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Examiners' report

GCSE

TWENTY FIRST CENTURY SCIENCE PHYSICS B

OCR Level 1/Level 2 GCSE (9-1) in Physics B (Twenty First Century Science)

J259

For first teaching in 2016

J259/03 Summer 2025 series

Version 1

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.

Paper 3 series overview

J259/03 Breadth in Physics is one of the two examination units aimed at Higher Tier candidates studying the GCSE (9-1) Twenty First Century Science Suite.

The nine questions of this 90-mark paper assess knowledge and understanding from all six chapters of the syllabus, Practical Skills (Question 1 – determining a distance, Question 4 – reflection and dispersion, Question 6 – how a speaker works) and ideas about science (Question 2 (b) (i), (ii) – theories about fission, Question 5 (c) – the handling of a radioactive artefact).

Questions 1 to 3 are overlap questions which appear in identical form on the Foundation tier paper. In common with previous qualifications, approximately 50% of the marks were given for demonstrating knowledge and understanding of scientific ideas, techniques and procedures, 30% for applying that knowledge to solve problems and 20% for analysing information, drawing conclusions and improving experimental procedures. Approximately 30% of the marks are for simple and developed calculations (Questions 1 (a) (i), (1) (a) (ii), 1 (c), 3 (b), 4 (d), 5 (b) (i), 5 (b) (ii), 6 (b) (iii), 8 (b) (i), 8 (d), 9 (b)).

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• converted data into appropriate units, e.g. Questions 1 (a) (ii) – minutes to seconds; 6 (b) (iii) – cm to m; 8 (b) (i) – Pa to kPa • applied a range of mathematical skills, for example Questions 1 (c) – determining acceleration from a speed–time graph; 3 (b) – recording in standard form; 4 (b) – multiplied numbers in standard form; 5 (b) (i) and (ii) – decayed fraction and remaining activity following half-lives • applied knowledge of the outcomes of practical work, e.g. Questions 4 (a) – reflection of a ray of light in a plane mirror; 4 (c) – dispersion of white light by prism; 6 (b) (iv) – modifications to increase the size of magnetic force; 7 (a) – the component require to produce a d.c. output • showed precision when drawing or drawing on diagrams, for example Questions 4 (a) – rulers and protractors used for the reflected ray; perpendicular normal and angles *i* and *r* ; 5 (a) – construction lines on the graph to determine half-life; 6 (a) - correct understanding of radii to indicate the field lines • used calculations and other data to support conclusions, for example Questions 2 (a) (i) and (ii) – selected data from the table; 5 (c) – a reference to activity and use of the graph, when explaining the hazard; 8 (e) (i) – to explain trends in volume and density; 8 (e) (ii) – to explain sinking.	• did not appear to make full use of the information provided, for example Questions 1 (a) (ii) – using minutes when the answer line unit is m / s; 2 (b) (i) and (ii) – not referring to the table of information; 8 (d) – multiplying mass and volume when the unit is kg / m^3; 8 (e) (i) – describing trends but not explaining them • did not appear to make use of the scientific vocabulary in the question stem to make links, for example Questions 6 (b) (i) – no reference to magnetic field when shown a diagram with a magnet and asked about force; 6 (b) (ii) – no reference to vibration when asked about sound; 9 (a) (iii) – no reference to changing velocity when asked about acceleration • did not appear to be aware of necessary unit conversions • did not appear to consider the plausibility of some calculations, for example Questions 1 (a) (ii) – a canal boat moving at 67 m / s; 5 (a) – a half-life in negative years; a force of 1.8 N (or more) on a very short wire with a tiny current; 8 (d) – a density that implies a penguin with a volume of more than 25 m^3.

Question 1 (a) (i)

1 A boat makes a journey along a canal.

Fig. 1.1 shows part of the canal **drawn to scale**.

The boat travels from **A** to **C** via **B**.

Fig. 1.1

(a) The distance travelled from **A** to **C** is 5000 m.

(i) Find the distance from **A** to **B**.

Use:
- **Fig. 1.1**
- a ruler.

Distance from **A** to **B** = ... m **[2]**

Almost all candidates used their length measurement to find A–B as a proportion of the total distance.

Question 1 (a) (ii)

(ii) When the boat leaves **A**, the time is 09:23.
When the boat reaches **B**, the time is 09:53.

Calculate the average speed of the boat for its journey from **A** to **B**.

Use the Equation Sheet.

Give your answer in **m/s**.

Average speed = ... m/s **[3]**

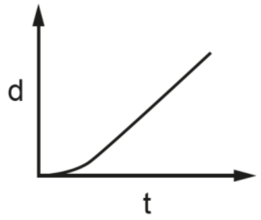
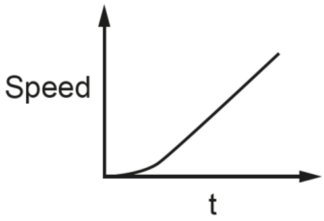
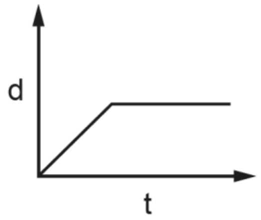
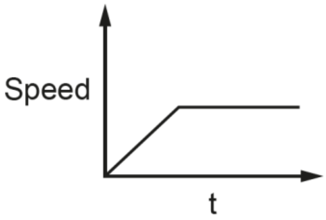
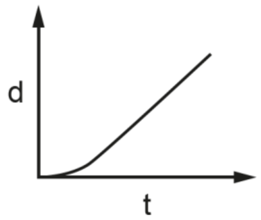
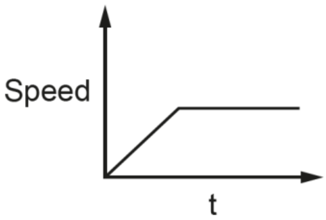
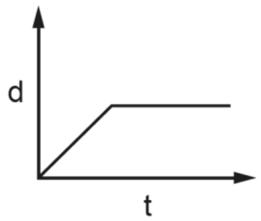
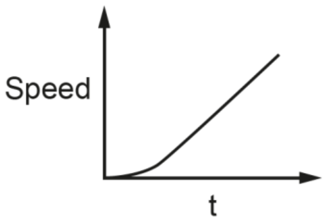
Almost all candidates determined a time of 30 minutes and converted to seconds. They determined the average speed using $v = \frac{s}{t}$ and their distance from part (a) (i).

Question 1 (b)

(b) The boat sets off from **A** at constant acceleration and then reaches a constant speed.

Which row in the table shows the correct distance-time graph **and** speed-time graph for the motion of the boat from **A**?

Tick (✓) **one** box.

Distance-time	**Speed-time**	
		☐
		☐
		☐
		☐

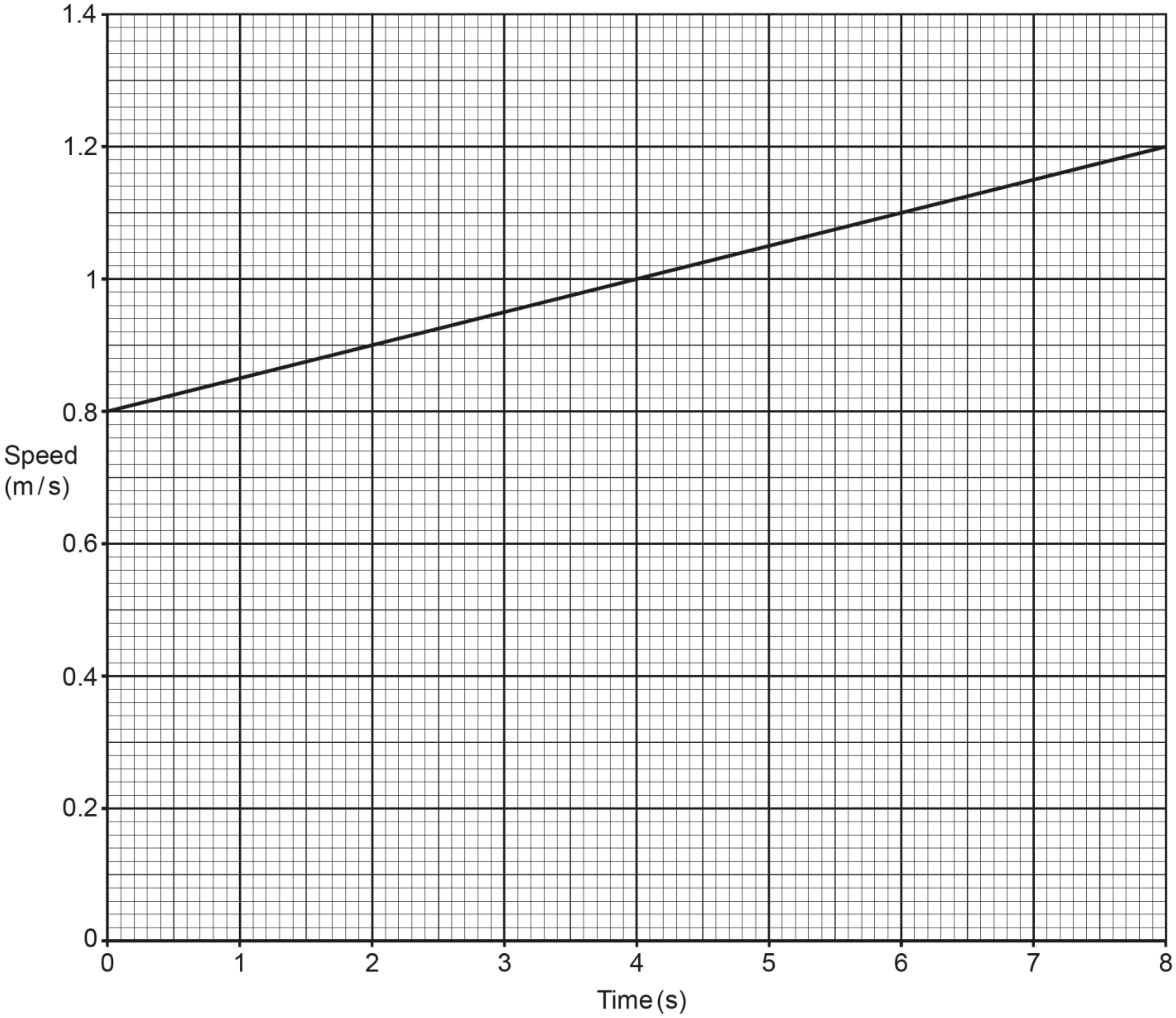
[1]

Almost all candidates checked the box in row 3.

Question 1 (c)

(c) **Fig. 1.2** shows the speed–time graph for the boat for a short period.

Fig. 1.2



Calculate the acceleration of the boat.

Use **Fig. 1.2**.

Acceleration = ... m/s^2 **[3]**

Almost all candidates used the graph appropriately to determine a speed increase from 0.8 to 1.2 in a time of 8 s and use $a = \frac{v-u}{t}$ to find the acceleration. Most candidates indicated their method using triangles or coordinates on the graph and substitution into the equation.

Question 1 (d)

(d) The boat has a force acting on it from the wind.

Which of these is a typical value for the speed of wind?

Tick (✓) **one** box.

0.12 m/s ☐

12 m/s ☐

1200 m/s ☐

120 000 m/s ☐

[1]

Most candidates checked the box in row 2.

Question 2 (a)

2 In the 1930s, scientists experimented with elements and split their nuclei.

(a) Complete the sentences about splitting the nucleus.

Use words from the list.

fission	**fusion**	**negative**
power	**stable**	**unstable**

The nuclei of certain elements can be split into two smaller nuclei because they

are ....

The process is called nuclear ....

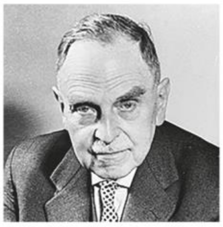
[2]

Almost all candidates selected unstable and fission to complete these sentences.

Question 2 (b) (i)

(b) The discovery that nuclei could be split developed over several years in the 1930s.

The table shows a timeline of some of the scientists involved and what they did.

Year	Scientist	What they did
1934	Enrico Fermi 	Fired neutrons at uranium nuclei which were captured by the uranium nuclei and made different elements. Fermi thought he created elements **heavier** than uranium.
1934	Ida Noddack Image of Ida Noddack, © shethoughtit.ilcml.com, She Thought It. Item removed due to third party copyright restrictions. Link to material - shethoughtit.ilcml.com/biography/ida-tacke-noddack/	Published a paper suggesting that Fermi's elements might be **lighter** than uranium. Her paper was ignored as she had no experimental data or theory.
1939	Otto Hahn 	Repeated Fermi's experiment and identified one of the elements that was made as the lighter element **barium**.
1939	Lise Meitner 	Calculated the energy changes for Hahn's data and confirmed that energy is **conserved** when splitting a uranium nucleus into a barium nucleus and another nucleus.

(i) Suggest why Enrico Fermi's hypothesis was believed in 1934.

....

.... **[1]**

Most candidates selected key information from the table and referred to the idea Noddack had no experimental data or that neutrons add mass. Question 1 candidates' responses tended to suggest reasons based on their own knowledge of nuclear fission.

Question 2 (b) (ii)

(ii) Explain why, by 1940, more scientists had confidence in the theory that nuclei can be split.

Use information from the table to support your answer.

[2]

Almost all candidates selected key information from the table and gained 1 mark usually for referring to additional data or experimentation. About a quarter of the candidates obtained both marks. Candidates were often unclear how the 'confidence' described in the stem of the question was related to the supporting evidence (presence of lighter nuclei, Meitner's calculations) for the theory of nuclear fission.

Exemplar 1

- there had been more scientific discoveries about it, increasing confidence.
- Hahn had found tangible evidence, as he now knew barium was one of the elements ~~to~~ nuclei could split into, confirmed by Meitner.

[2]

The candidate clearly uses information from the table and understands the idea of scientific confidence.

Question 2 (c)

(c) When uranium nuclei split, neutrons are released and a chain reaction happens.

Which statement correctly explains how a chain reaction happens?

Tick (✓) **one** box.

The neutrons released are absorbed by other uranium nuclei.	☐
The neutrons released contaminate the surroundings.	☐
The neutrons released link to form a chain.	☐

[1]

Almost all candidates checked the box in row 1.

Question 2 (d)

(d) Which **two** statements describe how the energy is released when uranium nuclei split?

Tick (✓) **two** boxes.

As kinetic energy of the new particles. ☐

As kinetic energy of the uranium nuclei. ☐

As potential energy of the new particles. ☐

By emission of infrared radiation. ☐

By emission of ionising radiation. ☐

[2]

About half the candidates scored both marks, for 1 mark they were most likely to check the box in row 5.

Question 3 (a)

3 A force is applied to a spring.

There is a linear relationship between the force and the extension of the spring.

(a) Complete the sentence to describe a linear force-extension relationship.

In a linear system, for each 1 N of force added, ...

....

....

.... **[2]**

Most candidates gained both marks. They recognised the need to define 'extension' relating the increased length of the spring. Some candidates simply assumed that the word extension needed no explanation and did not gain the first mark. Most candidates did, however, relate the term 'linear' to proportionality in some way.

Question 3 (b)

(b) A spring has a spring constant of 15 N / m.

Calculate the energy stored when its extension is 0.01 m.

Use the Equation Sheet.

Give your answer in **standard form**.

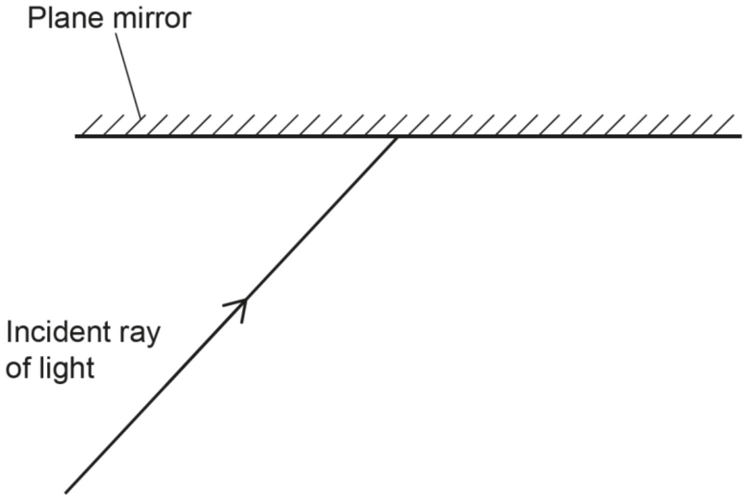
Energy stored = ... J **[4]**

Most candidates gained all 4 marks for this calculation and showed their working clearly in the space provided. Many candidates are methodically recording the equation and then substituting numbers in a new row below.

Question 4 (a)

4 Light and sound both travel as waves.

The diagram shows a ray of white light directed at a plane mirror.



(a) Draw on the diagram:

- the reflected ray of light
- the normal, labelled **N**
- the angle of incidence, labelled **i**
- the angle of reflection, labelled **r**.

[3]

Most candidates gained all 3 marks. Normal lines and reflected rays were generally drawn using rulers and at appropriate angles. A common error was to label the angles *i* and *r* between the mirror and the rays rather than the normal.

Question 4 (b)

(b) Which **two** of these words can be used to describe light waves?

Tick (✓) **two** boxes.

Compression ☐

Electromagnetic ☐

Longitudinal ☐

Radioactive ☐

Seismic ☐

Transverse ☐

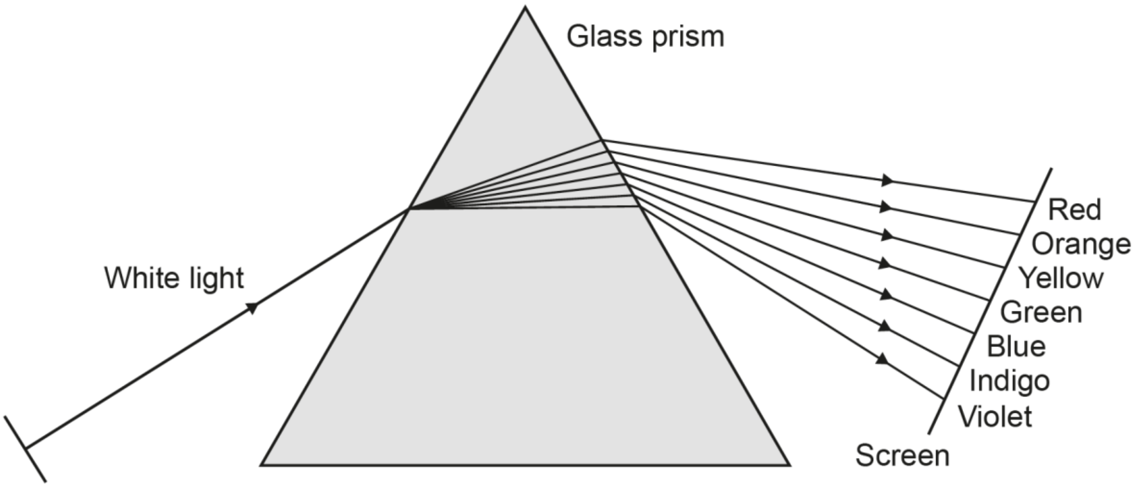
[2]

Most candidates gained both marks. If candidates gained only 1 mark it was usually for 'transverse'.

Question 4 (c)

(c) The diagram shows a ray of white light passing through a glass prism.

The white light is split into the spectrum of different colours.



Explain why the prism splits the white light into the spectrum of different colours.

[2]

This question discriminated strongly between candidates' performances. Many responses did not refer to frequency or wavelength even though these key wave terms are directly referred to in part 4 (d) where candidates calculated the speed of orange light using its frequency and wavelength in the prism.

Exemplar 2

• colours have different wavelengths
↳ red has highest violet lowest
• refract at different angles because different
wavelengths have different speeds **[2]**
• white light is combination of all colours

This response explains the differences in refraction angles.

Question 4 (d)

(d) An orange light wave has a frequency of 5.0×10^{14} Hz.

Its wavelength in the glass prism is 400×10^{-9} m.

Calculate the speed of the wave in the glass prism.

Use the Equation Sheet.

Speed of the wave = ... m/s **[3]**

Almost all candidates used the data to calculate the speed of the wave correctly.

Question 4 (e)

(e) Draw lines to connect each **medium** a sound wave is travelling in with its correct **speed**.

Medium	**Speed of sound wave**
Air	0 m/s
Steel	330 m/s
Vacuum	1500 m/s
Water	5000 m/s

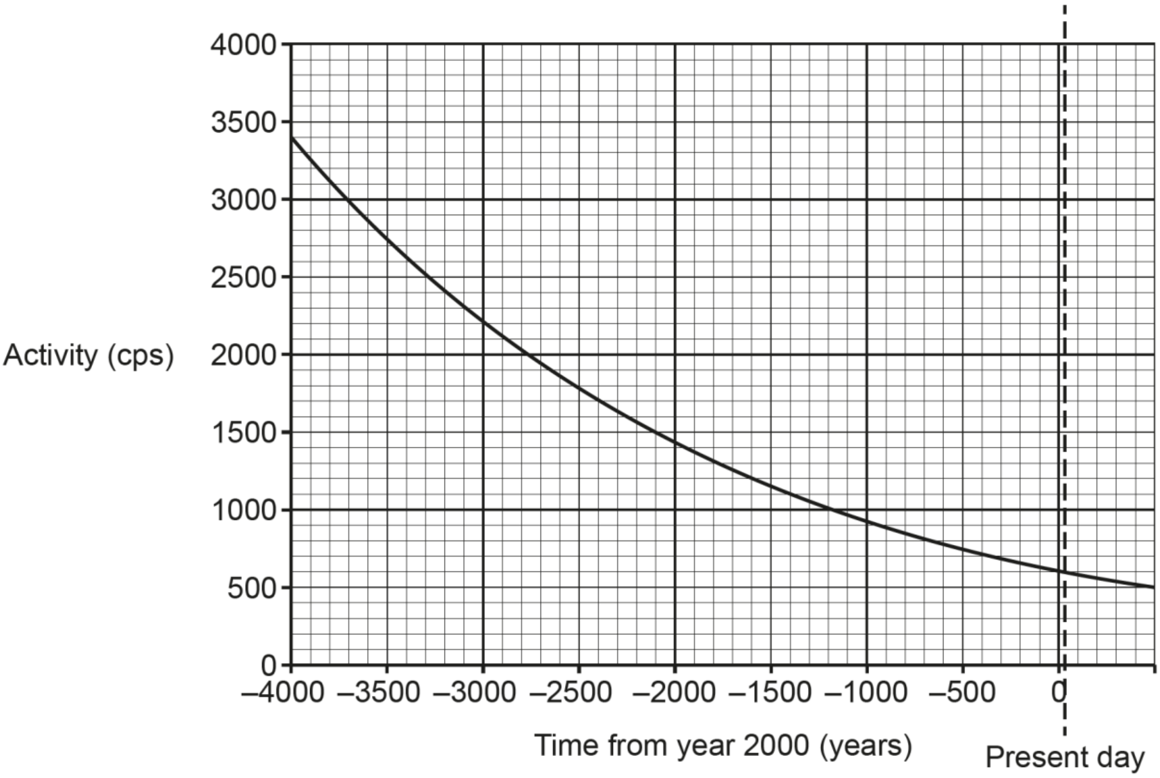
[3]

This question discriminated strongly between candidates. Candidates in each quartile show a similar steep increase in performance. Many responses suggest that candidates do not know that sound cannot travel in a vacuum.

Question 5 (a)

5 Marie Curie discovered radioactive elements by extracting them from their ores.
Her notebook became contaminated with radium and is still radioactive today.

The graph shows the activity of a sample of radium from approximately 4000 years ago until now.



(a) Find the half-life of radium.

Use the graph.

Half-life = ... years **[3]**

This question discriminated strongly between candidates. Many candidates gained 1 mark for halving the initial activity (3400 → 1700). This gives an x-intercept of –2400 years and many candidates recorded this value (often as a negative number) instead of 1600.

Assessment for learning

Ideas about Science (IaS) 2: What conclusions can we make from data?

The cycle of collecting, presenting and analysing data usually involves translating data from one form to another, mathematical processing, graphical display and analysis. Only then can we begin to draw conclusions.

Question 5 (b) (i)

(b) The radium that remains on Marie Curie's notebook has an activity today of around 600 cps.

(i) The activity of the radium that remains on the notebook will decrease in the future.

Calculate the activity of the radium that remains on the notebook after 3 further half-lives.

Activity = ... cps **[2]**

Almost all candidates gained 2 marks for three halvings from an initial 600 cps.

Question 5 (b) (ii)

(ii) Calculate the fraction of the number of nuclei that will decay in 3 half-lives.

Fraction = ... **[1]**

This question discriminated strongly between candidates. A common error was to record the remaining fraction ($\frac{1}{8}$). Some candidates divided the activity calculated in part (b) (i) by the initial activity (also $\frac{1}{8}$) rather than the corresponding reduction in activity ($\frac{7}{8}$).

Question 5 (c)

(c) Handling the notebook is hazardous to health.

Compare how hazardous handling the notebook was 100 years ago to how hazardous it is today.

[2]

Few candidates scored both marks on this question. Those that did clearly used the graph to justify the very small decrease in activity (less than 50 cps) posing a similar hazard. A few also recognised that 100 years is a tiny fraction of the half-life. Candidate responses indicate that many simply assumed that the notebook was more hazardous 100 years ago and made no reference to the data.

Assessment for learning

Ionising radiation is emitted from unstable nuclei as they decay - activity decreases as the number of undecayed nuclei decreases.

Candidates should learn that the activity of a source is associated with the hazard it presents.

Question 6 (a)

6 A permanent magnet and a coil of wire are used in a speaker as shown in **Fig. 6.1**.

Fig. 6.1

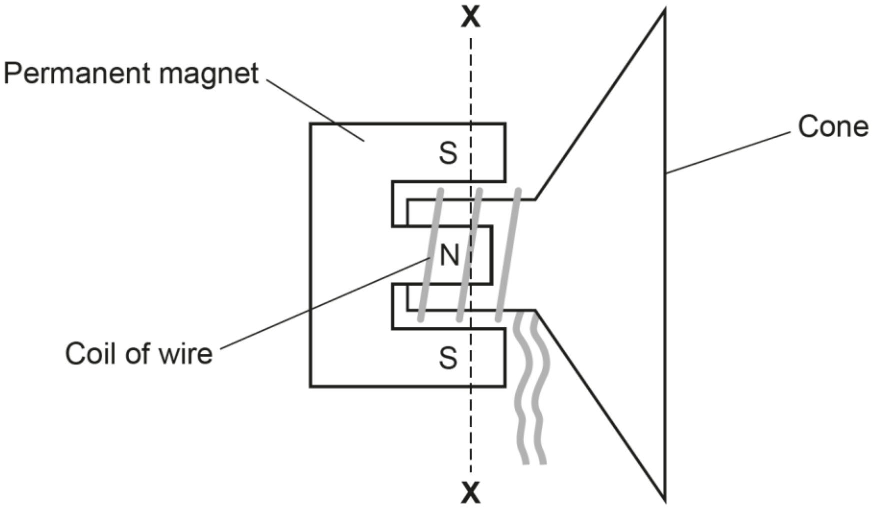
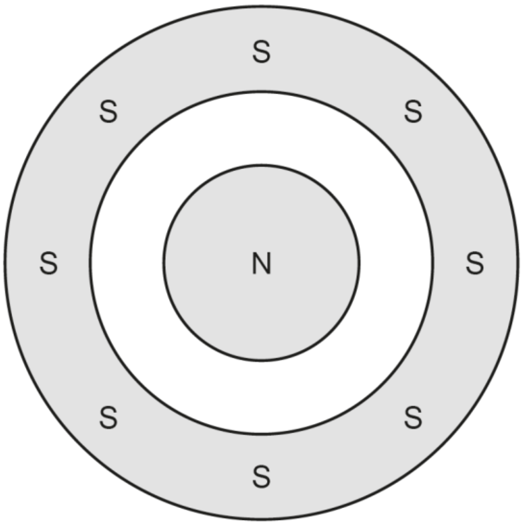


Fig. 6.2 shows a cross-section view of the permanent magnet along X–X.

Fig. 6.2



(a) Draw **four** lines to show the magnetic field of the permanent magnet on **Fig. 6.2**.

Include arrows to show the direction of the magnetic field of the permanent magnet.

[2]

This question discriminated strongly between candidates. Many responses showed confusion on the arrangement of magnets with the field lines around a single bar magnet. In this arrangement, the field direction is an undeviating straight line from N to S.

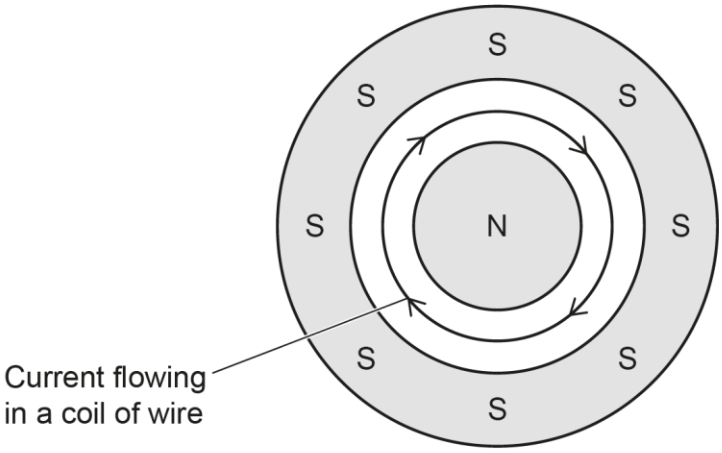
Misconception

There is a misconception that magnetic field lines must be curved.

Question 6 (b) (i)

(b) **Fig. 6.3** shows **one** coil of wire around the centre of the permanent magnet.

Fig. 6.3



When an alternating current flows in the coil of wire, the wire experiences a force.

(i) Explain why there is a force on the coil of wire.

....

....

....

....

....

.... **[3]**

This question discriminated strongly between candidates. Higher performing candidates were most likely to score more than just 1 mark. Some candidates did not refer to the presence of a magnetic field. Some candidates know that there is a magnetic field between N and S, as indicated in part (a) but did not clearly use the diagram to state that the current in the wire is in this field. There is also a misconception that the current is being induced in this situation.

Exemplar 3

The alternating current which flows in the coil of wire produces a magnetic field around the
coil, which ~~inte~~ ~~int~~ interacts with the magnetic field of the
magnet's magnetic field to produce a force on the coil of wire.

This answer gives a concise explanation.

Question 6 (b) (ii)

(ii) Explain how the force on the coil of wire produces sound from the speaker with the same frequency as the alternating current.

....

....

....

....

....

.... **[3]**

This question discriminated strongly between candidates. Higher performing candidates were most likely to score more than just 1 mark. Many did not score. Higher performing candidates were more likely to recognise in part (a) (i) that the alternating current has an alternating magnetic field (1). This changes the direction of the force (1) which vibrates the coil (1). Alternative marks could also be gained for recalling that sound is a longitudinal wave (1) produced by vibrations, e.g. the cone of the speaker (1).

Question 6 (b) (iii)

(iii) Calculate the force on the **one** coil of wire.

- The magnetic flux density is 1.2 T.
- The current is 0.3 A.
- The circumference of the coil of wire is 5 cm.

Use the Equation Sheet.

Force = ... N **[4]**

Most candidates were given 2 marks for selecting the relevant equation and substituting the data. Candidates familiar with this experiment or demonstration should know that 1.8 N is an implausibly high force for such a small current on such a short length of wire.

Question 6 (b) (iv)

(iv) Suggest **three** ways to increase the size of force on the coil of wire in the speaker.

1 ....

....

2 ....

....

3 ....

....

[3]

Most candidates scored more than one mark on this question. Frequent references to increasing magnetic flux density indicated that many candidates were correctly referring to the equation $F = BIl$ to guide their answer. A common error is to suggest increasing the voltage without referring to how this increases the current, or to suggest increasing the thickness or reducing the resistance of the wire in the coil – again, without explaining how this increases the current. Some candidates suggested increasing the turns and the length of the wire without realising this amounts to the same difference.

Using Physics equations

Physics equations are essential for carrying out calculations.

However, they are just as useful for identifying the key variables and how they affect each other when they are varied.

Question 7 (a)

7 An exercise bike is connected to a magnet which turns when the wheels go round.

When the exercise bike is ridden, the magnet turns inside a coil of wire.
This induces a potential difference in a circuit.

(a) What must the coil of wire be connected to so that a direct current is produced in the circuit?

Tick (✓) **one** box.

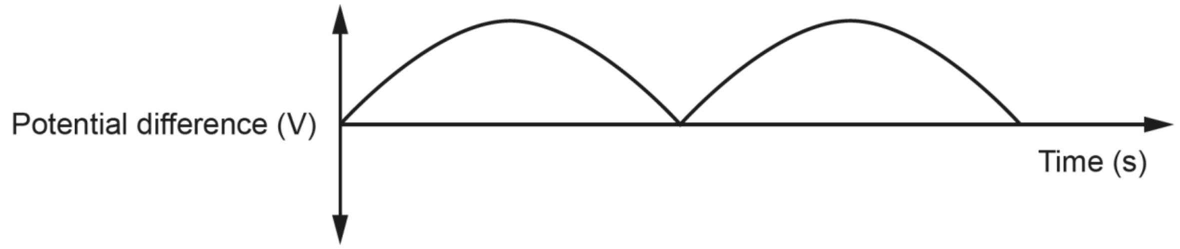
An ammeter	☐
A slip ring	☐
A split ring commutator	☐
A switch	☐

[1]

Most candidates gained the mark for checking the box in row 3.

Question 7 (b)

(b) The graph shows the potential difference-time graph for the exercise bike.



Which feature of the potential difference-time graph shows that a direct current is produced?

Tick (✓) **one** box.

The potential difference always has the same maximum value. ☐

The potential difference is always a positive value. ☐

The potential difference is zero each cycle. ☐

The potential difference varies with time. ☐

[1]

Most candidates interpreted the graph correctly and checked the box in row 2.

Question 7 (c) (i)

(c)
(i) Define a renewable energy resource.

....

.... **[1]**

Almost all candidates express that renewable energy sources will not run out. This is a familiar question and a familiar response that typically gains credit at GCSE.

Question 7 (c) (ii)

(ii) Explain whether the electricity produced by riding the bike has come from a renewable or non-renewable source.

....

....

....

.... **[1]**

Most candidates concluded that the electricity is produced by a renewable source (the rider) explaining that human's 'won't run out'.

Question 8 (a)

8 Emperor penguins dive very deep in the sea.

(a) Explain why the pressure on an object increases as its depth in the sea increases.

Use ideas about forces in your answer.

....

....

....

.... **[2]**

A few candidates gained more than on mark on this question. There were many vague answers that did not clearly describe the force due to the increasing weight of water above the penguin or pushing down on the penguin. The candidates gaining both marks used the equation linking force and pressure and recognised that the area of the penguin is a constant.

Question 8 (b) (i)

(b) An emperor penguin dives to a depth of 400 m.

(i) Calculate the pressure on the penguin.

- The approximate density of seawater is 1020 kg / m^3.
- The gravitational field strength is 10 N / kg.

Use the Equation Sheet.

Give your answer in **kPa**.

Pressure = ... kPa **[4]**

Almost all candidates gained at least 3 marks for this calculation of pressure using $p = \rho g h$.

Question 8 (b) (ii)

(ii) Colder water has a higher density.

Explain the effect on your answer to **(b)(i)** if the penguin still dives to 400 m but the water is colder.

....

....

....

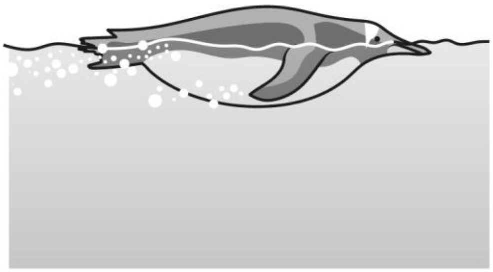
.... **[2]**

Almost all candidates gained 1 mark for stating that the pressure will be higher. However, the equation $p = \rho g h$ can be used descriptively. In this regard the phrase 'still dives to 400m' means that h doesn't change and, to gain the mark, neither does g.

Question 8 (c)

(c) **Fig. 8.1** shows an emperor penguin partially submerged on the surface of the water.

Fig. 8.1



Explain why the water exerts a net force upwards on the penguin.

....

....

....

.... **[2]**

Relatively few students scored marks on this question. Many tried to explain why the penguin was floating, rather than explain the cause of the upwards force.

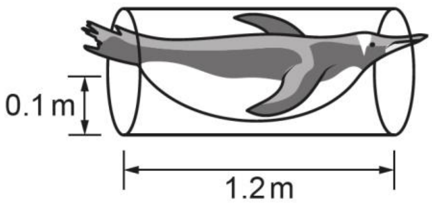
There is a common misconception that Newton's third law applies. However, upthrust, due to the weight of the displaced water, is a different type of force to the weight of the penguin due to the effect of gravity on its mass.

In this situation the weight of the displaced water produces upthrust which acts on the lower surface area of the penguin. It is a net force upwards because it is more than the weight of the atmosphere acting on the upper surface area of the penguin. When the weight due to gravity of the penguin is considered, it explains where there is no vertical movement.

Question 8 (d)

(d) **Fig. 8.2** shows how the volume of a penguin can be modelled as a cylinder.

Fig. 8.2



Calculate the density of the penguin when it is modelled as a cylinder as shown in **Fig. 8.2**.

The mass of the penguin is 25 kg.

Use:
- the equation: volume of a cylinder = $\pi r^2 l$, where r is the radius and l is the length of the cylinder
- the Equation Sheet.

Density = ... kg/m^3 **[3]**

Almost all students calculated the density correctly for 3 marks.

Question 8 (e) (i)

(e) When an emperor penguin dives deeper into the sea, air sacs in its body compress.

The table shows the body volume and body density for an emperor penguin at increasing depths.

Depth (cm)	Body volume of penguin (m^3)	Body density of penguin (kg/m^3)
72	0.028	893
84	0.027	925
96	0.023	1087
108	0.022	1136
120	0.021	1190

(i) Explain the trends in the data shown in the table.

....

....

....

....

....

.... **[3]**

Almost all students gained 1 mark for describing one of the three trends in this data. Many candidates described more than one trend. Many also quoted data in a simplistic way (*x* number is bigger than *y* number).

Some attempted to explain decreasing volume with reference to the compression of the air sacs. However, candidates need to add additional detail when re-stating information from the stem of the question. They needed to refer to the air inside the air sacs being compressed. Some candidates used the density equation to explain the increase with respect to decreasing volume. Again, this is insufficient at this level. They needed to refer to the mass of the penguin being constant.

Question 8 (e) (ii)

(ii) Explain why the penguin will sink at a depth of 100 cm if it is **not** swimming.

Use the data in the table.

The approximate density of seawater is 1020 kg / m^3.

....

....

....

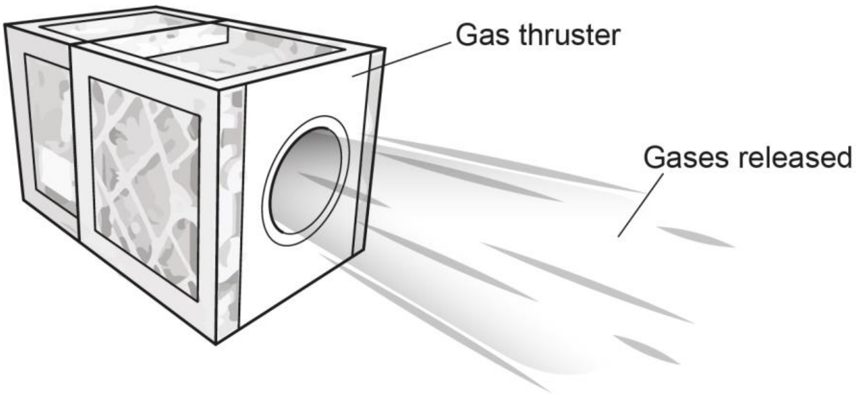
.... **[2]**

Higher performing candidates used the data appropriately to deduce that at this depth; the penguin's density is higher than seawater. However, very few candidates gained the second mark, usually for saying that swimming produces a force that prevents sinking.

Question 9 (a) (i)

9 The diagram shows a gas thruster.

The gas thruster releases a gas to change the orbit of a satellite.



(a) The satellite is in a stable circular orbit at a height of about 500 km above the Earth.
The gas thruster moves the satellite about 3 km further away from Earth.
The gas thruster is turned off and the satellite settles into a new stable circular orbit.

(i) Compare the force of gravity at the two orbits.

....

.... **[1]**

Most candidates know that the force of gravity decreases with distance from the Earth.

Question 9 (a) (ii)

(ii) Explain the difference in the speed of the satellite in its new orbit compared to its speed in the original orbit.

....

....

....

.... **[2]**

About half of the candidates knew that the satellite has a lower speed in its new, higher orbit. Only a handful of candidates referred to the increase in the radius of the orbit.

Assessment for learning

The force needed to keep an object moving in a circle depends on the speed of the object and the radius of the circle. The greater the speed and/or the smaller the radius, the greater the force needed. If a satellite or planet slows down, it will be pulled into a smaller radius orbit.

Question 9 (a) (iii)

(iii) Explain why the satellite is accelerating when it is in a stable circular orbit.

....

....

....

.... **[2]**

Relatively few candidates scored marks on this question. A few candidates linked acceleration to changing velocity. A few have the misconception that the velocity is increasing. A handful also know that the direction of the satellite changes as it orbits.

Question structure gives clues to how answers are connected

Questions 9 (a) (i), (ii), and (iii) are connected. Using the information 'higher circular orbit' in the stem a simple drawing would show a radius. Using the information 'difference in speed' in part (a) (ii), and the 'accelerating' a candidate may consider there is a different velocity. Candidates are reminded that the orbit is circular. Any two arrows on a circle have different directions, which also explains acceleration.

Question 9 (b)

(b) When the satellite moves to its new orbit its momentum is 9 144 000 kg m/s.

Calculate the velocity of the satellite in its new orbit.

The mass of the satellite is 1200 kg.

Use the Equation Sheet.

Velocity = ... m/s **[3]**

Almost all candidates selected and rearranged the momentum equation to calculate the velocity of the satellite. Note that the command phrase 'calculate…..' implies that the velocity is different in the new orbit. There's no evidence that any candidate used this instruction to amend their answer in part (a) (iii).

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