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Examiners' report

A LEVEL

PHYSICS B (ADVANCING PHYSICS)

OCR Level 3 Advanced GCE in Physics B (Advancing Physics)

H557

For first teaching in 2015

H557/01 Summer 2025 series

Contents

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. A selection of candidate responses is also provided. 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 question paper and the mark scheme can be downloaded from Teach Cambridge.

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Paper 1 series overview

H557/01 'Fundamentals of Physics' component is worth 110 marks and assesses specification content from across all the teaching modules.

Section A consisted of thirty multiple-choice questions, each worth 1 mark.

Section B included five structured short answer questions worth a total of 27 marks. Each question typically examined a single context. To do well on this section candidates needed to be comfortable answering questions that involved problem-solving and practical-based questions as well as performing calculations.

Section C consisted of five questions worth 53 marks in total. These longer questions included two opportunities for extended writing (Questions 36 (b) and 39 (b) (ii)) worth 6 marks each.

There was little evidence that any time constraints had led to a candidate underperforming with most candidates answering the final question well.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• attempted all the multiple-choice questions in Section A • performed the calculations required for Section B well • articulated how to calculate the average velocity of the space in Question 33 • used sound physics, covering fully the required strands identified in the question, in a logical structure such as for the extended response Questions 36 (b) and 39 (b) (ii) • were able to explain the formation of eddy currents in transformers in Question 38 (b) • were able to describe for Question 39 (b) how to use the equipment given in the question to find the plane of polarisation.	• found it difficult to explain physics concepts with the required depth and clarity - for example in Question 38 (c) where they were asked to explain how the performance of a transformer is affected by air • made arithmetic errors, for example, not converting cm into m in Question 40 (a) (ii) • drew lines for Question 36 (b) that did not represent the maximum or minimum gradients – often joining the tips of the error bars • covered just one of the required strands for the extended response Questions 36 (b) and 39 (b) (ii) and lacked structure in their reasoning.

Section A overview

This section consisted of 30 multiple-choice questions, each worth 1 mark. Candidates performed very well on Questions 1, 9, 10 and 16. Questions 2, 6, 13 and 15 were the most challenging.

Question 2

2 A student measures the change in temperature of some water when it is heated for 10 seconds. The student's results are:

Starting temperature = (53.4 ± 0.2) °C
Final temperature = (96.1 ± 0.2) °C

What is the average rate of change in temperature of the water together with its associated uncertainty?

A (4.27 ± 0.02) $°C\,s^{-1}$

B (4.27 ± 0.04) $°C\,s^{-1}$

C (4.27 ± 0.2) $°C\,s^{-1}$

D (4.27 ± 0.4) $°C\,s^{-1}$

Your answer [ ] **[1]**

Only a few candidates were able to correctly apply their understanding of how to combine uncertainties, allowing them to identify B as the correct answer.

OCR support

Support with how to process and calculate uncertainties can be found on page 32 of the Practical skills handbook and section M1.5 of the Mathematical skills handbook.

Question 5

5 Two identical cells are connected in series.
The e.m.f. of each cell is ε and the internal resistance of each cell is r.
Which row shows the combined e.m.f. and the combined resistance of the two cells when they are connected in series?

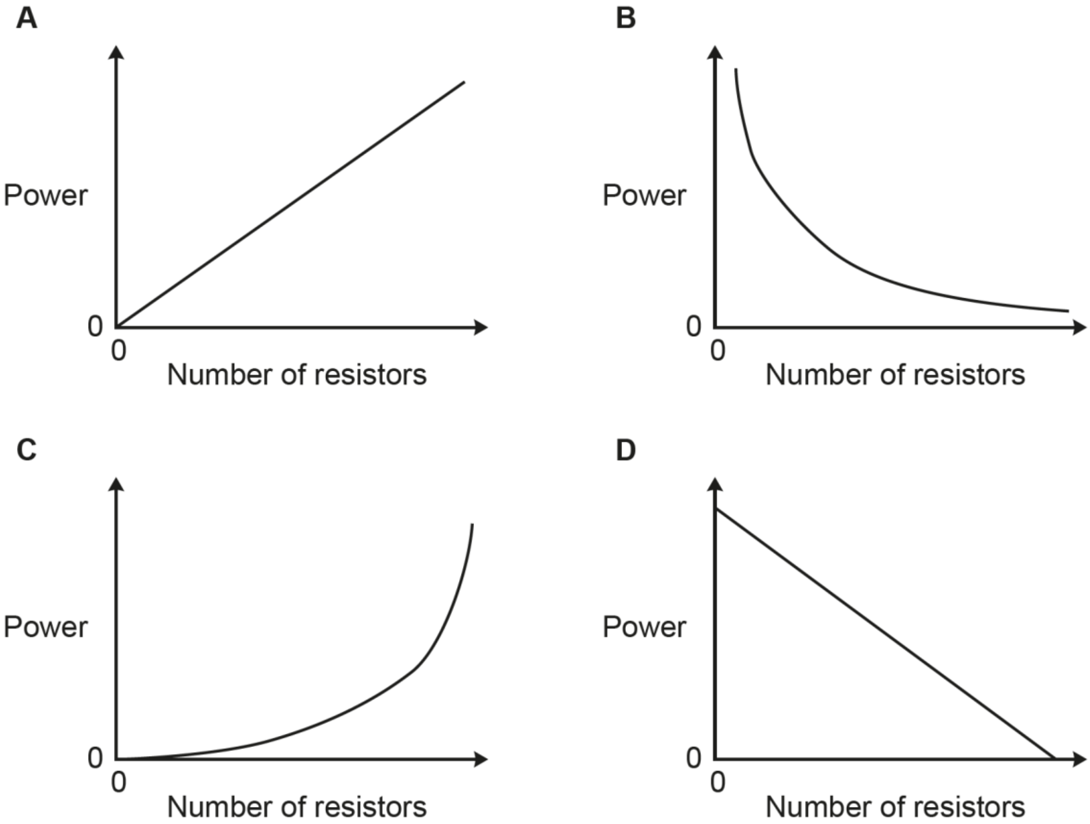
	E.m.f	**Internal resistance**
A	$-\varepsilon$	r
B	ε	$2r$
C	2ε	r
D	2ε	$2r$

Your answer ☐ **[1]**

Most candidates were correctly able to identify that the E.m.f. and internal resistance would double, correctly identifying D as the answer.

Question 6

6 A number of identical resistors are connected in parallel to a cell of negligible internal resistance. Which graph shows how the power dissipated in the circuit varies with the number of resistors?



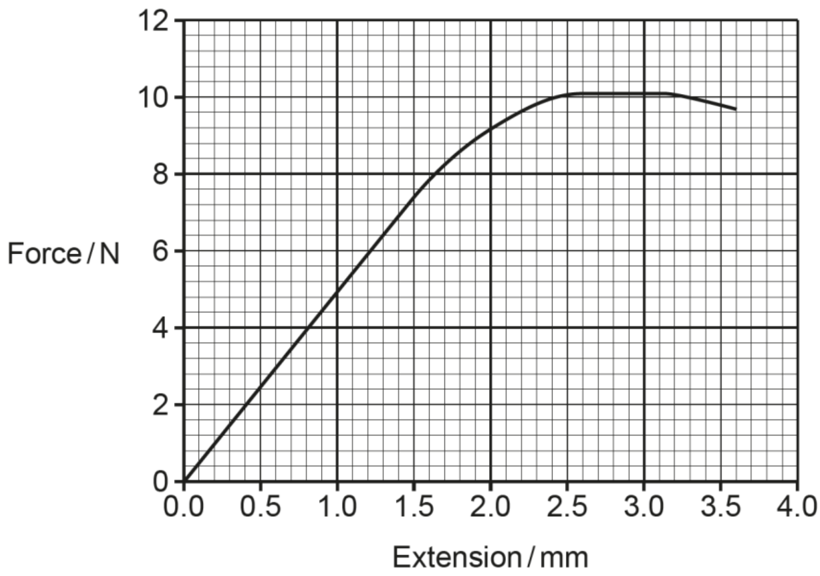
Your answer **[1]**

A number of candidates incorrectly said that P is proportional to R^2 which led to them selecting C.

Question 10

The following information is for use in questions **10**, **11** and **12**.

A wire is clamped at one end so that it hangs vertically, and weights are suspended from the lower end. The graph shows how the force on the wire varies with extension.



10 Which statement describes both the deformations and the nature of the wire?

	Deformations	Nature
A	elastic followed by plastic	brittle
B	elastic followed by plastic	ductile
C	plastic followed by elastic	brittle
D	plastic followed by elastic	ductile

Your answer **[1]**

The majority of candidates were able to identify that this graph was elastic and then plastic which meant that it was ductile in nature.

Question 13

13 An electron travels in a straight line at non-relativistic speed. It has speed v, kinetic energy E, and wavelength λ.

The kinetic energy of the electron is increased to $4E$.

What is the new wavelength?

A $\dfrac{\lambda}{4}$

B $\dfrac{\lambda}{2}$

C 2λ

D 4λ

Your answer ☐ **[1]**

Very few candidates were able to recognise the relationship of v=fλ and then substitute into $E_k = \frac{1}{2}mv^2$ which, when you substitute 4E into and rearrange, leads to the correct selection of B.

Question 14

14 The diagram shows some of the energy levels in a hydrogen atom.

$n = 4$ ——— $E_4 = -0.85\,\text{eV}$

$n = 3$ ——— $E_3 = -1.51\,\text{eV}$

$n = 2$ ——— $E_2 = -3.40\,\text{eV}$

$n = 1$ ——— $E_1 = -13.6\,\text{eV}$

Which electron transition results in the emission of a photon of frequency 2.46×10^{15} Hz?

A $n = 4$ to $n = 3$

B $n = 4$ to $n = 2$

C $n = 3$ to $n = 1$

D $n = 2$ to $n = 1$

Your answer ☐ **[1]**

The majority of students were able to calculate the energy correctly from $E = hf$ and then use this to identify the transition correctly as D.

Question 15

15 A stationary thorium-232 nucleus emits an alpha particle. The velocity of the emitted alpha particle is $1.4 \times 10^4\,\mathrm{m\,s^{-1}}$. No other particles are emitted with the alpha particle.

What is the recoil speed of the resulting radium-228 nucleus?

A $121\,\mathrm{m\,s^{-1}}$

B $123\,\mathrm{m\,s^{-1}}$

C $241\,\mathrm{m\,s^{-1}}$

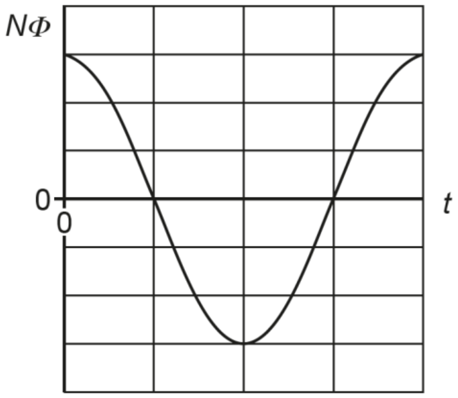
D $246\,\mathrm{m\,s^{-1}}$

Your answer ☐ **[1]**

Most candidates were able to correctly calculate the momentum before the emission. A common error was to use the mass of the thorium-232 nucleus rather than the radium-228 nucleus when working out the speed, which led to C being selected instead of D.

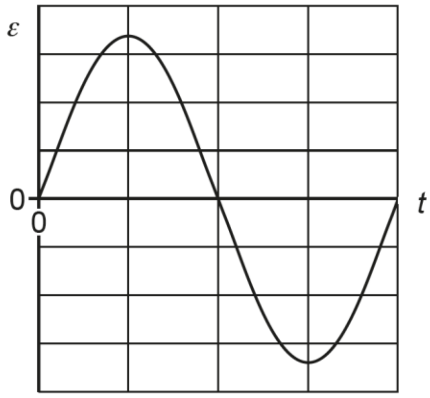
Question 22

22 The graph shows how the flux linkage for a coil rotating in a magnetic field varies with time.

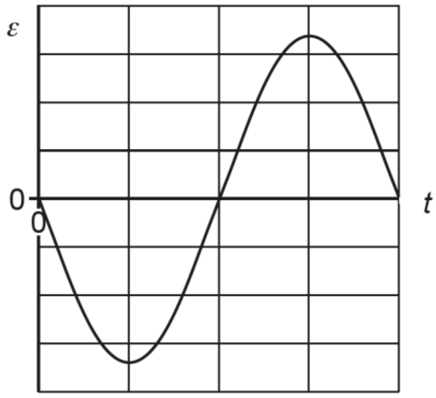


Which graph shows how the induced e.m.f. ε in the coil varies with time?

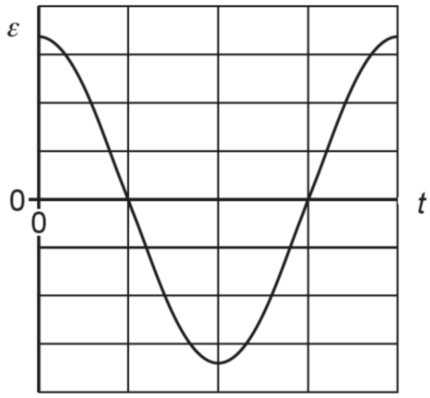
A



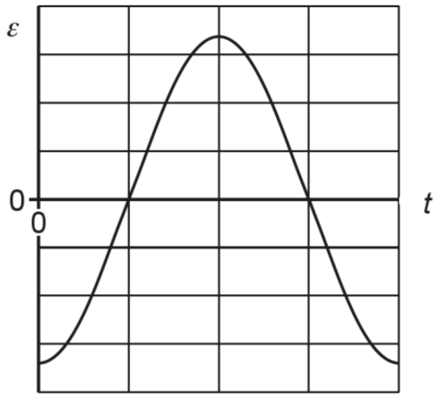
B



C



D



Your answer **[1]**

Most candidates were able to correctly select the answer of A. Some candidates omitted the - sign from the equation leading to the incorrect selection of C.

Question 23

23 Which quantity gives the strength of an electric field around an isolated charge?

A The area under a graph of electric field versus distance

B The area under a graph of electric force versus distance

C The gradient of a graph of electric potential energy versus distance

D The gradient of a graph of electrical potential versus distance

Your answer ☐ **[1]**

Most candidates were able to correctly select D. Some candidates appeared to confuse the terminology of electric potential and electric potential energy.

Misconception

Candidates need to understand the difference between the key terms electric field, electric potential and electric potential energy.

Question 26

26 Which statement about the binding energy per nucleon in a nucleus is correct?

A It becomes less negative when hydrogen nuclei undergo fusion to produce a helium nucleus.

B It determines the stability of the nucleus.

C It gives the kinetic energy a neutron must have to cause the fission of a nucleus.

D It gives the total energy required to separate all the nucleons in a nucleus.

Your answer ☐ **[1]**

Candidates who could identify the correct response, B, quickly from their knowledge of binding energy per nucleon saved time answering this question.

Question 28

28 An isotope emits alpha particles of energy 9.0×10^{-13} J. All of the alpha particles are absorbed by 0.25 kg tissue. The isotope gives a dose equivalent to 2.0 mSv in 2 hours.

What is the activity of the isotope?

The quality factor for alpha particles is 20.

A 3.9 kBq

B 78 kBq

C 1.5 MBq

D 28 MBq

Your answer [ ] **[1]**

Most candidates were able to successfully calculate the absorbed dose and then use this to calculate the energy deposited per unit mass. Candidates then used this to work out the energy deposited and then divided by the energy per alpha particle, to the correct selection of A.

Assessment for learning

Most of the successful candidates showed their working alongside the questions in Section A allowing them to perform multi-step calculations well.

Section B overview

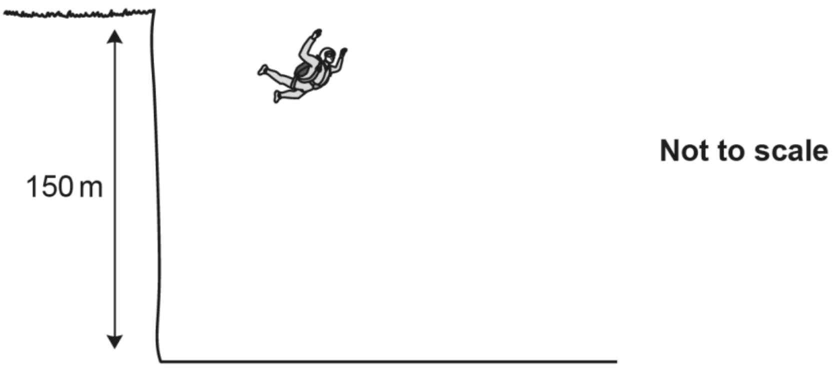
This section included five short answer questions worth a total of 27 marks.

Question 31 (a) (i)

31 Base jumping is a dangerous sport in which participants jump from high cliffs or structures and then open a parachute before reaching the ground.

Fig. 31.1 shows a base jumper just after they have run off the edge of a cliff.
The base jumper's velocity when they leave the top of the cliff is 8 m s^{-1} horizontally.
The cliff is 150 m high.

Fig. 31.1



(a)
(i) Calculate the vertical component of the velocity 1.5 s after the base jumper leaves the edge of the cliff.

vertical component = ... m s^{-1} **[2]**

Most candidates were able to correctly use $v = u + at$ to calculate the vertical component of the velocity. Some candidates used u as 8 ms^{-1} which is in the horizontal direction and not the vertical which led to an incorrect answer of 22.7 ms^{-1}.

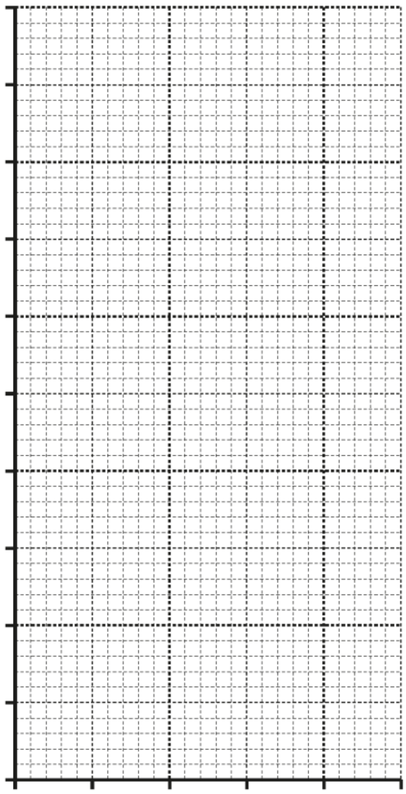
Question 31 (a) (ii)

(ii) Use the grid in **Fig 31.2** to draw the vectors for the horizontal and vertical components of the base jumper's velocity 1.5 s after they have left the top of the cliff.

Use the scale 1 cm : 2 m s^{-1}.

Use the scale drawing to find the speed of the base jumper at that time.

Fig 31.2



speed = ... m s^{-1} **[2]**

Very few candidates correctly drew a scale drawing using correctly arranged vectors to work out the resultant force. Some candidates used Pythagoras' equation to calculate the resultant which scored 0.

Question 31 (b)

(b) To avoid injury, the base jumper must open the parachute when:

- they are at least 20 m from the cliff
- at least 80 m above the ground.

Deduce whether or not the base jumper can avoid injury on this jump.

....

....

....

....

....

.... **[3]**

Most candidates correctly calculated the time for when the horizontal distance was 20 m and then used this to calculate the vertical displacement. Other candidates took the approach of calculating the time to fall 70 m and then calculated the horizontal displacement. Both routes led to the correct conclusion of the parachutist is safe.

Some candidates incorrectly used 80 m as the distance fallen rather than doing (150 m - 80 m) to calculate the height fallen.

Question 32 (a)

32 Capacitors can be used as energy storage devices.
A capacitor of capacitance C is charged until the potential difference across it is V.

(a) Show that the energy stored in the capacitor is given by $E = \frac{1}{2}CV^2$.

[1]

Most candidates successfully identified the two equations to start from as $E = \frac{1}{2}QV$ and $Q = C$.

Question 32 (b)

(b) A 680 μF capacitor is charged until it stores 12 mJ energy. It is then discharged through a 1.2 kΩ resistor.

Calculate the time taken for the capacitor to transfer 8 mJ energy when discharging through the 1.2 kΩ resistor.

time = ... s **[4]**

The few candidates that were successful in answering this question correctly converted E to V and recognised that the energy transferred 8 mJ so the final energy stored was 4 mJ.

Some candidates could insert and rearrange the capacitor discharge equation with the correct calculation of 12 mJ into 5.94 V.

Question 33

33 A spacecraft approaches a planet. It uses radar to measure its distance from the planet and its average velocity towards the planet. Radar pulses are sent at intervals of exactly 900.000 s. The time intervals for the signal to travel from spacecraft to the planet and back (journey time) are given in the table.

Time pulse sent / s	Journey time / s
00.00	12.000014
900.00	12.000

Explain how this data can be used to determine the average velocity of the spacecraft.

....

....

....

.... **[2]**

Most candidates explained clearly how to calculate the average velocity with some using calculations to illustrate their answer. Some candidates were not clear as to which time they were using in their explanations resulting in a loss of marks.

Question 34 (a) (i), (ii) and (iii)

34 A car is supported by four springs in its suspension. A student models the oscillation of the car on the springs iteratively. They assume that, when the car is oscillating vertically on the springs:

- the oscillation is simple harmonic
- the acceleration is uniform over time intervals of 0.02 s.
- the acceleration a, is given by

$$a = \frac{100\,000x - 240}{1200}$$

where x is the vertical displacement of the car from its equilibrium position.

(a) The car is lifted 0.050 m above its equilibrium position and then released.

(i) Show that the initial downward acceleration of the car is approximately 4.0 m s^{-2}.

[1]

(ii) Show that the change of displacement over the initial 0.02 s is approximately 0.0008 m.

[2]

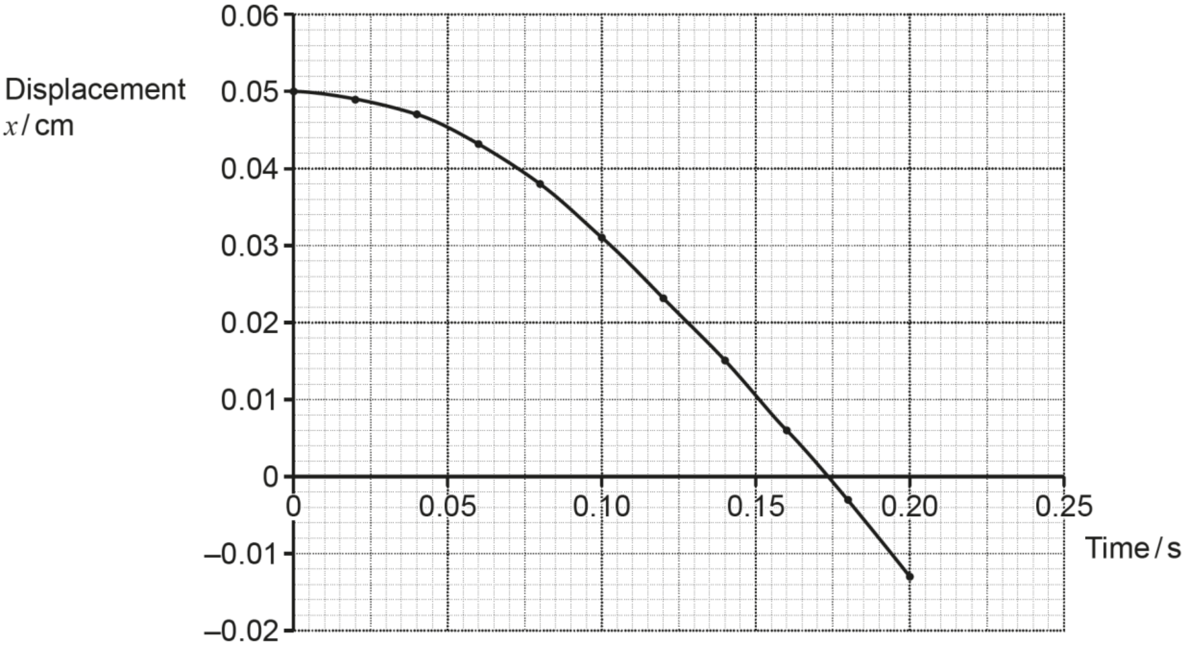
(iii) Hence calculate the displacement of the car from its equilibrium position after the first 0.02 s.

displacement = ... m
[1]

Almost all candidates were able to correctly insert 0.05 m into the equation and calculate the value of 3.97 ms^{-1} for part (a) (i). The majority of candidates correctly substituted their value from (a) (i) or 4.0 into $s = ut + \frac{1}{2}at^2$ to correctly calculate 0.000794. The majority of candidates were able to use the answer from (a) (ii) to then subtract it from 0.05 m to work out the displacement. Some candidates had a power of ten error in their answer.

Question 34 (b) (i)

(b) Further iterations of the model produce the graph shown below.



(i) Use data from the graph to estimate the period of the oscillation.

period = ... s **[2]**

The majority of candidates did not read the scale of the graph correctly and were not accurate enough in the reading of x-intercept which resulted in a transcription error for the first mark and an error carried forward for the second mark.

Question 34 (b) (ii)

(ii) Calculate a value for the time period of the oscillation.

Use the equation $a = 4\pi^2 f^2 x$ where f = frequency of oscillation.

Use data from **(a)(i)**

period calculated from equation = ... s **[2]**

The majority of candidates went back to part (a) (i) as stated in the question and used the acceleration calculated and the displacement stated to then work out the frequency. Some candidates incorrectly rearranged the equation or did not convert from frequency into period.

Question 34 (b) (iii)

(iii) Explain how the iterative model can be improved.

....

.... **[1]**

Many candidates stated to take repeat readings which would not affect the iterative model.

Question 35 (a)

35 A neutrino detector uses germanium crystals cooled to a temperature of a few mK to detect neutrinos. When a neutrino interacts with a germanium crystal its energy is transferred as thermal energy in the crystal and results in a small but detectable temperature rise.

Germanium crystals, each of mass 0.5 g, are used.

The specific thermal capacity of germanium close to absolute zero is $0.10\,\mathrm{J\,kg^{-1}\,K^{-1}}$.

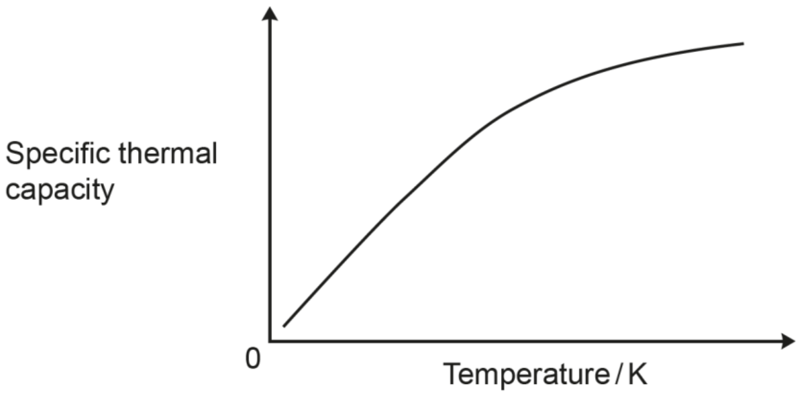
(a) Calculate the maximum temperature increase in one of the germanium crystals caused by a 1200 MeV neutrino.

temperature increase = ... K **[3]**

The majority of candidates correctly calculated the change in temperature. Some candidates did not know the correct conversions of g into kg and MeV into J, resulting in power of ten errors.

Question 35 (b)

(b) The graph shows how the specific thermal capacity of germanium varies with temperature.



Suggest a reason for operating the neutrino detector at a very low temperature.

....

....

.... **[1]**

Some candidates were able to explain that at lower temperatures there would a larger change in temperature detected due to the lower specific thermal capacity. Many candidates said that there would be a large proportion of temperature change but did not explain why this would occur.

Section C overview

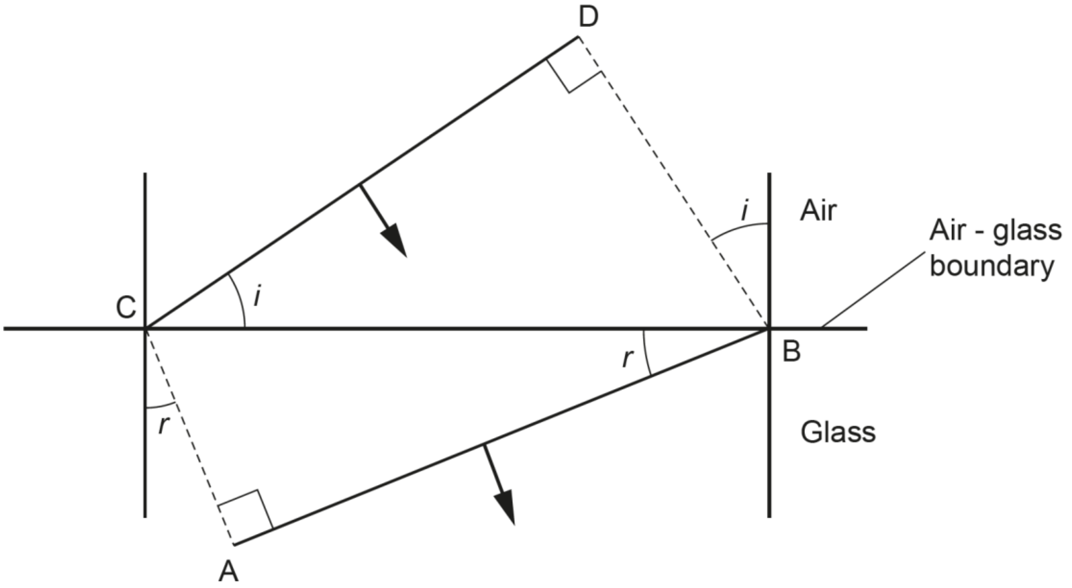
This section consisted of five questions worth 53 marks in total.

Question 36 (a) (i) and (ii)

36

(a) A student studies the refraction of light as it passes from air to glass using the wave model of light.
Before reaching the air-glass boundary the wavefronts AB and CD are parallel to each other.
Fig. 36.1 shows the wavefronts after AB has entered the glass.

Fig. 36.1



In the diagram:

- CD strikes the surface a time Δt after AB has entered the glass
- i is the angle of incidence and r is the angle of refraction.

(i) Explain why the length DB is greater than the length CA in **Fig. 36.1**.

....

.... **[1]**

(ii) The student measures the distances DB and CA on a scale drawing.

DB = 4.5 cm

CA = 3.0 cm

Use this data to calculate the refractive index of the glass.

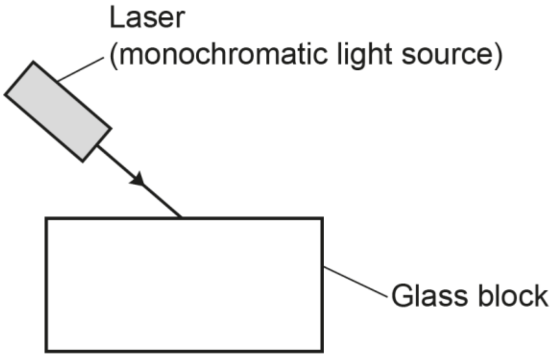
refractive index = ... **[2]**

Almost all students were able to correctly explain that light travelled slower in the glass than air in part (a) (i). Some students omitted the lengths of DB, CA and BC resulting them not being given the first mark for part (a) (ii).

Question 36 (b)*

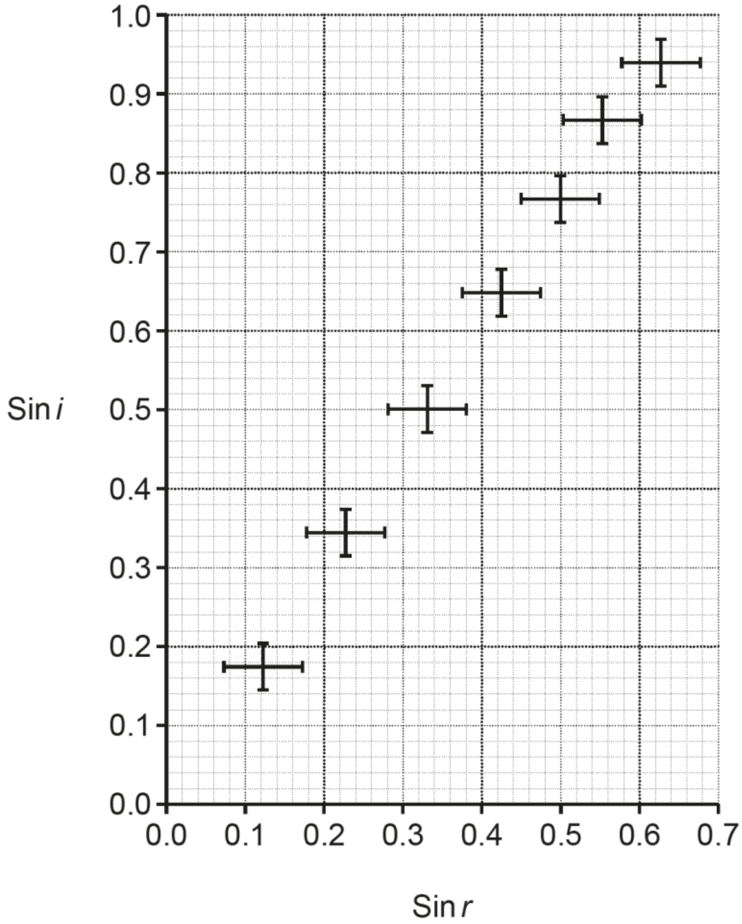
(b)* A student carries out an experiment to determine the refractive index of a glass block using the apparatus shown in **Fig. 36.2**.

Fig. 36.2



The graph in **Fig. 36.3** shows the results of the experiment.

Fig. 36.3



The student believes that the block is made from either crown glass or flint glass.
The table gives information about these two types of glass.

Type of glass	Refractive index
crown glass	1.50–1.54
flint glass	1.60–1.62

Using data from **Fig. 36.3** and the table, determine whether the block is made from crown glass or flint glass.

Include calculations of the uncertainty in your value.

Comment on the validity of your conclusion.

....

....

....

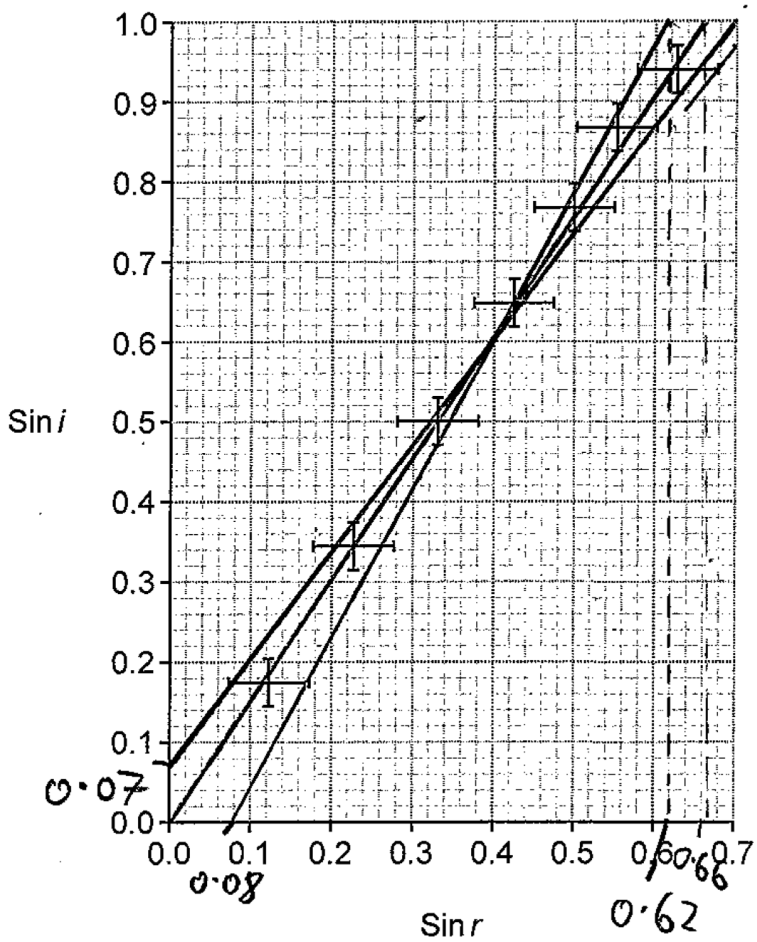
....

....

.... **[6]**

This question expected candidates to calculate the refractive index of a block, including the uncertainty, to then conclude which glass it was most likely to be. To do this, candidates needed to draw an appropriate line of best fit as well as lines of worst fit for maximum and minimum gradient.

Exemplar 1



refractive index = $\frac{\sin i}{\sin r}$ = gradient of graph.

• Line of best fit: $n = \frac{1}{0.66} = 1.52$

• Line of steepest fit: $n = \frac{1}{0.62 - 0.08} = 1.85$

• Line of shallowest fit: $n = \frac{1 - 0.07}{0.7} = 1.33$

• Range = $1.52 - 1.33 = 0.19$ $\frac{1}{2}$ range = 0.10

Therefore refractive index = 1.52 ± 0.10

This suggests that the material is likely crown glass (centre of range) but could be either as they both fall within the **[6]**

Extra answer space if required.

calculated range.

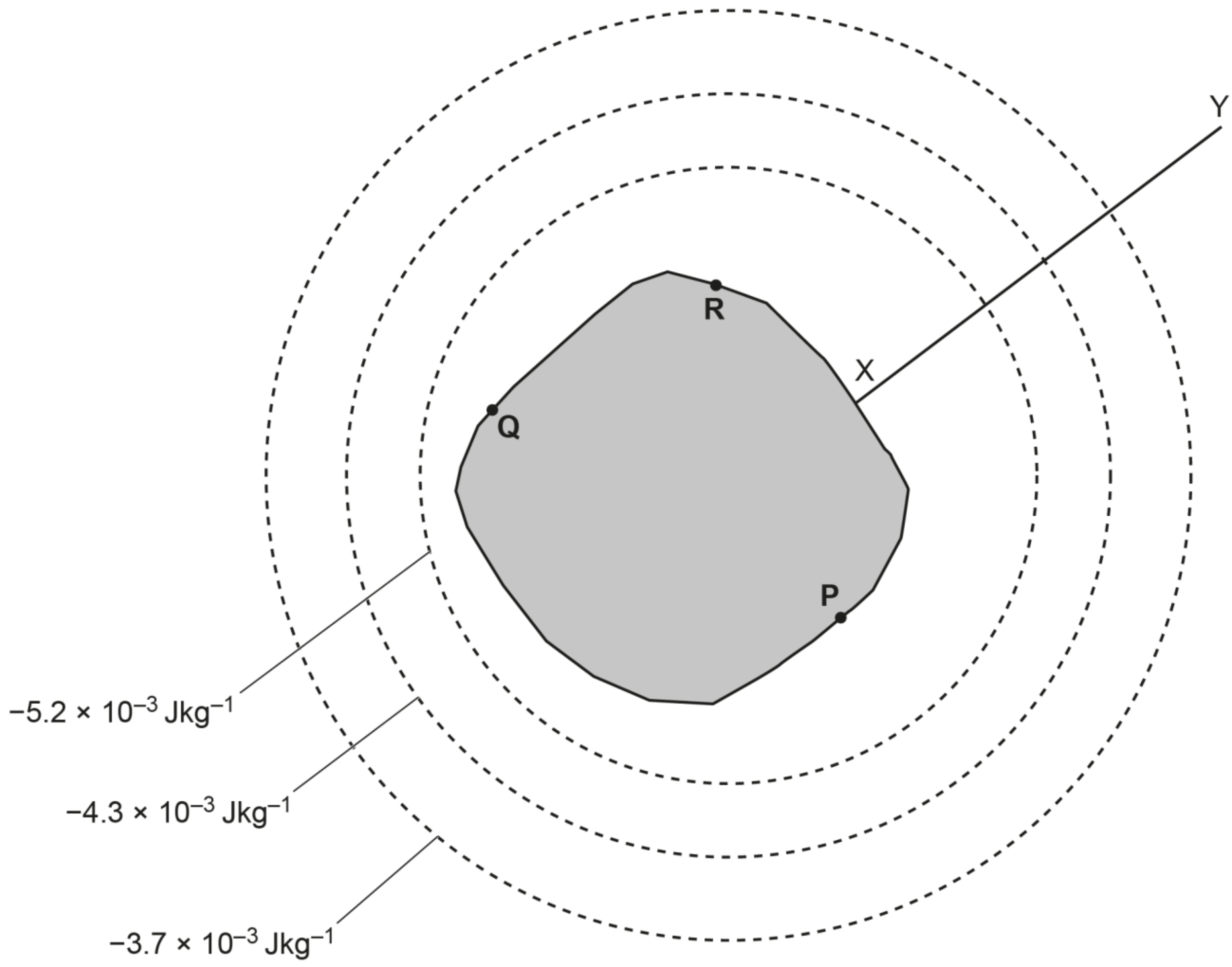
This response has three clearly drawn appropriate lines of fit. The candidate has correctly taken readings from over half their lines of fit and made a final conclusion. Their values did not fall within the gradients provided and as such could not achieve Level 3 where it states, 'Covers all strands fully and **accurately**.'

Question 37 (a) (i)

37 In September 2016 NASA sent the Osiris-Rex spacecraft to intercept and study the comet Bennu. To prepare for the mission, scientists developed models of Bennu.

Fig. 37.1 illustrates one simple model, in which a number of gravitational equipotential surfaces are shown, centred on the centre of mass of the comet.

Fig. 37.1



(a)

(i) On **Fig. 37.1 draw one** gravitational field line that starts from the point **P** on the surface of Bennu. **[2]**

The majority of candidates correctly drew a straight line from the surface of Bennu out at 90° to the lines. Some candidates omitted the arrow from the field line or drew it facing out rather than towards the surface.

Question 37 (a) (ii)

(ii) For the spacecraft to travel at a constant height above Bennu from **R** to **Q**, requires a thrust from its engines.

Explain why a thrust is needed.

....

....

....

....

....

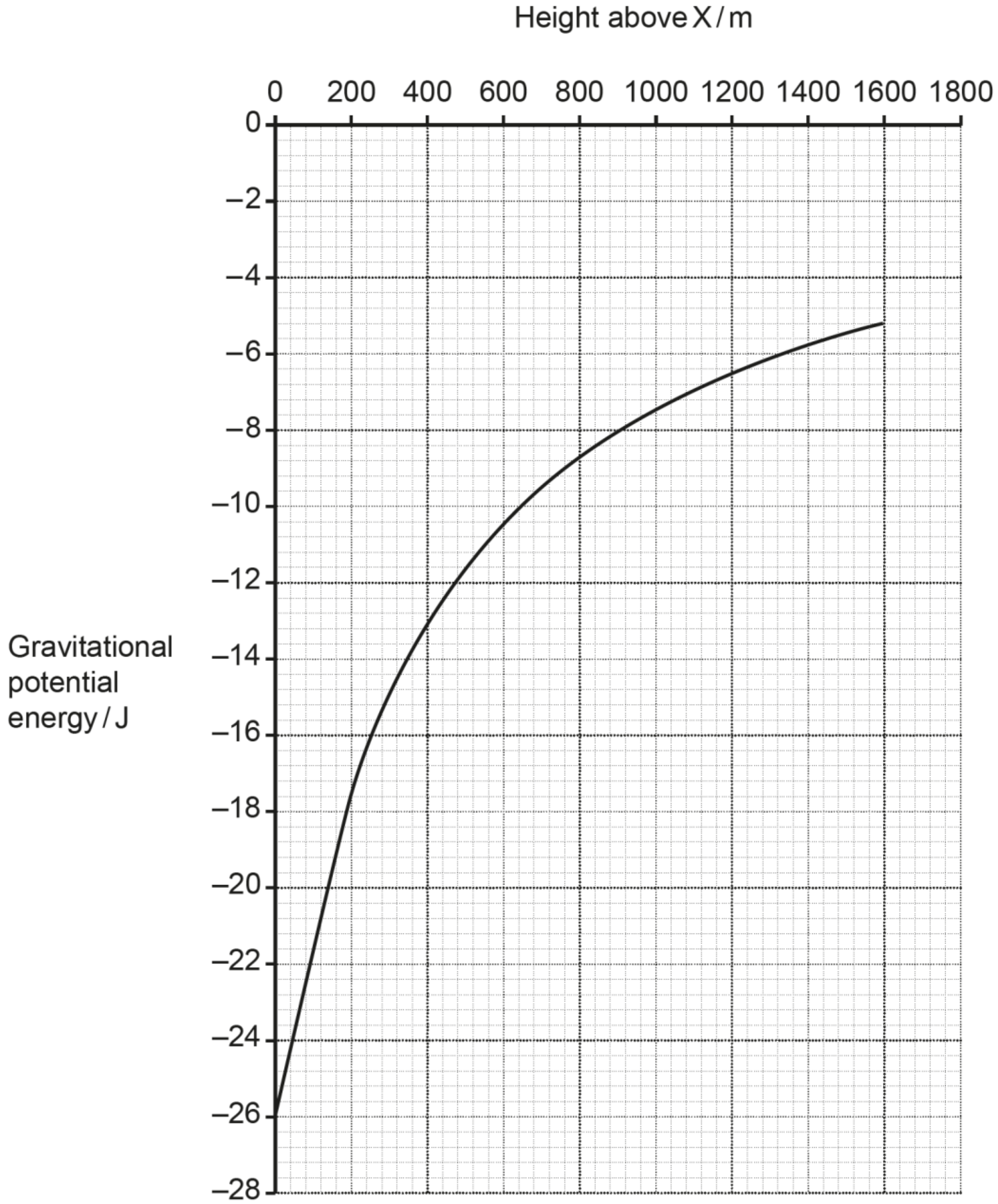
.... **[2]**

Many candidates did not observe or explain that the equipotential lines were not parallel to the surface of Bennu and hence going from R to Q parallel to the surface would result in a change in the equipotential value. Some candidates incorrectly explained how thrust would be needed to leave the surface of Bennu rather than stay parallel to the surface.

Question 37 (b) (i)

(b) The graph in **Fig. 37.2** shows how the gravitational potential energy of the Osiris-Rex spacecraft varies with height above point X on the surface of Bennu along the line XY.

Fig. 37.2



(i) Use the graph in **Fig. 37.2** to calculate the gravitational force on the spacecraft when it is 600 m above the surface.

force = ... N **[4]**

Few candidates successfully drew a tangent at the appropriate position and so that it only touched at 600 m. Some candidates omitted the tangent and attempted to calculate the gravitational using a single point.

For those that drew a tangent, some candidates did not take readings correctly and the most successful candidates took readings where their tangent intercepted the x and y axis.

Question 37 (b) (ii)

(ii) At the time of its departure from Bennu the Osiris-Rex spacecraft is orbiting 400 m above Bennu.

Calculate the velocity required to escape the gravitational field of Bennu from this height.

Mass of the spacecraft = 2000 kg.

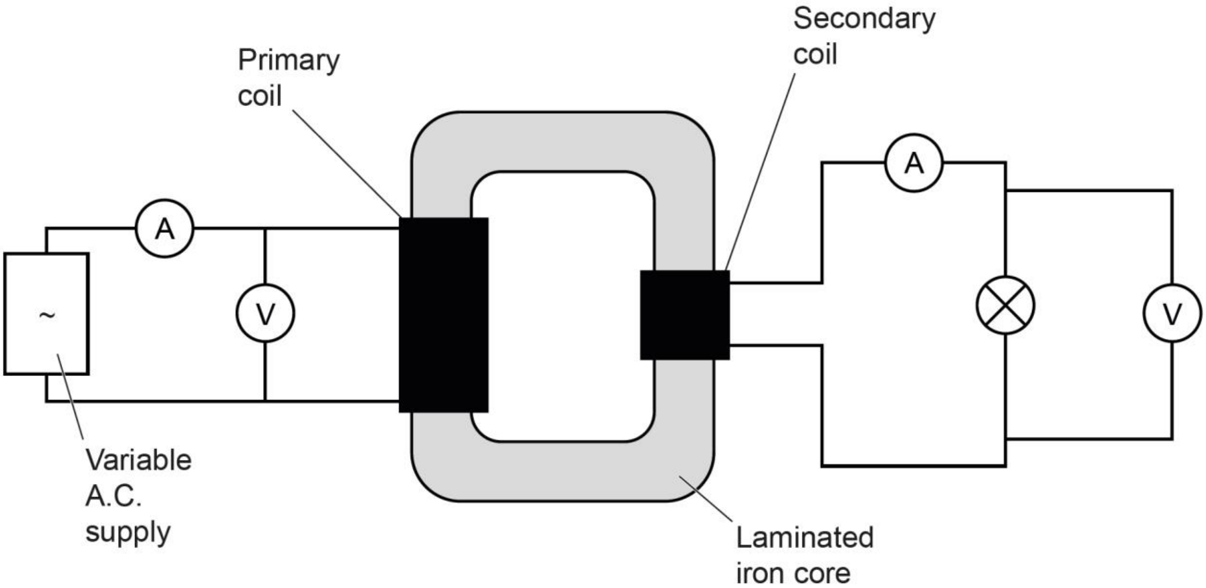
velocity = ... $m\,s^{-1}$ **[3]**

The candidates that successfully answered this question recognised that values would need to be read off of the graph to then be substituted into the kinetic energy equation.

Question 38 (a)

38 Students investigate the action of a transformer. **Fig. 38.1** shows the apparatus used in the investigation.

Fig. 38.1



The students keep the secondary coil the same and change the number of turns on the primary coil. They then adjust the variable A.C. supply to make the filament lamp operate at normal brightness.

(a) The filament lamp connected to the secondary coil is rated at 3 V, 0.6 W.

In one experiment the number of turns on the primary coil is 400 and the number of turns on the secondary coil is 50.

Calculate the potential difference across the primary coil and the current through it when the filament lamp is operating normally.

Assume the transformer is ideal.

potential difference = ... V

current = ... A

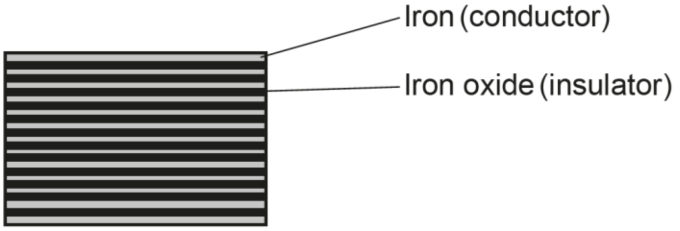
[5]

Many candidates appeared unfamiliar with transformer equations. Those that were, and showed any working, correctly calculated the potential difference to be 24 V. Some candidates then successfully substituted this into $P = IV$ knowing that the power is the same for both coils.

Question 38 (b)

(b) **Fig. 38.2** shows an enlarged top view of the top section of the laminated core.

Fig. 38.2



Explain how the laminations make the transcformer more efficient.

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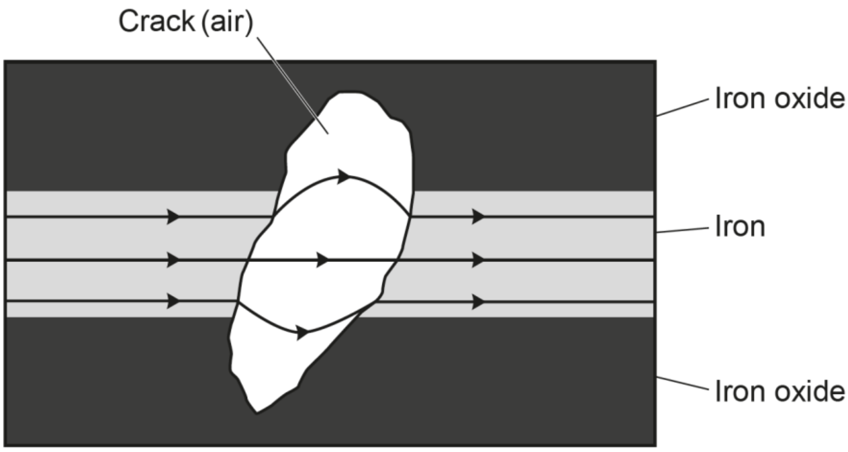
.... **[3]**

Many candidates correctly understood that the transformer would produce eddy currents and that the laminations would reduce their formation, which would lead to less heat being produced, which was given 2 marks. Many candidates did not explain further about how eddy currents were formed to get the 3rd mark.

Question 38 (c)

(c) In practice the transformer is not ideal and the students find that the values of the potential difference across the primary coil and the current in it are significantly higher than those calculated in part **(a)**.
The students think that this may be caused by small cracks in the core. **Fig. 38.3** shows one such crack and the effect it has on the magnetic field in the core.

Fig. 38.3



Explain how a large number of such cracks reduces the efficiency of the transformer.

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....

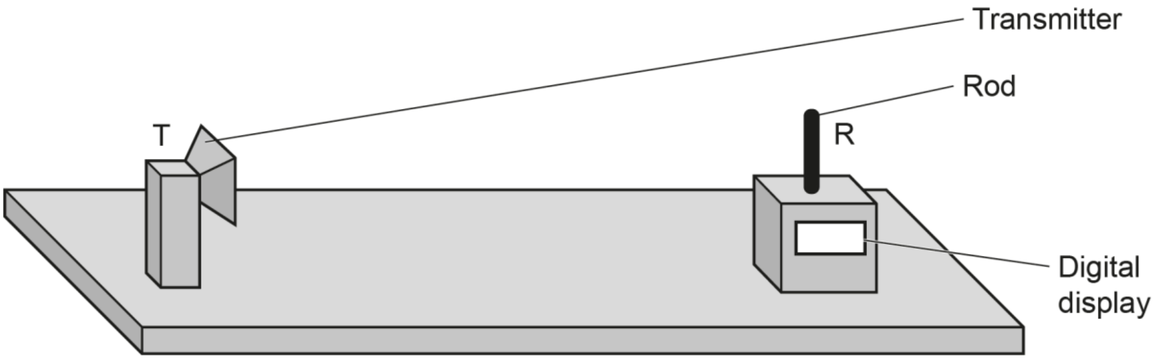
.... **[3]**

Many candidates correctly stated that air has a lower permeability than iron for the first mark. They did not then go on to explain how flux density and rate of change of magnetic flux were affected.

Question 39 (a)

39 **Fig. 39.1** shows the apparatus used by a student to investigate the properties of microwaves. The microwaves from transmitter T are detected by the vertical metal rod R and their intensity is shown on the digital display.

Fig 39.1



(a) Explain how the apparatus can be used to test if the microwaves from T are polarised vertically or horizontally.

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.... **[2]**

Some candidates correctly identified that when rotated there would be minimum and maximum values and that when there was a maximum this would be the plane of polarisation.

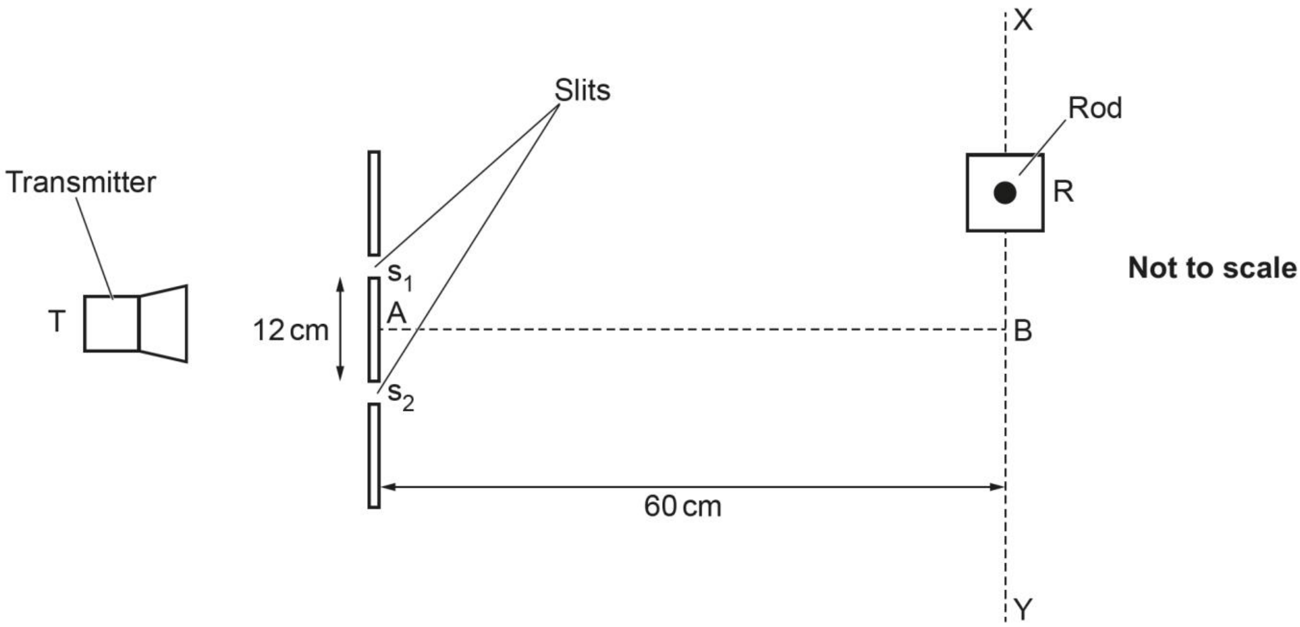
The majority of candidates added apparatus to be able to test the polarisation when the question asks 'Explain how the apparatus can be used…'

Very few candidates correctly identified the plane of rotation for the rod which is required to be able to identify the plane of polarisation.

Question 39 (b) (i) and (ii)

(b) The student then investigates the interference of microwaves. **Fig. 39.2** shows the experiment viewed from above.

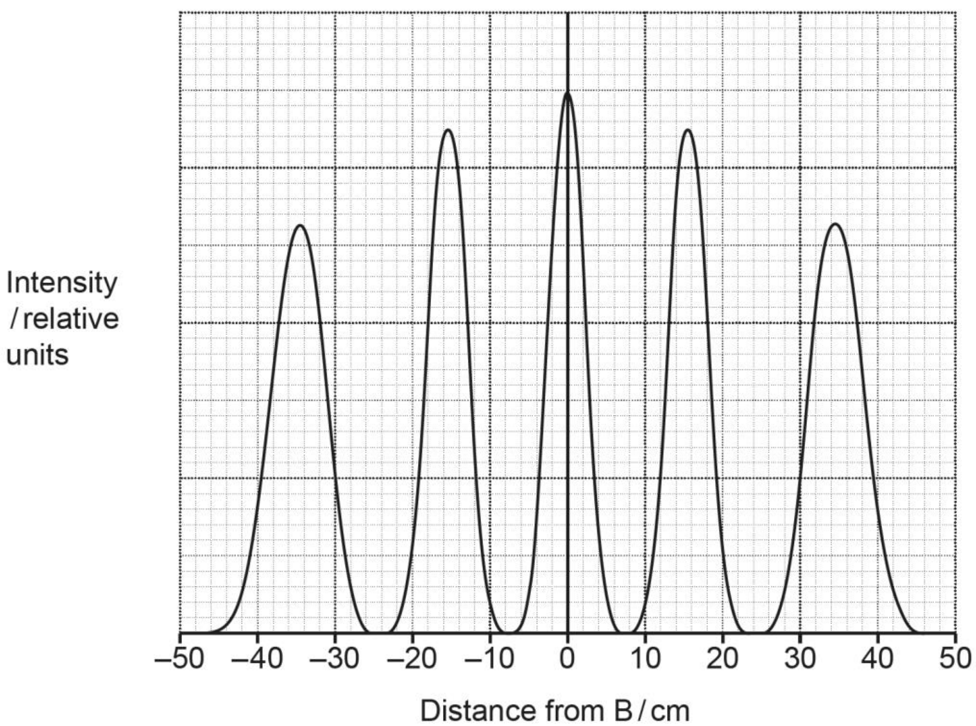
Fig. 39.2



- The microwaves emitted from T are incident on two slits, s_1 and s_2, which then act as coherent sources.
- The slits are 12 cm apart and point A is mid-way between them.
- R is initially placed at point B, directly opposite point A, and 60 cm from point A.
- The receiver and rod R are then moved along the straight line XY at 90° to the line AB.

Fig. 39.3 shows how the intensity of the microwaves detected by R varies with the distance of R from the point B.

Fig. 39.3



(i) Use information from **Fig. 39.2** and **Fig. 39.3** to show that the wavelength of the microwaves is about 3 cm.

[3]

(ii)* The graph has peaks of decreasing amplitude either side of the central peak.

Explain these features using **either** the wave model **or** the particle model.

....

....

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....

....

.... **[6]**

This question required candidates to explain how interference results in maximum and minimum intensity and to explain how the intensity of maximum reduces symmetrically from the central maximum. Candidates could choose to do this by either explaining this in terms of the wave model or photon model.

Exemplar 2

Using the wave model, the microwaves are diffracted from the slits, so they are coherent with a constant phase difference. When the light reaches the line XY, light from both sources can superpose and interfere. If they arrive with a path difference of ~~n wavele~~ integer multiples of wavelength or a phase difference of 2nπ, they can constructively interfere and produce maximum intensity. ~~When they~~ Conversely, when they arrive with a path difference of ½ of a wavelength, or phase difference of π, they can destructively interfere and cause minimum intensity.

The amplitude decreases as intensity of light decreases the further the you are from B as distance travelled by the light increases. Light acts as a point source so intensity follows the inverse square law, so the further away from the slits the lower the intensity of light.

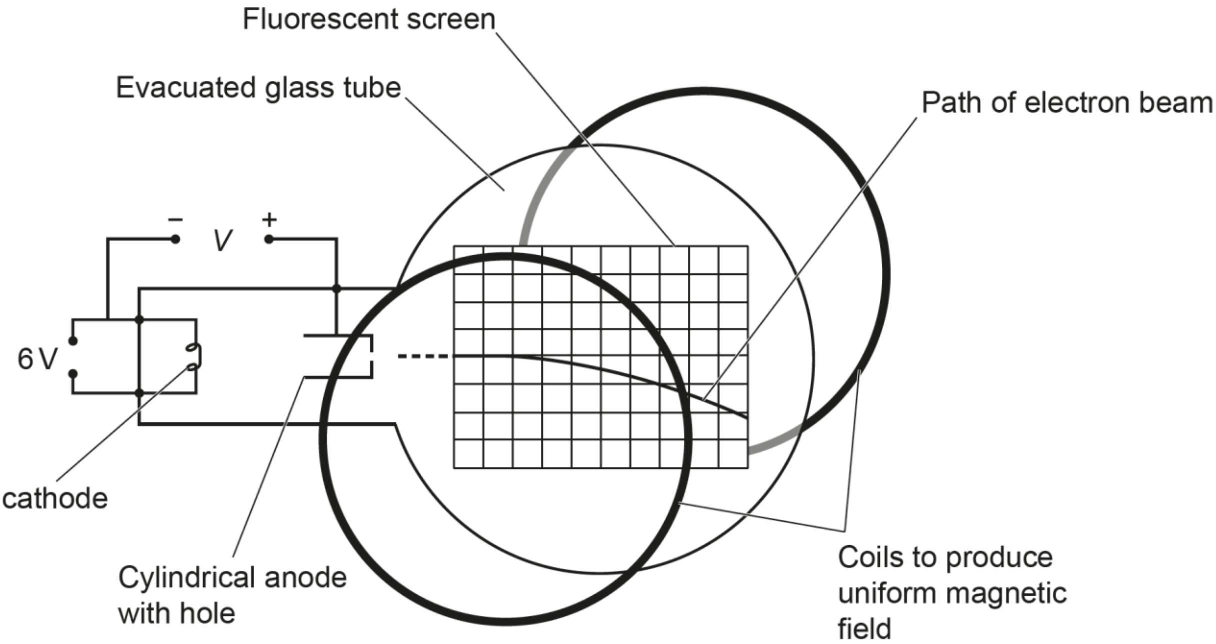
This candidate chose to explain the phenomena using the wave model. The candidate successfully explained diffraction, constructive and destructive interference, and that intensity follows the inverse square law. This response covers all strands well to be given a mark in the Level 3 response band and is written with a good logical and well-developed line of reasoning therefore the higher mark – 6 – was given.

Question 40 (a) (i)

40

(a) **Fig. 40.1** shows apparatus that can be used to determine the charge to mass ratio of the electron $\frac{e}{m_e}$.

Fig. 40.1



- Electrons are emitted by the cathode and then accelerated through the hole in the anode by a large potential difference V to form an electron beam.
- The fluorescent screen shows the path of the beam.
- A uniform magnetic field is applied perpendicular to the beam by the two coils.
- The deflection of the electron beam is observed on the screen.

(i) The electrons in the beam are accelerated through a potential difference V. When they enter the magnetic field of flux density B they follow a circular path of radius r.

Show that the charge to mass ratio of the electron is given by:

$$\frac{e}{m_e} = \frac{2V}{B^2 r^2}$$

Consider:

- the kinetic energy of the electrons
- the force due to the magnetic field which deflects them in a circular path.

[2]

The few candidates that were successful correctly identified $eV = \frac{1}{2}mv^2$ and $Bev = \frac{mv^2}{r}$ as the two sets of equations to start. Candidates then clearly laid out their working and substitutions so that they were easy to follow to the equation given in the question.

Question 40 (b) (ii)

(ii) Calculate the charge on the oil drop.

Use data for the oil drop when it is stationary.

charge = ... C **[3]**

Few candidates were able to identify that they had to use the equation $V\frac{q}{d} = mg$. If candidates correctly identified the equation then they were usually successful in substituting the values into the equation from earlier in the question.

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