Chapter 5

States of Matter

1. When r, P and M represent rate of diffusion, pressure and molecular mass, respectively, then the ratio of the rates of diffusion $\left(\frac{r_A}{r_B}\right)$ of two gases A and B, is given as **[AIEEE-2011]**

(1) $\left(\frac{P_A}{P_B}\right)\left(\frac{M_A}{M_B}\right)^{\frac{1}{2}}$ (2) $\left(\frac{P_A}{P_B}\right)^{\frac{1}{2}}\left(\frac{M_A}{M_B}\right)$

(3) $\left(\frac{P_A}{P_B}\right)\left(\frac{M_B}{M_A}\right)^{\frac{1}{2}}$ (4) $\left(\frac{P_A}{P_B}\right)^{\frac{1}{2}}\left(\frac{M_B}{M_A}\right)$

2. The molecular velocity of any gas is **[AIEEE-2011]** **[JEE (Main)-2020]**

(1) Directly proportional to square root of temperature

(2) Inversely proportional to the square root of temperature

(3) Inversely proportional to absolute temperature

(4) Directly proportional to square of temperature

3. The compressibility factor for a real gas at high pressure is **[AIEEE-2012]**

(1) 1 (2) 1 + pb/RT

(3) 1 – pb/RT (4) 1 + RT/pb

4. For gaseous state, if most probable speed is denoted by C^*, average speed by $\bar{C}$ and root mean square speed by C, then for a large number of molecules the ratios of these speeds are **[JEE (Main)-2013]**

(1) $C^* : \bar{C} : C = 1.225 : 1.128 : 1$

(2) $C^* : \bar{C} : C = 1.128 : 1.225 : 1$

(3) $C^* : \bar{C} : C = 1 : 1.128 : 1.225$

(4) $C^* : \bar{C} : C = 1 : 1.225 : 1.128$

5. If Z is a compressibility factor, van der Waals equation at low pressure can be written as **[JEE (Main)-2014]**

(1) $Z = 1 + \frac{RT}{Pb}$ (2) $Z = 1 - \frac{a}{VRT}$

(3) $Z = 1 - \frac{Pb}{RT}$ (4) $Z = 1 + \frac{Pb}{RT}$

6. The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is **[JEE (Main)-2014]**

(1) 1 : 4 (2) 7 : 32

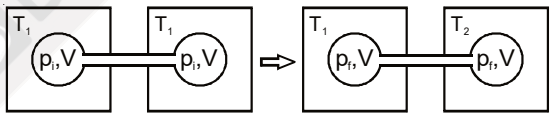
(3) 1 : 8 (4) 3 : 16

7. The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is **[JEE (Main)-2015]**

(1) Ion-ion interaction (2) Ion-dipole interaction

(3) London force (4) Hydrogen bond

8. Two closed bulbs of equal volume (V) containing an ideal gas initially at pressure p_i and temperature T_1 are connected through a narrow tube of negligible volume as shown in the figure below. The temperature of one of the bulbs is then raised to T_2. The final pressure p_f is **[JEE (Main)-2016]**



(1) $2p_i\left(\frac{T_1}{T_1+T_2}\right)$ (2) $2p_i\left(\frac{T_2}{T_1+T_2}\right)$

(3) $2p_i\left(\frac{T_1T_2}{T_1+T_2}\right)$ (4) $p_i\left(\frac{T_1T_2}{T_1+T_2}\right)$

9. 0.5 moles of gas A and x moles of gas B exert a pressure of 200 Pa in a container of volume 10 m^3 at 1000 K. Given R is the gas constant in $JK^{-1}\ mol^{-1}$, x is **[JEE (Main)-2019]**

(1) $\frac{2R}{4-R}$ (2) $\frac{2R}{4+R}$

(3) $\frac{4-R}{2R}$ (4) $\frac{4+R}{2R}$

10. The volume of gas A is twice than that of gas B. The compressibility factor of gas A is thrice than that of gas B at same temperature. The pressure of the gases for equal number of moles are **[JEE (Main)-2019]**

(1) $P_A = 2P_B$ (2) $P_A = 3P_B$

(3) $3P_A = 2P_B$ (4) $2P_A = 3P_B$

11. An open vessel at 27°C is heated until two fifth of the air (assumed as an ideal gas) in it has escaped from the vessel. Assuming that the volume of the vessel remains constant, the temperature at which the vessel has been heated is **[JEE (Main)-2019]**

(1) 750 °C

(2) 750 K

(3) 500 °C

(4) 500 K

12. Consider the van der Waals constants, a and b, for the following gases.

Gas	Ar	Ne	Kr	Xe
a/(atm dm^6 mol^{-2})	1.3	0.2	5.1	4.1
b/(10^{-2} dm^3 mol^{-1})	3.2	1.7	1.0	5.0

Which gas is expected to have the highest critical temperature? **[JEE (Main)-2019]**

(1) Ne (2) Kr

(3) Xe (4) Ar

13. At a given temperature T, gases Ne, Ar, Xe and Kr are found to deviate from ideal gas behaviour. Their equation of state is given as $P = \frac{RT}{V-b}$ at T.

Here, b is the van der Waal's constant. Which gas will exhibit steepest increase in the plot of Z (compression factor) vs P? **[JEE (Main)-2019]**

(1) Kr (2) Ar

(3) Xe (4) Ne

14. Consider the following table :

Gas	a/(k Pa dm^6 mol^{-1})	b/(dm^3 mol^{-1})
A	642.32	0.05196
B	155.21	0.04136
C	431.91	0.05196
D	155.21	0.4382

a and b are van der Waals constants. The correct statement about the gases is **[JEE (Main)-2019]**

(1) Gas C will occupy lesser volume than gas A; gas B will be lesser compressible than gas D

(2) Gas C will occupy more volume than gas A; gas B will be more compressible than gas D

(3) Gas C will occupy lesser volume than gas A; gas B will be more compressible than gas D

(4) Gas C will occupy more volume than gas A; gas B will be lesser compressible than gas D

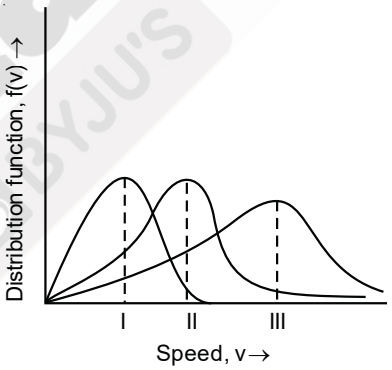
15. At 300 K and 1 atmospheric pressure, 10 mL of a hydrocarbon required 55 mL of O_2 for complete combustion, and 40 mL of CO_2 is formed. The formula of the hydrocarbon is **[JEE (Main)-2019]**

(1) C_4H_{10} (2) C_4H_8

(3) C_4H_6 (4) C_4H_7Cl

16. Points I, II and III in the following plot respectively correspond to

(V_{mp} : most probable velocity)



[JEE (Main)-2019]

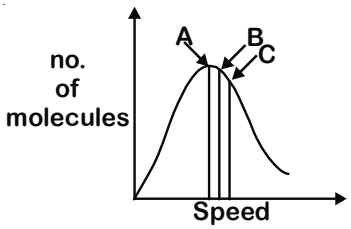
(1) V_{mp} of N_2 (300 K); V_{mp} of O_2 (400 K); V_{mp} of H_2 (300 K)

(2) V_{mp} of H_2 (300 K); V_{mp} of N_2 (300 K); V_{mp} of O_2 (400 K)

(3) V_{mp} of N_2 (300 K); V_{mp} of H_2 (300 K); V_{mp} of O_2 (400 K)

(4) V_{mp} of O_2 (400 K); V_{mp} of N_2 (300 K); V_{mp} of H_2 (300 K)

17. Identify the correct labels of A, B and C in the following graph from the options given below



Root mean square speed (V_{rms}); most probable speed (V_{mp}); Average speed (V_{av})

[JEE (Main)-2020]

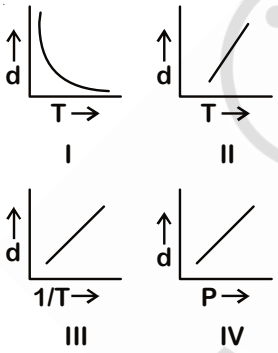
(1) A – V_{av}; B – V_{rms}; C – V_{mp}

(2) A – V_{rms}; B – V_{mp}; C –V_{av}

(3) A – V_{mp}; B – V_{rms}; C – V_{av}

(4) A – V_{mp}; B – V_{av}; C – V_{rms}

18. Which one of the following graphs is not correct for ideal gas?



d = Density, P = Pressure, T = Temperature

[JEE (Main)-2020]

(1) II (2) III

(3) I (4) IV

19. A mixture of one mole each of H_2, He and O_2 each are enclosed in a cylinder of volume V at temperature T. If the partial pressure of H_2 is 2 atm, the total pressure of the gases in the cylinder is **[JEE (Main)-2020]**

(1) 14 atm (2) 38 atm

(3) 22 atm (4) 6 atm

20. A spherical balloon of radius 3 cm containing helium gas has a pressure of 48 × 10^{-3} bar. At the same temperature, the pressure, of a spherical balloon of radius 12 cm containing the same amount of gas will be _____ × 10^{-6} bar.

[JEE (Main)-2020]

21. The volume occupied by 4.75 g of acetylene gas at 50°C and 740 mmHg pressure is ____ L. (Rounded off to the nearest integer)

[Given R = 0.0826 L atm K^{-1} mol^{-1}]

[JEE (Main)-2021]

22. A car tyre is filled with nitrogen gas at 35 psi at 27°C. It will burst if pressure exceeds 40 psi. The temperature in °C at which the car tyre will burst is _____. (Rounded-off to the nearest integer)

[JEE (Main)-2021]

23. A certain gas obeys $P(V_m - b) = RT$. The value of $\left(\frac{\partial Z}{\partial P}\right)_T$ is $\frac{xb}{RT}$. The value of x is _____.

(Integer answer) (Z : compressibility factor)

[JEE (Main)-2021]

24. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R

Assertion A : Dipole-dipole interactions are only non-covalent interactions, resulting in hydrogen bond formation.

Reason R : Fluorine is the most electronegative element and hydrogen bonds in HF are symmetrical.

In the light of the above statements, choose the most appropriate answer from the options given below: **[JEE (Main)-2021]**

(1) A is false but R is true

(2) Both A and R are true and R is the correct explanation of A

(3) A is true but R is false

(4) Both A and R are true but R is NOT the correct explanation of A

25. The pressure exerted by a non-reactive gaseous mixture of 6.4 g of methane and 8.8 g of carbon dioxide in a 10 L vessel at 27°C is ..... kPa.

(Round off to the Nearest Integer).

[Assume gases are ideal, R = 8.314 J mol^{-1} K^{-1}

Atomic masses : C : 12.0 u, H : 1.0 u, O : 16.0 u]

[JEE (Main)-2021]

26. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A : Sharp glass edge becomes smooth on heating it upto its melting point.

Reason R : The viscosity of glass decreases on melting.

Choose the most appropriate answer from the options given below. **[JEE (Main)-2021]**

(1) Both **A** and **R** are true and R is the correct explanation of A

(2) **A** is false but **R** is true.

(3) **A** is true but **R** is false.

(4) Both **A** and **R** are true but **R** is NOT the correct explanation of **A.**

27. A home owner uses 4.00×10^3 m^3 of methane (CH_4) gas, (assume CH_4 is an ideal gas) in a year to heat his home. Under the pressure of 1.0 atm and 300 K, mass of gas used is $x \times 10^5$ g. The value of x is _____. (Nearest integer)

(Given R = 0.083 L atm K^{-1} mol^{-1})

[JEE (Main)-2021]

28. An LPG cylinder contains gas at a pressure of 300 kPa at 27°C. The cylinder can withstand the pressure of 1.2×10^6 Pa. The room in which the cylinder is kept catches fire. The minimum temperature at which the bursting of cylinder will take place is _____ °C. (Nearest integer)

[JEE (Main)-2021]

29. The interaction energy of London forces between two particles is proportional to r^x, where r is the distance between the particles. The value of x is :

[JEE (Main)-2021]

(1) 3 (2) 6

(3) –6 (4) –3

30. The unit of the van der Waals gas equation parameter 'a' in $\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$ is :

[JEE (Main)-2021]

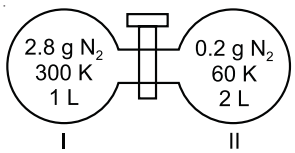
(1) atm dm^6 mol^{-2}

(2) kg m s^{-1}

(3) kg m s^{-2}

(4) dm^3 mol^{-1}

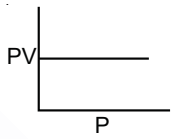
31. Two flasks I and II shown below are connected by a valve of negligible volume. **[JEE (Main)-2021]**

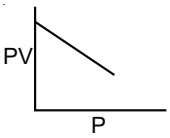


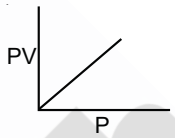
When the valve is opened, the final pressure of the system in bar is $x \times 10^{-2}$. The value of x is ____. (Integer answer)

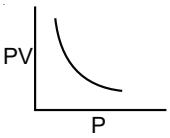
[Assume - Ideal gas; 1 bar = 10^5 Pa; Molar mass of N_2 = 28.0 g mol^{-1}, R = 8.31 J mol^{-1} K^{-1}]

32. Which one of the following is the correct PV vs P plot at constant temperature for an ideal gas? (P and V stand for pressure and volume of the gas respectively) **[JEE (Main)-2021]**

(1) 

(2) 

(3) 

(4) 

33. An empty LPG cylinder weighs 14.8 kg. When full, it weighs 29.0 kg and shows a pressure of 3.47 atm. In the course of use at ambient temperature, the mass of the cylinder is reduced to 23.0 kg. The final pressure inside the cylinder is _____ atm. (Nearest integer)

(Assume LPG to be an ideal gas)

[JEE (Main)-2021]

34. At 300 K, a sample of 3.0 g of gas A occupies the same volume as 0.2 g of hydrogen at 200 K at the same pressure. The molar mass of gas A is _____ g mol^{-1}. (nearest integer) Assume that the behaviour of gases as ideal.

(Given: The molar mass of hydrogen (H_2) gas is 2.0 g mol^{-1}).

[JEE (Main)-2022]

35. A rigid nitrogen tank stored inside a laboratory has a pressure of 30 atm at 06:00 am when the temperature is 27°C. At 03:00 pm, when the temperature is 45°C, the pressure in the tank will be _____ atm. [nearest integer]

[JEE (Main)-2022]

36. An evacuated glass vessel weighs 40.0 g when empty, 135.0 g when filled with a liquid of density 0.95 g mL^{-1} and 40.5 g when filled with an ideal gas at 0.82 atm at 250 K. The molar mass of the gas in g mol^{-1} is:

(Given : R = 0.082 L atm K^{-1} mol^{-1})

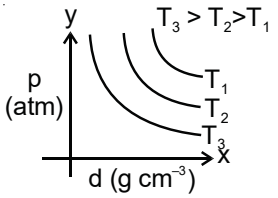
[JEE (Main)-2022]

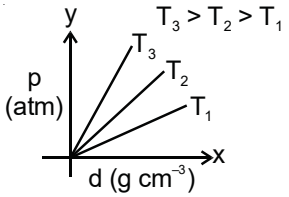
(1) 35 (2) 50

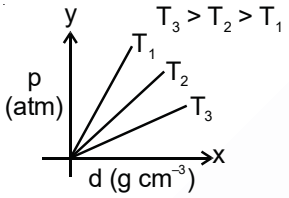
(3) 75 (4) 175

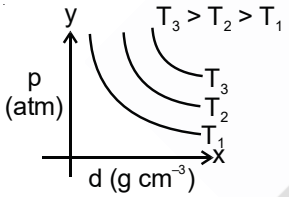
37. Which amongst the given plots is the correct plot for pressure (p) vs density (d) for an ideal gas?

[JEE (Main)-2022]

(1) 

(2) 

(3) 

(4) 

38. 100 g of an ideal gas is kept in a cylinder of 416 L volume at 27°C under 1.5 bar pressure. The molar mass of the gas is _____ g mol^{-1}. (Nearest integer).

(Given : R = 0.083 L bar K^{-1} mol^{-1})

[JEE (Main)-2022]

39. Geraniol, a volatile organic compound, is a component of rose oil. The density of the vapour is 0.46 gL^{-1} at 257°C and 100 mm Hg. The molar mass of geraniol is ____ g mol^{-1}. (Nearest Integer) [Given: R = 0.082 L atm K^{-1} mol^{-1}] **[JEE (Main)-2022]**

40. The pressure of a moist gas at 27°C is 4 atm. The volume of the container is doubled at the same temperature. The new pressure of the moist gas is _____ ×10^{-1} atm. (Nearest integer)

(Given: The vapour pressure of water at 27°C is 0.4 atm.) **[JEE (Main)-2022]**

41. A sealed flask with a capacity of 2 dm^3 contains 11 g of propane gas. The flask is so weak that it will burst if the pressure becomes 2 MPa. The minimum temperature at which the flask will burst is _____ °C. [Nearest integer]

(Given: R = 8.3 JK^{-1} mol^{-1}, Atomic masses of C and H are 12u and 1u, respectively.) (Assume that propane behaves as an ideal gas.)

[JEE (Main)-2022]

42. A mixture of hydrogen and oxygen contains 40% hydrogen by mass when the pressure is 2.2 bar. The partial pressure of hydrogen is _____ bar. (Nearest integer) **[JEE (Main)-2022]**

43. A 10 g mixture of hydrogen and helium is contained in a vessel of capacity 0.0125 m^3 at 6 bar and 27°C. The mass of helium in the mixture is _____ g. (nearest integer)

Given : R = 8.3 J K^{-1} mol^{-1}

(Atomic masses of H and He are 1 u and 4 u, respectively) **[JEE (Main)-2022]**

44. For a real gas at 25°C temperature and high pressure (99 bar) the value of compressibility factor is 2, so the value of Van der Waal's constant 'b' should be _____ × 10^{-2} L mol^{-1} (Nearest integer)

(Given R = 0.083 L bar K^{-1} mol^{-1})

[JEE (Main)-2022]

45. Given below are the critical temperatures of some of the gases :

Gas	**Critical temperature (K)**
He	5.2
CH_4	190.0
CO_2	304.2
NH_3	405.5

The gas showing least adsorption on a definite amount of charcoal is **[JEE (Main)-2022]**

(1) He (2) CH_4

(3) CO_2 (4) NH_3

46. 'x' g of molecular oxygen (O_2) is mixed with 200 g of neon (Ne). The total pressure of the non-reactive mixture of O_2 and Ne in the cylinder is 25 bar. The partial pressure of Ne is 20 bar at the same temperature and volume. The value of 'x' is ___.

[Given : Molar mass of O_2 = 32 g mol^{-1}.

Molar mass of Ne = 20 g mol^{-1}]

[JEE (Main)-2022]

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