Qualification Accredited

Oxford Cambridge and RSA

GCSE (9–1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259

For first teaching in 2016

J259/02 Summer 2022 series

Version 1

ocr.org.uk/science

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 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 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.

Paper 2 series overview

J259/02 is the foundation tier of one of the two examination components for the GCSE (9-1) Physics B specification (21st Century Science.) Candidates will have already sat the examination for the Breadth in Physics component and this is the examination for the Depth in Physics component. The last two questions, 11 and 12, are also on the higher tier and are marked with the same mark scheme as the higher tier. These are the most challenging questions on this paper.

This component accesses content from across the whole specification. It allows candidates to demonstrate their depth of understanding of specific aspects of the content. To do well on this component, candidates need to be able to apply their knowledge and understanding to new contexts and to be able to analyse the information and ideas presented by the questions. In calculations they should write down the equation they are going to use and show their working

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• Used the information given in the question and their own knowledge in their answers. • Could select the appropriate equation from the data sheet if one was needed. • Did the required calculations and showed their working. • Were able to apply their knowledge and understanding to new situations. • Attempted all the questions.	• Did not select the appropriate equations. • Were unable to rearrange equations correctly. • Did not show the steps in their calculations. • Could not apply their knowledge to unfamiliar situations. • Gave no response to a number of questions.

Question 1 (a)

1 The table shows some information from the Highway Code.

Speed (mph)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
30	9	14	....
40	....	24	36

(a) Complete the missing values in the table.

Use the equation: stopping distance = thinking distance + braking distance

[2]

Almost all candidates answered this question successfully.

Question 1 (b)

(b) Different factors affect stopping distance.

Draw lines to connect each factor with either thinking distance, braking distance, or both thinking distance and braking distance.

Factor

Factor	
Wet road	Thinking distance
Alcohol	Braking distance
Speed	Both thinking distance and braking distance
Mobile phone use	

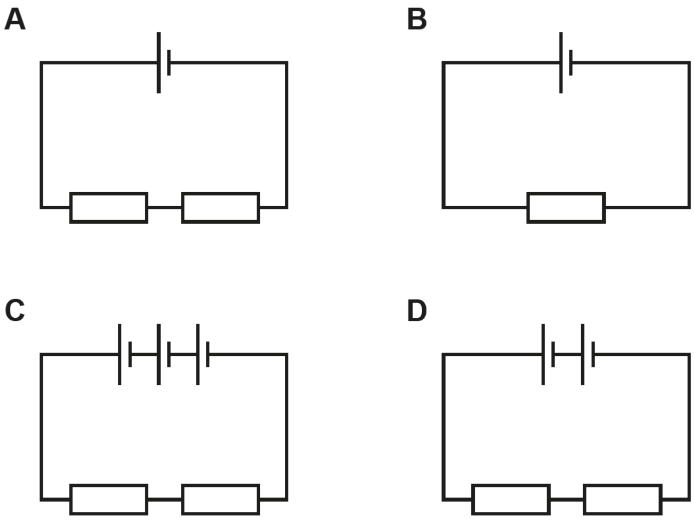
[4]

Although most candidates attempted this question, 2 marks was the most common score. A wet road was often thought to affect thinking distance, for example, and many different combinations of answers were seen.

Question 2

2 A group of students build four electrical circuits.

All the cells and resistors are identical.



For Question 2 (a) A majority of candidates chose the correct answer C, for the circuit with the greatest current flowing through its wires, but all other choices were frequently seen.

For Question 2 (b) (i) Only the most able foundation candidates correctly chose B and D as the two circuits with the same current flowing through their wires.

Question 2 (b) (ii)

(ii) Explain your answer to **(b)(i)**.

Use the equation: current = $\frac{\text{potential difference}}{\text{resistance}}$ to help.

....

....

....

.... **[2]**

Some of those who understood well enough to give the correct answer to 2 (b) (i) struggled to explain their reasoning.

Misconception

Some candidates explained that, because the current doesn't change in a circuit, the answer was A and B as they had the same number of cells, or the same potential difference.

Question 3 (a)

3 Kareem wants to use solar energy to provide electricity for his house.

He fits photo-voltaic solar panels to his roof. These solar panels use energy from the Sun to generate electricity.

(a) Which **two** statements are correct about solar panels?

Tick (✓) **two** boxes.

Solar panels generate more electricity when it's sunny. ☐

Solar panels generate more electricity at night than in the day. ☐

Solar panels generate all the electricity needed for the National Grid. ☐

Solar panels release carbon dioxide gas when producing electricity. ☐

Solar panels use a renewable source of energy to generate electricity. ☐

[2]

All almost all candidates answered this question. They knew that solar panels generate more electricity when it is sunny, and that they use a renewable resource.

Question 3 (b) (i)

(b) The total energy transferred from the Sun to one of Kareem's solar panels is 200 J.
The useful energy transferred is 32 J.
The rest of the energy is transferred to the surroundings as thermal energy.

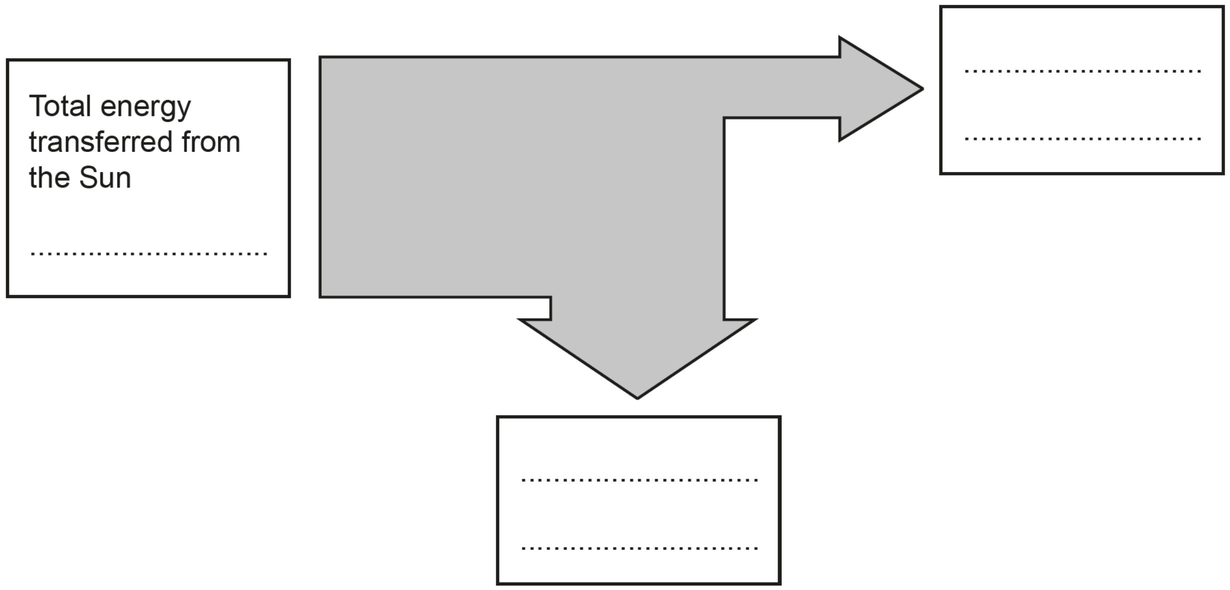
(i) Calculate how much energy the solar panel transfers to the surroundings.

Energy transferred to surroundings = ... J **[1]**

The majority of candidates were able to correctly calculate 168 J. A small minority calculated the efficiency at this point. A common incorrect answer was 200 x 32 = 6400.

Question 3 (b) (ii)

(ii) Kareem draws an outline of a Sankey diagram for this solar panel.



Complete the Sankey diagram for this solar panel. **[1]**

This was generally well answered, with most candidates scoring the mark. In general, most candidates chose to write in the numerical values, and, if they had an incorrect answer to 3 (b) (i) it was accepted here. A few candidates chose to give longer descriptions which were acceptable.

Question 3 (b) (iii)

(iii) Calculate the efficiency of the solar panel.

Use the equation: efficiency = useful energy transferred ÷ total energy transferred

Efficiency = ... **[2]**

The majority of candidates successfully calculated an efficiency using their values from the previous parts of the question.

Question 3 (c) (i)

(c) Complete the sentences about the energy transfers of the solar panels.

Put a (ring) around each correct option.

(i) The total energy transferred from the Sun is carried by

electromagnetic / sound / mechanical waves. **[1]**

Most candidates knew that the energy is carried by electromagnetic waves.

Question 3 (c) (ii)

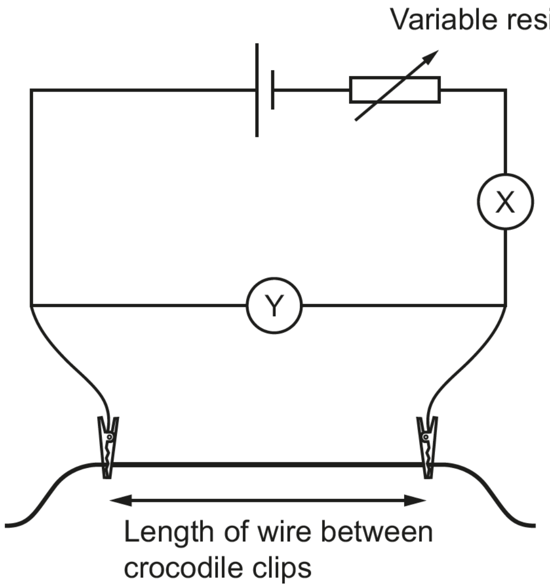
(ii) The energy transferred to the surroundings are in the form of

infrared / gamma / radio waves. **[1]**

More than half of the candidates understood that this was infrared waves. Many candidates thought that the energy transferred was in the form of gamma rays.

Question 4 (a)

4 Charlie builds a circuit to investigate how the potential difference across a **fixed** length of wire varies with the current in the wire.



(a) Name the meters X and Y.

X = ...

Y = ...
[2]

Some candidates suggested that current was measured with an ampmeter. There were a number who did not know how to answer, either omitting this part, or giving some numbers, or names of other components. Among those who could answer, some confused the two saying that X was a voltmeter and Y an ammeter.

Question 4 (b)

(b) What is the correct purpose of the variable resistor in this circuit?

Tick (✓) **one** box.

To change the potential difference keeping the current constant. ☐

To measure the potential difference keeping the current constant. ☐

To change the potential difference and the current. ☐

To keep the potential difference and current constant. ☐

[1]

Misconception

? A common answer was that the variable resistor was to change the potential difference keeping the current constant.

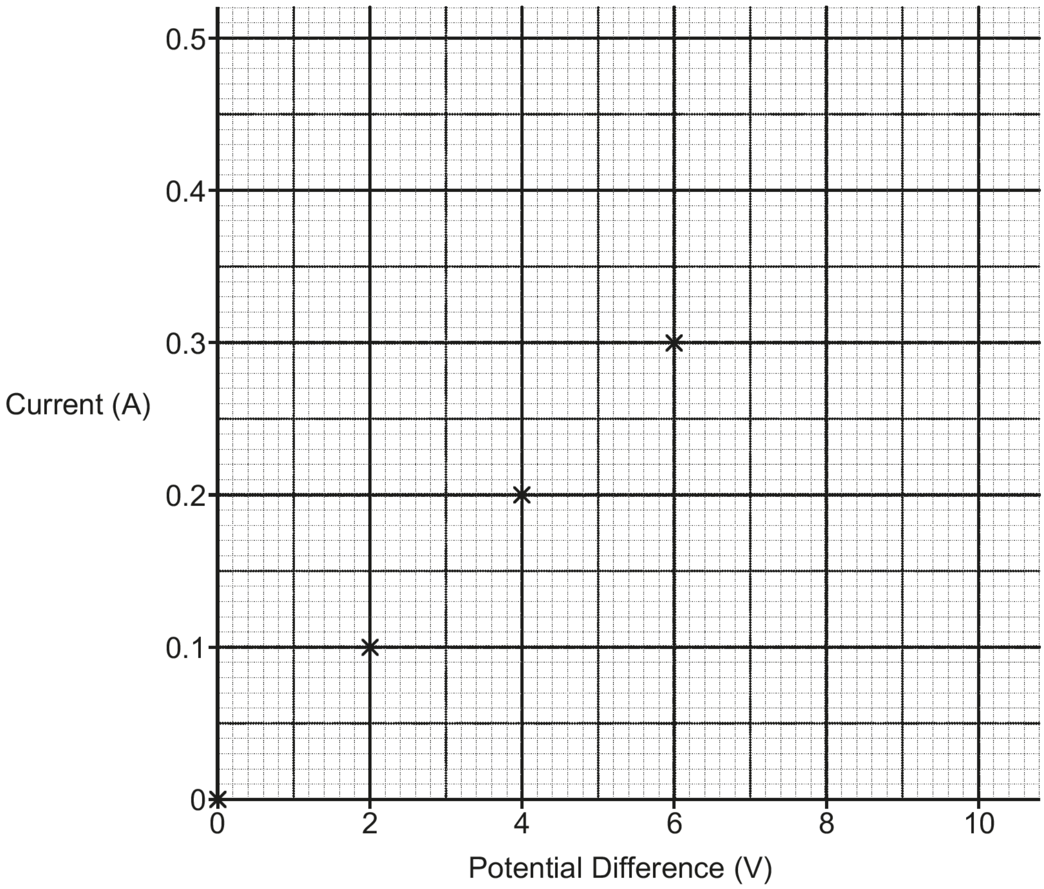
Question 4 (c) (i)

(c) The results from the investigation are shown in the table.

Potential difference (V)	**Current (A)**
0	0
2	0.1
4	0.2
6	0.3
8	0.4
10	0.5

(i) Plot the results from the table on the graph **and** draw a line of best fit.

Four points have already been plotted.



[2]

The majority of candidates plotted the points correctly and drew an acceptable straight line, but there were a number of candidates who plotted the correct points and either did not draw a line or did not draw it with a ruler.

Question 4 (c) (ii)

(ii) Use the graph to find the value of current when the potential difference is 7 V.

Current = ... A **[1]**

This was generally well answered, with candidates using points from the line, or calculating from the table.

Question 4 (c) (iii)

(iii) Calculate the resistance of the metal wire.

Use the equation: resistance = potential difference ÷ current

Use the graph or the table.

Resistance = ... Ω **[3]**

Most candidates successfully calculated the resistance to be 20 ohms. Some others successfully scored the marks using their incorrectly plotted graph, or incorrect answer to Question 4 (c) (ii).

Question 4 (d)

(d) Suggest how Charlie can find out if the resistance of the wire changes with its length.

....

....

....

.... **[2]**

This question was not well answered. Some candidates stated the result they expected Charlie to get. Some explained how to calculate the resistance. Some explained that Charlie should plot a graph to find out but did not explain what Charlie should plot. The more able candidates explained that Charlie would need to change the length of the wire, but only about half of those explained what else was required.

Exemplar 2

he could measure a smaller and larger length and measure the resistance then compare and see which has the largest resistance if it changes. [2]

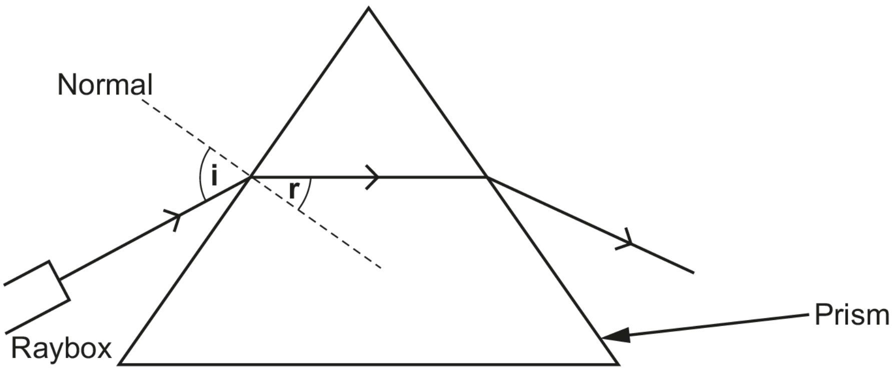
2 Turn over

This response was given 2 marks. The candidate has explained that Charlie should change, and measure, the length of the wire for the first mark, and that he should measure the resistance for the second mark. More detail of how to measure resistance, or what to measure to calculate resistance would have been equally acceptable.

Question 5 (a)

5 Sam investigates how blue light moves through a glass prism.

Sam draws a ray diagram for his experiment, showing the angles that he measures.
He measures the angle of incidence, **i**, and the angle of refraction, **r**, in degrees.



(a) Which statements about the experiment are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	True	False
A protractor is used to measure angle **i**.		
The normal line needs to be drawn at a 45° angle to the side of the prism.		
The prism needs to be moved to measure angle **r**.		
Angle **i** is always the same as angle **r**.		

[2]

Very few candidates got all four answers correct, although a majority chose two or three. The most common correct answers were to use a protractor, and that angle **i** and **r** are always the same.

Question 5 (b)

(b) Suggest **one** hazard in this experiment, and **one** way of reducing the risk of this hazard.

Hazard ....

....

Reducing risk of hazard ....

.... **[2]**

Misconception

? That a ray box is a danger to the eyes. The majority of candidates attempted this question, with almost all the candidates saying that there was a danger to eyes. Suggested ways to reduce this risk included wearing goggles or sunglasses.

Question 5 (c)

(c) Sam's results are shown in the table.

Angle of incidence, i°	Angle of refraction, r°
10	7
20	13
30	19
40	25
50	30
60	34
70	38
80	40

Give **two** conclusions that Sam can make from the results.

1 ....

....

2 ....

....

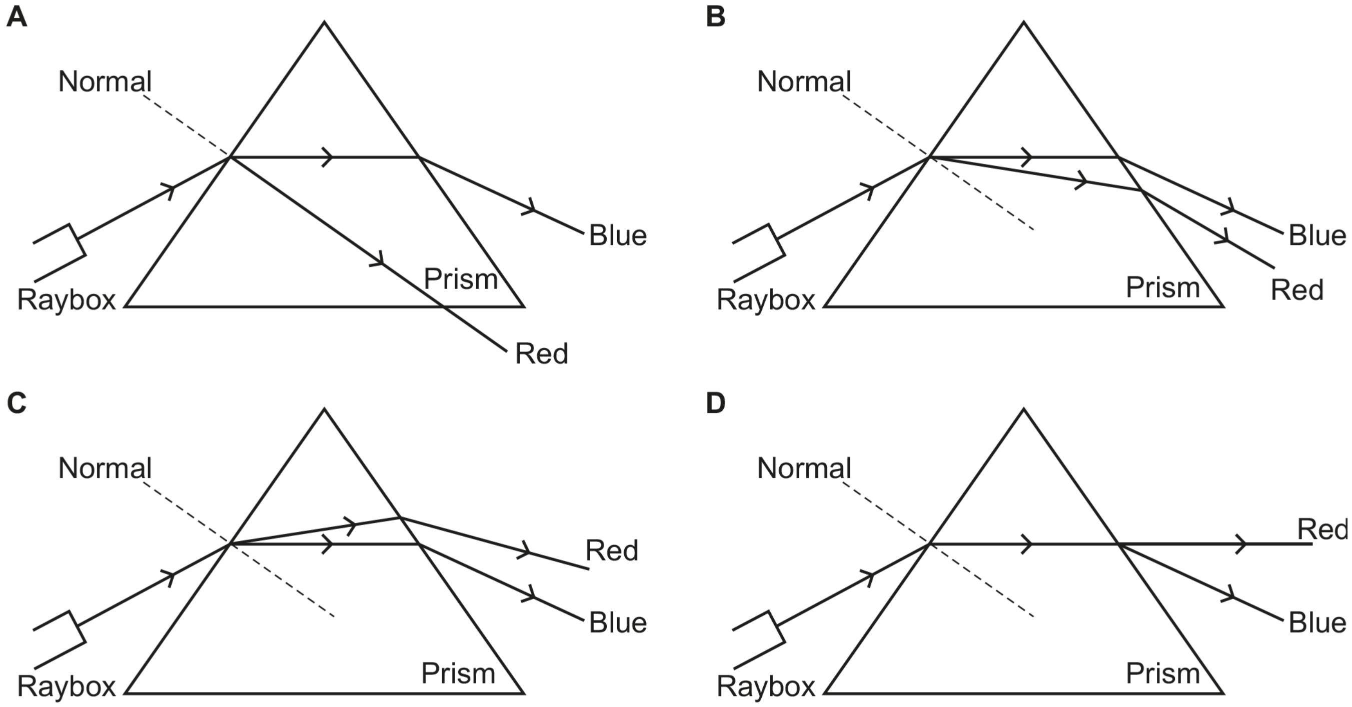
[2]

Many candidates observed that as the angle of incidence increases the angle of refraction increases. Some of the higher scoring candidates also said that the angle of incidence was always larger than the angle of refraction. Answers about the rate of increase of the angles were seen but were rare. Common answers which did not score included 'There is no pattern' and 'The angle of incidence goes up in tens.'

Question 5 (d)

(d) Sam repeats the experiment with a ray of **red** light.

Which diagram shows the correct path for the ray of red light?



Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

In general, the more able candidates were better at recalling diagram C and more of the candidates with an incorrect answer chose B. Among the lower ability candidates, A and D were also common incorrect answers.

Question 5 (e)

(e) Give **one** reason for your answer to **(d)**.

....

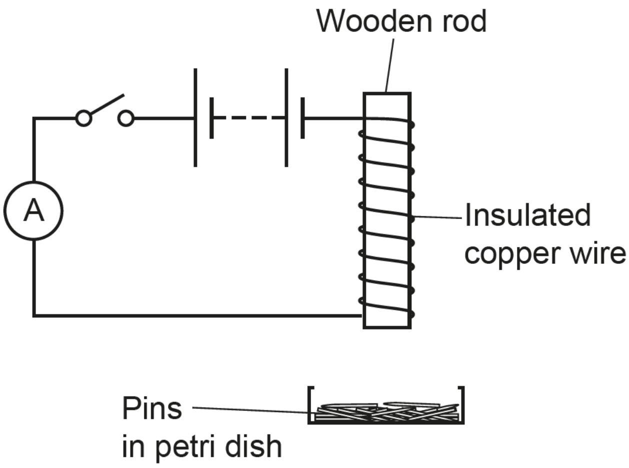
.... **[1]**

Only a very small percentage of candidates could answer this question. A few candidates described how they remembered it, for example, 'Blue bends Best', but this was not an acceptable reason.

Question 6*

6* Azmi builds a circuit to investigate how the strength of a magnetic field produced by an electromagnet affects the number of metal pins attracted to it.

He changes the number of turns of insulated copper wire on a wooden rod to change the strength of the magnetic field produced.



Azmi's results are shown in the table.

Number of turns on insulated copper wire	**Number of pins attracted to electromagnet**
20	9
30	14
40	18
50	22
60	28

Describe how the results in the table can be collected, and what conclusions Azmi can make from his results.

Include the independent, dependent, and control variables in your answer.

....

....

....

....

....

.... **[6]**

Many candidates described the conclusions that Azmi could make from his results. Many candidates understood that 'the more turns the more pins'. Some made an attempt to describe the variables. It was very rare to see an answer that made any attempt to describe how to do the experiment. Some lower ability candidates misunderstood the term 'turns' and suggested that the wooden rod was spinning.

Misconception

The names given to the types of variables are widely misunderstood. Some of the examples explained by candidates were: The control variable is the one Azmi controls, (i.e. the independent variable.) The dependent variable is the one that depends on Azmi changing it (i.e. the independent variable.) The independent variable is the one that does not, or should not, affect the experiment, (i.e. the control variable.)

Exemplar 1

The independent variable is the number of turns on the insulated copper wire. The dependant variable is the number of pins attached to the electromagnet. The control variable is the distance of the magnet from the pins. The table results ~~[illegible]~~ could be put on a graph to visually see the correlation. A conclusion Azmi could make is that the number of turns on the wire increases the magnetism.

This response from one of the more able candidates was given Level 3 (5 marks). The candidate has started by correctly identifying 3 variables. They have given a correct, but vague, conclusion; 'the number of turns' does not specify an increase or decrease and 'increases the magnetism' is a vague description. To achieve full marks they needed to explain, for example, that increasing the number of turns increased the strength of the magnetic field. the force on the pins, or the number of pins attracted.

Question 7 (a)

7 In November 2020 a space company carried out a test flight of a rocket. The rocket reached a height of 12.5 km before falling back to Earth.

(a) Complete the sentences about the change in the energy stores for the test flight of the rocket.

Use words from the list.

chemical	**kinetic**	**nuclear**	**thermal**	**electromagnetic**	**elastic**

The fuel in the rocket provided a .... energy store.

As the rocket accelerated, the useful .... energy store increased.

[2]

Answers to this part were very mixed. While a number of candidates, especially the more able, correctly chose chemical and kinetic, there were also many incorrect choices. Common incorrect answers for the fuel energy store included nuclear and kinetic. For the useful energy store many candidates chose thermal.

Question 7 (b)

(b) Describe **one** energy transfer as the rocket returned to Earth.

....

.... **[1]**

Many candidates wrote down an energy store, and all of the options from part (a) were seen suggested in candidate answers.

Question 7 (c)

(c) The rocket reached a maximum height above the surface of the Earth of 12.5 km.
The rocket had a mass of 120 000 kg.

Calculate its gravitational potential energy store at its maximum height.

Use the equation: gravitational potential energy = mass × gravitational field strength × height

Gravitational field strength = 10 N / kg

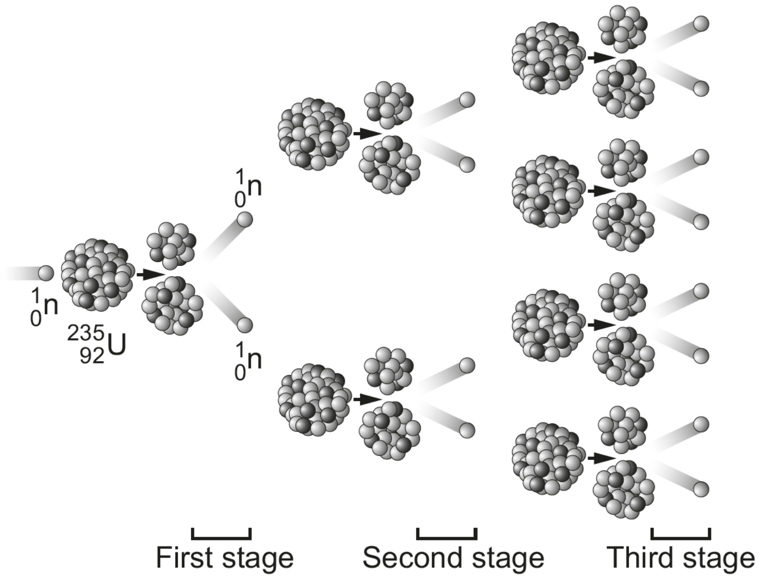
Gravitational potential energy = ... J **[3]**

Most candidates scored 2 marks here by omitting the conversion from kilometres to metres, but successfully using the equation to calculate an energy of 15 000 000 J. The correct answer was rarely seen.

Question 8 (a)

8 In a nuclear fission reactor enriched uranium-235 (U-235) is used.

The diagram shows the stages in one possible series of fission reactions.



(a) Which **three** statements are true about the series of fission reactions in the diagram?

Tick (✓) **three** boxes.

The diagram shows a chain reaction. ☐

Fission means the splitting of neutrons. ☐

Neutrons are absorbed by the U-235 nuclei. ☐

At each stage the number of nuclei doubles. ☐

Fission is the joining of two nuclei. ☐

Energy is released from the nucleus, carried away as elastic energy. ☐

Energy is released from the nucleus, carried away by microwave radiation. ☐

[3]

Most candidates scored 2 marks here, and many others scored one. Very few candidates scored 3 marks. The first option of the diagram showing a chain reaction was often chosen. The fission of neutrons was a common incorrect response.

Question 8 (b)

(b) One possible product of the nuclear fission of uranium-235 is strontium-90.

Strontium-90 emits beta particles, and decays to yttrium (Yt).

Complete the decay equation for strontium-90.

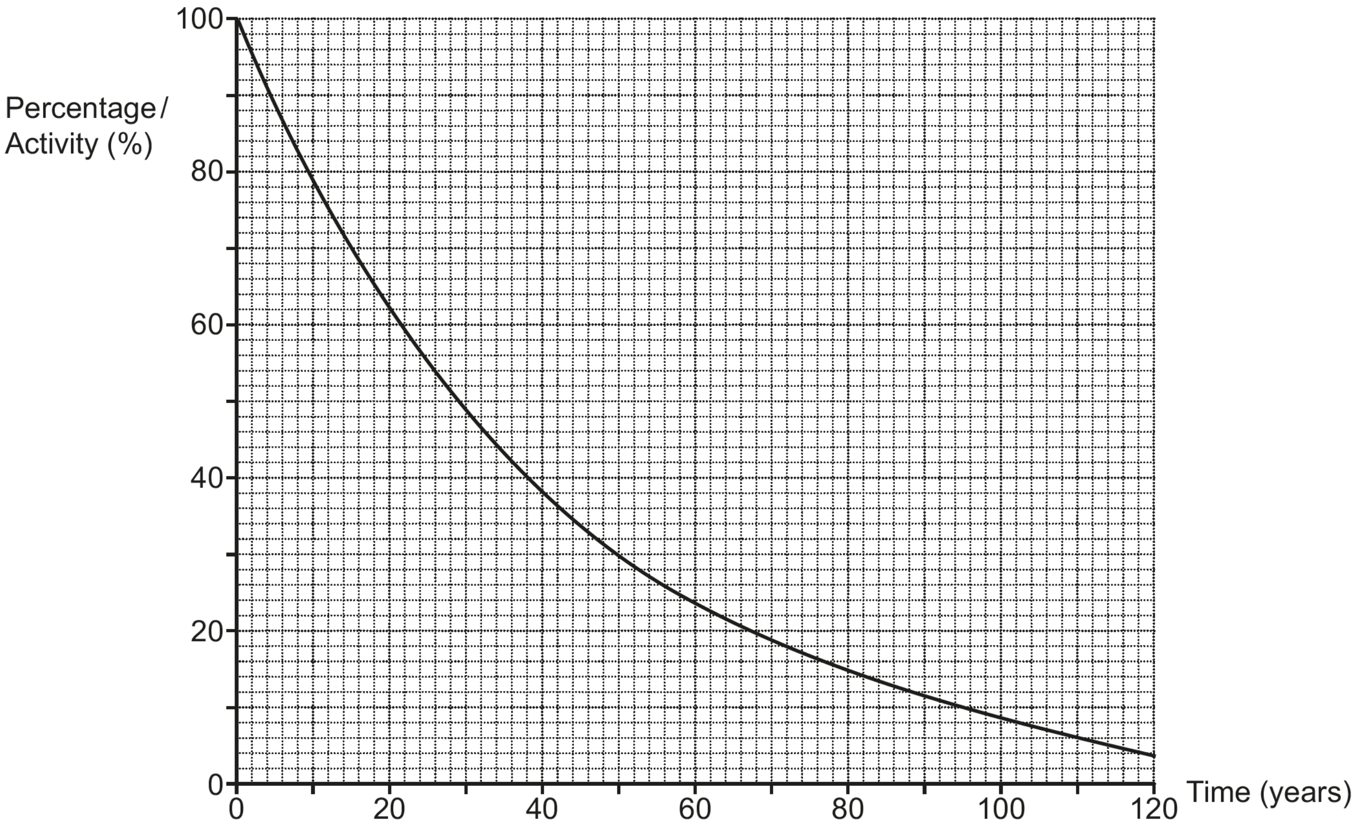
$$^{90}_{38}\text{Sr} \rightarrow \,^{\ldots\ldots}_{\ldots\ldots}\text{Yt} + \,^{0}_{-1}e$$

[2]

A number of candidates did not attempt this question. Some candidates knew that the mass number was 90 but incorrectly calculated the atomic number.

Question 8 (c) (i)

(c) The decay graph for strontium-90 is shown.



(i) Use the graph to find the half-life of strontium-90.

Half-life = ... years **[2]**

Although the most able foundation candidates completed this question successfully, half-life is not understood by the majority. Answers of 60 years and 45 years were common. Very few candidates made any marks on the graph. A few gave answers just outside the range and marking 50% on the graph might have led to a more accurate 2 mark answer, or 1 mark for showing that they understood the concept.

Question 8 (c) (ii)

(ii) Use the graph to find the percentage activity of strontium-90 after 100 years.

Percentage activity = ... % **[1]**

Many candidates were able to read the correct value from the graph. A few candidates thought the activity was about 90%.

Question 8 (d) (i)

(d) One other isotope of strontium is strontium-88 ($^{88}_{38}Sr$).

(i) How many protons are there in a strontium-88 nucleus?

.... **[1]**

Although many candidates had learned this, and gave the correct answer of 38, the most common answer was 88 protons.

Question 8 (d) (ii)

(ii) How many neutrons are there in a strontium-88 nucleus?

.... **[1]**

Fewer candidates knew how to calculate the number of neutrons, and the common incorrect answers were 38 and 88.

Question 9 (a) (i)

9 Scientists want to understand more about the similarities and differences between the Earth and the Moon.

In 1969 Neil Armstrong and Buzz Aldrin were the first men to walk on the Moon. One of their mission objectives was to return samples of Moon rock to the Earth.

(a) **(i)** Suggest why they wanted to analyse samples of rock from the Moon.

....

.... **[1]**

Most candidates were able to make a reasonable suggestion. However, some candidates simply repeated the phrase about the similarities and differences, without expanding on this idea, and did not score.

Question 9 (a) (ii)

(ii) The Moon mission was dangerous and if something went wrong it could have resulted in their death.

Suggest **two** reasons why they were willing to take this risk.

1 ....

2 ....
[2]

Most candidates gave at least one sensible suggestion, and many gave two. Reasons that did not score included suggestions such as, 'to understand why the Moon orbits the Earth'

Question 9 (b)

(b) When they returned the samples of Moon rock to Earth, scientists identified the rocks by measuring their density.

The table shows the density of some rocks.

Type of rock	Typical range of density (g/cm^3)
Sandstone	2.1–2.4
Limestone	2.5–2.7
Granite	2.6–2.9
Peridotite	3.1–3.3
Magnetite	4.9–5.2
Hematite	5.1–5.3

One of the Moon rocks had a mass of 31 g and a volume of 9.7 cm^3.

Which type of rock was this?

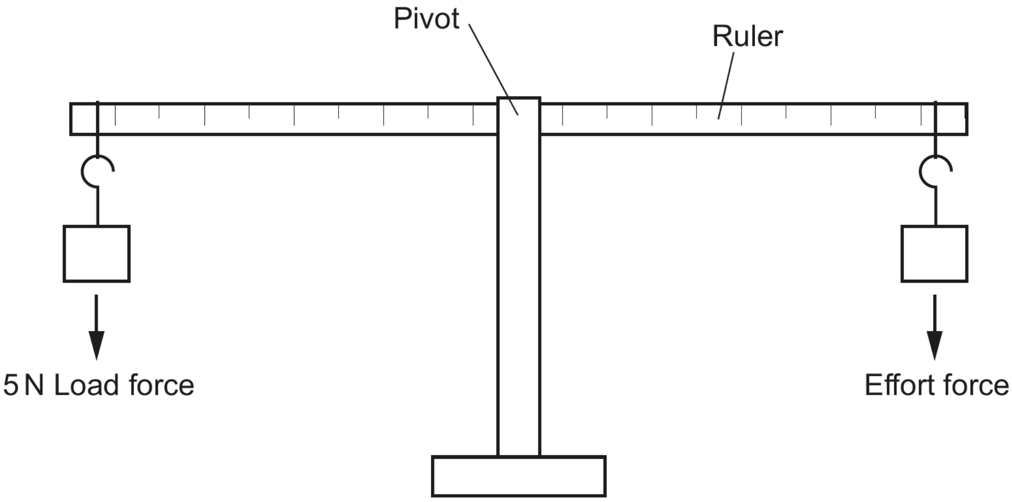
Use the Data Sheet.

Type of rock = ... **[4]**

Many candidates achieved full marks for this question. However, some candidates just wrote down one of the types of rock.

Question 10 (a)

10 Amir is using a ruler and pivot to balance a 5 N load and an effort force, as shown in the diagram.



He makes some measurements and records them in the table.

He uses this equation: moment of a force = force × distance

Measurement	Load force (N)	Distance from load to the pivot (cm)	Anticlockwise moment (Ncm)	Effort force (N)	Distance from effort to the pivot (cm)	Clockwise moment (Ncm)
A	5	20	100	5	20	100
B	5	30	150	7.5	20	150
C	5	40	200	6	30	180
D	5	50	250	10	25	250

(a) In which measurement, **A**, **B**, **C** or **D**, is the ruler unbalanced?

Tick (✓) **one** box

A ☐

B ☐

C ☐

D ☐

[1]

Just under half of candidates could answer this question correctly. All of the incorrect answers were commonly seen.

Question 10 (b)

(b) Give **one** reason for your answer to **(a)**.

....

.... **[1]**

Only the most able candidates who correctly answered part (a) were able to explain why in terms of moments. Other candidates tried to answer in terms of forces or distances and did not make their meaning clear.

Question 10 (c)

(c) Amir replaces the load force with an unknown weight, W, and places it 45 cm from the pivot.

He finds that the ruler balances when a 6 N effort force is placed 35 cm from the pivot.

Calculate the size of the unknown weight, W.

Give your answer to **2** decimal places.

Weight, W = ... N **[4]**

The majority of candidates could not do this calculation. A few candidates were able to write the answer to their incorrect calculation to two decimal places, and were given 1 mark for demonstrating this skill.

Question 11 (a)

11 Layla is investigating how the pressure of a given mass of gas changes when the volume of the gas is increased.

She uses the apparatus shown in **Fig. 11.1**, and keeps the experiment at a constant temperature.

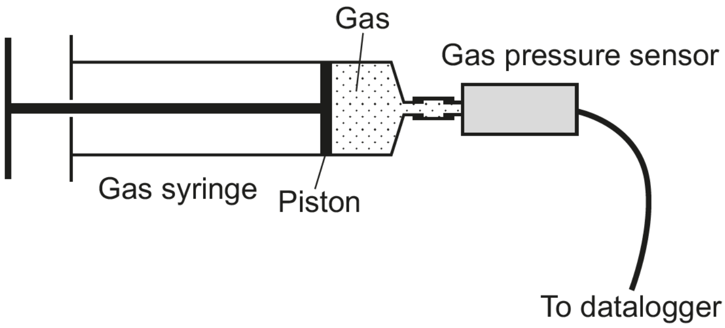


Fig. 11.1

(a) Explain why Layla needs to keep the temperature constant.

Use ideas from the particle model in your answer.

....

....

....

.... **[2]**

Only a few candidates were able to answer this correctly in terms of the particle model. Changing energy or speed was the most common correct answer, but a number of candidates said that the particles would move more, which was not sufficient for the mark. Candidates who mentioned collisions often said the particles would collide, but not that they would collide more often. It was quite common to see answers explaining why Layla needed to keep the temperature constant in terms of the effect on volume or pressure that did not mention particles and gained no marks.

Question 11 (b)

(b) **Fig. 11.2** shows a close-up image of the gas syringe and the path of a gas particle hitting the piston.

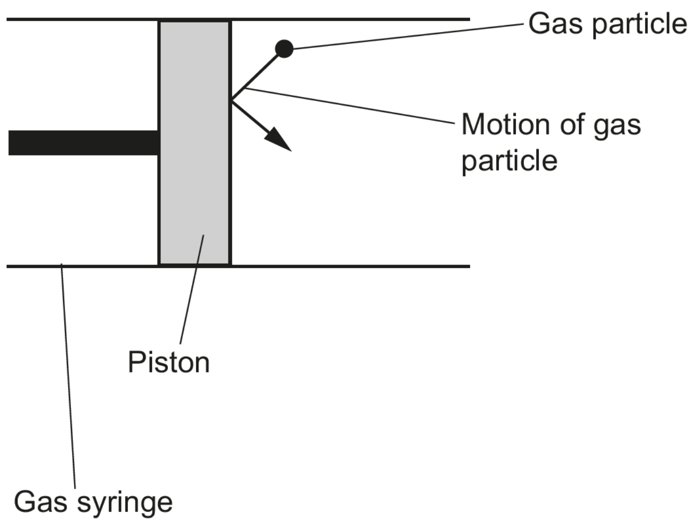


Fig. 11.2

Draw an arrow on **Fig. 11.2** to show the direction of the net force applied to the piston by the gas particle. **[1]**

Candidates drew arrows that suggested the force was to the right, upwards or downwards, as well as many other directions. Some candidates drew arrows on the particle. More candidates omitted this question than any other.

Question 11 (c) (i)

(c) Layla moves the piston to increase the volume of the gas and records her results in the table.

Volume (cm^3)	**Pressure (N/cm^2)**
4.0	8.40
8.0	4.20
12.0	2.80
16.0	2.10
20.0	1.68

(i) Calculate the total force acting on the area of the piston when the volume of the gas is $8.0\,cm^3$.

The cross sectional area of the piston is $4\,cm^2$.

Use information from the table and the Data Sheet.

Force = ... N **[3]**

A calculation that few candidates could do. A few candidates gained 1 mark for correctly selecting the equation or the force. Many candidates wrote 8 ÷ 4 = 2.

Question 11 (c) (ii)

(ii) Calculate the constant for this given mass of gas.

Use the equation: pressure × volume = constant

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

Constant = ... Ncm **[3]**

This calculation presented fewer difficulties for most candidates. However, while the most able could correctly write their answer to two significant figures (34 N cm), the majority of candidates with correct calculations scored 2 marks for leaving the answer as 33.6 N cm, but some truncated it to give 33 N cm.

Question 11 (c) (iii)

(iii) Explain what conclusions Layla can make from the results in her table.

Use data from the table to support your answer.

....

....

....

.... **[3]**

The majority of candidates scored at least 1 mark for explaining that the pressure decreased as the volume increased. A few scored 2 marks by also illustrating this using two pairs of values from the table. To show this required a comparison of two pairs of values, a small minority of candidates gave just one pair of values and did not score the second mark.

Question 12*

12* The table shows the half-life and penetration power of some isotopes, A to E.

Isotope	Half-life	Penetration power
A	5 years	Reduced by thick lead
B	5 hours	Stopped by thin aluminium
C	2 minutes	Stopped by skin
D	6 hours	Reduced by thick lead
E	47 days	Stopped by thin aluminium

A medical tracer is injected into the body, for medical imaging purposes. A medical tracer contains a radioactive isotope that emits radiation. This radiation is detected from outside the body to produce an image.

Evaluate which isotope would be best suited to be used as a medical tracer.

Use your knowledge of the risks and benefits of using radioactive isotopes for medical imaging in your answer.

....

....

....

....

....

.... **[6]**

In their evaluation, many candidates did not address risks and benefits of exposing the patient to radioactive emissions. Together with several misconceptions about half-life and penetration power, this led to a low score in many cases.

Misconception

Many candidates were aware that an isotope with a short half-life may initially have a much higher activity than one with a long half-life, and thought that this meant that isotopes A and E were the best choices, because they had longer half-lives.

Misconception

Many lower ability candidates did not understand that the radioactive material was injected into the body. They understood that, because skin was a barrier, C was not suitable, but thought that, because B and E would not penetrate through aluminium, these would be better than A and D, which would require lead screening of patient or medical staff.

Exemplar 3

Isotope B. This is because, isotope B can still ~~penetr~~ penetrate the skin, yet it's half life is only 5 hours. This means the after effects from the radiation would of gone. As for if A and E were used, the radioactive after effects could cause damage to the skin. If C was used, it would not be able to penetrate the skin and if D was used, the penetration power would cause damage to the cells within the skin. [6]

This response was given Level 2: 4 marks. In their evaluation the candidate has chosen isotope B. They have given valid reasons for choosing this based on its the half-life of isotopes A, E and C. They have discussed the damage to the cells of the skin caused by radiation. This fulfils the requirements for Level 2. Level 3 was not given because the comments about penetrating power are all limited to the skin and imply that the radiation is being directed into the body from outside, rather than being released inside the body and detected from outside.

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