4. States of matter

4.1 The gaseous state- ideal and real gases

Paper 2

Question Paper

1 **(d)** Molten $KClO_3$ reacts with glucose, $C_6H_{12}O_6$.

$$4KClO_3 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O + 4KCl$$

$KClO_3$ melts at 630 K. At this temperature, both CO_2 and H_2O are gases.

(i) Use the ideal gas equation to calculate the volume, in m^3, of one mole of gas at 630 K and 1.00×10^5 Pa.

Show your working. Give your answer to 3 significant figures.

volume of 1 mol of gas = ... m^3
[1]

2 **(d)** A 3.30 g sample of a Period 3 chloride is heated to 500 K in a sealed flask.
At this temperature, the chloride is a gas of volume 250 cm^3 and the pressure in the flask is 323 kPa.

Use the ideal gas equation $pV = nRT$ to calculate the M_r of the Period 3 chloride.
Deduce its formula.

M_r = ...

formula of Period 3 chloride = ...
[3]

3 Carbon monoxide gas, CO(g), and nitrogen gas, $N_2(g)$, are both diatomic molecules.

(c) Both carbon monoxide and nitrogen are gases at room temperature and pressure.

They both behave like ideal gases under certain conditions.

(i) State the **two** conditions necessary for these two gases to approach ideal gas behaviour.

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..... [1]

(ii) Explain why $N_2(g)$ behaves more like an ideal gas than CO(g) does at 20.0 °C and 101 kPa.

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..... [2]

(d) Calculate the amount, in mol, of pure nitrogen gas which occupies 100 cm^3 at 101 kPa and 20.0 °C.

Use relevant information from the *Data Booklet*. Show your working.

Assume nitrogen behaves as an ideal gas.

..... mol
[3]

4 The strength of interaction between particles determines whether the substance is a solid, liquid or gas at room temperature.

(c) Nitrogen, N_2, is also a gas at room temperature and pressure. Neither CO nor N_2 is an ideal gas.

(i) State two assumptions that are made about the behaviour of particles in an ideal gas.

1 .....

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2 .....

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[2]

(ii) Explain why N_2 does not behave as an ideal gas at very high pressures.

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..... [2]

5 Hydrogen iodide, HI, is a colourless gas at room temperature.

(e) HI(g) can also be formed by the reaction of $I_2(g)$ with hydrazine, $N_2H_4(g)$.

$$2I_2(g) + N_2H_4(g) \rightarrow 4HI(g) + N_2(g)$$

State the change in pressure that would occur when 2 mol $I_2(g)$ fully reacts with 1 mol $N_2H_4(g)$ in a sealed container at constant temperature. Explain your answer.

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..... [2]

6 **(d)** Chlorine exists as a diatomic gas, $Cl_2(g)$. A sample of $Cl_2(g)$ was made during a chemical reaction. When measured at 404 kPa and 25 °C the sample occupied a volume of 20.0 cm^3.

(i) Calculate the mass, in grams, of $Cl_2(g)$ formed.

For this calculation, assume that chlorine behaves as an ideal gas under these conditions.

mass of $Cl_2(g)$ = ... g [3]

(ii) Calculate the number of chlorine atoms in this sample of $Cl_2(g)$. You may find it helpful to use your answer to **(d)(i)**.

If you are unable to calculate an answer to **(d)(i)**, use 0.36 g of Cl_2. This is **not** the correct answer.

number of chlorine atoms = ... [2]

(iii) $Cl_2(g)$ does **not** behave as an ideal gas under these conditions.

Explain why $Cl_2(g)$ behaves even **less** ideally at:

- very high pressures

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- very low temperatures.

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[2]