

GASEOUS STATE

Q.1 The behaviour of a real gas is usually depicted by plotting compressibility factor Z versus P at a constant temperature. At high temperature and high pressure, Z is usually more than one. This fact can be explained by Vander Waal's equation when

- (A) The constant a is negligible and not b
- (B) The constant b is negligible and not a
- (C) Both the constants a and b are not negligible
- (D) Both the constants a and b are negligible.

Q.2 The numerical value of $\frac{RT}{PV}$ for a gas at critical conditions is times of $\frac{RT}{PV}$ at normal conditions :

- (A) 3 (B) $\frac{8}{3}$ (C) $\frac{3}{4}$ (D) $\frac{3}{8}$

Q.3 A perfect gas of a given mass is heated first in a small vessel and then in a large vessel, such that their volume remains unchanged. The $P - T$ curves are :

- (A) Parabolic with same curvature
- (B) Linear with different slope
- (C) Linear with same slope
- (D) Parabolic with different curvature

Q.4 For two gases A and B with molecular weights M_A and M_B , it is observed that at a certain temperature T , the mean velocity of A is equal to the root mean square velocity of B. Thus the mean velocity of A can be made equal to the mean velocity of B, if :

- (A) A is at temperature T , and B at T' , $T > T'$.
- (B) A is lowered to a temperature $T_2 < T$ while B is at T
- (C) Both A and B are raised to a higher temperature
- (D) Both A and B are placed at lower temperature

Q.5 If for two gases of molecular weights M_A and M_B at temperature T_A and T_B , $T_A M_B = T_B M_A$, then which property has the same magnitude for both the gases :

- (A) Density (B) Pressure (C) KE Per mol (D) *rms* velocity

Q.6 Boyle's law may be expressed as :

- (A) $\left(\frac{dP}{dV}\right)_T = \frac{K}{V}$ (B) $\left(\frac{dP}{dV}\right)_T = -\frac{K}{V^2}$
(C) $\left(\frac{dP}{dV}\right)_T = -\frac{K}{V}$ (D) None.

Q.7 If the inter molecular forces vanish away, the volume occupied by the molecules contained in 4.5 kg. water at STP will be :

- (A) 5.6 m³ (B) 6.5 m³ (C) 11.2 litre (D) 7.5 m².

Q.8 At a constant pressure, what should be the percentage increase in the temperature in kelvin for a 10% increase in volume :

- (A) 10% (B) 18% (C) 30% (D) 5%.

Q.9 The temperature at which hydrogen at one atm. pressure has the same root mean square velocity as that of oxygen at NTP is :

- (A) 27 K (B) 17 K (C) 517 K (D) 37 K.

Q.10 A gas is contained in a vessel. If the pressure is halved and the absolute temperature is doubled; the volume of the gas :

- (A) Will be doubled
(B) Will be 1/4th of original volume
(C) Will remain same
(D) Will increase four times.

ANSWER KEY

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|-------|---|---|---|---|---|---|---|---|---|----|
| Q.No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Ans. | A | B | B | B | D | B | A | A | B | D |

SOLUTIONS (GASEOUS STATE)

Ans.1 From Vander Waal's equation

$$\left[P + \frac{a}{V^2} \right] (V - b) = nRT \quad \dots(1)$$

$$\therefore Z = \frac{PV}{nRT} \text{ if } Z > 1 \text{ then } PV > nRT$$

which is possible from (1) when $\frac{a}{V^2}$ is negligible.

$$\text{i.e., } P(V - b) = RT$$

$$\text{or } PV = RT + Pb$$

$$\text{or } PV > RT.$$

$$\begin{aligned} \text{Ans.2 } \frac{RT_C}{P_C V_C} &= \frac{8}{3} = \frac{8}{3} \times 1 \\ &= \frac{8}{3} \times \frac{RT}{PV} \end{aligned}$$

$$\begin{aligned} \text{Ans.3 } \therefore PV &= nRT \\ \text{First } P_1 V_1 &= nRT_1 \\ \text{and } P_2 V_2 &= nRT_2 \end{aligned}$$

$$\therefore \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Thus P - T curves are linear but with different slopes.

$$\text{Ans.4 } u_{av - A} = \sqrt{\frac{8RT}{\pi M_A}} ;$$

$$u_{rms - B} = \sqrt{\frac{3RT}{M_B}}$$

$$\therefore \frac{8}{3\pi} = \frac{M_A}{M_B}$$

$$\text{For } u_{av - A} = \sqrt{\frac{8RT_2}{\pi M_A}}$$

$$u_{av - B} = \sqrt{\frac{8RT}{\pi M_B}}$$

$$\frac{T_2}{T} = \frac{M_A}{M_B} = \frac{8}{3\pi}$$

$$\therefore T_2 = \frac{8}{3\pi} \cdot T$$

$$\text{or } T_2 < T.$$

Ans.5 Given $T_A \cdot M_B = T_B \cdot M_A$

or $\frac{T_A}{M_A} = \frac{T_B}{M_B}$

Also, $u_{rms} = \sqrt{\frac{3RT}{M}}$

Ans.6 $PV = \text{Constant}$; on differentiating
 $P dV + VdP = 0$

or $\frac{dP}{dV} = -\frac{P}{V} = -\frac{K}{V^2}$ ($\because PV = K$)

Ans.7 Mole of water evaporated = $\frac{4.5 \times 10^3}{18}$; Now calculate volume of vapours assuming 1 mole occupies 22.4 litre.

Ans.8 Use $V \propto T$ then

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

If $V_2 = \left[V_1 + \frac{10V_1}{100} \right]$. Find T_2 and calculate percent change.

Ans.9 $u_{H_2} = u_{O_2}$

$$u = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3RT}{M}}$$

$$\sqrt{\frac{3RT}{M_{H_2}}} = \sqrt{\frac{3RT}{M_{O_2}}}$$

$$\sqrt{\frac{T}{M_{H_2}}} = \sqrt{\frac{T}{M_{O_2}}}$$

$$\sqrt{\frac{T}{2}} = \sqrt{\frac{273}{32}}$$

Square both sides, $\frac{T}{2} = \frac{273}{32}$

$$T = \frac{273 \times 2}{32} = 17.06 \text{ K.}$$

Ans.10 In initial state $V_1 = \frac{nRT}{P}$

In final state $V_2 = \frac{nR2T}{1/2P} = \frac{4nRT}{P}$

Hence $V_1 : V_2 = \frac{nRT}{P} : \frac{4nRT}{P} = 1 : 4$.