Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259
For first teaching in 2016

J259/03 Summer 2019 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. 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 can be downloaded from OCR.

Paper 3 series overview

Breadth in Physics is one of the two examination units aimed at Higher Tier candidates studying 21st Century Science GCSE (9-1). The 13 questions of this 90 mark paper assess knowledge and understanding from all six chapters of the syllabus plus Practical Skills and Ideas about Science. Half of the available marks are aimed at Grades 4–6 demand and half at Level 7–9 demand. Questions 1 to 3 are overlap questions which appear in identical form on the foundation tier paper. There is an increase in demand through the examination, although there are standard demand items within each question, so that there some items in every question will be accessible to all candidates.

Learning is assessed in three areas with different weightings:

- demonstrating knowledge and understanding of scientific ideas, techniques and procedures ~50%
- applying that knowledge to solve problems ~30 %
- analysing information, drawing conclusions and improving experimental procedures ~20%

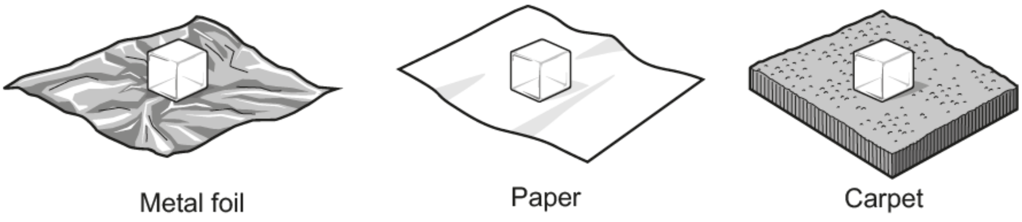
Most successful candidates have strengths in these areas	*Least successful candidates had specific weaknesses in these areas*
• To recall, rearrange and substitute numbers into equations with working shown clearly. • To recognise when units needed to be converted, e.g. grams to kilograms. • To make use of more than one piece of information given in the form of tables and charts to develop their responses. • A small number of questions were synoptic where candidates were required to piece together ideas from the different chapters of the syllabus in their answer. These candidates generally performed well on this type of question.	• Understanding of the differences between series and parallel circuits and how ammeters, voltmeters and resistors are used in circuits to determine other characteristics such as power output. • Applying the wave equation, recalling the speed of light and converting nanometres to standard form. • Converting units such as minutes to seconds in order to calculate distances. • Describing the transfer of energy between stores. • Understanding that the kinetic energy equation can be used to determine a maximum velocity. • Understanding that the term 'useful power output' implies using the efficiency equation.

The majority of candidates were able to attempt all questions within the allocated time. Only a very small number of candidates achieved marks that indicated that the Foundation Tier exam would have been a more appropriate paper for them. By contrast one in every eight candidates was credited with more than 60 marks.

Question 1 (a)

1 Amir investigates melting ice.

He puts ice cubes on different materials. He then measures the time taken for each ice cube to completely melt.



Amir's results are shown in the table.

Material	**Time (min)**
Metal foil	86
Paper	105
Carpet	162

(a) Calculate the thermal energy needed to melt 20 g of ice.

The specific latent heat of melting for ice is 334 000 J / kg.

Thermal energy = ...J **[3]**

The two most common errors were either to make no attempt to convert grams to kilograms or to make an incorrect conversion from grams to kilograms.

Question 1 (b)

(b) Explain why the ice cubes take different times to melt on different materials.

....

....

....

....

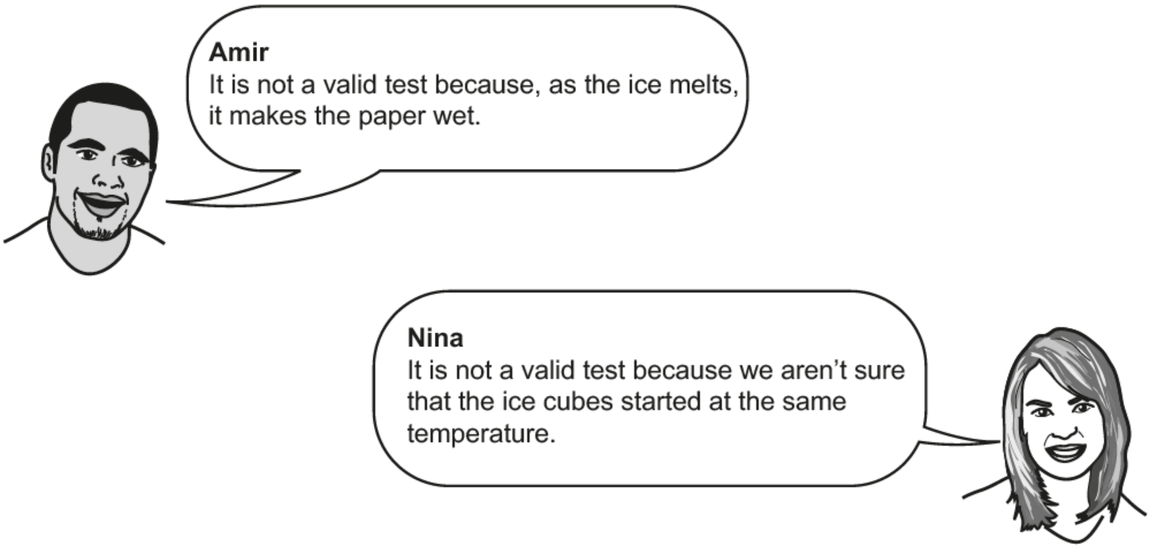
.... **[2]**

Only higher ability candidates were able to explain the observation in terms of thermal energy transfer. The most common misconceptions were that the materials were heating the ice and describing the materials as either absorbers or reflectors.

?	**Misconception**	It is important to answer the question in this case explaining the different melting times. Many candidates identified the materials as either conductors or insulators of heat but make no attempt to explain how this material property causes different melting times for the ice.

Question 1 (c) (i)

(c) Amir discusses the experiment with Nina, another student.



(i) Suggest improvements to the experiment to solve each of these problems.

Amir's problem ....

....

....

Nina's problem ....

....

.... **[2]**

In response to Amir's problem several candidates suggested using a material other than paper. Clearly this does not solve the problem of how to find about a valid measurement of the time taken for ice on paper to melt.

In response to Nina's problem many candidates gained marks for suggesting storing the ice in a freezer. However, it was surprising that on a few candidates suggested measuring the starting temperature of the ice cubes in some part of their response.

Question 1 (c) (ii)

(ii) Amir wants to speed up the experiment so it can be repeated more quickly.

Suggest **one** way he can change the experiment so that the ice melts more quickly, without making the experiment invalid.

....

.... **[1]**

	AfL	Candidates need to be aware that practical science skills are assessed in examinations and should try to give examples of improvements that are specific to the context of the question.

Question 2 (a) (i)

2 Jamal is on a water slide.

(a) **Fig. 2.1** shows the force of gravity (weight) acting on Jamal.

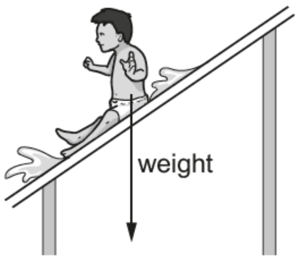


Fig. 2.1

(i) **Add an arrow** to **Fig 2.1** to show the normal contact force between Jamal and the slide. Label this arrow **N**. **[1]**

Very few candidates answered this question successfully. The most common misconception was that the normal contact force acts vertically upwards opposite to the weight

	Misconception	Many candidates believe that the normal contact force always acts in the opposite direction to the gravitational force. They need to learn that the normal contact force acts at a right angle to the contact surface.

Question 2 (a) (ii)

(ii) **Add an arrow** to **Fig. 2.1** to show the force of friction between Jamal and the slide. Label this arrow **F**. **[1]**

Most candidates understand that the force of friction is in the opposite direction to the motion down the slope.

Question 2 (b) (i)

(b) **(i)** State Newton's third law.

....

....

.... **[2]**

Most candidates gained marks for some understanding of equal and opposite forces. Very few candidates were able to find a form of words to express the idea that for two objects A and B, A exerts a force on B and B exerts a force on A.

Question 2 (b) (ii)

(ii) Explain how Newton's third law applies to the force of gravity (weight) acting on Jamal.

....

.... **[1]**

Very few candidates answered this question correctly. Application of this law requires understanding that the forces exerted are *the same type of force*. So, if [Earth's] gravity acts on Jamal then Jamal's gravity acts on the Earth. The most common misconception was to describe Earth pulling down and the slide pushing back.

Question 3 (a)

3 Beth works at a nuclear power station.

She is asked to investigate the risk caused by radioactive isotopes accidentally coming into contact with food.

(a) Would swallowing this food be a contamination effect or an irradiation effect?

Contamination effect ☐

Irradiation effect ☐

Explain your answer.

....

.... **[2]**

Most candidates recognised that contamination implies taking the source material into the body. A common insufficient explanation was to state that that the 'radiation is inside you'.

Question 3 (b)

(b) Explain why it is hazardous if radioactive isotopes enter the body.

....

....

.... **[1]**

A common error was to describe the effects of radioactive isotopes such as cancer and tumours. However, most candidates used the space well to include a description of ionisation.

Question 3 (c)

(c) Information about three isotopes is shown in the table.

Isotope	Type of decay	Half-life	Biological effects
Plutonium-241	beta	14 years	absorbed by the bones
Radium-226	alpha	1600 years	absorbed by the bones
Technetium-99m	gamma	6 hours	excreted after a few days

Which isotope is most hazardous when inside the body?

Explain your answer.

....

....

....

....

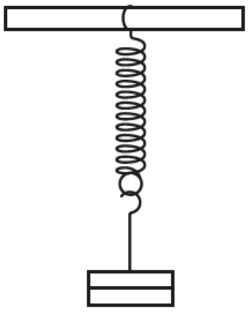
....

.... **[2]**

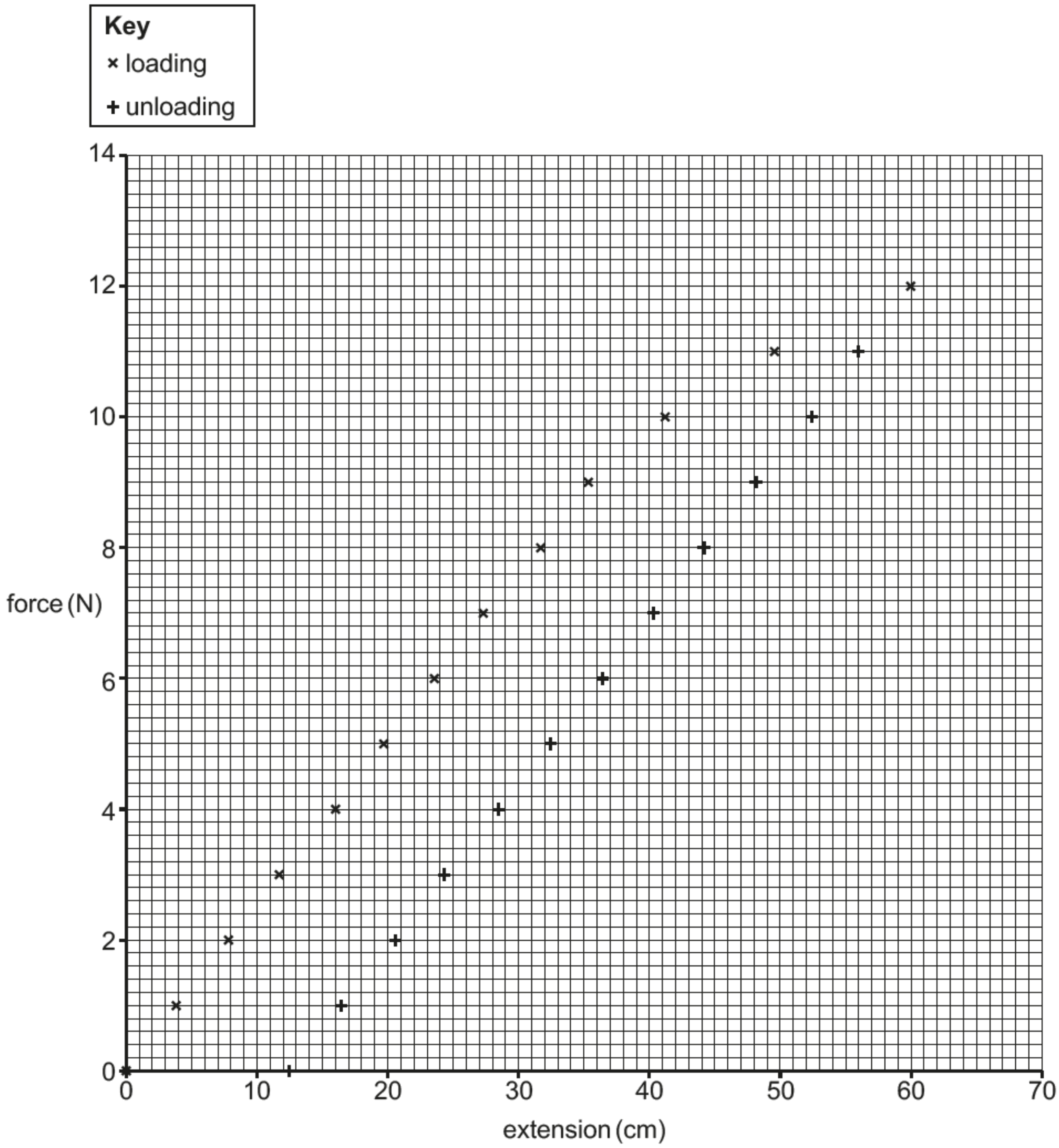
Most candidates gained at least one mark. A common error was to just restate the data in the table, for example 'Ra-226 because it is alpha and it is absorbed by the bones'. Most candidates gave at least one explanation, such as that alpha is the most ionising/absorption means staying inside the body. Examples of higher level responses included: alpha cannot penetrate out of the body (so it is absorbed by tissue), and technetium has the shortest half-life so it gives you a very high dose in a short period of time.

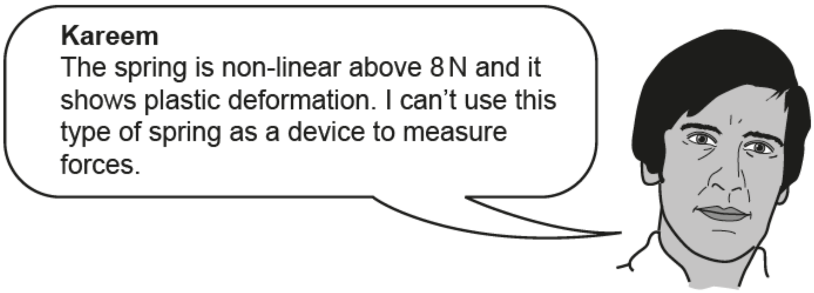
Question 4 (a) (i)

4 Kareem investigates the behaviour of a spring when it is loaded with masses and then unloaded.



He measures the extension of the spring each time he changes the load and plots his data onto the graph shown below.





(a) (i) Explain how the data from the graph shows that the spring is non-linear.

....

....

....

.... **[2]**

Most candidates were able to link the term 'non-linear' to the idea that the loading points do not increase in a straight line. However, very few candidates gained the second mark on this question because they did not address '*how the data from the graph shows*' in their responses. Some got close by explaining that the extension increases with each additional Newton above 8N.

	AfL	This is an analysing information (AO3) type of question. Candidates need to demonstrate the skill of selecting and quoting data from tables and read offs from graphs to do well on this type of question.

Question 4 (a) (ii)

(ii) Suggest whether a non-linear spring could be used as a device to measure forces.

Justify your answer.

....

.... **[1]**

A common misconception is that a non-linear spring would not be accurate or more simply 'it wouldn't work'. Only the most able candidates realised that if you knew the extension then you could use the graph to determine the force that had been applied in exactly the same way as a linear spring.

Question 4 (b) (i)

(b) (i) Explain how the data on the graph shows plastic deformation.

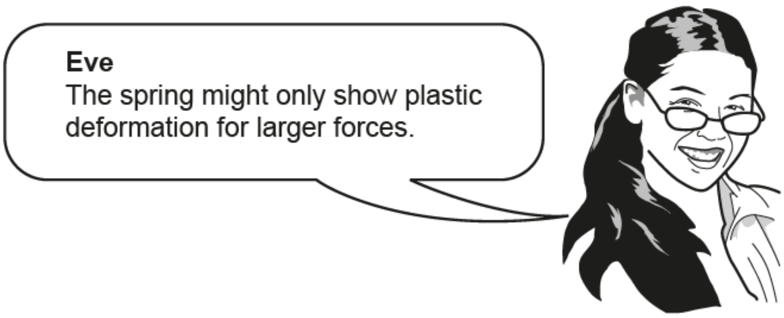
....

.... **[1]**

Many candidates answered this in general terms, such as 'it doesn't return to its original shape'. A few candidates made specific reference to the data in the graph and identified the permanent extension of 12.5 cm indicated by the unloading line.

Question 4 (b) (ii)

(ii) Eve also looks at the data shown on the graph.



Suggest how to find out the force at which plastic deformation begins for this type of spring.

....

....

....

.... **[2]**

Very few candidates were able to describe a clear method for this experiment. The procedure involves loading the spring with a weight and then removing the weight to see if the original length of the spring has increased. Most candidates described continuously adding weight until the extension started to increase. As the extension will naturally increase with more weight, candidates need to be more precise, for example by measuring how the rate of extension increases. Similarly, candidates often described using the graph 'to see where it curves'. This could be anywhere above 30 cm.

Question 4 (c)

(c) Kareem uses his spring to measure the weight of a metal block as 5.1 N.

Calculate the mass of the metal block.

Use the equation: weight = mass × gravitational field strength

Gravitational field strength = 10 N / kg

Mass = ...kg **[2]**

Almost all candidates were able to convert 5.1 N into kilograms.

Question 5 (a)

5 Thorium-232 is radioactive. It decays to an isotope of radium.

The graph in **Fig. 5.1** shows how the number of neutrons and protons in the nucleus changes during this decay.

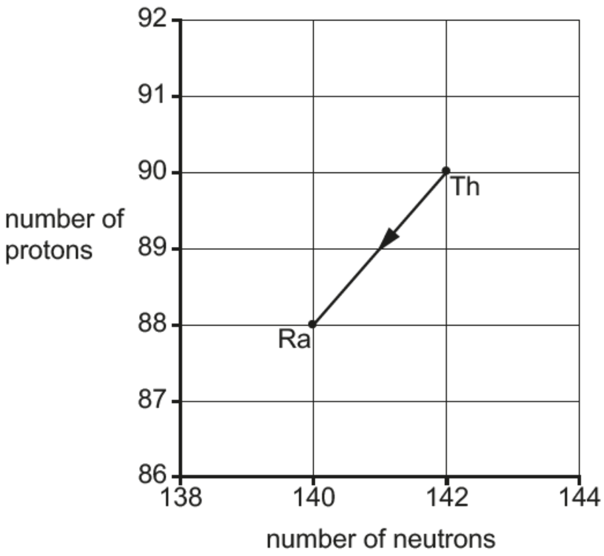


Fig. 5.1

(a) Thorium-232 can be represented as:

$$^{232}_{90}\mathrm{Th}$$

Complete the correct representation of the isotope of radium shown in **Fig. 5.1**.

$$^{\dots\dots}_{\dots\dots}\mathrm{Ra}$$

[2]

The majority of candidates gained successfully answered this question and were credited with both marks, although around a sixth of candidates only gave the correct atomic number or atomic mass.

Question 5 (b)

(b) State the type of radiation emitted during the decay shown in **Fig. 5.1**.

Give a reason for your answer.

Type of radiation ....

Reason ....

.... **[2]**

Most candidates were able to identify this alpha decay. An occasional error was to describe the change in terms of the mass number and the atomic number of radium rather than the 2 protons and 2 neutrons of the alpha particle.

Question 5 (c)

(c) The isotope of radium is also radioactive. It decays by emitting a beta particle.

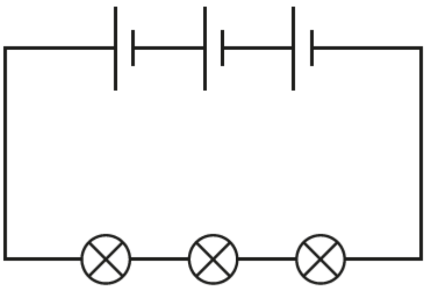
Add an arrow to the graph in **Fig. 5.1** to show this decay. **[1]**

Only the most able candidates recognised that beta emission involves the conversion of a neutron to a proton so that the arrow goes from 140,88 to 139,89. A common misconception is that only the proton number increases; perhaps there is confusion in some candidates understanding of ideas about charges.

Question 6 (a)

6 Kai is designing a head torch. The torch uses three small lamps.

The series circuit for Kai's first design is shown in **Circuit A**.



Circuit A

(a) The resistance of each bulb is 2800 Ω.

Calculate the current in **Circuit A**.

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

Current = ... A **[4]**

The most common misunderstandings were either add the voltages but not the resistances or vice versa.

Exemplar 1

(a) The resistance of each bulb is 2800 Ω.

Calculate the current in **Circuit A**.

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

$V = IR$

$I = \frac{V}{R}$

$3+3+3=9$

$2800 \times 3 =$

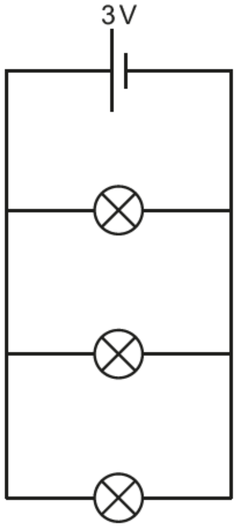
$\frac{9V}{8400\Omega} = 0.0010714285$

Current = 0.0011 A **[4]**

This is good example of a candidate that structured their approach to clearly show the steps in their calculation of the current.

Question 6 (b) (i)

(b) Kai changes the circuit so that it now contains only one cell, but with the lamps wired together in parallel, as shown in **Circuit B**.



Circuit B

(i) Describe and explain how the brightness of the lamps in **Circuit A** compares to the brightness of the lamps in **Circuit B**.

....

....

....

.... **[2]**

This question was a standard demand question comparing a parallel and series circuit. However only a fifth of candidates gained any marks. The most able candidates recognised that the 9 V potential difference is shared equally between the three lamps in series (3 V per lamp) but that each lamp in parallel receives the full supply voltage (also 3 V) and consequently the lamps in both circuits have equal brightness.

Question 6 (b) (ii)

(ii) Justify which circuit is most suitable for use in the torch.

....

....

.... **[1]**

More able candidates recognised that a head torch with the least number of cells, to reduce weight and bulk, was most suitable. However, as most candidates had not understood how series and parallel circuits worked, they selected the circuit that they mistakenly thought would have the brightest lamps as most suitable.

Question 7 (a) (i)

7 Sarah experiments with magnets.

(a) **(i)** Complete the diagram by drawing the pattern of magnetic field lines around the bar magnet.

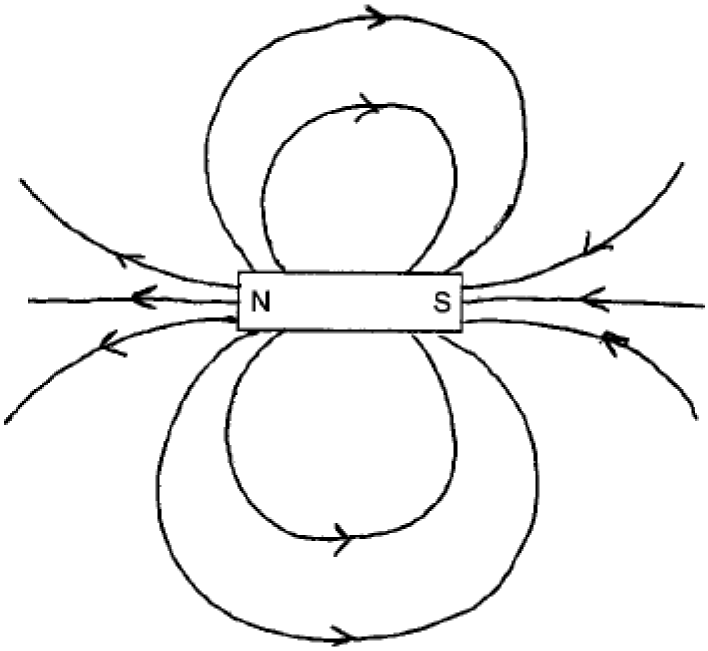
[2]

Most candidates understood in a general way that the field has a direction from north to south. However, many were unmindful in their drawing of the magnetic field around the bar magnet.

?	**Misconception**	Candidates at all levels often showed the field overlapping or merging together into single field lines. Each field line is discrete and the distance between the field lines indicates the strength of the magnetic field (i.e. closer together the stronger the strength of the field).

Exemplar 2

(a) (i) Complete the diagram by drawing the pattern of magnetic field lines around the bar magnet.



[2]

This response is a better example of the magnetic field drawn by a mindful candidate. Most other candidates drew the magnetic field around the bar magnet with overlapping and merging field lines.

Question 7 (a) (ii)

(ii) Describe where the magnetic field is strongest, and how this is shown by the field lines.

....

....

.... **[1]**

A common error was to explain the strength of the magnetic field in terms of 'more field lines' at the poles rather than the magnetic field lines being closer together.

Question 7 (b)

(b) Sarah makes a needle for a compass.

She repeatedly moves the needle across the bar magnet until it is magnetised. She then suspends the needle from a thread and it points north.

Explain whether the compass needle is a permanent or induced magnet.

....

....

....

.... **[2]**

In this standard demand question only the most able candidates were able to distinguish between the process of magnetising the needle and the outcome of it pointing north. Since this is only possible if it produces its own magnetic field then it must be a permanent magnet. However, the vast majority of candidates across the ability range concluded that it must be an induced magnet and gave a further explanation that it would lose its magnetisation once removed from the magnetic field. The evidence in the stem of the question that these candidates had missed is that the needle is aligned with the magnetic field of the Earth.

Question 8 (a)

8 A solar flare is an explosion on the surface of the Sun.

Solar flares release huge amounts of radiation, including visible light and X-rays.

(a) Describe **two** differences between visible light and X-rays.

1 ....

....

2 ....

.... **[2]**

Most candidates were able to describe differences in frequency, wavelength, ability to ionise or be seen by the eye.

Question 8 (b) (i)

(b) Sometimes when there is a solar flare, a huge cloud of gas is also forced out from the Sun.

Jack finds out the following information:

- Speed of X-rays in a vacuum 3.0×10^8 m/s
- Typical wavelength of X-rays: 0.10 nm
- Time taken for visible light to travel from the Sun to the Earth: 8.3 minutes
- Speed of cloud of gas: 500 000 m/s

(i) Use the data to calculate the typical frequency of X-rays.

Frequency = ... Hz **[3]**

Very few candidates were able to convert nm (nanometres) to standard form. A common error was to divide the speed of the X-rays by 0.1. Candidates who had not written down the wave equation, suitably rearranged to make frequency the subject, were still able to gain a mark for substitution of appropriate values.

Question 8 (b) (ii)

(ii) Calculate the time taken, in minutes, for the cloud of gas to reach the Earth.

Time taken = ... minutes **[4]**

Candidates who recalled that the speed of light is the same as the speed of X-rays also knew to convert minutes to seconds before calculating the Earth–Sun distance. This distance divided by the speed of the gas cloud (and then divided by 60) gives the time in minutes for the cloud to reach Earth. Candidates who recalled the speed of light incorrectly (3×10^6 m/s) could still gain 3 marks on this question for showing their method of calculation. Other approaches also gained full marks. A few candidates calculated that the cloud was 600 times slower than the speed of light so it would take 600 x 8.3 minutes longer to reach the Earth, and this was a valid method too.

Exemplar 3

(ii) Calculate the time taken, in minutes, for the cloud of gas to reach the Earth.

x-rays and visible light travel at the same speed

8·3 minutes = 498 seconds

distance = speed × time

$= 3 \times 10^8 \times 498$

$= 1.494 \times 10^{11}$ m

cloud time to travel = $\frac{\text{distance}}{\text{speed}} = \frac{1.494 \times 10^{11}}{500,000}$ = 298800 s

= 4980 mins

Time taken = 4,980 minutes **[4]**

This is a good example of a candidate who has taken a structured approach to this calculation.

Question 9 (a)

9 Jane investigates the maximum power provided by two types of solar cell, as shown in **Fig. 9.1**. The solar cells are **not** the same size.

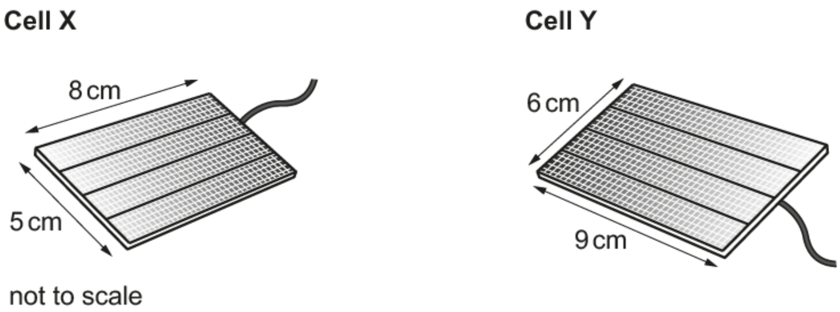


Fig. 9.1

Jane uses the circuit shown in **Fig. 9.2** to measure the power provided by each cell. She carefully controls the intensity of light falling on each solar cell so that it does not change.

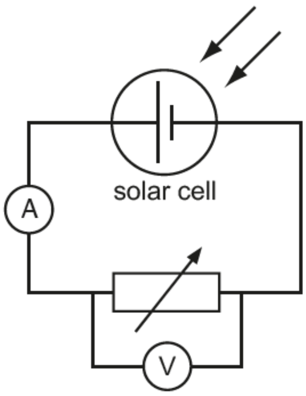


Fig. 9.2

(a) Describe how to use the circuit in **Fig. 9.2** to measure the maximum power provided by each cell.

Include details of any calculations that must be completed.

....

....

....

....

....

....

.... **[3]**

Most candidates recalled P = VI in their responses. While many candidates did indeed refer to taking readings from the ammeter and voltmeter, it appears that most candidates do not recognise the symbol for a variable resistor. So, very few candidates explained that the resistor should be adjusted to optimise the current and voltage in the circuit.

	AfL	A common rubric error was to not address the question stem '*how to use the circuit*'. As previously commented, candidates need to be aware that several questions in the paper are designed to assess their knowledge of practical procedures and they need to learn how to spot this type of question.

Exemplar 4

Measure the voltage input using the voltmeter and also the current in the circuit using the ammeter when the maximum amount of light is let in. From these two readings use power = current x voltage to find the maximum power provided by each cell.

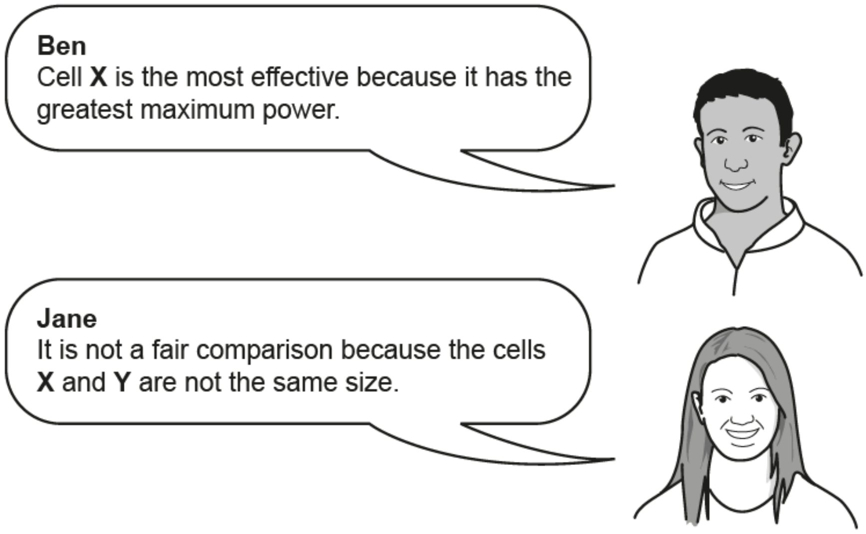
[3]

A typical example of a high level candidate response that makes no reference to the variable resistor or the need to adjust it.

Question 9 (b)

(b) The table shows the results of Jane's experiment.

Cell	Maximum power (W)
X	25
Y	32



Compare the effectiveness of solar cells **X** and **Y**, taking into account their surface area.

[3]

Most candidates gained at least one mark here for calculating the area of each solar cell. Most candidates used a further calculation to compare the solar cells either by determining the power per unit area of each cell or the area per unit power. Some used scale factors and compared how many times bigger is Y compared to X with how much more power from Y compared to X.

	AfL	Candidates are advised that it would be better to use the answer space rather than writing calculations next to diagrams in the stem of a question. This will ensure that their workings are seen by the examiner in a place where they are expecting to see the candidate's response.

Question 9 (c)

(c) Suggest **two** factors, other than maximum power, that could affect someone's decision to use solar cells to generate electricity for their home.

1 ....

....

2 ....

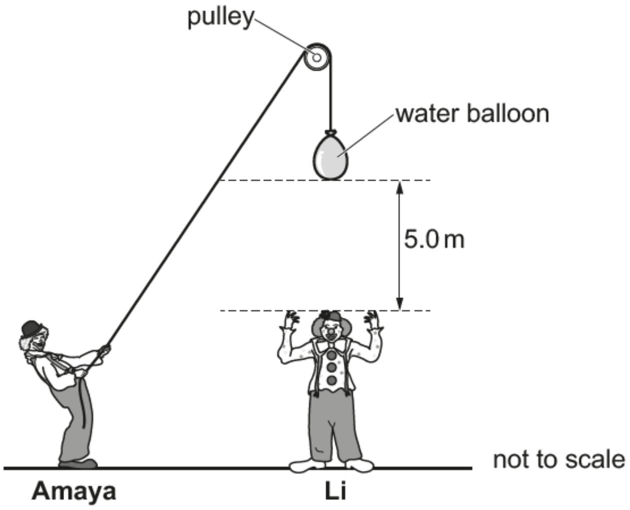
.... **[2]**

Although most candidates were credited with some marks for Question 9(c), although a third of candidates only gained one of the marks. A common misconception was to only consider variations on an economic argument such as the cost of installation and also how much money they will save for both Cell 1 and Cell 2. Candidates need to consider wider science linked reasons such as positive environmental impact, availability of sunlight at site or available space for the solar cells.

Question 10 (a)

10 Amaya and Li are clowns in a circus. They are preparing a new show.

In the show, a water balloon will be dropped on Li's head from different heights. Amaya lifts the water balloon to a height 5.0 m above Li's head using a pulley.



(a) Describe all the **changes** in the way energy is stored, starting from before Amaya starts to lift the water balloon, and finishing after the water balloon has hit Li.

In your answer you should clearly state what is happening to the water balloon as the energy is transferred between each of the stores.

....

....

....

....

....

.... **[3]**

This question was aimed at higher achieving candidates and few gained more than one mark for their response. The most able candidates recalled that there is a store of chemical energy in Amaya. Where other candidates commonly gained a single mark was for describing the transfer from the gravitational potential store to the kinetic store in the falling balloon. All candidates should know that energy transfers that involve work (i.e. using a force) also result in a transfer to a thermal energy store (in this case as the balloon bursts on Li's head).

?	**Misconception**	Candidates generally began their descriptions with reference to the 'kinetic energy' in the rising balloon. This is a rubric error as it does not address the question stem *'before Amaya starts to lift'*. These descriptions was also mistakenly believe that the energy is in a mechanical store during this process rather than being transferred mechanically from the chemical store to a kinetic store in the falling balloon

Exemplar 5

Amaya converts kinetic energy to gravitational potential energy as Amaya uses kinetic energy to lift the balloon. When the balloon is dropped, the gravitational potential energy converts back to kinetic energy but also friction on the rope against the pulley. As the balloon hits Li, it pops as the ~~[illegible]~~ velocity suddenly becomes 0 creating a force on Li's head.

.... **[3]**

A typical example of a high level candidate response that makes no reference to the store of chemical energy before the balloon is lifted or the store of thermal energy after the balloon has landed.

Question 10 (b) (i)

(b) The mass of the water balloon is 1.6 kg.

(i) Calculate the minimum work that must be done by Amaya to lift the water balloon a height of 5.0 m.

Gravitational field strength = 10 N / kg

Work done = ...J **[2]**

Candidates are clearly familiar with this type of calculation and many did not show any working but simply multiplied all three numbers together. However, teachers need to check that candidates understand that the gain in the gravitational potential store is the same as the work done in this situation. The orthodox approach is to calculate the weight using F = mg and substitute F into the work equation where d is the height 5.0 m.

Question 10 (b) (i)

(ii) Use your answer to **(b)(i)** to calculate the maximum possible speed of the water balloon when it hits Li.

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

Only the most able candidates were able to recall that the kinetic energy equation relates energy to speed. These candidates rarely had any difficulty rearranging this equation to make v the subject.

Question 11 (a)

11 Kepler-445d is a planet orbiting a distant star in our galaxy. It was discovered in 2015.

Astronomers believe that Kepler-445d is similar to the Earth. However, it orbits a star that emits light with a longer principal wavelength than the Sun.

(a) State how the surface temperature of the star compares to the surface temperature of the Sun.

....

.... **[1]**

Most candidates related a longer wavelength to a cooler star.

Question 11 (b)

(b) The intensity of radiation emitted by the star is much lower than that emitted by the Sun. However, the surface temperature of Kepler-445d is thought to be similar to the surface temperature of the Earth.

Give **two** possible reasons to explain how Kepler-445d could be at a similar temperature to Earth.

1 ....

....

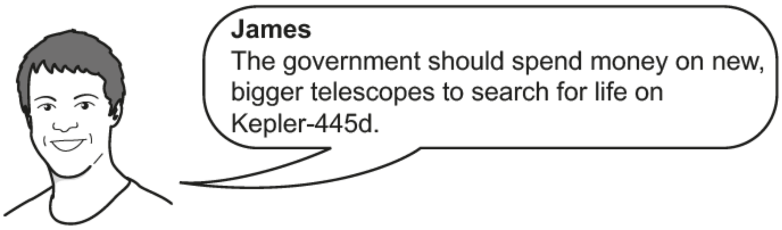
2 ....

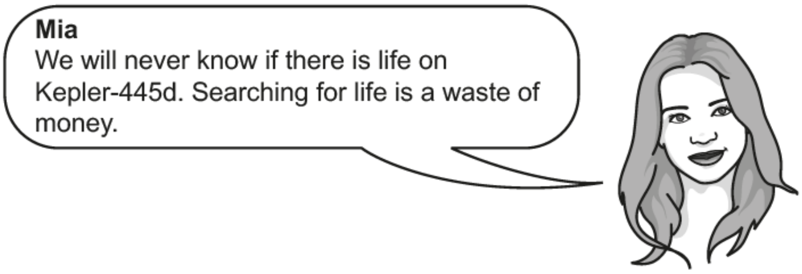
.... **[2]**

Most candidates gained one mark for explaining that the planet is closer to its star. A common error was to be less precise about the atmosphere of the planet, for example 'an atmosphere with more greenhouse gases / traps more heat.' Common but insufficient responses were 'it has a thick atmosphere' and 'it absorbs more heat'.

Question 11 (c)

(c) James and Mia discuss whether scientists should look for life on Kepler-445d.





Who do you agree with? Explain why.

James ☐

Mia ☐

Explanation ....

....

....

.... **[2]**

Very few candidates gave more than one explanation for these two marks. Many candidates referred to travelling to the planet to avoid the environmental break down on Earth or in order to learn from the aliens. Some of these candidates explained that it would be impossible to travel there and therefore concluded that any research would be pointless. Very few candidates appreciate the enormity of discovering that life has evolved elsewhere in the galaxy.

	AfL	Candidates should be aware that in general the overall demand of questions increases towards the end of the question so they should be prepared to give more detailed responses

	OCR support	Students that discussed the cost of the telescope showed many common misconceptions about the funding of large science projects. IaS4 How do science and technology impact society? Gives example on what candidates should be taught about real world science, which include being able to make decisions based on the evaluation of evidence and arguments. https://www.ocr.org.uk/Images/234601-specification-accredited-gcse-twenty-first-century-science-suite-physics-b-j259.pdf

Question 12 (a) (i)

12 Sundip reads an article about a new way to generate electricity.

> Scientists have invented 'energy harvesters' called 'twistrons'. Twistrons are made by twisting carbon fibres.
>
> When a twistron changes shape, it can generate electricity. 1 kg of twistrons could generate up to 250 W of electrical power. The efficiency of a twistron is only 1.1%.
>
> In the future, twistrons could be sewn into people's clothes so that they generate electricity as they move around.

(a) (i) Calculate the possible energy transferred from 3.5×10^{-5} kg of twistrons in 1 minute.

Energy output = ...J **[3]**

A common error was to multiply the mass 3.5×10^{-5} kg by 60 seconds. Candidates who recalled and used the rearranged power = energy ÷ time equation were able to determine that 1 kg of twistrons could provide 15000 J of energy and hence the 0.525 J supplied by this far smaller mass.

Question 12 (a) (ii)

(ii) Calculate the total power supplied for a twistron to transfer a useful output power of 10 W.

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

Total power = ...W **[3]**

A common error was to substitute 1.1 in the rearranged efficiency equation.

Question 12 (b) (i)

(b) (i) Describe a positive impact that twistrons and other similar inventions could have on society.

....

....

.... **[1]**

Most candidates were able to describe a specific positive impact such as encouraging people to take more exercise or reducing the amount of greenhouse gases from other forms of energy generation.

Question 12 (b) (ii)

(ii) Suggest why the scientists decided to give their invention of 'twistron' a short and memorable name.

....

....

.... **[1]**

Candidate responses that contained the idea of communicating to a non-specialist audience gained credit. A common error from many candidates was to explain using a circular argument that 'a memorable name would be easy to remember'.

Question 13 (a)

13 Alex is a deep-sea diver.

As he swims downwards into the ocean, the pressure changes.

(a) Explain why the pressure changes with increasing depth in the ocean.

....

....

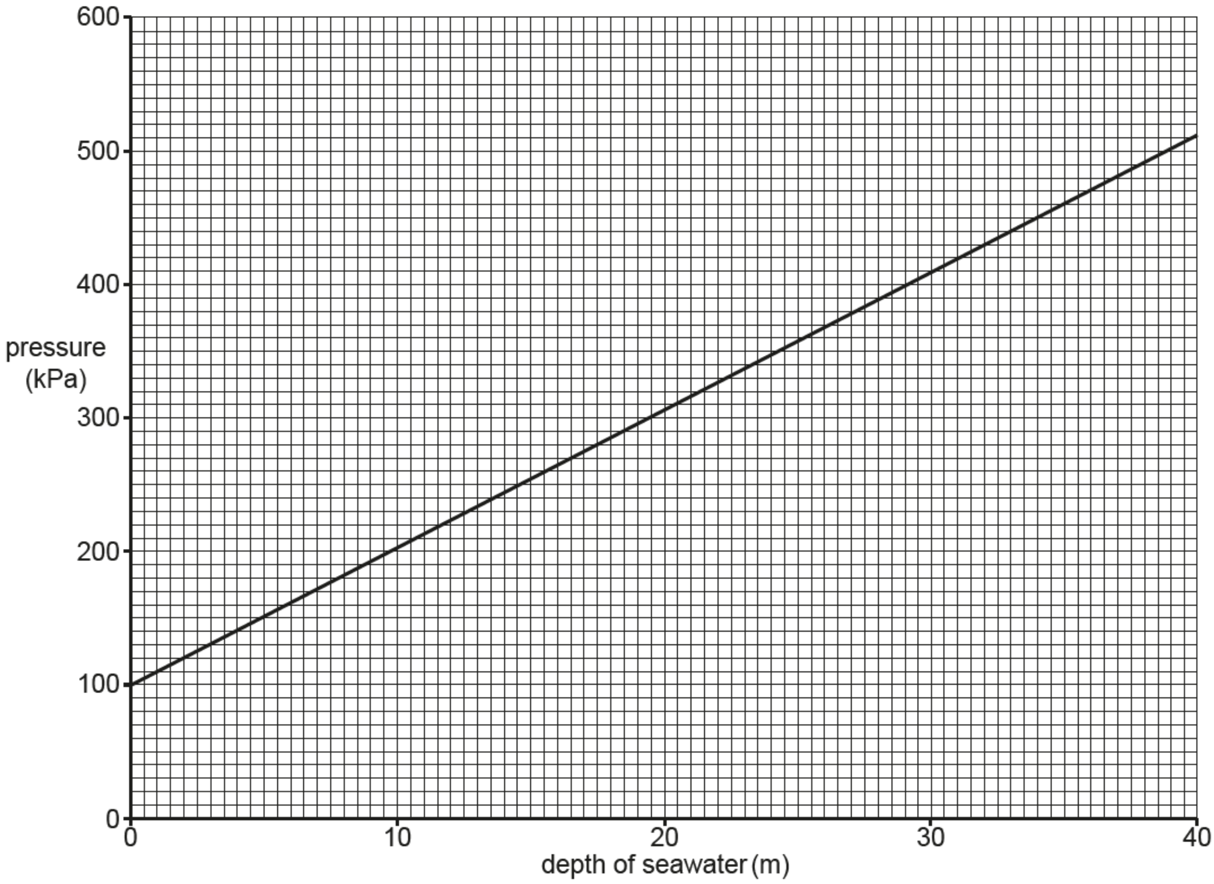
....

.... **[2]**

Most candidates can state that pressure increases with depth but far fewer understood that this is due to the weight of the water above. A few candidates were able to explain the pressure change by referring to the equation $P = \rho g h$. A common misconception among quite a few candidates is that the availability of oxygen decreases with depth and that this is the cause of the pressure change.

Question 13 (b) (i)

(b) The graph shows how pressure changes with depth of seawater.



(i) Determine the intercept of the graph.

Intercept = ... kPa **[1]**

This was a very accessible mark for almost all candidates. A common error was '500'.

Question 13 (b) (ii)

(ii) Explain the physical meaning of the value of the intercept.

....

....

....

.... **[2]**

Most candidates identified the y-axis intercept as the pressure when the depth of the seawater is 0 m or expressed this idea in words to that effect. Only the most able candidates realised that this was the pressure of the atmosphere. A common error was to describe the intercept in mathematical terms rather than its physical meaning, such as 'where the line crosses the *y*-axis'.

Question 13 (c) (i)

(c) (i) Determine the gradient of the graph.

Gradient = ... kPa / m **[2]**

Most gained one mark for calculating a gradient. Answers with a better resolution than '10' gained both marks. The expected range of appropriate answers was 10.20 to 10.33 kPa/m.

Question 13 (c) (ii)

(ii) Calculate the density of seawater.

Use the equation: density = gradient of graph ÷ gravitational field strength

Gravitational field strength = 10 N / kg

Density = ... kg / m^3 **[2]**

Almost all candidates did not convert from kilopascals (kPa) to Pascals. Some candidates simply dividing their response to (c)(i) by 10 and did not gain any credit. Candidates should also be encouraged to think about what their numerical answers mean.

	AfL	It is important for candidates to check their numerical answers make sense, by estimating an expected result. The final answers given to this question by some students meant that they believed that a cubic metre of seawater would have a mass of 1 kg, rather than 1025 kg

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