Do not write outside the box

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.

Figure 4

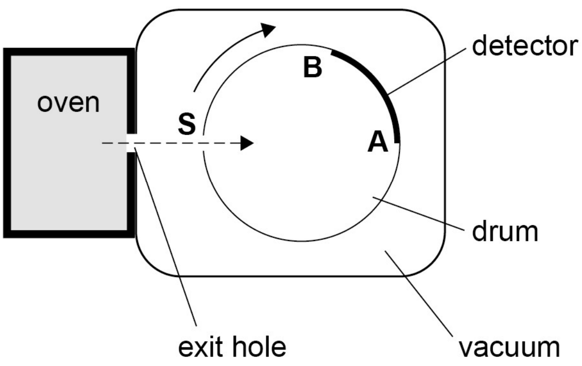
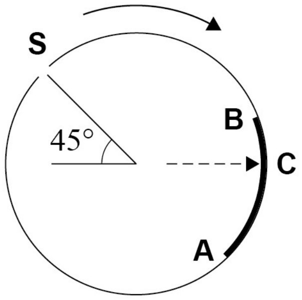


Figure 5



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]

otherwise the gas particles will collide with other particles which will change their speed and direction

Do not write outside the box

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]

distance moved by detector is $\frac{1}{8}$ revs
time for 1 rev = $\frac{1}{120}$ s ∴ time to move detector = $\frac{1}{120} \times \frac{1}{8} = \frac{1}{960}$ sec during which time particle moves 0.5 m

$v = \frac{0.05}{1/960} = 480$ m/s

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]

$\frac{3}{2} kT = \frac{1}{2} m (c_{rms})^2$ ← 480

$= \left(\frac{0.209}{6.02 \times 10^{23}}\right)$

1.38×10^{-23}

∴

temperature = 1932 K

1930 K

Question 3 continues on the next page

Do not write outside the box

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]

pressure is due to the momentum change that occurs when particles collide with the wall.

Temp stays the same so this means that the average change in mom stays the same, but as N drops then so does the number of these collisiiosn in 1 second, meaning the force drops, and as the volume is fixed the pressure falls

or $pV = \frac{1}{3} N m (c_{rms})^2$

fixed ↓N fixed

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]

$pV = nRT$

$n = \frac{pV}{RT}$

$\therefore \Delta n = \frac{V(\Delta p)}{RT} =$ (pressure)

$= \frac{2.7 \times 10^{-2} (0.5 \times 10^4)}{8.31 \times 1930}$

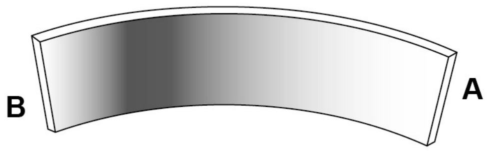
$= \frac{135}{16038.3}$

amount of gas = 8.42×10^{-3} mol

Do not write outside the box

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]

at a higher temp the partciles are moving faster, and therefore the darkest point (which represents the average Crms) will be more towards point A as the drum wont have rotated as much

11

Turn over for the next question

Do not write outside the box

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 A solar panel transfers energy at a rate of $1.2\ \text{kW}$ 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 $3.0\ \text{K}$.

The flow rate of the liquid is

[1 mark]

A $0.10\ \text{kg s}^{-1}$. ○

B $1.1\ \text{kg s}^{-1}$. ○

C $10\ \text{kg s}^{-1}$. ○

D $100\ \text{kg s}^{-1}$. ○

Turn over ►

Do not write outside the box

0 8 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 $2u$ ⬭

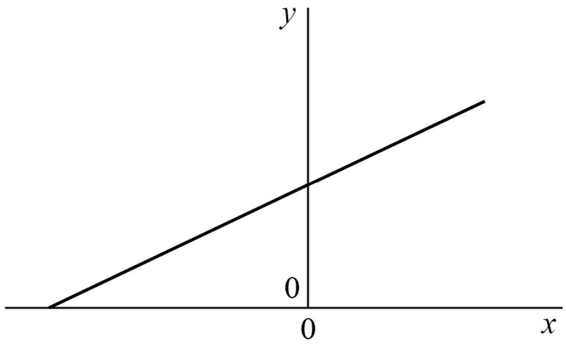
D $4u$ ⬭

$\frac{3}{2}kT = \frac{1}{2}m(c_{rms})^2$

$\therefore T \propto (c_{rms})^2$

temp is constant!!! therefore so is Crms

0 9 A fixed mass of gas is heated at constant volume. The graph is drawn for this process.



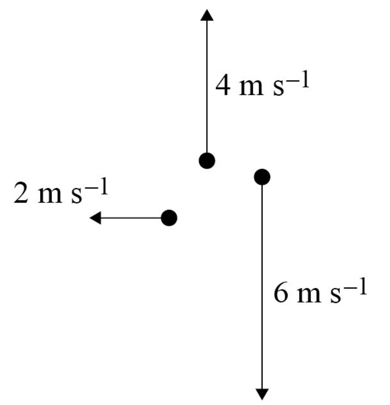
What do x and y represent?

[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	⬭

Do not write outside the box

1 0 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 m s^{-1}

B 7.5 m s^{-1}

C 19 m s^{-1}

D 56 m s^{-1}

Turn over for the next question