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OCR GCSE PHYSICS A (J249): QUESTIONS BY TOPIC

Topic P1: Matter (H)

GCSE Physics A Higher Tier (J249) · Topic P1

46 questions · 198 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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QUESTIONS

46 questions · 198 marks · grouped by sub-topic, lowest tariff first



SUB-TOPIC P1.1

THE PARTICLE MODEL

9 questions in this sub-topic · 29 marks · lowest tariff first



2 What is the typical diameter of an atom?

A $1.0 \times 10^{-15} \text{ m}$

B $1.0 \times 10^{-10} \text{ m}$

C $1.0 \mu\text{m}$

D 1.0 mm

Your answer

[1]



- 3** A liquid has a volume of 0.01 m^3 and a mass of 12 kg .

What is the density of the liquid?

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

- A** 0.12 kg/m^3
- B** 12 kg/m^3
- C** 120 kg/m^3
- D** 1200 kg/m^3

Your answer

[1]

1 What is 15 J converted into newton-metres?

A 0.15 Nm

B 1.5 Nm

C 15 Nm

D 150 Nm

Your answer

[1]



2 What is the correct order of the three states of matter in **increasing** density?

A Gas → liquid → solid

B Liquid → gas → solid

C Liquid → solid → gas

D Solid → liquid → gas

Your answer

[1]



- 1 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]



15 Water has a density of 1000 kg/m^3 .

Water of volume 1 m^3 is frozen. The volume of the ice formed is 1.09 m^3 .

What is the density of the ice?

Use the Equation Sheet.

A 0.917 kg/m^3

B 1.09 kg/m^3

C 917 kg/m^3

D 1090 kg/m^3

Your answer

[1]



17 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.

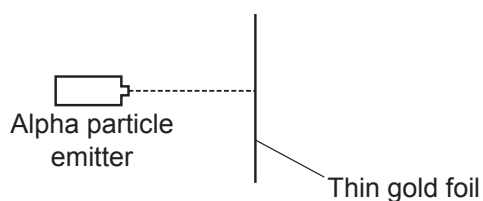
Use the Equation Sheet.

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



- 19 (a)** Between 1908 and 1913, two scientists did experiments to help understand the structure of atoms.

The diagram shows how the scientists fired alpha particles at a thin piece of gold foil and detected what happened to these particles.



- (i) The scientists detected that a very small number of particles reflected directly back, some particles were deflected, and most particles passed straight through the foil.

Describe the model of the atom following these observations.

.....

.....

.....

.....

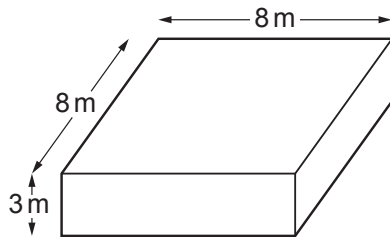
..... [3]

- (ii) Explain why the previous model of the atom needed to change after this experiment.

.....

..... [1]

(b) A classroom contains air particles. A drawing of the classroom is shown in the diagram.



(i) Calculate the volume of the classroom.

Volume = ... m^3 [1]

(ii) The density of air is 0.012 kg/m^3 .
Calculate the mass of air in the classroom.

Use the equation: density = mass/volume

Mass = ... kg [3]

- 20 (a)** A student uses a ruler to determine the volume of a cube, **A**. The length of one side of the cube is 0.100 m.

(i) Calculate the volume of cube **A**.

Volume of cube **A** = ...m³ [2]

(ii) Cube **B** has the same volume as cube **A**.

The mass of cube **B** is ten times greater than the mass of cube **A**.

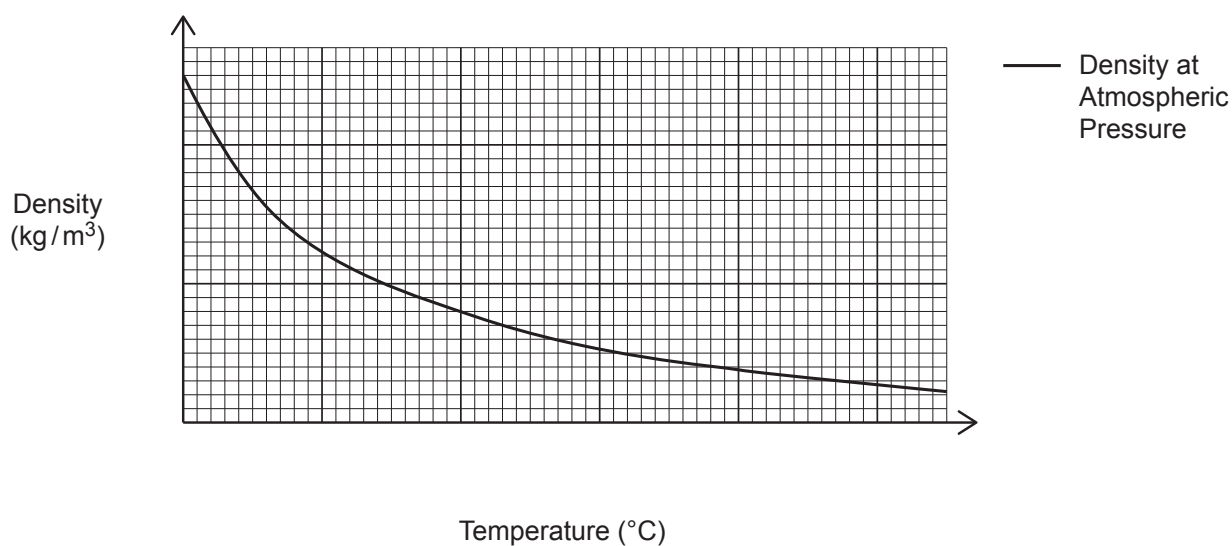
Compare the density of cube **B** with cube **A**.

Use the equation for density to help your explanation.

.....

 [2]

- (b)** A student researches how the density of air varies with the temperature of the air. Look at the graph of her findings.



Describe the relationship between the temperature and density of air shown in the graph.

..... [1]

(c) Give **one** reason why a solid is more dense than a gas.

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

(d) A boat can be made out of concrete.

Explain why a concrete boat floats but a lump of concrete sinks.

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



SUB-TOPIC P1.2

CHANGES OF STATE

15 questions in this sub-topic · 108 marks · lowest tariff first



10 A student investigates what happens when she heats a beaker of water.

	The temperature increases	The state changes	The energy stored in the water changes
A	✓	✓	✓
B	✓	✗	✗
C	✗	✓	✗
D	✗	✗	✓

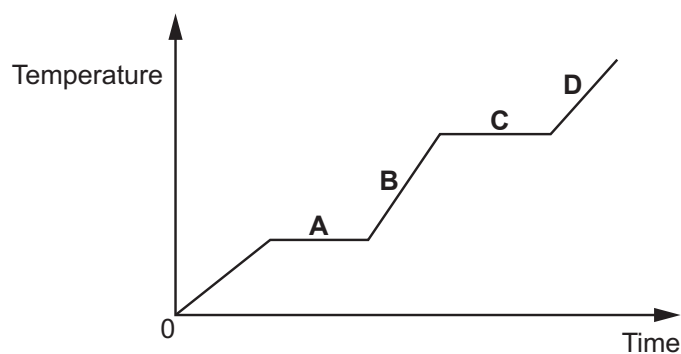
Which row in the table describes what **could** happen when the water is heated?

Your answer

[1]



- 6 A student heats a substance steadily from a solid to a gas. The temperature change is recorded on the graph.



Which section of the graph is where the specific latent heat of vaporisation is used to calculate the energy needed for this change of state?

Your answer

[1]

- 9** The mass of a block of ice at a temperature of 0°C is 2 kg.
The specific latent heat of ice is $3.34 \times 10^5 \text{ J/kg}$.

What amount of energy is needed to melt the block of ice?
Use the Data Sheet.

- A** $1.67 \times 10^2 \text{ J}$
B $1.67 \times 10^5 \text{ J}$
C $6.68 \times 10^5 \text{ J}$
D $6.68 \times 10^8 \text{ J}$

Your answer

[1]



8 Ice at 0°C is heated until it turns into water at 25°C . The mass of the ice is known.

Which extra information is needed to calculate the energy required for this change?

Use the Equation Sheet.

- A** Specific heat capacity of water and specific latent heat of fusion of ice
- B** Specific heat capacity of water and specific latent heat of vaporisation of water
- C** Specific heat capacity of water only
- D** Specific latent heat of fusion of ice and specific latent heat of vaporisation of water

Your answer

[1]



13 Which change of state releases energy?

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

Your answer

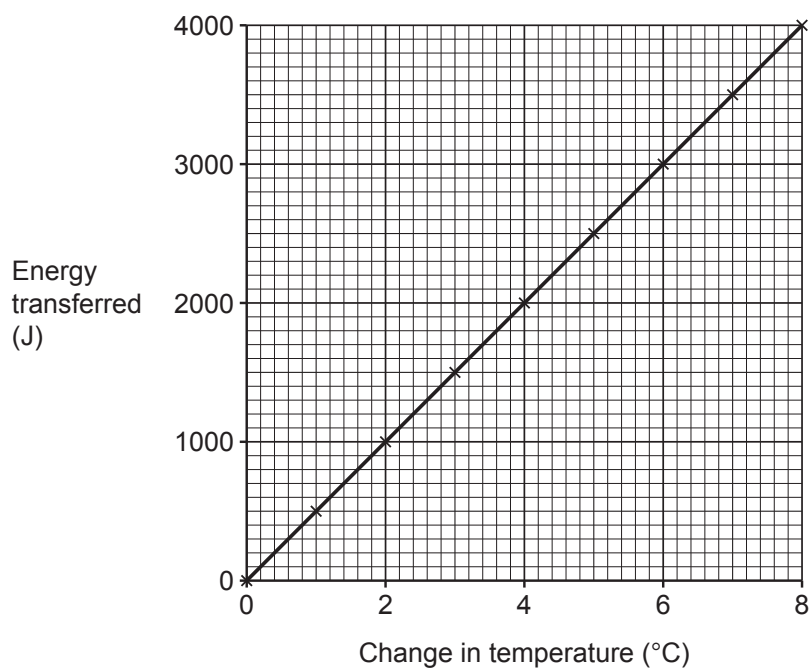
[1]



15 A student uses an immersion heater to increase the temperature of 0.25 kg of oil.

The student calculates the energy transferred to the oil.

This is a graph of the student's results.



What is the specific heat capacity of the oil?

Use the graph and the Equation Sheet.

- A** 500 J/kg °C
- B** 2000 J/kg °C
- C** 4200 J/kg °C
- D** 16 000 J/kg °C

Your answer

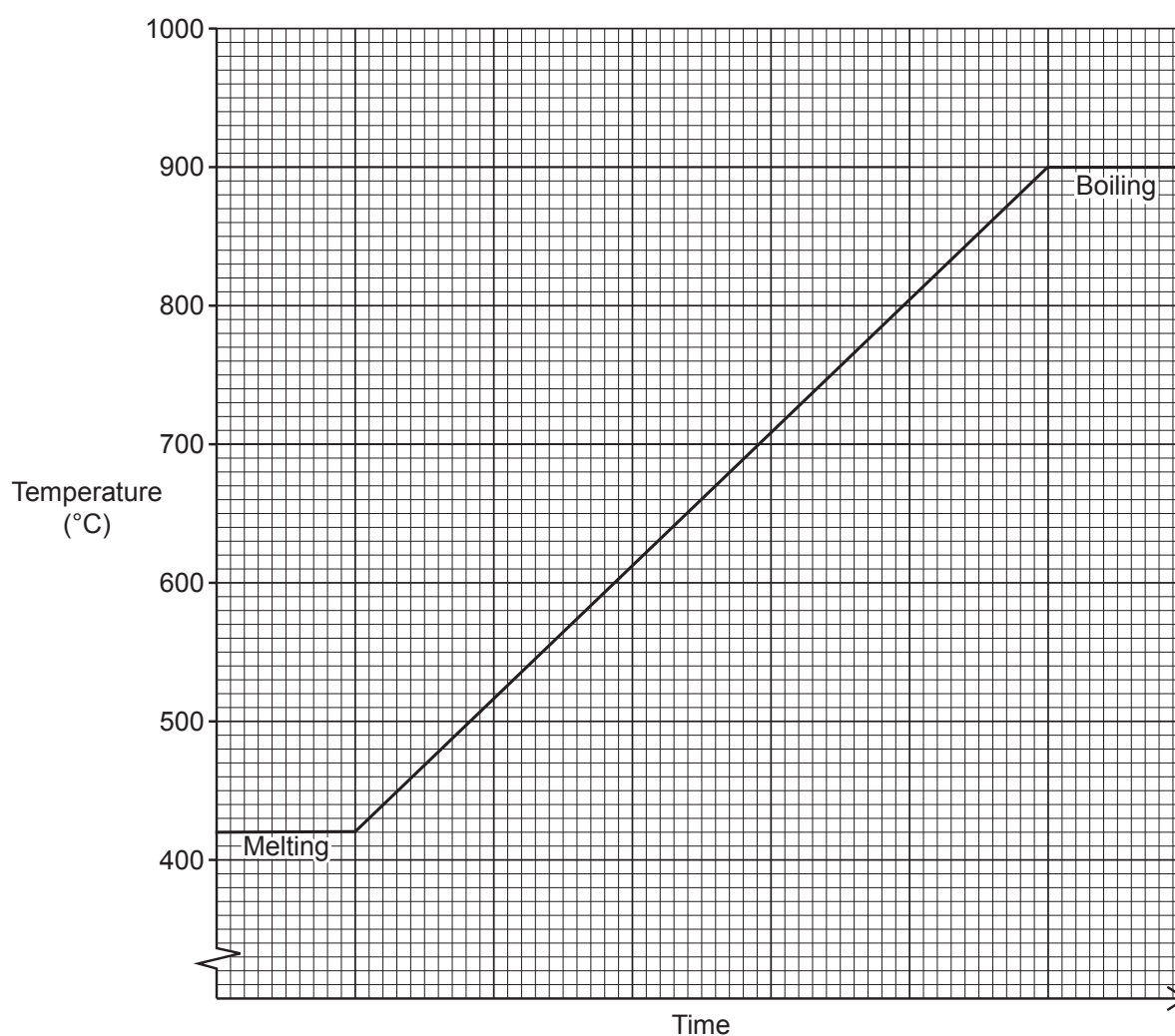
[1]

23 The table shows the specific heat capacities of different materials.

Material	Specific heat capacity (J/kg °C)
Copper	330
Brass	380
Zinc	385
Nickel	440
Concrete	880
Aluminium	913

A scientist heats an unknown substance from a solid to a liquid.

The graph shows how the temperature of the substance varies with time.



The scientist has 2.5 kg of the substance and records that it takes 462 kJ of energy to increase it from the lowest to the highest temperature in the liquid state.

- (a) Use the graph to calculate the specific heat capacity of the substance.

Suggest what material it could be from the table.

Specific heat capacity = ... J/kg °C

Material = ...
[5]

- (b) Suggest **two** reasons why the scientist cannot be certain that the substance has been identified correctly.

1
.....
.....

2
.....
.....

[2]



(b) The students find that 250 g of ice takes 95 kJ of energy to change state.

Calculate the specific latent heat.

Answer = ... J/kg [3]



16 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)**.

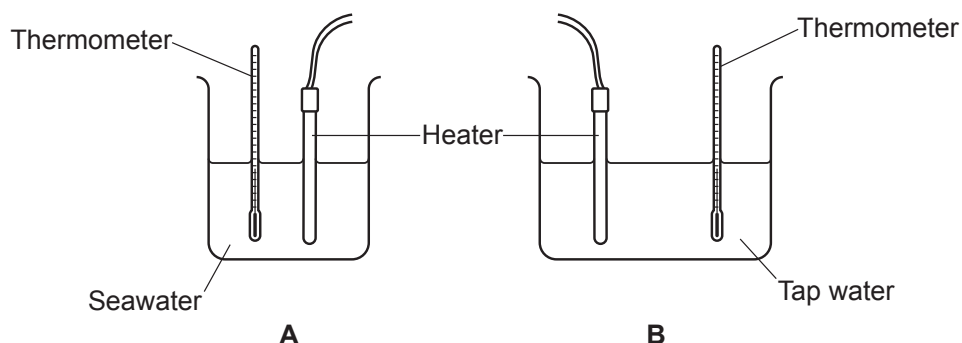
.....
.....
..... [2]

(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]

18 A student heats 0.20 kg of water in a beaker until it evaporates into steam. The starting temperature of the water is 20 °C.

(a) (i) The specific heat capacity of water is 4200 J/kg °C.

Calculate the energy needed to raise the temperature of the water to 100 °C.

Use an equation from the data sheet to help you.

Energy needed = ... J **[2]**

(ii) The specific latent heat of vaporisation of water is 2 260 000 J/kg.

Calculate the energy needed to turn all the water at 100 °C into steam.

Use an equation from the data sheet to help you.

Energy needed = ... J **[2]**

(iii) Use your answers from **(a)(i)** and **(a)(ii)** to calculate the **total** energy needed to turn 0.20 kg of water at 20 °C into steam at 100 °C.

Write your answer in **standard form** and to **2 significant figures**.

Total energy needed = ... J **[3]**



- (b) (i) Suggest **two** reasons why the actual energy needed to turn the water into steam was **more** than the value calculated in (a)(iii).

Reason 1

.....

Reason 2

.....

[2]

- (ii) Another student says, 'You should repeat your experiment three times and calculate a mean.'

Suggest **one** advantage of repeating an experiment.

.....

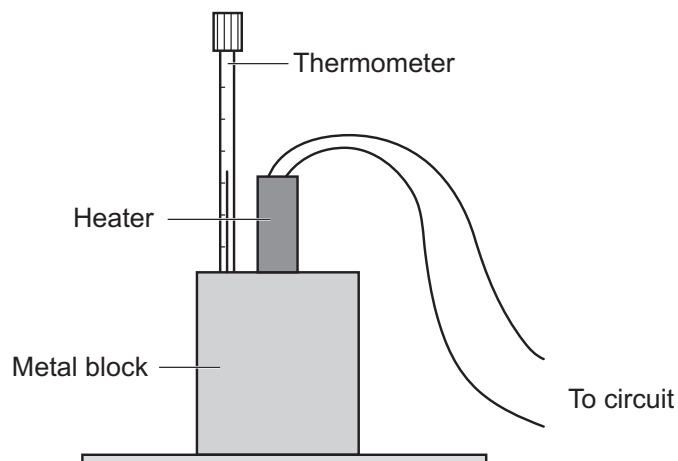
..... [1]



20 A student does an experiment to measure the specific heat capacity of a metal block.

Fig. 20.1 shows the student's equipment.

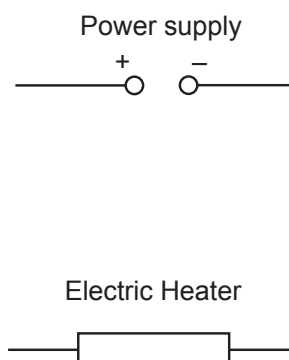
Fig. 20.1



(a) The student measures current and potential difference to calculate the power of the heater.

Complete the circuit diagram in **Fig. 20.2** to show how the student measures current and potential difference.

Fig. 20.2



[2]

- (b) (i) The table shows the student's results.

Energy supplied to heater	24 kJ
Starting temperature	20 °C
Final temperature	45 °C
Change in temperature	25 °C
Mass of block	2.0 kg

Use the data in the table to calculate the specific heat capacity of the metal block.

Use the Data Sheet.

Specific heat capacity = ... J/kg °C [4]

- (ii) The value calculated in (b)(i) is higher than the actual value.
The student recorded all data correctly.

Suggest why the value calculated is higher than the actual value.

Use Fig. 20.1.

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

- (iii) Suggest how the experiment could be improved.

Use Fig. 20.1.

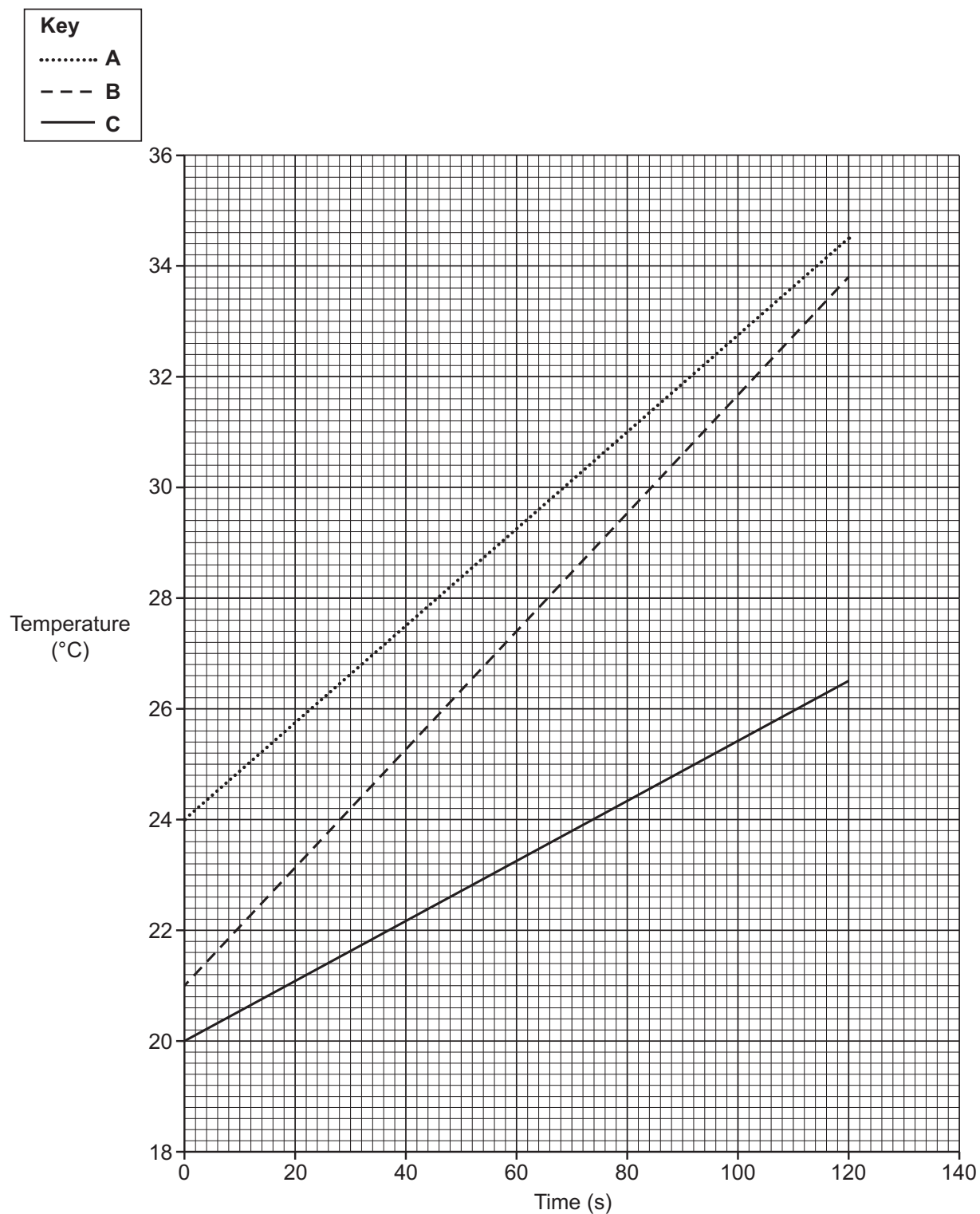
.....
..... [1]



(c) The student repeats the same experiment using 3 different blocks, **A**, **B** and **C**.

- Each block is made of a different metal but has the same mass.
- The power of the heater stays the same.

The graph shows how the temperature of blocks **A**, **B** and **C** change with time.



Which metal has the **highest** specific heat capacity?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

State a reason for your answer.

.....

..... [2]



20 A student uses an electric heater to raise the temperature of water.

Fig. 20.1 shows some of the equipment the student uses.

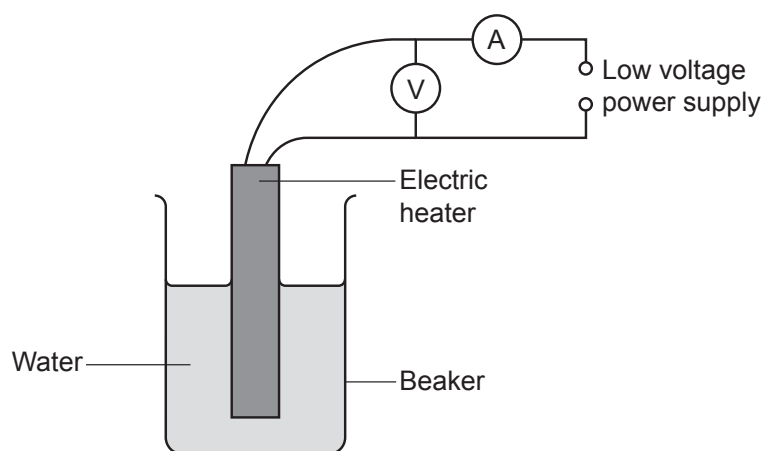


Fig. 20.1

The student obtains the data in **Table 20.1**:

Energy input to the heater	12 000 J
Increase in thermal energy store of the water	8 400 J

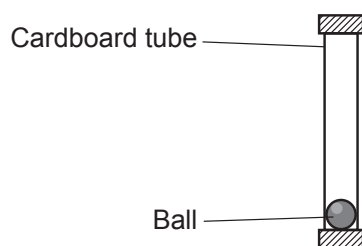
Table 20.1

(a) Use the data in **Table 20.1** to calculate the efficiency of the heater.

Efficiency = ... [3]

22 (a) Fig. 22.1 shows a sealed cardboard tube containing a ball.

Fig. 22.1



The cardboard tube is quickly turned upside down so that the ball falls the whole length of the tube.

Fig. 22.2 shows the energy stores of the ball at the **top** of the tube.

Complete Fig. 22.3 to show the energy stores of the ball before it hits the **bottom** of the tube. [3]

Fig. 22.2

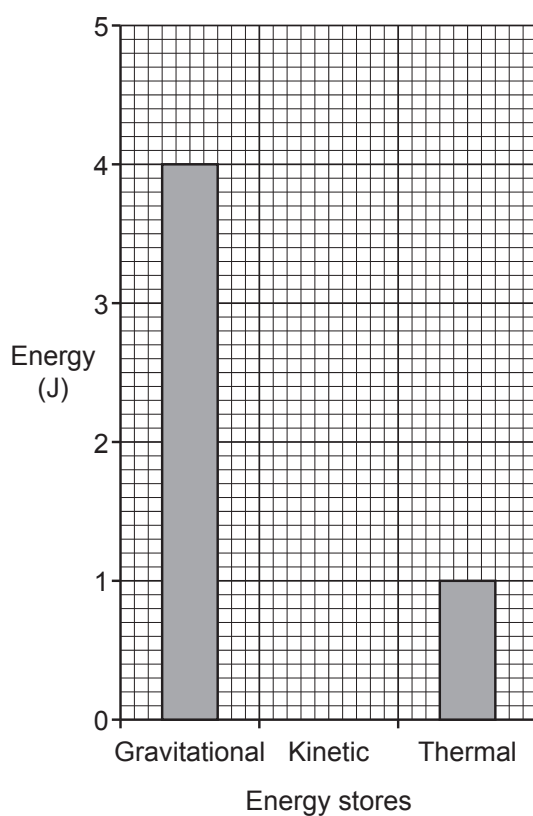
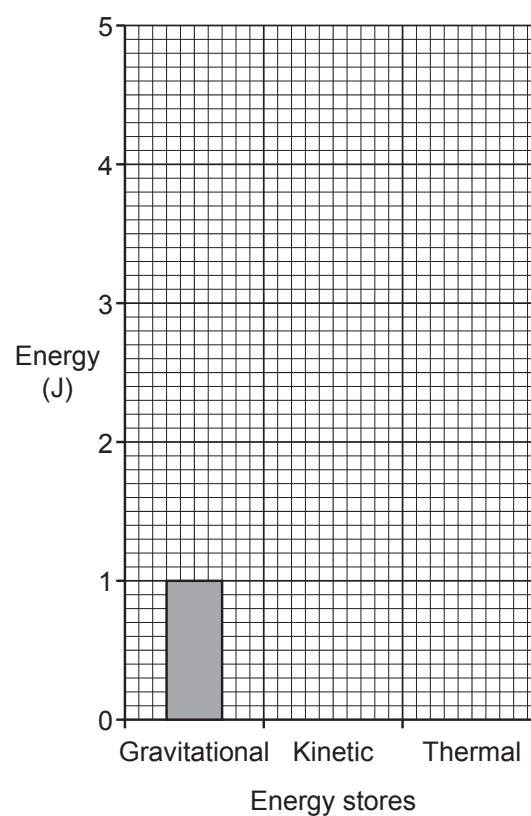


Fig. 22.3

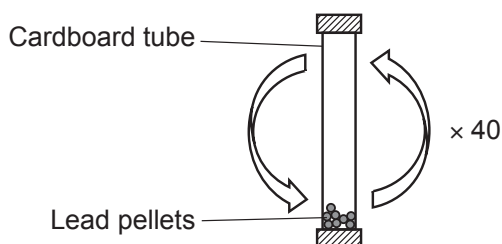


(b) Student **A** and student **B** determine the specific heat capacity of lead using this method.

- Measure the mass and initial temperature of small lead pellets.
- Place the pellets in a sealed cardboard tube.
- Quickly turn the tube upside down 40 times.
- Measure the final temperature of the lead pellets.

Fig. 22.4 shows a diagram of the equipment:

Fig. 22.4



(i) State **one** way to improve the experiment.

.....
 [1]

(ii) Explain why the cardboard tube is turned upside down very quickly.

.....
 [1]

(iii) Student **A** uses 0.030 kg of lead pellets and a 1.5 m long cardboard tube.

Calculate the change in potential energy of the pellets when the tube is turned upside down **once**.

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

Potential energy = ... J [2]

- (iv) **Student B** repeats the experiment using a different tube.

The total change in potential energy of 0.030 kg of lead pellets for this tube is 21 J.
The temperature change of the lead pellets is 5 °C.

Calculate the specific heat capacity of lead. Include the correct unit.

Use the Equation Sheet.

Specific heat capacity = ... Unit **[4]**

- (v) **Student A** says, 'I think we should use a metal with a higher specific heat capacity. This will give us more accurate results.'

Student B says, 'I think we should turn the tube upside down 100 times. This will give us more accurate results.'

Explain why both student **A** and student **B** are **not** correct.

Student A

.....

.....

.....

Student B

.....

.....

.....

[3]



23 A medical freezer is used to keep vaccines cool.

- (a) (i)** Calculate the energy required by the freezer to cool 0.50 kg of solid vaccines from -5°C to -35°C .

Assume the specific heat capacity of the vaccines is $1900\text{ J/kg}^{\circ}\text{C}$.

Use the Equation Sheet.

Energy = ... J **[2]**

- (ii)** It takes 5 minutes for the freezer to cool the vaccines.

Calculate the power of the freezer.

Use the Equation Sheet.

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

- (iii)** Suggest **two** reasons why the actual power of the freezer will be greater than that calculated in part **(a)(ii)**.

1

.....

2

.....

[2]



- (b) (i) When the vaccine is used by doctors, it has to be changed back into a liquid. The temperature of the vaccine is first raised to its melting point but it remains as a solid.

Explain **two** reasons why more energy is needed to change the solid vaccine into a liquid at its melting point.

1

.....

2

.....

[2]

- (ii) Calculate the number of 5 mg vaccine doses which can be melted using 6800 J of energy.

Assume the specific latent heat of fusion for the vaccines is 340 000 J/kg.

Use the Equation Sheet.

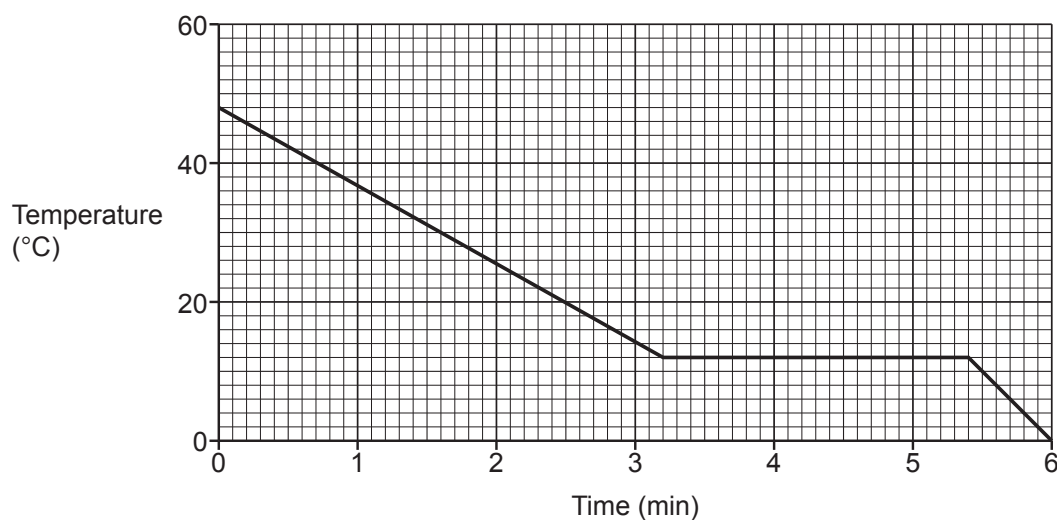
Number of vaccine doses = ... [6]



23 A scientist investigates how liquids cool when they are placed in a freezer.

(a) The scientist places 200 g of liquid **A** in a freezer.

The graph shows how the temperature changes with time as the liquid cools.



(i) What is the initial temperature of liquid **A**?

Initial temperature = ... °C [1]

(ii) What is the freezing point of liquid **A**?

Freezing point = ... °C [1]

(iii) Liquid **A** has a specific heat capacity of 3750 J/kg °C.

Calculate the energy needed to cool the liquid from its initial temperature until it starts to freeze.

Use the Equation Sheet.

Energy = ... J [4]

(b)

(i) Liquid **B** is placed in the freezer.

The freezer needs 54 kJ of energy to cool liquid **B** from its initial temperature to its freezing point. This takes 360 s.

Calculate the minimum power of the freezer needed to cool liquid **B**.

Use the equation: energy transferred = power × time

Minimum power = ... W [4]

(ii) Why is the actual power needed to cool liquid **B** larger than your answer to (b)(i)?

..... [1]

(c) The power of a different portable freezer is 240 W.

The components in the freezer have a total resistance of $0.80\ \Omega$.

Calculate the current in the freezer.

Use the Equation Sheet.

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

Current = ... A [4]



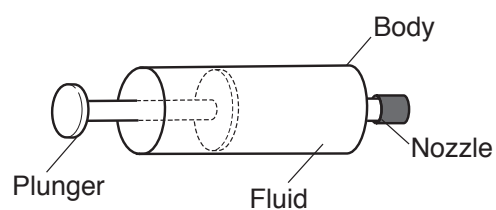
SUB-TOPIC P1.3

PRESSURE

22 questions in this sub-topic · 61 marks · lowest tariff first



- 3 A fluid is compressed by pushing the plunger into the body of a sealed syringe.



Which of these statements is true?

- A There is a net force towards the plunger.
- B There is no force towards the nozzle.
- C There is a force parallel to all points on the surface of the fluid.
- D There is a force at 90° to all points on the surface of the fluid.

Your answer

[1]

5 Which factor influences whether an object floats or sinks?

- A** Size of object
- B** Depth of water
- C** Distance from the shore
- D** Density of object

Your answer

[1]



- 4 An elephant has a weight of 60 kN. Its four feet have a total area of 0.75 m^2 in contact with the ground.

Calculate the total pressure the elephant exerts on the ground.

Use the equation: pressure = force normal to a surface / area of that surface

- A 45 Pa
- B 80 Pa
- C 45 000 Pa
- D 80 000 Pa

Your answer

[1]



- 6** Which statement explains why atmospheric pressure changes as you climb up a mountain?
- A** Number of air molecules above you decrease the further you move from the centre of the Earth.
 - B** Density of air increases the further you move from the centre of the Earth.
 - C** Gravity increases the further you move from the centre of the Earth.
 - D** Temperature decreases the further you move from the centre of the Earth.

Your answer

[1]



14 What is the change in pressure when a diver moves from a depth of 3.0 m to a depth of 8.0 m?

Assume gravitational field strength on Earth = 10 N/kg and water density = 1000 kg/m^3 .

Use an equation from the data sheet to help you.

A 30 000 Pa

B 50 000 Pa

C 80 000 Pa

D 110 000 Pa

Your answer

[1]



9 A fluid under pressure causes a force.

In which direction does the net force always act?

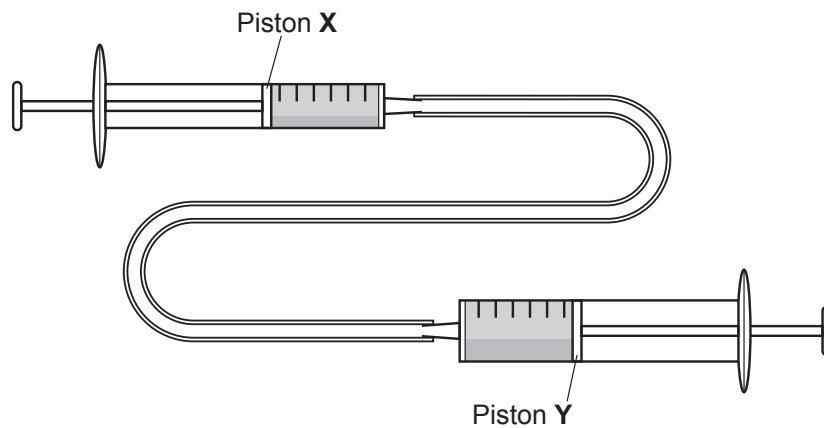
- A** At right angles to any surface.
- B** In the opposite direction to the gravitational force.
- C** In the same direction as the gravitational force.
- D** Parallel to any surface.

Your answer

[1]



- 15 A simple hydraulic machine containing water is made from two pistons connected together with plastic tubing. The cross-sectional area of piston **Y** is **twice** the cross-sectional area of piston **X**.



A force of 2 N is exerted on piston **X**.

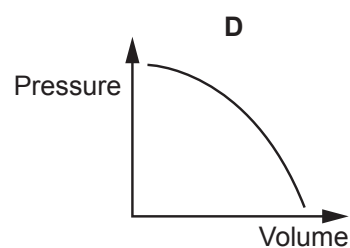
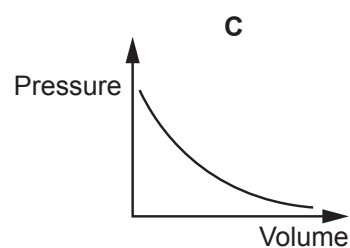
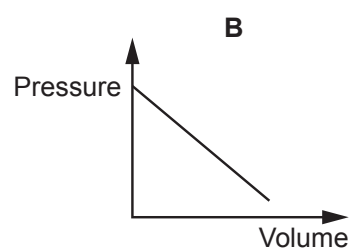
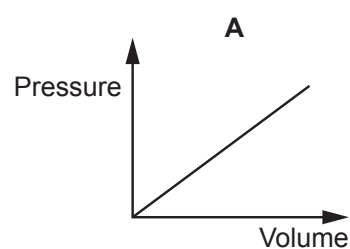
What is the force exerted on piston **Y**?

- A 1 N
- B 2 N
- C 4 N
- D 8 N

Your answer

[1]

- 9 A teacher measures the pressure and volume of a fixed gas at a constant temperature.



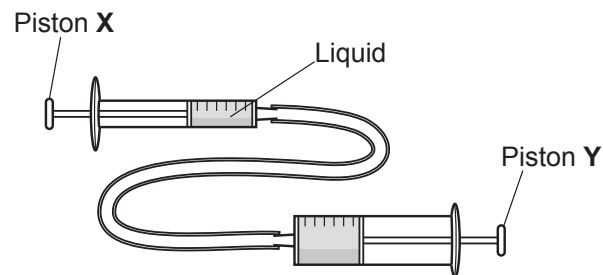
Which graph shows the correct relationship between pressure and volume for the gas?

Your answer

[1]

- 10** The diagram shows when a hydraulic machine uses a liquid to transmit a force. When piston **X** is pressed, the force is transmitted and piston **Y** moves.

The area of piston **X** is 4.0 cm^2 and the area of piston **Y** is 20 cm^2 .



Piston **X** is pressed with a force of 10 N .
What is the force produced at piston **Y**?

Use the equation: $\text{pressure} = \frac{\text{force normal to a surface}}{\text{area of that surface}}$

- A** 2.0 N
- B** 40 N
- C** 50 N
- D** 200 N

Your answer

[1]

14 An object floating in water experiences an upwards force.

What causes this upwards force on the object?

- A** Pressure at the top of the object is greater than at the bottom of the object.
- B** Pressure at the top of the object is less than at the bottom of the object.
- C** The density of the object is greater than the density of the water.
- D** The weight of the water displaced is less than the weight of the object.

Your answer

[1]



- 15** A submarine travels to the bottom of an ocean. The ocean is 2.5 km deep and the density of the sea water is 1020 kg/m^3 .

What is the water pressure on the submarine at the bottom of the ocean?

Use the Data Sheet.

Gravitational field strength = 10 N/kg .

- A** 2.55 kPa
- B** 25.5 kPa
- C** 2.55 MPa
- D** 25.5 MPa

Your answer

[1]

12 A submarine in an ocean dives from a depth of 50 m to a depth of 60 m.

What is the change in pressure due to the water acting on the submarine?

Use the Equation Sheet.

Density of seawater = 1010 kg/m^3

Use $g = 10 \text{ N/kg}$

A 10.1 Pa

B 1010 Pa

C 101 000 Pa

D 606 000 Pa

Your answer

[1]



12 Which statement describes a **simple** model of the Earth's atmosphere?

- A It covers the Earth to a height of about 700 km and is of uniform density.
- B It covers the Earth to a height of about 700 km and its density increases as the distance from the Earth increases.
- C It covers the Earth to a height of about 700 m and is of uniform density.
- D It covers the Earth to a height of about 700 m and its density increases as the distance from the Earth increases.

Your answer

[1]



6 An object is 1.0 m below the surface of a swimming pool.

Which statement describes the vertical forces acting on the object if it is **not** moving?

A Upthrust = water resistance

B Upthrust > water resistance

C Upthrust = weight

D Upthrust > weight

Your answer

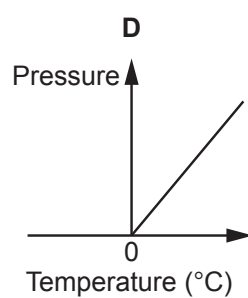
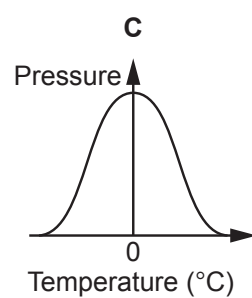
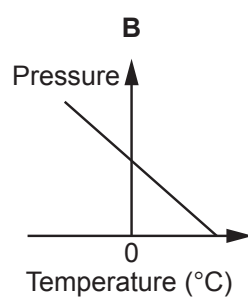
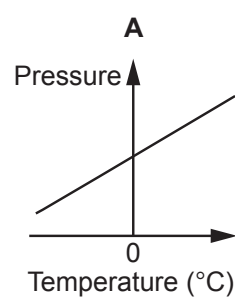
☐

[1]



11 A scientist investigates how pressure changes with temperature for a fixed volume of gas.

Which graph shows the relationship between pressure and temperature for the gas?



Your answer

[1]

14 Calculate the change in pressure when a diver moves from a depth of 3.0 m to a depth of 7.0 m.

Use the Equation Sheet.

Gravitational field strength = 10 N/kg

Density of water = 1000 kg/m³

A 4000 Pa

B 30 000 Pa

C 40 000 Pa

D 70 000 Pa

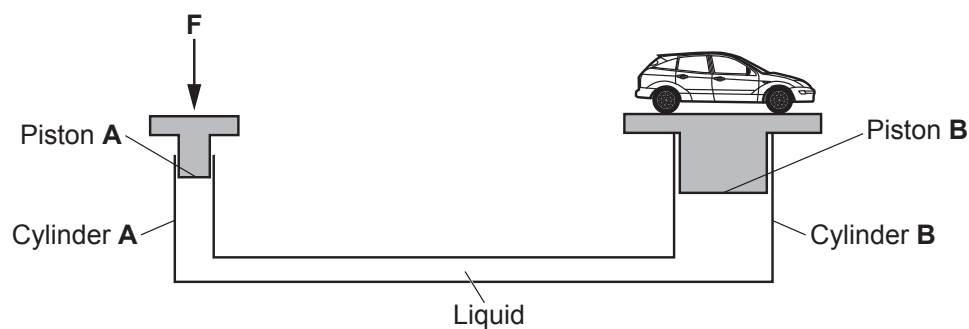
Your answer

[1]



24 A car mechanic uses a hydraulic lift to raise cars.

The diagram represents a simple model of a hydraulic lift.



(a) Which statement correctly compares the pressure in the cylinders?

Tick (✓) **one** box.

Pressure in cylinder **A** > pressure in cylinder **B**

☐

Pressure in cylinder **A** < pressure in cylinder **B**

☐

Pressure in cylinder **A** = pressure in cylinder **B**

☐

[1]

(b) Piston **A** has an area of $2.0 \times 10^{-4} \text{ m}^2$.

Piston **B** has an area of $10 \times 10^{-4} \text{ m}^2$.

A force F of 1000 N is applied to the liquid by piston **A**.

Calculate the minimum force exerted by the liquid on piston **B**.

Use the Equation Sheet.

Force = ... N [4]

23 (a) The air in a car tyre has a pressure of 200 kPa.

A driver notices that after a long journey the pressure in the tyre has increased. They think this is because the temperature of the tyre has increased.

Explain, in terms of molecules, why the pressure in the tyre has increased.

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..... [4]

(b) A student writes down a simple model of the Earth's atmosphere.

Simple model of the Earth's atmosphere

- The atmosphere is a single layer of gas that covers the Earth.
- The density of the air is uniform.
- The thickness of the atmosphere is large compared to the diameter of the Earth.

The student has made **one** mistake in their work.

Identify the wrong word the student used and write the correct word needed to replace it.

Wrong word:

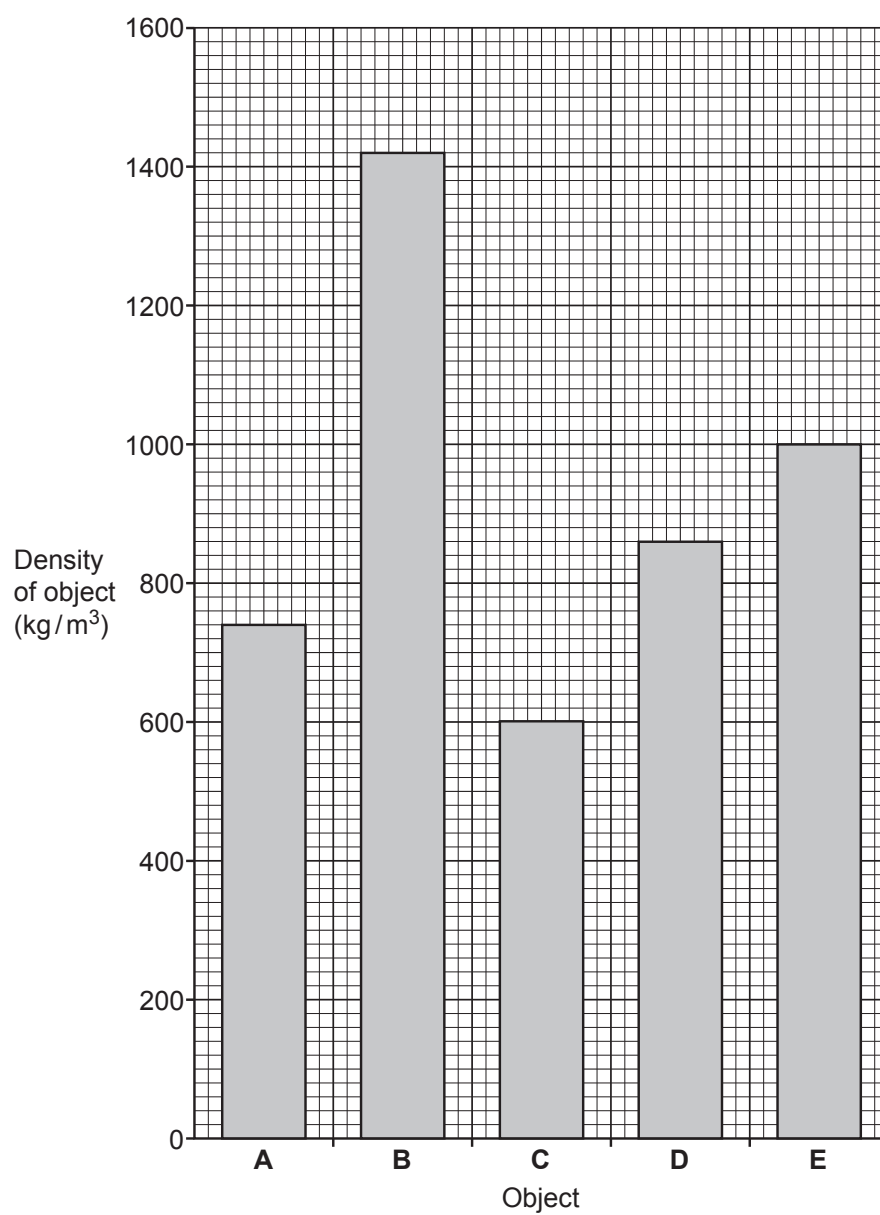
Correct word:

[2]



21 A student investigates floating and sinking.

The student draws a bar chart to show the densities of five objects, **A**, **B**, **C**, **D** and **E**.



The student places the five objects into an unknown liquid and observes if each object floats or sinks.

- Objects **A** and **C** float.
- Objects **B**, **D** and **E** sink.

(a) Explain why some objects float and some objects sink in a liquid.

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..... [2]

(b) Use the bar chart to estimate the density of the liquid used.

Density = ... kg/m^3 [1]

(c) The student uses the internet to research the densities of five different liquids.

Liquid	Density (kg/m^3)
Alcohol	800
Diesel	870
Vegetable oil	910
Dishwashing soap	1120
Treacle	1430

In which liquid would **all five** of the objects **A**, **B**, **C**, **D** and **E** float?

Liquid [1]



(d) A swimmer in a pool dives from a depth of 0.5 m to a depth of 2.0 m.

Calculate the change in pressure the swimmer experiences.

Use the Equation Sheet.

Gravitational field strength = 10 N/kg

Density of water = 1000 kg/m^3

Change in pressure = ... Pa **[2]**



17 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.

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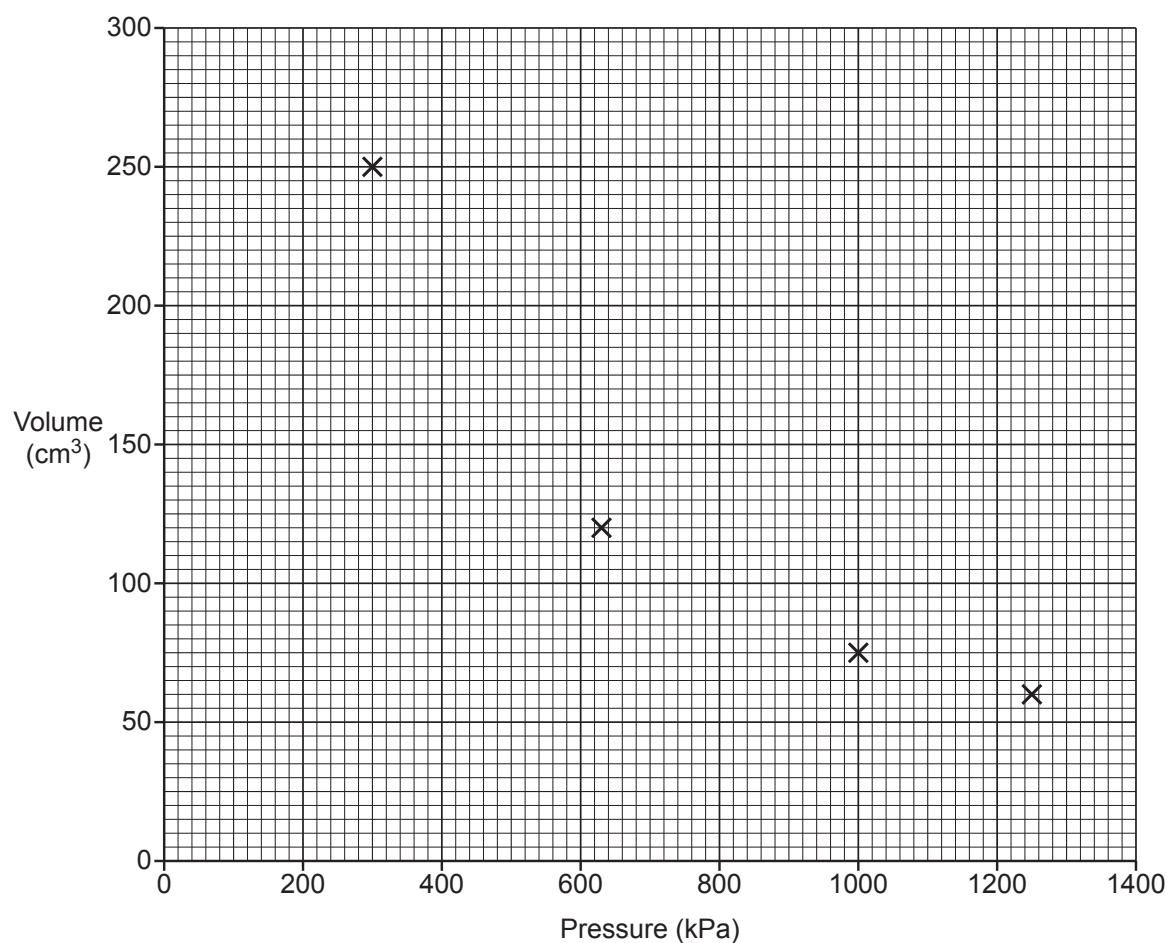
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..... [3]



(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.

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..... [2]



22 A student investigates four gases.

Look at her data.

Gas	Pressure (Pa)	Volume (m ³)
A	5	0.5
B	10	0.4
C	20	0.2
D	40	0.2

Two readings are for the same mass of the same gas at a constant temperature.

(a) Which two readings are for the **same mass** of the **same gas** at a constant temperature?

Use calculations in your answer.

[3]

(b) The student investigates another gas at **constant volume**.

Explain, using ideas about particles, how temperature affects gas pressure.

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..... [3]

(c) Calculate the pressure at the bottom of a 0.5 m tall measuring cylinder filled with a liquid.

Density of the liquid = 1100 kg/m³.

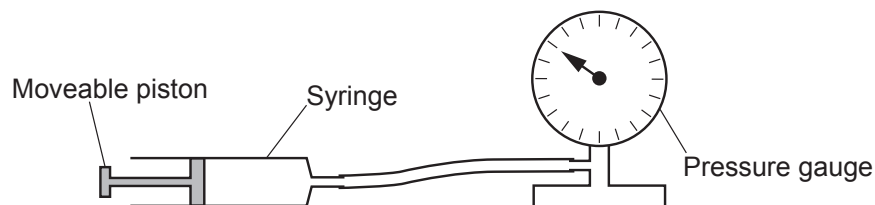
Pressure = ... Pa [3]



20

- (a) A teacher connects a sealed syringe of gas with a moveable piston to a pressure gauge as shown in Fig. 20.1.

Fig. 20.1



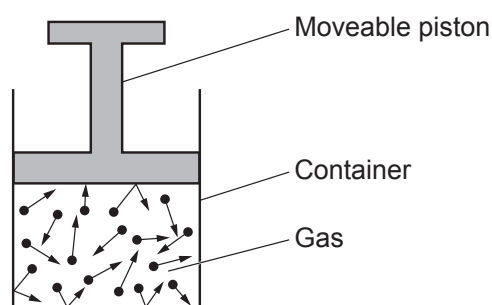
State **one** way the teacher can increase the reading on the pressure gauge.

..... [1]

(b)

- (i) The teacher also has a gas enclosed in a container as shown in Fig. 20.2.

Fig. 20.2



The teacher slowly moves the piston outwards until the gas has twice its original volume. The temperature of the gas is kept constant.

Explain how and why the pressure in the container changes.

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.....

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.....

..... [3]

- (ii) When the volume of a gas is $2.4 \times 10^{-4} \text{ m}^3$, the pressure is $2.5 \times 10^4 \text{ Pa}$.

Calculate the volume when the pressure is $1.5 \times 10^5 \text{ Pa}$.

Use the Equation Sheet.

Volume = ... m^3 [4]

- (c) Explain why a bicycle pump gets warmer when it is used to inflate a tyre.

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.....

.....

..... [3]



MARK SCHEMES

official Pearson Edexcel mark schemes



Question				Answer	Marks	AO element	Guidance
2				B ✓	1	1.1	



Question				Answer	Marks	AO element	Guidance
3				D ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
1	C	1	1.1	



Question	Answer	Marks	AO element	Guidance
2	A	1	1.1	



Question	Answer	Marks	AO element	Guidance
1	D	1	2.1	



Question	Answer	Marks	AO element	Guidance
15	C	1	2.1	



17	(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

19	(a)	(i)	Any three from: small / tiny nucleus ✓ positively charged nucleus ✓ mass is concentrated in the nucleus ✓ most of atom is empty space ✓	3	3 x 1.1	IGNORE reference to electrons ALLOW maximum 2 marks for implying nucleus but not stating nucleus ALLOW atom has empty space
		(ii)	Previous models could not explain new observations / new evidence disproves old model / AW ✓	1	1.2	ALLOW (idea of) previous/plum pudding/Thomson's model did not fit with these observations ALLOW shows there is a nucleus / empty space IGNORE reference to neutrons (1932)
	(b)	(i)	$(3 \times 8 \times 8 =) 192 \text{ (m}^3\text{)} \checkmark$	1	2.1	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.3 / 2.30 / 2.304 award 3 marks mass = density x volume ✓ $0.012 \times 192 \checkmark$ $2.3 / 2.30 / 2.304 \text{ (kg)} \checkmark$	3	1.2 2.1 2.1	Possible ECF from 19(b)(i) Correct re-arrangement Correct substitution

20	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = $0.001 / 1 \times 10^{-3} \text{ (m}^3\text{)}$ award 2 marks $0.1 \times 0.1 \times 0.1 \checkmark$ $= 0.001 / 1 \times 10^{-3} \text{ (m}^3\text{)} \checkmark$	2	2x2.2	
		(ii)	Density = mass/volume / density is proportional to mass $\checkmark$ (Cube B has 10 x mass of cube A, so) density of cube B is 10 x density of cube A $\checkmark$	2	1.2 2.2	ALLOW density is 10 times larger ALLOW numerical values used to show density of cube B is 10 x density of cube A
	(b)		As temperature increases, density decreases / ORA $\checkmark$	1	3.1a	IGNORE negative correlation / inversely proportional
	(c)		Particles (in solid) are close(r) together / (more) compact / ORA / AW $\checkmark$	1	1.1	Assume answer refers to a solid unless indicated otherwise
	(d)		Any three from: Boat has bigger upthrust/buoyancy force (compared to weight of lump) / ORA / AW $\checkmark$ Upthrust on boat is equal to weight of boat / resultant force is zero / AW $\checkmark$ Weight of water displaced by the boat is equal to the weight of the boat / AW $\checkmark$ (Overall) density of the boat includes the air / ORA / AW $\checkmark$ (Overall) density of the boat (and air) is less than the density of the water / ORA / AW $\checkmark$	3	3x2.1	ALLOW upthrust on lump is less than weight of lump / there is a resultant force (acting downwards) ALLOW weight of water displaced by lump is less than weight of lump / AW ALLOW hollow for air ALLOW maximum of 1 mark for boat is hollow / contains air / ORA / AW

Question				Answer	Marks	AO element	Guidance
10			A		1	2.1	



Question	Answer	Marks	AO element	Guidance
6	C ✓	1	1.2	



Question				Answer	Marks	AO element	Guidance
9				C ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
8	A	1	1.1	



Question	Answer	Marks	AO element	Guidance
13	A	1	1.1	



Question	Answer	Marks	AO element	Guidance
15	B	1	2.2	



23	(a)	FIRST CHECK THE ANSWERS ON ANSWER LINES If answer = 385 (J/kg °C) AND material = zinc award 5 marks $c = (E / m\theta) \checkmark$ $(\theta = 900 - 420 =) 480 (^{\circ}\text{C}) \checkmark$ $(c =) 462000 / (2.5 \times 480) \checkmark$ $(c =) 385 (\text{J/kg}^{\circ}\text{C}) \checkmark$ (substance is) zinc $\checkmark$	5	1.2 2.2 2.2 2.2 3.2b	ALLOW ecf for missing or incorrect unit conversion e.g. 0.385 (J/kg °C) for 3 marks (E = mcθ does not score a mark) ALLOW ecf for closest material to the answer calculated for shc if answer is incorrect. IGNORE another material quoted with its value from the table given as the answer unless workings shown
	(b)	Any two from: Not all substances are shown in the table / it could be a substance not in the table $\checkmark$ Named uncertainties/errors in the experiment $\checkmark$ It assumes all of the energy went to heat the material $\checkmark$ The value is (very) close to other values $\checkmark$ It assumes the substance is pure/not a mixture $\checkmark$	2	2x3.1b	ALLOW there could be more than one substance with the same shc ALLOW assumes no energy transferred to other stores / no energy/heat loss ALLOW ecf from 23(a) ALLOW maximum of 1 mark for idea of results not repeated/reproduced



21 (*)	(a)	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) A detailed explanation of experimental procedure AND detailed discussion about accuracy <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) EITHER a detailed explanation of the experimental procedure OR detailed discussion about accuracy OR a brief explanation of the experimental procedure and simple discussion about accuracy <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) Brief explanation of the experimental procedure OR simple comment about accuracy <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6 2 x 2.2 2 x 3.3a 2 x 1.2	A01.2 and AO2.2 Applies knowledge and understanding of how to use the equipment to find specific latent heat of water. For example: • Measure the initial mass / weight of beaker • Turn on the heater • Start timing • Use the voltmeter, ammeter and stopclock to calculate the energy supplied ($E=VIt$) • Turn off the heater • Stop timing • Use a balance to measure the mass of the beaker and melted ice • Subtract the original mass of the beaker to find the mass / weight of the melted ice / calculate mass / weight of melted ice • Calculate specific latent heat by dividing energy by mass A03.3a Analyses information and ideas to develop experimental procedures and consider accuracy of the experiment. For example: • Make sure that the heater is always covered with ice • Insulate / put lid on the funnel to reduce heat losses • Make sure that the mass of water produced is sufficiently large – run the experiment for long enough • Repeat the experiment to minimise (random) errors
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Question			Answer	Marks	AO element	Guidance
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 380 000 (J) award 3 marks SLH = E ÷ m ✓ = 95000 ÷ 0.25 ✓ = 380000 (J/kg) ✓	3	1.2 2.1 2.1	Rearranging equation 95 ÷ 250 or 0.38 scores ✓ (evidence of rearranged formula) 95 000 ÷ 250 = 380 scores ✓✓ Or 95 ÷ 0.25 = 380 ✓✓ Or 380 ✓✓



16	(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	

18	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 67 200 (J) award 2 marks (Energy = mass x shc x temperature change) $0.2 \times 4200 \times 80$ ✓ $67\,200$ (J) ✓	2	2.1 2.1	ALLOW 67 000 (J) Note use of 20 or 100 for temperature, scores zero No ECF
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 452 000 (J) award 2 marks (Energy = mass x specific latent heat) $0.2 \times 2\,260\,000$ ✓ $452\,000$ (J) ✓	2	2.1 2.1	ALLOW 450 000 (J) Note inclusion of a temperature, scores zero No ECF
		(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5.2×10^5 (J) award 3 marks $67\,200 + 452\,000 = 519\,200$ ✓ 5.19200×10^5 ✓ 5.2×10^5 (J) ✓	3	2.1 2.1 1.2	ALLOW ECF from 18(a)(i) and 18(a)(ii) ALLOW ECF for wrong calculation ALLOW 520 000 (J) for 2 marks
	(b)	(i)	Any two from: Some of the energy was used to heat the container ✓ Heat/energy lost to the environment ✓	2	3.2a 3.3a	ALLOW 1 mark maximum for any general 'energy losses' response
		(ii)	Any one from: Reduces random errors ✓ Helps identify anomalies ✓ Allows checks for precision ✓	1	3.3b	ALLOW improves accuracy

20	(a)		Power supply attached to electric heater AND correct symbol for ammeter in series with heater ✓ Correct symbol for voltmeter in parallel with heater or power supply ✓	2	2 × 1.2	Maximum of 1 mark if a line drawn through the ammeter and/or voltmeter IGNORE extra ammeters/other components in series ALLOW 1 mark for incorrect symbols for ammeter and voltmeter in the correct places
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 480 (J / kg °C) award 4 marks 24 kJ = 24 000 J ✓ Rearrangement: Specific heat capacity = change in thermal energy ÷ (mass × change in temperature) ✓ (Specific heat capacity =) 24 000 ÷ (2 × 25) ✓ (Specific heat capacity =) 480 (J / kg °C) ✓	4	2 × 1.2 2 × 2.1	ALLOW 2 marks for 24 ÷ (2 × 25) or 2.4 × 10 ⁿ ÷ (2 × 25) ALLOW 3 marks for answer of 0.48 or 4.8 × 10 ⁿ (J/kg°C)
		(ii)	(Idea that) thermal energy is lost/wasted to the surroundings / not all energy supplied to the heater is transferred into the metal block ✓	1	3.2a	ALLOW heat for thermal energy ALLOW thermal energy is dissipated (to the surroundings)
		(iii)	Any one from: Insulate the metal block ✓ Put the heater further into the metal block / use a smaller heater ✓ Use oil/lubricant to improve contact between heater and block ✓ Repeat and calculate the mean ✓	1	3.3b	ALLOW add lid

Question		Answer	Marks	AO element	Guidance
20	(c)	Block C (has the highest specific heat capacity) ✓ It has the smallest change in temperature (for the same rate of input in energy) ✓	2	3.2b 3.1b	No mark if block A or B chosen ALLOW it has the lowest gradient/slope ALLOW it has the slowest change in temperature IGNORE (idea that) it needs more energy to raise temperature by 1°C

20	(a)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.7 OR 70% award 3 marks (Efficiency =) useful energy output ÷ energy input ✓ (Efficiency =) $8400 \div 12000$ or 70 ✓ (Efficiency =) 0.7 ✓	3	1×1.2 2×2.1	ALLOW equation in any form ALLOW 70 (without % sign) for 2 marks ALLOW 0.7% for 2 marks
	(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 40 (W) award 3 marks (Power =) energy transferred ÷ time ✓ (Power =) $12000 \div 300$ ✓ (Power =) 40 (W) ✓	3	1×1.2 2×2.1	ALLOW 2400 (W) for 2 marks (no unit conversion) ALLOW equation in any form

Question	Answer	Marks	AO element	Guidance
20 (c)*	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 explanation of how equipment is used to take appropriate measurements AND Detailed explanation of how the quantities are calculated. <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 explanation of how equipment is used to take appropriate measurements OR Detailed explanation of how the quantities are calculated OR Explanation of how equipment is used to take appropriate measurements AND explanation of how the quantities are calculated. <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) Simple explanation of how equipment is used to take appropriate measurements OR Simple explanation of how the quantities are calculated. OR correct equation stated.	6	2×1.2 $4 \times 3.3a$	AO3 – Analyses information to develop a method to calculate energy input and energy output - p.d./voltage measured with voltmeter - Current measured with ammeter - Mass of water measured with top-pan balance (allow weighing scales) or volume of water measured using measuring cylinder and density of water used - Temperature change measured using thermometer / temperature probe attached to data-logger - Heater used for a fixed time / AW measured with stopwatch - Keep temperature changes low / fully immerse immersion heater in water / do not touch hot immersion heater / insulate the beaker - Stopwatch used to measure time AO1 – Demonstrates knowledge of scientific ideas to work out energy input and energy output - Energy input = power (of heater) × time - Power (of heater) = current × p.d. - Energy input = $I \times V \times t$ - Energy increase in water = mass × SHC × temperature rise - Mass of water = density × volume

Question	Answer	Marks	AO element	Guidance
	<i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>			



22	(a)		Bar for kinetic energy higher than zero ✓ Bar for thermal energy higher than previous bar ✓ Sum of the heights of the bars = 5 ✓	3	3 × 2.2	DO NOT ALLOW this mark if candidate has drawn a kinetic energy bar which is higher in Fig. 22.2
	(b)	(i)	Any one from: Insulate the tube ✓ Repeat (the experiment) and take an average (temperature rise) ✓	1	3.3b	ALLOW use a tube made of a more insulating material
		(ii)	So pellets do not rub against side of tube / to reduce friction / to reduce thermal energy transfer (to tube)	1	2.2	ALLOW pellets to fall (more) vertically / to reduce the cooling of the pellets
		(iii)	First check the answer on answer line If answer = 0.45 (J) award 2 marks (GPE ⇒) $0.03 \times 10 \times 1.5$ ✓ (GPE ⇒) 0.45 (J) ✓	2		ALLOW 0.44 (J) 2.1 ALLOW use of 9.8(1) N / kg 2.1 ALLOW 0.44 (J)

Question	Answer	Marks	AO element	Guidance
22 (b) (iv)	First check the answer on answer line If answer = 140 J / kg °C award 4 marks Rearrange to give: $c = E / (m \times \Delta\theta)$ ✓ (c ⇒) $21 / (0.03 \times 5)$ ✓ (c ⇒) 140 ✓ J / kg °C ✓	4		ALLOW 0.14 J / g °C for 4 marks ALLOW K for °C 2.1 2.1 ALLOW 1 mark for correct substitution into unarranged equation, e.g., $21 = 0.03 \times c \times 5$ 2.1 1.1 Unit mark is independent ALLOW J / kg / °C
	(v) Any three from: Student A: A higher SHC would lead to a lower temperature rise/change ✓ (small) temperature rise/change is more difficult to measure ✓ Student B: More turns mean more energy dissipated as thermal energy (in the tube or surroundings) ✓ a larger SHC value is obtained ✓	3	3 × 3.1b	

23	(a)	(i)	First check the answer on answer line If answer = 28 500 (J) award 2 marks $(E = mc\theta)$ $E = 0.50 \times 1900 \times 30 \checkmark$ $E = 28\,500 \text{ (J)} \checkmark$	2	2.1 2.1	ALLOW 29 000 J (rounded to 2 significant figures) ALLOW 28.5 kJ
		(ii)	First check the answer on answer line If answer = 95 (W) award 3 marks $P = E \div t \checkmark$ $P = 28\,500 \div (5 \times 60) \checkmark$ $P = 95 \text{ (W)} \checkmark$	3	1.2 2.1 2.1	ALLOW 23(a)(i) divided by 5 for 2 marks ALLOW 23(a)(i) divided by 300 for 3 marks ALLOW ECF from 23(a)(i) ALLOW 5700 (W) for 2 marks (no unit conversion)
		(iii)	Containers of vaccines / other contents of the freezer need to be cooled $\checkmark$ Energy / heat dissipated / transferred to surroundings / environment or energy heat dissipated in motor / compressor $\checkmark$	2	2 x 3.2a	IGNORE not 100% efficient
	(b)	(i)	Any two from: Energy is needed to change the state of a material $\checkmark$ Energy is needed to break / weaken the bonds (between molecules / particles) or overcome attractive forces (between solid (vaccine) molecules) $\checkmark$ Some heat transfer with the surroundings / container $\checkmark$	2	2 x 1.2	ALLOW ideas about energy needed to increase separation of molecules
		(ii)	First check the answer on answer line If answer = 4000 (doses) award 6 marks $m = E \div L \checkmark$ $m = 6800 \div 340000 \checkmark$ $m = 0.02 \text{ kg} \checkmark$ $0.02 \text{ kg} = 20\,000 \text{ mg} \checkmark$ (number of doses =) $0.02 \div 5 \times 10^{-6}$ OR $20\,000 \div 5 \checkmark$ (number of doses =) 4000 $\checkmark$ Or $5 \text{ mg} = 5 \times 10^{-6} \text{ kg} \checkmark$ energy of one dose $5 \text{ (mg)} \times 340000 \checkmark \checkmark$ energy of one does = 1.7 J $\checkmark$ (number of doses =) $6800 \div 1.7 \checkmark$ (number of doses =) 4000 $\checkmark$	6	1.2 2.1 2.1 1.2 2.1 3.1b	Rearrangement of the equation ALLOW $0.02 \div 5 \times 10^n$ (missing or incorrect conversion from mg to kg) for 4 marks ALLOW 4×10^n doses for 5 marks ALLOW $5 \times 10^n \times 340000$ for 2 marks ALLOW 1.7×10^n (power of ten error) for 3 marks ALLOW 4×10^n doses for 5 marks

23	(a)	(i)	48°C	1	3.2a	
		(ii)	12°C	1	3.2a	
		(iii)	First check the answer on the answer line If answer = 27,000 (J) award 4 marks $(E = mc\theta)$ 200 g = 0.2(00) kg ✓ $\theta = 48 - 12 = 36^\circ\text{C}$ ✓ $E = 0.2 \times 3750 \times (48 - 12)$ ✓ $E = 27,000 / 2.7 \times 10^4$ ✓	4	1.2 1.2 2.2 2.2	ALLOW 27 kJ for full marks ALLOW ECF from (a)(i) and (a)(ii) IGNORE -ve sign ALLOW 3 marks for $E = 2.7 \times 10^7$ J (did not convert g to kg)
	(b)	(i)	First check the answer on the answer line If answer = 150 (W) award 4 marks $(E = Pt)$ $P = E / t$ ✓ $E = 54 \times 1000 = 54000$ J ✓ $P = 54000 / 360$ ✓ $P = 150$ (W) ✓	4	1.2 1.2 2.1 2.1	 ALLOW 1.5 x 10 ⁿ for 3 marks (no or incorrect conversion of kJ)
		(ii)	Any one from: Not 100% efficient / AW ✓ Energy is <u>gained</u> from the surroundings ✓ There is not enough insulation of the fridge ✓	1	3.2a	IGNORE energy is lost to surroundings (unless clearly related to the efficiency of the motor) ALLOW cooling fridge / other contents

Question			Answer	Marks	AO element	Guidance
	(c)		First check the answer on the answer line If answer = 17 (Ω) award 4 marks $P = I^2 R$ ✓ $(I =) \sqrt{(240 / 0.80)}$ ✓ $I = 17.32$ (A) ✓ $I = 17$ (A) ✓ (2 sig fig)	4		1.2 ALLOW equation in any form 2.1 ALLOW substitution into unrearranged equation for this mark 2.1 ALLOW any number of significant figures for this mark 1.2 ALLOW an incorrectly <u>calculated</u> value to 2 sig figs if working shown IGNORE unqualified 2 sig fig ALLOW 300 (A) for 2 marks (check correct equation used)



Question			Answer	Marks	AO element	Guidance
3			D ✓	1	1.2	



Question			Answer	Marks	AO element	Guidance
5			D ✓	1	1.1	



Question				Answer	Marks	AO element	Guidance
4				D	1	2.1	



Question				Answer	Marks	AO element	Guidance
6			A		1	1.1	



Question				Answer	Marks	AO element	Guidance
14				B	1	2.1	



Question				Answer	Marks	AO element	Guidance
9				A ✓	1	1.1	



Question			Answer	Marks	AO element	Guidance
15			C ✓	1	1.2	



Question	Answer	Marks	AO element	Guidance
9	C ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
10	C ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
14	B ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
15	D ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
12	C	1	2.1	



Question	Answer	Marks	AO element	Guidance
12	A	1	1.1	



Question	Answer	Marks	AO element	Guidance
6	C	1	1.2	



Question	Answer	Marks	AO element	Guidance
11	A	1	1.1	



14	C	1	2.1	A: 4×1000 B: $3 \times 10 \times 1000$ C: $4 \times 10 \times 1000$ D: $7 \times 10 \times 1000$
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24	(a)		pressure in cylinder A = pressure in cylinder B ✓	1	3.2b	
	(b)		First check the answer on the answer line If answer = 5,000 (N) award 4 marks Pressure calc For cylinder A: $P_A = F/A = 1000 / 2.0 \times 10^{-4} \checkmark$ $P_A = 5,000,000 / 5.0 \times 10^{-6} \text{ Pa} \checkmark$ $(P_A = P_B)$ $F = AP_B = AP_A = 5.0 \times 10^6 \times 10 \times 10^{-4} \checkmark$ $F = 5,000 \text{ (N)} \checkmark$	4		ALLOW answers using ratios for full marks Force Ratios $10 \times 10^{-4} / 2.0 \times 10^{-4} \checkmark$ $= 5 \checkmark$ 2.1 2.1 $5 \times 1000 \checkmark$ $= 5,000 \text{ (N)} \checkmark$ OR 2.1 2.1 Equate $F_A / A_A = F_B / A_B \checkmark$ $F_B = F_A A_B / A_A \checkmark$ $F_B = (1000 \times 10 \times 10^{-4}) / 2.0 \times 10^{-4} \checkmark$ $F_B = 5,000 \text{ (N)} \checkmark$ ALLOW ECF from A to B

23 (a)	Any four from: Increase in temperature is because driving does work (on the tyre) / energy transfer (to molecules) due to friction (between tyre and road) ✓ (Higher temperature means) higher (average) speed of the gas molecules ✓ More (frequent) collisions <u>with the walls / sides</u> (of the tyre) / <u>with the tyre</u> ✓ Increase the force (over a certain area) ✓ A larger force over the same area increases the pressure / area ✓	4	1 x 2.1 3 x 1.1	ALLOW particles / atoms for molecules ALLOW higher <u>kinetic</u> energy
(b)	Mistake: (The thickness of the atmosphere is) large (compared to the diameter of the Earth) ✓ Correction linked to correct mistake: (The thickness of the atmosphere is very) small / AW (compared to the diameter of the Earth) ✓	2	3.2a 2.1	



21	(a)	Any one from: Objects float when upthrust is equal to weight ✓ Objects float when weight of liquid displaced equals the weight of the object ✓ Objects float when the density of the object is less than the density of the liquid ✓ Any one from: Objects sink when weight is greater than upthrust ✓ Objects sink when weight of liquid displaced is less than the weight of the object ✓ Objects sink when the density of the object is more than the density of the liquid ✓	2	1.1 x2	
	(b)	In the range 740 to 859 (kg / m ³) ✓	1	3.1a	
	(c)	treacle ✓	1	3.1b	
	(d)	First check the answer on the answer line If answer = 15000 (Pa) award 2 marks (P=hpg) P = 1.5 x 1000 x 10 ✓ P = 15000 (Pa) ✓	2	2.1 2.1	15 x 10 ³ or 1.5 x 10 ⁴ (Pa) OR 15 kPa (unit needed)

17	(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

22	(a)	Pressure is inversely proportional to volume OR $pV = \text{constant}$ for a particular gas OR for any of the gases calculation of $p \times V$ ✓ For gas B: $10 \times 0.4 = 4$ <u>and</u> for gas C: $20 \times 0.2 = 4$ OR Pressure of C is double the pressure of B <u>and</u> volume of C is half the volume of B ✓ B and C ✓	3	3.2b 3.1a 3.2b	NOTE could be written next to table
	(b)	For an increase in temperature / heating of gas: gas particles / molecules / atoms have a higher (average) speed / more (kinetic) energy OR ✓ They collide more frequently / often with the walls (of container) / container AW ✓ Bigger force (over same area) equals greater pressure ✓	3	3x1.1	Direction of temperature change must be clear ALLOW move faster for higher (average) speed ALLOW linked to increase/decrease of KE if temperature change not explicit ALLOW bigger change in momentum
	(c)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5500 (Pa) award 3 marks pressure due to a column of liquid (Pa) = height of column (m) x density of liquid (kg/m^3) x g (N/kg) / $P = h\rho g$ (no mark – on formula sheet) $g = 10 \text{ (N/kg)}$ ✓ $P = 0.5 \times 1100 \times 10$ ✓ $P = 5500 \text{ (Pa)}$ ✓	3	1.1 2.1 2.1	ALLOW three marks for 5390 Pa if $g=9.8 \text{ N/kg}$ or 5395.5 Pa if $g=9.81 \text{ N/kg}$ is used ALLOW 9.8(1) N/kg

20	(a)		Apply a force to the piston ✓	1	1.2	IGNORE increase the pressure / decrease the volume / syringe ALLOW heat the gas ALLOW push / move the (moveable) piston (in) DO NOT ALLOW pull / move out piston (CON)
	(b)	(i)	The pressure halves / reduces / goes down / decreases ✓ AND The <u>rate</u> of collisions <u>with the sides</u> (of the container) decreases ✓✓ OR There are fewer collisions <u>with the sides</u> (of the container) ✓ Less frequent collisions / more time between collisions ✓	3	3.2b 1.1x2	IGNORE reverse argument ALLOW walls / surface (of the container) ALLOW rate of change of momentum of particles <u>with the sides</u> (of the container) decreases ✓✓ ALLOW less frequent collisions <u>with the sides</u> (of the container) ✓✓ IGNORE less likely ALLOW less often collisions
		(ii)	First check the answer on the answer line If answer = $4(.0) \times 10^{-5} \text{ (m}^3\text{)}$ award 4 marks (PV = constant) (Constant =) $2.5 \times 10^4 \times 2.4 \times 10^{-4}$ ✓ (Constant =) 6 ✓ $V = \text{constant} / P = 6 / 1.5 \times 10^5$ ✓ $V = 4(.0) \times 10^{-5} \text{ (m}^3\text{)}$ ✓	4		ALLOW three marks for 4×10^n or 1/25000 ALLOW three marks for $V_2 = \frac{2.5 \times 10^4 \times 2.4 \times 10^{-4}}{1.5 \times 10^5}$ ALLOW use of $P_1 V_1 = P_2 V_2$ method to calculate a constant ✓ constant value e.g., 6 or 1/6 or 0.17 ✓ use of constant to determine ✓ $4(.0) \times 10^{-5} \text{ (m}^3\text{)}$ ✓ e.g., $\frac{2.5 \times 10^4}{1.5 \times 10^5} (= \frac{P_1}{P_2} = \frac{V_2}{V_1} = \text{constant})$ ✓ (Constant =) 0.167 ✓ $V = 2.4 \times 10^{-4} \times 0.167$ ✓ $V = 4(.0) \times 10^{-5} \text{ (m}^3\text{)}$ ✓

Question	Answer	Marks	AO element	Guidance
(c)	Any three from: Work is being done on the gas ✓ Average/mean speed of the particles increases ✓ Kinetic energy of the particles increases ✓ Energy from the kinetic store of the gas is transferred to the thermal store (of the gas) ✓ Energy from the thermal store of the gas is transferred to the thermal store of the pump ✓ Temperature is a measure of the average/mean kinetic energy ✓ Friction between piston and the side of the pump ✓	3	1.1x3	IGNORE Heat transfer from tyre ALLOW faster ALLOW kinetic energy for kinetic store and thermal energy / heat for thermal store