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 2022 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 answers are 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 OCR.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

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Paper 3 series overview

J259_03 Breadth in Physics is one of the two examination units aimed at Higher Tier candidates studying the new revised GCSE (9-1) 21st Century Science Suite.

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. 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. In contrast with previous qualifications, the new examination has a greater mathematical content with approximately 30% of the marks for simple and developed calculations. A very small number of questions worth approximately 5 marks on this paper were synoptic. This means that candidates were required to piece together ideas from the different chapters of the syllabus in order to answer them.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• recalled, rearranged and substituted numbers into equations with their working shown clearly. • recognised when units such as mA needed to be converted to amps for example. • made use of the rubric (question context or stem) to guide their thinking when responding to 'suggest' command words. • used data from charts and graphs or applied scientific models when guided by the rubric. • did not simply quote data when responding to 'explain' command words.	• relied on opinion rather than data to support their conclusions. • rearranged selected equations incorrectly during the substitution of data. • made no reference to apparatus or how it is used when describing methods. • made no attempt to convert units. • selected incorrect equations and made extraordinary efforts to bend the data to try and fit. • applied ideas that are more appropriate to chemical reactions than physical phenomena.

There was no evidence that any candidates were disadvantaged by time constraints. 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.

Question 1 (a)

1 Nina investigates how the resistance of a thermistor depends on its temperature.

She controls the temperature of the thermistor by placing it in a beaker of water at different temperatures.

Fig. 1.1 shows part of her circuit diagram.

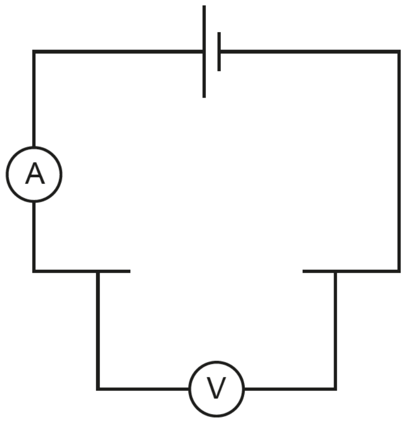


Fig. 1.1

(a) Complete **Fig. 1.1** to include a thermistor correctly connected to the circuit. **[1]**

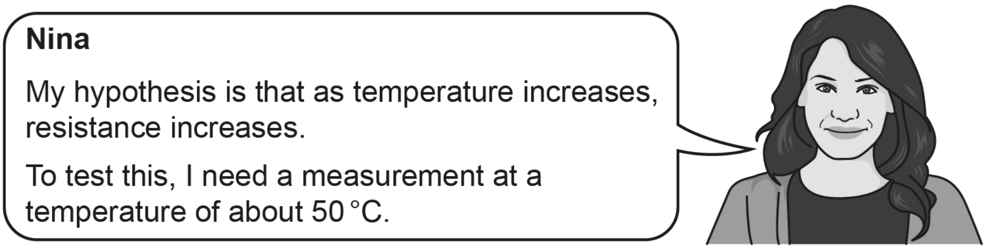
Most candidates recalled the thermistor symbol correctly and placed it in parallel with the voltmeter.

Question 1 (b) (i)

(b) **Table 1.1** shows her data.

Temperature (°C)	Resistance (Ω)
0	1300
80	1800

Table 1.1



(i) Suggest how she could make water with a temperature of about 50 °C.

....

.... **[1]**

Most candidates identified suitable heating apparatus with which to heat water e.g., a kettle, Bunsen burner or water bath, or they described a method of cooling hot water e.g. mix with cold or wait for it to cool.

Question 1 (b) (ii)

(ii) **Table 1.2** shows her data including the measurement at 50 °C.

Temperature (°C)	Resistance (Ω)
0	1300
50	350
80	1800

Table 1.2

How will the new data affect Nina's confidence in her hypothesis?

Explain your answer.

Tick (✓) **one** box.

Less confident ☐

More confident ☐

No effect ☐

Explanation: ....

....

.... **[2]**

Most candidates recognised that Nina would be less confident in her hypothesis and explained that the new data either went against the trend or the prediction or that it was anomalous.

Question 1 (c)

(c) Nina made 7 more measurements at different temperatures.

All her data is plotted in **Fig. 1.2**.

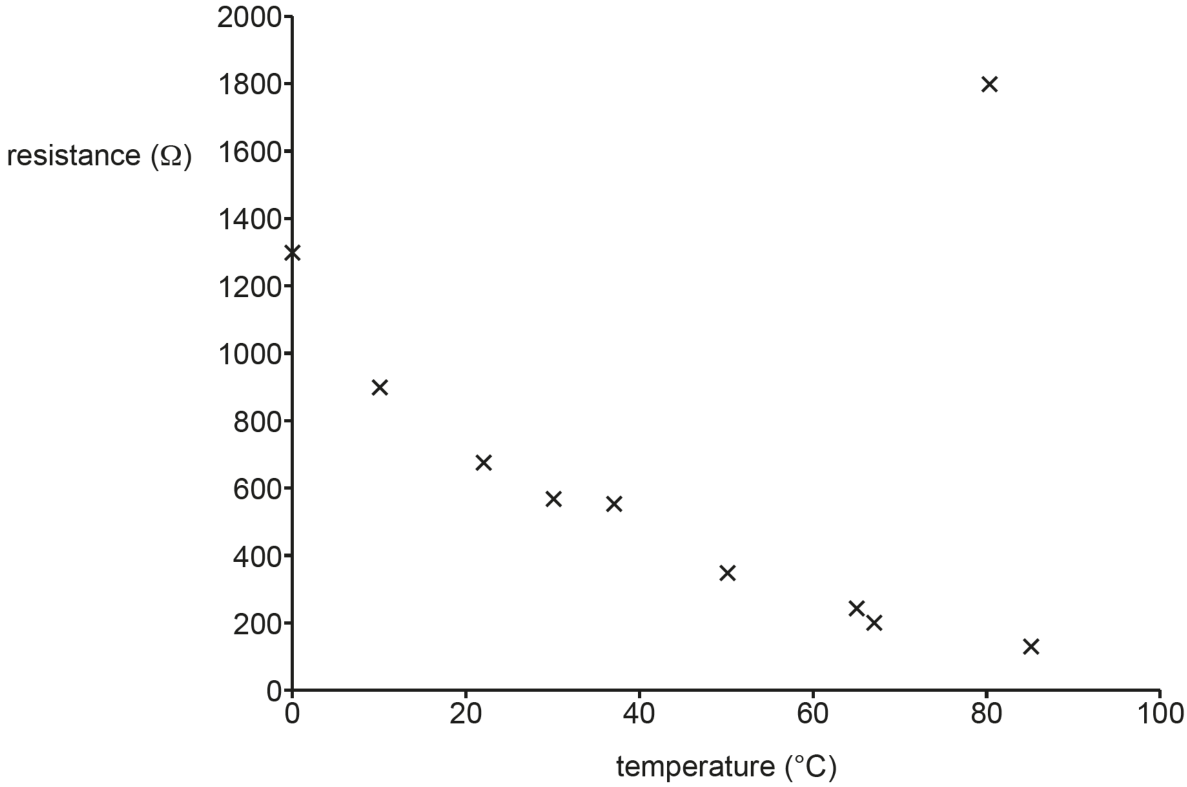


Fig. 1.2

Describe the trend shown in **Fig. 1.2**.

....

....

....

.... **[2]**

Most candidates correctly used the axis labels in their description of the trend. They often used the term 'negative correlation' but rarely as their complete answer. Most candidates observed the outlier but only a few noticed that the data forms a curve or that the change in resistance gets less as the temperature increases.

Question 2 (a)

2 Jamal, Sara and Jack are playing rounders.

Rounders is a game played with a bat and ball. **Fig. 2.1** shows the layout of the pitch. The bowler stands at X and throws the ball towards the batter at Y.

The batter hits the ball and then tries to run around the pitch once, from Y to Z.

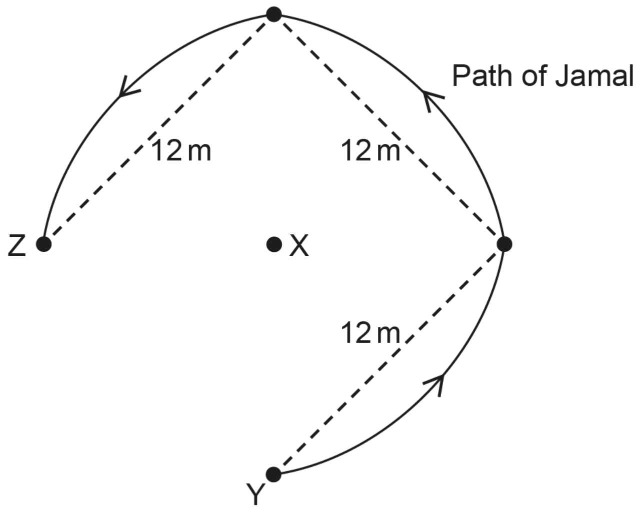
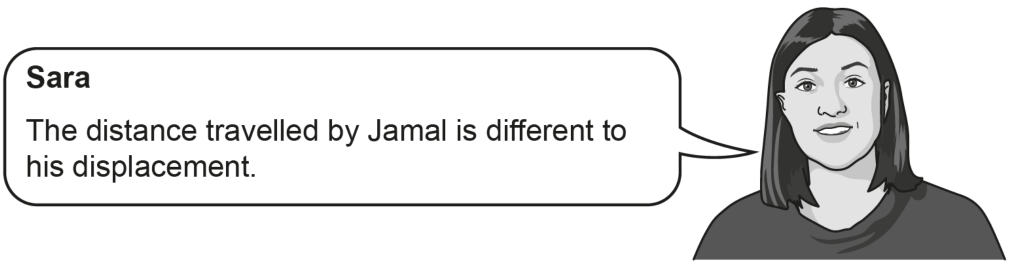


Fig. 2.1

(a) Jamal hits the ball and runs along the path from Y to Z shown in **Fig. 2.1**.



Explain why Sara is correct. Use information from **Fig. 2.1** in your answer.

....

....

....

.... **[2]**

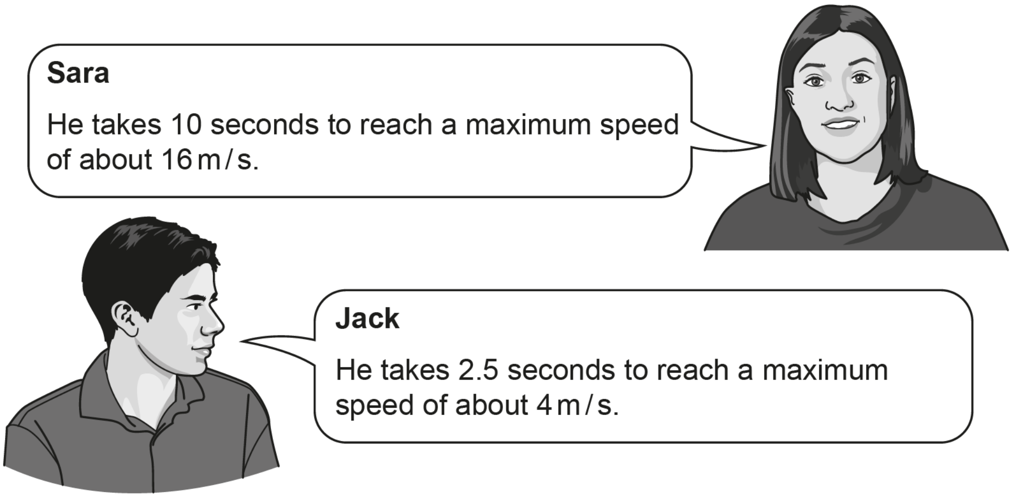
Very few candidates scored 2 marks. Most recognised that the distance (> 36m) was more than the displacement (12m). Some candidates were confused about the curved path compared to the straight line distance between the bases. However, it is expected that more candidates at this level should understand that displacement is a vector and has both magnitude and direction.

Scalars and vectors

4.2.5. explain the vector–scalar distinction as it applies to displacement and distance, velocity and speed.

Question 2 (b) (i)

(b) Sara and Jack try to estimate how quickly Jamal speeded up.



(i) Which is the better estimate? Explain your answer.

Tick (✓) **one** box.

Sara ☐

Jack ☐

....

.... **[1]**

Most candidates recognised that Jack gives the better estimate often with reference to 'realistic' running speeds or that accelerating for 10s is not realistic.

Question 2 (b) (ii)

(ii) Use **either** estimate to calculate Jamal's acceleration.

Use the Data Sheet.

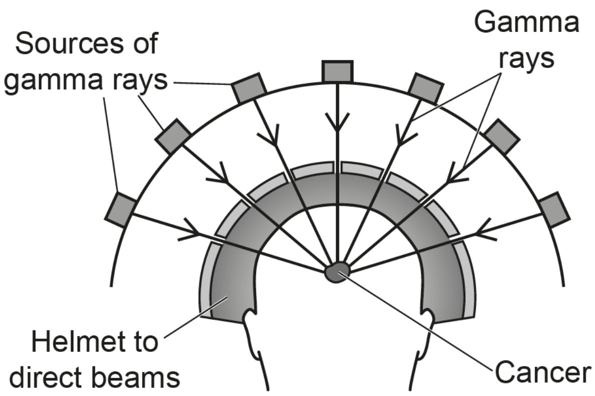
Acceleration = ... m/s^2 **[3]**

Most candidates calculated the acceleration of 1.6 m/s^2 correctly.

Question 3 (a)

3 Cancer can be treated using radiation. This is called radiotherapy.

The diagram shows one way to use gamma rays to treat cancer.



(a) Describe why gamma rays can be used to treat cancer using the method shown in the diagram.

....

....

....

....

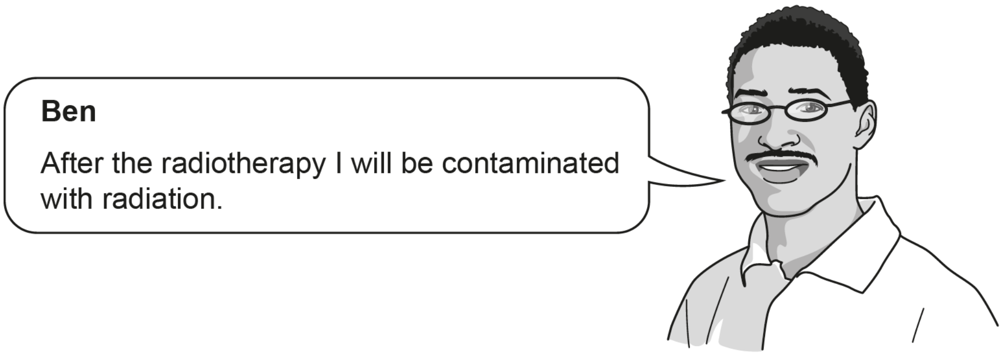
....

.... **[3]**

Candidates often scored 2 marks on this question. The most common error was to describe killing the cancer rather than the cancer cells. Candidates often referred to ionisation in the phrase 'not very ionising' (which still gained marks) without reference to the concentration of several weakly ionising rays on the cancer.

Question 3 (b)

(b) Ben's cancer is treated using gamma rays.



Explain why Ben is wrong.

....

....

.... **[2]**

Very few candidates scored both marks for this question.

Contamination and irradiation

5.2. recall the differences between contamination and irradiation effects and compare the hazards associated with each of these

Misconception

There is a common misconception among candidates that the gamma ray emitters are not contaminating because 'they don't stay in the body'.

Teaching and learning narrative:

Ionising radiation can damage living cells and these may be killed or may become cancerous, so radioactive materials must be handled with care. In particular, a radioactive material taken into the body (contamination) poses a higher risk than the same material outside as the material will continue to emit ionising radiation until it leaves the body.

Question 3 (c)

(c) X-rays can also be used for radiotherapy.

X-rays are produced electrically using a machine.

Suggest an advantage of treating cancer using X-rays instead of gamma rays.

....

....

.... **[1]**

Many candidates compared the ionising powers of X-rays with gamma rays concluding that X-rays were safer as they were less ionising. This may be correct for an individual ray but it depends more on the intensity of the rays.

However, both X-rays and gamma rays must be of sufficient intensity to be equally ionising in order to kill the cancer cells.

The command word here is 'suggest'. This often means that information in the stem of the question should be used to guide thinking rather than any direct recall of syllabus knowledge. In this regard candidates should note the phrase 'produced electrically'.

Command words

Suggest: suitable answers do not assess direct recall of syllabus knowledge. Look for guidance in the stem or context of the question.

Question 4 (a)

4 Different types of wave can be used for communications.

Fifty years ago, microwaves were used for long distance communications. Microwaves travel through the air between microwave aerials.

Now, light waves travelling along optical fibres are normally used instead.

(a) Compare and contrast microwaves and light waves.

....

....

.... **[2]**

Very few candidates gained both marks here. Most identified differences in wavelength and/or frequency. Very few referred to the electromagnetic spectrum when comparing these waves. If a second mark was gained it was often for recognising that only light waves are visible.

Radiation and waves

1.1 describe the main groupings of the electromagnetic spectrum

1.1 recall that all electromagnetic radiation is transmitted through space with the same very high (but finite) speed.

Question 4 (b) (i)

(b) The table shows information about these waves.

How it works	Speed of wave (m/s)	Time to travel 90 km (µs)
Microwaves in air	3.0×10^8	300
Light waves in an optical fibre		450

(i) Calculate the speed of light waves in an optical fibre.

Use the Data Sheet.

Speed = ... m/s **[4]**

Many candidates attempted to apply the wave equation to this situation. Candidates who used the speed equation often made at least one error in converting kilometres to metres or microseconds to seconds.

Question 4 (b) (ii)

(ii) An engineer suggests using an optical fibre made using a new material.

In this new material, light waves take 432 μs to travel 90 km.

Calculate the percentage decrease in the travel time for this new material.

Percentage decrease = ... % **[2]**

Most candidates calculated the 4% decrease correctly.

Question 4 (b) (iii)

(iii) The new material would be 10% more expensive than the old material.

Suggest why it is not worth using the new material. Use your answer to part **(b)(ii)**.

....

....

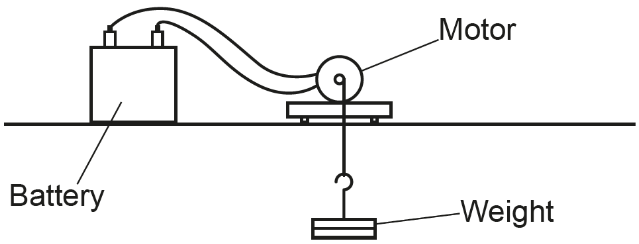
.... **[1]**

Most candidates gained this mark with comments such as 'It's only 4% faster'

Question 5 (a) (i)

5 Alex investigates the efficiency of a motor.

He uses the motor to lift a weight as shown in the diagram.



He takes measurements and calculates the energy transfers.

(a) The electrical energy input to the motor is 5.6 J.

The work done lifting the weight is 3.5 J.

The motor is switched on for 20 seconds.

(i) Calculate the electrical power input to the motor.

Use the Data Sheet.

Power input = ... W **[3]**

Most candidates correctly applied power input = input energy (5.6) ÷ time (20)

Question 5 (a) (ii)

(ii) Calculate the efficiency of the motor when lifting the weight.

Use the Data Sheet.

Efficiency = ... % **[3]**

Most candidates calculated 62.5% correctly using useful work done lifting (3.5) and the total input (5.6). Common errors were not converting 0.625 or calculating the percentage of energy lost (37.5%).

Question 5 (b) (i)

(b) Alex researches how to improve the efficiency of the energy transfer.

Alex
Adding thermal insulation to the motor will increase its efficiency.

(i) Explain why Alex is wrong.

....

....

....

.... **[2]**

Very few candidates gained both marks here. The common error is to explain 'why…wrong' by simply contradicting the statement. Candidates must firstly consider the efficiency of the energy transfer in the motor. Friction and electrical resistance are the causes of inefficiency. Secondly, candidates should mention friction (or electrical resistance) as the cause of inefficiency for a motor.

Question 5 (b) (ii)

(ii) Suggest a better method to increase the efficiency of the energy transfer.

....

.... **[1]**

Very few candidates are able to identify ways to increase the efficiency of energy transfer.

Thermal insulation / Efficiency

2.1 and describe ways to increase efficiency

2.1 explain ways of reducing unwanted energy transfer e.g., through lubrication, thermal insulation

Question 6 (a)

6 Mia's teacher uses a Van de Graaff generator to demonstrate static electricity shown in **Fig. 6.1**.

Electrons are transferred to the metal dome, giving it a negative charge.

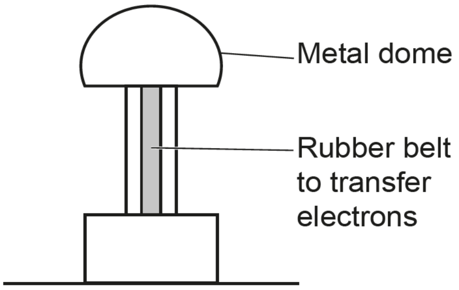


Fig. 6.1

(a) In **Fig. 6.2** a doll's head is attached to the top of the dome. When the dome is charged, the doll's hair also becomes negatively charged. The hair stands on end.

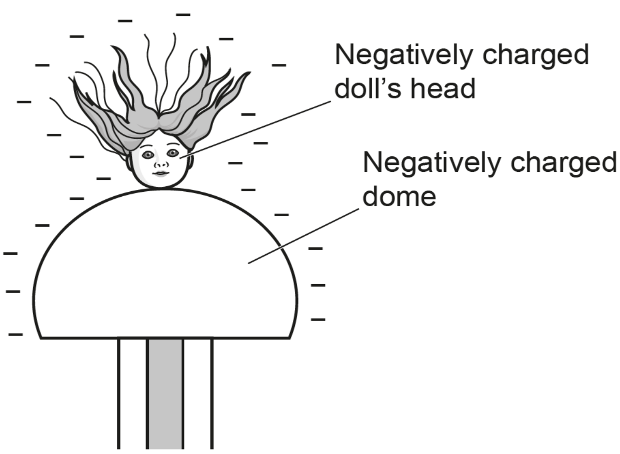
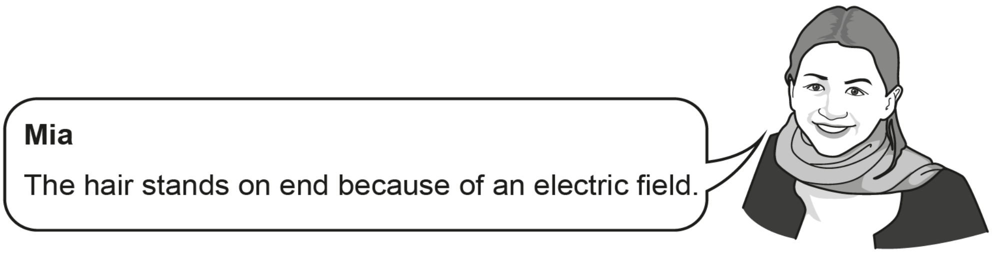


Fig. 6.2

Mia discusses the experiment with her teacher.



Explain why.

....

....

....

.... **[2]**

Very few candidates demonstrated an understanding of this question beyond the idea of repulsion between negatively charged objects.

Teaching and learning narrative:

3.1 What is electric charge?

Around every electric charge there is an electric field; in this region of space the effects of charge can be felt; when another charge enters the field there is an interaction between them and both charges experience a force.

Exemplar 1

~~It~~ The dolls hair has gained electrons and become a charged particle, charged particles are surrounded by an electric ~~feild~~ field and when ~~the~~ two electrical fields overlap and a force is caused. Here, two like charges **[2]**
:2 are repelling eachother and the hair is tending away from the generator

This candidate has some misconceptions which can be ignored (hair…becomes a charged particle) and 'force is caused' is vague. However, charged particles are surrounded by an electric field and like charges repel gains both marks.

Question 6 (b) (i)

(b) Mia's teacher switches off the Van de Graaff generator. He then uses a wooden metre rule to discharge the dome shown in **Fig. 6.3**.

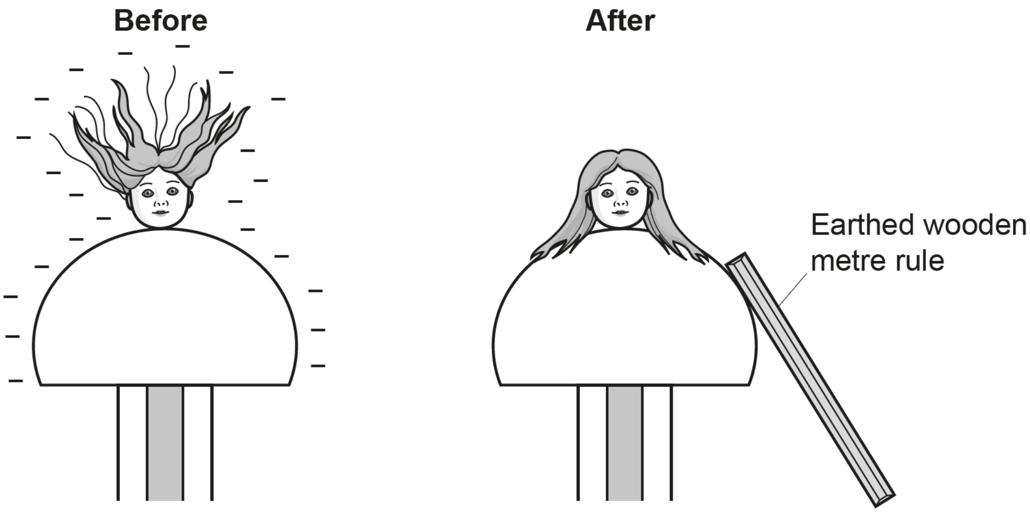


Fig. 6.3

The initial voltage of the charged dome is 120 000 V. The initial charge on the dome is 1.5 μC. The resistance of the wooden rule is $5.0 \times 10^{11}\,\Omega$.

(i) Calculate the initial current that flowed through the wooden rule.

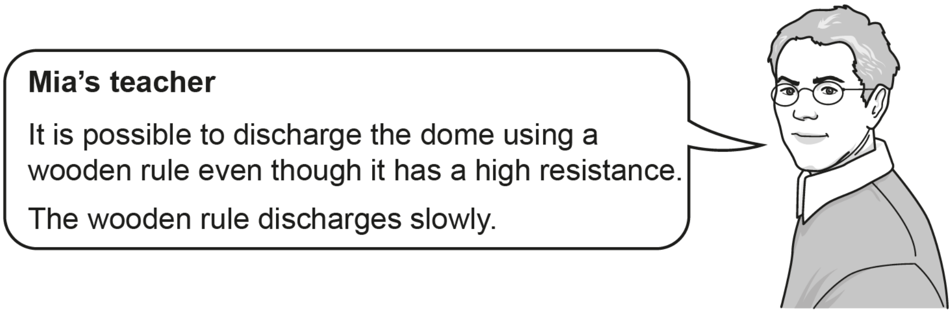
Use the Data Sheet.

Current = ... A **[3]**

Most candidates selected and applied the correct equation to calculate 2.4×10^{-7}. The common error was to invert the equation during the substitution.

Question 6 (b) (ii)

(ii) Mia's teacher talks about how he discharged the dome.



Use the information given in part **(b)** to explain why it was possible to discharge the dome using the wooden metre rule. You may include a calculation in your answer.

....

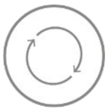
....

....

.... **[2]**

Despite calculating or attempting to calculate the current in the ruler in (b)(i) many candidates stated that the ruler could not conduct. Candidates who scored here either used information from the stem that the ruler is earthed or they used $Q = It$ to calculate the time taken for the dome to discharge. Other candidates recognised that the potential difference that drives the charge is very high.

What determines current in an electric circuit



3.2 The larger the resistance in a given circuit, the smaller the current will be.

The idea of electrical non-conductors is not in the syllabus. All materials with finite resistance are regarded as conductors.

Question 7 (a) (i)

7 Kareem investigates floating and sinking.

He places a block of wood in salty water as shown in **Fig. 7.1**. The block of wood floats.

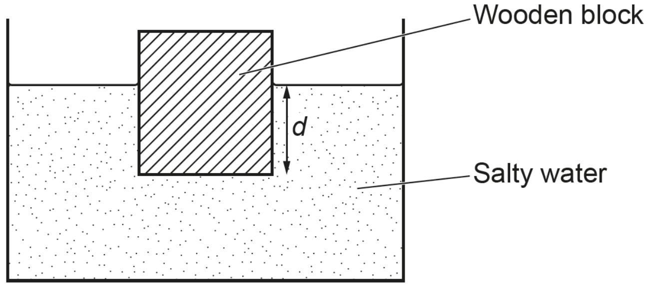


Fig. 7.1

(a) The weight of the block of wood is 0.48 N.

The water pressure acting on the base of the block of wood is 300 Pa.

The density of the salty water is 1200 kg / m^3.

Gravitational field strength = 10 N / kg.

(i) Calculate the surface area of the bottom of the block of wood.

Use the Data Sheet.

Surface area = ... m^2 **[3]**

This question differentiated well between more and less successful responses. Common errors included selecting $p = \rho gh$, inverting the equation $p = F/a$ during the substitution and converting the weight of 0.48 to a mass of 0.048.

Question 7 (a) (ii)

(ii) Calculate the depth *d* shown on **Fig. 7.1**.

Use the Data Sheet.

Depth *d* = ... m **[3]**

This also differentiated well in favour of the more successful candidates.

A majority of the candidates were unable to select the relevant equation.

How does the particle model relate to pressure in fluids?

6.4 select and apply the equation to calculate the differences in pressure at different depths in a liquid:

pressure = density × gravitational field strength × depth

Question 7 (b)

(b) Kareem compares how the wooden block and a copper block behave in different liquids.

Fig. 7.2 shows his results.

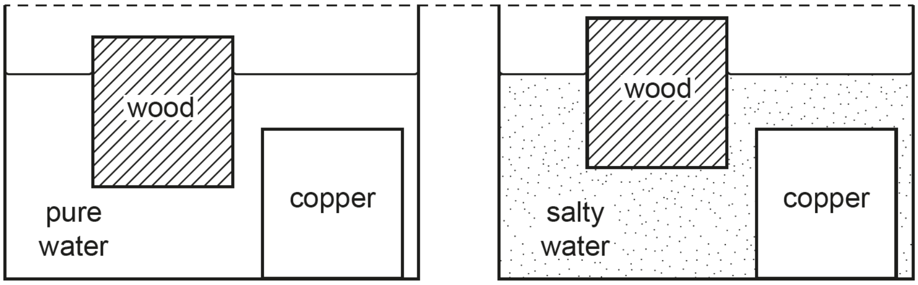


Fig. 7.2

The table shows the densities of the materials and liquids he uses.

Material	Density (kg/m^3)
Wood	750
Copper	9000
Pure water	1000
Salty water	1200

Explain why the wooden block floats higher in salty water.

....

....

....

....

.... **[3]**

A very small number of candidates scored 2 marks. Most candidates did not access this question beyond comparing the densities in the table. Candidates must understand that stating which numbers are less and which are more is not likely to score any marks.

Often, in physics, the best explanations come from analysing the relevant equation. Candidates who applied $P = \rho gh$ in (b)(ii) should appreciate that increasing ρ (adding salt to water) or increasing h (depth) will both increase P. This would gain 2 marks. Realising that the area doesn't change means that any increase in density must be matched by a decrease in the depth.

Teaching and learning narrative

6.4. The pressure at a point in a fluid increases with depth, because it is caused by the gravitational force on the fluid above that point. A fluid with greater density will experience a greater gravitational force and so exert a greater pressure.

Question 8 (a)

8 Eve investigates the reflection of white light from a mirror.

Fig. 8.1 shows her equipment.

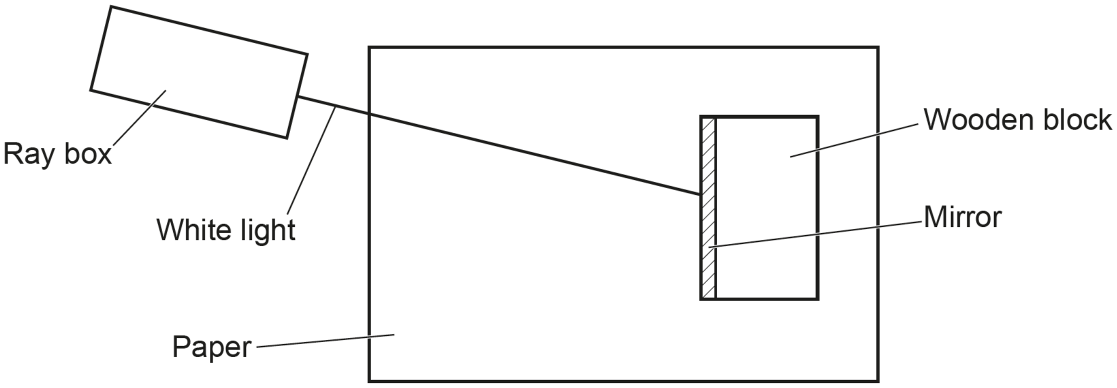


Fig. 8.1

(a) Describe a method to record the path of the ray of light shown in **Fig. 8.1**.

....

....

.... **[2]**

Many candidates gave quite vague answers to this question. For some it was clear that they were describing what to do in Fig. 8.2.; 1 mark was for the idea of marking or drawing along the path of the ray. This was often expressed quite poorly e.g., 'she should draw where she sees the light coming out' and so does not get any marks.

The second mark was for using a ruler along the path of the ray.

IaS1 What needs to be considered when investigating a phenomenon scientifically?

IaS1.2. suggest appropriate apparatus … and techniques

Question 8 (b)

(b) **Fig. 8.2** shows a ray of light striking the mirror.

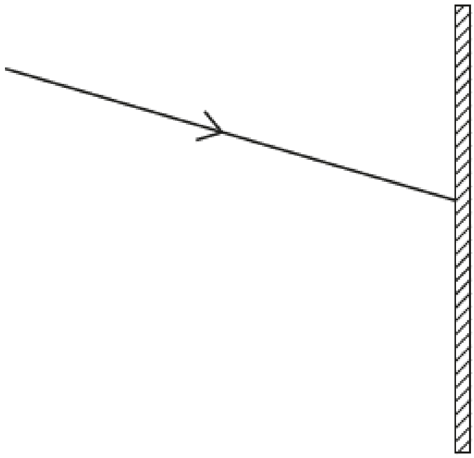


Fig. 8.2

Complete **Fig. 8.2** to show the ray of light reflected from the mirror. **[2]**

It was clear in part (b) that almost all candidates used a ruler to draw the reflected ray. Many also used protractors to give precise angles.

Question 8 (c)

(c) Eve wants to investigate whether infrared radiation reflects from a mirror at the same angle as visible light.

Suggest how she can produce and detect infrared radiation to complete this investigation.

....

....

.... **[2]**

Most candidates were able to give the name of an object that produces infrared radiation – often referring to remote controls. Fewer candidates were able to suggest detection apparatus. As mentioned previously this is a 'suggest' command word so does not rely on direct recall of syllabus content.

Question 9 (a) (i)

9 Gears are used in many household appliances.

(a) **Fig. 9.1** shows two gears A and B.

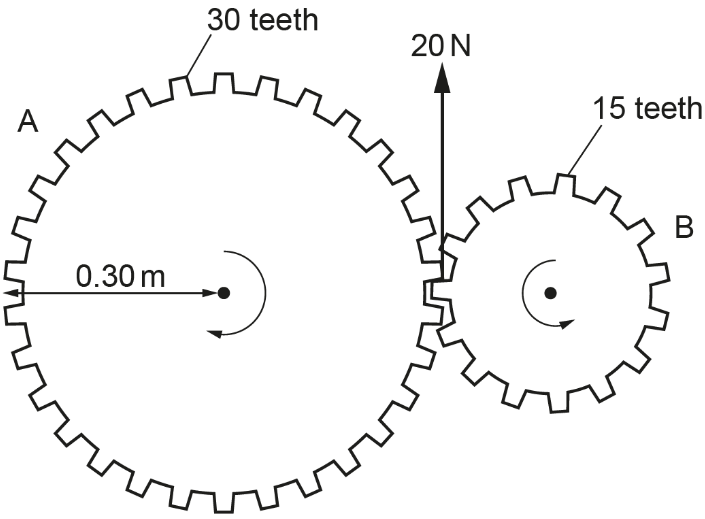


Fig. 9.1

Use the information in **Fig. 9.1** to answer these questions.

Use the Data Sheet.

(i) Gear B exerts a 20 N force on Gear A.

Calculate the moment of the 20 N force on Gear A.

Most candidates calculate 20 x 0.3 = 6

Question 9 (a) (ii)

(ii) Gear A also exerts a force on Gear B.

Compare the forces and moments acting on Gear A and Gear B.

....

....

....

.... **[2]**

Most candidates recognise that Gear B has a smaller moment than Gear A. Only a very small number of candidates recognised that the force on each gear is equal. However, this was still insufficient as a clear reference to the opposite direction of the moments or forces was also needed.

Teaching and learning narrative

4.1. Force arises from an interaction between two objects, and when two objects interact, both always experience a force and that these two forces form an interaction pair. The two forces in an interaction pair are the same kind of force, equal in size and opposite in direction, and act on different objects (Newton's third law).

Question 9 (b)

(b) Gear C is added, as shown in **Fig. 9.2**.

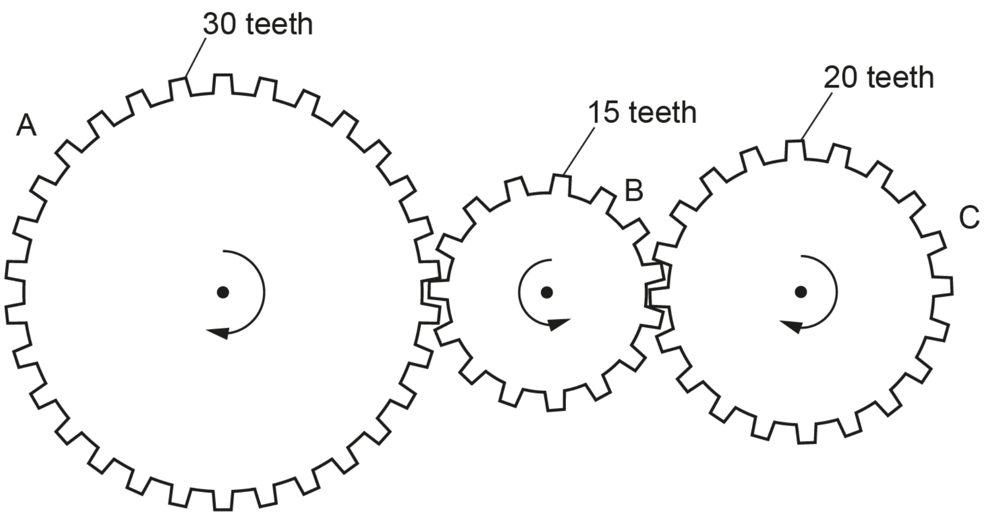


Fig. 9.2

Gear A rotates 24 times in one minute.

How many times does **gear C** rotate in one minute?

Rotations in one minute = ... **[2]**

One rotation of A corresponds to 30 teeth passing a point. On gear C, in the same time, 30 teeth must pass a point, and as C has 20 teeth, 30 teeth corresponds to 1.5 rotations of C.

For each rotation of A, C rotates 1.5 times.

Many candidates gave the answer 16, perhaps dividing 24 by 1.5 instead of multiplying it by 1.5.

Question 10 (a)

10 Ben uses a battery-powered shaver.

The shaver uses an electric motor to move the blades.

(a) Describe the changes in stored energy when the shaver is switched on.

....

....

.... **[2]**

Most candidates recognised that energy is transferred from the chemical store in the battery. They recognised that the energy is transferred electrically in the motor. At constant speed the kinetic store is unchanging. Only a very small number of candidates recognised that the thermal store increases as a result of this transfers.

Question 10 (b) (i)

(b) **Fig. 10.1** shows a simplified diagram of the electric motor in the shaver.

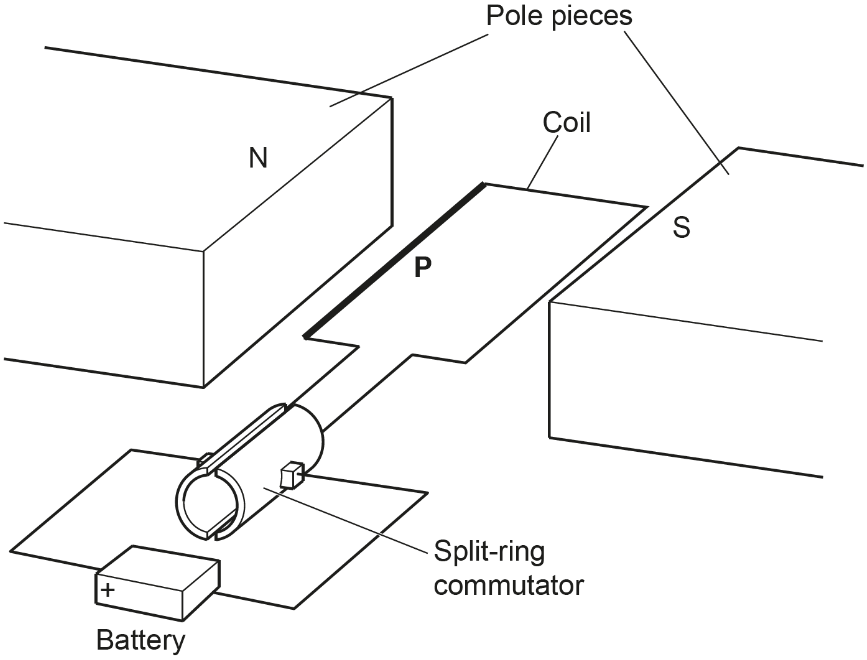


Fig. 10.1

(i) The wire **P** experiences a downwards magnetic force of 2.4×10^{-4} N when it carries a current of 0.80 A. The length of wire **P** is 0.012 m.

Use the Data Sheet.

Calculate the magnetic flux density.

Magnetic flux density = ... T **[3]**

Most candidates selected and applied the correct equation here to calculate 0.025 T

The common error was to invert the equation during the substitution.

Question 10 (b) (ii)

(ii) Explain why the coil of wire in the motor rotates.

....

....

....

.... **[2]**

In the stem of (b)(i) candidates are informed that wire P experiences a downwards force. Only a very small number of candidates used this information to deduce that the wire opposite P will experience an upwards force due to current returning to the battery in the opposite direction to the current in P.

Candidates who scored marks here referred to the interaction of magnetic fields, however they often incorrectly used ideas about the coil being attracted and repelled.

When learning Fleming's left hand rule candidates often benefit from an understanding of the catapult effect to show how the magnetic field lines interact and become closer together above or below the coil to produce a resultant force.

Question 11 (a)

11 The sensitivity of the human ear to sound waves depends on frequency. Perceived loudness is how loud a sound appears to be when you hear it.

Fig. 11.1 shows how perceived loudness depends on frequency for a typical human ear.

The range of frequencies shown is the most sensitive range for the human ear.

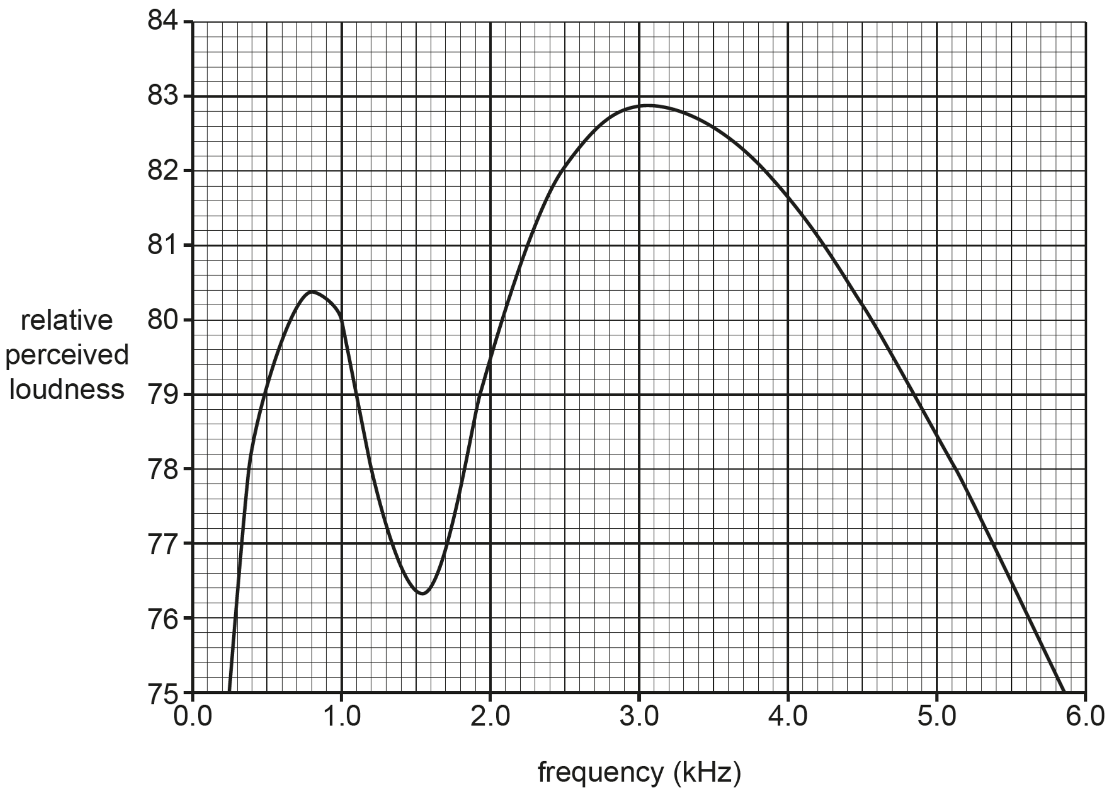


Fig. 11.1

(a) Use **Fig. 11.1** to determine the frequency at which the human ear is most sensitive.

Frequency = ... kHz **[1]**

Most candidates identified the correct frequency between 3 and 3.1 kHz.

Question 11 (b)

(b) Describe how sounds are transmitted through the middle ear and suggest how this could affect the perceived loudness of different frequency sounds.

....

....

....

....

....

.... **[2]**

Few candidates referred to the ear bones to explain how sound is transmitted. Answers were often vague e.g., by vibrations or as waves. Descriptions of damage to hair cells in the cochlea were often seen. The cochlea is the inner ear, not the middle ear.

The candidates that did refer to the bones were clearly uncertain how they worked (as a system of levers) to increase the amplitude of the vibrations caused by some frequencies. Many described the trend incorrectly as e.g., the higher the frequency the more the bones vibrate. This is not supported by the evidence in the graph.

Question 11 (c)

(c) Eve's hearing is tested and is typical for the human ear. Describe how the loudness of the sound she hears changes when she listens to a sound, with constant amplitude, that gradually increases in frequency from 500 Hz to 5000 Hz.

Use information from **Fig. 11.1**.

....

....

....

.... **[2]**

Many candidates made rubric errors here and did not use information from Fig. 11.1. The candidates that did use the graph recognised two peaks of perceived loudness and gave the x and y coordinates of at least one peak or the coordinates of the start or end of the range.

Question 12 (a)

12 The Sun formed when gravity caused a cloud of dust and gas to collapse.

(a) Use the particle model to explain why the temperature of the cloud of dust and gas increased as it collapsed.

....

....

....

....

....

.... **[3]**

Very few candidates have a clear understanding of this process. Many gained a mark for recognising that the volume of the cloud would decrease or its density and pressure would increase. Only a few candidates referred to the particles in the cloud coming closer together.

Almost all candidates then described an increase in particle collisions. There is a widespread misconception that these collisions release thermal energy. Candidates did not go as far as to describe exothermic reactions but it is clear from their responses that they think a similar process is occurring. However, this can be ignored. Very few candidates expressed clearly that the particles gain energy e.g., they move faster.

The reference to gravity in the stem of the question should encourage candidates to think about force and the movement of particles in the cloud in the direction of that force. Only the most able candidates made the connection between work done and thermal energy.

Scientific models

Teaching and learning narrative:

When a force is used to compress a gas, work is done on the gas, leading to an increase in temperature.

Misconception

Collisions between particles that have sufficient activation energy to form new compounds with lower bond energies release energy in the form of heat to the surroundings. This type of reaction is an exothermic reaction.

Exothermic reactions do not occur when gas pressure increases e.g., when air is pumped into a bicycle tyre.

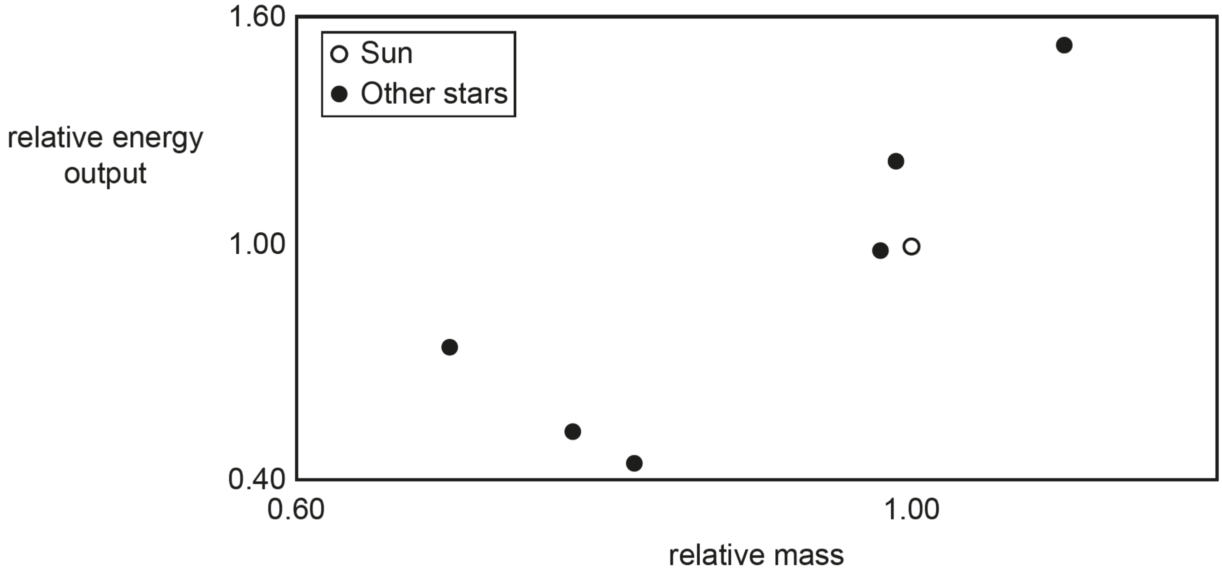
Exemplar 2

When work is done to compress a gas, temperature rises. In this case gravity did work to compress the gasses, which can be as they are not in a rigid structure, therefore causing the temperature rise to create the sun. [3]

This candidate is one of a handful to refer to work done in raising the pressure of a gas. Alas, the candidate does not use the particle model in their answer. **2 marks were given in the first two lines.**

Question 12 (b) (i)

(b) There are many stars similar to the Sun. The graph shows the relative mass and relative energy output of several stars similar to the Sun.



(i) Stars with a larger mass exert a larger gravitational force.

Use this information to explain the trend shown in the graph.

....

....

....

.... **[2]**

Most candidates were able to describe the trend in this scattered data. The explanation was beyond the abilities of almost all candidates, although a very small number of candidates did recognise that there is an outward pressure due to fusion reactions. However, they did not go far enough to explain that the pressure to expand would reduce the rate of fusion (energy output) if it were not offset by an equal inward force due to gravity. Hence stars with the more gravity can sustain more energy output.

Question 12 (b) (ii)

(ii) Beth evaluates the quality of the data.

Beth

The data on the graph is very scattered. The stars do not follow the trend exactly.

Suggest why measurements of stars produce very scattered data.

....

.... **[1]**

Most candidates gave vague answers about stars being made of different things or being a long way away. Candidates who gained marks referred to the difficulty in obtaining accurate measurements. Some gained marks for referring to different stages of the star cycle.

Question 13 (a)

13 Layla is designing a torch. She builds a circuit using a cell and 6 identical light-emitting diodes (LEDs).

Fig. 13.1 shows her circuit.

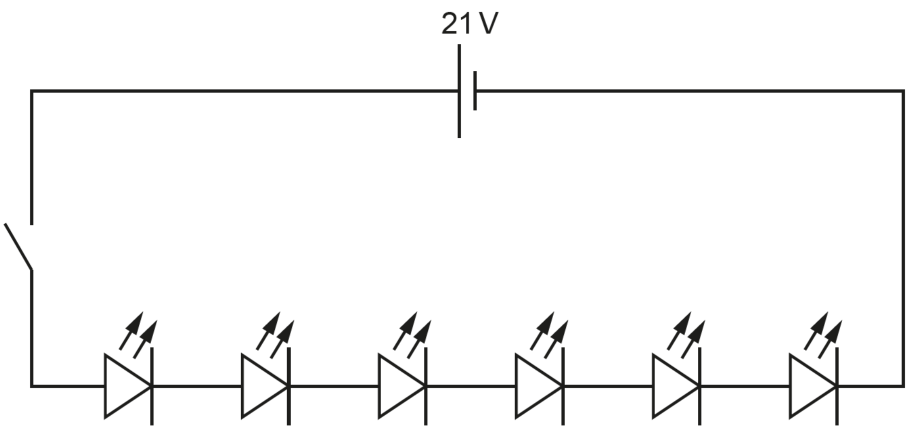


Fig. 13.1

(a) The switch is closed. Show that the potential difference across each LED is 3.5 V.

[1]

Almost all candidates were able to show how this voltage is calculated.

Question 13 (b)

(b) **Fig. 13.2** shows the voltage-current characteristic for one LED.

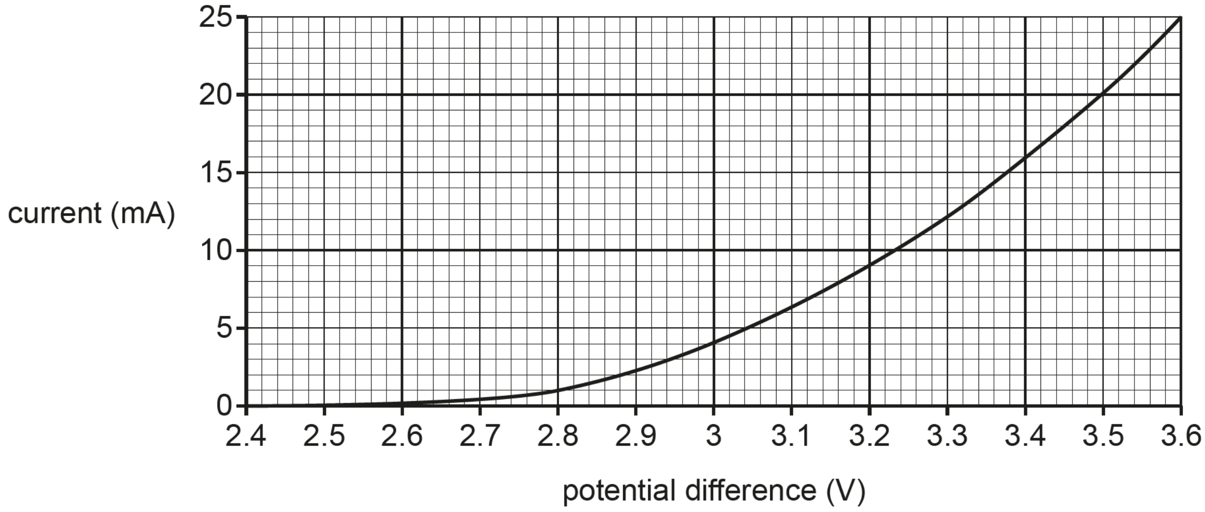


Fig. 13.2

Use the Data Sheet.

Calculate the power delivered to each LED in this circuit.

Power = ... W **[3]**

Most candidates gained a mark. But only a very small number of candidates recognised that 20 mA is 20 x 10^{-3} A (0.02 A)

Question 13 (c)

(c) **Fig. 13.3** shows how the intensity of light from each LED is related to the current.

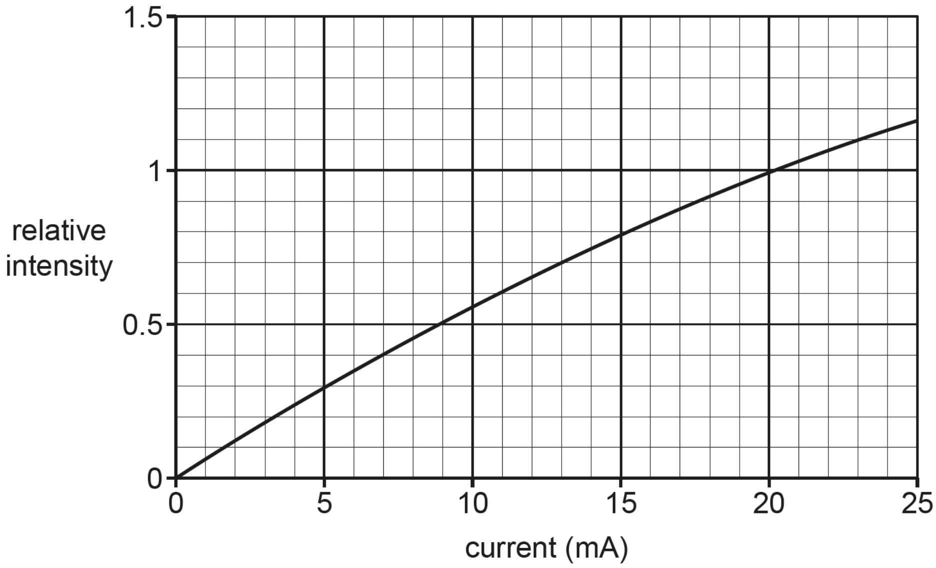


Fig. 13.3

Layla considers adding one extra LED to her circuit.

Use the data in **Fig. 13.2** and **Fig. 13.3** to explain whether the torch will be brighter with 6 or 7 LEDs.

Include a calculation in your answer.

....

....

....

....

....

.... **[3]**

Many candidates did not score any marks on this question. Those that did applied the same process in part (a) to determine that each LED would receive less voltage and would therefore be dimmer.

More able candidates followed the rubric instruction. They used Fig. 13.2 to obtain a current of 4mA (due to 3V per LED) and they then used Fig. 13.3 to obtain 0.25 relative intensity (due to 4 mA). They compared this with 1.0 relative intensity for 6 LEDs to conclude that 7 LEDs would be dimmer.

Exemplar 3

The torch will be brighter with 6 LEDS as it will have a greater potential difference across each one ~~and~~ and the higher the potential difference the higher the current and the higher the current the greater the light intensity. If you have 6 LEDS you will have 3.5 v across each LED but if you have 7 it will be 12/7 = 3v. 3v < 3.5v so 6 will be brighter at relative light intensity 1 whereas 7 will have a relative light intensity of 0.25 1 > 0.25. [3]

END OF QUESTION PAPER

This candidate draws the correct conclusion in line 1 and compares the relative intensities due to the current values of each voltage on the last three lines.

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