

1. If Z is the compressibility factor, van der Waals' equation at low pressure can be written as :

- (1) $Z = 1 - Pb/RT$
- (2) $Z = 1 + Pb/RT$
- (3) $Z = 1 + RT/Pb$
- (4) $Z = 1 - a/V_mRT$

Solution:

$$(P + a/V_m^2)(V_m - b) = RT \quad [\text{Van der waals equation of state}]$$

$$V_m - b \approx V_m$$

$$\text{So the equation becomes } (P + a/V_m^2)V_m = RT$$

$$\Rightarrow PV_m + a/V_m = RT$$

Divide all terms by RT

$$PV_m/RT + a/V_mRT = RT/RT$$

$$PV_m/RT = 1 - a/V_mRT$$

$$Z = 1 - a/V_mRT \quad [Z = PV_m/RT]$$

Hence option (4) is the answer.

2. Which intermolecular force is most responsible in allowing xenon gas to liquefy?

- (1) Instantaneous dipole induced dipole
- (2) Ion dipole
- (3) Ionic
- (4) Dipole-dipole

Solution:

For the liquefaction of xenon, instantaneous dipole induced dipole forces are responsible.

Hence option (1) is the answer.

3. The temperature at which oxygen molecules have the same root mean square speed as helium atoms have at 300 K is :

(Atomic masses : He = 4 u, O = 16 u)

- (1) 1200 K
- (2) 600 K
- (3) 300 K
- (4) 2400 K

Solution:

Given Atomic masses : He = 4 u, O = 16 u

$$(V_{rms})_{O_2} = (V_{rms})_{He}$$

$$\sqrt{3RT_1/M_1} = \sqrt{3RT_2/M_2}$$

$$T_1/M_1 = T_2/M_2$$

$$T_1/32 = 300/4$$

$$T_1 = 300 \times 32/4$$

$$= 2400 \text{ K}$$

Hence option (4) is the answer.

4. The compressibility factor for a real gas at high pressure is :

(1) $1 - P_b/RT$

(2) $1 + RT/P_b$

(3) 1

(4) $1 + P_b/RT$

Solution:

$$(P + a/V^2)(V - b) = RT \quad [\text{Real gas equation}]$$

a/V^2 can be neglected at high pressure.

$$PV - P_b = RT$$

$$PV/RT = (RT/RT) + (P_b/RT)$$

$$PV/RT = 1 + (P_b/RT) \quad \dots(1)$$

$$Z = PV/RT \quad \dots(2)$$

Equating (1) and (2)

$$Z = 1 + (P_b/RT)$$

Hence option (4) is the answer.

5. The relationship among most probable velocity, average velocity and root mean Square velocity is respectively :

(1) $\sqrt{2} : \sqrt{8/\pi} : \sqrt{3}$

(2) $\sqrt{2} : \sqrt{3} : \sqrt{8/\pi}$

(3) $\sqrt{3} : \sqrt{8/\pi} : \sqrt{2}$

(4) $\sqrt{8/\pi} : \sqrt{3} : \sqrt{2}$

Solution:

$$V_{mpv} = \sqrt{2RT/M}$$

$$V_{av} = \sqrt{8RT/\pi M}$$

$$V_{rms} = \sqrt{3RT/M}$$

$$V_{mpv} : V_{av} : V_{rms} = \sqrt{2RT/M} : \sqrt{8RT/\pi M} : \sqrt{3RT/M}$$

$$= \sqrt{2} : \sqrt{8/\pi} : \sqrt{3}$$

Hence option (1) is the answer.

6. Value of gas constant R is

- (1) 0.082 L atm
- (2) 0.987 cal mol⁻¹ K⁻¹
- (3) 8.3 J mol⁻¹ K⁻¹
- (4) 83 erg mol⁻¹K⁻¹

Solution:

$$R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$$

Hence option (3) is the answer.

7. By how many folds the temperature of a gas would increase when the root mean Square velocity of the gas molecules in a container of fixed volume is increased from 5×10^4 cm/s to 10×10^4 cm/s?

- (1) Four
- (2) three
- (3) Two
- (4) Six

Solution:

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

$$V_1/V_2 = \sqrt{T_1/T_2} = 5 \times 10^4 / 10 \times 10^4$$

squaring, we get

$$T_1/T_2 = 25/100 = \frac{1}{4}$$

$$T_2 = 4T_1$$

Hence option (1) is the answer.

8. Kinetic theory of gases proves

- (1) Only boyle's law
- (2) Only Charle's law
- (3) Only Avogadro's law
- (4) all of these

Solution:

One of the postulates of kinetic theory of gases is average kinetic energy proportional to T. This theory proves all the above given laws.

Hence option (4) is the answer.

9. Which one of the following is the wrong assumption of kinetic theory of gases?

- (1) All the molecules move in a straight line between collision and with the same velocity.
- (2) Molecules are separated by great distances compared to their sizes.
- (3) Pressure is the result of elastic collision of molecules with the container's wall.
- (4) Momentum and energy always remain conserved.

Solution:

The molecules are always in random motion and obey Newton's law of motion. They have velocities in all directions ranging from zero to infinity.

Hence option (1) is the answer.

10. 'a' and 'b' are Vander Waal's constants for gases. Chlorine is more easily liquified than ethane because:

- (1) a for $\text{Cl}_2 < a$ for C_2H_6 but b for $\text{Cl}_2 > b$ for C_2H_6
- (2) a for $\text{Cl}_2 > a$ for C_2H_6 but b for $\text{Cl}_2 < b$ for C_2H_6
- (3) a and b for $\text{Cl}_2 > a$ and b for C_2H_6
- (4) a and b for $\text{Cl}_2 < a$ and b for C_2H_6

Solution:

Greater the 'a' value, more easily the gas is liquified, lower the 'b' value, more easily the gas is liquified. Hence option (2) is the answer.

11. A gaseous compound of nitrogen and hydrogen contains 12.5% (by mass) of Hydrogen. The density of the compound relative to hydrogen is 16. The molecular formula of the compound is :

- (1) NH_2
- (2) NH_3
- (3) N_3H
- (4) N_2H_4

Solution:

Given that gaseous compound of nitrogen and hydrogen contains 12.5% (by mass) of Hydrogen.

Element	Percentage	Atomic ratio	Simple ratio
H	12.5%	$12.5/1 = 12.5$	$12.5/6.25 = 2$
N	87.5%	$87.5/14 = 6.25$	$6.25 / 6.25 = 1$

Empirical formula = NH_2

Empirical mass = 16

Molecular weight = $2 \times \text{Vapour density} = 2 \times 16 = 32$
So $n = \text{molecular mass} / \text{empirical mass} = 32/16 = 2$
Molecular formula = Empirical formula $\times n$
= $(\text{NH}_2) \times 2$
= N_2H_4

Hence option (4) is the answer.

12. The one that is extensively used as a piezo electric material is

- (1) quartz
- (2) amorphous silica
- (3) trydymite
- (4) mica

Solution:

Quartz is used as a piezo electric material.

Hence option (1) is the answer.

13. Which primitive unit cell has unequal edge lengths and all axial lengths different from 90° .

- (1) Monoclinic
- (2) Triclinic
- (3) Tetragonal
- (4) Hexagonal

Solution:

Triclinic primitive unit cell has unequal edge lengths and all axial lengths different from 90° .
Hence option (2) is the answer.

14. In Van der waals equation of state of the gas law, the constant b is a measure of

- (1) Intermolecular repulsions
- (2) Intermolecular attraction
- (3) Volume occupied by molecules
- (4) Intermolecular collisions per unit volume.

Solution:

Van der waals constant b is the measure of effective volume occupied by the gas molecules.

Hence option (3) is the answer.

15. A pressure cooker reduces cooking time for food because

- (1) Heat is more evenly distributed in the cooking space.
- (2) B.P of water involved in cooking is increased
- (3) The higher pressure inside the cooker crushes the food.
- (4) Cooking involves chemical changes helped by a rise in temperature.

Solution:

By Gay Lussac's law, at constant pressure of a given mass of a gas is directly proportional to the absolute temperature of the gas. So on increasing pressure, temperature also increases. So the boiling point of water is also increased.

Hence option (2) is the answer.

16. According to kinetic theory of gases, in an ideal gas, between two successive collisions a gas molecule travels

- (1) In a circular path
- (2) In wavy path
- (3) In a straight line path
- (4) with an accelerated velocity

Solution:

According to kinetic theory of gases, in an ideal gas, between two successive collisions a gas molecule travels in a straight line path.

Hence option (3) is the answer.