

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249

For first teaching in 2016

J249/03 Summer 2018 series

Version 1

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the examination paper can be downloaded from OCR.

Paper J249/03 series overview

This 90-mark higher paper gave a good range of marks up to 89 and a relatively higher mean (50) than the recent legacy award. This healthy mean mark is encouraging given the change in specification and the change in examination approach and content. Compared to the legacy papers there was a greater emphasis on mathematical content and practical based questions. Answers showed that candidates generally were well prepared and appropriately entered for this tier. As always though, a few candidates would have been better suited to the foundation paper as they had very limited access to these challenging questions. The paper was of appropriate length and there were only a few examples of candidates running out of time. Although a small number of candidates left some answers blank, these 'no responses' tended to be scattered throughout the paper rather than concentrated at the end.

Section A overview

Section A is a 15 mark multiple choice section which is new to Gateway candidates. It contained AO1 (demonstrating knowledge of scientific ideas, techniques and procedures) and AO2 type questions (Applying knowledge and understanding of scientific ideas, scientific enquiry, techniques and procedures). This section covered the whole higher tier grade range. Generally the questions start at around grade 4 demand and increase in difficulty throughout the section to the higher grades.

Question 1

1 The atomic model has changed over time.

Why did the model need to change over time?

- A Models only have a finite lifetime
- B Computers were invented
- C The older models could not explain new evidence
- D Peer review

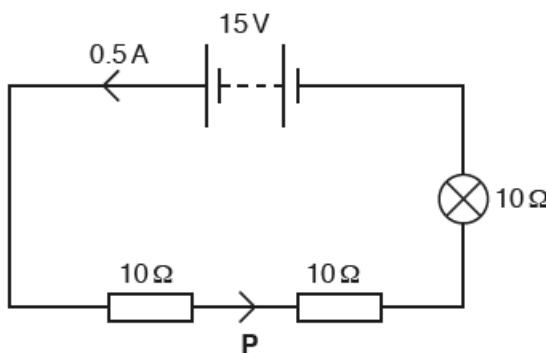
Your answer

[1]

The great majority of candidates gave the correct answer C.

Question 2

2 What is the current at point P in the circuit?



- A 0.5A
- B 7.5A
- C 15.0A
- D 20.5A

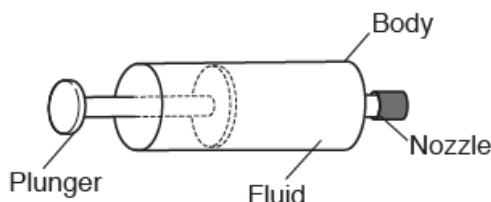
Your answer

[1]

About 80% of candidates gave the correct answer A. Common incorrect answers were randomly selected from the other distractors.

Question 3

3 A fluid is compressed by pushing the plunger into the body of a sealed syringe.



Which of these statements is true?

- A There is a net force towards the plunger.
- B There is no force towards the nozzle.
- C There is a force parallel to all points on the surface of the fluid.
- D There is a force at 90° to all points on the surface of the fluid.

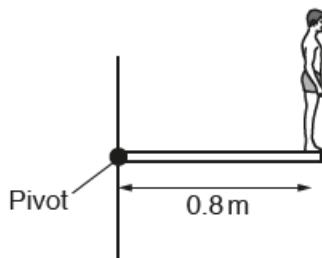
Your answer

[1]

About two thirds of candidates gave the correct answer D. A common incorrect response was 'C'.

Question 4

4 A diver stands on a diving board. He weighs 400N.



What is the moment of the force provided by the diver around the pivot?

- A 320 Nm anti-clockwise
- B 320 Nm clockwise
- C 500 Nm anti-clockwise
- D 500 Nm clockwise

Your answer

[1]

This was the first calculation on the paper and about 80% gave the correct answer B. A common incorrect response was 'A', presumably due to confusion over clockwise and anticlockwise.

Question 5

5 Which factor influences whether an object floats or sinks?

- A Size of object
- B Depth of water
- C Distance from the shore
- D Density of object

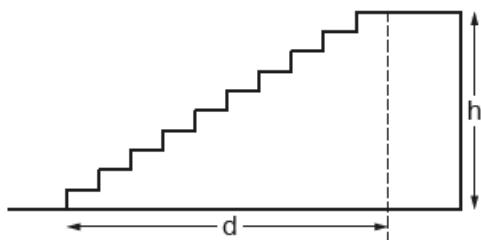
Your answer

[1]

This was well known by nearly all candidates who gave D as their answer.

Question 6

6 A student of weight W runs up a flight of stairs.



She moves a distance d metres horizontally and h metres vertically.

What is the work done against gravity running up the stairs?

- A $W \times d$
- B $W \times h$
- C $(W \times d) + (W \times h)$
- D $W \times \frac{h}{d}$

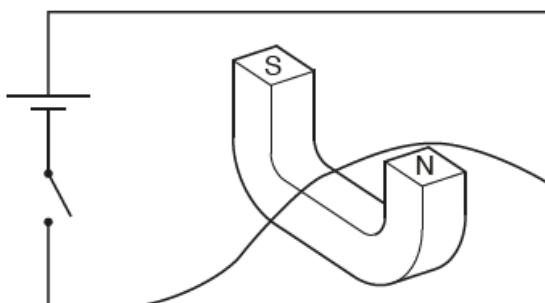
Your answer

[1]

Only about a third of candidates gave the correct answer 'B'. A common incorrect response was 'A' although the other distractors were also seen on occasions.

Question 7

7 A wire is placed inside a horseshoe magnet.



Which direction will the wire move when the switch is closed?

- A Downwards
- B Left
- C Right
- D Upwards

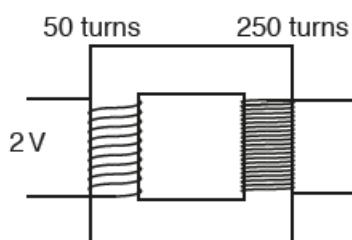
Your answer

[1]

About 40% of the candidature gave the right answer A. The common incorrect response was usually 'D'.

Question 8

8 What output voltage does the transformer produce?



- A 0.2V
- B 0.4V
- C 5V
- D 10V

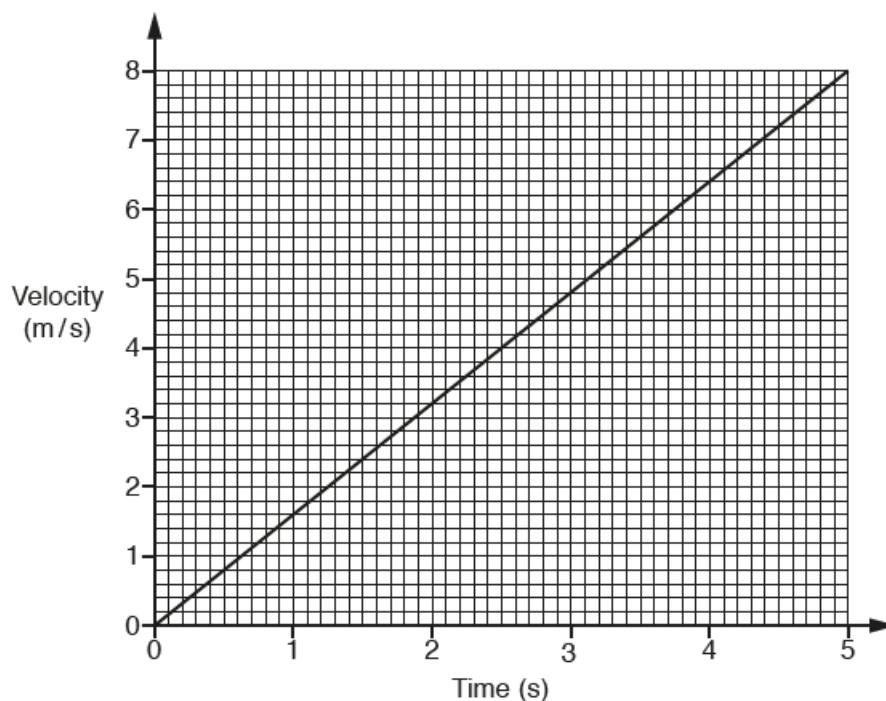
Your answer

[1]

This calculation was answered successfully by about three quarters of the candidates stating D.

Question 9

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



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

- A 0.63m
- B 1.6m
- C 20m
- D 40m

Your answer

[1]

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 \times time, $8 \times 5 = 40$ m).

Question 10

10 Which statement is equivalent to the mass of an object?

- A The ratio of acceleration over force
- B The ratio of force over acceleration
- C The ratio of velocity over acceleration
- D The ratio of displacement over acceleration

Your answer

[1]

This question about $F = ma$ was answered well with about 80% of candidates getting it correct with the answer B. All other responses were seen with A being the most common incorrect answer given.

Question 11

11 Which does **not** increase the magnetic effect of a solenoid?

- A Increasing the cross-sectional area of the solenoid
- B Increasing the current in the solenoid
- C Increasing the number of turns on the solenoid
- D Putting a soft iron core in the solenoid

Your answer

[1]

About two thirds of candidates gave the correct answer A.

Question 12

12 Two cars head towards each other on a road.



What velocity does the driver of car Q see car P travelling towards him at?

- A 10 m/s
- B 15 m/s
- C 25 m/s
- D 40 m/s

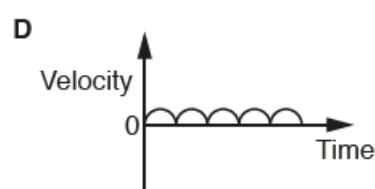
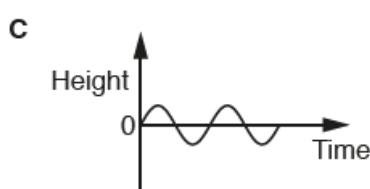
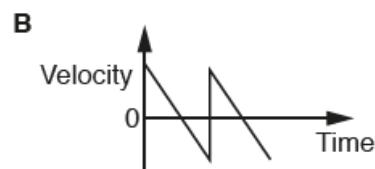
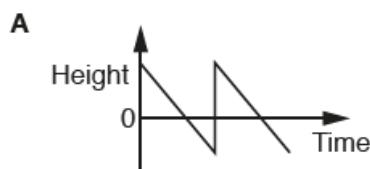
Your answer

[1]

About 40% of candidates gave the correct answer D. A common incorrect response (the differences in speeds rather than velocities with direction) was 'A'.

Question 13

13 Which graph shows a bouncing ball?



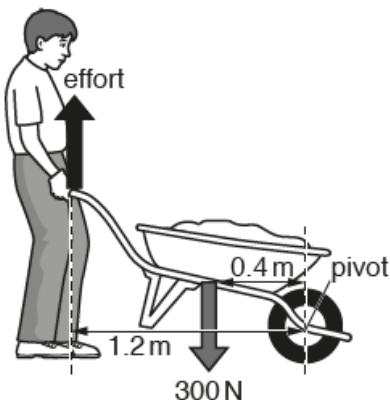
Your answer

[1]

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'.

Question 14

14 A man lifts a load using a wheelbarrow.



What is the effort needed to lift the load using the wheelbarrow?

- A 100 N
- B 120 N
- C 250 N
- D 144 N

Your answer

[1]

In this calculation about a third of candidates gave the correct answer A. The other distractors were randomly selected.

Question 15

15 A 0.5 m length of wire is placed inside four different magnetic fields.

Magnetic Field	Force on wire (N)	Current in wire (A)
A	2.0	0.1
B	2.0	0.2
C	4.0	0.1
D	4.0	0.4

Which magnetic field has the **greatest** magnetic flux density?

Your answer

[1]

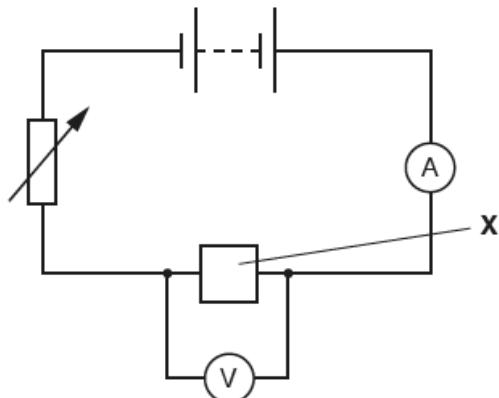
About two thirds of candidates gave the correct answer C.

Section B overview

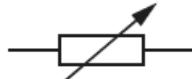
All questions in this section were attempted by the great majority of candidates. There were few 'no responses' and both the practical aspects and in particular the greater mathematical content was handled well by most.

Question 16(a)(i)

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



(a) (i) What is the name of this component?



[1]

Most named this correctly as a variable resistor for 1 mark. 'LDR' or 'resistor' and 'thermistor' were common incorrect answers.

Question 16(a)(ii)

(ii) Why is this component needed in this circuit?

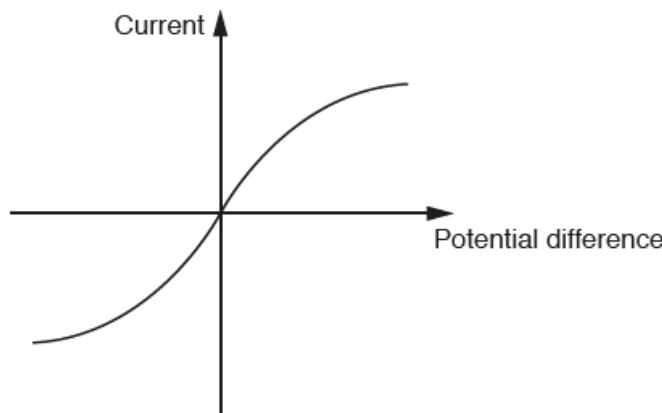
..... [1]

About half of candidates referred correctly to changing, varying or controlling the current or resistance for 1 mark. Incorrect answers varied but frequently seen were a device to measure current or resistance.

Question 16(b)(i)

(b) 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]

Most gave the correct answer as a filament lamp. Lamp or bulb was acceptable also.

Question 16(b)(ii)

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

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

.....
.....
.....

[3]

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 answers 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.

Question 16(c)(i)

(c) Component X has a resistance of 16Ω when a current of $0.25A$ flows.

(i) Calculate the potential difference across component X.

Use the equation: Potential difference = Current \times Resistance

Answer = V [2]

This standard demand Ohm's law calculation was very well answered by almost all candidates. As, on this occasion, the formula was given in the question then the mark total was limited to 2 marks.

Question 16(c)(ii)

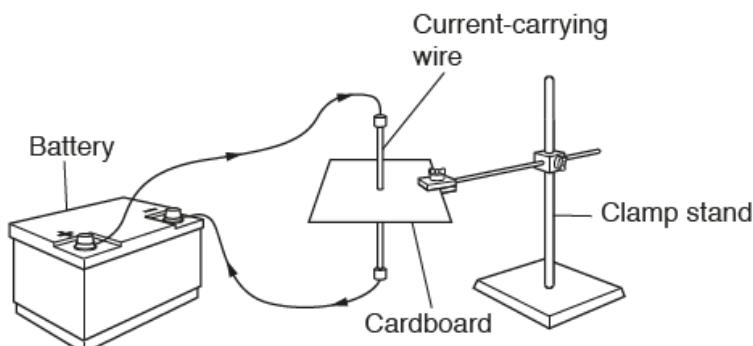
(ii) Calculate the power of component X when a current of $0.25A$ flows.

Answer = W [3]

About two thirds of candidates gained all 3 marks here for the calculation on power.

Question 17(a)(i)

17 A student sets up an experiment to investigate the magnetic field around a current-carrying wire.



(a) (i) Describe how the student could use this experiment and a compass to investigate the magnetic field produced by the wire.

- [3]

Some candidate did not attempt to describe the experiment here. Most got the idea of placing the compass on the card or near the wire. Rather fewer described the plotting or observing using the compass. Fewer still suggested the idea of repeating at different distances or places. About a quarter of candidates gained all 3 marks here and about a quarter did not gain credit.

Question 17(a)(ii)

(ii) Draw the shape of the field which would be found around **this** wire.

[2]

This was well answered with about half of the candidates drawing a circular field [1] with arrows showing a clockwise direction [1]. Some candidates drew a circular field [1] but either got the direction wrong or did not indicate a direction at all. Some labelled it with both clockwise **and** anticlockwise arrows so the direction mark could not be given.

Question 17(b)

(b) The behaviour of a magnetic compass is evidence that the core of the Earth is magnetic. Explain why.

.....

 [2]

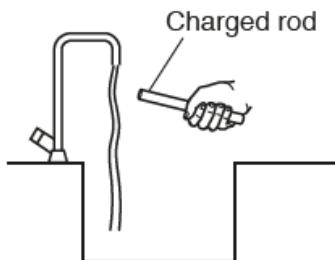
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Most candidates gained 1 mark for the idea of pointing north. Better answers (about a third) stated that the compass always pointed north and gained both marks. There were very few answers referring to the angle of dip.

Question 18(a)

18 This question is about electrostatic charges.

A charged rod is brought towards a gentle stream of water from a tap.



(a) Explain how the charged rod affects the stream of water.

.....

 [3]

The diagram was interpreted differently by candidates. Some thought it attracted (ideal scenario) and others thought it repelled. However marks were made available for both lines of thought as both interpretations were valid from the diagram. It gave a full range of marks and discriminated well with about 10% gaining full marks by including the idea of polarisation. The ideas of repulsion of water and opposite charges repelling were credited 2 marks.

Question 18(b)(i)

(b) (i) Write down the conditions needed for charge to flow through a conductor.

.....
.....

[2]

Only about 10% here gained both marks. Delocalised electrons was a common correct answer for 1 mark. Less often seen were a potential difference [1] and a complete circuit [1].

Question 18(b)(ii)

(ii) Calculate the charge that flows past a point in a circuit with a 5.0A current for five minutes.

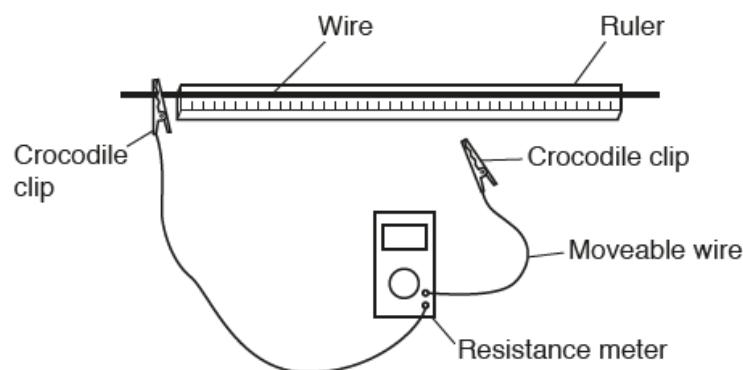
Answer = C [4]

This was reasonably well answered and about two thirds of candidates gained 3 marks for 1500. Some forgot to convert minutes to seconds but were credited some reward for their working.

Question 19(a)(i)

19 Two students investigate the resistance of a wire.

They tape a length of wire to a metre ruler and connect it to a resistance meter using crocodile clips.



Look at their results.

Length of wire (cm)	Resistance (Ω)			
	Attempt 1	Attempt 2	Attempt 3	Mean
25	8.8	8.3	8.5	8.533
50	16.2	16.1	16.4	16.4
75	23.5	23.8	18.7	23.7
100	30.8	31.1	31.0	31.0

(a) (i) Describe the pattern shown by these results.

Use data in your answer.

.....
.....
.....

[2]

Most answers indicated the correct relationship between the length of the wire and its resistance for 1 mark. It was common in answers for values to be merely quoted rather than used. For example, better answers (from about a fifth of candidates) that stated 'doubling the length doubles the resistance' were credited both marks.

Question 19(a)(ii)

(ii) The students made **two** mistakes when they recorded their results and completed the table.

Identify the mistakes **and** explain what they should have done.

.....
.....
.....

[2]

About third of answers identified clearly the mean for 25cm was recorded to three decimal places and it should only be one. Also shown in about a fifth of answers was the mean at 50cm should be 16.2.

Question 19(a)(iii)

(iii) The students have correctly handled an error in their results.

Identify the error and explain how it was correctly handled.

.....
.....
.....

[2]

Please note an erratum notice was issued for this question. You can view this at the end of the report.

There was an erratum included for this question. Virtually all candidates edited their question to include this. There was no evidence at all that any candidates were disadvantaged by this and 80% gained full marks.

Question 19(a)(iv)

(iv) The students plan to plot a graph of mean resistance against length.

What would you expect a graph of these results to look like?

.....
.....
.....

[2]

Some sketched a straight line graph through the origin for 2 marks here. Some described it as a straight line through the origin [2] or it was directly proportional [2]. Others described the shape as a straight line or proportional [1] but did not mention the origin.

Question 19(b)(i)

(b) (i) The actual mean resistance values are more than expected.

Suggest **two** possible errors with the experiment.

.....
.....
.....

[2]

Answers here were often vague here and examiners were seeking to award marks for clearly described errors. About a third gained one mark for either the idea of the crocodile clip not being at zero or the meter not being zeroed or calibrated.

Question 19(b)(ii)

(ii) For **one** of the errors, suggest how the experimental procedure could be improved.

.....
.....

[1]

About a quarter gained one mark here for taking an error from part (i) and providing a solution.

Question 20(a)(i)

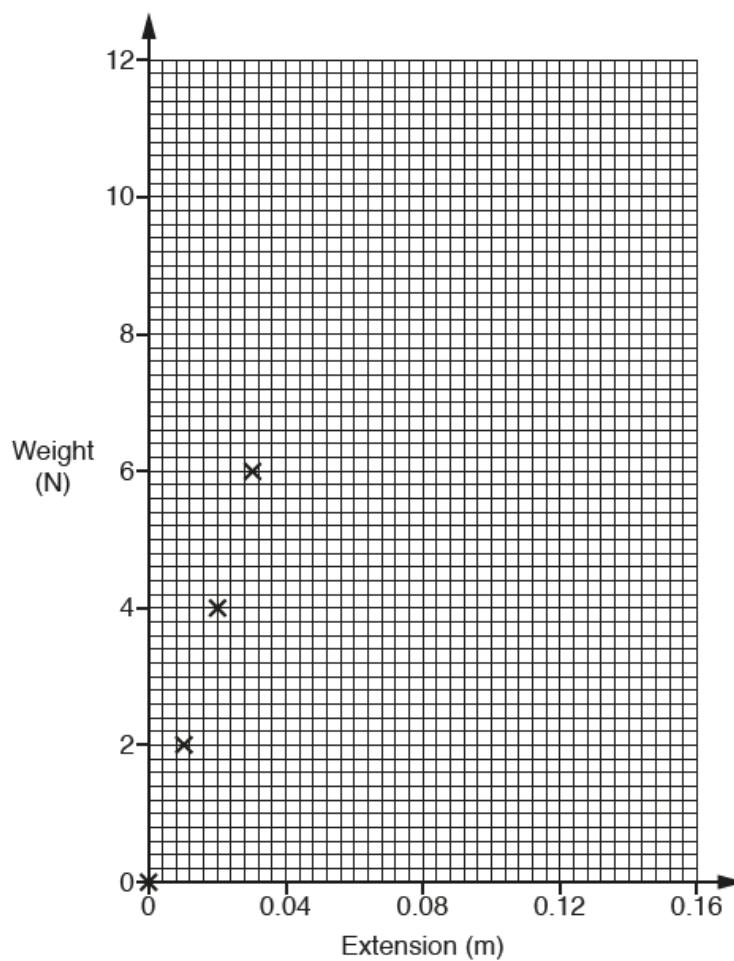
20 A student hangs a length of copper wire from the ceiling.

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

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



[2]

All the points were usually plotted correctly.

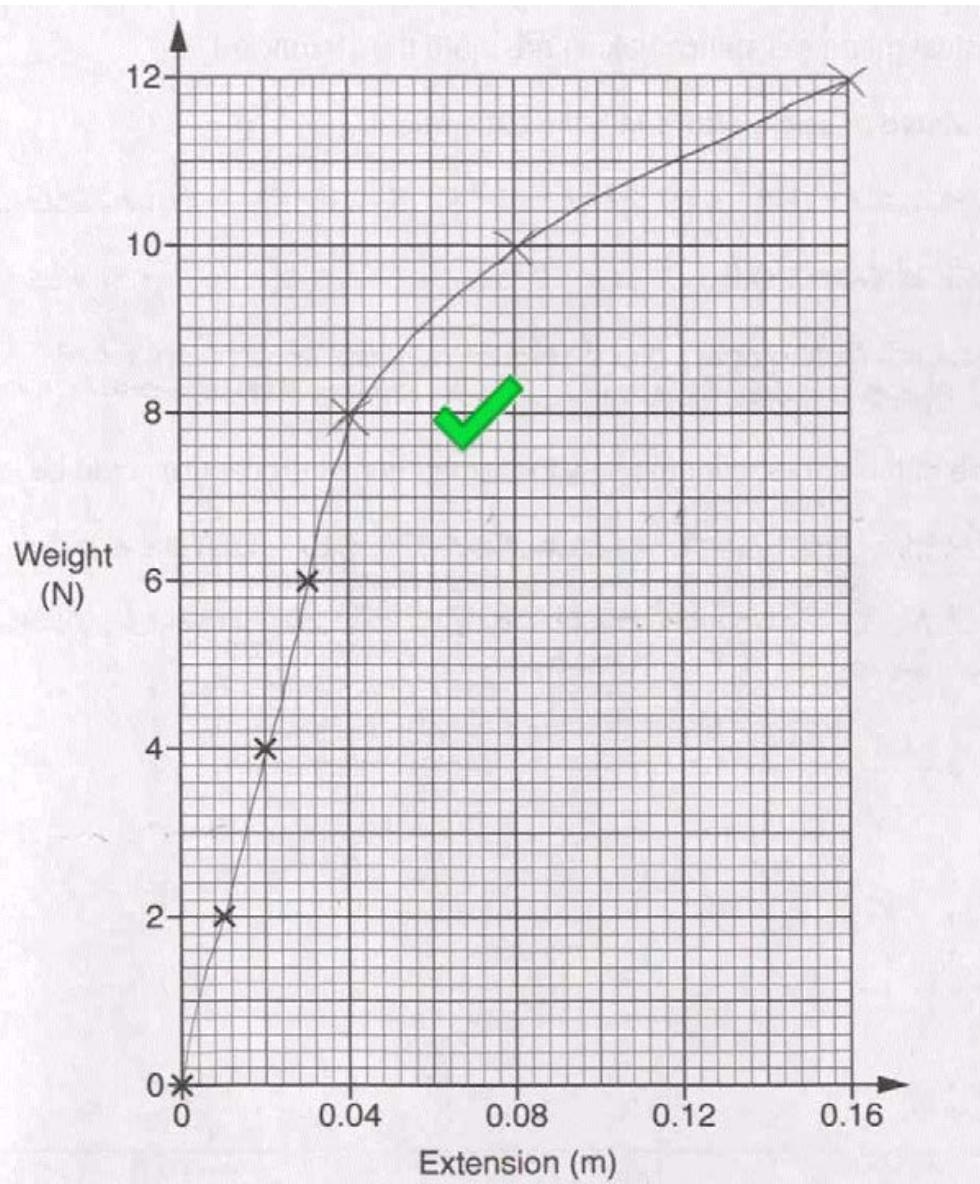
Question 20(a)(ii)

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

[1]

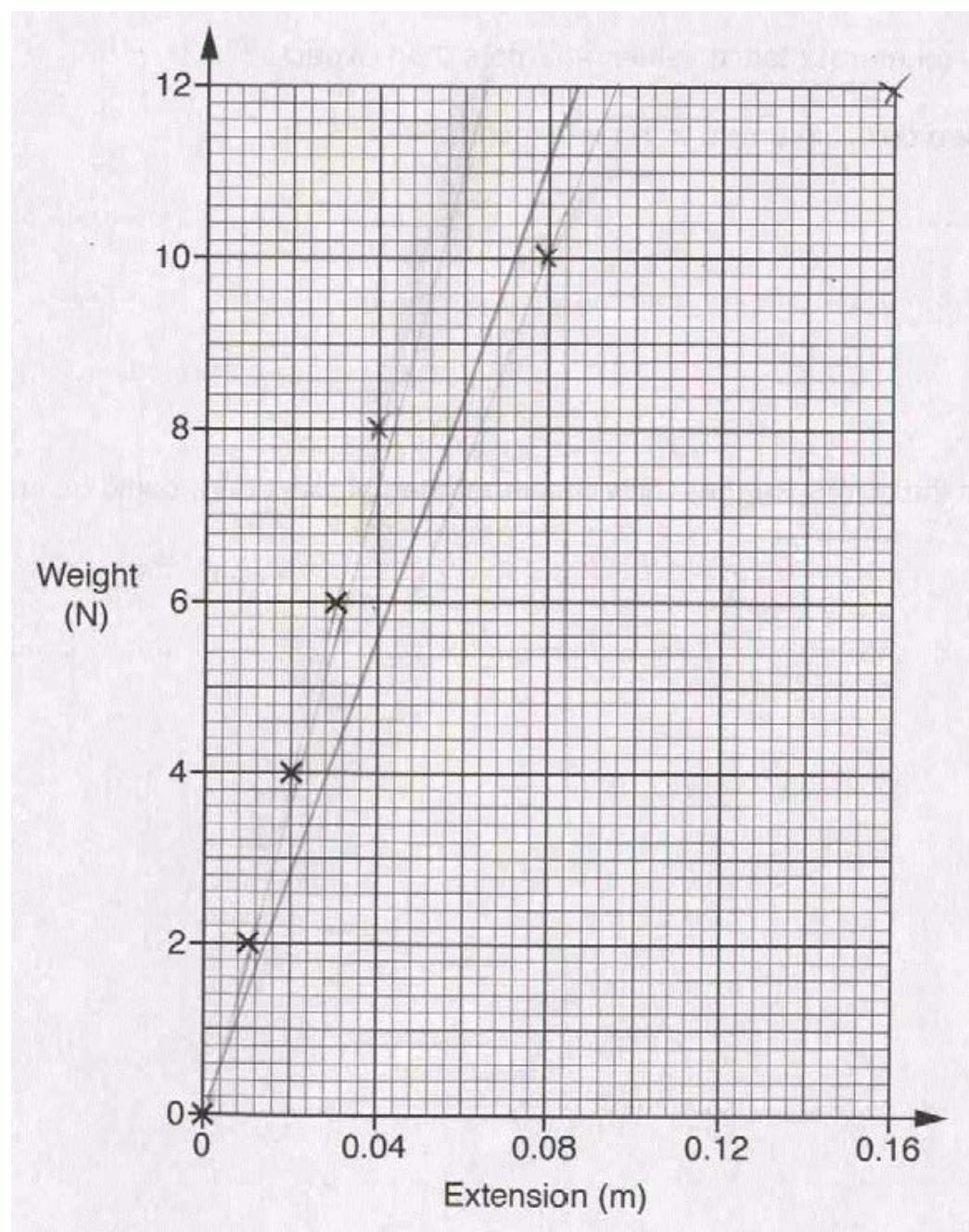
Just over half of answers gained the one mark here. Common mistakes were double lines, lines too thick (larger than half a square) and straight line of best fit with no curve.

Exemplar 1



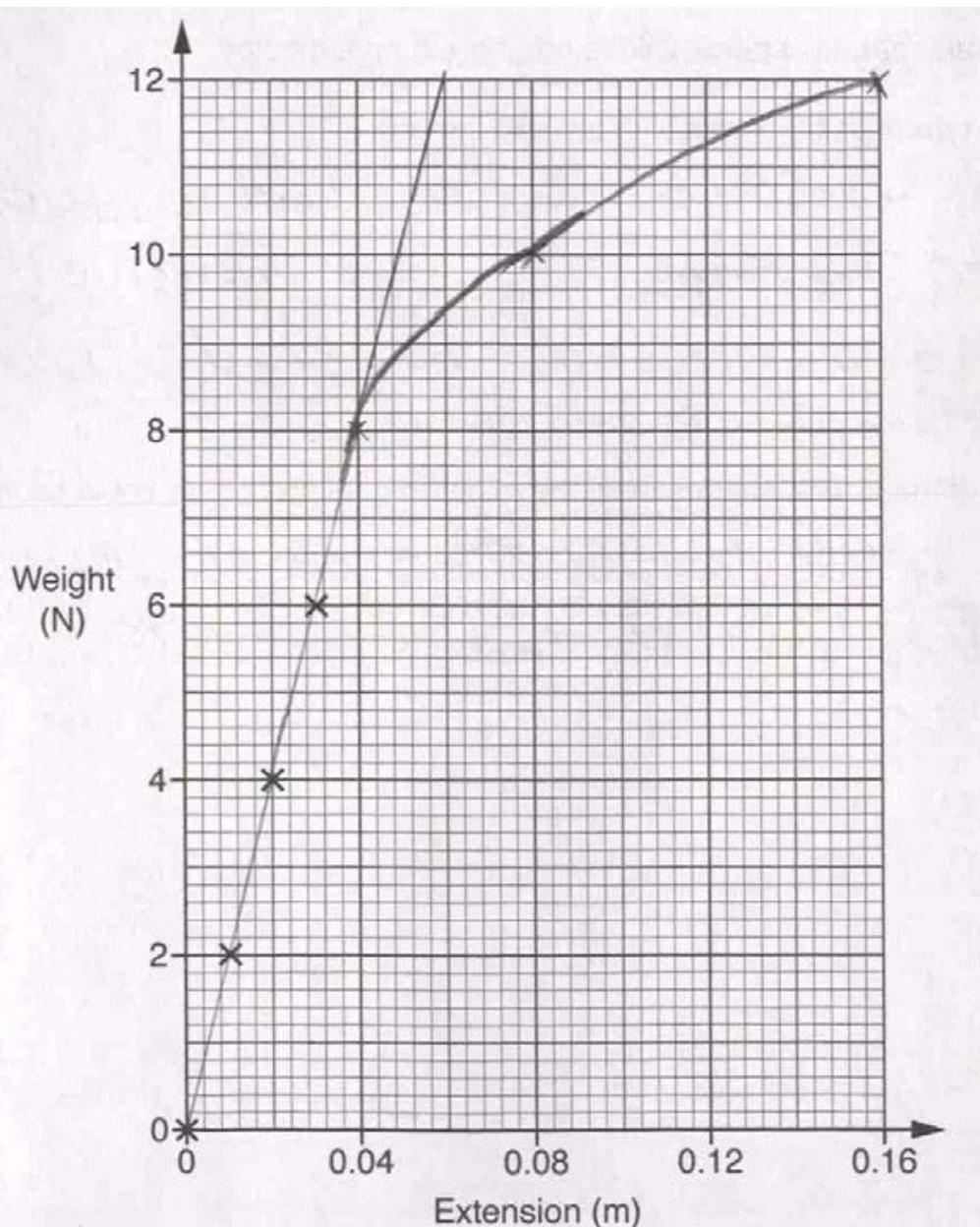
This gets full marks for both parts as the answer shows accurate plotting for part i of the question and produces a straight line graph in part ii that becomes curved after 8N. Although the line does slightly miss the point at 8N, the line and curve are reasonable.

Exemplar 2



This was a common error with points plotted accurately but a straight line drawn so this was credited 0 marks.

Exemplar 3



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.

Question 20(a)(iii)

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

.....

 [3]

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.

Question 20(b)

(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]

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 $k = F \div x$.

Question 20(c)

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

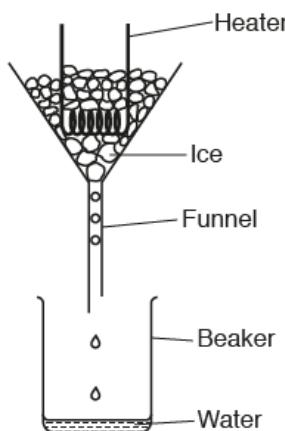
Answer = J [2]

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.

Question 21(a)

21 Two students design an experiment to find the specific latent heat of water.

They set up their equipment as shown in the diagram.



The students also have access to a power supply, a voltmeter, an ammeter, a stop-clock and a top-pan balance.

(a)* Explain how the students could use this equipment to determine an accurate value for the specific latent heat of water.

• [6]

This six mark level of response question is the only one on this paper. It gave the full range of marks and discriminated well at higher grade demand with about 10% giving level 3 answers and gaining 5 or 6 marks. The procedure was explained quite well with many gaining level 2 scores. A few were very brief with the description (level1) and did a little more than relate the equipment given in the question. Most got the idea of measuring the ice melted, measuring the voltage and current (and multiplying them to get power). Many showed how to calculate the energy and then use this to calculate the specific latent heat (SLH). Very few wrote about accuracy and therefore did not get level 3 rewards at all. A few misread the question and wrote about specific heat capacity (SHC) rather than SLH. As in previous qualifications candidates highlighted key words in the question. This helped them focus their attention on structuring their answers in a clear and concise manner thus gaining marks along the way.

Exemplar 4

The students can use this equipment to get an accurate value as first of all they should use the top ~~as~~ pan balance to work out the weight of ice they are melting. Then, they should connect

L2 the voltmeter and ammeter up to the

A heater and power supply in a circuit, before using the formula $\text{power} = \text{current}^2 \times$ ~~delivered~~ resistance to work out the power. ~~Then~~

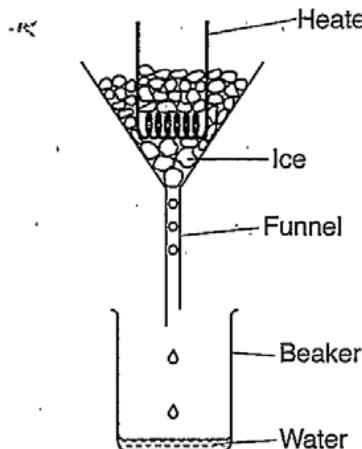
The stopwatch should be used to time how long it takes for the ice to melt in seconds.

When all the ice has melted & multiply the **[6]** value for power by the amount of time to work out how ~~less~~ much energy was supplied in total, then use the formula $\text{specific latent heat} = \frac{\text{Energy Supplied}}{\text{Mass}}$ to calculate the specific latent heat of the water.

This answer has some idea of the method but often restates the information in the diagram. For example connects the ammeter and voltmeter to the heater – rather than connects the voltmeter in parallel and the ammeter in series. The formula suggested seems a little insecure for a full level 2 answer so the candidate is credited 3 marks.

Exemplar 5

They set up their equipment as shown in the diagram.



$$\Delta \text{latent heat} = \frac{\Delta \text{thermal energy}}{\text{mass}}$$

$$\text{power} = \text{current} \times \text{potential difference}$$

$$\text{energy} = \text{power} \times \text{time}$$

The students also have access to a power supply, a voltmeter, an ammeter, a stop-clock and a top-pan balance.

(a)* Explain how the students could use this equipment to determine an accurate value for the specific latent heat of water.

- The Students must find out the mass and the change in thermal energy during this experiment.
- To do this ~~has~~ they can create a circuit with the heater as the component. They should ~~put~~ ^{connect} the ammeter in series with the circuit to measure the current in amps. They should connect the voltmeter in parallel with the heater to measure the potential difference in volts.
- They should ~~turn on the power supply~~ time how long it takes to melt all of the water to melt using the stop-clock.
- Then they should use the equation $\text{power} = \text{current} \times \text{potential difference}$ and use their ^[6] values to find the power. Then they should use the equation $\text{energy transferred} = \text{power} \times \text{time}$ to find out the change in energy. (continued on back page ^x)

This answer clearly explains the method in some detail. It describes the measurements taken and the calculations and formulae needed. It does not attempt to describe anything about accuracy so it is limited to level 2 and is credited 4 marks.

Question 21(b)

(b) The students find that 250 g of ice takes 95 kJ of energy to change state.

Calculate the specific latent heat.

Answer = J/kg [3]

Slightly over a half gained all 3 marks for this calculation. Some gained fewer marks because of power of 10 errors in conversions for example 360 [2] rather than 360 000 [3]. Others gained [1] for the correct rearrangement of the formula.

Question 22(a)

22 A student investigates collisions of trolleys on a horizontal airtrack.

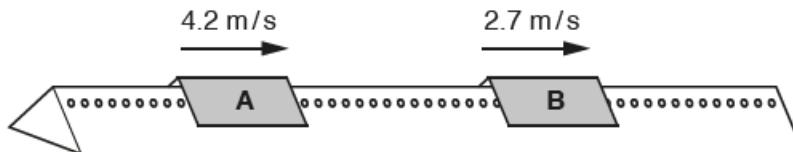
(a) Write down the **two** quantities involved with motion which are conserved during an elastic collision.

..... [2]

Kinetic energy and momentum were the answers here. Full marks (in 10% of cases) were attained by more able candidates only. Just less than a half gained 1 mark only. 'Energy' or 'potential energy' (rather than kinetic energy) was often seen along with mass, velocity.

Question 22(b)(i)

Trolley **A** has a mass of 2kg. Trolley **B** has a mass of 2.5kg.



(b) (i) Calculate the **momentum** of each trolley.

$$\text{Trolley A} = \dots \text{ kg m/s}$$

$$\text{Trolley B} = \dots \text{ kg m/s}$$

[3]

The great majority calculated both values of momentum correctly and gained 3 marks.

Question 22(b)(ii)

(ii) The two trolleys collide and stick together after the collision. Use your answers to (b)(i) to calculate the **speed** of the combined trolleys after the collision.

Record your answer to **2** significant figures.

$$\text{Answer} = \dots \text{ m/s} \quad [3]$$

Just under a half of candidates calculated this correctly to two significant figures. About a third did gain any credit at all and gave attempts of calculations that were incorrect or difficult to follow.

Question 23(a)(i)

23 A student wants to find out the depth of a well.

She thinks that she can calculate this by dropping a stone into the well and timing how long it takes to hear the stone splash at the bottom.

(a) (i) Explain how she could use this measurement to find the depth of the well.

.....
.....
.....
.....
.....

[3]

This was an intentionally challenging question where less than 10% did not score at all. Most of these wrote about $g = 10$ and the initial velocity was 0 and gained 1 mark. Very few successfully continued further.

Question 23(a)(ii)

(ii) It takes 2.2 seconds for the stone to drop from rest and splash into the water at the bottom.

What is the speed of the stone when it hits the water?

Answer = m/s [2]

Again this challenging calculation saw about 1/5th gaining both marks with 22 (m/s). A few correctly used $g = 9.8$ or 9.81 and still scored full marks. Many used speed = distance \div time and did not score.

Question 23(b)

(b) Describe the motion of the stone as it falls.

Assume it does not reach terminal velocity.

Use a free body diagram to help you.

[4]

There were some good answers here. A common error was to state 'gravity' rather than weight or force of gravity. The relative sizes of the arrows were often correct. Upthrust was often unsuccessfully substituted for air resistance. The question discriminated well with about a third gaining full marks.

Erratum notice

Instructions to invigilators:

Before the start of the exam, please read the following notice out **twice** to candidates:

Turn to **page 15** of the **question paper** and look at question **19(a)(iii)**.

In the first sentence, cross out the word 'error' and replace with 'anomaly'.

In the second sentence, cross out the word 'error' and replace with 'anomaly'.

The question should now read:

The students have correctly handled an anomaly in their results.

Identify the anomaly and explain how it was correctly handled.

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