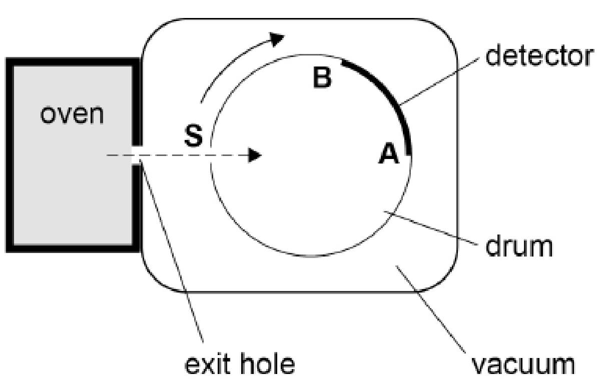
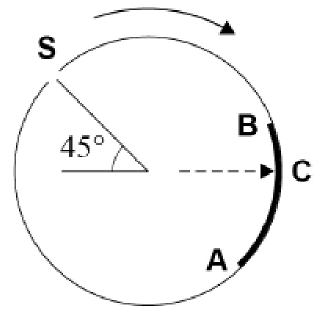
AQA – Thermal physics – A2 Physics P2

1. June/2021/Paper_7408_2/No.03

0 3 **Figure 4** and **Figure 5** show apparatus used in an experiment to confirm the distribution of atom speeds in a gas at a particular temperature.





The oven contains an ideal gas kept at a constant temperature. Atoms of the gas emerge from the oven and some pass through the narrow slit **S** in a rapidly rotating drum. The drum is in a vacuum.

0 3 . 1 Explain why the drum must be in a vacuum.

[1 mark]

One atom leaves the oven, enters the drum through **S** and travels in a straight line across the drum.
In the time taken for the atom to move from **S** to the detector **AB**, the drum rotates through $45°$. The atom hits the detector at point **C**, as shown in **Figure 5**.

drum diameter = distance from **S** to **A** = 0.500 m
drum rotational speed = 120 revolutions per second

0 3 . 2 Show that the atom is moving at a speed of about 500 m s^{-1}.

[2 marks]

0 3 . 3 The speed of the atom in Question **03.2** is equal to c_{rms}, the root mean square speed of the atoms of the gas in the oven.
The molar mass of the gas is $0.209 \text{ kg mol}^{-1}$.

Calculate the temperature of the gas in the oven.

[3 marks]

temperature = ______________________ K

0 3 . 4 The oven temperature is kept constant during the experiment but the pressure in the oven decreases as atoms leave through the exit hole.

Explain, using the kinetic theory, why the pressure decreases.

[2 marks]

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0 3 . 5 The pressure of gas in the oven is initially 5.0×10^4 Pa.
The volume of the oven is 2.7×10^{-2} m^3.
During the experiment the pressure in the oven decreases to 4.5×10^4 Pa.

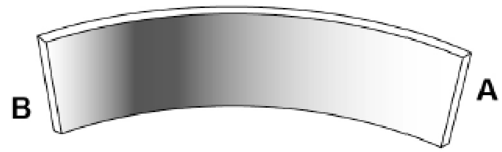
Calculate, in mol, the amount of gas that has emerged from the oven.

[1 mark]

amount of gas = ____________________ mol

0 3 . 6 Atoms enter the drum every time **S** passes the exit hole. The detector darkens at the point where an atom strikes it.
After a time, the detector is removed from the drum.
Figure 6 shows the appearance of the detector.

Figure 6



A new detector is placed in the drum and the experiment is repeated with a new sample of the same gas at a higher temperature.

Describe and explain the appearance of this detector when the experiment is repeated.

[2 marks]

2. June/2021/Paper_7408_2/No.07

A solar panel transfers energy at a rate of 1.2 kW to liquid passing through it. The liquid has a specific heat capacity of $4.0 \text{ kJ kg}^{-1} \text{ K}^{-1}$.

When the liquid flows through the solar panel, its temperature increases by 3.0 K.

The flow rate of the liquid is

[1 mark]

A 0.10 kg s^{-1}. ⬭

B 1.1 kg s^{-1}. ⬭

C 10 kg s^{-1}. ⬭

D 100 kg s^{-1}. ⬭

3. June/2021/Paper_7408_2/No.08

A gas occupies a volume V. Its particles have a root mean square speed (c_{rms}) of u. The gas is compressed at constant temperature to a volume $0.5V$.

What is the root mean square speed of the gas particles after compression?

[1 mark]

A $\frac{u}{2}$ ⬭

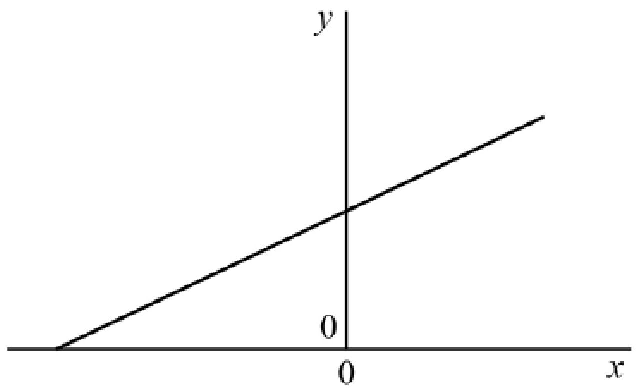
B u ⬭

C $2u$ ⬭

D $4u$ ⬭

4. June/2021/Paper_7408_2/No.09

A fixed mass of gas is heated at constant volume. The graph is drawn for this process.



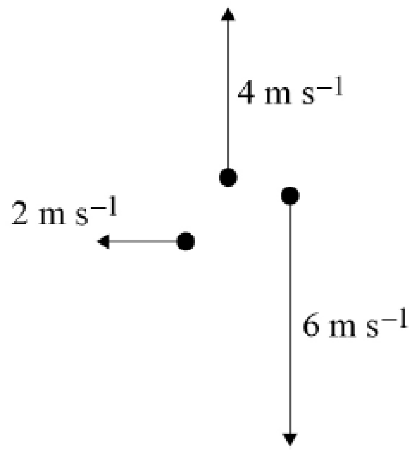
What do x and y represent?

[1 mark]

	x	y	
A	pressure in Pa	temperature in °C	⬭
B	temperature in °C	pressure in Pa	⬭
C	pressure in Pa	temperature in K	⬭
D	temperature in K	pressure in Pa	⬭

5. June/2021/Paper_7408_2/No.10

Three particles are travelling in the same plane with velocities as shown in the vector diagram.



What is the root mean square speed of the particles?

[1 mark]

A $4.3\ \text{m s}^{-1}$ ⬭

B $7.5\ \text{m s}^{-1}$ ⬭

C $19\ \text{m s}^{-1}$ ⬭

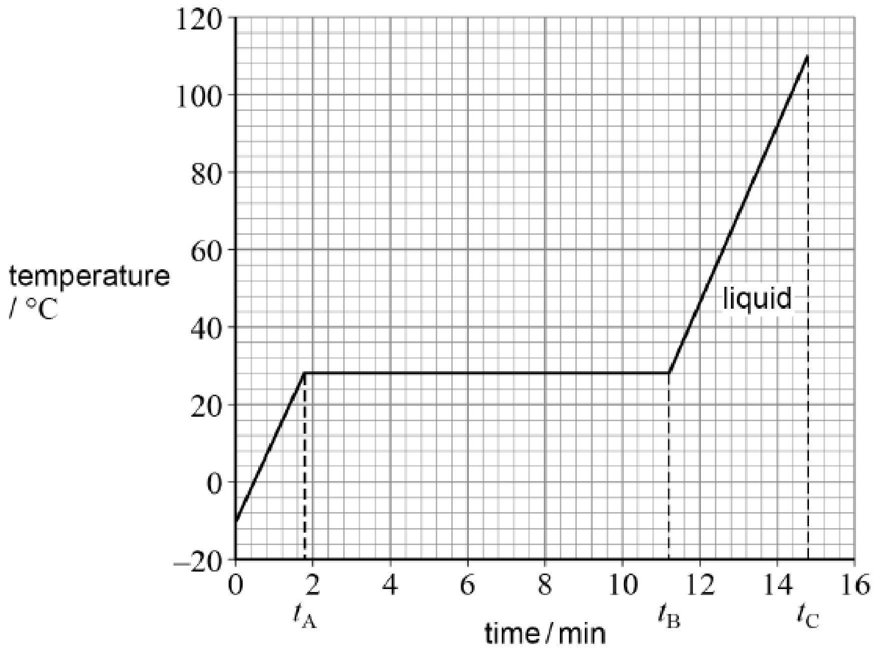
D $56\ \text{m s}^{-1}$ ⬭

6. June/2020/Paper_7408_2/No.01

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 = ____________________ °C

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]

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]

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

[1 mark]

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

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

[3 marks]

specific heat capacity = ____________________ unit = ____________

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]

M = ____________________

7. June/2020/Paper_7408_2/No.07

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]

A 15 °C ○

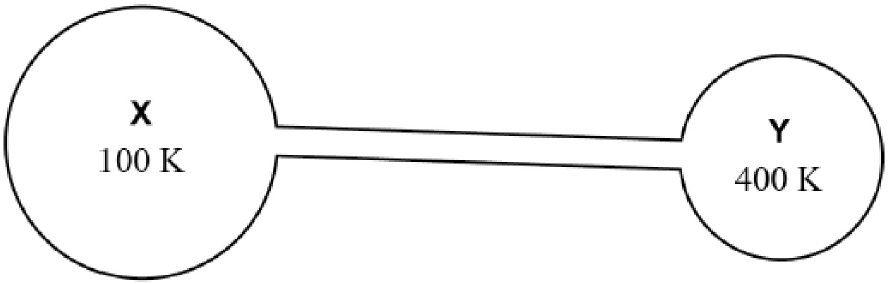
B 47 °C ○

C 171 °C ○

D 252 °C ○

8. June/2020/Paper_7408_2/No.08

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



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.

X contains gas of mass m.

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

[1 mark]

A $\frac{m}{8}$ ○

B $\frac{m}{2}$ ○

C $2m$ ○

D $8m$ ○

9. June/2020/Paper_7408_2/No.09

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**?

[1 mark]

A $\frac{2}{3}E$ ⬭

B $\frac{3}{4}E$ ⬭

C $\frac{4}{3}E$ ⬭

D $\frac{3}{2}E$ ⬭

10. June/2020/Paper_7408_2/No.10

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?

[1 mark]

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

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

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

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

11. June/2020/Paper_7408_2/No.11

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. ⬭