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OCR GCSE PHYSICS A (J249): QUESTIONS BY TOPIC

Topic P1: Matter (F)

GCSE Physics A Foundation Tier (J249) · Topic P1

50 questions · 191 marks · Mark schemes included

OCR GCSE (9–1) Physics A (Gateway Science) J249, June 2018 – June 2025

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HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic; within each sub-topic they run from the lowest mark tariff to the highest.

Click any heading or question row below to jump straight to it.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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P1.3 PRESSURE

15 questions · 79 marks

48

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QUESTIONS

50 questions · 191 marks · grouped by sub-topic, lowest tariff first



SUB-TOPIC P1.1

THE PARTICLE MODEL

14 questions in this sub-topic · 53 marks · lowest tariff first



14 Which distances are the **same**?

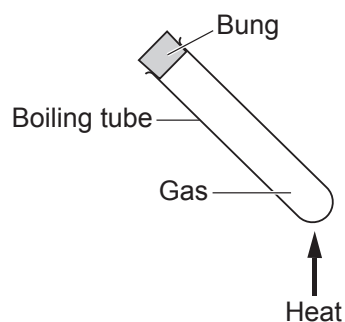
- A** $1 \times 10^{-3}\text{m}$ and $1\text{ }\mu\text{m}$
- B** $1 \times 10^{-6}\text{m}$ and 1 mm
- C** $1 \times 10^{-9}\text{m}$ and 1 nm
- D** $1 \times 10^{-12}\text{m}$ and 1 Gm

Your answer

[1]



- 1 A sealed boiling tube contains gas.



The boiling tube is heated.

What happens?

- A The particles in the gas evaporate.
- B The particles in the gas expand.
- C The particles in the gas move faster.
- D The particles in the gas move slower.

Your answer

[1]

6 Different states of matter have different densities.

Which of the following shows the states of matter in density order, starting with the lowest density?

A Solid – liquid – gas

B Solid – gas – liquid

C Gas – liquid – solid

D Liquid – gas – solid

Your answer

[1]



14 An object has a volume of 1.5 m^3 and a mass of 3.0 kg .

What is the density of the object?

Use the equation: $\text{density} = \text{mass} \div \text{volume}$

A 0.5 kg/m^3

B 2.0 kg/m^3

C 4.5 kg/m^3

D 6.0 kg/m^3

Your answer

[1]



1 10 g of ice melts and then evaporates.

What is the mass of the **gas** produced?

A 0 g

B 1 g

C 10 g

D 11 g

Your answer

[1]



3 Which row describes the particles in a **gas**?

	Distance between particles	Arrangement of particles
A	close together	random
B	close together	regular
C	far apart	random
D	far apart	regular

Your answer

[1]



- 7 An object has a mass of 37.5 kg and a volume of 0.15 m³.

What is the density of the object?

Use the equation: $\text{density} = \frac{\text{mass}}{\text{volume}}$

- A** 0.0040 kg/m³
B 2.5 kg/m³
C 5.6 kg/m³
D 250 kg/m³

Your answer

[1]



15 A molecule is made up of 10 atoms in a row.

Which measurement is a typical size for this **molecule**?

A $1 \times 10^{-15} \text{ m}$

B $1 \times 10^{-13} \text{ m}$

C $1 \times 10^{-11} \text{ m}$

D $1 \times 10^{-9} \text{ m}$

Your answer

[1]



23 An engineer is investigating the density of polystyrene.

(a) Describe how to determine the mass and volume of a rectangular polystyrene block.

.....

.....

.....

.....

.....

.....

.....

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

(b) One polystyrene block has a density of 50 kg/m^3 .

The mass of the block is 0.60 kg.

Calculate the volume of the block.

Use the Equation Sheet.

Volume = ... m^3 **[3]**



20 A student investigates density using cubes made of different types of material.

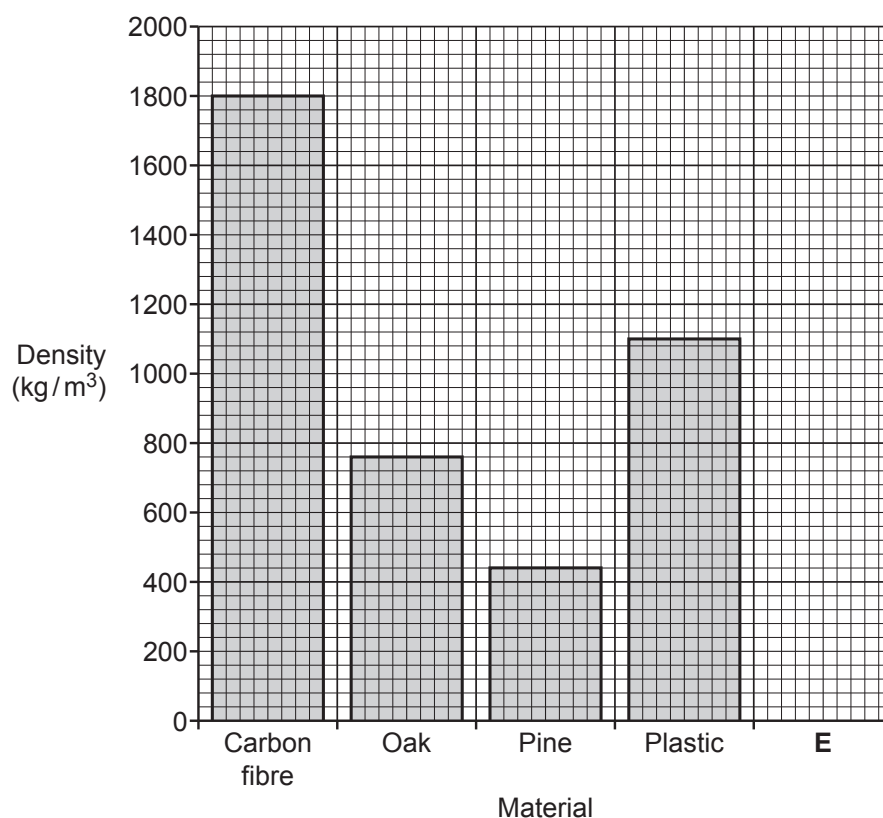
Each cube has dimensions of $5\text{ cm} \times 5\text{ cm} \times 5\text{ cm}$.

(a) Calculate the volume of **one** cube.

Volume = ... cm^3 [1]

(b) The table and the bar chart show the student's results.

Material	Density (kg/m^3)
carbon fibre	1800
oak	760
pine	520
plastic	1100



(i) The student makes a mistake when drawing one of the bars. Identify the mistake that the student has made.

.....
 [1]

(ii) Water has a density of 1000 kg/m^3 . Draw a bar for water in space **E** on the bar chart.

r11



(iii) The student wants to make a simple solid toy boat which can carry a heavy load.

Suggest which material the student should use. Explain your answer.

Material:

Explanation:

..... [2]

(c) Which **two** properties affect the density of an object?

Put a ring around the **two** correct answers.

**mass of
particles**

**particle
arrangement**

**position
on Earth**

**specific heat
capacity**

[2]



17 Atomic models have changed over time.

Old atomic model – Atoms are a positive mass with negative electrons fixed in it.

Current atomic model – Atoms are made from protons, neutrons and electrons. Protons and neutrons are in a central nucleus surrounded by a cloud of electrons.

(a) (i) Write down **two** differences between these models.

1

.....

2

..... [2]

(ii) Why did the atomic model change?

.....

.....

..... [2]

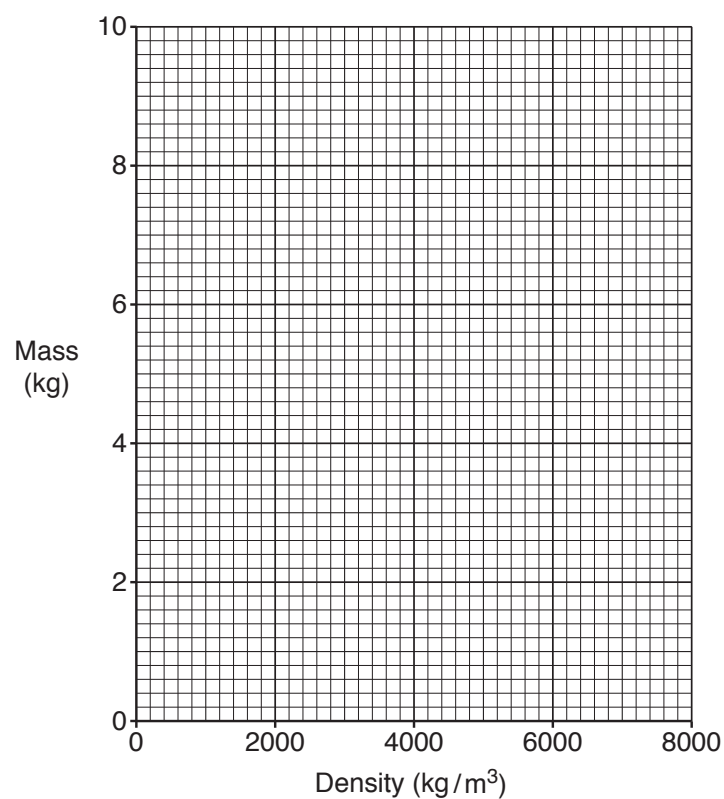


(b) A student has data on four blocks of different materials.

Each block has the **same** volume.

Block	Mass (kg)	Density (kg/m^3)
A	2	2000
B	4	4000
C	6	6000
D	8	8000

(i) Plot this data onto the graph and draw a line of best fit.



[2]

(ii) Describe the pattern shown on the graph.

.....

.....

..... [2]

16 (a) Complete the sentences about an atom.

Use words from the list.

You may use each word once, more than once, or not at all.

Atom	Electrons	Negatively	Neutrons
Nucleus	Orbits	Positively	Protons

An atom has a charged nucleus surrounded by charged electrons.

The nucleus contains protons and

Almost all of the mass of an atom is in the

[4]

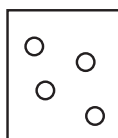
(b) (i) A swimming pool contains 9970 kg of water in 10 m^3 .

Calculate the density of water.

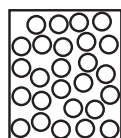
Use the equation: density = mass $\div$ volume

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

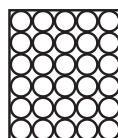
(ii) The diagrams, **A**, **B** and **C**, show the particles in three states of matter.



A



B



C

Write the letters in the boxes to give the correct order of density, from **most** to **least** dense.

Most dense —————→ **Least dense**



[1]

(iii) Explain why you chose the order in (b)(ii).

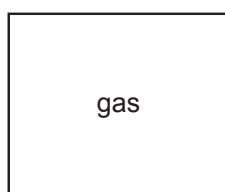
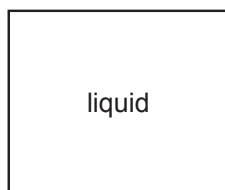
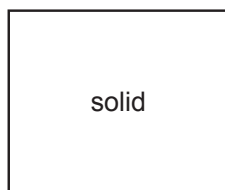
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[1]

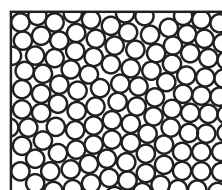
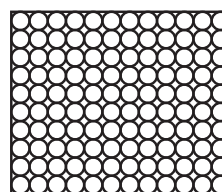
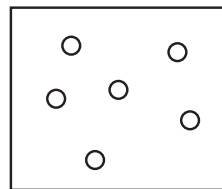
16 A student draws particle models of a solid, a liquid and a gas.

(a) Draw lines to connect each **state of matter** with its correct **particle model**.

State of matter



Particle model



[2]

(b) Which state of matter is the easiest to compress?

Tick (✓) **one** box.

Solid ☐

Liquid ☐

Gas ☐

[1]

(c) Which state of matter is the **least** dense?

Tick (✓) **one** box.

Solid ☐

Liquid ☐

Gas ☐

[1]

(d) Which state of matter has the **least** kinetic energy per particle?

Tick (✓) **one** box.

Solid ☐

Liquid ☐

Gas ☐

[1]

(e) A sealed plastic bottle containing warm air is placed into icy water.

(i) Complete the sentences to describe what happens to the air in the bottle.

Use words from the list.

decreases

increases

stays the same

The mass of the air

The speed of the air molecules

The force exerted by the air molecules on the walls of the bottle

.....

The pressure exerted by the air

[4]

(ii) Suggest what might happen to the shape of the sealed plastic bottle if it is kept in the icy water for a long time.

.....

..... [1]



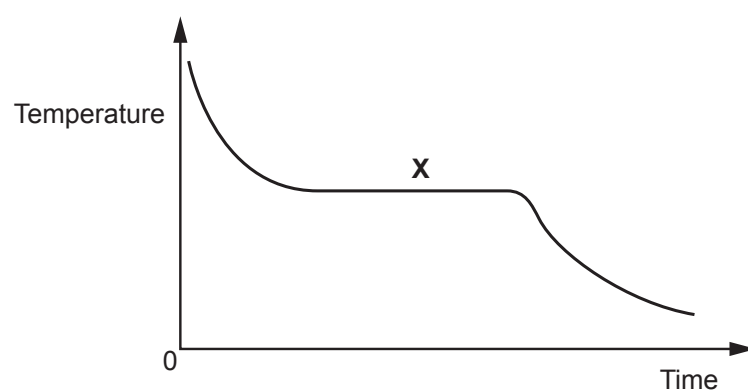
SUB-TOPIC P1.2

CHANGES OF STATE

21 questions in this sub-topic · 59 marks · lowest tariff first



15 A student studies how the temperature falls when a liquid cools.



What is happening at point **X** on the graph?

- A** Boiling
- B** Freezing
- C** Melting
- D** Subliming

Your answer

[1]

- 6 A student wants to find out which heater produces the largest temperature rise.

Look at the results she collects and the calculations she makes.

Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)
A	18	28	20
B	18	36	16
C	18	44	26
D	18	51	23

Which heater has results that are correctly calculated?

Your answer

[1]



14 A wooden block has a mass of 2 kg and a specific heat capacity of 2000 J/kg °C.

Calculate the energy needed to raise its temperature by 6 °C.

Use the equation:

Change in thermal energy = Mass × Specific Heat Capacity × Change in Temperature

A 1200 J

B 2400 J

C 12000 J

D 24000 J

Your answer

[1]



15 Energy is needed to change ice into water.

Calculate the energy needed to change 5 kg of ice into water.

Use an equation from the data sheet to help you.

Specific latent heat of melting = $3.34 \times 10^5 \text{ J/kg}$.

A 16.7 J

B 1670 J

C 1670000 J

D 1670000000 J

Your answer

[1]



5 Which of the following is an example of a chemical change?

- A** Burning
- B** Evaporating
- C** Melting
- D** Sublimating

Your answer

[1]

13 A teacher evaporates 50g of water. They collect all of the steam and condense it back into water.

Which statement is true?

- A** The mass of the steam produced is less than 50g.
- B** The mass of the steam produced is more than 50g.
- C** The mass of the water at the end is 50g.
- D** The mass of the water at the end is less than 50g.

Your answer

☐

[1]



15 The specific latent heat of fusion for lead is $24\,500\text{ J/kg}$.

Calculate the thermal energy required for 0.2 kg of lead to melt.

Use an equation from the data sheet to help you.

A 2450 J

B 4900 J

C $12\,250\text{ J}$

D $122\,500\text{ J}$

Your answer

[1]

11 A student calculates the change in the thermal energy of a 1 kg metal block.

The student heats the block and measures the change in temperature.

What other quantity is needed?

- A** Density of the metal
- B** Resistance of the metal block
- C** Specific heat capacity of the metal
- D** Volume of the metal block

Your answer

[1]



- 8 A student is studying examples of physical and chemical changes.

	Chemical change	Physical change
A	boiling water	frying an egg
B	boiling water	melting ice
C	burning wood	frying an egg
D	burning wood	melting ice

Which row in the table shows a correct example of a chemical change and a physical change?

Your answer

[1]



- 9 Mercury has a melting point of -40°C and a boiling point of 357°C .

	State at -20°C	State at 300°C
A	solid	gas
B	solid	liquid
C	liquid	liquid
D	liquid	gas

Which row in the table is correct?

Your answer

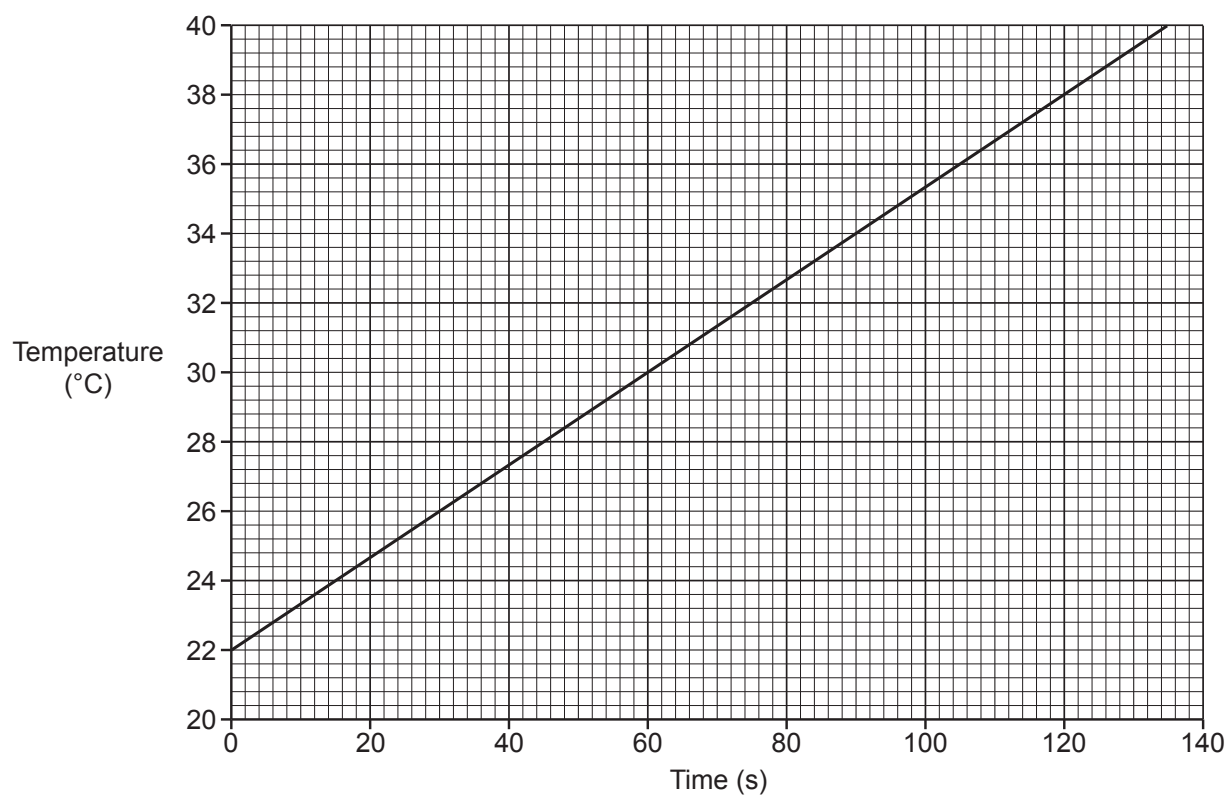
[1]



9 A student increases the temperature of a metal block.

They measure how the temperature of the metal block increases with time.

The graph shows their results.



What is the increase in temperature between 60 s and 120 s?

- A 8°C
- B 16°C
- C 30°C
- D 38°C

Your answer

[1]

1 Which statement is an example of a chemical change?

- A Boiling milk
- B Freezing water
- C Frying an egg
- D Melting ice cream

Your answer

[1]



11 Specific latent heat is the energy transferred when 1 kg of a substance changes state.

Which row lists the correct change of state for specific latent heat of fusion and specific latent heat of vaporisation?

	Specific latent heat of fusion	Specific latent heat of vaporisation
A	boiling	melting
B	condensing	boiling
C	freezing	condensing
D	melting	freezing

Your answer

[1]



- 7 The mass of an aluminium block is 1.5 kg. Its temperature changes by 5 °C.

What is the change in thermal energy of the aluminium block?

The specific heat capacity of aluminium is 920 J/kg °C.

Use the equation:

change in thermal energy = mass × specific heat capacity × change in temperature

- A 123 J
- B 276 J
- C 3070 J
- D 6900 J

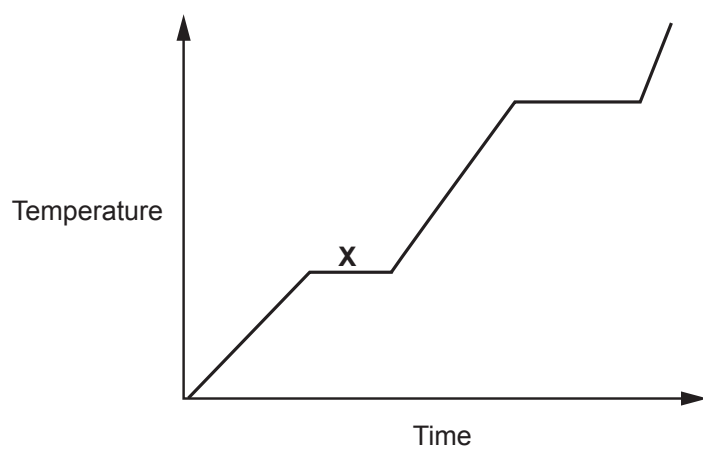
Your answer

[1]



- 4 Energy is steadily supplied to a solid substance.

The graph shows the change in temperature with time.



Which term describes what is happening to the substance at point X?

- A Boiling
- B Condensing
- C Freezing
- D Melting

Your answer

[1]

15 A large freezer contains 10.0 kg of ice at 0 °C.

How much energy is needed to change the ice into water?

Use the equation: thermal energy for a change in state = mass × specific latent heat

Specific latent heat of water = 334 000 J/kg

A 3.34 kJ

B 33.4 kJ

C 3.34 MJ

D 33.4 MJ

Your answer

[1]



21* A student does an experiment using 0.2 kg of water.

Here is some information from the experiment:

The aim is to find the energy needed to raise the temperature of the water by 20°C .

An electrical heater is used to heat the water. The temperature of the water increases by 20°C .

The **specific heat capacity** of water is $4\,200\text{ J/kg }^{\circ}\text{C}$.

Describe how the student should carry out the experiment, including the equipment used.

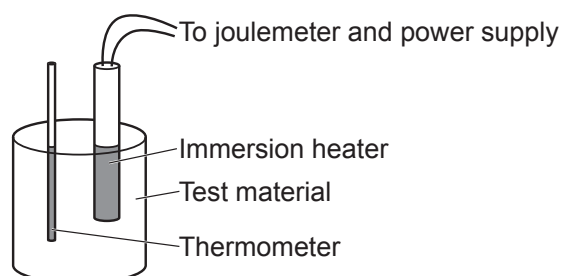
In your answer calculate the change in internal energy for the water.

You may include a diagram in your answer.



20 A scientist investigates the specific heat capacity of different solid materials.

The diagram shows the equipment the scientist uses.



(a) The scientist wants to get more accurate values for the specific heat capacities of the different materials.

Suggest **one** thing the scientist can do to improve the set-up of their equipment.

Give a reason for your answer.

Suggestion

.....

Reason

.....

[2]

(b) The table shows the results for the materials.

Material	Specific heat capacity (J/kg °C)
aluminium	900
concrete	1000
copper	385
iron	450

A chef buys a saucepan made from the material in the table which will increase in temperature the most quickly when it is heated.

State and explain which material the saucepan is made from.

Material

Explanation

.....

[2]

(c) Complete the sentence to explain the meaning of **specific latent heat of vaporisation**.

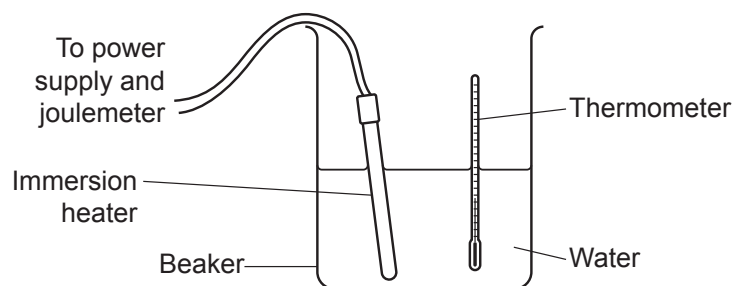
Specific latent heat of vaporisation is the energy transferred when

.....

..... [2]



18 A student completes an experiment to find the specific heat capacity of water.



He heats up 1 kg of water, using an immersion heater. He measures the temperature rise and calculates the specific heat capacity of the water.

Attempt	Energy supplied (J)	Temperature rise (°C)	Specific heat capacity (J/kg °C)
1	10 000	2	5000
2	21 000	4	5250
3	44 000	8	5500

(a) (i) Calculate the **mean** specific heat capacity.

Answer = ... J/kg °C [1]

(ii) Describe the conclusions that can be drawn from the data.

.....

.....

.....

..... [3]

(b) The actual value for the specific heat capacity of water is $4200 \text{ J/kg } ^\circ\text{C}$.

- (i) Explain why the mean specific heat capacity calculated in (a)(i) is higher than the actual value.

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

- (ii) Write down **two** problems with this experiment **and** suggest how they could be solved.

Use the diagram and results table to help you.

Problem 1

.....

Solution

.....

Problem 2

.....

Solution

.....

[4]



22 A student puts an ice cube into a beaker. The mass of the ice cube is 40 g.

The ice cube melts.

(a) (i) Write down the mass of the water produced.

Mass = ... g [1]

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

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

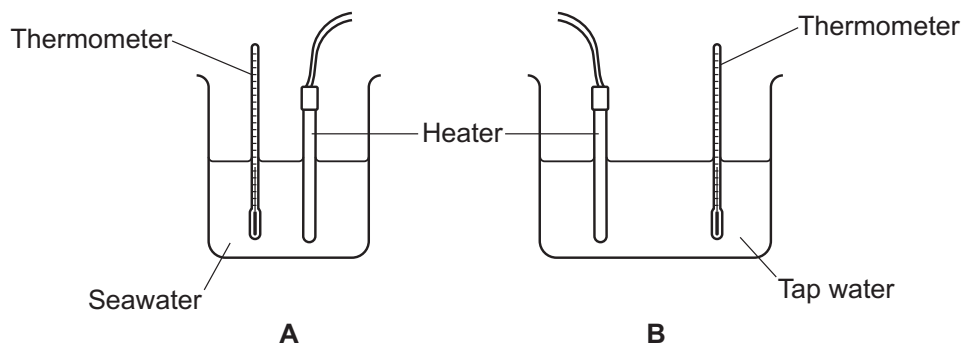
(b) Describe **one** difference between a **physical change** and a **chemical change**.

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



- (c) A student does an experiment to find the difference between the specific heat capacities of seawater and tap water.

The student places a heater and a thermometer into two beakers, **A** and **B**.
Look at the diagram.



- (i) There are 5 steps to the method for this experiment.

Complete the missing steps for this method.

Step 1 – Put seawater into beaker **A** and tap water into beaker **B**.

Step 2 –

Step 3 –

Step 4 –

Step 5 – Calculate the temperature change of beaker **A** and beaker **B**.

[3]

- (ii) Suggest **one** mistake the student made when choosing their equipment.

..... [1]

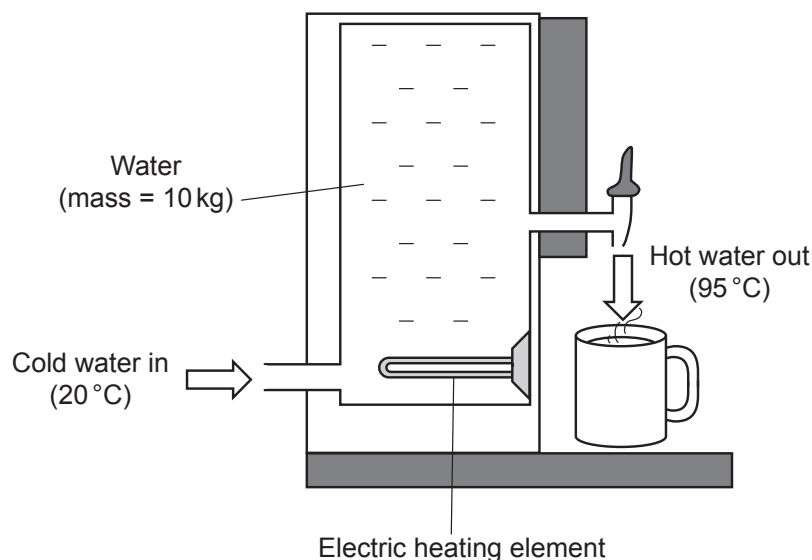
- (iii) Suggest **two** improvements to the method followed.

1

2

[2]

- 19 An electric water heater is used to make hot water for drinks.



- (a) The water heater is plugged into the mains supply and turned on.

Explain why the temperature of the water increases.
Write about energy stores in your answer.

.....

.....

.....

..... [2]

- (b) The temperature of the water increases from 20 °C to 95 °C.
The mass of water is 10 kg.
The specific heat capacity of water is 4200 J/kg °C.

Calculate the energy required to increase the temperature of the water.

Use the equation:

change in thermal energy = mass × specific heat capacity × change in temperature

Energy = ... J [3]

- (c) (i) The power of the water heater is 1840 W.
The p.d. of the mains supply is 230 V.

Calculate the current in the heating element.

Use the equation: power = potential difference $\times$ current

Current = ... A [3]

- (ii) An engineer says, 'You should use a water heater with a higher current.'

Suggest **two** reasons why this is a good idea.

- 1
.....
2
..... [2]

- (d) The water heater is plugged into the mains supply.
The water heater has a metal case.

Which wire(s) should be connected in the electric plug of the water heater?

Tick (✓) one, two **or** three boxes.

- Earth wire ☐
Live wire ☐
Neutral wire ☐

[1]

SUB-TOPIC P1.3

PRESSURE

15 questions in this sub-topic · 79 marks · lowest tariff first



12 These statements are about pressure and volume of a gas.

Which statement is correct?

- A** Volume doubles, pressure doubles
- B** Volume doubles, pressure halves
- C** Volume halves, pressure halves
- D** Volume halves, pressure stays constant

Your answer

[1]

13 A cylinder contains a gas.

The volume of the gas is halved and the temperature remains the same.

What happens to the pressure of the gas?

- A** It remains the same.
- B** It halves.
- C** It doubles.
- D** It quadruples.

Your answer

[1]

13 A student measures the weight of four boxes and the area in contact with the ground.

Box	Weight (N)	Area (cm ²)
A	50	100
B	75	250
C	90	400
D	100	500

Which box exerts the greatest pressure on the ground?

Your answer

[1]



7 Why does atmospheric pressure decrease as the height above the Earth's surface increases?

- A** The distance from the equator decreases.
- B** The number of air molecules above you decreases.
- C** The temperature of the air increases.
- D** The weight of each air molecule increases.

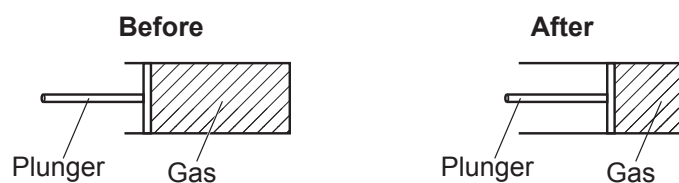
Your answer

[1]



- 11 The diagram shows a gas in a sealed syringe.

The plunger is pushed half-way into the syringe. The gas temperature stays constant.



	Volume	Pressure
A	doubles	halves
B	doubles	doubles
C	halves	doubles
D	halves	halves

Which row in the table describes what happens to the volume and pressure of the gas?

Your answer

[1]

7 What is a correct unit for **pressure**?

A kgm/s^2

B Nm

C N/m

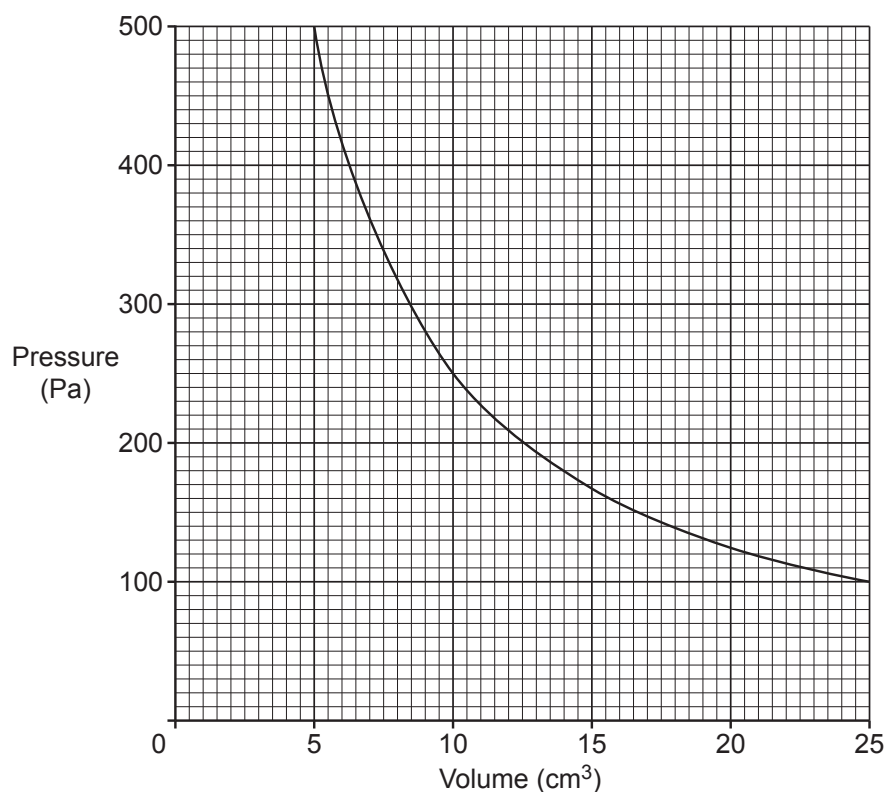
D Pa

Your answer

[1]



- 18** A student investigates the link between the volume and pressure of a gas. The student uses a fixed mass of gas in a closed container. The student plots a graph of the results.



- (a)** The student thinks that pressure multiplied by volume is always equal to the same number.

Explain why the student is correct.

Use data from the graph to support your answer.

.....

 [2]

- (b)** Complete the sentences to explain how volume and pressure are related.

Use words from the list.

You can use each word once, more than once, or not at all.

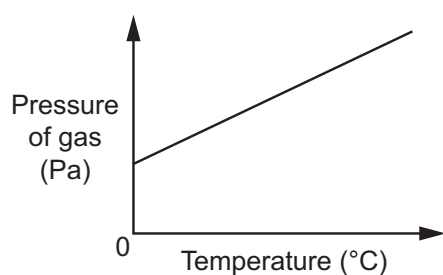
doubled halved the same

If the volume of a gas is halved, the number of collisions per second between the gas particles and the container is

The pressure is

[2]

- (c) The student then investigates how temperature and pressure of a gas are linked. The student measures the pressure of a gas as its temperature increases. The results are plotted on a graph.



Explain how temperature and pressure are linked.

Use the graph to support your answer.

.....

.....

.....

..... [2]

21**(a)** A teacher fills up a plastic bottle with water.

The teacher makes a small hole in the side of the bottle so that the water flows out.

(i) At what angle to the side of the bottle does the water flow out?

..... [1]

(ii) Explain why the water flows out of the bottle at this angle.

.....

..... [1]

(b) A force of 1.8 N acts on a 0.12 m^2 area of ground.**(i)** Calculate the pressure exerted on the ground.

Use the Equation Sheet.

Pressure = ... Pa [3]

(ii) The force is kept constant and the area the force acts on is halved.

What happens to the pressure exerted on the ground?

..... [1]

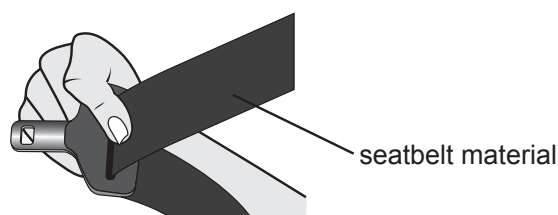


- 21 (a) A car has a total weight of 12 000 N. It has four tyres which each have an area of 25 cm^2 in contact with the road.

Calculate the pressure of the car on the road.

Answer = ... N/cm^2 [3]

- (b) Seatbelts in cars are made of a wide material that stretches in a crash.



- (i) Explain why it is important that the material is **wide**.

.....
 [1]

- (ii) Explain why it is important that the material is **stretchy**.

.....
 [1]

- (c) Children in cars use special seats with their own seatbelts.



The seatbelts for children are narrower than adult seatbelts.

Why is it safe for children's seatbelts to be **narrower** than adult seatbelts?

.....

 [2]

18 This question is about gas pressure.

(a) Complete each sentence to explain how temperature affects the pressure of a gas.

You can use each word once, more than once, or not at all.

area distance energy pressure speed

When the temperature of a gas increases, the particles have a greater average

..... and a greater average

The particles now collide more often with the sides of the container. More frequent collisions

over a fixed area produce a greater **[3]**

(b) A student investigates how pressure and volume are linked for a gas at a fixed temperature.

Their results are shown in **Table 18.1**.

Pressure (kPa)	Volume (cm ³)
200	50
250	40
400	25
1000	10

Table 18.1

The student suggests that **pressure × volume = constant**

Use the data in **Table 18.1** to work out if the student is correct.

.....

 **[3]**

(c) Explain why atmospheric pressure **decreases** with height above the surface of the Earth.

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



23 A scientist investigates how the pressure and volume of a gas are related.

The results from their experiment are shown in the table.

Pressure (kPa)	Volume (cm ³)
300	250
500	150
625	120
1000	75
1250	60

(a) Explain how these results show that pressure × volume = constant.

Use calculations in your answer.

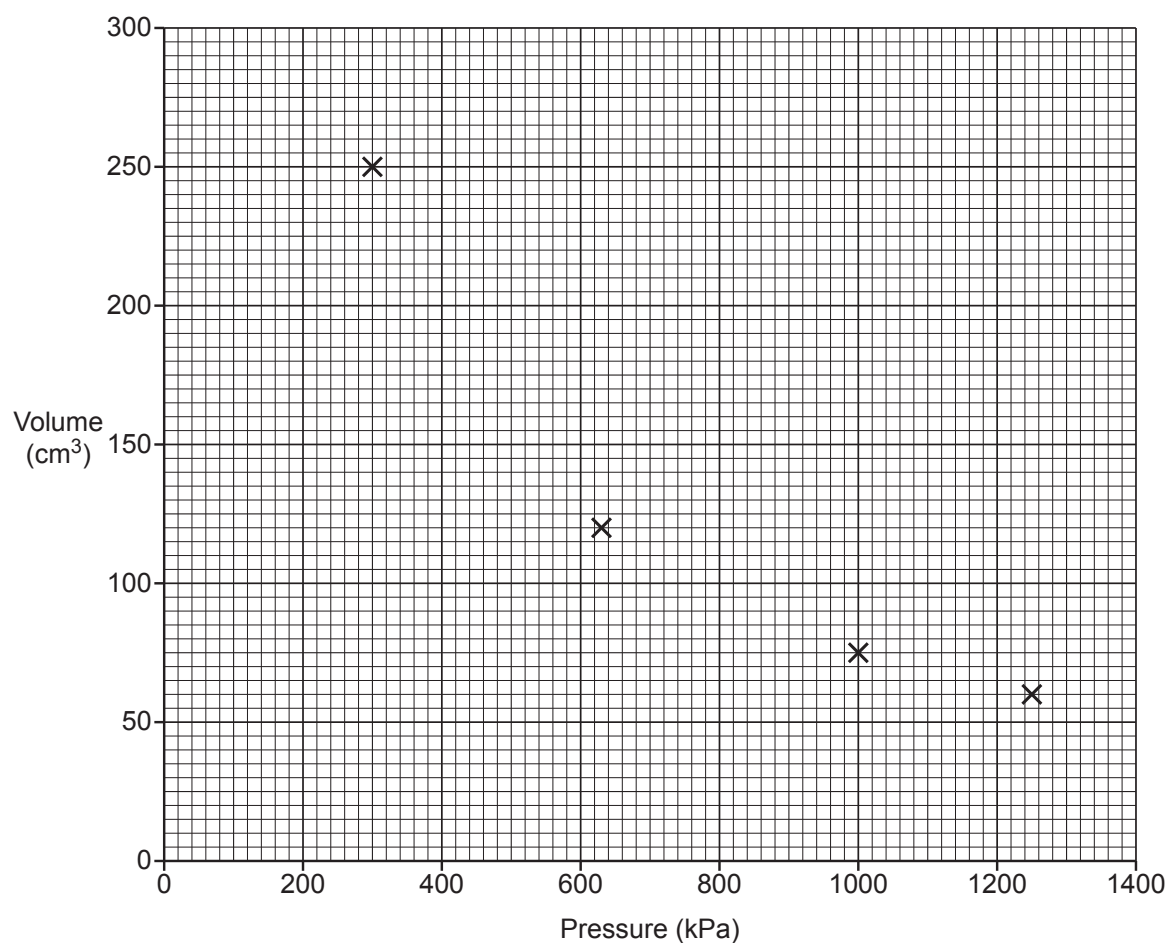
.....

.....

.....

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

(b) The graph shows the scientist's results.



- (i) Plot the missing point on the graph. [1]
- (ii) Draw a line of best fit on the graph. [1]
- (iii) Use the graph to find the volume of gas at 900 kPa.

Volume of gas = ... cm³ [1]

(c) Explain how and why atmospheric pressure changes with height above the surface of the Earth.

.....

.....

.....

..... [2]



21 Different planets have different gravitational field strengths at their surface.

Planet	Gravitational field strength (N/kg)
Earth	10
Mars	3.7
Venus	8.8

(a) (i) On which planet's surface would an astronaut have the greatest weight?

Surface

Explanation

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

(ii) Which property of a planet affects its gravitational field strength?

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

(b) (i) On Earth the astronaut has a weight of 600 N. Their feet have a total area of 0.3 m^2 in contact with the ground.

Calculate the pressure they exert on the ground.

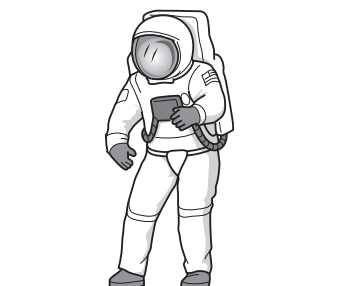
Pressure = ... N/m^2 **[3]**



(ii) The astronaut is standing on the ground. Two forces acting on them are:

- The force exerted by the Earth (their weight).
- The force exerted by the ground (normal contact force).

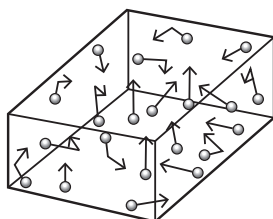
Draw and label a free body force diagram for the astronaut.



[3]

16 This question is about how gas molecules cause pressure.

- (a) The diagram shows gas molecules exerting a pressure when they collide with the walls of a container.



Complete each sentence to explain how gas pressure changes with temperature.

Use words from the list.

decreases	force	increases	size	speed	temperature
-----------	-------	-----------	------	-------	-------------

As the of the gas increases the molecules have greater average

The gas molecules collide more often with the walls of the container.

This exerts a greater over the same area and the gas pressure

[4]

- (b) Scientists often use models to help develop explanations and solve problems.

Which statements describe a **simple** model of the Earth's atmosphere?

Tick (✓) **three** boxes.

It covers the Earth to a height of about 700 km.

It covers the Earth to a height of about 700 m.

The atmospheric pressure decreases as you move away from the Earth's surface.

The density is greater as you move away from the Earth's surface.

The density is uniform.

The thickness of the atmosphere is large compared to the Earth's diameter.

☐
☐
☐
☐
☐
☐

[3]

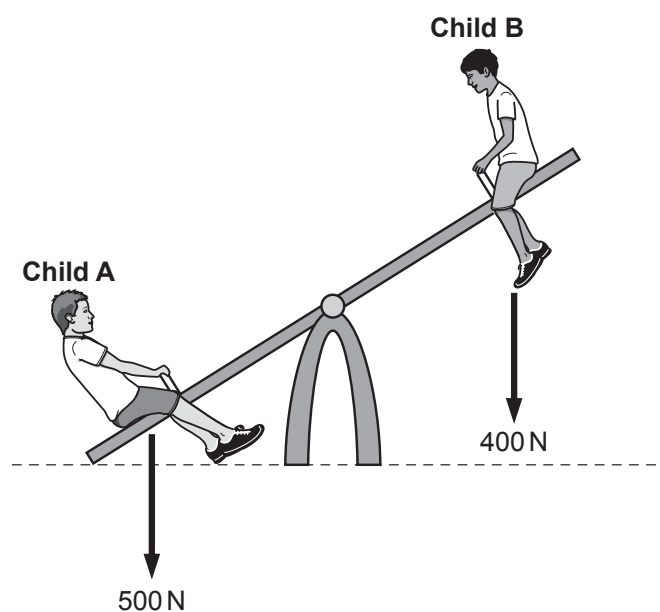
(c) Calculate the constant for a gas with a volume of 1.5 m^3 and a pressure of 5000 Pa .

Use the equation: pressure $\times$ volume = constant

Constant = ... Pa m^3 [2]



21 Two children play on a seesaw.



Both children sit **2 m** from the pivot.

- (a) (i) Calculate the clockwise and anti-clockwise moments around the pivot when the seesaw is horizontal.

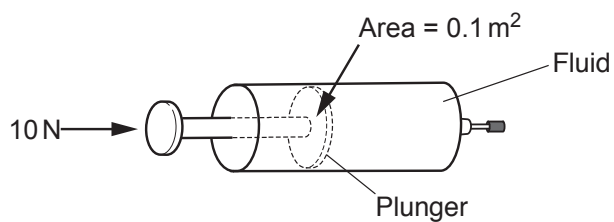
Clockwise moment = ... Nm

Anti-clockwise moment = ... Nm
[3]

- (ii) Calculate where **Child A** should sit to balance the seesaw.

Answer = ... [3]

- (b) A student tries to compress the fluid in a sealed syringe with a force of 10 N.



The area of the end of the syringe is 0.1 m^2 .

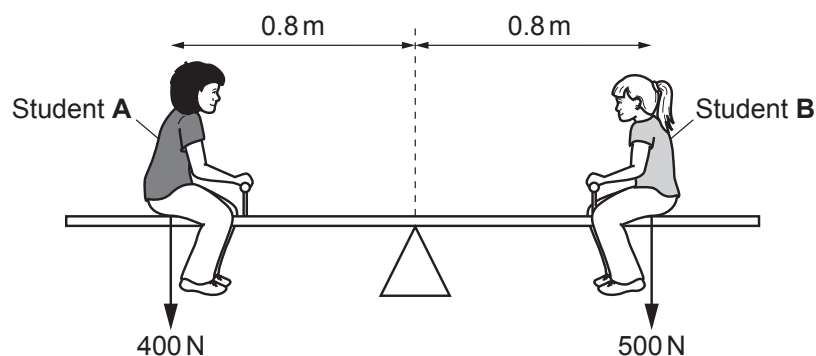
- (i) Calculate the pressure in the fluid.

Answer = ... Pa [3]

- (ii) Write down the direction of the force produced by the fluid on the plunger.

..... [1]

21 The diagram shows two students sitting on a seesaw.



(a) (i) Explain what happens to the seesaw when both students lift their feet off the ground.

.....

 [2]

(ii) Calculate the distance from the pivot that student B sits to balance the seesaw when student A sits 0.6 m from the pivot.

Use the equation: moment of a force = force $\times$ distance

Distance = ... m [3]

(b) Student A has a weight of 400 N.

(i) Calculate the mass of student A.

Use the equation: gravitational force = mass $\times$ gravitational field strength

Mass = ... kg [3]

(ii) Student A stands on one foot when they leave the seesaw.

The area of their foot in contact with the ground is $2.5 \times 10^{-2} \text{ m}^2$.

Calculate the pressure student A exerts on the ground.

Use the Equation Sheet.

Pressure = ... Pa [3]

MARK SCHEMES

official Pearson Edexcel mark schemes



Question			Answer	Marks	AO element	Guidance
14			C ✓	1	1.2	



Question				Answer	Marks	AO element	Guidance
1				C ✓	1	1.1	



Question				Answer	Marks	AO element	Guidance
6				C ✓	1	2.1	



Question				Answer	Marks	AO element	Guidance
14				B ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
1	C ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
3	C	1	1.1	



Question	Answer	Marks	AO element	Guidance
7	D	1	2.1	



Question	Answer	Marks	AO element	Guidance
15	D	1	2.1	



20	*	Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description of method(s), including relevant equipment and equation(s) AND Detailed comments about accuracy/precision. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Description of method, including relevant equipment OR Description of method, including relevant equation(s) AND Basic comment about accuracy/precision. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i>	6	1x1.2 2x2.2 1x3.1b 2x3.3b	AO1.2 Demonstrate knowledge and understanding of relevant equations: - volume of cube = $l \times b \times h$ or $(\text{length})^3$ OR can use displacement for the regular block - density = mass / volume AO2.2 Apply knowledge and understanding of techniques and procedures to describe methods of determining density - relevant equipment to include e.g. ruler, balance, measuring cylinder, displacement can - mass of copper/iron measured using balance - measure length/side/edge of cube - place copper (in water) in measuring cylinder and record increase in volume (of water) OR place copper (in water) in displacement can and use a measuring cylinder to measure the volume of the displaced water ALLOW volume of cube measured using displacement method AO3.1b / 3.3b Analyse information and ideas to evaluate and improve accuracy and precision of experimental procedures - repeat readings and calculate the mean - make sure no zero error on balance - use equipment with a high resolution - read measuring cylinder at eye level / no parallax error - dry the objects before measuring mass
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Question	Answer	Marks	AO element	Guidance
	Level 1 (1–2 marks) Basic description of method with some omissions. AND One relevant equation. OR Basic comment about accuracy/precision. <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks <i>No response or no response worthy of credit.</i>			



23	(a)	(Measure the mass of the block using a mass) balance ✓ AND any two from: Measure three dimensions of the block ✓ Using a (metre)ruler/tape measure ✓ (Multiply) length x width x height / LxWxH / AW ✓	3	3 × 3.3a	ALLOW scales IGNORE weigh(ing) ALLOW three of: height, depth, base, width, breadth, length throughout IGNORE Displacement methods e.g. Eureka can
	(b)	First check the answer on the answer line If answer = 0.012 (m³) award 3 marks Density = mass ÷ volume ✓ Volume = $\frac{0.60}{50}$ ✓ = 0.012 (m³) ✓	3	1.2 2.1 2.1	ALLOW equation in any form e.g. Volume = $\frac{\text{mass}}{\text{density}}$ MP2 is rearrange AND substitute ALLOW 1.2 x 10^x for 2 marks

20	(a)		125 (cm ³) ✓	1	2.1	
	(b)	(i)	Pine bar drawn to the incorrect height / pine bar drawn to 440 kg/m ³ / AW	1	2.2	
		(ii)	Water bar drawn to correct height of 1000 kg/m ³ ✓	1	2.2	ALLOW correct height drawn to $\pm \frac{1}{2}$ small square
		(iii)	Pine ✓ It has the lowest density / density is less than the density of water / less than 1000 (kg/m ³) / AW ✓	2	1 x 3.2b 1 x 2.1	ALLOW oak ALLOW (oak) as its density is less than the density of water / less than 1000 (kg/m ³) / AW
	(c)		Particle arrangement ✓ Mass of particles ✓	2	2 x 1.1	



17	(a)	(i)	Any two from: The old model has no protons / ORA ✓ The old model has no neutrons / ORA ✓ There is no nucleus in the old model / ORA ✓ The electrons are in fixed positions in the old model / ORA ✓ The positive particles are in a nucleus in the current model ✓ The negative particles/electrons are outside / surround the nucleus in the current model ✓	2	2 x 1.1	
		(ii)	Any two from: new evidence ✓ more experiments completed ✓ previous model couldn't explain new observations ✓	2	2 x 1.1	ALLOW mention of Rutherford, Geiger/Marsden
	(b)	(i)	All points correctly plotted ✓ line of best fit drawn correctly ✓	2	2 x 1.2	± 0.5 small squares e.c.f. plotting errors
		(ii)	As the mass increases/goes up the density increases ✓ (Direct) proportionally ✓	2	2 x 3.1a	ORA Needs word 'proportion(al)' or equivalent e.g. density ÷ mass is same

16	(a)		Positively ✓ Negatively ✓ Neutrons ✓ Nucleus ✓	4	1.1 x 4	
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 997 (kg/m³) award 2 marks 9970 ÷ 10 ✓ = 997 (kg/m ³) ✓	2	2.1 2.1	
		(ii)	C B A	1	1.1	Correct order only
		(iii)	Any one from: C has more/the most particles (for the same volume) ✓ A has fewer/the least particles (for the same volume) ✓	1	1.1	ALLOW C has particles closest together/least spread out/most tightly packed ALLOW A has particles furthest apart/most spread out/least tightly packed ALLOW correct identification of C = solid, (B = liquid,) A = gas

16	(a)	(i)		2	2 × 1.1	1 mark for 1 or 2 correct 2 marks for 3 correct
	(b)		Gas ✓	1	1.1	
	(c)		Gas ✓	1	1.1	
	(d)		Solid ✓	1	1.1	

Question	Answer	Marks	AO element	Guidance
(e) (i)	stays the same ✓ decreases ✓ decreases ✓ decreases ✓	4	1.1 2.1 2.1 2.1	
(e) (ii)	It becomes crushed / its volume decreases / AW ✓	1	3.2b	ALLOW (it) collapses (in on itself) / compress(ed) / shrink / shrivel up / scrunch up / implode IGNORE deforms/changes DO NOT ALLOW it breaks/bursts

Question			Answer	Marks	AO element	Guidance
15			B ✓	1	1.2	



Question				Answer	Marks	AO element	Guidance
6				C ✓	1	2.2	



Question			Answer	Marks	AO element	Guidance
14			D ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
15	C	1	2.1	

Grey shading in column 1 (questions 22 & 23) indicates an overlap question also found on J249/03



Question			Answer	Marks	AO element	Guidance
5			A ✓	1	1.1	



Question			Answer	Marks	AO element	Guidance
13			C ✓	1	1.2	



Question			Answer	Marks	AO element	Guidance
15			B ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
11			C ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
8	D ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
9	C ✓	1	2.1	



Question				Answer	Marks	AO element	Guidance
9				A ✓	1	2.2	



Question	Answer	Marks	AO element	Guidance
1	C	1	1.2	



Question	Answer	Marks	AO element	Guidance
11	C	1	1.1	



Question	Answer	Marks	AO element	Guidance
7	D	1	2.1	



Question	Answer	Marks	AO element	Guidance
4	D	1	2.2	



15	C	1	2.1	A: $334000 \times 10.0 \div 10^6$ (wrong units) B: $334000 \div 10.0 \div 10^3$ C: $334000 \times 10.0 \div 10^6$ D: $334000 \div 10.0 \div 10^3$ (and wrong units)
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21	*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description of the procedure and the measurements (including a labelled diagram). AND Correct calculation of the change in thermal energy. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Detailed description of the procedure and the measurements (with a diagram). OR Description of the procedure and the measurements (with a diagram). AND Correct calculation of the change in thermal energy. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Basic description of the procedure and the measurements. OR Correct calculation of the change in thermal energy. <i>There is an attempt at a logical structure with a line of</i>	6	2×3.3a 2×2.2 2×2.1 AO3.3a Analyse information and ideas to develop experimental procedures - liquid placed in beaker - heater immersed in liquid - heater connected to power supply - insulation arranged to reduce heat loss - thermometer - instrument(s) to determine energy e.g. stopwatch, circuit AO2.2 Apply knowledge and understanding of scientific enquiry, techniques and procedures - measurements - Explanation of obtaining mass of 200 g - Initial temperature measured - Temperature rise / change / temperature after measured - Method to determine the energy e.g. use of joule meter / $E = ItV$ method / power of heater and time. AO2.1 Apply knowledge and understanding of scientific ideas to calculate change in thermal energy - use of $E = m \times c \times t$ $E = 0.2 \times 4200 \times 20$ $E = 16800 \text{ J}$
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Question	Answer	Marks	AO element	Guidance
	<i>reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>			



20	(a)	Any pair of answers from: Insulate (the block) ✓ To reduce heat loss/energy being lost to the surroundings/ AW ✓ OR Make sure the heater is fully in the block ✓ To reduce energy being lost to the surroundings ✓ OR Wait until the thermometer stops rising before measuring the final temperature ✓ To account for the fact that there is a delay in the heat from the heater conducting to the thermometer / to ensure that the maximum temperature is recorded / AW ✓	2	3.3b x2	IGNORE (put a) lid (on it) ALLOW examples of appropriate insulation ALLOW Immersion heater in the middle More even heat distribution ALLOW Oil etc. in the hole To improve conduction ALLOW Temperature probe/digital thermometer Better resolution
	(b)	Copper ✓ It has the lowest/smallest specific heat capacity ✓	2	2.1 x2	No marks if copper is not chosen ALLOW it's the best conductor
	(c)	1kg of material ✓ (changes state) liquid to gas / gas to liquid ✓	2	1.1 x2	ALLOW liquid evaporating / gas condensing



18	(a)	(i)	5250 (J/kg°C) ✓	1	1.2	
		(ii)	Any three from: specific heat capacity increases with temp rises ✓ specific heat capacity increases with energy supplied ✓ temp rise increases with energy supplied ✓ different amounts of energy were supplied ✓ all of the s.h.cs. are close together (within 5%) / within the range 5000 – 5500 ✓ the experiment was repeated / done 3 times ✓	3	3 x 3.2b	ALLOW other reasonable observation, e.g. s.h.c. increases with longer heating
	(b)	(i)	Any two from: more energy (than expected) heated the water ✓ energy losses must have occurred/not all the energy went into the water ✓ energy transferred to environment / AW ✓	2	2 x 3.2b	ALLOW heat for energy
		(ii)	Any two linked answers from: part of the immersion heater is out of the water ✓ make sure the heater is fully in the water/use a larger/deeper beaker ✓ beaker is not lagged/insulated ✓ lag/insulate the beaker ✓ there is no lid on the beaker ✓ put a lid on the beaker ✓ the temperature rises are quite small ✓ apply more energy to the water ✓ insufficient data ✓ take more readings ✓	4	3.3a 3.3b 3.3a 3.3b 3.3a 3.3b 3.3a 3.3b 3.3a 3.3b	

22	(a)	(i)	40 (g) ✓	1	3.2b	
		(ii)	<u>Mass</u> before = <u>mass</u> after / <u>Mass</u> is conserved AW ✓ Explanation in terms of particle rearrangement / conservation of numbers of particles ✓	2	1.1 x2	ALLOW no <u>mass</u> is lost ALLOW matter for mass ALLOW atoms/molecules for particles
	(b)		Any one from: Original properties return if change is reversed for physical changes ✓ Chemical change can't be reversed (easily) OR physical change easily reversible ✓ The substance after the change is the same as the substance before the change for physical changes ORA ✓	1	1.1	ALLOW in a chemical change particles join together in a different way
	(c)	(i)	Any three from: Measure start/initial temperatures ✓ Turn on the heaters / heat water ✓ Measurements to determine energy or mass of water ✓ For a set time ✓ Measure the final/end temperatures ✓	3	2.2 x3	IGNORE put thermometer or heater in beaker Initial can be implied ALLOW for a fixed temperature change ALLOW for a fixed temperature change, measure time
		(ii)	Any one from: Beakers are different sizes OR different volumes /mass of liquid in A and B ✓ Beakers are not insulated / no lids ✓	1	3.3a	ALLOW Heater is not fully in the water

Question	Answer	Marks	AO element	Guidance
	(iii) Any two from: Use beakers of the same size / same volume ✓ Use same mass or volume of liquid ✓ Stir water / keep distance from thermometer to heater fixed ✓ Insulate the beakers or put the beakers on an insulating material ✓ Put a lid on the beakers ✓ Make sure the heater is fully inserted into the liquid ✓	2	3.3b	



19	(a)	Any two from: Energy transferred electrically from the supply to the heating element or energy transferred by heating from element to the water. ✓ (So) thermal energy store of the element increases. ✓ (So) thermal energy store of water increases. ✓	2	2 × 2.1	IGNORE conduction and convection (as question refers to energy stores).
	(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3 150 000 (J) award 3 marks Temperature change = $95 - 20 = 75^{\circ}\text{C}$ ✓ Change in thermal energy = $10 \times 4200 \times 75$ ✓ (Change in thermal energy =) 3 150 000 (J) ✓	3	2.2 2 × 2.1	ALLOW ECF from their temperature change.
	(c) (i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8 (A) award 3 marks Current = power ÷ p.d ✓ (Current =) $1840 \div 230$ ✓ (Current =) 8 (A) ✓	3	1.2 2 × 2.1	Rearrangement of the given equation

Question		Answer	Marks	AO element	Guidance
	(c) (ii)	Any two from: The power would be higher ✓ The water would heat up quicker ✓ (So) more water could be heated (in the same time) ✓	2	3.2a	IGNORE Higher currents are more dangerous IGNORE it would get hotter
	(d)	All three boxes ticked ✓	1	1.2	

Question				Answer	Marks	AO element	Guidance
12				B ✓	1	1.2	



Question				Answer	Marks	AO element	Guidance
13				C ✓	1	2.1	



Question				Answer	Marks	AO element	Guidance
13			A		1	2.1	



Question	Answer	Marks	AO element	Guidance
7	B ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
11	C ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
7	D	1	1.1	



18	(a)	Any one set of readings from the graph multiplied together to give a correct number ✓ Any second set of readings from the graph multiplied together to give the same constant ✓	2	3.1b x 2	e.g. $5 \times 500 = 10 \times 250 = 20 \times 125 = 25 \times 100 = 2500$
	(b)	Doubled ✓ Doubled ✓	2	1.1 x 2	
	(c)	Any two from: As temperature increases, pressure increases / AW ✓ Linear /straight line relationship ✓ Higher temperature means more (frequent) collisions (between particles and container) / AW ✓	2	1.1.x 2	ALLOW higher temperature means bigger pressure DO NOT ALLOW T & P in wrong order DO NOT ALLOW (directly) proportional relationship ALLOW pressure goes up at the same rate as temperature IGNORE idea of more collisions with other particles

21	(a)	(i)	90° (to the side of the bottle)	1	1.2	ALLOW perpendicular/at right angles/horizontally
		(ii)	Pressure causes a net force at right angles to any surface/ AW ✓	1	1.1	
	(b)	(i)	First check the answer on the answer line If answer = 15 (Pa) award 3 marks P = F / A ✓ P = 1.8 / 0.12 ✓ P = 15 ✓	3	1.2 2.1 2.1	
		(ii)	doubles ✓	1	3.1b	ALLOW 2 x their answer to (b)(i) (e.g., 30) IGNORE increases



21	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 120 (N/cm²) award 3 marks Recall: pressure = force ÷ area ✓ 12000 ÷ 100 OR 40000 ÷ 25 ✓ = 120 (N/cm ²)	3	1.2 2.1 2.1	ALLOW 12000÷25 for one mark ALLOW for two marks 480 (N/cm ²)
	b	i	Reduces <u>pressure</u> / spreads the <u>force</u> / AW ✓	1	1.1	
		ii	Absorb energy (in a crash) ✓	1	1.1	ALLOW higher level answers: eg. Reduces force / acceleration E.g. Increases time / distance to stop
	c		Mass / inertia of child is lower ✓ Less force is needed (for the same deceleration)✓	2	2.1 1.1	ALLOW weight of child is lower/child is smaller



18	(a)	energy ✓ speed ✓ pressure ✓	3	3 x 1.1	ALLOW energy and speed in either order
	(b)	Any two correct calculations (one mark each): 200 x 50 = 10 000 ✓ 250 x 40 = 10 000 ✓ 400 x 25 = 10 000 ✓ 1000 x 10 = 10 000 ✓ Comment that they are the same and therefore PV does equal a constant ✓	3	2 x 2.1 3.2b	
	(c)	Less air (molecules) as height increases / weight of air decreases with height / AW / ORA ✓	1	1.1	

23	(a)	One correct calculation is completed ✓ A second correct calculation is completed ✓ Conclusion from at least two calculations, e.g., $P \times V$ for two (or more) calculations gives the same / equal value (so the formula is true) ✓	3	2.1 2.1 3.2b	E.g., $300 \times 250 = 75\,000$ / $500 \times 150 = 75\,000$ / $625 \times 120 = 75\,000$ / $1250 \times 60 = 75\,000$ ALLOW 75 000 on at least two rows of the table IGNORE pressure $\times$ volume = constant (from question)
	(b)	(i) Correct point plotted at (500, 150) ✓	1	1.1	Point plotted with $\frac{1}{2}$ small square Diameter of point less than $\frac{1}{2}$ small square
		(ii) Best fit line drawn as a single unbroken curve (by eye) ✓	1	2.2	DO NOT ALLOW straight line IGNORE line before 300 kPa and after 1250 kPa
		(iii) Value read from graph in the range 80 to 90 (cm^3) ✓	1	3.1b	ALLOW ECF from candidate's graph if outside range – volume value read to $\frac{1}{2}$ small square.
	(c)	It decreases / reduces / goes down (with increased height) / ORA ✓ There is less atmosphere / air above (pushing down) ✓	2	2 x 1.1	ALLOW fewer particles above it IGNORE gravity / density

21	(a)	(i)	Earth ✓ g is largest ($W = mg$ and m is fixed) ✓	2	3.2a 1.1	
		(ii)	Mass ✓	1	1.1	ALLOW distance from another object
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2000 (N/m²) award 3 marks pressure = force / area ✓ 600 / 0.3 ✓ 2000 (N/m ²) ✓	3	1.2 2.1 2.1	
		(ii)	Upwards arrow labelled as normal contact force ✓ Downwards arrow labelled as weight ✓ Arrows are equal length (by eye) ✓	3	3 x 1.1	ALLOW force exerted by ground ALLOW two upwards arrows, one per foot ALLOW force exerted by Earth If two upwards arrows, each should be half the weight

16	(a)	temperature ✓ speed ✓ force ✓ increases ✓	4	1.1 x4	Answers must be in the correct order
	(b)	It covers the Earth to a height of about 700 km ✓ The atmospheric pressure decreases as you move away from the Earth's surface ✓ Density is uniform ✓	3	1.1 x3	One mark for each correct box ticked
	(c)	First check the answer on the answer line If answer = 7500 (Pa m³) award 2 marks (constant = PV) constant = 5000 x 1.5 ✓ constant = 7500 ✓	2	2.1 x2	



21	(a)	(i)	moment = force x distance ✓ clockwise moment = 800 (Nm) ✓ anti-clockwise moment = 1000 (Nm) ✓	3	1.2 2.1 2.1	ALLOW 2 marks (total) if clockwise and anti-clockwise moments are reversed Correct calculation of either moment implies correct equation so gets m.p.1 also
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.6 (m) award 3 marks (anti-clockwise moment) 500 (N) × distance = 800 (N m) ✓ distance = 800 ÷ 500 ✓ = 1.6 (m) ✓	3	1.2 2.2 2.2	E.c.f. clockwise moment from (a)(i) for 800 (N m) If child B chosen, giving 1000 ÷ 400 = 2.5 (m), award 2 marks (loses m.p.1)
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (Pa) award 3 marks pressure = force ÷ area ✓ = 10 ÷ 0.1 ✓ = 100 (Pa) ✓	3	1.2 2.1 2.1	
		(ii)	at right angles/perpendicular/90° (to the plunger)	1	1.1	ALLOW to the left opposite to the force from the plunger

21	(a)	(i)	Moves clockwise / student B goes down / student A goes up ✓ More turning force/moment on the right-hand side / student B provides more turning force/moment ✓	2	1.2 2.2	ALLOW down on the right / up on the left ALLOW heavier (student) goes down / lighter student goes up ALLOW student A is heavier than student B AND is sitting the same distance from the pivot.
		(ii)	First check the answer on answer line If answer = 0.48 (m) award 3 marks (LHS/anticlockwise moment = $400 \times 0.6 \Rightarrow 240$ (Nm) / (RHS/clockwise moment $\Rightarrow 500 \times d$ ✓ LHS moment = RHS moment / $240 = 500d$ ✓ ($d \Rightarrow 0.48$ (m) ✓	3	2.1 2.1 2.1	ALLOW $240 \div 500 = d$ ✓
	(b)	(i)	First check the answer on answer line If answer = 40 (kg) award 3 marks ($W = mg$) $g = 10$ (N/kg) ✓ ($m \Rightarrow W \div g$ / $400 \div 10$ ✓ ($m \Rightarrow 40$ (kg) ✓	3	1.1 2.1 2.1	ALLOW 9.8 / 9.81 (N/kg) ALLOW ($m \Rightarrow 400 \div 9.8$ / 9.81 ALLOW 40 to 40.82 (kg)
		(ii)	First check the answer on answer line If answer = 16 000 (Pa) award 3 marks ($P \Rightarrow F \div A$ ✓ ($P \Rightarrow 400 \div (2.5 \times 10^{-2})$ ✓ ($P \Rightarrow 16\,000$ ✓ (Pa)	3	1.2 2.1 2.1	ALLOW equation in any form