Solutions

S1. Ans.(c)

At same temperature, curve with higher volume corresponds to lower pressure.

$V_3 > V_2 > V_1$

$\Rightarrow P_1 > P_2 > P_3$

(We draw a straight line parallel to volume axis to get this).

S2. Ans.(c)

V = (no. Of moles) (22.4 litre)

$= \frac{\text{mass}}{\text{molar mass}}(22.4 \times 10^{-3} m^3)$

$= \frac{4.5\times10^3}{18\times10^{-3}} \times 22.4 \times 10^{-3}\ m^3$

$= 5.6\ m^3$

S3. Ans.(c)

$T_i = -50°\text{C}$

= 223 K

$\text{v}_{rms} \propto T$

As v_{rms} increased by 3 times

So $(\text{v}_{rms})_f = 4(\text{v}_{rms})_{initial}$

$T_f = 16T_i$

$= 16 \times 223$

$= 3568\ K$

S4. Ans.(b)

S5. Ans.(a)

For monoatomic gas, degree of freedom is 3. Energy associated with each degree of freedom is $\frac{1}{2}k_BT$. So energy is $\frac{3}{2}k_BT$

S6. Ans.(a)

According to the formula $\lambda = \frac{1}{\sqrt{2}n\pi d^2}$

S7. Ans.(a)

As we know that

PM = ρRT

Here, $P = 249 \times 10^3 \text{N/m}^2$

$\text{M} = 2 \times 10^{-3}\text{kg};\ \text{T} = 300\ \text{K}$

$\therefore \rho = \frac{(249\times10^3)(2\times10^{-3})}{8.3\times300} = \frac{0.2\text{kg}}{\text{m}^3}$

S8. Ans.(d)

Mean free path $(l) = \frac{1}{\sqrt{2}\pi d^2 n} \propto \frac{1}{d^2}$

S9. Ans.(b)

From the gas equation pv = nRT

$\Rightarrow \text{p} = \frac{1}{\text{v}}\frac{\text{m}}{\text{M}_0}\text{RT} = \left(\frac{\text{m}}{\text{v}}\right)\left(\frac{\text{RT}}{\text{M}_0}\right)$

$\Rightarrow \text{p} = \frac{\rho\text{RT}}{\text{M}_0}$

$\rho = \frac{\text{m}}{\text{v}}$ = mass density

M_0 = molar mass

S10. Ans.(b)

Increase in temperature would lead to the increase in kinetic energy of gas (assuming far as to be ideal) as increase in temperature increases the speed in which the gas molecule move. Mass will remains constant. Pressure will increase and intermolecular space will also increases.

S11. Ans.(b)

$V_{rms} = \sqrt{\frac{3KT}{m}}$

V_{rms} should be equal to escape speed

$11.2 \times 10^3 = \sqrt{\frac{3KT}{m}}$

$T = 8.36 \times 10^4 K$

S12. Ans.(c)

$U = \frac{f}{2}nRT$

$U_T = U_{O_2} + U_{Ar}$

$U_T = \frac{5}{2} \times 2RT + \frac{3}{2} \times 4RT$

$U_T = 11RT$

S13. Ans.(b)

$T_1 = 273 + 30 = 303K$

$T_2 = 273 + 90 = 363K$

$V_{rms} \propto \sqrt{T}$

$\frac{V_1}{V_2} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{303}{363}}$

$\frac{V_2}{V_1} = 1.1$

$\frac{V_2}{V_1} - 1 = 1.1 - 1$

[∵ Subtract 1 from both sides]

$\frac{\Delta V}{V} \times 100$

Percent increase $\frac{\Delta V}{V} = 10\%$

S14. Ans.(d)

$\frac{P}{\rho} = \frac{RT}{M_w}$ (Ideal gas equation)

$\Rightarrow \rho = \frac{PM_w}{RT} = \frac{P \times (mN_A)}{kN_AT} = \frac{Pm}{kT}$

S15. Ans.(b)

PV^x = constant (Polytropic process)

Heat capacity in polytropic process is given by $\left[C = C_v + \frac{R}{1-x}\right]$

Given that

PV^3 = constant $\Rightarrow x = 3$ ...(1)

Gas is monoatomic therefore

$C_v = \frac{3}{2}R$ ...(2)

by formula $C = \frac{3}{2}R + \frac{R}{1-3} = \frac{3}{2}R - \frac{R}{2} = R$

S16. Ans.(a)

From Wein's displacement law

$\lambda_m \propto \frac{1}{T}$

Now form sequence 'VIBGYOR'

$(\lambda_m)_P < (\lambda_m)_R < (\lambda_m)_Q$

So $T_P > T_R > T_Q$

S17. Ans.(b)

$\gamma = 1 + \frac{2}{f}$

Here degree of freedom → n

$\therefore \gamma = 1 + \frac{2}{n}$

S18. Ans.(b)

Molecular mass M = 4.0 g

$v_{sound} = \sqrt{\frac{\gamma RT}{M}} \Rightarrow \gamma = \frac{Mv^2}{RT} = 1.6$

So, $C_p = \gamma C_v \Rightarrow 1.6 \times 5$

$= 8\ JK^{-1}mol^{-1}$

S19. Ans.(c)

$P = \frac{\rho RT}{M} \Rightarrow M = \frac{\rho RT}{P}$

So, $\frac{M_A}{M_B} = \frac{\rho_A T_A P_B}{\rho_B T_B P_A} = (1.5)(1)\left(\frac{1}{2}\right) \Rightarrow \frac{M_A}{M_B} = \frac{3}{4}$

S20. Ans.(b)

Mean free path $\lambda_m = \frac{1}{\sqrt{2}\pi d^2 n}$

Where d = diameter of molecule $\Rightarrow \lambda_m \propto \frac{1}{r^2}$

S21. Ans.(b)

Number of moles in 1g He = ¼

Volume of the gas remains constant so we choose

$\Delta Q = nC_v\Delta T$

Amount of heat energy required to raise its temperature from T_1K to T_2K

$= nC_v\Delta T$

$= \left(\frac{1}{4}\right)\left(\frac{3}{2}R\right)(T_2 - T_1) = \frac{3}{8}k_B N_A(T_2 - T_1)$