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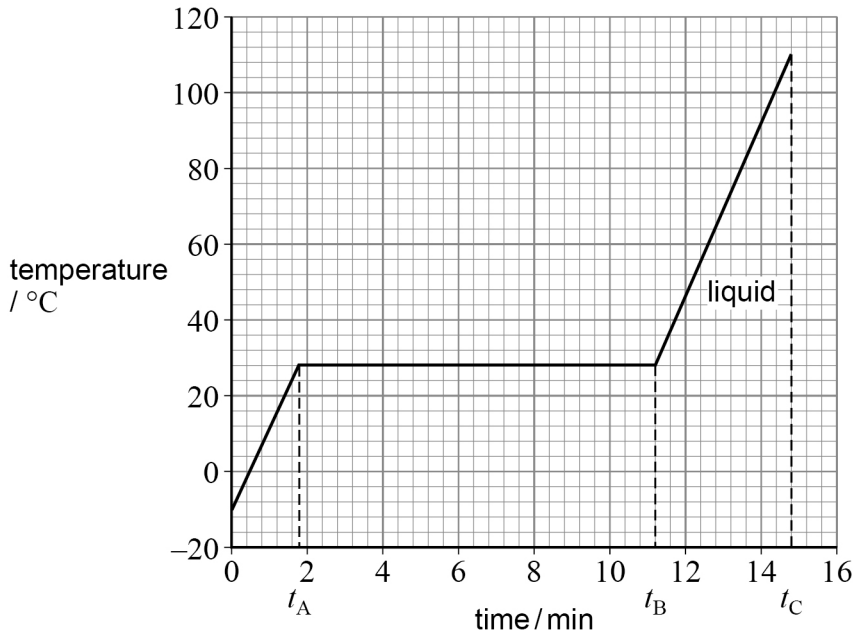
Section A

Answer **all** questions in this section.

0 1 A perfectly insulated flask contains a sample of metal **M** at a temperature of −10 °C.

Figure 1 shows how the temperature of the sample changes when energy is transferred to it at a constant rate of 35 W.

Figure 1



0 1 . 1 State the melting temperature of **M**.

[1 mark]

temperature = 28 °C

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0 1 . 2 Explain how the energy transferred to the sample changes the arrangement of the atoms during the time interval t_A to t_B.

[1 mark]

the solid is meting, meaning that bonds are being broken so the particles are moving from an ordered to a random (amorphous) structure

0 1 . 3 State what happens to the potential energy of the atoms and to the kinetic energy of the atoms during the time interval t_A to t_B.

[2 marks]

mean Ek stays the same, but the mean Ep is increasing

0 1 . 4 Describe how the motion of the atoms changes during the time interval t_B to t_C.

[1 mark]

the mean Ek is increasing so the mean speed is increase

Question 1 continues on the next page

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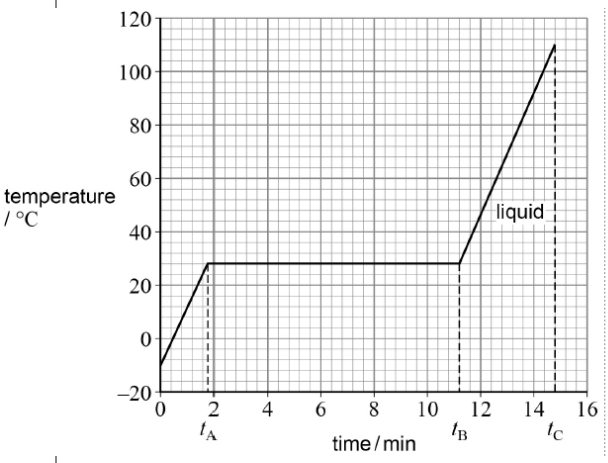
0 1 . 5 The sample has a mass of 0.25 kg.

power = 35 W

Determine the specific heat capacity of **M** when in the liquid state.
State an appropriate SI unit for your answer.

[3 marks]



$\Delta Q = mc\Delta\theta$ ← P x t

$\frac{Pxt}{m\Delta\theta} = c$

$\frac{35 \times (114.8 - 11.2) \times 60}{0.25 \times (110 - 28)} = 369$

specific heat capacity = 370 unit = J/(kg°C)

0 1 . 6 **Table 1** shows the specific latent heats of fusion l for elements that are liquid at similar temperatures to **M**.

Table 1

Element	Caesium	Gallium	Mercury	Rubidium
l / **kJ kg^{-1}**	16	80	11	26

M is known to be one of the elements in **Table 1**.

Identify **M**.

[2 marks]

$\frac{Q}{m} = \frac{mL}{m} = \frac{35 \times (11.2 - 1.8) \times 60}{0.25}$

$\Rightarrow L = 78960$

$= 79000$ J/kg

so closest to Gallium

M = Gallium

10

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Section B

Each of Questions **07** to **31** is followed by four responses, **A**, **B**, **C** and **D**.

For each question select the best response.

Only **one** answer per question is allowed.
For each question, completely fill in the circle alongside the appropriate answer.

CORRECT METHOD  WRONG METHODS 

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

You may do your working in the blank space around each question but this will not be marked. Do **not** use additional sheets for this working.

0 7 When an ideal gas at a temperature of 27 °C is suddenly compressed to one quarter of its volume, the pressure increases by a factor of 7

What is the new temperature of the gas?

[1 mark]

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$T_1 P_2 V_2 = T_2 P_1 V_1$ $\quad \frac{P_2}{P_1} = 7 \quad \frac{V_2}{V_1} = 0.25$

$(273 + 27) \times 7 \times 0.25 = T_2$

$T_2 = 525\,K$

$= 252\,^{\circ}C$

A 15 °C 

B 47 °C 

C 171 °C 

D 252 °C 

Turn over for the next question

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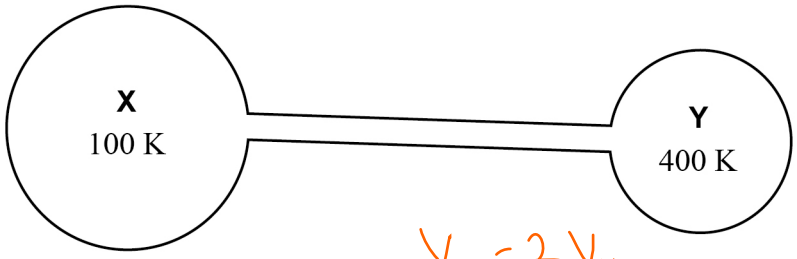
0 8 The diagram shows two flasks **X** and **Y** connected by a thin tube of negligible volume.



$V_x = 2V_y$

The flasks contain an ideal gas.

The volume of **X** is twice the volume of **Y**. When **X** is at a temperature of $100\ \text{K}$ and **Y** is at a temperature of $400\ \text{K}$ there is no net transfer of particles between the flasks.

so $P_x = P_y$

X contains gas of mass m.

What is the mass of gas in **Y**?

[1 mark]

$P_x V_x = nRT_x$

$\frac{n_x RT_x}{V_x} = \frac{n_y RT_y}{V_y}$ (100, 400)

$V_x = 2V_y$

$\frac{n_x \times 50}{2V_y} = \frac{n_y \times 400}{V_y}$

so $n_x = 400\, n_y$

$\therefore n_y = \frac{50}{400 n_x}$ $\therefore n_y = \frac{1}{8} n_x$ so A

A $\frac{m}{8}$ ○

B $\frac{m}{2}$ ○

C $2m$ ○

D $8m$ ○

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0 9 A sample **P** of an ideal gas contains $1\ \text{mol}$ at an absolute temperature T.

A second sample **Q** of an ideal gas contains $\frac{2}{3}\ \text{mol}$ at an absolute temperature $2T$.

The total molecular kinetic energy of **P** is E.

What is the total molecular kinetic energy of **Q**?

Q has temp 2T therefore the Ek of a molecule is twice what it is for P

total energy is energy of each molecule x N (number of molecules)

Q has 2/3 the number of molecules therefore has 2*2/3 = 4/3 as much energy

[1 mark]

A $\frac{2}{3}E$ ○

B $\frac{3}{4}E$ ○

C $\frac{4}{3}E$ ○

D $\frac{3}{2}E$ ○

1 0 An ideal gas is contained in a cubical box of side length a.
The gas has N molecules each of mass m.

What is the pressure exerted by the gas on the walls of the box?

a^3

$pV = \frac{1}{3}Nm(c_{rms})^2$

$p = \frac{Nmc_{rms}^2}{3a^3}$

[1 mark]

A $\frac{mNa^3}{2} \times c_{\text{rms}}^2$ ○

B $\frac{mNa^2}{2} \times c_{\text{rms}}^2$ ○

C $\frac{mN}{3a^2} \times c_{\text{rms}}^2$ ○

D $\frac{mN}{3a^3} \times c_{\text{rms}}^2$ ○

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1 1 Which statement is true about an experiment where Brownian motion is demonstrated using smoke particles in air?

[1 mark]

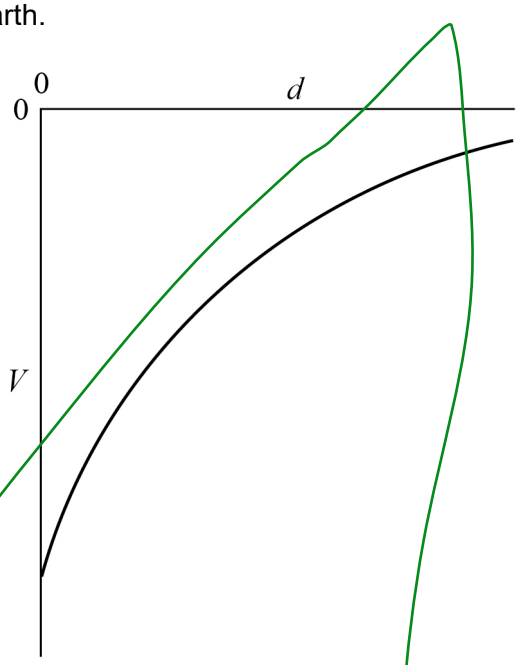
A The experiment makes it possible to see the motion of air molecules. ⬭

B The motion is caused by the collisions of smoke particles with each other. ⬭

C The motion is caused by collisions between air molecules and smoke particles. ⬭

D The motion occurs because air is a mixture of gases and the molecules have different masses. ⬭

1 2 The graph shows how the gravitational potential V varies with the vertical distance d from the surface of the Earth.



What does the gradient of the graph represent at the surface of the Earth?

[1 mark]

A potential energy ⬭

B mass of the Earth ⬭

C magnitude of the gravitational constant ⬭

D magnitude of the gravitational field strength ⬭