Answers to Self-check Questions

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D	B	D	B	C	D	A	B	C

Explanations to Self-check Questions

1 *Concept:*
Manipulating pV = nRT to determine if the equations available are legitimate.

Eqn 1: Manipulate ideal gas equation to contain the density term, ρ

Since $n = \frac{m}{M}$
$pV = nRT$
$pV = \left(\frac{m}{M}\right)RT$
Rearrange to give ρ *which is* $\frac{m}{V}$
$p = \left(\frac{m}{V}\right)\frac{RT}{M} = \frac{\rho RT}{M}$ (option 1 is correct)

Eqn 2: This is an incorrect expression of ideal gas equation which is *pV* = *nRT*, not MRT as shown in Eqn 2. (Option 2 is incorrect)

Eqn 3: Manipulate ideal gas equation to contain the concentration term, *c*

$pV = nRT$
$p = \left(\frac{n}{V}\right)RT$
Since $c = \frac{n}{V}$, the equation can be written as
$p = cRT$ (option 3 is incorrect).

2 *Concept:*
Using pV = nRT to solve for M_r. Involves units conversion from °C to K and cm^3 to m^3.

$pV = nRT$
$= \frac{m}{M}RT$

$\therefore M = \frac{mRT}{pV}$
$= \frac{(0.200)(8.31)(30 + 273)}{(101 \times 10^3)(96.0 \times 10^{-6})}$
$= 52.0 \text{ g mol}^{-1}$

$\therefore M_r = 52.0$

Ans: **B**

Note: 1 cm^3 = 1 x 10^{-6} m^3

3 *Concept:*
Using pV = nRT to express the pressure exerted. Involves units conversion from ºC to K and dm^3 to m^3.

pV = nRT

$p = \frac{nRT}{V}$

$= \frac{1.6 \times 10^{-3} \times 8.31 \times (273+273)}{3.0 \times 10^{-3}}$

Ans: **D**

Note: 1 dm^3 = 1 x 10^{-3} m^3

4 *Concept: By conservation of mass*

$p_1V_1 + p_2V_2 = p_TV_T$

$(50)(10) + (100)(30) = p_T \times 40$

p_T = 87.5 kPa

Or applying Boyle's Law which states that p is inversely proportional to V for a fixed mass of gas under constant T

For smaller spacecraft: $p_1V_1 = p_2V_2$

10 x 50 = p_2 x 40

p_2 = 12.5 kPa

For bigger spacecraft: $p_3V_3 = p_4V_4$

30 x 100 = p_4 x 40

p_4 = 75 kPa

p_T = 12.5 + 75 = 87.5 kPa

Ans: **B**

5 *Concept: Refer to page 11 of notes*
At low pressure, the gas particles are very far apart and can be considered to have negligible volume compared to the volume of the container. In addition, the intermolecular attractive forces between the widely spaced gas molecules are negligible.
At high temperature, the gas molecules possess sufficiently high kinetic energy to overcome the intermolecular attractive forces. Hence the intermolecular attractive forces can be considered negligible.

Ans: **C**

6 *Concept:*
Since mass and volume are fixed,

$(\frac{p_1}{T_1} = \frac{p_2}{T_2})$ *can be used to solve for T. Involves units conversion from ºC to K.*

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$
$$\frac{p}{27 + 273} = \frac{2p}{T_2}$$
$\therefore T_2 = (27 + 273) \times 2 = 600$ K

Ans: **D**

7 *Concept:*
The stronger the intermolecular attractive forces, the greater the deviation from ideal gas.

From the given graph, **C** deviates from ideal gas behaviour more greatly than **B**. This implies that **C** has stronger intermolecular forces of attraction compared to **B.**

	B	**C**
A	CH_4 (non-polar) • Id-id interactions	NH_3 (polar) • Pd-pd and id-id interactions and hydrogen bonding • Greater deviation from ideal gas
B	HF (polar) • Pd-pd, id-id interactions and hydrogen bonding • Greater deviation from ideal gas	HBr (polar) • Pd-pd and id-id interactions
C	CH_3CH_2Cl (polar) • Pd-pd and id-id interactions • Greater deviation from ideal gas	CH_3CH_3 (non-polar) • Id-id interactions
D	O_2 (non-polar) • Id-id interactions • Larger electron cloud (stronger id-id interactions) • Greater deviation from ideal gas	H_2 (non-polar) • Id-id interactions • Smaller electron cloud (weaker id-id interactions)

Ans: **A**

8 *Concept: Dalton's law of partial pressure. Calculating partial pressure of a gas in a mixture. Involves units conversion from atm to Pa.*

$n_{SO2} = \frac{32.1}{32.1+16+16} = 0.50078$ mol

$n_{NH3} = \frac{25.5}{14+3} = 1.50$ mol

$p_{SO2} = x_{SO2} \cdot p_{total}$

$= \frac{0.50078}{1.50+0.50078} \cdot (0.369 \times 101325)$

$= 9358.2$ Pa

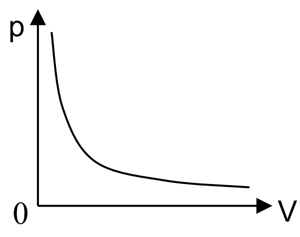
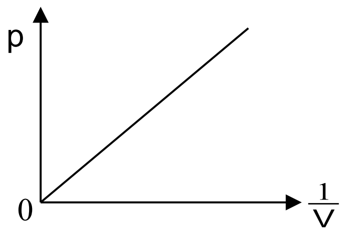
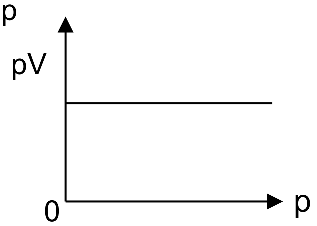
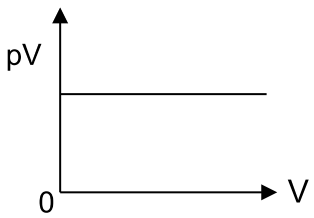
$= 9.36$ kPa (3 s.f.)

Ans: **B**

9 *Concept: Rearrange the ideal gas equation pV=nRT in the form y = mx + c, according to what is given in the x and y axis.*

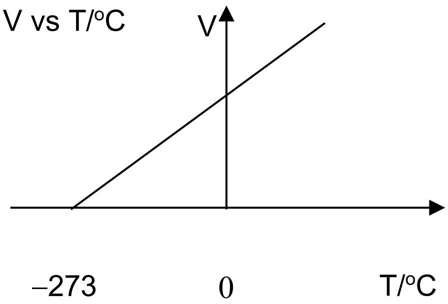
A	$p = nRT\frac{1}{V}$. Hence this is a y=kx graph where k=nRT. At higher temperature T_2, the gradient of the line should be steeper. (wrong graph)
B	pV = nRT. Since pV is always a constant (at constant n and T) and not affected by value of p, this is a y=k graph where k=nRT. At T_2, the line should be at a higher value. (wrong graph)
C	$p = nRT\frac{1}{V}$. Hence this is a $y=\frac{k}{x}$ graph. There is an inverse relationship between p and V. For a given volume, the pressure should be higher at T_2. Hence the graph should shift upwards and outwards. **(correct graph)**
D	$V = \frac{nRT}{p}$. Hence this is a y=kx graph where $k=\frac{RT}{p}$. At T_2, the gradient of the line should be steeper. (wrong graph)

10(a) **At constant T**

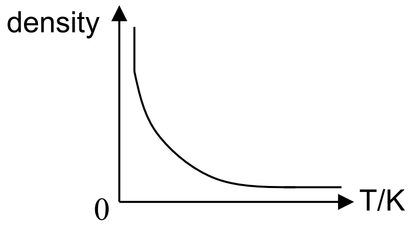
(i) p vs V 	**(ii)** p vs $\frac{1}{V}$ 
(iii) pV vs p 	**(iv)** pV vs V 

(b) At constant p

(i) V vs T/°C

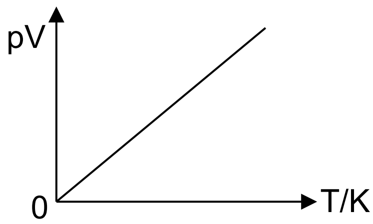


(ii) density vs T/K



(c) At constant *n*

(i) pV vs T/K



(ii) $\frac{pV}{T}$ vs p