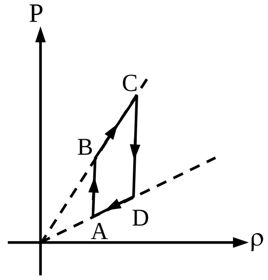
1. A vessel is filled with a gas at a pressure of 76 cm of mercury at a certain temperature. The mass of the gas is increased by 50 % by introducing more gas in the vessel at the same temperature. The resultant pressure, in cm of Hg, is -
(a) 76 (b) 152 (c) 114 (d) 1117

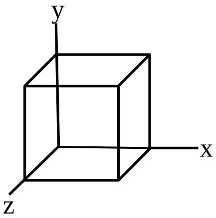
2. Pressure versus density graph of an ideal gas is shown in figure -



(a) During the process AB work done by the gas is positive
(b) During the process AB work done by the gas is negative
(c) During the process BC internal energy of the gas is increasing
(d) None of these

3. The ratio of specific heats of an ideal gas is -
(a) $\frac{1}{1-\frac{R}{C_P}}$ (b) $1+\frac{R}{C_V}$ (c) $\frac{1}{1-\frac{C_V}{R}}$ (d) $\frac{C_V}{C_P}+R$

4. In the figure shown, n molecules of a gas of mass nm move only along x-axis (i.e. either towards +ve x-axis or –ve x-axis) inside a cube of edge 1m. Half molecules have speed v and other half have 2v. The pressure on a wall ⊥ to x-axis is -



(a) $2.5\ n\ m\ v^2$ (b) $\frac{n m v^2}{5}$ (c) $\frac{3}{2}\ n\ m\ v^2$ (d) None

5. A graph is plotted with $\frac{PV}{T}$ on y-axis and mass of the gas along x-axis for different gases. The graph is -
(a) A straight line parallel to x-axis for all the gases
(b) A straight line passing through origin with a slope having a constant value for all the gases
(c) A straight line passing through origin with a slope having different values for different gases
(d) A straight line parallel to y-axis for all the gases

6. A gas is enclosed in a vessel at a constant temperature at a pressure of 2.5 atmospheres and a volume of 4 litres. Due to a leak in the vessel, after some time the pressure is reduced to 2 atmospheres. As a result -
(a) 20% of the gas remains in the vessel
(b) 20% of the gas escapes out
(c) 25% of the gas escapes out
(d) 25% of the gas remains in the vessel.

7. For Boyle's law to hold, the gas should be -
(a) Perfect and of constant mass and temperature
(b) Real and of constant mass and temperature
(c) Perfect and at constant temperature but variable mass
(d) Real and at constant temperature but variable mass

8. The equation of state corresponding to 8 g of O_2 is -

(a) PV = 8RT (b) PV = $\frac{RT}{4}$

(c) PV = RT (d) PV = $\frac{RT}{2}$

9. Consider 1 cc sample of air at absolute temperature T_0 at sea level and another 1 cc sample of air at a height where pressure is one-third atmosphere. The absolute temperature T of the sample at the height is -

(a) Equal to $(T_0/3)$

(b) Equal to $(3/T_0)$

(c) Equal to T_0

(d) Cannot be determined in terms of T_0 from the above data

10. A balloon contains 500 m^3 of helium at 27^0C and 1 atmosphere pressure. The volume of the helium at -3^0C temperature and 0.5 atmosphere pressure will be-

(a) 500 m^3 (b) 700 m^3 (c) 900 m^3 (d) 1000 m^3

11. The r.m.s. speed of a group of 7 gas molecules having speeds (6, 4, 2, 0, –2, –4, –6) m/s is-

(a) 1.5 m/s (b) 3.4 m/s (c) 9 m/s (d) 4 m/s

12. The ratio of translational KE per molecule of He and H_2 at same temperature is -

(a) 1 : 1 (b) 1 : 2 (c) 1 : 4 (d) 2 : 1

13. Two identical container contain equal amount of same ideal gas at temp T_0, and pressure P_0. Now the two container is connected through a tube having negligible volume and one container is heated to $2T_0$ while other is kept at T_0. The final common pressure is -

(a) $\frac{2P_0}{3}$ (b) $\frac{4P_0}{3}$ (c) $\frac{P_0}{3}$ (d) 2 P_0

14. If masses of all molecules of a gas are halved and their speed doubled, then the ratio of initial and final pressure is -

(a) 2 : 1 (b) 1 : 2 (c) 4 : 1 (d) 1 : 4

15. The velocities of the three molecules are 3v, 4v and 5v. The rms velocity is -

(a) 4v (b) $\frac{25}{3}$v (c) $\frac{50}{3}$v (d) $\sqrt{\frac{50}{3}}$v

16. A sample of an ideal gas occupies volume V at a pressure P and absolute temperature. The mass of each molecule is m. Which of the following expressions gives the density of the gas ?

(a) P/Kt (b) Pm/kT (c) m/kT (d) P/kTV

17. The plot of isotherms will not be a straight line when a plot is drawn between :

(a) PV and V (b) U and ρ (density)

(c) $\frac{1}{P}$ vs $\frac{1}{V}$ (d) $\frac{1}{U}$ and ρ

18. The molecules of a given mass of a gas have arms velocity of 200 m/sec at 27^0C and $1.0 \times 10^5\ N/m^2$ pressure. When the temperature is 127°C and pressure is $0.5 \times 10^5\ N/m^2$, the rms velocity in m/sec will be

(a) $\frac{100\sqrt{2}}{3}$ (b) $100\sqrt{2}$

(c) $\frac{400}{\sqrt{3}}$ (d) None of these

19. Read the given statements and decide which is/are correct on the basis of kinetic theory of gases
(I) Energy of one molecule at absolute temperature is zero
(II) rms speeds of different gases are same at same temperature
(III) For one gram of all ideal gas kinetic energy is same at same temperature
(IV) For one mole of all ideal gases mean kinetic energy is same at same temperature
(a) All are correct (b) I and IV are correct
(c) IV is correct (d) None of these

20. An air bubble of volume V_0 is released by a fish at a depth h in a lake. The bubble rises to the surface. Assume constant temperature and standard atmospheric pressure P above the lake. The volume of the bubble just before touching the surface will be (density of water is ρ)
(a) V_0 (b) $V_0(\rho gh / P)$
(c) $\frac{V_0}{\left(1+\frac{\rho gh}{P}\right)}$ (d) $V_0\left(1+\frac{\rho gh}{P}\right)$

21. A perfect gas at 27^0C is heated at constant pressure to 327^0C. If original volume of gas at 27^0C is V then volume at 327^0C is
(a) V (b) 3V (c) 2V (d) V/2

22. One mole of a gas filled in a container at N.T.P., the number of molecules in 1 cm^3 of volume will be
(a) $6.02\times10^{23}/22400$ (b) 6.02×10^{23}
(c) 1/22400 (d) $6.02\times10^{23}/76$

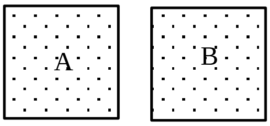
23. Energy of all molecules of a monoatomic gas having a volume V and pressure P is $\frac{3}{2}PV$. The total translational kinetic energy of all molecules of a diatomic gas as the same volume and pressure is
(a) $\frac{1}{2}PV$ (b) $\frac{3}{2}PV$ (c) $\frac{5}{2}PV$ (d) 3 PV

24. The specific heat of a gas
(a) Has only two values of C_p and C_v
(b) Has a unique value at a given temperature
(c) Can have any value between 0 and ∞
(d) Depends upon the mass of the gas

25. A gas, is heated at constant pressure. The fraction of heat supplied used for external work is
(a) $\frac{1}{\gamma}$ (b) $\left(1-\frac{1}{\gamma}\right)$ (c) $\gamma-1$ (d) $\left(1-\frac{1}{\gamma^2}\right)$

26. A gas mixture consists of 2 mole of oxygen and 4 mole of argon at temperature T. Neglecting all vibrational modes, the total internal energy of the system is
(a) 4 RT (b) 15 RT (c) 9 RT (d) 11 RT

27. Two containers A & B contain ideal gases helium and oxygen respectively. Volume of both containers are equal and pressure is also equal. Container A has twice the number of molecules than container B then if v_A&v_B represent the rms speed of gases in containers A & B respectively, then -



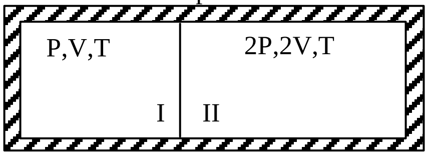
(a) $\frac{v_A}{v_B} = \sqrt{2}$ (b) $\frac{v_A}{v_B} = 4$

(c) $\frac{v_A}{v_B} = 2$ (d) $\frac{v_A}{v_B} = \sqrt{8}$

28. Jar A filled with gas characterized by parameter P,V and T and another jar B filled with a gas with parameter 2P, V/4 and 2T. The ratio of the number of molecules in jar A to those in jar B is-

(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 4 : 1

29. A partition divides a container having insulated walls into two compartments I and II. The same gas fills the two compartments (shown in figure). The ratio of the number of molecules in compartments I and II is–



(a) 1 : 6 (b) 6 : 1 (c) 4 : 1 (d) 1 : 4

30. 2 mole of an ideal monoatomic gas mix with 1 mole of a ideal diatomic gas. The $\frac{C_P}{C_V}$ for the mixture is -

(a) $\frac{15}{11}$ (b) $\frac{17}{11}$ (c) $\frac{13}{11}$ (d) None

1. (c)

$P \propto m$

Since m is increased by a factor of $\frac{3}{2}$,

therefore, P will increase by a factor of $\frac{3}{2}$.

$\therefore$ New pressure = $\frac{3}{2} \times 76$ cm of Hg = 114 cm of Hg.

2. (d)

As density increases, work done is – ve.

3. (b)

$\because\ C_P - C_V = R, \frac{C_P}{C_V} - 1 = \frac{R}{C_V}$

$\therefore\ \frac{C_P}{C_V} = \gamma = 1 + \frac{R}{C_V}$

4. (a)

Pressure = (momentum transferred to wall in one second)/Area of wall

5. (c)

$\frac{PV}{T} = \frac{M}{RM_w}$ So $y = \frac{x}{RM_w}$ i.e. $\boxed{y \propto x}$

Straight line having slope $m = \frac{1}{RM_w}$

i.e. diff. for diff. gas.

6. (b)

$PV = nRT = \frac{m'}{M} RT$

7. (a)

Conceptual

8. (b)

8g of oxygen is equivalent to $\left(\frac{1}{4}\right)$ mole

$\therefore\ PV = \mu RT = \frac{RT}{4}$

9. (d)

As mass of the gas at sea level and at height is not same, so data is insufficient

10. (c)

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{1 \times 500}{300} = \frac{0.5 \times V_2}{270} \Rightarrow V_2 = 900 m^3$

11. (d)

$$v_{rms} = \sqrt{\frac{(6)^2 + (4)^2 + (2)^2 + (0)^2 + (-2)^2 + (-4)^2 + (-6)^2}{7}}$$

= 4 m/s

12. (a)

$$\frac{KE_{H_2}}{KE_{He}} = \frac{\frac{3}{2}KT}{\frac{3}{2}KT} = \frac{1}{1}$$

13. (b)

$$\frac{P_0V}{RT_0} + \frac{P_0V}{RT_0} = \frac{PV}{RT_0} + \frac{PV}{R2T_0}$$

$2P_0 = P + \frac{P}{2}$ or $2P_0 = \frac{3P}{2}$ or $P = \frac{4P_0}{3}$

14. (a)

$$P = \frac{m'.v_{rms}^2}{3V} m$$

15. (d)

$$v_{rms} = \frac{\sqrt{9V^2 + 16V^2 + 25V^2}}{3} = \sqrt{\frac{50}{3}}v$$

16. (b)

$P = \frac{1}{3}\rho v_{rms}^2$ and

$$\frac{1}{2}mv_{rms}^2 = \frac{3}{2}KT \text{ and } C^2 = \frac{3KT}{m} \quad \rho = \frac{3P}{C^2} = \frac{3Pm}{3KT} = \frac{Pm}{KT}$$

17. (c)

Isotherm $\Rightarrow$ Temperature constant

$\Rightarrow$ U = constant

18. (c)

Change in pressure will not affect the *rms* velocity of molecules. So we will calculate only the effect of temperature.

As $v_{rms} \propto \sqrt{T}$

$$\therefore \frac{v_{300^o}}{v_{400^o}} = \sqrt{\frac{300}{400}} = \sqrt{\frac{3}{4}}$$

$$\Rightarrow \frac{200}{v_{400}} = \sqrt{\frac{3}{4}} \Rightarrow v_{400} = \frac{200 \times 2}{\sqrt{3}} = \frac{400}{\sqrt{3}} m/s .$$

19. (c)

If the gas is not ideal then its molecule will possess potential energy. Hence statement (I) is wrong.

rms speed of different gases at same temperature depends on its molecular weight $\left(v_{rms} \propto \frac{1}{\sqrt{M}}\right)$. Hence statement (II) also wrong.

Kinetic energy of one *gram* gas depends on the molecular weight $\left(E_{gm} \propto \frac{1}{M}\right)$. Hence statement (III) also wrong.

But K.E. of one mole of ideal gas does not depends on the molecular weight $\left(E = \frac{3}{2}RT\right)$. Hence (IV) is correct.

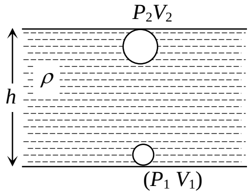
20. (d)

According to Boyle's law multiplication of pressure and volume will remains constant at the bottom and top.

If P is the atmospheric pressure at the top of the lake and the volume of bubble is V then from $P_1V_1 = P_2V_2$

$$(P + h\rho g)V_0 = PV \Rightarrow V = \left(\frac{P + h\rho g}{P}\right)V_0$$

$$\therefore \quad V = V_0\left[1 + \frac{\rho gh}{P}\right]$$



21. (c)

From Charle's law $V \propto T \quad \therefore \frac{V_2}{V_1} = \frac{T_2}{T_1} = \frac{327 + 273}{27 + 273} = \frac{600}{300} = 2 \Rightarrow V_2 = 2V.$

22. (a)

Number of molecule in 22.4 *litre* gas at N.T.P. $= 6.023 \times 10^{23}$

or number of molecule in $22.4 \times 10^3\ cm^3 = 6.023 \times 10^{23}$ [As $22.4\ litre = 22.4 \times 10^3\ cm^3$]

$\therefore$ Number of molecules in $1\,cm^3 = \frac{6.023 \times 10^{23}}{22400}$.

23. (c)

Energy of 1 mole of gas $= \frac{f}{2}RT = \frac{f}{2}PV$

where f = Degree of freedom

Monoatomic or diatomic both gases posses equal degree of freedom for translational motion and that is equal to 3 *i.e.* $f = 3$

$$\therefore \quad E = \frac{3}{2}PV$$

Although total energy will be different, For monoatomic gas $E_{total} = \frac{3}{2}PV$ [As $f = 3$]

For diatomic gas $E_{total} = \frac{5}{2}PV$ [As $f = 5$]

24. (c)

Range of specific heat varies from positive to negative and from zero to infinite. It depends upon the nature of process.

25. (b)

We know fraction of given energy that goes to increase the internal energy $= \frac{1}{\gamma}$

So we can say the fraction of given energy that supplied for external work $= 1 - \frac{1}{\gamma}$.

26. (d)

Total internal energy of system

$$= U_{\text{oxygen}} + U_{\text{argon}} = \mu_1 \frac{f_1}{2} RT + \mu_2 \frac{f_2}{2} RT$$

$$= 2\frac{5}{2} RT + 4\frac{3}{2} RT = 5\,RT + 6\,RT = 11\,RT$$

[As $f_1 = 5$ (for oxygen) and $f_2 = 3$ (for argon)]

27. (c)

$T_A = \frac{P_A V_A}{n_A R}$ and $T_B = \frac{P_B V_B}{n_B R}$

Given, $P_A = P_B$, $V_A = V_B$ and $n_A = 2n_B$

$\therefore \quad T_A = \frac{T_B}{2}$

Now, $\frac{V_A}{V_B} = \sqrt{\frac{T_A}{T_B} \times \frac{M_B}{M_A}} = 2$

28. (d)

$N = \frac{PV}{KT}$

$$\frac{N_A}{N_B} = \frac{PV}{KT} \times \frac{K2T}{2P(V/4)} = \frac{4}{1}$$

29. (d)

$$\frac{N_I}{N_{II}} = \frac{P_I.V_I}{T_I} \times \frac{T_{II}}{P_{II}.V_{II}} = 1:4$$

30. (b)

$$\frac{2+3}{\gamma_{\min-1}} = \frac{2}{\frac{5}{3}-1} + \frac{1}{\frac{7}{5}-1}$$

$$\frac{3}{\gamma_{\min-1}} = 3 + \frac{5}{2}$$

$$\frac{3}{\gamma_{\min-1}} = \frac{11}{2}$$

$$\gamma_{\min-1} = \frac{6}{11}$$

$$\gamma_{\min} = \frac{6}{11} + 1 = \frac{17}{11}$$