OCR
Oxford Cambridge and RSA

F

Thursday 23 June 2022 – Morning

GCSE (9–1) Physics B (Twenty First Century Science)

J259/02 Depth in physics (Foundation Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9-1) Physics B (inside this document)

You can use:
- a scientific or graphical calculator
- an HB pencil

8999964861 3

J259902

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

Answer **all** the questions.

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]

(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

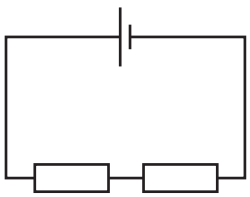
Wet road	Thinking distance
Alcohol	Braking distance
Speed	Both thinking distance and braking distance
Mobile phone use	

[4]

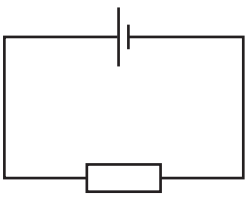
2 A group of students build four electrical circuits.

All the cells and resistors are identical.

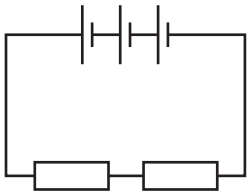
A



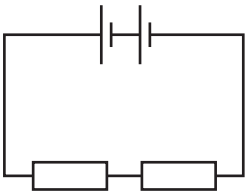
B



C



D



(a) Which circuit will have the greatest current flowing through its wires?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

(b) **(i)** Which **two** circuits will have the same current flowing through the resistors?

Tick (✓) **two** boxes.

A ☐

B ☐

C ☐

D ☐

[1]

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

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

.....

.....

.....

..... **[2]**

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.	☐

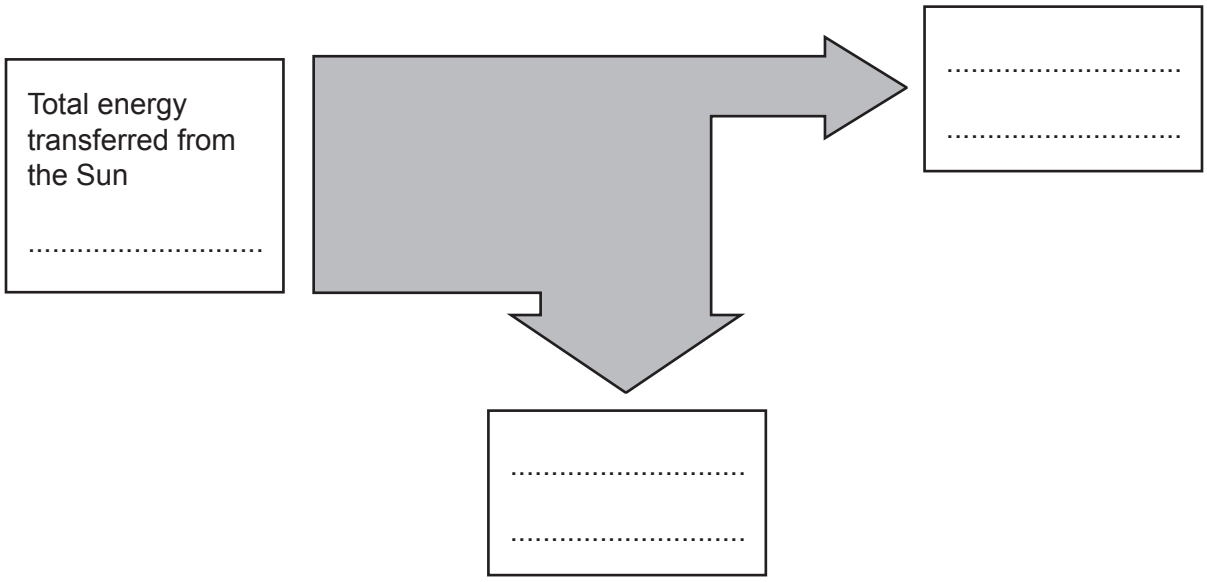
[2]

(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]**

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



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

(iii) Calculate the efficiency of the solar panel.

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

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

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

Put a (ring) around each correct option.

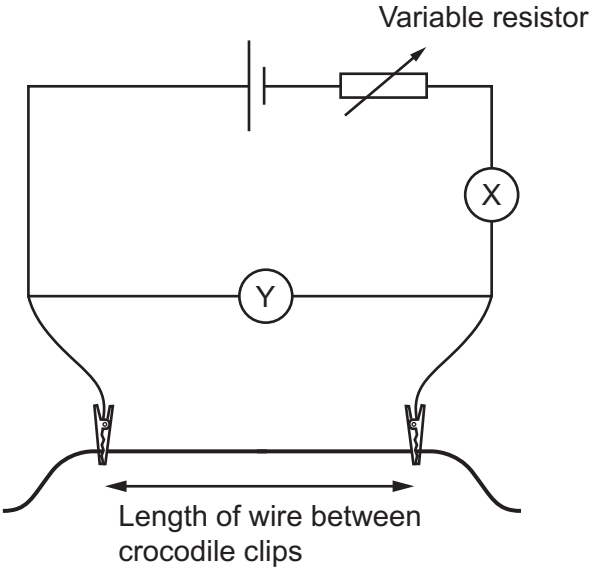
(i) The total energy transferred from the Sun is carried by

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

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

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

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]

(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. ☐

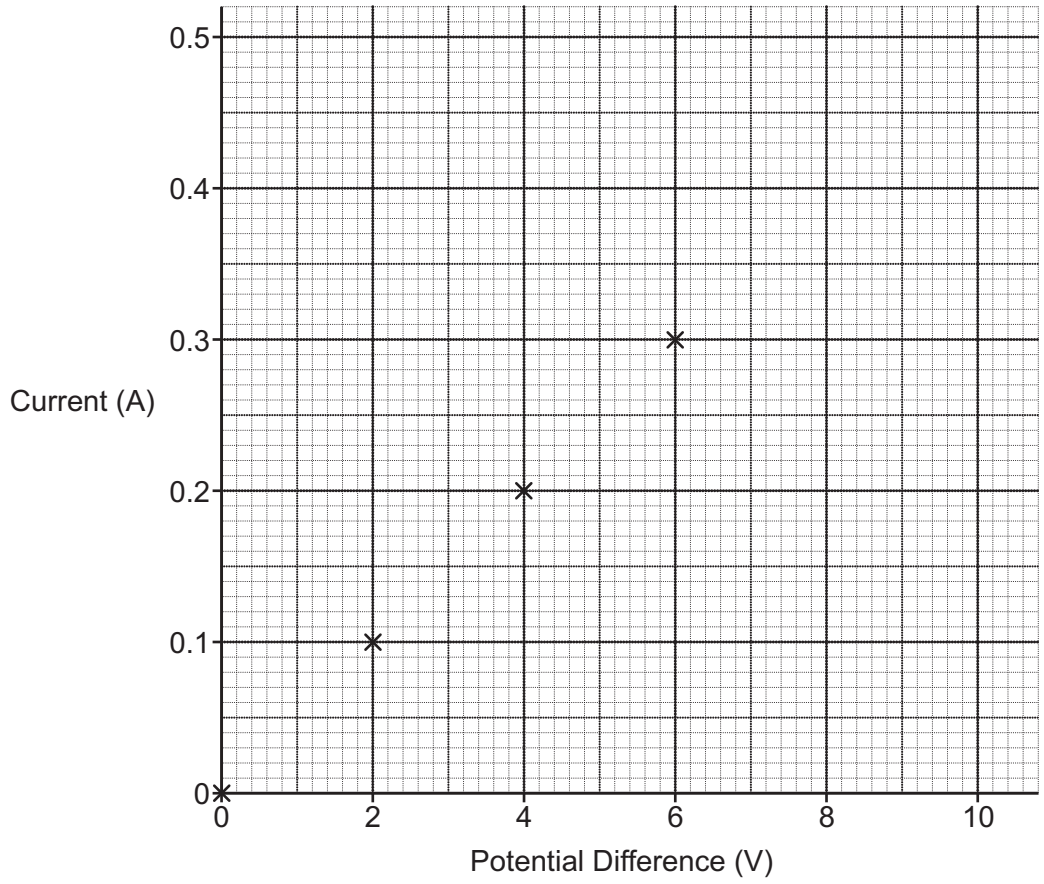
[1]

(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]

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

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

(iii) Calculate the resistance of the metal wire.

Use the equation: resistance = potential difference ÷ current

Use the graph or the table.

Resistance = ... Ω **[3]**

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

.....

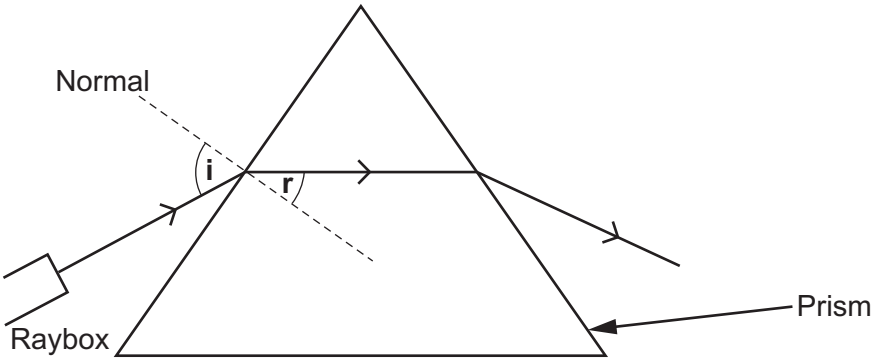
.....

.....

..... **[2]**

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]

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

Hazard .....

.....

Reducing risk of hazard .....

.....

[2]

(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 .....

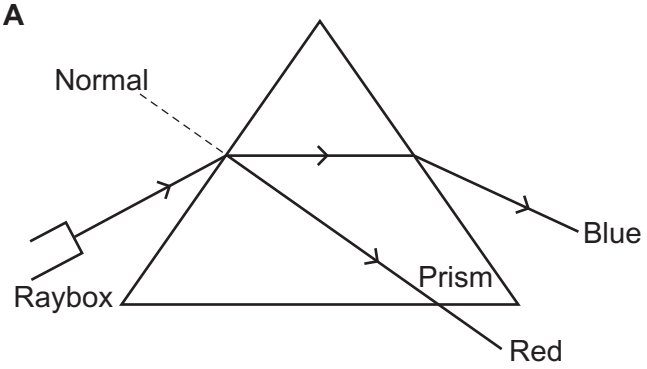
.....

[2]

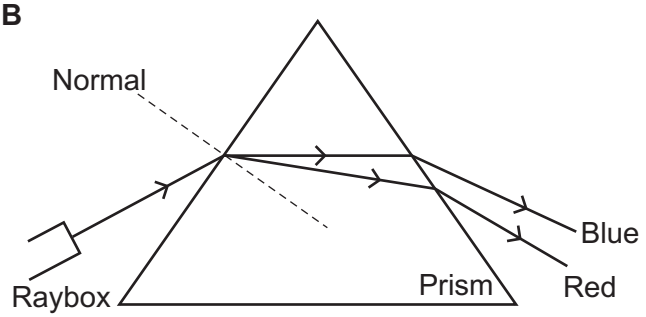
(d) Sam repeats the experiment with a ray of **red** light.

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

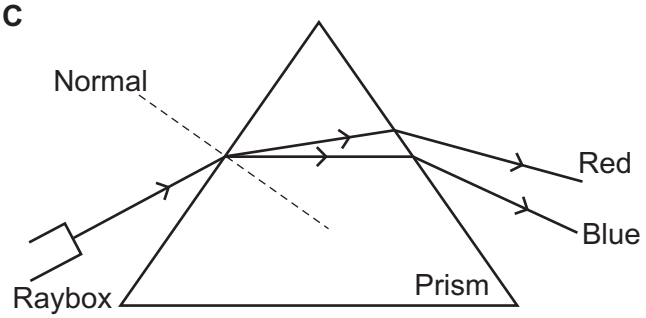
A



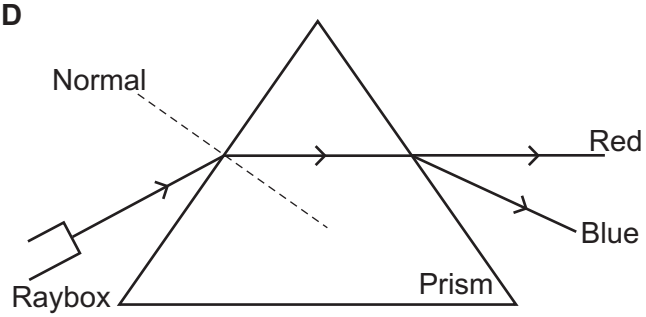
B



C



D



Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

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

.....

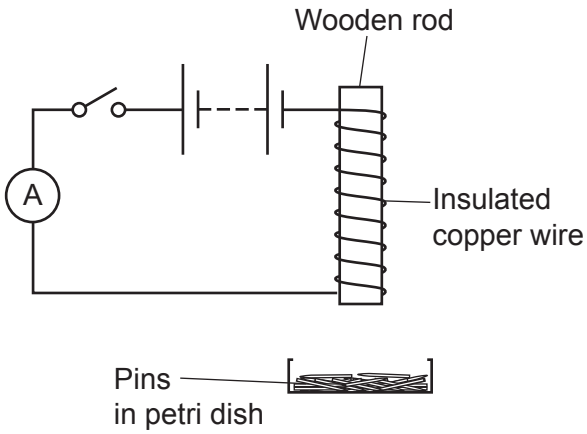
..... **[1]**

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

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

13

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]**

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]

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

.....

..... **[1]**

(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.

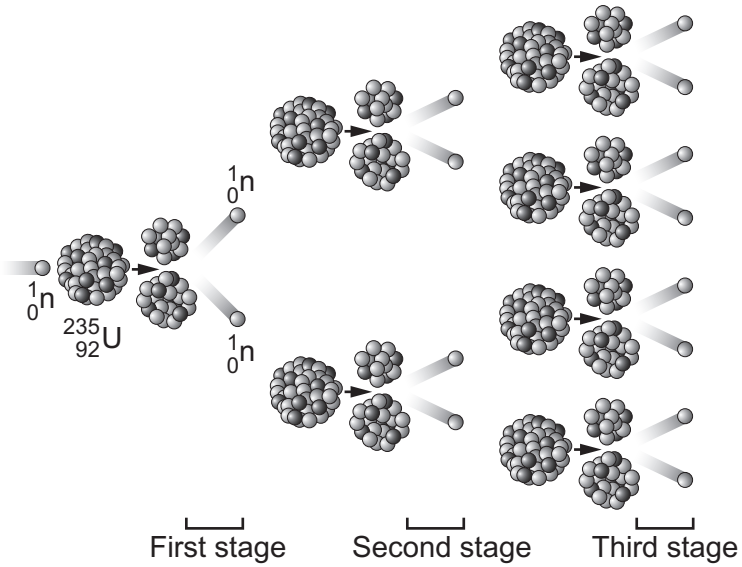
Use the equation: gravitational potential energy = mass × gravitational field strength × height

Gravitational field strength = 10 N / kg

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

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]

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

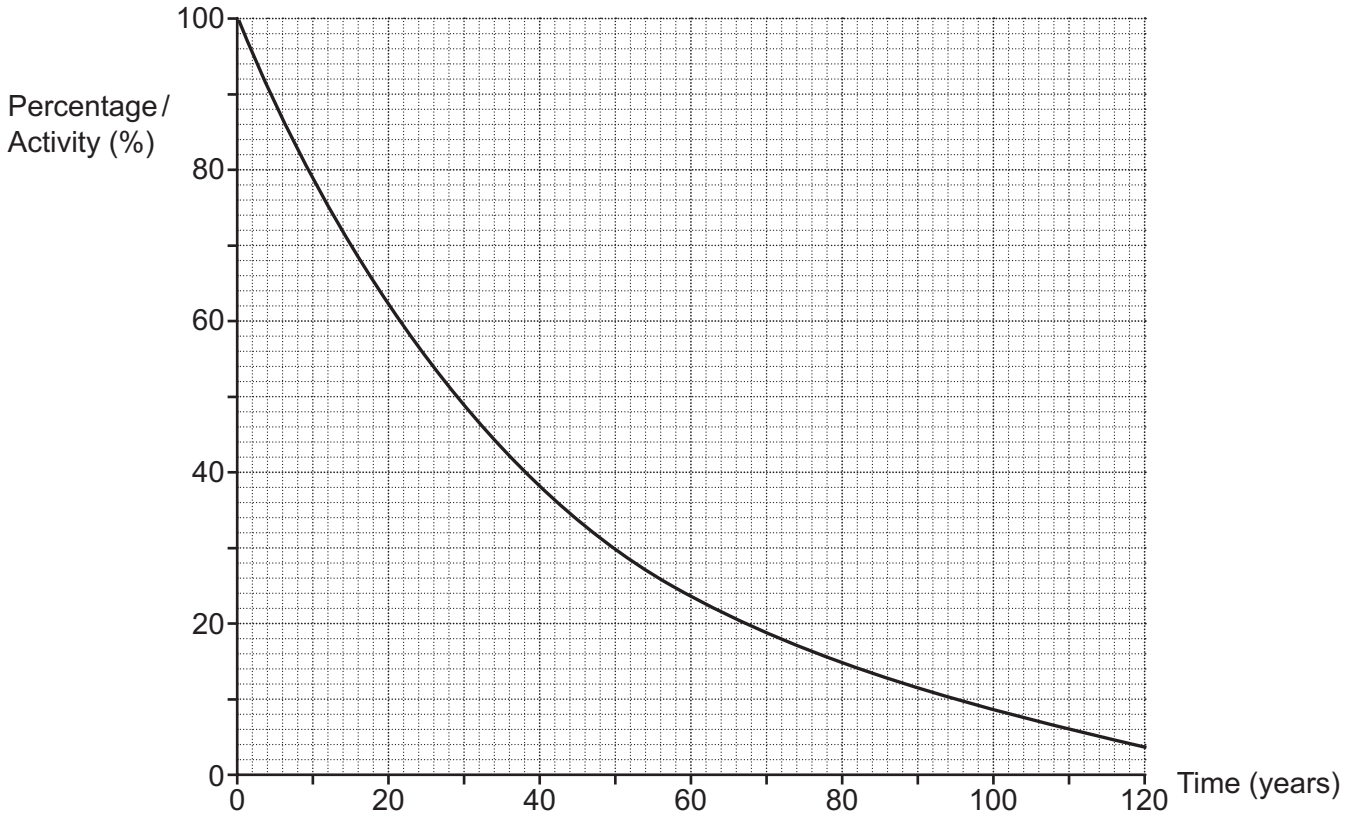
Strontium-90 emits beta particles, and decays to yttrium (Yt).

Complete the decay equation for strontium-90.

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

[2]

(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]**

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

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

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

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

..... **[1]**

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

..... **[1]**

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]**

(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]

(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?

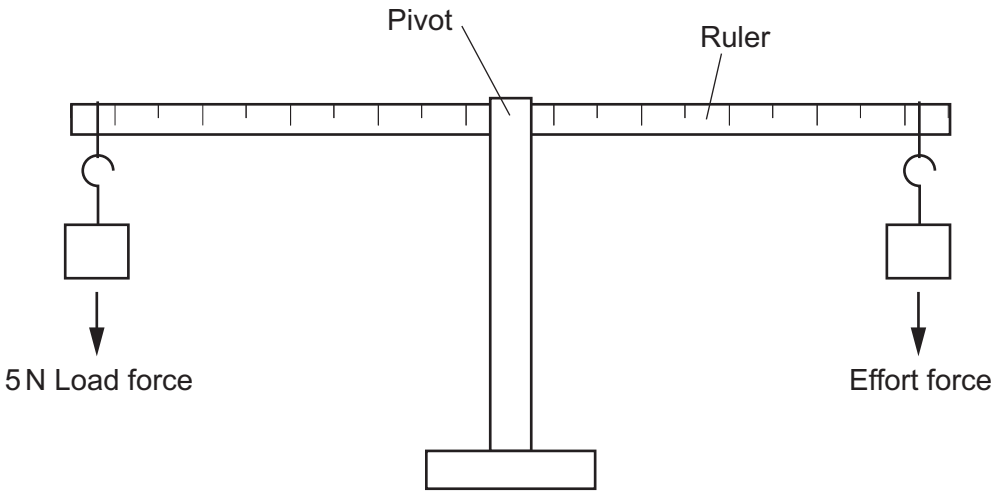
Use the Data Sheet.

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

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

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]

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

.....

..... **[1]**

(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]**

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.

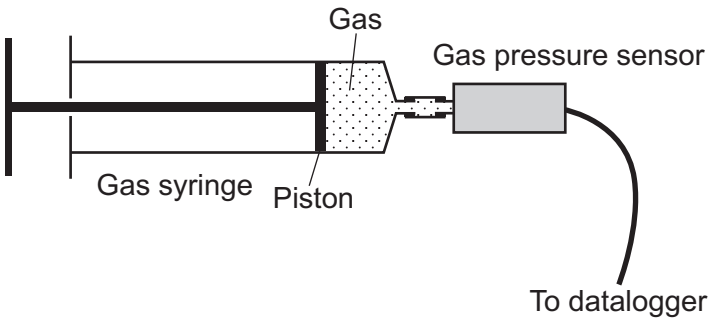


Fig. 11.1

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

Use ideas from the particle model in your answer.

.....

.....

.....

..... **[2]**

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

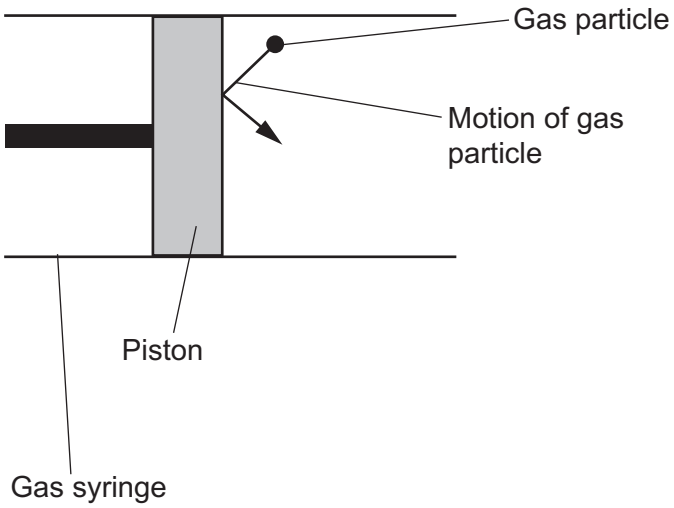


Fig. 11.2

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

(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]**

(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]**

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

Use data from the table to support your answer.

.....

.....

.....

..... **[3]**

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]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).