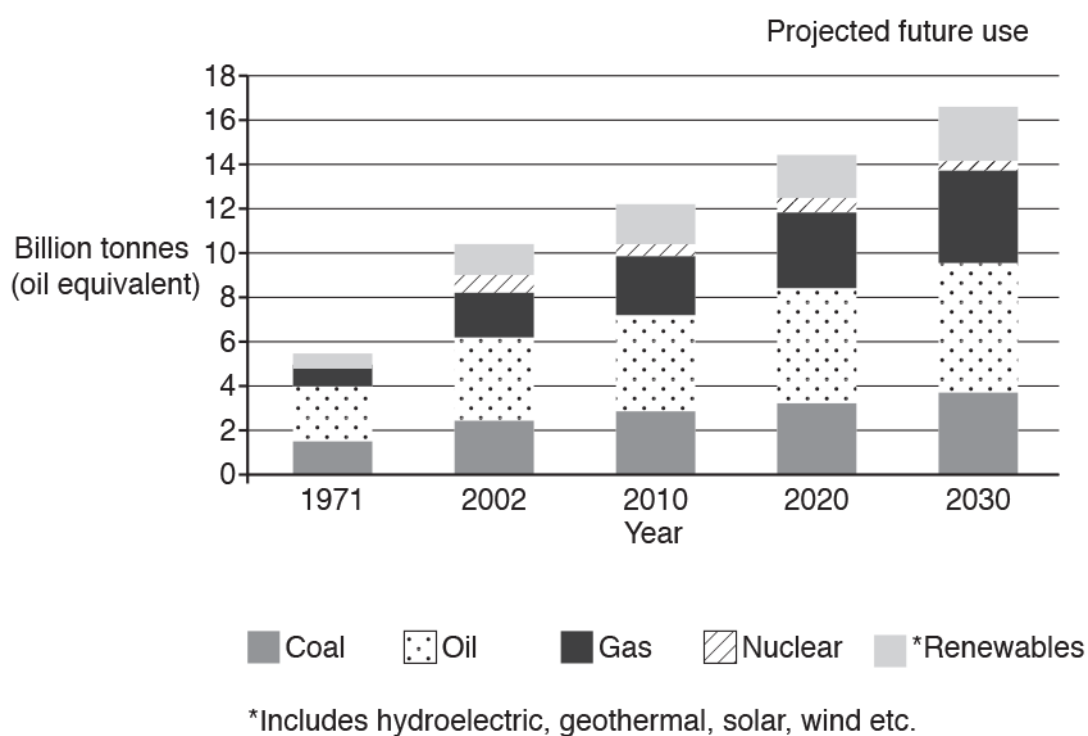
(iii) The total energy use in the year 2003 was 10.6 billion tonnes (oil equivalent).

Approximately what percentage of this amount was due to fossil fuel use?

Answer = ... % [2]

(b) Scientists are researching the World's energy use for the future.

The graph shows some of their research.



(i) The future demand for fossil fuels is expected to increase.

Give two reasons why scientists are worried about this increase in demand.

1

2

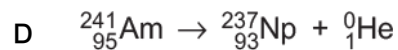
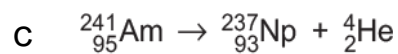
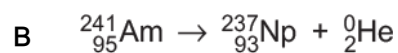
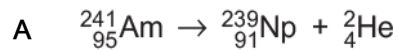
[2]

- (ii) In the UK the government is closing coal fired power stations and planning for new nuclear power stations to be built.

Suggest why the government wants more nuclear power stations.

[2]

10 Which equation shows a correct alpha decay?

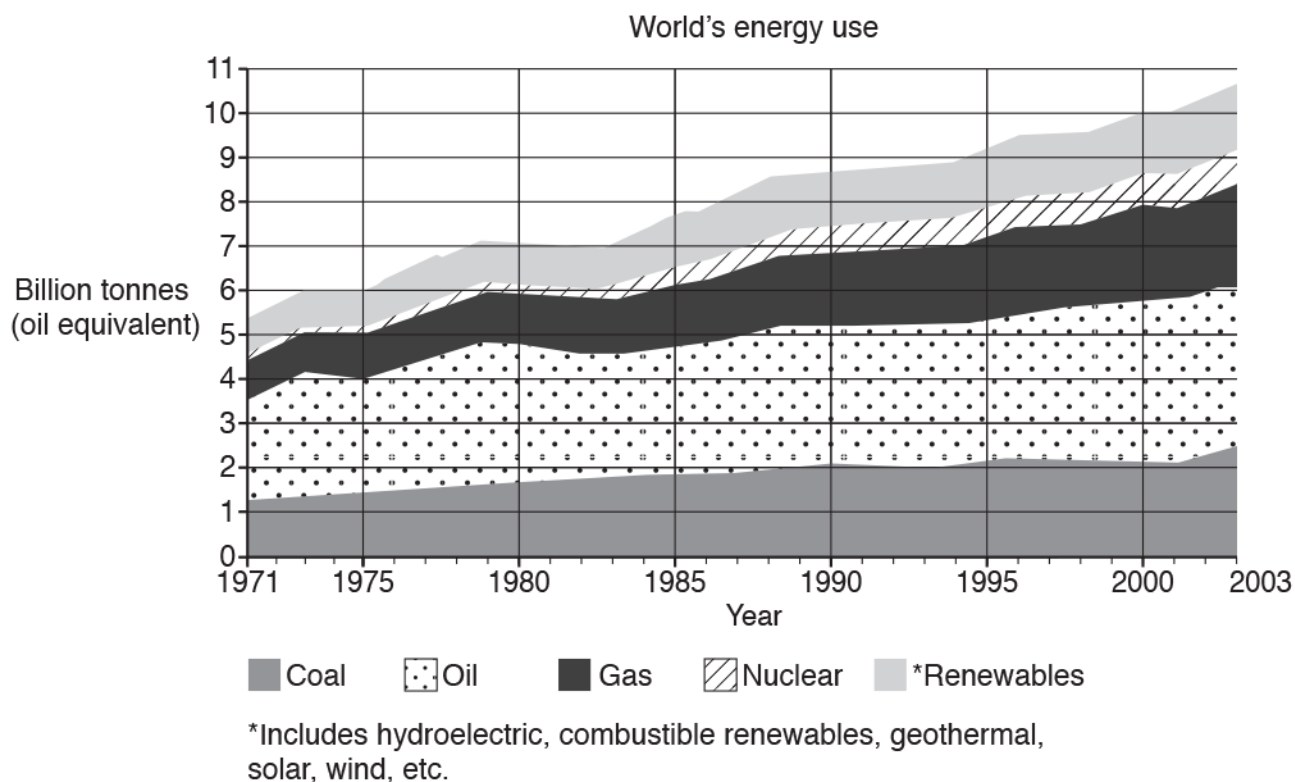


Your answer

[1]

11(a) The graph shows how the World's energy use has changed from the year 1971 to the year 2003.

It also shows the amount of different energy sources used.



(i) Approximately how much did the total World's energy use increase from the year 1971 to the year 2003?

Answer = _____ billion tonnes (oil equivalent) [1]

(ii) Which energy source had the **greatest** use in the year 2003?

_____ [1]

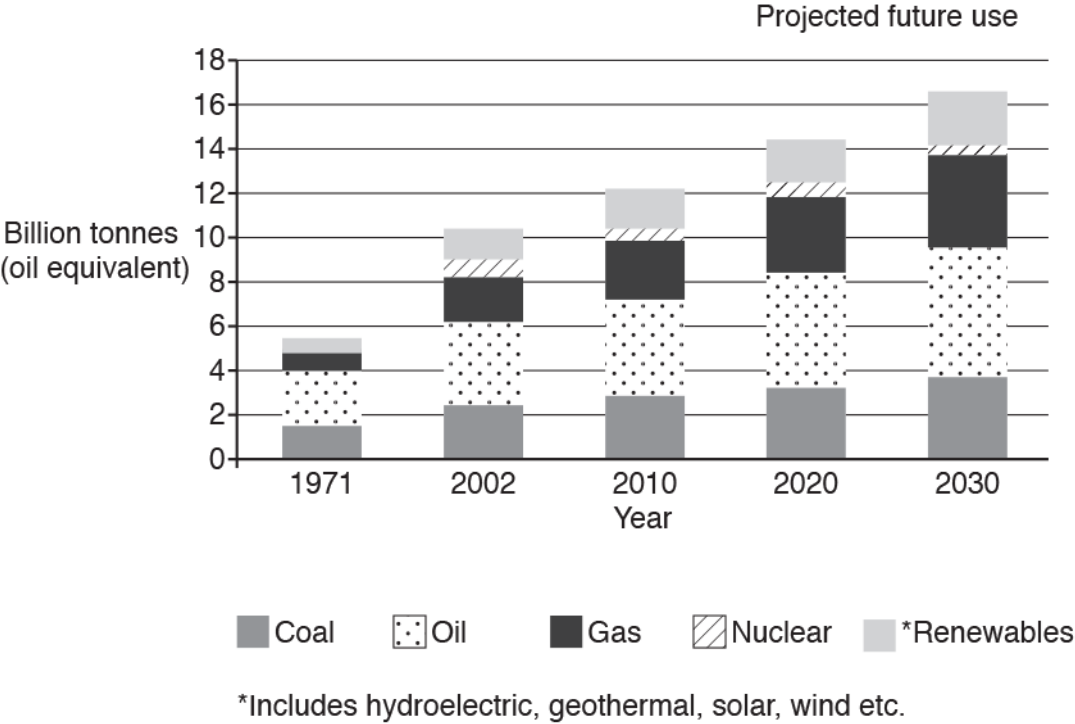
(iii) The total energy use in the year 2003 was 10.6 billion tonnes (oil equivalent).

Approximately what percentage of this amount was due to fossil fuel use?

Answer = _____ % [2]

(b) Scientists are researching the World’s energy use for the future.

The graph shows some of their research.



(i) The future demand for fossil fuels is expected to increase.

Give two reasons why scientists are worried about this increase in demand.

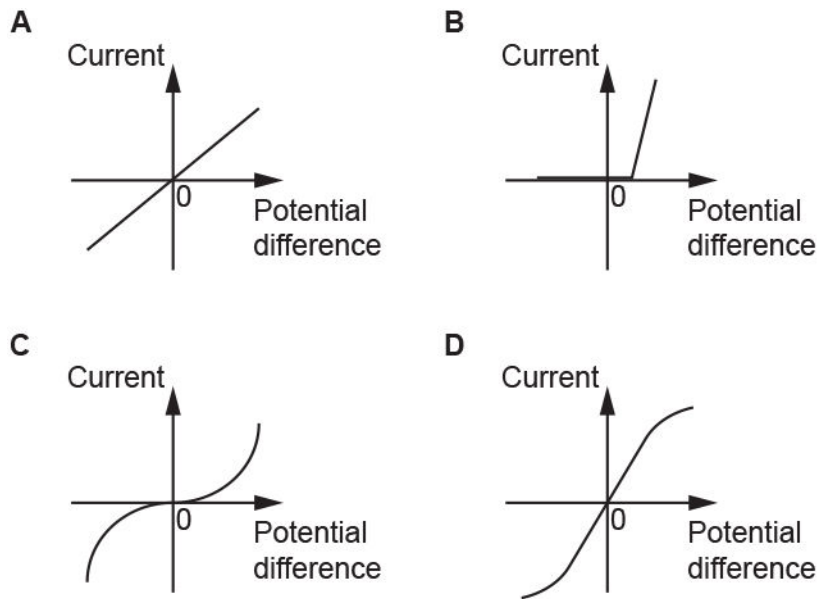
1.
-
2.
-
- [2]

(ii) In the UK the government is closing coal fired power stations and planning for new nuclear power stations to be built.

Suggest why the government wants more nuclear power stations.

12 A student investigates four different electrical components.

She plots current-potential difference graphs for the components.



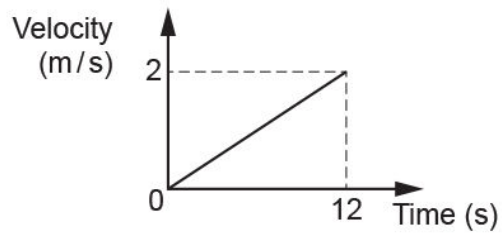
Which of the above shows the characteristic graph for a diode?

Your answer

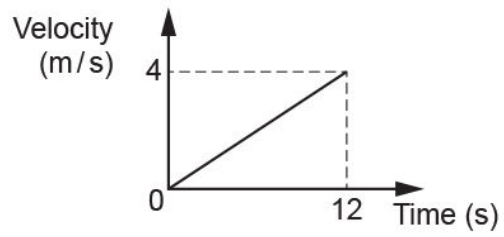
[1]

13 Look at the motion graphs.

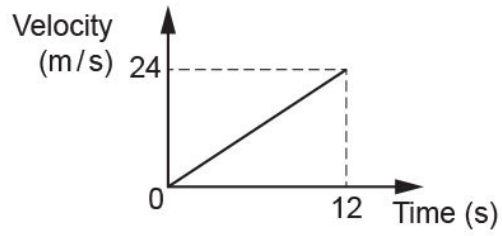
A



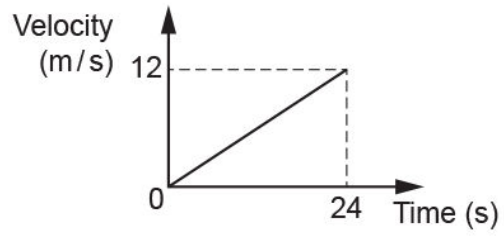
B



C



D



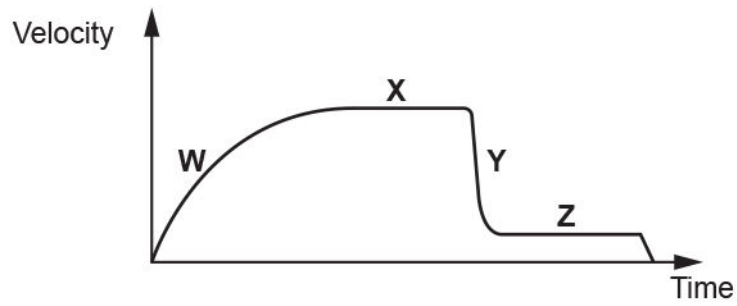
Which graph shows a journey with a distance of 24 m?

Your answer

[1]

14 A skydiver falls from a plane. His parachute opens and he lands safely.

Look at the velocity-time graph of his journey.



Which parts of the graph show balanced forces on the skydiver?

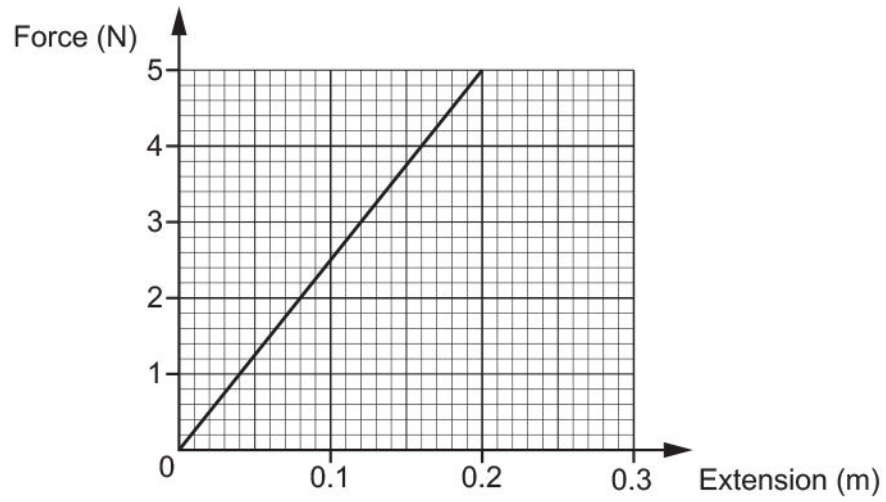
- A X only
- B Y and Z
- C X and Z
- D Y only

Your answer

[1]

15(a) A student investigates how a spring stretches when a force is added.

Look at a graph of his results.



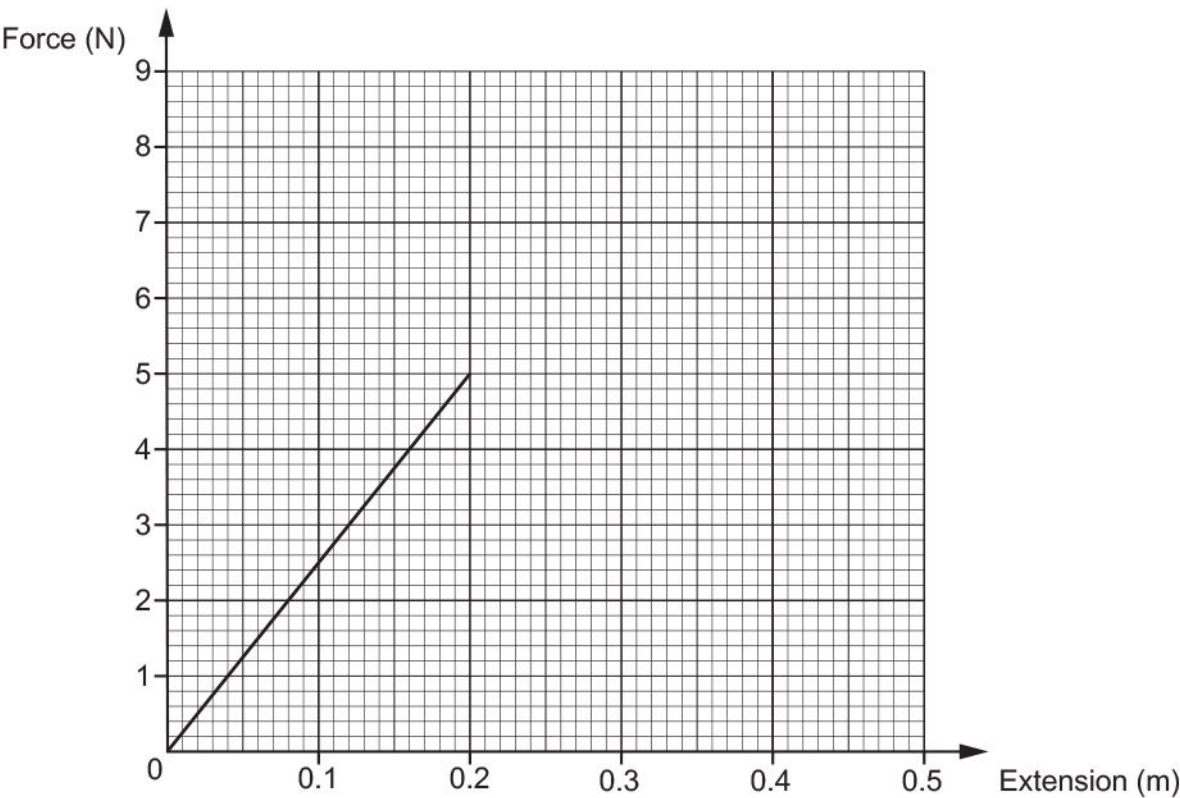
Calculate the spring constant of the spring.

Spring constant = ... N / m [3]

(b) A student investigates how a spring stretches when a force is added.

The student continues to load the spring until it passes its elastic limit.

Complete the force-extension graph and label the elastic limit.



[2]

16(a) A student investigates how the angle of a ramp affects the final speed of a trolley.

He uses light gates to record the speed of the trolley at the bottom of the ramp.

The student releases the trolley from rest at the same point on the ramp each time.

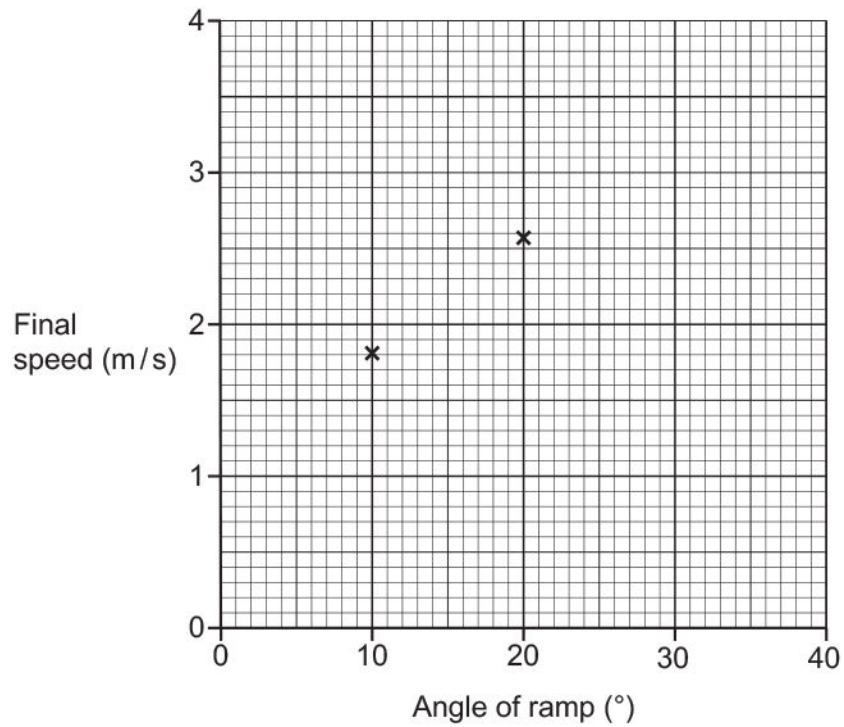
Look at his results.

Angle of ramp (°)	Final speed (m / s)			
	Attempt 1	Attempt 2	Attempt 3	Mean
10	1.81	1.80	1.81	1.81
20	2.58	2.56	2.57	2.57
30	3.1	3.11	3.11	3.11

40	3.52	3.51	3.50	3.51
----	------	------	------	------

(i) Plot the results on the graph and draw a line of best fit.

Two results have been plotted for you.



[2]

(ii) Describe the pattern shown by the results.

Use data from the table or graph in your answer.

[3]

(iii) Explain why the final speed changes when the angle of the ramp increases.

In your answer use ideas about energy.

[2]

(iv) The student made a mistake when recording one of his results.

Identify the mistake **and** explain what he should have done.

[2]

(v) The student thinks this data shows that his results are **reproducible**.

He is **not** correct.

Explain why.

[2]

(b)

- (i) The mean final velocity for the ramp at a 40° angle is 3.51 m / s . The distance from the top of the ramp to the light gate at the bottom is 1.0 m .

Calculate the acceleration of the trolley when the ramp is at a 40° angle.

Give your answer to decimal places.

Acceleration = ... m / s^2 [5]

- (ii) The trolley has a mass of 2.0 kg .

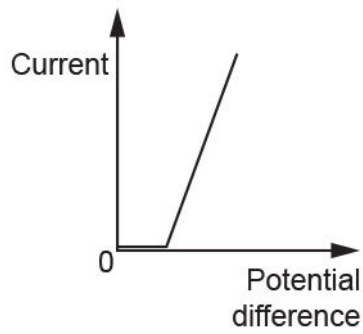
Calculate the kinetic energy of the trolley at a speed of 3.0 m / s .

Kinetic energy = ... J [3]

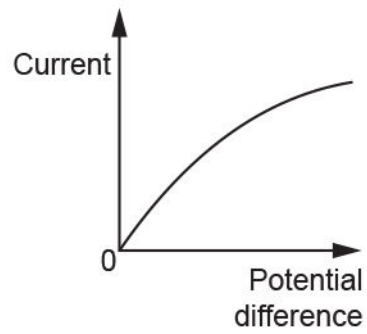
17 A student investigates how current and potential difference vary in different components.

Look at the graphs of her results.

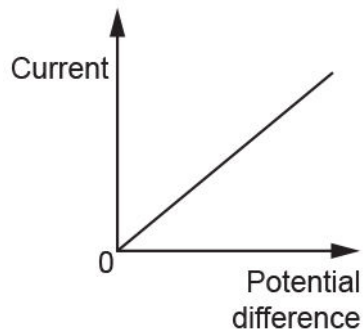
A



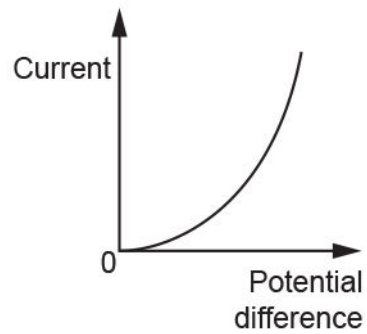
B



C



D

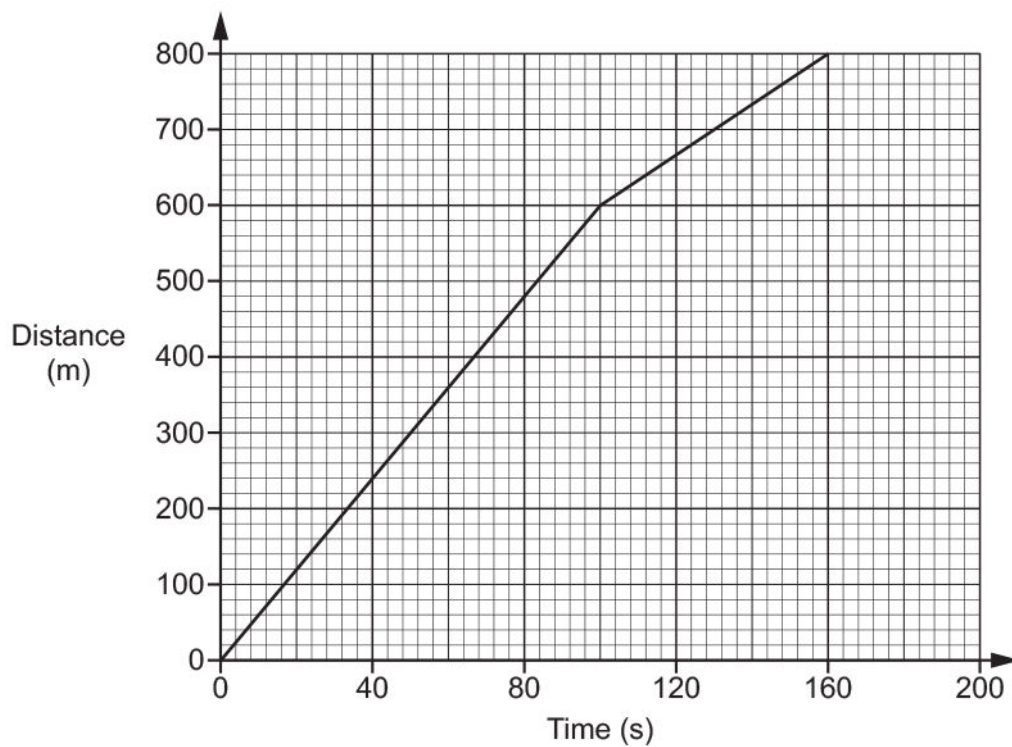


Which graph shows a filament lamp?

Your answer

[1]

18 Look at the distance-time graph for a journey to school.



What is the average speed for the journey?

Use the equation: average speed = distance travelled $\div$ time

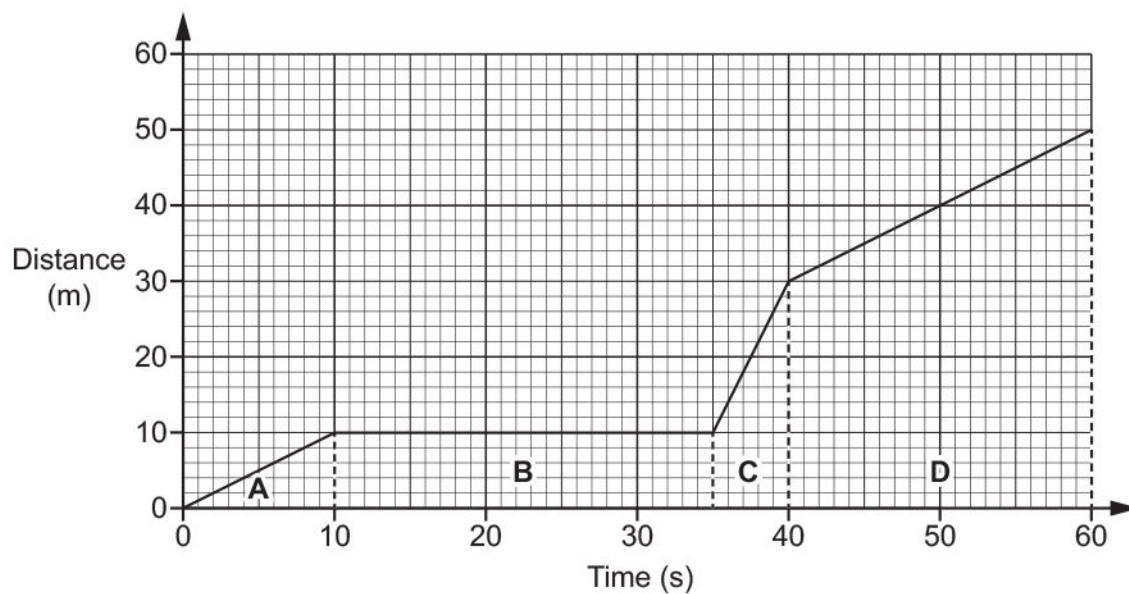
- A 0.2 m/s
- B 5.0 m/s
- C 6.0 m/s
- D 50 m/s

Your answer

[1]

19(a) A student investigates motion graphs.

Look at a distance-time graph for the movement of a dog in a park.



(i) How far did the dog move in the park?

Distance = ... m [1]

(ii) How long was the dog in the park?

Time = ... s [1]

(iii) Name a piece of apparatus the student could use to accurately measure the distance the dog moved.

----- [1]

(b) The distance-time graph has four sections: A, B, C and D.

(i) Which section of the graph shows the **greatest** speed?

Tick (✓) **one** box.

A

☐

B

☐

C

☐

D

☐

Explain your answer.

[2]

(ii) Which section of the graph shows **zero** speed?

Tick (✓) **one** box.

A

☐

B

☐

C

☐

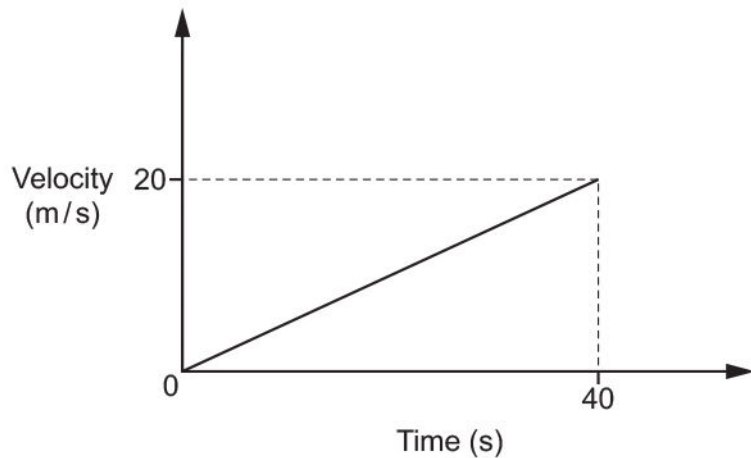
D

☐

Explain your answer.

[2]

(c) The student draws a velocity-time graph for a boat accelerating.



Acceleration is the gradient of a velocity-time graph.

Calculate the acceleration of the boat.

Use the equation: acceleration = change in velocity ÷ time

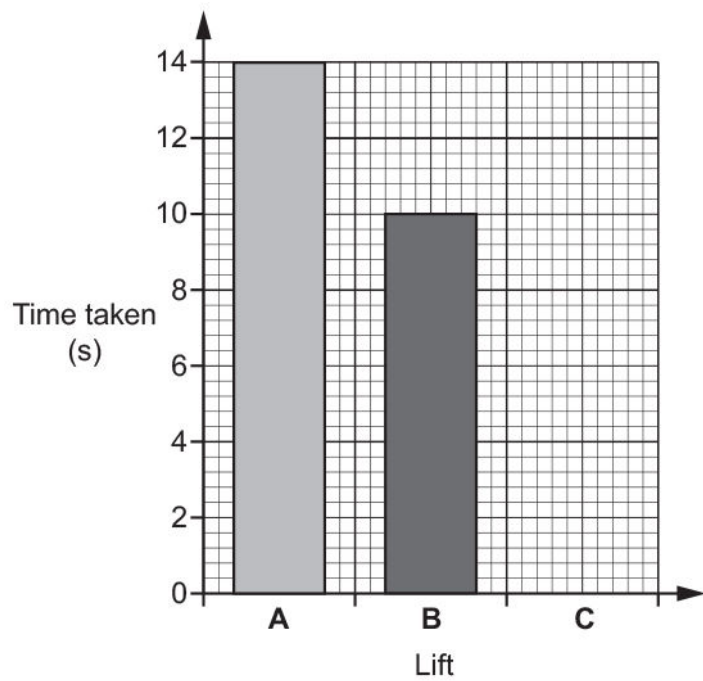
Acceleration = ... m/s² [2]

20 A tall building needs a lift to move people from one floor to another.

The builder has a choice of three different lifts.

Each lift takes a different amount of time to move between the two floors.

Look at a bar chart of the time taken for each lift.



(i) Lift C takes 12 s to move between the two floors.

Draw a bar for lift C on the bar chart.

[1]

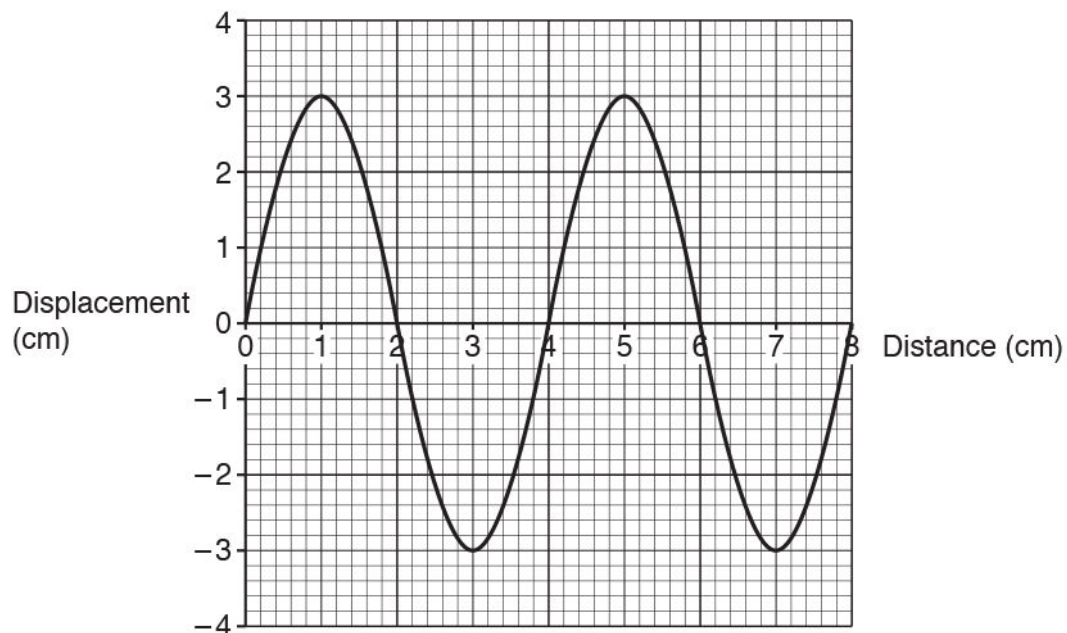
(ii) Calculate the **mean** time of the three lift journeys.

Mean = ... s [2]

(iii) Explain which lift uses the most power.

[2]

21 Look at the diagram of a wave.



What is the wavelength of the wave?

- A 2 cm
- B 3 cm
- C 4 cm
- D 6 cm

Your answer

[1]

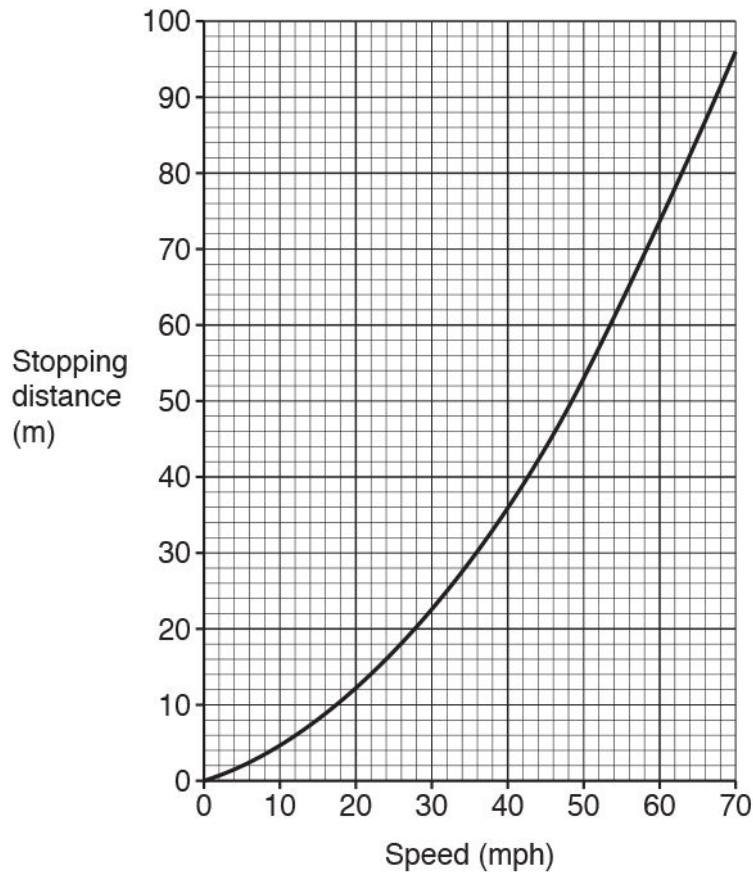
The driver of a car makes an emergency stop.

The thinking distance is 9 m. The braking distance is 14 m.

(i) Calculate the total stopping distance of the car.

Stopping distance = ... m [1]

(ii) This graph shows how this driver's stopping distance changes with speed.



- A car is travelling at 50 mph.
- There is a barrier in the road 40 m in front of the car.

- The driver makes an emergency stop.

Use the graph to work out if the car hits the barrier.

Explain how you obtained your answer.

----- [2]

- (iii) State one factor, other than speed, that affects braking distance.

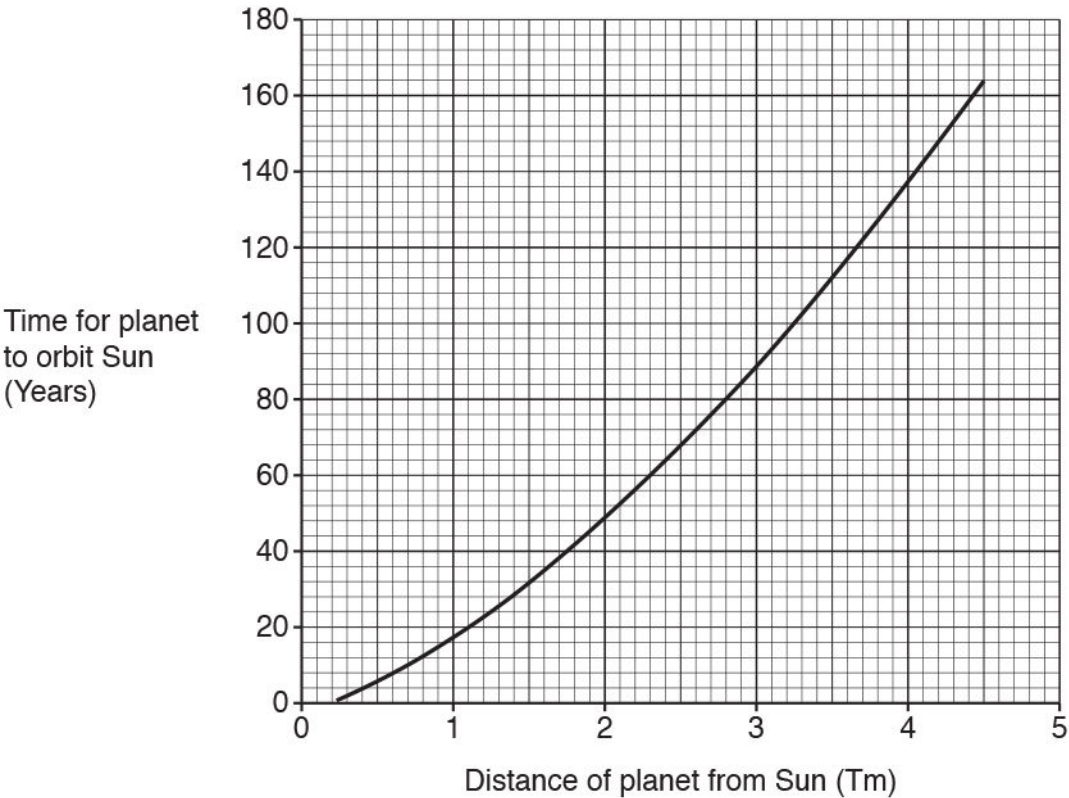
Explain how this factor changes braking distance.

Factor -----

Explanation -----

[3]

23 * This graph shows how a planet's orbit time changes with distance from the Sun in our solar system.



Describe and explain the relationship shown by the graph.

Use data from the graph and ideas about our solar system in your answer.

[6]

24 A student investigates the rate of cooling using a cardboard box to model the walls of a building.

She puts a beaker of hot water into the cardboard box. She measures the temperature of the water every two minutes.

She investigates how the rate of cooling changes with the thickness of the walls.

Here are the results of one of her experiments.

Time (minutes)	Temperature of water (°C)
0	90
2	75
4	63
6	54
8	47
10	41
12	37

(i) Plot the results on the grid in Fig. 22.1.

Two of the points have been plotted for you.

[2]

(ii) Draw a line of best fit on your graph.

[1]

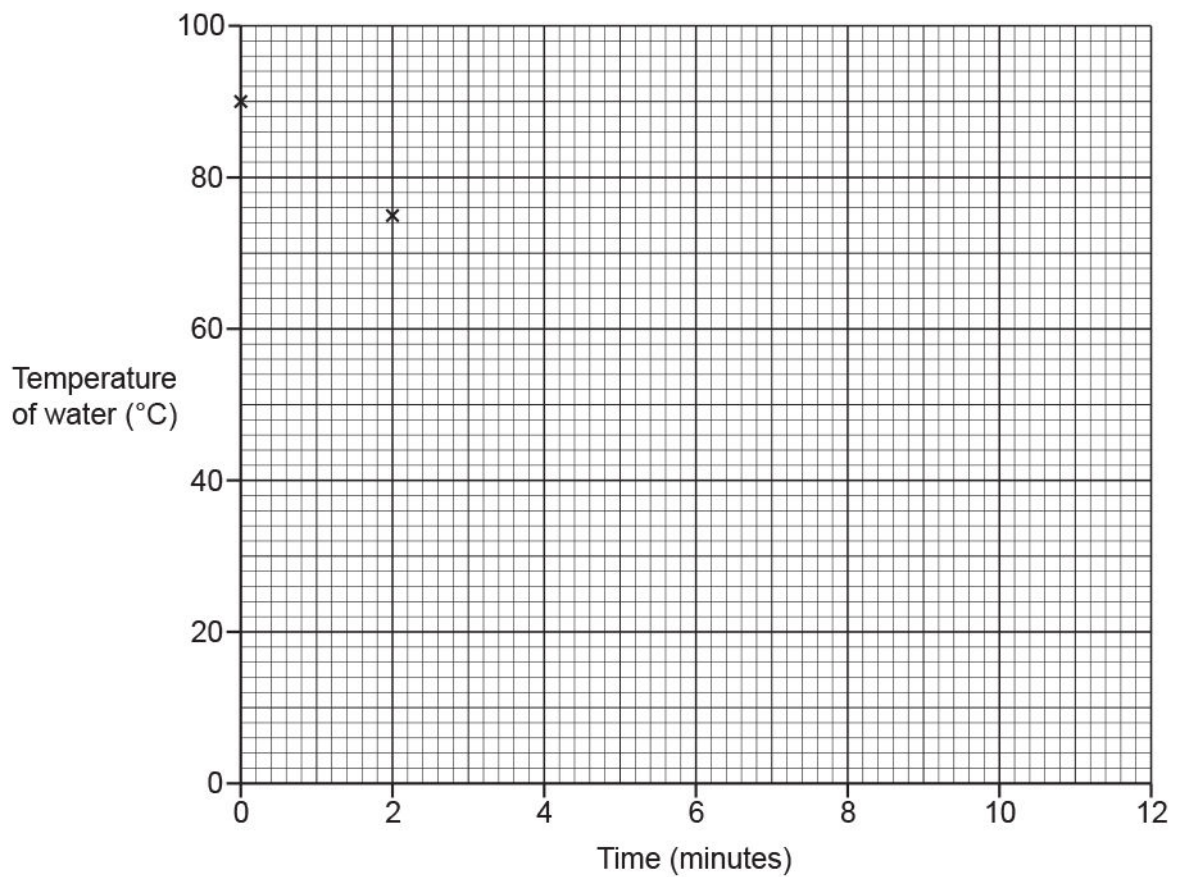


Fig. 22.1

- (iii) Describe how the temperature of the water changes with time.
Use data from the graph in Fig. 22.1 in your answer.

----- [2]

- (iv) The thickness of the cardboard box is doubled. Everything else stays the same.

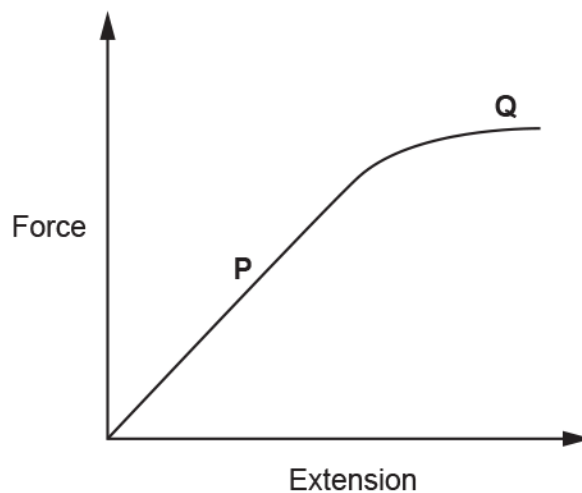
Sketch a line on the graph in Fig. 22.1 to suggest what these new results may look like.
Label your line Z.

[1]

(v) Suggest **one** way to improve the investigation.

[1]

25 A student plots a force-extension graph for a material.



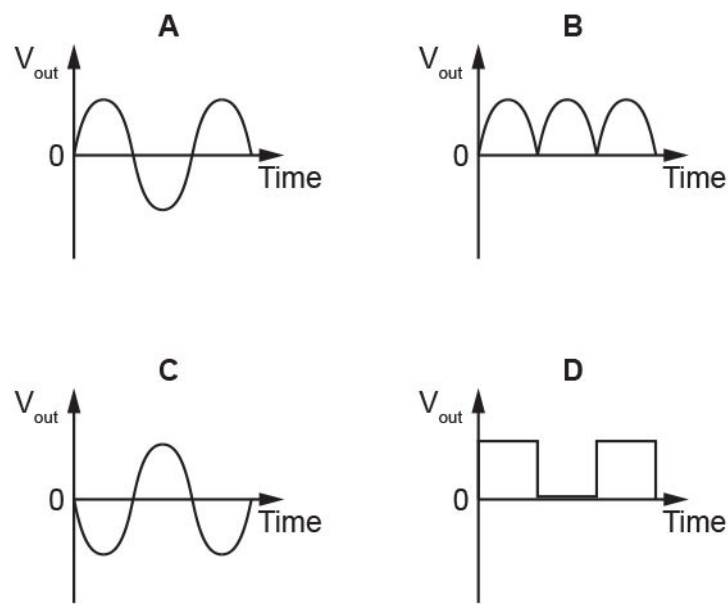
Which row in the table correctly identifies part P and part Q of the graph?

	Part P	Part Q
A	Elastic	Elastic
B	Elastic	Plastic
C	Plastic	Elastic
D	Plastic	Plastic

Your answer

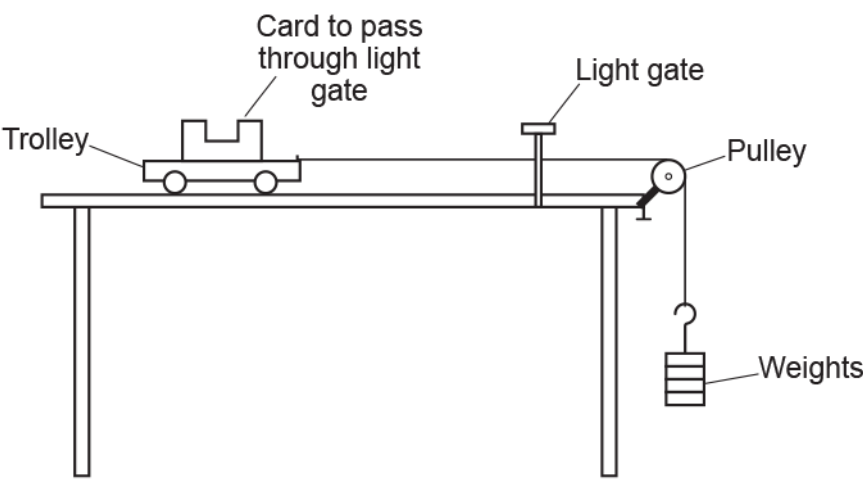
[1]

26 Which of the following graphs shows the typical output potential difference, V_{out} , for a dynamo?



Your answer

[1]



The trolley is released from a fixed position and accelerates.

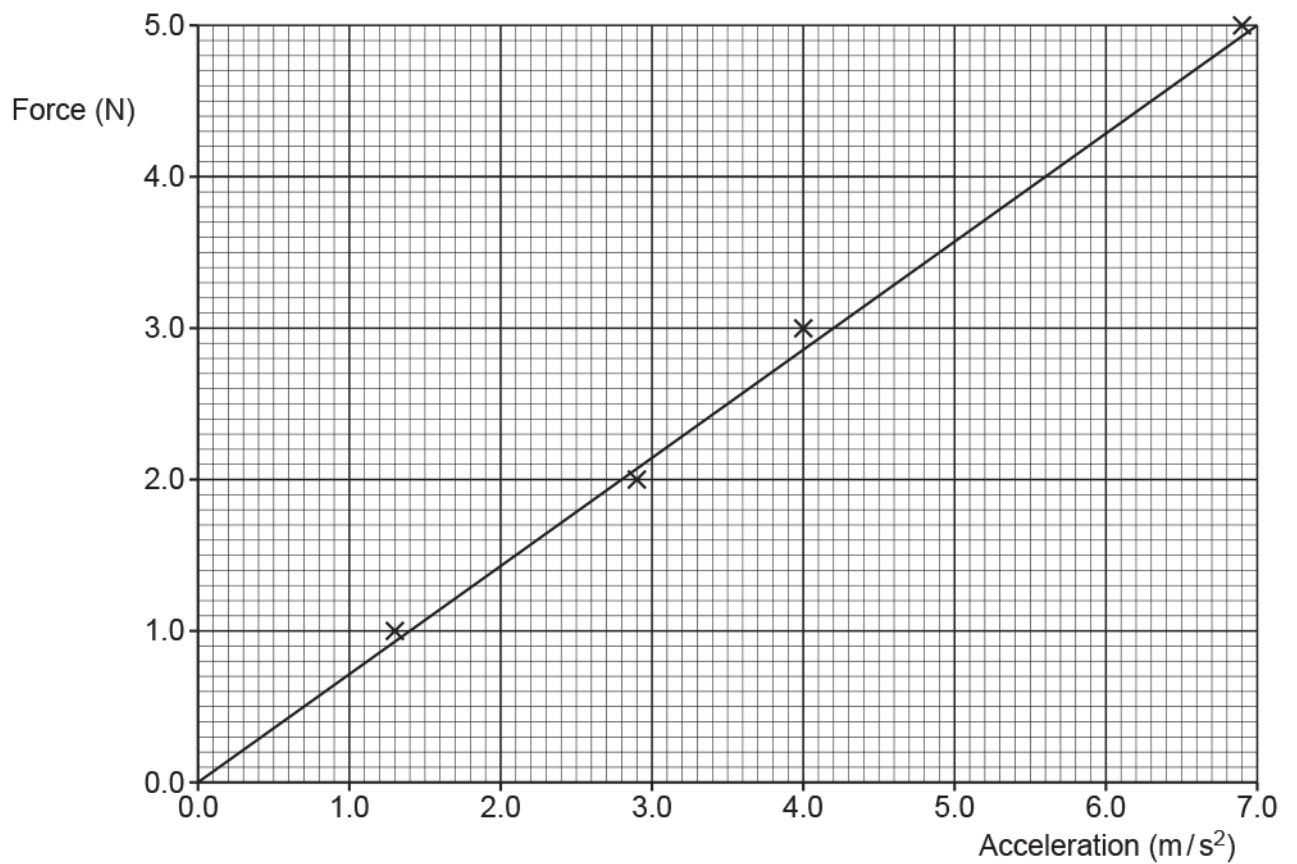
The accelerating force is provided by the weights attached to the trolley with string.

Acceleration is measured using a light gate and data logging equipment.

Look at the results from the experiment.

Force (N)	Acceleration
1.0	1.3
2.0	2.9
3.0	4
4.0	5.7
5.0	6.0

The student plots the results on a graph.



(i) One point has not been plotted on the graph. Plot the missing point on the graph.

[1]

(ii) Describe the relationship between the two variables on the graph.

[2]

(iii) Calculate the gradient of the graph and use this to determine the mass of the trolley.

Mass = ... kg [2]

- (iv) The actual mass of the trolley is lower than that found in the experiment. Suggest two reasons why.

Use ideas about forces and energy in your answer.

1

.....

2

.....

[2]

- (v) Suggest **two** ways the experiment could be improved.

1

.....

2

.....

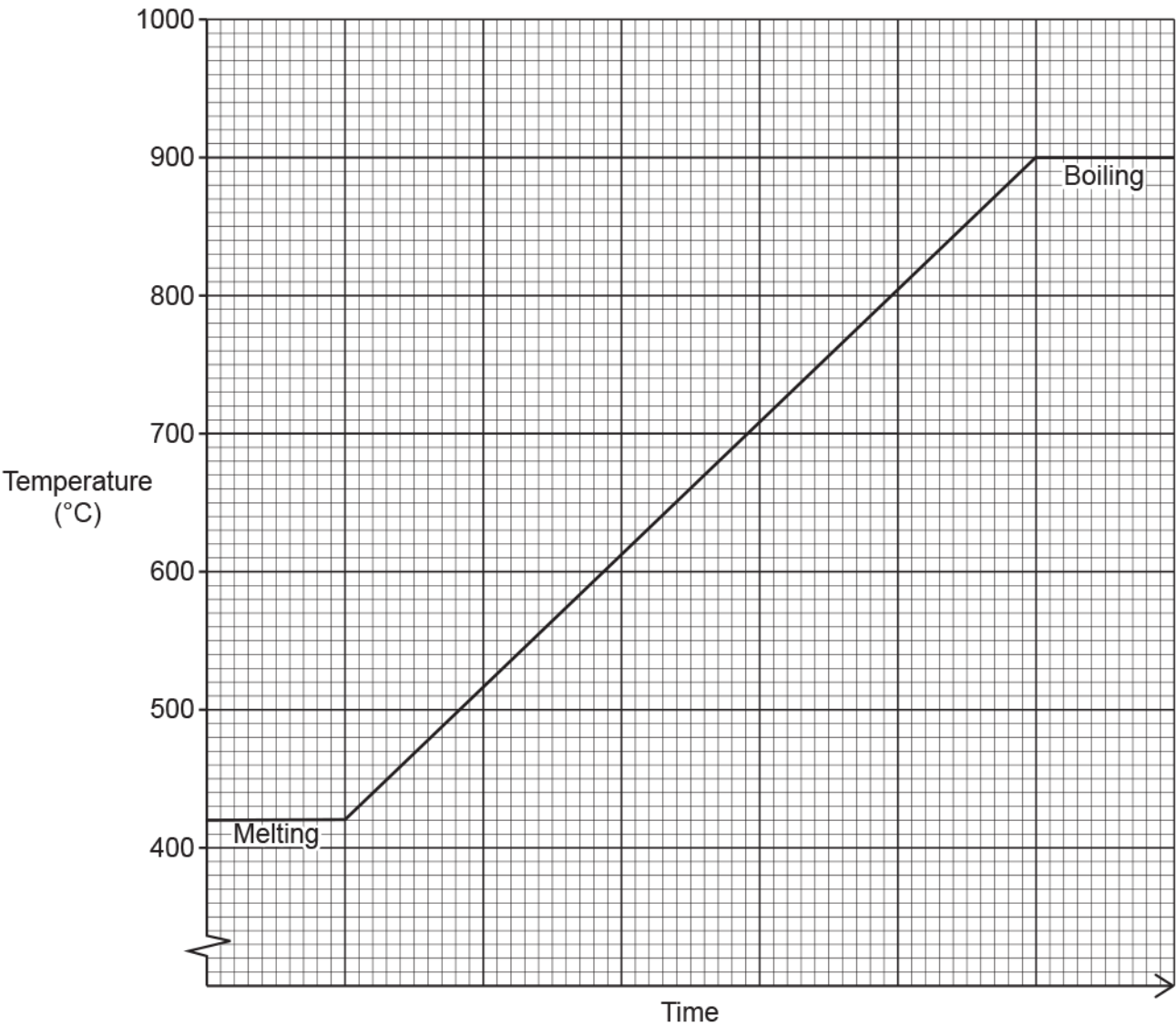
[2]

28(a) The table shows the specific heat capacities of different materials.

Material	Specific heat capacity (J / kg °C)
Copper	330
Brass	380
Zinc	385
Nickel	440
Concrete	880
Concrete	913

A scientist heats an unknown substance from a solid to a liquid.

The graph shows how the temperature of the substance varies with time.



The scientist has 2.5 kg of the substance and records that it takes 462 kJ of energy to increase it from the lowest to the highest temperature in the liquid state.

Use the graph to calculate the specific heat capacity of the substance.

Suggest what material it could be from the table.

Specific heat capacity = ... J / kg °C

Material = ...

[5]

(b) Suggest **two** reasons why the scientist cannot be certain that the substance has been identified correctly.

1

.....

.....

2

.....

.....

[2]

29 A student investigates the rate of cooling using a cardboard box to model the walls of a building.

She puts a beaker of hot water into the cardboard box. She measures the temperature of the water every two minutes.

She investigates how the rate of cooling changes with the thickness of the walls.

Here are the results of one of her experiments.

Time (minutes)	Temperature of water (°C)
0	90
2	75
4	63
6	54
8	47
10	41
12	37

(i) Plot the results on the grid in Fig. 17.1.

Two of the points have been plotted for you.

[2]

(ii) Draw a line of best fit on your graph.

[1]

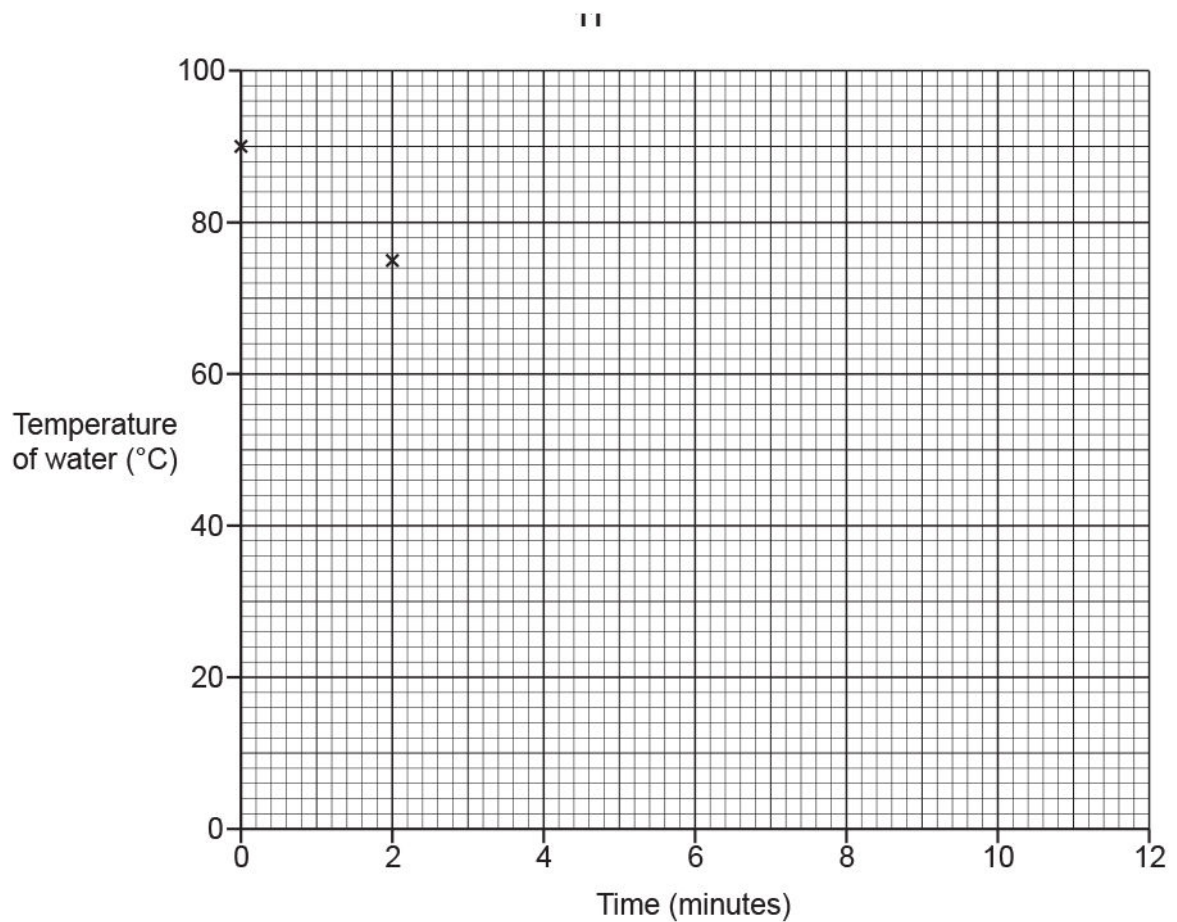


Fig. 17.1

- (iii) Describe how the temperature of the water changes with time.
Use data from the graph Fig. 17.1 in your answer.

[2]

- (iv) The thickness of the cardboard box is doubled. Everything else stays the same.

Sketch a line on the graph in Fig. 17.1 to suggest what these new results may look like.
Label your line Z.

[1]

(v) Suggest **one** way to improve the investigation.

[1]

30 * The UK generates some of its electrical power from wind turbines.

Fig. 18.1 shows the total electrical power generated by wind turbines in the UK.

The graph is for a single day in December which had very strong winds.

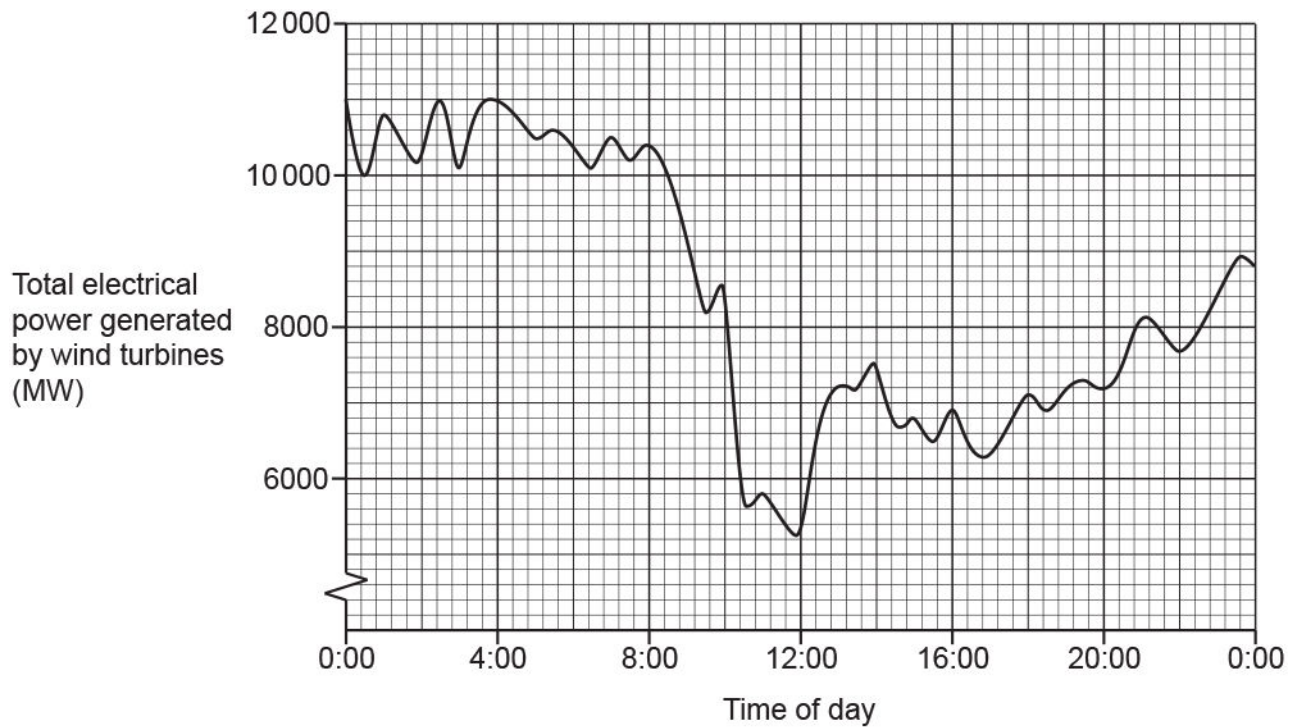


Fig. 18.1

Fig. 18.2 shows the total demand for electrical power in the UK on the same day.

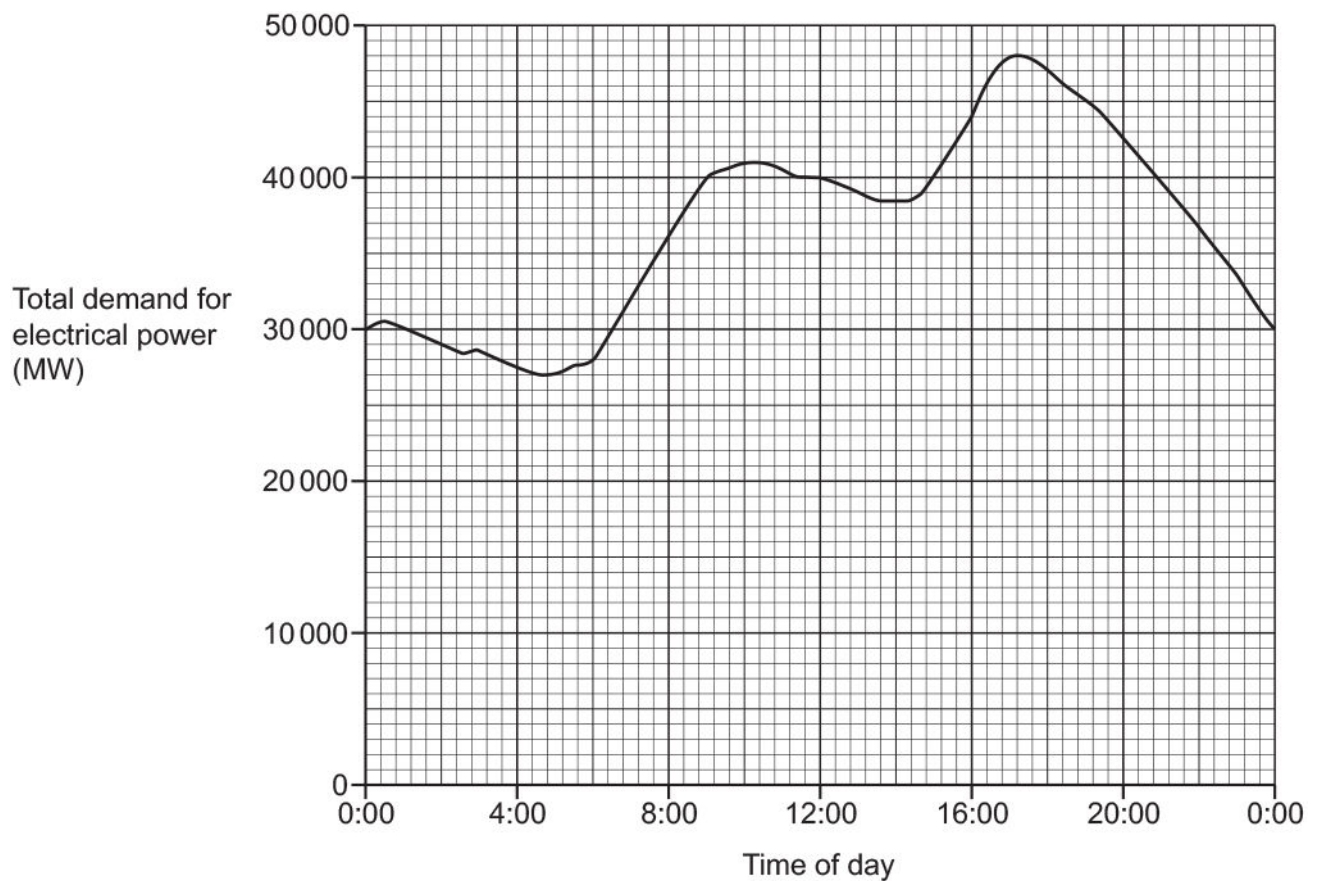


Fig. 18.2

Some experts believe the UK should generate most of its electrical power from wind.

Evaluate the advantages and disadvantages of this idea.

Use the graphs in Fig. 18.1 and Fig. 18.2 and your own ideas about wind turbines to support your answer.

- 31 The graph in Fig. 19.1 shows how displacement of an ultrasound wave varies with distance.

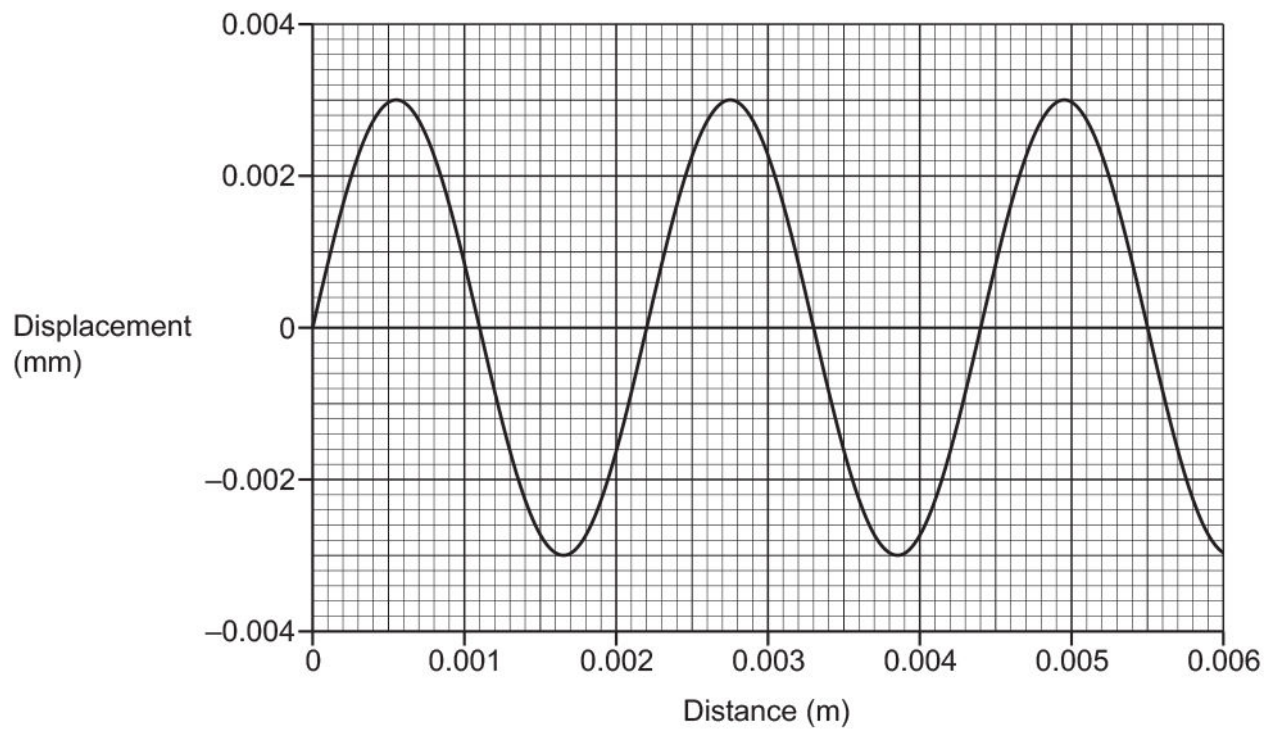


Fig. 19.1

- (i) Use the graph in Fig. 19.1 to determine the wavelength of an ultrasound wave.

Wavelength = ... m [1]

(ii) The speed of ultrasound waves in (i) is 4500 m / s.

Calculate the frequency of the ultrasound wave in Fig. 19.1.

Use the equation: wave speed = frequency $\times$ wavelength

Give your answer in **standard form** and to 2 significant figures.

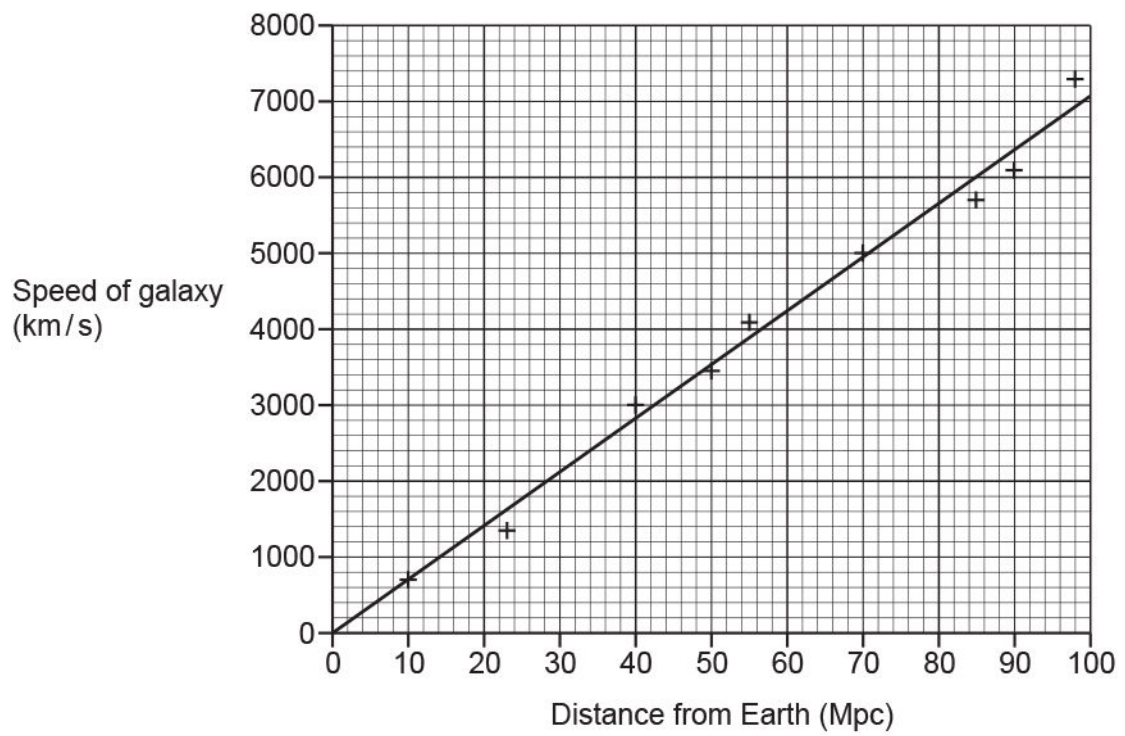
Frequency = ... Hz [4]

32(a) Edwin Hubble discovered that all distant galaxies were moving away from the Earth.

Explain how he could tell that all distant galaxies were moving away from the Earth.

----- [2]

(b) This graph shows how the speed of a galaxy changes with distance from the Earth.



- (i) Use data from the graph to show that the speed of the galaxy is proportional to the distance from the Earth.

[2]

- (ii) Explain how data from the graph provides evidence for the Big-Bang.

[1]

(c) Before Edwin Hubble could publish his results, his work was peer reviewed.

Suggest why peer review is important.

----- [1]

(d) The parsec (pc) is a unit used for measuring large distances in the Universe.

(i) A galaxy is at a distance of 82 Mpc from the Earth.

Use the graph to determine the speed of this galaxy.

Give your answer in metres per second (m / s).

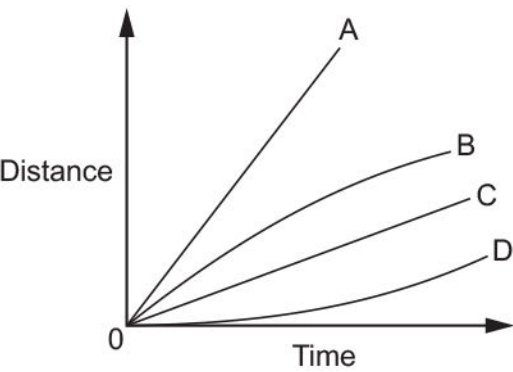
Speed = ... m / s [2]

(ii) Calculate the time it takes for the galaxy to travel 2.53×10^{24} m.

Use your answer to (i) to help you.

Time = ... s [3]

33 Look at the distance-time graph.



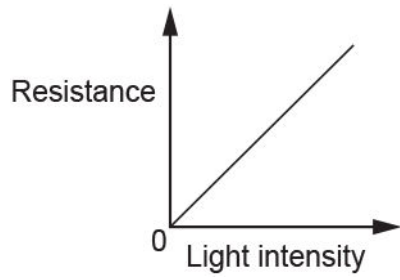
Which line shows the largest average speed?

Your answer

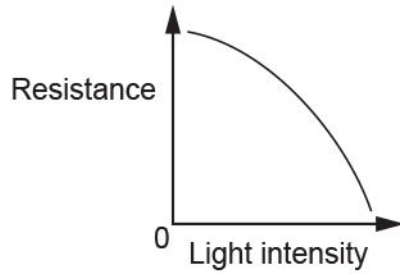
[1]

34 A student investigates how the resistance of a light dependent resistor (LDR) changes with light intensity.

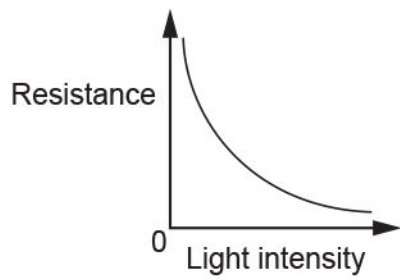
A



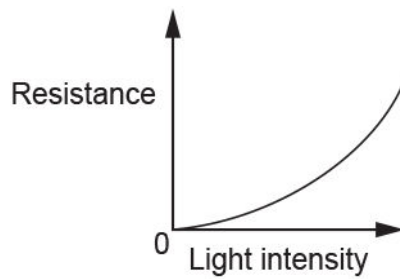
B



C



D

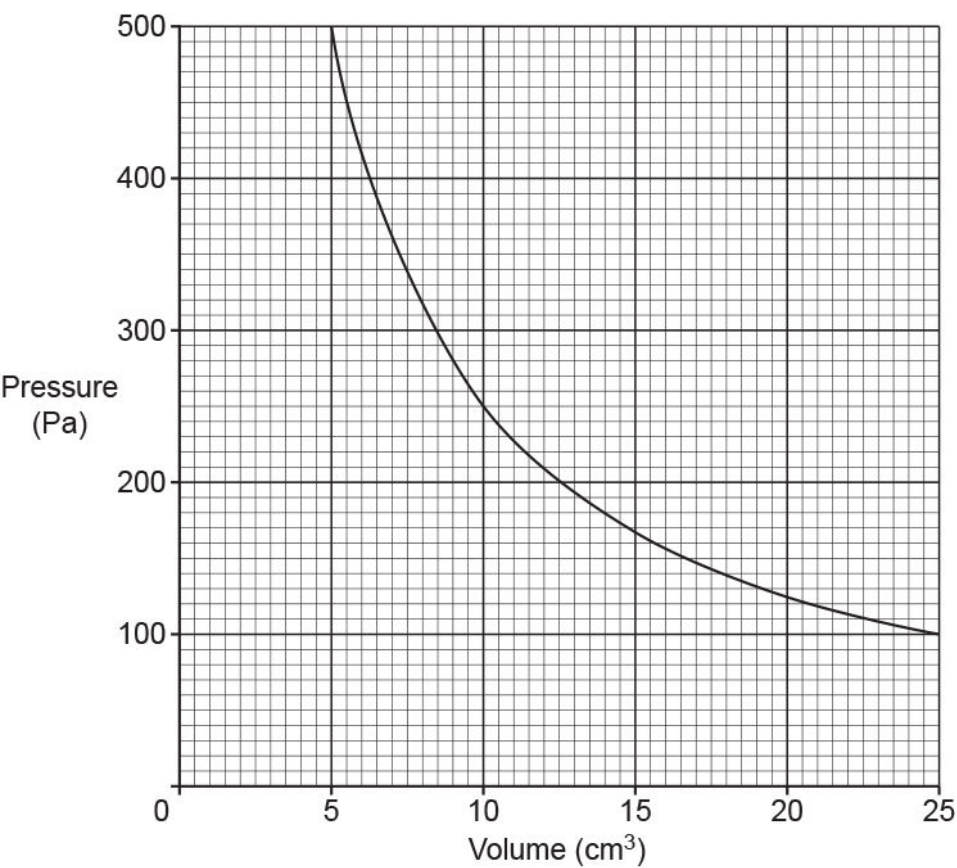


Which graph shows the correct relationship between the resistance of an LDR and light intensity?

Your answer

[1]

35(a) A student investigates the link between the volume and pressure of a gas. The student uses a fixed mass of gas in a closed container. The student plots a graph of the results.



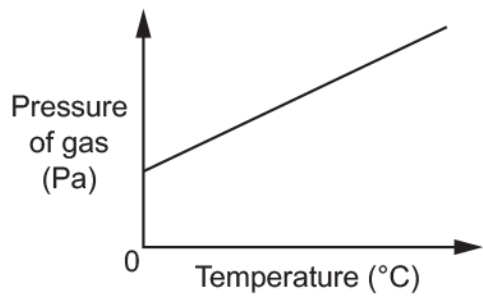
The student thinks that pressure multiplied by volume is always equal to the same number.

Explain why the student is correct.

Use data from the graph to support your answer.

[2]

- (b) A student investigates how temperature and pressure of a gas are linked. The student measures the pressure of a gas as its temperature increases. The results are plotted on a graph.



Explain how temperature and pressure are linked.

Use the graph to support your answer.

[2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		14.60/14.6 (1)	1	
	b		16 / 16.0 / 16.00 (2) If answer incomplete or incorrect then 48 – 15.65 – 16.35 or 48 – 32 scores (1)	2	
	c		1.75 (2) But if answer is incomplete or incorrect then: 1.750666 scores (1)	2	
	d	i	All 4 points plotted accurately (1) Straight line (by inspection) (1)	2	allow tolerance of $\pm \frac{1}{2}$ square
		ii	Increasing length increases time period / AW (1)	1	
		iii	220 (1) Evidence of working on graph scores (1)	2	allow 216 → 224 (1) allow ecf from previous parts allow value sources from table (rather than graph)
			Total	10	
2		i	(filament) bulb / lamp ✓	1 (AO3.2a)	<u>Examiner's Comments</u> More able candidates were able to recognise the response of a filament lamp.
		ii	gradient / slope (of graph) changes (as potential difference / voltage changes) ✓ idea of increasing resistance (with more p.d.) / ORA ✓ idea of increasing temperature / AW ✓	3 (AO3.1a) (AO1.2) (AO2.2)	ALLOW 'graph / line / slope levels off' ✓ } Resistance increases with greater temperature ✓✓ <u>Examiner's Comments</u> This overlap question was challenging for most candidates. Most stated 'as p.d. increases, current increases' which does not address the fact that the V/I ratio is increasing, due to the graph curving downwards, so R must be increasing also.
			Total	4	

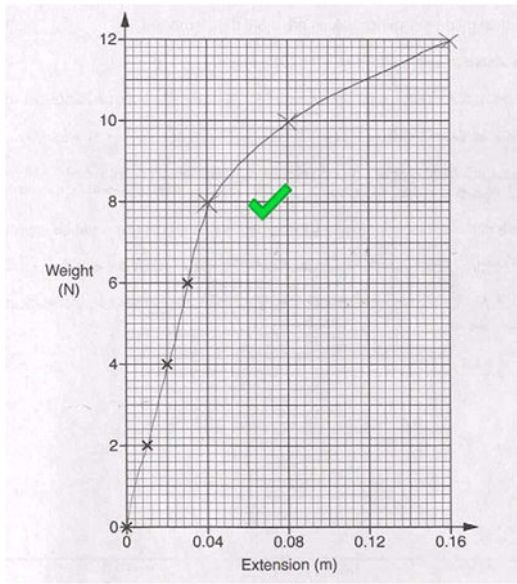
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
3		i	1000km takes 105 minutes and 2000km takes 127–128 minutes (1) not double / use of values to show not double/ 23 difference (1)	2	
		ii	any one from scan whole surface of the Earth / can ‘see’ much of the surface of the Earth / can ‘see’ the weather patterns (of the Earth) (1) orbit the Earth many times a day / can ‘see’ changes in weather patterns / can be used to forecast future weather / can see the changes more quickly(1) idea of a more detailed image (due to proximity to the Earth) (1)	1	ignore more accurate allow clearer image (1)
			Total	3	
4			C ✓	1 (AO2.2)	<u>Examiner’s Comments</u> About half of the candidates could correctly calculate the distance travelled from the graph (by area or calculation) and gave C as the answer. Working out was often seen on this question and answer D was a frequently chosen distractor (velocity × time, $8 \times 5 = 40\text{m}$).
			Total	1	
5			B ✓	1 (AO2.1)	<u>Examiner’s Comments</u> This was an intentionally challenging question AO2 question and about a quarter of candidates gave the correct answer B. A common incorrect response was ‘D’.
			Total	1	

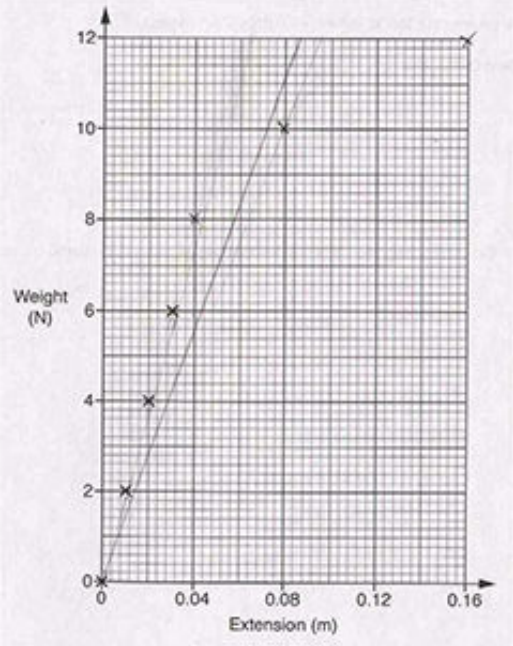
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6		i	(filament) bulb / lamp ✓	1 (AO3.2a)	<u>Examiner's Comments</u> Most gave the correct answer as a filament lamp. Lamp or bulb was acceptable also.
		ii	gradient / slope (of graph) changes (as potential difference / voltage changes) ✓ idea of increasing resistance (with more p.d.) / ORA ✓ idea of increasing temperature / AW ✓	3 (AO3.1a) (AO1.2) (AO2.2)	ALLOW 'graph / line / slope levels off' / non-linear } Resistance increases with greater temperature ✓✓ <u>Examiner's Comments</u> Many of the answers here did not refer to the graph so these did not secure the first marking point about the slope or the gradient changing. Other marks were available for increasing resistance (often given) and increasing temperature (less often seen). The answered covered the whole range here with only about 10% gaining all three. About a third of candidates gained 1 mark only, usually for the idea of increasing resistance.
			Total	4	

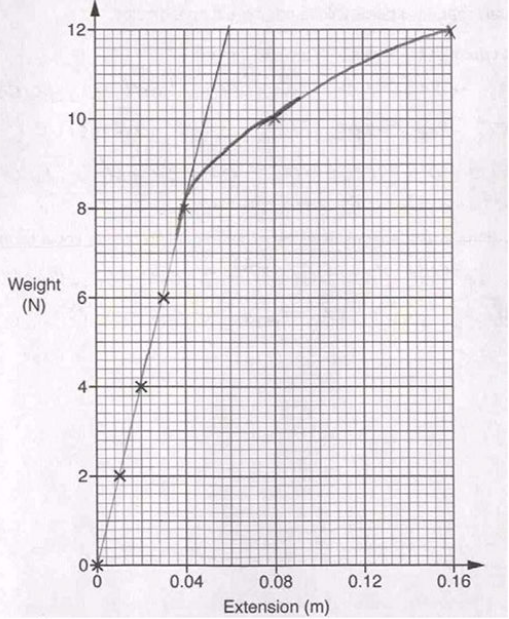
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a	i	All three points correctly plotted ✓✓ OR two points correctly plotted ✓	2 (AO 2 × 2.2)	Points should be + / - ½ square or less (by eye) <u>Examiner's Comments</u> All the points were usually plotted correctly.
		ii	straight line up to 0.04, 8 and curved line consistent with points plotted past this point ✓	1 (AO 3.1a)	ALLOW ecf from part ai for misplotted points ALLOW straight part of graph drawn without ruler. DO NOT ALLOW dot-to-dot for curve Single line should be thin (less than ½ square thick) and continuous to gain the mark. <u>Examiner's Comments</u> Just over half of answers gained the one mark here. Common mistakes were double lines, lines too thick (larger than half a square) and straight line of best fit with no curve. Exemplar 1  This gets full marks for both parts as the answer shows accurate plotting for part i of

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			the question and produces a straight line graph in part ii that becomes curved after 8N. Although the line does slightly miss the point at 8N, the line and curve are reasonable. Exemplar 2  This was a common error with points plotted accurately but a straight line drawn so this was credited 0 marks. Exemplar 3

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			 This shows two lines, one curved and one straight. The marker cannot give credit as they are unsure which one to mark. In any case the curved line would have been too thick to award the mark as it is thicker than half a square.
iii	Initially the extension increases steadily / linearly / uniformly / (directly) proportionally / elastically / AW ✓ (then the) wire reaches its elastic limit ✓ the extension increases plastically / by more for each (2N) weight added (past this point) / AW ✓	3 (AO 3.1a) (AO 1.2) (AO 3.1a)	ALLOW gradient is steady up to 8N ALLOW initially obeys Hooke's law IGNORE limit of proportionality (as this is an AO3 answer for an AO1 question) ALLOW Hooke's law not obeyed after 8N <u>Examiner's Comments</u> This gave a good range of marks with most describing the first stage as extension is linear or proportional. Some clearly referred to elastic limit [1 mark] although vague answers such as 'limit of proportionality' was frequently seen [0 mark]. Some were successful in describing the extension after the limit is reached.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 200 (N/m) award 3 marks $k = F \div x$ ✓ $k = 6 \div 0.03$ ✓ (or equivalent correct expression from 0 to 6N) $k = 200$ (N/m) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	IGNORE $F=kx$ Substitution into correctly rearranged formula ✓✓ <u>Examiner's Comments</u> This calculation, like many on the paper was answered well. Here about third quarters of answers gained all three marks. For unsuccessful calculations however, 1 mark was given for the correct rearrangement of the formula $k = F \div x$.
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.16 (J) award 2 marks $E = 0.5 \times 200 \times 0.04^2$ ✓ $E = 0.16$ (J) ✓	2 (AO 1.2) (AO 2.1)	ALLOW ecf from part b ALLOW area under graph method: $0.5 \times 8 \times 0.04$ ✓ BUT area under graph method used to calculate 0.16 scores ✓✓ <u>Examiner's Comments</u> Most candidates incorrectly used 'work done = force $\times$ distance' giving the answer 0.32 (J). Better answers used $E = 0.5 \times 200 \times 0.4^2$ to successfully get 0.16 (J) and gained full marks.
			Total	11	
8			B ✓	1 (AO1.2)	<u>Examiner's Comments</u> This question required candidates to use their knowledge of half-life to interpret the graph. The majority of candidates were able to work out the half-life of the source using the graph.
			Total	1	

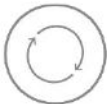
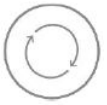
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9	a	i	5.2 (billion tonnes oil equivalent) ✓	1 (AO3.1a)	ALLOW answers between 5.0 and 5.5 IGNORE wrong units
		ii	Oil ✓	1 (AO3.1a)	<u>Examiner's Comments</u> Part (a)(i) and (ii) assessed AO3 and required candidates to use estimated values from the graph. The majority of candidates were able to do this successfully.
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 78 (%) award 2 marks 8.3 / 10.6 (x 100) ✓ =78 (%) ✓	2 (AO 2 × 3.1a)	ALLOW answers that round between 77(%) and 80(%) ✓✓ ALLOW 8.2 / 10.6 (x 100) OR 8.4 / 10.6 (x 100) OR 8.5 / 10.6 (x 100) OR answers that round between 0.77 and 0.80 <u>Examiner's Comments</u> This question required candidates to use estimated values from the graph to work out the amount of energy use due to fossil fuels and then convert their answer into a percentage of the total energy use. The question discriminated well as the lower ability candidates struggled to identify the proportion due to fossil fuel use. Many did not take into account all three of the fossil fuels which resulted in percentages that were much smaller than the expected answer. The higher ability candidates, who did identify the amount of energy use due to fossil fuels, were able to calculate the percentage correctly.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	Fossil fuel may run out / is non-renewable / be in short supply / become very costly ✓ Named damage to environment: Eg (increased) greenhouse gases / global warming / sea levels rise / carbon dioxide / climate change / acid rain ✓	2 (AO3.1b) (AO3.1b)	ALLOW being used faster than being produced / finite resource ALLOW ice caps melting / droughts and storms / more polluting gases / other named polluting gases e.g. SO₂ / carbon emissions IGNORE just pollution or bad for the environment / more CFCs <u>Examiner's Comments</u> This question assessed AO3 and the majority of candidates gained at least 1 mark, usually for the idea that fossil fuels are not renewable. A significant number of candidates did not gain the second mark as their responses included statements about pollution that were too vague e.g. 'harmful emissions' or 'bad for the environment'. Exemplar 2 1. Fossil fuels are non-renewable and will eventually run out ✓ 2. Fossil fuels release lots of pollution, which causes damage to people and the planet [2] This response was credited with 1 mark for stating that fossil fuels are renewable. The second mark was not achieved as the candidate's statement that 'fossil fuels release lots of pollution' is not specific enough. To gain the second mark, the candidate should have referred to an appropriate scientific reason, for example more CO₂ or more greenhouse gases.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	To meet demand for electricity / not enough energy from renewable resources ✓ Less named damage to environment: (decreased) greenhouse gases / global warming / sea levels may fall / carbon dioxide / climate change / acid rain / ORA for coal ✓	2 (AO1.2) (AO1.2)	ALLOW will not run out as fast (as coal) / to preserve fossil fuels / produces more energy (per kg than coal) ALLOW less polluting gases / carbon emissions / ice caps melting / droughts and storms IGNORE just less pollution or just better for the environment / less CFCs <u>Examiner's Comments</u>  Although many candidates achieved 1 or 2 marks, a significant proportion did not gain any credit. Some candidates had the misconception that nuclear power is renewable. Others gave vague suggestions about 'damage to the environment'. Only the highest ability candidates usually gained full credit.  AfL Candidates should be aware that in a Physics exam what they write will be assessed as a specific scientific response. Where candidates use unnamed, vague statements about 'pollution' or 'damage to the environment' these are unlikely to gain credit. For example graffiti, fly tipping and loud music are examples of pollution that are unlikely to be caused a power station.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10			C ✓	1 (AO 2.2)	<u>Examiner's Comments</u> Almost half of the candidates correctly recalled that an alpha particle had 2 protons and 2 neutrons and were able to show that they understood standard nuclear notation (conventional representation for nuclei).
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a	i	5.2 (billion tonnes oil equivalent) ✓	1 (AO 3.1a)	ALLOW answers between 5.0 and 5.5 IGNORE wrong units Examiner's Comments Many candidates found it difficult to interrogate the stacked line graph and many candidates stated the total energy use in 1971 rather than the increase from 1971 to 2003. As the vertical scale on the graph was only marked at 1 billion tonne increments candidates were allowed to give an answer between 5.0 and 5.5 billion tonnes (oil equivalent).
		ii	Oil ✓	1 (AO 3.1a)	Examiner's Comments Most candidates correctly identified oil as the greatest use. Other candidates suggested coal or renewables.
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 78 (%) award 2 marks 8.3 / 10.6 (× 100) ✓ =78 (%) ✓	2 (AO 2 x 3.1a)	ALLOW answers that round between 77(%) and 80(%) ✓✓ ALLOW 8.2 / 10.6 (× 100) OR 8.4 / 10.6 (× 100) OR 8.5 / 10.6 (× 100) OR answers that round between 0.77 and 0.80 Examiner's Comments Only around 10% of candidates were able to answer this question fully and most other candidates were not credited with any marks. Many candidates struggled to identify coal, oil and gas as fossil fuels. Those less able candidates that attempted to show their working were could be credited with a compensatory mark.

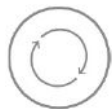
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	Fossil fuel may run out / is non-renewable / be in short supply / become very costly ✓ Named damage to environment: Eg (increased) greenhouse gases / global warming / sea levels rise / carbon dioxide / climate change / acid rain ✓	2 (AO 3.1b) (AO 3.1b)	ALLOW being used faster than being produced / finite resource ALLOW ice caps melting / droughts and storms / more polluting gases / other named polluting gases e.g. SO₂ / carbon emissions IGNORE just pollution or bad for the environment / more CFCs <u>Examiner's Comments</u> Most candidates recognised that fossil fuels may run out or be in short supply or stating that they are non-renewable. However, fewer candidates went on to give specific scientific reasons for scientists concerns that were creditable. Most candidates gave generalised responses about fossil fuels damaging the environment or causing 'pollution'.
		ii	To meet demand for electricity / not enough energy from renewable resources ✓ Less named damage to environment: (decreased) greenhouse gases / global warming / sea levels may fall / carbon dioxide / climate change / acid rain / ORA for coal ✓	2 (AO 1.2) (AO 1.2)	ALLOW will not run out as fast (as coal) / to preserve fossil fuels / produces more energy (per kg than coal) ALLOW less polluting gases / carbon emissions / ice caps melting / droughts and storms IGNORE just less pollution or just better for the environment / less CFCs <u>Examiner's Comments</u> Higher ability candidates said that there were not enough renewable energy resources and nuclear power stations would assist in meeting the demand for electricity, or help in preserving fossil fuels. Answers which gave detail about less damage to the environment were also credited, although a number of candidates thought that nuclear power stations would not cause any potential damage to the environment.
			Total	8	

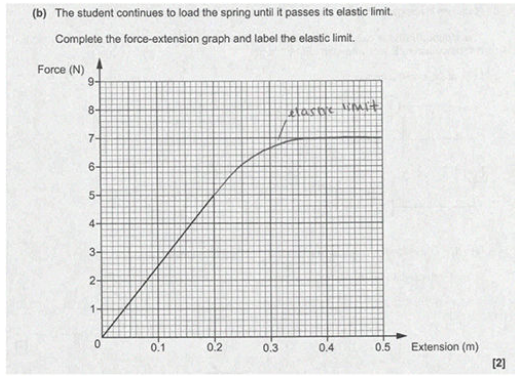
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
12			B ✓	1 (AO1.2)	<u>Examiner's Comments</u> Overall this question was very well answered. Some lower ability candidates incorrectly selected response C.
			Total	1	
13			B ✓	1 (AO2.1)	<u>Examiner's Comments</u> A very large number of candidates incorrectly chose A. Higher ability candidates worked out the area for each graph. Candidates should be encouraged to check each of the four responses.
			Total	1	
14			C ✓	1 (AO2.1)	<u>Examiner's Comments</u> This question was well answered. Candidates should be encouraged to consider each letter of the diagram, adding a small cross to the ones that are eliminated.
			Total	1	

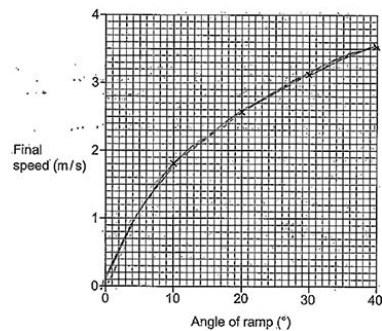
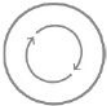
Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
15	a	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 25 (N/m) award 3 marks Recall and rearrange: spring constant = force exerted by a spring ÷ extension ✓ = 5 ÷ 0.2 ✓ = 25 (N/m) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW any other correct pair of points from the graph – points to be read to $\pm\frac{1}{2}$ a small square Final answer between 24 and 26 (N/m) scores three marks <u>Examiner's Comments</u> The majority of candidates scored highly on this question. Higher ability candidates stated either the equation for spring constant or stated that the spring constant was the gradient of the graph. It was then expected that candidates would substitute into their equation appropriate values from the graph. A small but significant minority of candidates tried to use the same equation from the data sheet which had been used to determine the energy transferred and substituted in a force for the energy. This approach was not creditworthy.  AfL Candidates should be able to read information from graphs and determine a gradient.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		Line curves and gradient decreases ✓ Point at the end of the linear section of the line labelled 'elastic limit' ✓	2 (AO2x 1.2)	IGNORE poorly drawn curves/thick lines DO NOT ALLOW curve with negative gradient at any point <u>Examiner's Comments</u> This question required candidates to demonstrate that they understood how a spring stretched with an increasing force and the term "elastic limit". For marks to be given the straight line section (if any) should be drawn with a ruler and the curve should be smooth. Sometimes the labelling of the elastic limit was vague. Higher ability candidates added a small cross at the elastic limit and then labelled the cross. Exemplar 2  (b) The student continues to load the spring until it passes its elastic limit. Complete the force-extension graph and label the elastic limit. This candidate has clearly extended a straight line and then drawn a curve with decreasing gradient which gains the first mark. The labelling of the elastic limit is vague and incorrect. It would have been helpful if this candidate had indicated precisely on the line with a dot or cross where the elastic limit is located and then added a label.
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16	a	i	Both points correctly plotted ✓ Smooth curve correctly drawn ✓	2 (AO1.2)	ALLOW within ½ small square for plotting DO NOT ALLOW straight lines between data points IGNORE any line drawn for $<10^\circ$ <u>Examiner's Comments</u> Candidates needed to plot the last two data points before drawing the best fit line. Many candidates incorrectly drew a straight line through plots that appeared to lie on a curved trend. Other candidates did not draw smooth curves, or had many lines. Exemplar 5  This candidate has clearly indicated the correct positions of the two missing plots using two small crosses. The smooth line was not considered good enough in that there appeared to be more than one line in several places. This candidate has correctly assumed that the graph starts from the origin.  AfL Candidates should be encouraged to plot graphs using a sharp pencil. The points should be indicated with a small cross. It may help candidates to draw smooth curves by rotating the paper so that the

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					curve can be drawn naturally with the arc of the candidates' arm. Candidates should be encouraged to check the plotting of their data points - particularly points which do not appear to fit a pattern. The line of best fit may not pass through every data point. There should be a balance of data points about the line of best fit.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Increase in angle of ramp increases speed (at bottom ramp) OR A✓ Increase is not linear/doubling angle does not double final speed / AW ✓ Reference to quantitative data for two calculations, for example, increase from 10° to 20° the speed increases by 0.76 whilst 20° to 30° the speed increases by 0.54 ✓	3 (AO3.1a) (AO3.1a) (AO3.1b)	IGNORE correlation ALLOW Not directly proportional / Not constant increase NOTE comparison of two increases required NOTE Speed increase from 0° to 10° is 1.81 and speed increase from 30° to 40° is 0.40 <u>Examiner's Comments</u> Most candidates correctly stated that the as the angle of the ramp increased the speed increased. It was essential that candidates included a comparison between the angle of the ramp and the speed. The next two marks were more challenging and required candidates to state that the angle of the ramp and the speed were not directly proportional or linear since there was not a constant increase in speed for the same increase in angle. Candidates were expected to demonstrate this by carrying out two calculations using data from the table or graph. AfL Understand how to test from a graph whether two quantities are directly proportional. 1 Take the quantity on the x-axis and double it and read off the y-axis values and see whether they double as well 2 See whether there is a straight line through the origin.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	(Increase in angle) increases potential energy of the trolley/more work is done raising trolley to that point on the ramp ✓ This increases the / more kinetic energy at the bottom of the ramp ✓	2 (AO1.1 x2)	ALLOW more PE is transferred to KE <u>Examiner's Comments</u> Most candidates found this question challenging to gain two marks due to some vague answers relating to the transfer energy from the PE store to the KE store without specifically referring to the greater energy in the PE store being transferred so that there more energy in the KE store.
		iv	Attempt 1 at 30° (is only recorded to 1 decimal place)/ 3.1 ✓ Student should record data to a consistent number of decimal places or 2 dp / the reading should be recorded as 3.10 / AW ✓	2 (AO3.3a) (AO3.3b)	ALLOW only recorded to 2 significant figures ALLOW should be recorded to 3 significant figures NOT same accuracy <u>Examiner's Comments</u> Many candidates correctly identified that the first attempt (3.1) at an angle of 30° was only recorded to one decimal place. Most candidates then suggested that that the raw data should have been recorded to the same number of decimal places and the reading should have been recorded as 3.10. Some candidates referred to significant figures, which was allowed this year. Candidates need to understand that raw data should be recorded to the same number of decimal places while calculated data is recorded to a number of significant figures which is dependent on the number of significant figures in the raw data.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		v	Any two from: Reproducible means that the results can be reproduced by someone else ✓ Only one student has collected this data ✓ The experiment is repeatable (as the repeated readings are close together) ✓	2 (AO2.2 x2)	NOT experiment can be repeated <u>Examiner's Comments</u> Most candidates discussed apparatus details such as not indicating what sort of surface was used, etc. Few candidates realised that reproducible results would need to be reproduced by someone else. A few candidates did state that the experiment is repeatable since the repeated reading are close to each other. AfL Understand the terms used in the language of measurement. See the Glossary of terms on the OCR website at: https://www.ocr.org.uk/Images/467774-glossary-of-terms.doc
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6.16 (m/s²) award 5 marks $v^2 - u^2 = 2as$ (no mark – on formula sheet) $u = 0$ ✓ $a = v^2 \div 2s$ ✓ $a = 3.51^2 \div (2 \times 1.0)$ ✓ $a = 6.16005$ (m/s²) ✓ $a = 6.16$ (m/s²) (2 decimal places) ✓	5 (AO2.1) (AO1.2) (AO2.1) (AO2.1) (AO1.2)	NOTE must be rearranged ALLOW Any number which rounds to 6.16 ALLOW one mark for any calculated answer to 2dp <u>Examiner's Comments</u> About half the candidates gained full marks for this question. It was expected that candidates would

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					select an appropriate equation from the data sheet, rearrange the equation and substitute in the numbers from the question before calculating the answer. It was expected that the initial speed of zero would be shown in any calculation. Many candidates who did not gain full marks attempted to gain the answer by using the definition of acceleration and the equation linking average speed with distance and time without realising the importance of the word "average". Candidates using this method often arrived with an incorrect answer of 12.32 m/s^2. Exemplar 6 $(final\ velocity)^2 - (initial\ velocity)^2 = 2 \times acceleration \times distance$ $acceleration = \frac{(final\ velocity)^2 - (initial\ velocity)^2}{2 \times distance}$ $= \frac{(3.5)^2 - (0)^2}{2 \times 1} = \frac{(3.5)^2}{2} = 6.16005$ Acceleration = 6.16 m/s² [5] This candidate has correctly selected the equation from data sheet. The candidate has then rearranged the equation before substituting in the values from the question. Helpfully the candidate has indicated that the initial velocity was zero. The candidate then correctly calculates the answer as 6.16005 before correctly rounding the answer to two decimal places.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 9 (J) award 3 marks kinetic energy (J) = $0.5 \times \text{mass (kg)} \times (\text{speed (m/s)})^2 /$ KE = $\frac{1}{2} mv^2$ / KE = $0.5mv^2$ ✓ KE = $0.5 \times 2.0 \times 3.0^2$ ✓ KE = 9 (J) ✓	3 (AO1.2) (AO2.1) (AO2.1)	Examiner's Comments Candidates who were able to recall the equation for kinetic energy scored well on this question. Candidates should be encouraged to show their working.
			Total	19	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17			B ✓	1 (AO2.2)	<u>Examiner's Comments</u> Candidates clearly recalled that the current-voltage graph for a filament lamp was non-linear and they then had to choose between options B and D. Option D, the graph for a thermistor, was chosen by many. Option C is the correct answer as the increased current heats the lamp filament, a hotter filament has an increased resistance and therefore a smaller current is observed than might be expected.
			Total	1	
18			B ✓	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19	a	i	50 (m) ✓	1 (AO2.2)	<u>Examiner's Comments</u> 16(a) was a gentle introduction to the structured questions in Section B and almost all candidates were awarded all three marks.
		ii	60 (s) ✓	1 (AO2.2)	<u>Examiner's Comments</u> 16(a) was a gentle introduction to the structured questions in Section B and almost all candidates were awarded all three marks.
		iii	Any one from: Tape measure/ Measuring tape ✓ Trundle wheel ✓	1 (AO1.1)	ALLOW Metre ruler / metre stick / metre wheel / surveyors' wheel DO NOT ALLOW ruler ALLOW Fitbit/smartphone app <u>Examiner's Comments</u> 16(a) was a gentle introduction to the structured questions in Section B and almost all candidates were awarded all three marks.
	b	i	C ✓ It has the steepest line/gradient/slope / greatest change in distance per second / AW ✓	2 (AO 2.2) (AO 1.1)	ALLOW calculation of all 4 speeds NOT 'highest distance change in shortest amount of time' <u>Examiner's Comments</u> 16(b) provided the first questions where more than one mark was available, and this helped a number who could identify the important factor but had selected the wrong option A – D. In (i) a number calculated all four speeds (including 0) in order to identify C. Most candidates appreciated that it was the section with the highest gradient/steepness which they needed to identify.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	B ✓ The line is horizontal/flat /distance does not change/AW ✓	2 (AO 2.2) (AO 1.1)	<u>Examiner's Comments</u> 16(b) provided the first questions where more than one mark was available, and this helped a number who could identify the important factor but had selected the wrong option A – D. In (i) a number calculated all four speeds (including 0) in order to identify C. Most candidates appreciated that it was the section with the highest gradient/steepness which they needed to identify.
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 (m/s²) award 2 marks $v = 20 \div 40$ ✓ $v = 0.5$ (m/s²) ✓	2 (AO2.1) (AO2.1)	Mp2 dependent on correct substitution for mp1 <u>Examiner's Comments</u> The equation for acceleration was given and it required no rearrangement. Most candidates were credited with both marks here.
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20		i	Bar C drawn to the correct height of 12s ✓	1 (AO1.2)	<u>Examiner's Comments</u> Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (s) award 2 marks $14 + 10 + 12 = 36 / (14 + 10 + 12)/3$ without the 36 ✓ $36 \div 3 = 12$ (s) ✓	2 (AO3.1a) (AO1.2)	ECF from (a)(i) ECF from mp1 above <u>Examiner's Comments</u> Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.
		iii	Lift B ✓ Takes the least time (power is work done ÷ time taken)/AW ✓	2 (AO3.1b) (AO1.2)	If A chosen and correct explanation (for B) given, award mp2 but not mp1 <u>Examiner's Comments</u> Many candidates identified lift B uses the most power correctly but did not provide an explanation of why it use the most power for the second mark. Some candidates clearly thought the highest bar in the bar chart indicated a greater height reached by the lift and so chose lift A.
			Total	5	
21			C ✓	1 (AO2.2)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
22		i	$(9 + 14) = 23 \text{ (m)}$ ✓	1 (AO2.2)	
		ii	Stopping distance at 50 mph = 53 m ✓ Stopping distance is greater than 40 m / Car hits the barrier ✓	2 (AO3.1a) (AO3.2a)	ALLOW 52-54m
		iii	Factor: larger mass (of car) ✓ Reason: Braking distance is increased ✓ because deceleration is less / larger KE to dissipate ✓ OR Factor: Poor quality brakes / tyres ✓ Reason: Braking distance is increased ✓ Less friction / smaller deceleration ✓ OR Factor: Icy / wet / slippery road ✓ Reason: Braking distance is increased ✓ Less friction / smaller deceleration ✓ OR Factor: Going uphill ✓ Reason: Braking distance is decreased ✓ Weight of car increases deceleration ✓ OR Factor: Going downhill ✓ Reason: Braking distance is decreased ✓ Weight of car decreases deceleration ✓	3 (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1)	DO NOT ALLOW distance for braking/thinking distance DO NOT ALLOW stopping distance
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
23			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) States that greater orbital distance goes with a longer time period but that the relationship is not proportional. Attempts to explain orbital motion in terms of gravity. AND Relates data from the graph to at least two named planets. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) States that greater orbital distance goes with a longer time period. AND Relates the curve to different named planets in the solar system. OR Reads data from the graph. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) States that greater orbital distance goes with a longer time period. OR Relates the curve to the properties of at least one planet in the solar system. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.	6 (AO3 × 2.1) (AO3 × 3.1a)	AO3.1a Analyses information and ideas by interpreting graph - As distance increases, orbit time increases. - Time read correctly for a specific distance. - Comparison of two data points. - Recognises that the data for the Earth is very close to the origin - Outermost planets have periods of over a century - Time is not proportional to distance. - Time increases faster than distance. - Gradient of line increases. - Calculation using data to show non-proportionality, e.g. when distance doubles from 1 to 2, time more than doubles. AO2.1 Applies knowledge and understanding of the solar system - Inner planets are Mercury, Venus, Earth and Mars. - Outer planets are Jupiter, Saturn, Uranus and Neptune. - As distance from Sun increases, orbital period of planet increases. - Period of Earth's orbit is 1 year - Distance planet travels in one orbit increases with distance from the Sun. - If distance is larger, time will be greater (for same speed) - As speed is smaller, time will be greater by a greater factor.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
24		i	5 or 4 points correctly plotted to within $\frac{1}{2}$ small square ✓✓	2 (AO2 × 2.2)	3 or 2 correctly plotted points gains 1 mark IGNORE 'blobs' more than $\frac{1}{2}$ square diameter
		ii	Smooth curved line of best fit through most points ✓	1 (AO1.2)	DO NOT ALLOW a straight line of best fit
		iii	Temperature decreases (with time) ✓ At a decreasing rate / by a smaller change in temperature for each increase in time ✓	2 (AO2 × 3.1a)	IGNORE non-linear relationship / positive/negative correlation ALLOW inverse proportion for this mark only ALLOW gradient decreases / temperature decreases more quickly at the start (than at the end) ALLOW use of data from the graph to show decreasing rate
		iv	Line starts at 90°C and decreases but remains <u>above</u> their LOBF ✓	2 (AO3.2b)	IGNORE shape of the line but no mark for a horizontal line ALLOW 90 +/- 2 °C
		v	Any one from: Repeat (and find a mean) / check reproducibility/repeatability ✓ Use smaller time intervals ✓ Use more precise timer/thermometer ✓	1 (AO3.3b)	ALLOW any sensible suggestion IGNORE a longer time / use more thicknesses ALLOW use equipment with higher resolution / data logger IGNORE better equipment unless qualified
			Total	7	
25			B	1 (AO1.2)	
			Total	1	
26			B	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
27		i	Point correctly plotted at (5.7 m/s ² , 4N) within ½ a small square ✓	1 (AO2.2)	
		ii	Force is (directly) proportional to acceleration ✓✓ OR Maximum of one mark from: Linear relationship (through the origin)✓ As force increases, acceleration increases / OR A ✓	2 (AO2x3.1 a)	ALLOW (directly) proportional to each other / they are (directly) proportional ALLOW $y = mx + c$, $c = 0$ so $y = mx$ IGNORE positive correlation
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.7, 0.71 or 0.72 (kg) award 2 marks Change in y / change in x or 5(.0)/7(.0) ✓ (mass =) 0.7(0) / 0.71 / 0.72 (kg) ✓	2 (AO2.2) (AO2.2)	ALLOW eg 4.3/6.0, 4.0/5.6 etc. to within +/- ½ small square ALLOW other answers between 0.65 and 0.75 only if workings shown using correct values read from the graph to within +/- ½ small square ✓✓
		iv	Any two from: Not all of the energy is transferred to the trolley / energy is transferred/lost to other stores It assumes all of the force on the trolley is equal to the weight added on the string ✓ Friction on the pulley / between the wheels and the surface ✓ Mass of the string/card is ignored ✓ The card on the trolley was not measured properly✓ The card on the trolley did not pass through the light gates vertically/at 90° ✓	2 (AO2x3.2 a)	ALLOW energy is transferred/lost to the surroundings/due to friction/air resistance ✓ ALLOW table is not smooth / friction in the wheels

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		v	Any two from: Compensate for/reduce friction, e.g. by raising the ramp / use a linear air-track / oil/grease pulley ✓ Repeat the experiment and calculate the mean ✓ Measure the acceleration between two points which are further apart ✓ Use different equipment (to check if it produces similar results) ✓ Use equipment with higher resolution/precision ✓ Use string/card with less mass/weight ✓	2 (AO2x3.3 b)	ALLOW repeat to remove/identify anomalies ALLOW use lighter string/card / subtract mass of card/string (from measurements) ALLOW use a pulley with less mass to reduce energy wasted when turning pulley / AW
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
28	a		FIRST CHECK THE ANSWERS ON ANSWER LINES If answer = 385 (J/kg°C) AND material = zinc award 5 marks $c = (E / m\theta) \checkmark$ $(\theta = 900 - 420 =) 480 (^{\circ}\text{C}) \checkmark$ $(c =) 462000 / (2.5) \times 480) \checkmark$ $(c =) 385 (\text{J/kg}^{\circ}\text{C}) \checkmark$ (substance is) zinc $\checkmark$	5 (AO1.2) (AO2.2) (AO2.2) (AO2.2) (AO3.2b)	ALLOW ecf for missing or incorrect unit conversion e.g. 0.385 (J/kg°C) for 3 marks (E = mcθ does not score a mark) ALLOW ecf for closest material to the answer calculated for shc if answer is incorrect. IGNORE another material quoted with its value from the table given as the answer unless workings shown
	b		Any two from: Not all substances are shown in the table / it could be a substance not in the table $\checkmark$ Named uncertainties/errors in the experiment $\checkmark$ It assumes all of the energy went to heat the material $\checkmark$ The value is (very) close to other values $\checkmark$ It assumes the substance is pure/not a mixture $\checkmark$	2 (AO2x3.1 b)	ALLOW there could be more than one substance with the same shc ALLOW assumes no energy transferred to other stores / no energy/heat loss ALLOW ecf from the part above ALLOW maximum of 1 mark for idea of results not repeated/reproduced
			Total	7	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
29		i	5 or 4 points correctly plotted to within $\frac{1}{2}$ small square ✓✓	2 (AO2 × 2.2)	3 or 2 correctly plotted points gains 1 mark IGNORE 'blobs' more than $\frac{1}{2}$ square diameter
		ii	Smooth curved line of best fit through most points ✓	1 (AO1.2)	DO NOT ALLOW a straight line of best fit
		iii	Temperature decreases (with time) ✓ At a decreasing rate / by a smaller change in temperature for each increase in time ✓	2 (AO2 × 3.1a)	IGNORE non-linear relationship / positive/negative correlation ALLOW inverse proportion for this mark only ALLOW gradient decreases / temperature decreases more quickly at the start (than at the end) ALLOW use of data from the graph to show decreasing rate
		iv	Line starts at 90°C and decreases but remains <u>above</u> their LOBF ✓	1 (AO3.2b)	IGNORE shape of the line but no mark for a horizontal line ALLOW 90 +/- 2 °C
		v	Any one from: Repeat (and find a mean) / check reproducibility/repeatability ✓ Use smaller time intervals ✓ Use more precise timer/thermometer ✓	1 (AO3.3b)	ALLOW any sensible suggestion IGNORE a longer time / use more thicknesses ALLOW use equipment with higher resolution / data logger IGNORE better equipment unless qualified
			Total	7	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
30	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed evaluation of the advantages and disadvantages of wind power AND Analysis of Fig. 18.1 and Fig. 18.2 AND An attempt to give a conclusion about the use of wind power <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Evaluation of the advantages and disadvantages of wind power AND Analysis of Fig. 18.1 and Fig. 18.2 OR Evaluation of the advantages and disadvantages of wind power AND An attempt to give a conclusion about the use of wind power OR Analysis of Fig. 18.1 and Fig. 18.2 AND An attempt to give a conclusion about the use of wind power <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Evaluation of the advantages or disadvantages of wind power OR Analysis of Fig. 18.1 or Fig. 18.2 OR An attempt to give a basic conclusion	6 (AO2 × 1.1) (AO2 × 3.1a) (AO3 × 3.2b)	AO1.1 Demonstrates knowledge and understanding of advantages and disadvantages of wind power Advantages • Wind is renewable • Does not create greenhouse gases (CO₂) • Does not contribute to global warming/climate change • Cheap to run (once built) • Less fossil fuels used Disadvantages • Unreliable – when wind drops so does power output / turbines switched off if it is too windy • Takes up lots of land • Some people think they are unsightly/noisy • Expensive to build AO3.1a Analyses information by interpreting graphs of power output and use • Wind pattern/power generated does not follow demand • Power generation is (always) below that of demand • Demand peaks at 17.00, lowest at ~5.00 • Peak demand is ~48000MW or Lowest demand is ~27000MW • Greatest power generation is ~11000MW or lowest power generation is ~5300MW • Power generation fluctuates AO3.2b Analyses information to draw conclusions about use of wind power • Current wind power cannot meet the demand for the UK • To meet the demand lots more wind turbines need to be built • Even more land/sea will be taken up with wind turbines

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			about the use of wind power <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.		• Expensive to build as so many wind turbines required • There will still be some days when wind cannot meet the demand requirements • There will need to be other power generation systems (examples given) • We need to be able to store the energy generated
			Total	6	
31		i	0.0022 (m) ✓	1 (AO2.2)	
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.0×10^6 (Hz) award 4 marks (Rearrange: frequency =) speed / wavelength OR (f =) $4500 / 0.0022$ ✓ (f =) $2\,045\,455$ (Hz) ✓ (f =) $2\,000\,000$ (Hz) ✓ (f =) 2.0×10^6 (Hz) ✓	4 (AO1.2) (AO2 x 2.1) (AO1.2)	ALLOW ecf from (i) ALLOW three marks for 2.0 MHz ALLOW a mark for their answer to 2 significant figures ALLOW a mark for their answer in standard form
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
32	a		(All galaxies) showed <u>red-shift</u> ✓ (Hubble measured the) wavelength/frequency of <u>light</u> (from the galaxy) ✓	2 (AO2 × 1.1)	ALLOW (all galaxies) showed <u>light</u> with a longer wavelength/lower frequency for 2 marks
	b	i	Readings of speed taken for two different values of distance ✓ Working to show that the factor increase in speed is the same as distance ✓	2 (AO2 × 3.1a)	ALLOW +/- ½ a small square ALLOW a statement for the second mark e.g. as the distance doubles so does the speed. <u>Example:</u> At 20 Mpc, speed = 1400 km/s At 40 Mpc, speed = 2800 km/s $40/20 = 2 = 2800/1400$ ALLOW 1 mark maximum for it is a (straight) line of best fit through the origin (therefore it is proportional)
		ii	Any one from: The more distant galaxies are travelling faster ✓ The evidence suggests the universe is expanding ✓ The universe was smaller in the past ✓	1 (AO1.1)	ALLOW galaxies are moving away from each other
	c		To ensure results are reproducible / check the work is of high enough quality / claims are not false / for new theories to be accepted / to develop theories / AW ✓	1 (AO1.1)	ALLOW check validity / for mistakes/anomalies / AW ALLOW check that it's not biased / AW
	d	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5 800 000 (m/s) award 2 marks (Reads off speed from graph =) 5800 (km/s) ✓ Speed = $5800 \times 1000 = 5\,800\,000$ (m/s) ✓	2 (AO2.2) (AO1.2)	ALLOW 5.8×10^6 (m/s) ALLOW ecf for their speed from graph x 1000

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4.36×10^{17} (s) award 3 marks time = distance / speed ✓ (time =) $2.53 \times 10^{24} / 5\,800\,000$ ✓ (time =) 4.36×10^{17} (s) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW ecf from (i) ALLOW 4.4×10^{17} (s) ALLOW equation in any form
			Total	11	
33			A	1 (AO2.1)	
			Total	1	
34			C	1 (AO2.2)	
			Total	1	
35	a		Any one set of readings from the graph multiplied together to give a correct number ✓ Any second set of readings from the graph multiplied together to give the same constant ✓	2 (AO3.1b x 2)	e.g. $5 \times 500 = 10 \times 250 = 20 \times 125 = 25 \times 100 = 2500$
	b		Any two from: As temperature increases, pressure increases / AW✓ Linear /straight line relationship ✓ Higher temperature means more (frequent) collisions (between particles and container) / AW✓	2 (AO1.1.x 2)	ALLOW higher temperature means bigger pressure DO NOT ALLOW T & P in wrong order DO NOT ALLOW (directly) proportional relationship ALLOW pressure goes up at the same rate as temperature IGNORE idea of more collisions with other particles
			Total	4	