CHEMISTRY

BOOKS - CHHAYA CHEMISTRY (BENGALI ENGLISH)

STATES OF MATTER : GASES AND LIQUIDS

Numerical Examples

1. At a certain place, the atmospheric pressure is 740 mm Hg, what will be the value of this pressure in the units of

(1) torr

(2) atm

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2. A bulb filled with a gas is connected to an open -end manometer. the level of mercury in the arm attached to the gas bulb is 20 cm lower than that in the open. end arm, calculate the pressure of the gas in the bulb in the units of atm and Pa? Consider the atmospheric pressure to be 76 cm Hg.

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3. An open-end manometer was used to determine the pressure of a gas present in a container. It was found that the height of mercury level in the arm attached to the gas-filled container was 4 cm higher than that in the open ene arm. If the atmospheric pressure was measured to be 76 cm Hg, then what will be the pressure of the gas inside the container in atm unit?

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4. A balloon contains 1.2L of air at a particular temperature and 90 cm Hg pressure. What will be the volume of air if the pressure is reduced to 70 cm Hg, while keeping the temperature constant?

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5. The volume of a certain amount of gaa containing an incompressible solid is 100 cc at 760 mm Hg and 80cc at 1000 mm Hg. What is the volume of the solid?

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6. At constant pressure, the temperature of a difinite amount of a gas is increased from $0°C$ to $t°C$. As a result, the volume of the gas is increased by a factor of three. Calculate the value of t.

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7. A 16 sample of oxygen at 760 Hg pressure and $27°C$ is kept in a container of 12.30 L capacity. What will be the temperature of the gas if the entire gas is transferred to a container of 24.6 L capacityt, keeping the pressure constant?

8. When sample of hydrogen is immersed in a mixture of ice and water, it occupies an exact volume of 69.37 cc at 1 atm. At the same pressure, if the gas is immersed in boiling benzene, then its volume expands to 89.71 cc. what is the boiling point of benzene ?

9. An iron cylinder contains He gas at a pressure of 250 kPa at 300K. The cylinder can withstand a pressure of $1 \times 10^6 Pa$. The room in which the cylinder is placed catches fire. Predict whether the cylinder will blow up before it melts or not. [M.P. of the cylinder=1800 K]

10. A cylinderical of cooking gas can withstand a pressure of 14.9 atm at $27°C$, the pressure gauge of the cylinder records a pressure of 12 atm. Due to a sudden fire in the building, the temperature starts rising. At what temperature, will the cylinder explode?

11. At a given temperature annd pressure, the volume of 10 g of He gas is 61.6 L. how much of He gas has to be taken out at the same temperature and pressure to reduce its volume to 25 L?

12. At a particular temperature and pressure, the volume of 12 g of H_2 gas is 134.5 L. what will be the final volume of the gas if 4 g of H_2 gas is added to it at the same temperature and pressure?

13. Find the volume of 2.2 g CO_2 gas at $25°C$ & 570 mm Hg presssure. Consider that CO_2 behvaes ideally.

14. A sample of Ar vapour contains 3×10^4 atoms of Ar in a vacuum tube with a volume of 5 mL of $-100°C$. Calculate the presure of the vapour in microtorr unit.

15. At 273 K and 76 cm Hg pressure, the volume of 0.64 g of a gas is 224 mL. what temperature 1 g of this gas will occupy a volume of 1 litre at 1 atm pressure?

16. At $25°C$ and at a certain pressure, 3.7 g of a gas occupies the same volume as the volume occupied by 0.184 of H_2 gas at $17°C$ and the same pressure. Calculate molar mass of the gas.

17. A He balloon is such that it can rise to a maximum height of 50 km above the Earth's surface. When the balloon rises to this height, its expansion reaches maximum with a volume of $10^5 L$. If the temperature and pressure of the air at this height are $-10°C$ and 1.8 mm Hg, respectively, then what mass of He gas will be required for the maximum expansion of the balloon?

18. At 300 K, an evacuated cylinder with a volume of 10Lgt is filled with 2 g of H_2 and $2g$ of D_2. Find the pressure of the gas mixture in the cylinder.

Will the presure be the samme if the container is cubical having the same volume?

19. When an open vessel at $27^\circ C$ ws heated, three-fifths of the air is in escaped from it. If the volume of the vessel remained unchanged, calculate the temperature at which the vessel was heated?

20. A spherical balloon with a diameter of 21 cm is to be filled with hydrogen gas at STP from a cylinder of H_2 gas at 20 atm pressure and $27^\circ C$. If the cylinder can hold 2.82 L of water, how many balloon can be filled with the hydrogen gas from the cylinder?

21. When 2 g of a gas 'M' is introduced into an empty flask at $30°C$, its pressure becomes 1 atm. Now, if 3g of another gas 'N' is introduced in the same flask at the same temperature, the total pressure becomes 1.5 atm. Find the ratio of the molar masses of the two gases.

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22. What is the density (in $g \cdot cm^{-3}$) of nitric oxide (assuming ideal behaviour) at $27°C$ and 1 atm pressure?

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23. The density of CO_2 at STP is $1.96g \cdot L^{-1}$. A sample of CO_2 occupies a volume of 480 mL at $17°C$ and 800 mm Hg pressure. What is the mass of the sample?

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24. At $27° C$, a cylinder of volume 10 L contains a gas mixture consisting of 0.4 He, 1.6g $O_2 \& 1.4g\ H_2$. Determine the total pressure of the mixture and the partial pressure of He in the mixture.

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25. The volume percentages of N_2, O_2 and He in gas mixture are 25, 35 and 40 , respectively. At a given temperature, the pressure of the mixture is 760 mm Hg. Calculate the partial pressure of each gas at the same temperature.

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26. A mixture of N_2 and O_2 at 1 bar pressure contains 80% N_2 by weight. Calculate the partial pressure of N_2 in the mixture.

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27. At a given temperature, the pressure in a oxygen cylinder is 10.3 atm. At the same temperature the pressure in another oxygen cylinder of volume 1/3rd of the first cylinder is 1.1 atm. Keeping temperature constant, if the two cylinders are connected, then what will be the pressure of O_2 gas in the system?

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28. Thermal decomposition of x g of $KClO_3$ produces 760 mL O_2, which is collected over water at $27^\circ C$ and 714 mm Hg pressure. Find the value of x. [Given tht at $27^\circ C$, aqueous tension=26 mm Hg and atomic weights of K=39, Cl=35.5, O=16]

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29. The rate of diffusion of a gas is 2.92 times that of NH_3 gas. Determine the molecular weight of that gas.

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30. 432 mL of gas A effuses out through a fine orifice in 36 min. 288 mL of another gas B effuses out through the same orifice in 48 mon. if the molecular weight of B is 64, what is the molecular weight of A?

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31. Molecular weights of two gases are 64 annd 100 respectively. If rate of diffusion of first gas be 15 $mL \cdot \sec^{-1}$, then what is the rate of diffusion of the other?

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32. Determine the relative rates of diffusion of $^{235}UF_6$ and $^{238}UF_6$ gases?

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33. In a mixture of O_2 and an unknown gas, the percentage of the unknown gas is 20% by mass. At a given temperature and pressure, time required to effuse V mL of the gas mixture through an aperrture is 234.1 s. under the same conditions, time required to effuse the same volume of pure O_2 gas is 223.1 s. what is the molar mass of unknown gas?

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34. A gas mixture consisting of He and CH_4 gases in mole ratio 4:1 is present in a vessel at a pressure of 20 bar. Due to a fine hole in the vessel, the gas mixture undergoes effusion. What is the composition (or ratio) of the initial gas mixture that is effused out?

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35. X' and 'Y' are the two open ends of a glass tube with a length of 1m. NH_3 gas through 'X' and HCl gas through 'Y' are simultaneously allowed to enter the tube. As NH_3 and HCl gases diffuse towards each other

inside the tube, they meet and react to form $NH_4Cl()$, and as a result of which a white fume appears. where will the white fume appear first inside the tube?

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36. Determine the rato of root mean square velocity nad average velocity of the molecules in a gas at a given temperature.

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37. Show that the root mean square velocity of an O_2 molecule at $54°C$ is not twice its root mean square velocity at $27°C$.

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38. Determine the rms velocity, average velocity and most probable velocity of H_2 molecules at 300 K.

39. At what temperature will the most probable velocity of H_2 molecule be equal to the root mean square velocity of O_2 molecule at $20°C$?

40. The density of O_2 gas at 1 atm pressure and 273 K is 1.429 $g \cdot dm^{-3}$. Calculate the root mean square velocity of O_2 molecule at 273 K?

41. Determine the total kinetic energy of the molecule of 1 g CO_2 at $27°C$ in the units of erg and calorie. Assume the ideal behaviour of the gas.

42. Determine the total kinetic energy of the molecules of 8.0 g CH_4 at $27°C$ in the unit of joule.

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43. At a given temperature, the average kinetic energy of H_2 molecules is $3.742\ kJ \cdot mol^{-1}$. Calculate root mean square velocity of H_2 molecule at this temperature.

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44. 2 mol of a van der waals gas at $27°C$ occupies a volume of 20 L. what is the pressure of the gas? [a=6.5 $atm \cdot L^{-2} \cdot mol^{-2}, b = 0.056L \cdot mol^{-1}$]

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45. A container with a volume of 5 L holds 100 g of CO_2 at $40°C$. For CO_2 gas, a $= 3.59L^2 \cdot atm \cdot mol^{-2}$ and $b = 4.27 \times 10^{-2}L \cdot mol^{-1}$. Determine the pressure of CO_2 gas. How much does this value differ from that calculated by using ideal gas equation?

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46. 2 mol of gas is kept in a 4 litre flask. The pressure of the gas at 300 K is 11 atm. If the value of 'b' for the gas is 0.05 $L \cdot mol^{-1}$, then determine the value of 'a' by using van der waals equation.

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Warm Up Exercise

1. Determine the types of intermolecular forces of attraction in the following substances.

n-hexane, SO_2, CO_2,　　$CHCl_3$,　　$(CH_3)_2CO$,　　I_2,　　$(CH_3)_2O$

2. Which type of intermolecular forces of attraction act between O_2 and water molecules when O_2 is dissolved in water?

3. Why does the magnitude of London forces increase with the increasing size of the atoms and molecules?

4. Which types of intermolecular force of attraction act between the molecules in liquid HF?

5. Why is the compressibility of a gas higher than that of a liquid or a solid?

6. Why is the number of molecules per unit volume of a gas is fewer compared to that of a liquid or solid ?

7. When a bottle of perfume is opened at one corner of a room, the entire room gets fragrant affter sometime-explain.

8. The average kinetic energy of the molecules in a gas at $T_1 K$ and $T_2 K$ are E_1 are $E_2 kJ$, respectively. If $E_2 > E_1$, then which one between

T_1 and T_2 is higher?

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9. What do you mean by pressure of a gas?

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10. At a constant temperature, the pressures of four gases A, B, C, D are 0.2 atm, 250 torr, 26.23 kPa and 14.2 bar, rspectively. Arrange them according to their increasing pressure.

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11. Define 1 atm, 1 torr, 1 Pa and 1 bar.

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12. What do you mean by absolute scale of temperature ?

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13. Among the four quantities-mass, pressure, temperature and volume, which are taken to be constant in the following gas laws?

(i) Boyle's law,

(ii) Charles' law

(iii) Gay-Lussac's law

(iv) Avogadro's law.

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14. Why does the volume of a given mass of gas increase on decreasing its pressure at constant temperature?

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15. Why does the volume of a gas increase on increasing its number of moles at a given temperature and pressure?

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16. Will the nature of the following graphical presentations for a given mass of gas be the same?

(i) P vs V at a constant temperature

(ii) V vs T at constant pressure.

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17. When does the graph showing variation of the volume of a given mass of gas with pressure at a constant temperature become linear?

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18. N_2 gas is present in a 1 L desiccator at 1 atm pressure. The pressure of the gas decreses to 78 mm Hg pressure when the desiccator is partially evacuated using a vacuum pump at constant temperature. Find out the final volume of the gas.

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19. Obtain a relationship between density and absolute temperature for a given mass of an ideal gas at a fixed pressure?

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20. Plot density vs pressure for a fixed mass of an ideal gas at a constant temperature.

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21. According to Boyle's law, at constant temperature, the volume of a given mass of gas is inversely proportional to its pressure. But when a balloon is filled with air, both volume and pressure of the gas inside it increase-explain.

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22.

Under two different conditions, the following graph is obtained from an ideal gas. Mentioning A and B, identify the conditions.

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23. What are the molar volumes of nitrogen and argon gases at 273.15 K temperature and 1 atm pressure? [consider both the gases behave ideally].

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24. Comment on the validity of Boyle's law for the following reaction: $N_2O_4(g) \Leftrightarrow 2NO_2(g)$.

25. If a substance were to be in gaseous state at absolute zero of temperature, other what would be the theoretical value of its pressure?

26. At a given pressure, the volume of a given amount of gas at $0°C$ is V_0. (i) will the V vs t (celsius temperature) plot for this gas be linear (ii) will it be a straight line passing through the origin? (iii) if this straight line does ot pass through the origin, then what will be its slope and intercept?

27. What is absolute zero? Why is it called absolute ?

28. (i) Plotting V vs T for a given mass of an ideal gas at two different fixed pressures P_1 and P_2 gives two straight lines, one of which corresponds to P_1 and the other corresponds to P_2. If P_1 is greater than P_2, then which one of thes straight lines will make a larger angle with the T-axis?

(ii) Plotting P vs T for a given mass of an ideal gas at two different fixed volumes V_1 and V_2 gives two straight lines, one of which corresponds to V_1 and the other corresponds to V_2. if V_1 is greater than V_2, then which one of these straight lines will make a larger angle with the T-axis?

29. Under what conditions will the value of $\dfrac{P}{T}$ always be the same irrespective of the value of T?

30. Under what conditions will the value of PV always be the same irrespective of the value of P (or V) ?

31. A certain amount of an ideal gas is enclosed in a cylinder fitted with a movable piston. What would be the changes of the volume of the gas in the following processes?

(i) The pressure of the gas is reduced by 25% at constant temperature.

(ii) The temperature of the gas is increased by 50% constant pressure.

32. Determine the values of molar gas constant in the following units- (i) $mL \cdot torr \cdot K^{-1} \cdot mol^{-1}$

(ii) $kPa. L \cdot K^{-1} \cdot mol^{-1}$.

33. For the same mass of two ideal gases X and Y at the same temperature and pressure, the volume of Y is found to be three times as large as that of X. compare the values of their molar masses.

34. At constant temperature and pressure volume of an ideal gas (molecular mass $28g \cdot mol^{-1}$) is 23.36 times greater than its mole number. Find out its density at the same temperature and pressure.

35. When a flask of fixed volume is filled with $\frac{x}{2}$ mol of an ideal gas A at a constant temperature, the pressure of the gas becomes 2 atom. Adint 2 y mol of another ideal gas B to the flask at the same temperature causes the pressure of the system to increase to 4.0 atm.

36. Rank the gases N_2, CO_2 and CH_4 in order of their increasing densities at a given temperature and pressure.

37. Under which of the following conditions will the density of a fixed mass of SO_2 gas be higher? (i) STP

(ii) $27°C$ and 3 atm pressure.

38. Determine the SI unit of $\dfrac{PV^2T^2}{n}$

39. At $27°C$ and 1 atm pressure the volume of a 5.0 g mixture of He and Ar gases is $10dm^3$. Find the mass percent of the two gases in the gas mixture.

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40. Why does a balloon filled with hot air rise upward in air?

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41. Density of an ideal gas at T temperature and P pressure is d_1. The pressure will be P/8 when the temperature increases to 4T. Find out the density (d_2) of the gas at this new conditions.

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42. Arrange O_2, CO_2, Ar and SO_2 gases present in a sample of air in order of their increasing partial pressure.

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43. A gas mixture consisting of O_2 and N_2 gases gas a volume of 5 L at $25°C$. In themixture, if the mass of O_2 gas is twice that of N_2 gas, then which one of them will have a greater contribution to the total pressure of the mixture.

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44. In a gas mixture of H_2 and He, the partial pressure of H_2 is half that of He. Find the mole fractions of H_2 and He in the mixture.

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45. A closed vessel contains an equal mass of O_2 and CH_4 gases at $25°C$. What fraction of the total presure is contributed by CH_4 gas?

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46. A mixture of O_2 and H_2 gases contains 20% of H_2 gas. At a certain temperature, the total pressure of the mixture is found to be 1 bar. What is the partial pressure of O_2 (in bar) in the mixture?

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47. At a constant temperature, gas A (volume V_A and pressure P_A) is mixed with gas B (volume V_B and pressure P_B). What will the total pressure of the gas mixture be?

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48. For which of the following gas mixtures is the dalton's law of partial pressure is applicable? (i) $NO + O_2$

(ii) $CO_2 + CO$

(iiii) $CO + O_2$

(iv) $CH_4 + C_2H_6$

(v) $CO + H_2$.

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49. In a mixture of A,B and C gases, the mole fractions of A and C are 0.25 and 0.45, respectively. If the total pressure of the mixture is P, then find the partial pressure of B in the mixture.

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50. A gas mixture consists of three gases A, B and C with the number of moles 1,2 and 4, respectively.w hich of the gases will have a maximum

partial pressure if the total pressure of the mixture is P at a given temperature ?

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51. Rank Cl_2, SO_2, CO_2, CH_4 gases in increasing order of their rates of diffusion under identical set of conditions.

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52. Why are the rates of diffusion of N_2O and CO_2 gases the same under identical set of conditions?

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53. At constant temperature and pressure the rate of diffusion of H_2 gas is $\sqrt{15}$ times that of C_nH_{4n-2} gas. Find the value of n.

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54. Under the same conditions, a gas diffuses $\sqrt{2}$ times as fast as SO_2 gas. Find the molecular mass of the gas.

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55. Besides the lower layer, CO_2 is also found in the upper layer of the atmosphere although it is heavier than O_2 or N_2-explain.

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56. The molecular masses of A,B,C are 2,4 and 28, respectively. Arrange them according to their increasing rates of diffusion.

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57. A closed vessel holds a gas mixture consisting of C_2H_6, C_2H_4 and CH_4, each with an amount of 2.5 mol. But due to a pinhole is the vessel, the gas mixture undergoes effusion. What will be the order of partial pressures of the gases in the vessel after sometime?

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58. Under similar conditions of temperature and pressure, the times it takes for the effusion of the same volume of H_2, N_2 and O_2 gases through the same porous wall are t_1, t_2 and t_3, respectively. Arrange t_1, t_2 and t_3 in order of their increasing values.

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59. At what temperature will the average velocity of O_2 molecules be equal to that of H_2 molecules at 20K?

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60. What will happen if the collisions of the gas molecules with each otherr are not perfectly elastic?

61. At what temperatures rms velocity, average velocity & most probable velocity of O_2 molecules will be 1500 $m \cdot s^{-1}$?

62. For which type of gas molecues are the total kinetic energy and translational kinetic energy equal?

63. Of the following types of velocity, which one has the highest value and which one has the lowest value at a given temperature ?

64. Which type of velocity does a gas molecule with average kinetic energy possess?

65. How does the average velocity or the root mean square velocity of gas molecules depend on temperature and pressure?

66. At a given temperature, the root mean square velocities of the molecules of gases A, and B are x and $y cm \cdot s^{-1}$, respectively. If x is greater than y, then which gas has larger molar mass?

67. According to the kinetic theory of gases, the average kinetic energies of O_2 and N_2 molecules are the same at a particular temperature. State whether the rms velocities of the molecules of the two gases at a given temperature will be the same or not.

68. 1 mol of N_2 & 3 mol of O_2 are kept in two different containers with a volume of V at a fixed temperature. Compare-(i) the average kinetic energy (ii) the total kinetic energy of the molecules.

69. On what factors does the total kinetic energy of the molecules in a gas depend?

70. At a given temperature , the most probable velocity of the molecules of gas A is the same as the average velocity of the molecules of gas B. which has larger molar mass?

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71. Between H_2 and CO_2 gas, which one has the value of compressibility factor greater than 1 at ordinary temperature and pressure?

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72. For a real gas, the van der Waals constant 'a' is zero. Can the gas the liquefied? Explain.

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73. Why are the deviations from ideal behaviour of CO_2 and CH_4 greater than those of H_2 and He?

74. For what reasons does a real gas deviate from ideal behaviour?

75. What do you mean by the compresiblity factor of a real gas? What is its value for an ideal gas? When does its value for a real gas become greater than, less than or equal to one?

76. At a given temperature and pressure, 1 mol of an ideal gas occupies a volum eof 20.8 L for 1 mol of a real gas at the same temperature and

pressure-

(i) Z will be equal to 1 if the volume of the real gas is

(ii) Z will be greater than 1 if the volume of the real gas is

(iii) Z will be less than 1 if the volume of the real gas is.

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77. What is Boyle temperature? What would be the value of compressibility factor of a real gas in the low pressure region at its boyle temperature?

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78. A real gas follows the equation P(V-ab)=nRT under all conditions of temperature and pressure. Show that the compressibility factor of this gas is always greater than one.

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79. The van dar waals constant 'a' for CO_2 and CH_4 gases are 3.6 and 2.3 $L^2 \cdot atm \cdot mol^{-2}$. Which one of these two gases can easily be liquefied?

80. Why is it not possible to liquefy an ideal gas?

81. For H_2 gas, $a = 0.024L^2 \cdot atm \cdot mol^{-2}$,

$b = 0.026L \cdot mol^{-1}$ and for CH_4 gas:

$a = 2.28L^2 \cdot atm \cdot mol^{-2}, b = 0.042L \cdot mol^{-1}$.

(i) At ordinary temperature and pressure, which one of the two gases will behave more like an ideal gas?

(ii) Which one of the two gases has a larger molecular size?

82. When does the effect of molecular volume dominate over the effect of intermolecular force of attraction ?

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83. Why does a real gas behave like an ideal gas at very high temperature and low pressures?

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84. At ordinary temperature, why can CO_2 but not O_2 gas be liquefied by applying pressure? Give reason.

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85. The critical temperature and the critical pressure of a gas are T_c and P_c, respectively. If the gas exists at a temperature of T and a

pressure P, then under which of the following conditions will the gas not be liquefied?

(i) $T > T_c, P > P_c$

(ii) $T = T_c, P > P_c$

(iii) $T = T_c, P < P_c$

(iv) $T < T_c, P = P_c$

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86. The critical temperature of H_2, NH_3 and CO_2 gases are 5K, 405 K and 304 K, respectively. Arrange them in the increasing order of their intermolecular forces of attraction.

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87. The critical temperature of NH_3 and SO_2 gases are 405.0 K and 430.3K, respectively. For which gas is the value of van der waals constant 'a' greater. And why?

88. The critical temperature of NH_3, CO_2 and O_2 gases are 405.6K, 304.1 K and 154.2 K, respectively. If the gases are cooled from 500 K to their respective critical temperature, then which gas will be liquefied first?

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89. The values of van der waals constants 'a' and 'b' for X, Y, and Z gases are 6,6,20 and 0.025, 0.15, 0.11, respectively. Which one has the highest critical temperature ?

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90. Why is the density of a liquid greater than that of a gas ?

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91. The intermolecular attractions is dimethyl ether are weaker than that of acetone. Which of them has a higher vapour pressure?

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92. Why does the vapour pressure of a liquid increase with the increase in temperature?

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93. Why does the boiling point of a liquid incrase with the increase in the external pressure?

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94. At $20°C$, the surface tension of water is thre times that of CCl_4-give reason.

95. Water wets the surface of a glass, but mercury does not. Why?

96. At $t_1 °C$ and $t_2 °C$, the values of viscosity coefficients of a liquid are x poise, and y poise respectively. If $x > y$, then which one is higher, t_1 or t_2?

97. Why is the nib of a fountain pen splitted?

98. Why does water rise inside a capillary tube?

99. At $20°C$ the increasing order of viscosity of acetic acid, acetone and methanol is: acetone $<$ methanol $<$ acetic acid. Arrange the liquids according to their increasing intermolecular attractive forces.

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100. Why is the upper meniscus of mercury convex in a glass tube?

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101. Compare the CGS and SI units of viscosity?

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102. Addition of soaps or detergents to water decreases the surface tension of water-why?

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103. Why does the surface enegy increase on dispersion of a large water drop into smaller droplets?

104. Why does oil spread over water when it is poured over water?

Question Answer Zone For Board Examination

1. Mention the variables and constant quantities in charles' law.

2. If P is plotted against 1/V for 1 mol of an ideal gas at $0°C$, then a straight line passing through the origin is obtained. What the slope of the straight line?

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3. The number of molecules in an ideal gas with a volume of V at pressure P and temperature T is 'n'. Write down the equation of state for this gas.

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4. At a definite temperature, the total pressure of a gas-mixture consisting of three gases A, B and C is P. If the number of moles of A, B and C are 2, 4 and 6, respectively, then arrange these gases in increasing order of their partial pressures.

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5. Under idential conditoins of temperature and pressure, it takes time t_1 for the effusion of VmL of N_2 gas through a porous wall and the time t_2 for the effusion of the same volume of CO_2 gas through the same porous wall. Which one is greater t_1 or t_2?

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6. Arrange the following gases in the increasing order of their densities at STP: H_2, air CO_2.

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7. What is the numerical value of N/n? [N and n are the number of gas molecules and number of moles of gas].

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8. At a constant temperature, a container of fixed vo,ume holds NH_3 and HCl gases. Can dalton's law of partial pressures be applied to this gases mixture?

9. On what factors does the value of total kinetiic energy of the molecules in a gas depend?

10. The equation of state of a real gas is $P(V - b) = RT$. Can this gas be liquefied?

11. At a low pressure, the van der waals equation reduces to $\left(P + \dfrac{a}{V^2}\right)V + RT$. What is the value of compressibility factor (Z) for this case at this condition?

12. The nomral boiling points of two gases A and B are $-150°C$ and $-18°C$, respectively. Which one of the two gases will behave more like an ideal gas at STP?

13. Prove that $c_{rms} = \sqrt{\dfrac{2E}{M}}$ [E=total kinetic energy of the molecules of 1 mol of a gas, M=molar mass of the gas, c_{rms} = root mean square velocity of gas molecule].

14. It is easier to liquefy a gas with higher critical temperature-explain.

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15. Why cannot CO_2 gas be liquified above $31.1°C$?

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16. Among the following properties of a liquid, whichone increases with the increase in temperature? Surface tension, viscosity and vapour pressure.

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17. The vapours pressures of benzene and water at $50°C$ are 271 and 92.5 torr, respectively. Which one would you expect to have stronger intermolecular forces of attraction?

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18. At $25°C$, the vapour pressure of ethanol is 63 torr. What does it mean?

19. The normal boiling point of diethyl ether is $34.6°C$. What will be its vapour pressure at this temperature?

20. The normal boiling points of ethanol and benzene are $78.3°C$ and $80°C$, respectively. Is the vapour presure of ethanol lower than, greater than or equal to the vapour pressure of benzene?

21. Why is the equilibrium established in the evaporation of a liquid in a closed vessel at constant temperature called dynamic equilibrium?

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22. Which one between water and ethanol greater surface tension at a particular temperature?

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23. What is the value of surface tension of a liquid at its critical temperature?

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24. At a given temperature, the viscosity of liquid A is greater than that of liquid B, which of these two liquids has stronger intermolecular forces of

attraction?

25. Give two examples where capillary action occurs.

26. When a football is pumped, both the volume and pressure of the gas inside it increase. Does this observation contradict boyle's law?

27. Equal mass of two gases A and B are kept in two separate containers under the same conditions of temperature and pressure. If the ratio of molar masses of A and B be 2:3, then what will be the ratio of volumes of the two containers?

28. A gas-mixture consists of two gases, A and B, each with equal mass. Molar mass of B is greater than that of A. which one of the two gases will contribute more to the total pressure of the gas mixture?

29. Under the same conditions of temperature and pressure, the rate of diffusion of hydrogen gas is four times that of oxygen gas-explain.

30. Four tyres of a motor car were filled with nitrogen, hydrogen, helium and air. In which order are these tyres to be filled with the respective gases again?

31. At constant pressure for a given amount of an ideal gas, will the graph obtained by plotting V vs $t°C$ and V vs TK be different ?

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32. Under similar conditions of temperature and pressures, if the time taken for effusion of the same volume of H_2, N_2 and CO_2 gas through the same porour wall are t_1, t_2 and t_3 respectively, then arrange t_1, t_2 and t_3 in their increasing order.

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33. Molar mass of UF_6 is 176 times as high as that of H_2, yet at a particular temperature the average kinetic enegy of both is found to be the same-why?

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34. If, at a given temperature, the totla kinetic energy of the molecules in unit volume of an ideal gas be E, show that the pressure of the gas, $P = 2/3E$.

35. For the molecules of a given gas at a constant temperature, arrange the most probable velocity (c_m), root mean square velocity (c_{rms}) and average (c_a) in the order of their increasing values. With the increase in temperature, will the ratio of these velocities increase, decrease or remain constant ? What will the effect of increasing temperature be on the value of $(c_{rms} - c_m)$ for a given gas?

36. A and B are closed flasks having the same volume. In flask A, O_2 gas is present at TK and 1 atm pressure. In flask B, H_2 gas is present at $\dfrac{T}{2}K$ and 1 atm pressure. If these gases behave ideally, then compare their (1) total

kinetic energies, (2) total number of molecules, (3) root mean square velocities.

37. Which one of the gases, under the given conditions, exhibits reas gas behaviour ? (1) 0.25 mol CO_2, T=1200K, P=24.63 atm, V=1L

(2) 1.0 mol SO_2, T=300K, P=50 atm, V=0.35 L.

38. Under what condition can a gas be liquefied?

(1) $T = T_c$ and $P < P_c$

(2) $T < T_c$ and $P = P_c$

39. Two gases, obeying van der waals equation, have identical values of 'b' but different values of 'a'. Which one of the two gases will occupy less volume under identical conditions? If the values of 'a' for the two gases are the same but the values of 'b' are different, then under identical conditions which gas will be more compressible?

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40. A real gas follows van der waals equation. Find the compressibility for 1 mol of the gas at its critical temperature.

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41. Derive van der waals equation for 'n' mol of a real gas from the equation for 1 mol of the gas.

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42. Write the van der wals equation for a real gas containig n molecules.

43. What will the nature of PV vs P graph be for a real gas at Boyle temperature?

44. What will the value of compressibility factor (Z) be for a gas if the pressure correction term in the van der waals equation for the gas is neglected?

45. The vlaue of van der waals constant 'a' for nitrogen gas is $1.37L^2 \cdot atm \cdot mol^{-2}$, but that for ammonia gas is $4.30L^2 \cdot atm \cdot mol^{-2}$

. What is the reason for this large difference ? Which one of these two gases would you expect to have higher critical temperature?

46. The values of 'a' & 'b' for three real gases A, B & C are-

(a) Which one of these gases gas the largest molecular size?

(2) Which one of these will behave most like an ideal gas at STP?

47. Why is the potential energy of a molecule in the bulk of a liquid lower than that for a molecule at the surface?

48. Between methanol (CH_3OH) and water (H_2O) whose surface tension is greater, and why?

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49. A liquid has a high normal boiling point. Will its viscosity and surface tension values be high or low?

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50. How is the vapour pressure of a liquid affected if the surface area of the liquid is increased at a given temperature ?

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51. Compare the viscoaity coefficient of the following liquids at a particular temperature: Propanol $(CH_3CH_2CH_2OH)$, ethylene glycol

$(HOCH_2 - CH_2OH)$ and glycerol $(HOCH_2 - CHOH - CH_2OH)$.

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Solved Wbchse Scanner

1. Determine the value of gas constant R in SI unit.

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2. Define critical temperature and critical pressure of a gas.

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3. Oxygen gas is present in a 1L flask at a pressure $7.6 \times 10^{-10} mmHg$ at $0°C$. Calculate the number of O_2 molecules in the flask.

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4. (i) Sketch P/T versus T plot for an ideal gas at constant volume. Indicate the value of the slope (mass fixed).

(ii) Under the same conditions of temperature and pressure NH_3, Cl_2 and CO_2 gases are allowed to diffuse through a porour wall. arrange these gases in the increasing order of the rate of diffusion.

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5. The value of 'R' in $J \cdot K^{-1} \cdot mol^{-1}$ unit is____.

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6. Indicate the correct answer: rate of diffusion of helium gas at constant temperature and pressure will be four times of the rate of diffusion of which of the following gases-

A. CO_2

B. SO_2

C. NO_2

D. O_2

Answer:

7. A 2L flask contains 0.4 g O_2 and 0.6 g H_2 at $100°C$. Calculate the total pressure of the gas mixture in the flask.

8. (i) The equation of state of a real gas is P(V-b)=RT. Can the gas be liquified? Explain.

(ii) Sketch log P vs log V graph for a given mass of an ideal gas at constant temperature and indicate the slope.

9. For a fixed mass of an ideal gas draw the following graphs:

(i) P/T vs T (volume remaining constant)

(ii) d (density) vs P (temperature remaining constant)

10. (i) State Dalton's law of patial pressure.

(ii) What is compressibility factor of a gas?

11. (i) Write down van der waals equation for 1 mol of a gas and hence deduce the equation for the same for n mol of the gas.

(ii) Arrange CO_2, SO_2 and NO_2 gases in increasing order of their rates of diffusion iunder the same condition of temperature and pressure wil reason.

12. (i) Any real gas behaves ideally at very low pressure and high temperature explain.

(ii) The value of van der waals constant 'a' for N_2 and NH_3 are 1.37 and 4.30 $L^2 \cdot atm \cdot mol^{-2}$ respectively explain the difference in values.

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13. For a definite mass of an ideal gas at constant pressure, V versus $\dfrac{1}{P}$ plot is a-

A. parabola

B. straight line

C. hyperbola

D. rectangular hyperbola

Answer:

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14. A gas of molar mass 84.5g/mol is enclosed in a flask at $27° C$ has a pressure of 2 atm. Calculate the density of the gas. [R=0.082 $\cdot atm \cdot K^{-1} \cdot mol^{-1}$]

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15. Which gas among the following exhibit maximum critical temperature-

A. N_2

B. O_2

C. CO_2

D. H_2

Answer:

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16. (i) Explain the nature of the graphs of logP versus log V and logV versus logT.

(ii) What are the units of the van der waals constant 'a' and 'b' ?

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17. Surface tension of water with increase of temperature may-

A. increase

B. decrease

C. remain same

D. shows irregular behaviour

Answer:

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18. (i) For which property of the liquid the shape of a liquid drop is spherical?

(ii) In a 10 volumetric flask contains 1 g He and 6.4 g of O_2 at $27°C$ temperature. If the total pressure of the mixture is 1.107 atm, then what is the partial pressure of He and O_2?

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19. Which of the following is the unit of van der waals gas constant b-

A. $L^{-2} \cdot mol$

B. $L \cdot mol^{-2}$

C. $L \cdot mol$

D. $L \cdot mol^{-1}$

Answer:

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20. (i) Write down the van der waals gas equation.

(ii) What will be the ratio of diffusion of $^{235}UF_6$ and $^{238}UF_6$?

21. The cause of spherical drop of water is-

A. viscosity

B. surface tension

C. hydrogen bond

D. high critical temperature of H_2O vapour.

Answer:

22. State Gay Lussac's lw related to pressure annd temperature of a gas.

3.2g of sulphur when vaporised, the sulphur vapour occupies a volume of

280.2 mL at STP. Determine the molecular formula of sulphur vapour under this condition. (S=32).

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23. Determine the value of 2.2 g of carbon dioxide at $27°C$ and 570 mm Hg pressure.

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Solved Ncert Exercise

1. Find out the minimum pressure required to compress 500 dm^3 of aiir at 1 bar to 200 dm^3 at $30°C.$

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2. A vessel of 120 mL capacity contains a certain amount of gas at $35°C$ and 1.2 bar pressure. The gas is transferred to another vessel of volume 180 mL at $35°C$. What would be its pressure ?

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3. Usingg the equation of state PV=nRT, show that at a given temperature, density of a gas is proportional to the gas pressure P.

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4. At $0°C$, the density of a certain oxide of a gas at 2 bar is same as that of dinitrogen at 5 bar. What is the molecular mass of the oxide?

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5. Pressure of 1g of ann ideal gas A at $27°C$ is found to be 2 bar. When 2 g of another ideal gas B is introduced in the same flask at same temperature, the pressure becomes 3 bar. Find a relationship between their molecular masses.

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6. The drain cleaner, Drainex contains small bits of aluminium which react with caustic soda to produce dihydrogen. What volume of dihydrogen at $20°C$ and 1 bar will be released when 0.15 g aluminium reacts?

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7. What will be the pressure exerted by a mixture of 3.2g of methane and 4.4 g of carbon dioxide contained in a $9dm^3$ flask at $27°C$?

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8. What will be the pressure of the gasesous mixture when 0.5L of H_2 at 0.8 bar and 2.0L of dioxygen at 0.7 bar are introduced in a 1L vessel at $27°C$?

9. Density of a gas is found to be $5.46g/dm^3$ at $27°C$ and 2 bar presure. What will be its density at STP?

10. 34.05 mL of phosphorus vapour weighs 0.0625g at 546^(@)C` and 0.1 bar pressure. What is the molar mass of phosphorus?

11. A student forgot to add the reaction mixture to the round bottomed flask at $27°C$ but put it on the flame.After a lapse of time, he realized his

mistake. Using a pyrometer he found the temperature of the flask was $477°C$ fraction of air would have been expelled ?

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12. Calculate the temperature of 4.0 mol of gas occupying 5 dm^3 at 3.32 bar. (R=0.083 bar $\cdot$ $dm^3 \cdot K^{-1} \cdot mol^{-1}$)

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13. Calculate the total number of electrons present in 1.4 g of dinitrogen gas.

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14. How much time would it take to distribute one avogadro number of wheat grains if 10^{10} grains are distributed each second?

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15. Calculate the total pressure in a mixture of 8 g of dioxygen and 4 g of dihydrogen confined in a vessel of 1 dm^3 at $27°C$, R=0.083 bar $\cdot dm^3 \cdot K^{-1} \cdot mol^{-1}$.

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16. Pay load is defined as the difference between the mass of displaced aiir and the mass of the balloon. Calculate the pay load when a balloon of radius 10m, mass 100 kg is filled with helium at 1.66 bar at $27°C$. (R=0.083 bar $\cdot dm^3 \cdot K^{-1} \cdot mol^{-1}$ and density of air $= 1.2kg \cdot m^{-3}$)

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17. Calculate the volume occupied by 8.8 g of CO_2 at $31.1°C$ & 1 bar pressure. R=0.083 bar $\cdot L \cdot K^{-1}mol^{-1}$.

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18. 2.9 g of a gas at $95°C$ occupied the samme volume as 0.184 g of dhydrogen at $17°C$, at the same pressure, what is the molar mass of the gas?

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19. A mixture of dihydrogen and dioxygenn at oone bar pressure contains 20% by weight of dihydrogen. Calculate the partial pressure of dihydrogen.

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20. What would be the SI unit for the quantity $\dfrac{PV^2T^2}{n}$?

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21. In terms of Charle's law explain why $-273°C$ is the lowest possible temperature.

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22. Critical temperature for carbon dioxide and methane are $31.1°C$ and $-81.9°C$ respectively. Which of these has stronger intermolecular forces and why?

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23. Explain the physical significance of van der waals parameters.

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Higher Order Thinking Skill Hots Questions

1. $c_{rms} = \sqrt{\dfrac{3RT}{M}} = \sqrt{\dfrac{3PV}{M}}$. According to this equation, with the increase in pressure or volume, the value of c_{rms} will increase. Justify this statement.

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2. The volume, number of molecules and average kinetic energies of two ideal gases A and B are the same. What is the relationship between the pressures of these two gases?

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3. At constant pressure, the value of V/T for different quantities of an ideal gas will be different. Is this statement true or false?

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4. Two ideal gases A and B are mixed together at temperature T and pressure P. show that $d = (X_A M_A + X_B M_B)\dfrac{P}{RT}$, [d=density of the mixture, X_A=mole fraction of A, X_B=mole fraction of B, M_A = Molar mass of A, M_B=Molar mass of B].

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5. A closed container holds a mixture of H_2, SO_2 and CH_4 gases, each with an amount off 0.5 mol. If these gases effuse through a fine orifice in the container, arrange them in the increasing order of their partial pressure once the effusion begins.

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6. "The total kinetic energy of the molecules in an ideal gas with a volume V at pressure P and temperature T is equal to the total kinetic energy of the molecules present in the same volume of another ideal gas at the same pressure and at temperature 2T"-Justify the statement.

7. Prove that at a certain pressure, the rate of diffusion of a gas is proportional to the square root of the absolute temperature of the gas.

8. The value of compressibility factor (Z) for a gas at STP is less than 1. what is the molar volume of this gas at STP?

9. ltBrgt At $0°C$, plots of PV vs P for three real gases A, B and C are given below,

(1) Which gas is present above its Boyle temperature?

(2) Which gas can be liquefied more easily?

10. At constant temperature and pressure, the compressbility factor (Z) for one mole of a van der waals gas is 0.5. if the volumes of the gas molecules are considered to negligible, then show that $a = \dfrac{1}{2}V_m RT$, where V_m and T are the molar volume and temperature of the gas respectively.

11. Rubber balloon filled with H_2 gas gets deflated after some time- explain why?

12. At a given temperature and pressure, the volume fraction of an ideal gas is equal to its mole fraction in a mixture of ideal gases- it is true or false?

13. For a real gas which obeys van der waals equation, a graph is obtained by plotting the values of PV_m along the y-axis and the values of P along the x-axis. What is the value of intercept on the y-axis of the graph?

14. A 15.0 L vessel containing 5.6g of N_2 is connected to a 5.0 L vessel containing 8.0g of O_2 by means of a valve. After the valve is opened and the gases are allowed to mix, what will be the partial pressure of each gas in the mixture at $27°C$?

15. The molecular speeds of gas molecules are analogous to the speeds of rifle bullets. Why is then odour of a gas not detected so fast?

16. Why is the quantity of air required to inflate the tyre of a car in summer less than that required in winter?

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17. Two flasks of equal volume are connected by a narrow tube of negligible volume and are filled with N_2 gas. When both the flasks are immersed in boiling water the gas pressure inside the system is 0.5 atm. Calculate the pressure of the system when one of the flasks is immersed in ice water while the other flask in boiling water.

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18. Assuming the same pressure in each case, calculate the mass of hydrogen required to inflate a balloon to a certain volume at $100°C$ if 3.5 g He is required to inflate the balloon to half the volume at $25°C$.

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19.

The given figure indicates the plot of vapour pressure vs. temperature for the three liquids, A, B, & C, arrange them in the increasing order of their intermolecular forces of attraction and normal boilinng points.

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20. Water spreads on a glass surface but it forms beads on a glass surface polished by paraffin-why?

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Entrance Question Bank

1. Equal weight of CH_4 and H_2 are mixed in an empty container at $25°C$. The fraction of the total pressure exerted by H_2 is-

A. $\dfrac{1}{9}$

B. $\dfrac{1}{2}$

C. $\dfrac{8}{9}$

D. $\dfrac{16}{17}$

Answer: C

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2. A van der waals gas may behave ideally when-

A. volume is very low

B. temperature is very high

C. the pressure is very low

D. the temperature, pressure and volume all are very high.

Answer: B::C

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3. Two gases X (mol wt. M_X) and Y (mo. At. M_Y, $M_Y > M_X$) are at the same temperature, T in two different containers. Their root mean square velocities are C_X and C_Y respectively. If average kinetic energies per molecule of two gases X and Y are E_X and E_Y respectively, then which of the following relation(s) is (are) true-

A. $E_X > E_Y$

B. $C_X > C_Y$

C. $E_X = E_Y = \dfrac{3}{2}RT$

D. $E_X = E_Y = \dfrac{3}{2}k_BT$

Answer: B::D

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4. The compresibility factor (Z) of one mole of a van der waals gas of negligible 'a' value is-

A. 1

B. $\dfrac{bP}{RT}$

C. $1 + \dfrac{bP}{RT}$

D. $1 - \dfrac{bP}{RT}$

Answer: C

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5. For one mole of an ideal gas the slope of V vs. T curve at constant pressure of 2 atm is $XL \cdot mol^{-1} \cdot K^{-1}$. The value of the ideal universal gas constant 'R' in terms of X is-

A. $XL \cdot atm \cdot mol^{-1} \cdot K^{-1}$

B. $\dfrac{X}{2}L \cdot atm \cdot mol^{-1} \cdot K^{-1}$

C. $2XL \cdot atm \cdot mol^{-1} \cdot K^{-1}$

D. $2Xatm \cdot L^{-1} \cdot mol^{-1} \cdot K^{-1}$

Answer: C

6. At a certain temperature the time required for the complete diffusion of 200 mL of H_2 gas is 30 minute. The time required for the complete diffusion of 50 mL of O_2 gas at the same temperature will be-

   A. 60 mins

   B. 30 mins

   C. 45 mins

   D. 15 mins

Answer: B

7. Four gases P, Q, R and S have almost same values of 'b' but their 'a' values (a,b are van der waals constants) are in the order $Q < R < S < P$. At a particular temperature, among the four gases the most easily liquefiable one is-

A. P

B. Q

C. R

D. S

Answer: A

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8. Units of surface tension and viscosity are-

A. $kg \cdot m^{-1} \cdot s^{-1}, N \cdot m^{-1}$

B. $kg \cdot s^{-2}, kg \cdot m^{-1} \cdot s^{-1}$

C. $N \cdot m^{-1}, kg \cdot m^{-1} \cdot s^{-2}$

D. $kg \cdot s^{-1}, kg \cdot m^{-2} \cdot s^{-1}$

Answer: B

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9. A gas can be liquefied at temperature T and pressure P if-

A. $T = T_c, P < P_c$

B. $T < T_c, P > P_c$

C. $T > T_c, P > P_c$

D. $T > T_c, P < P_c$

Answer: B

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10. The rms velocity of CO gas molecules at $27°C$ is approximately 1000 m/s. for N_2 molecules at 600 K the rms velocity approximately-

A. 2000 m/s

B. 1414 m/s

C. 1000 m/s

D. 1500 m/s

Answer: B

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11. Among the following which would have the highest rms speed at the same temperature-

A. SO_2

B. CO_2

C. O_2

D. H_2

Answer: D

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12. Which of the following has the dimension of ML^0T^{-2} -

A. coefficient of viscosity

B. surface tension

C. vapour pressure

D. kinetic energy

Answer: B

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13. 🖼 ltBrgt For same mass of two different ideal gases of molecular weights M_1 and M_2, plots of log V vs logP at a given constant temperature are shown. Identify the correct option-

A. $M_1 > M_2$

B. $M_1 = M_2$

C. $M_1 < M_2$

D. can be predicted only if temperature is known

Answer: A

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14. Equal weights of ethane and hydrogen are mixed in an empty container at $25°C$. The fraction of total pressure exerted by hydrogen is-

A. $1:2$

B. $1:1$

C. 1 : 16

D. 15 : 16

Answer: D

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15. Compressibility factor for a real gas at high pressure-

A. 1

B. $1 + \dfrac{Pb}{RT}$

C. $1 - \dfrac{Pb}{RT}$

D. $1 + \dfrac{RT}{Pb}$

Answer: B

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16. a' and 'b' are van der waals constant for gases. Chlorine is more easily liquefied than ethane because-

    A. a and b for $Cl_2 < a$ and b for C_2H_6

    B. a for $Cl_2 < a$ for C_2H_6 but b for $Cl_2 > b$ for C_2H_6

    C. a for $Cl_2 > a$ for C_2H_6 but b for $Cl_2 < b$ for C_2H_6

    D. a and b for $Cl_2 > a$ and b for C_2H_6

Answer: C

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17. For gaseous state, if most probable speed is denoted by c, average speed by $\bar{c}$ and mean square speed by c, then for a large number of molecules the ratios of these speeds are-

    A. $c^* : \bar{c} : c = 1.225 : 1.128 : 1$

    B. $c^* : \bar{c} : c = 1.128 : 1.225 : 1$

C. $c^* : \bar{c} : c = 1 : 1.128 : 1.225$

D. $c^* : \bar{c} : c = 1 : 1.225 : 1.128$

Answer: D

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18. if Z is a compressibility factor, van der waals equation at low pressures can be written as

A. $Z = 1 + \dfrac{Pb}{RT}$

B. $Z = 1 + \dfrac{RT}{Pb}$

C. $Z = 1 - \dfrac{a}{RTV}$

D. $Z = 1 - \dfrac{Pb}{RT}$

Answer: C

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19. Ratio of masses of oxygen & nitrogen in a gaseous mixture is 1:4 ratio of number of their molecules is-

A. $3 : 16$

B. $1 : 4$

C. $7 : 32$

D. $1 : 8$

Answer: C

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20. Intermolecular interaction that is dependent on the inverse cube of distance between the molecule is-

A. London force

B. hydrogen bond

C. ion-ion interaction

D. ion-dipole interaction

Answer: A::C::D

21. 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-

A. $p_i \left(\dfrac{T_1 T_2}{T_1 + T_2} \right)$

B. $2p_i \left(\dfrac{T_1}{T_1 + T_2} \right)$

C. $2p_i \left(\dfrac{T_2}{T_1 + T_2} \right)$

D. $2p_i \left(\dfrac{T_1 T_2}{T_1 + T_2} \right)$

Answer: C

22. A gas mixture was prepared by taking equal mole of CO and N_2. If total pressure of the mixture was 1 atm, the partial pressure of N_2 in the mixture is-

    A. 0.5 atm

    B. 0.8 atm

    C. 0.9 atm

    D. 1 atm

Answer: A

23. Two gases A and B having the same volume diffuse through a porous partition in 20 and 10 s respectively. The molecular mass of A is 49 u. Molecular mass of B will be

A. 50.00 u

B. 12.25 u

C. 6.50 u

D. 25.00 u

Answer: B

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24. By what factor does average velocity of a gas molecule increase when temperature (in K) is doubled-

A. 2

B. 2.8

C. 4

D. 1.4

Answer: D

25. 50 mL of each gas A and B takes 150s and 200s respectively for effusing through a pinhole under similar conditions. If molar mass of gas B is 36, molar rmass of gas A-

A. 20.25

B. 64

C. 96

D. 128

Answer: A

26. Set-I: O_2, CO_2, H_2 and He, Set-II: CH_4, O_2 and H_2. The gases in set-I in increasing order of 'b' and gases given in set-II in decreasing order

of 'a', are arranged below, where 'a' and 'b' are van der waals constants.

Selection the correct order from the following-

A. (I) $O_2 < He < H_2 < CO_2$ (II)$H_2 > O_2 > CH_4$

B. (I) $H_2 < He < O_2$ (II)$CH_4 > O_2 > H_2$

C. (I) $H_2 < O_2 < HE < CO_2$ (II)$O_2 > CH_4 > H_2$

D. (I) $He < H_2 < CO_2 < O_2$ (II)$CH_4 > H_2 > O_2$

Answer: B

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27. A certain gas takes three times as long to effuse out as helium. Its molecular mass will be-

A. 36u

B. 64u

C. 9u

D. 27u

Answer: A

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28. Maximum deviation from ideal gas is expected in case of-

A. $CH_4(g)$

B. $NH_3(g)$

C. $H_2(g)$

D. $N_2(g)$

Answer: B

29. Equal masses of H_2, O_2 and methane have been taken in a container of volume V at temperature $27°C$ in idential conditions. The ratio of the volumes of gases $H_2 : O_2 :$ methane would be-

    A. $8 : 16 : 1$

    B. $16 : 8 : 1$

    C. $16 : 1 : 2$

    D. $8 : 1 : 2$

Answer: C

30. A gas such as carbon monoxide would be most likely to obey the ideal gas law at-

    A. high temperature and low pressures

    B. low temperatures and high pressures

C. high temperatures and high pressures

D. low temperatures and low pressures

Answer: A

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31. Equal moles of hydrogen and oxygen gases are placed in a container with a pin-hole through which both can escape. What fraction of the oxygen escapes in the time required for one-half of the hydrogen to escape-

A. $\dfrac{1}{2}$

B. $\dfrac{1}{8}$

C. $\dfrac{1}{4}$

D. $\dfrac{3}{8}$

Answer: B

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32. The correction factor 'a' to be the ideal gas equation corresponds to-

A. forces of attraction between the gas molecules

B. density of the gas molecules

C. electric field present between the gas molecules

D. volume of the gas molecules.

Answer: A

33. Given van der waals constant 'a' of NH_3, H_2, O_2 and CO_2 are respectively 4.17, 0.244, 1.36 and 3.59. which one of the following gases is most easily liquefied-

A. NH_3

B. H_2

C. O_2

D. CO_2

Answer: A

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34. In the van der waals equation, 'a' signifies-

A. intermolecular attraction

B. interamolecular attraction

C. attraction between molecules and walls of container

D. volume of molecules

Answer: A

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35. Arrange the following gases in order of their critical temperature: NH_3, H_2O, CO_2, O_2-

A. $NH_3 > H_2O > CO_2 > O_2$

B. $O_2 > CO_2 > H_2O > NH_3$

C. $H_2O > NH_3 > CO_2 > O_2$

D. $CO_2 > O_2 > H_2O > NH_3$

Answer: C

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36. The density of a gas A is thrice that of a gas B at the same temperature. The molecular weight of gas B is twice that of A. what will be the ratio of the pressures acting on B and A-

A. $\dfrac{1}{4}$

B. $\dfrac{7}{8}$

C. $\dfrac{2}{5}$

D. $\dfrac{1}{6}$

Answer: D

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37. In van der waals equation at temperature 300k, if a=1.4 $atm \cdot L^{-2} \cdot mol^{-2}, V = 100mL, n = 1$ mole, then what is the pressure of the gas-

A. 42 atm

B. 210 atm

C. 500 atm

D. 106 atm

Answer: D

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38. When 1 g of gas A at 4 bar pressure is added to 2g of gas B, the total pressure inside the container becomes 6 bar. Which of the following is true-

A. $M_A = 2M_B$

B. $M_B = 2M_A$

C. $M_A = 4M_B$

D. $M_B = 4M_A$

Answer: D

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39. Gas in a cylinder is maintained at 10 atm pressure and 300 K temperature. The cyclinder will explode if pressure of gas geos beyond 15 atm. What is the maximum temperature to which gas can be heated-

A. 400 K

B. 500K

C. 450 K

D. 250 K

Answer: C

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40. Two separate bulbs contain gas A and gas B. the density of gas A is twice as that of B. the molecular mass of A is half as that of B. if temperature is constant, the ratio of the pressure of A and B is-

A. $1:1$

B. $1:2$

C. $4:1$

D. $2:1$

Answer: C

Mcq Hotspot

1. Which of the following does not change during compression of a gas at constant pressure-

A. density of a gas

B. distance between molecules

C. average speed of molecules

D. the number of collisions

Answer: C

2. For which of the following gaseous mixtures, Dalton's law of partial pressure is not applicable-

A. SO_2, He, Ne

B. NH_3, HBr, HCl

C. O_2, N_2, CO_2

D. N_2, H_2, O_2

Answer: B

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3. Volume of a given mass of an ideal gas is VL at $27°C$ and 1 atm pressure. If volume of the gas is reduced by 80% at constant pressure, temperature of the gas will have the be-

A. $-50°C$

B. $-127°C$

C. $-200°C$

D. $-213°C$

Answer: D

4. At STP, density of air is $1.3 \times 10^{-3} g \cdot cm^{-3}$. Vapour density of air is-

A. 1.3

B. 14.6

C. 2.56

D. 10.8

Answer: B

5. At a given temperature, molar concentration of N_2 is greater than that of H_2 in a mixture of N_2 and H_2 gases present in a closed containerr. I

the average kinetic enegies of N_2 and H_2 molecules are xJ and yJ respectively then,-

A. $x > y$

B. $x < y$

C. $x = y$

D. impossible to predict.

Answer: C

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6. The density of gas A is d_A at a temperature of T_AK, and the density of gas B is d_B at a temperature of T_BK. The molar mass of A is 4 times that of B. if $T_A : T_B = 2:1$ and $d_A, d_B = 1:2$, the ratio of pressure of A to B is-

A. $2:1$

B. $1:8$

C. $3:2$

D. $1:4$

7. Two gases A and B have respective van der waals constant $-(1), b_1$ and a_2, b_2. if 'A' is more compressible than 'B' when which of the following conditions has to be satisfied:

A. $a_1 = a_2$ and $b_1 > b_2$

B. $a_1 < a_2$ and $b_1 > b_2$

C. $a_1 < a_2$ and $b_1 = b_2$

D. $a_1 > a_2$ and $b_1 < b_2$

8. The dimension of coefficient of viscosity-

A. MLT

B. $ML^{-1}T^{-1}$

C. MLT^{-1}

D. MLT^{-2}

Answer: B

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9. The densities of water and water vapour are 1.0 $g \cdot cm^{-3}$ and $0.0006g \cdot cm^{-3}$ respectively at $100°C$ and 1 atmm pressure. At this temperature, the total volume occupied by watrer molecules in 1L of water vapour is-

A. 2.24 cc

B. 0.6 cc

C. 0.12 cc

D. 1.72 cc

Answer: B

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10. The most probable velocity of the molecules of gas A (molar mass 16 $g \cdot mol^{-1}$) and that of the molecules of gas B (molr mass 28 $g \cdot mol^{-1}$) are the same. If the absolute temperature of the gases A and B are T(A) and T(B) respectively, then-

A. T(A)=2T(B)

B. T(B)=3T(A)

C. T(B)=1.75T(A)

D. T(B)=2.5T(A)

Answer: C

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11. At a given temperature and pressure, the volume of 1 mol of an ideal gas is 10 L. at the same temperature and pressure, the volume of 1 mol of a real gas is VL. At this temperature and pressure, if the compressibility factor of the real gas is greater than 1, then -

A. V=10L

B. $V < 10L$

C. $V > 10L$

D. $V < 10L$

Answer: C

12. Pressure of a gas increases when its temperature is increased at constant volume. This is because, with increase in temperature -

A. collision frequency of the gas molecules increases.

B. motions of the gas molecules become more random

C. gas molecules make more collision with the walls of the container

D. compresesibility factor of the gas increases.

Answer: C

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13. Under a gives conditions, the rate of diffusion of CH_4 gas is $\sqrt{2}$ times that of B_2 gas. Gas B_2 reacts with element A to form gaseous compounds AB_2 and AB_3. Under a given conditon, the rate of diffusion of AB_2 is 1.12 times that of AB_3. the atomic mass of A (in $g \cdot mol^{-1}$) -

A. 32

B. 16

C. 8

D. 24

Answer: A

---

14. Two flasks are connected by a valve: One of them with volume 5L contains 0.1 mol of H_2 at $27°C$ and the other of volume 2L contains 0.1 mol of N_2 at the same temperature. If the valve is opened keeping temperature constant, then at equilibrium the contribution of H_2 gas to the total pressure of the gas mixture-

    A. is the same as that of N_2 gas

    B. is greater than that of N_2 gas

    C. is less than that of N_2 gas

    D. cannot be predicted

Answer: A

15. A balloon filled with acetylene is pricked by a pin and dropped readily in a tank of H_2 gas under identical conditions. After a while the balloon will-

A. enlarge

B. shrink

C. completely collapse

D. remain unchanged in size

Answer: A

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16. At STP, the density of a gas is $1.25g \cdot L^{-1}$. The molar concentrationn $\left(mol \cdot L^{-2}\right)$ of 0.7 g of this gas at $27°C$ and a pressure of 2 atm is-

A. 0.27

B. 0.08

C. 0.19

D. 0.64

Answer: B

17. There are 100 persons sitting at equal distances in a row XY. Laughing gas (N_2O) is released from the side X and tear gas (mol. Mass=176) from side Y at the same moment and at the same pressure. The person who will have a tendency to laugh and weep simultaneously is-

    A. 34th from side X

    B. 67th from side X

    C. 76th from side X

    D. 67th from side Y

Answer: B

18. Van der waals constant, b of a gas is 4.42 centrilitre $\cdot$ mol^{-1}. How near can centres of 2 molecules approach each other -

    A. 127.2 pm

    B. 427.2 pm

    C. 327.2 pm

    D. 627.2 pm

Answer: C

19. Which of the following liquids has least surface tension-

    A. acetic acid

    B. diethyl ether

C. chlorobenzene

D. benzene

Answer: B

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20. At P atm pressure and TK a sphetical air bubble is rising from the depth of a lake. When it comes to the surface of the lake the percentage increase inn the radius will be (assume pressure and temperature at the surface to be P/4 atmm and 2TK respectively)-

A. 1

B. 0.5

C. 0.4

D. 2

Answer: A

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21. A given mass of a perrfect gas is first heated in a small and then in a large vessel, such that their volumes remain unaltered. The P-T curves are-

A. parabolic with same curvature

B. linear with same slope

C. linear with different slopes

D. parabolic with different curvatures

Answer: C

22. At a given temperature, most of the molecules in a sample of oxygen gas move with a velocity of $4.06 \times 10^4 cm \cdot s^{-1}$. The average velocity of the molecules of the gas at the same temperature is-

A. $1.7 \times 10^4 cm \cdot s^{-1}$

B. $4.6 \times 10^4 cm \cdot s^{-1}$

C. $5.0 \times 10^4 cm \cdot s^{-1}$

D. $8.9 \times 10^3 cm \cdot s^{-1}$

Answer: B

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23. There is a depression in the surface of the liquid inside capillary tube when-

A. the cohesive force is greater than the adhesive force

B. the adhesive force is greater than the cohesive force

C. both adhesive and cohesive forces are equal

D. none of the above is true

Answer: A

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24. One mol of a real gas following the equation, P(V-b)=RT, the a compressibility factor of 1.2 at $0°C$ and 200 atm pressure. The value of 'b' for this gas is-

A. $0.03521\ L \cdot mol^{-1}$

B. $0.0224\ L \cdot mol^{-1}$

C. $0.04610\ L \cdot mol^{-1}$

D. $0.01270\ L \cdot mol^{-1}$

Answer: B

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25. At a given temperature, the root mean square velocity of O_2 molecules is $\sqrt{2}$ times than that of the molecules of a gas. The molar mass of the gas (in $g \cdot mol^{-1}$) is-

A. 8

B. 64

C. 96

D. 16

Answer: B

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26. At a given condition, 20 L of SO_2 gas a takes 60s for its effusion. At the same condition, the value of O_2 gas that will effuse out in 30s is -

A. 12.4 L

B. 10.9 L

C. 14.1 L

D. 6.8 L

Answer: C

27. The average velocity of the molecules of a gas at $T_1 K$ will be the same as the most probable velocity of the molecules of the gas at $T_2 K$ when-

A. $T_1 > T_2$

B. $T_2 > T_1$

C. $T_1 = T_2$

D. $T_1 > T_2$

Answer: B

28. Two ideal gases A and B have molar masses M_A and $M_B g \cdot mol^{-1}$ respectively. Volumes of the same mass of A and B are the same, and the rms velocity of A molecules is twice that of the molecules of B. if $M_A : M_B = 2 : 1$, then the ratio of the pressures of A to B is-

A. 4:1

B. 8:1

C. 2:1

D. 1:6

Answer: A

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29. The uncertainty in the position of an electron moving with a velocity

of $1 x 10^4 ms^{-1}$ (accurate up to 0.011 %) will be

A. $3.7 \times 10^4 cm \cdot s^{-1}$

B. $1.8 \times 10^4 cm \cdot s^{-1}$

C. $6.2 \times 10^3 cm \cdot s^{-1}$

D. $2.8 \times 10^4 cm \cdot s^{-1}$

Answer: D

30. An open vessel has a temperature of TK. When the vessel is heated at $477°C$, three fifths of air in the vessel escapes out. What fraction of air in the vessel would have been expelled out if the vessel were heated at 900 K (assume that volume of the vessel remains unchanged on heating)-

A. $\dfrac{1}{4}$

B. $\dfrac{2}{3}$

C. $\dfrac{1}{2}$

D. $\dfrac{1}{5}$

Answer: B

31. Critical temperature of the gases A, B, C and D are 126 K, 155K, 304 K and 356 K respectively. Among these gases the one with strongest

intermolecules forces of attraction is-

A. A

B. B

C. C

D. D

Answer: D

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32. The volumes of two gases A and B at $0°C$ and 200 atm pressure are

0.112 L and 0.09 L respectively. Which of the following comments is true

for these gases at this temperature and pressure-

A. compressibility of gases A and B are the same

B. compressibility of A is less than that of B

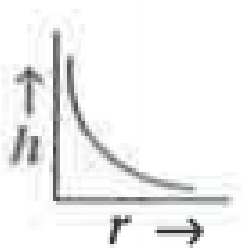C. compressibility of A is more than that of B

D. both gases show positive deviation from ideality

Answer: C

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33. Which of the following correctly represents the relation between capillary rise (h) and radius of capillary (r)-
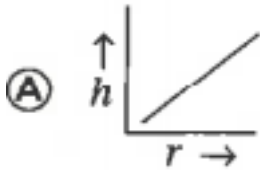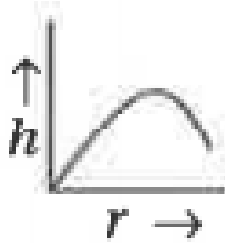

A.

B.
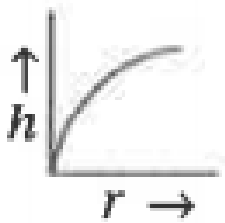
C.

D.

Answer: B

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34. For CO_2 gas the P vs V isotherms at temperature above $31.1°C$ are-
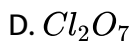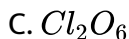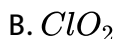
A. straight line

B. rectangular hyperbolic

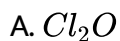C. eliptical

D. hyperbolic

Answer: B

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35. At a certain temperature, 1 mol of chlorine gas at 1.2 atm takes 40 sec to diffuse while 1 mol of its oxide at 2 atm takes 26.5 sec. the oxide is-

A. Cl_2O

B. ClO_2

C. Cl_2O_6

D. Cl_2O_7

Answer: A

---

36. At 10 bar pressure a 4:1 mixture of He and CH_4 is contained in a vessel. The gas mixture leaks out through a hole present in the vessel.

The mixture effusing out has an initial composition of -

A. $1:1$

B. $2:1$

C. $4:1$

D. $8:1$

Answer: D

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37. A gas mixture consisting of 1 mol of N_2 and 3 mol of O_2 has a pressure of 2 atmm at $0°C$. Keeping the volume and the temperature of the mixture constant, some amount of O_2 was removed from the mixture. As a result, the total pressure of the mixture and the partial pressure of N_2 in the mixture became 1.5 atm and 0.5 atm respectively. the amount of oxygen gas removed was-

A. 8 g

B. 16 g

C. 32 g

D. 64 g

Answer: C

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38. The quantity $\dfrac{PV}{kT}$ represents -

A. mass of a gas

B. translation energy of a gas

C. number of moles of a gas

D. number of molecules in a gas

Answer: D

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39. At STP, O_2 gas present in a flask was replaced by SO_2 under similar conditions. The mass of SO_2 present in the flask will be-

A. twice that of O_2

B. half that of O_2

C. equal to that of O_2

D. one-third of O_2

Answer: A

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40. The relative densities of oxygen annd carbon dioxide are 16 and 22 respectively. If $37.5cm^3$ of oxygen effuses out in 96s, what volume of carbon dioxide will effuse out in 75s under similar conditions-

A. $25cm^3$

B. $37.5cm^3$

C. $14cm^3$

D. $30.8cm^3$

Answer: A

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Mcq Hotspot More Than One Correct Type

1. At $27°C$, average translational kinetic energies of the molecules in 8g of CH_4, 8g of O_2 and 8g of He are $\overline{\in_1}$, $\overline{\in_2}$ and $\overline{\in_3}$ respectively and total kinetic energies of the molecules in these gases are E_1, E_2 and E_3 respectively. which of the following is true-

A. $\overline{\in_1} = \overline{\in_2} = \overline{\in_3}$

B. $\overline{\in_3} > \overline{\in_2} > \overline{\in_1}$

C. $E_1 = E_2 = E_3$

D. $E_2 < E_1 < E_3$

Answer: A

---

2. Number of molecules of an ideal gas present in a flask of volume 2 L are 10^{23}. The mass of each gas molecule is $6.64 \times 10^{-23} g$ and the root mean square velocity of the molecules is $4.33 \times 10^4 cm \cdot s^{-1}$. Hence-

A. pressure of the gas is 3.27 atm

B. average kinetic energy of each molecule is $6.63 \times 10^{-14} J$

C. total kinetic energy of the molecules is $6.23 \times 10^9 J$

D. total kinetic energy of the molecules is $1.492 \times 10^5 J$

Answer: B::C

3. In which conditions does the most probable velocity of O_2 molecules have maximum value and in which conditions does it have minimum value-

A. $O_2 : P = 1atm, d(density) = 0.0081g \cdot mL^{-1}$

B. $O_2 : P = 4atm, V = 2L$ and $w(mass) = 4g$

C. $O_2 : T = 300K$

D. $O_2 : STP$

Answer: A::B

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4. Time required to effuse V mL of H_2 gas through a porous wall at a constant temperature and pressure is 20 min. under the same conditions time required to effuse V mL of the following gases is-

A. He:28.28 min

B. CO_2 : 90.82min

C. CH_4 : 60.52 min

D. N_2 : 74.83 min

Answer: A::D

5. At a particular temperature and pressure, if the number of moles of an ideal gas is increased by 50% then-

A. final volume of the gas will be 1.5 times of its iniital volume

B. most probable velocity of gas molecules becomes 1.5 times of its

   initial value

C. total kinetic energy of the gas molecules becomes 1.5 times of its

   initial value

D. density of gas becomes 1.5 times of its initial value.

Answer: A::C

---

6. The pressure and temperature of a gas are P and T respectively. If the critcal pressure and critical temperature of the gas be P_c and T_c respectively, then liquefacction will be possible when-

A. $P < P_c, T < T_c$

B. $P = P_c, T = T_c$

C. $P = P_c, T > T_c$

D. $P > P_c, T = T_c$

Answer: B::D

7. If the orders of the values of van der waals constants a and b for three gases X, Y and Z are $X < Y < Z$ and $Z < Y < X$ respectively, then-

    A. Liquefaction will be easier for gas X than gases Y and Z.

    B. the size of the molecule, Y will be in between the sizes of the molecules X and Z

    C. the order of the critical temperature of these three gases is: $X < Y < Z$

    D. the gas Z, at $0°C$ and 1 atm will behave most ideally.

Answer: B::C

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8. Identify the correct statement-

    A. at a particular temperature, the vapour pressure of dimethyl ether is greater than water because the molar mass of dimentyl ether is

higher than that of water.

B. the vapour pressure of a liquid remains same when surface area of

the liquid is increased at a given temperature.

C. correct order of viscosity coefficient is: water $<$ ethylene glycol $<$

glycerol.

D. surface tension of water at $30°C$ is greater than that at $20°C$.

Answer: B::C

▶ **View Text Solution**

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9. $P(V - b) = RT$ equation of state is obeyed by a particular gas. Which

of the given statements are correct-

A. for this gas, the isochoric curves have slope $= \dfrac{R}{V - b}$

B. the compressibility factor of the gas is less than unity

C. for this gas, the isobaric curves have slope=R/P

D. in this gas the attraction forces are overcome by repulsive forces.

Answer: A::C::D

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10. Four gas balloons P, Qlt R and S of equal volumes containing H_2, N_2O, CO, CO_2 respectively were pricked with needle and immersed in a tank containing CO_2. Which of them will shring after sometime-

A. P

B. Q

C. R

D. S

Answer: A::C

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11. A liquid is in equilibrium with its vapour at its boiling point. On average, the molecules in the two phases have -

A. equal total energy and potential energy

B. equal kinetic energy

C. different total energy and potential energy

D. different kinetic energy.

Answer: B::C

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12. The room mean square velocity of an ideal gas in a closed vessel of fixed volume is increased from $5 \times 10^4 cm \cdot s^{-1}$ to $10 \times 10^4 cm \cdot s^{-1}$. Which of the following statements correctly explain how the change is accomplished-

A. by heating the gas, the temperature is quadrupled.

B. By heating the gas, the temperature is doubled

C. by heating the gas, the pressure is quadrupled

D. by heating the gas, the pressure is doubled.

Answer: A::C

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13. Which of the following pairs of gases have same type of intermolecular force of attraction-

A. CH_4, Cl_2

B. SO_2, CO_2

C. $HCl, CHCl_3$

D. N_2, NH_3

Answer: A::C

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14. Select the correct orders-

A. critical temperature $<$ Boyle's temperature $<$ inversion temperature

B. van der waals constant 'a': $H_2O > NH_3 > N_2 > Ne$

C. van der waals constant 'b': $CH_4 > O_2 > H_2$

D. mean free path: $He > H_2 > O_2 > N_2 > CO_2$

Answer: A::B::C::D

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15. Which are responsible for liquefaction of H_2-

A. Coulombic forces

B. London forces

C. Hydrogen bonding

D. van der waals forces

Answer: B::D

---

16. Which of the following gases will have the same rate of effusion under

identical conditions-

A. CO

B. N_2O

C. C_2H_4

D. CO_2

Answer: B::D; A:C

---

17. Select the correct statement-

A. presence of impurities invariable increses the viscosity of a liquid.

B. in presence of impurities the viscosity of a liquid remains unaltered

C. viscosity coefficient of associated liquids are larger than those of non-associated liquids.

D. viscosity coefficients of non-associated liquids are larger than those of associated liquids.

Answer: A::C

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18. Select the correct statement-

A. surface energy of a liquid $= \dfrac{\text{force} \times \text{distance}}{\text{area}}$

B. Surface energy can be represented as: force/area

C. addition of NaCl increases and addition of acetone decreases the surface tension of water.

D. addition of NaCl decreases and addition of acetone increases the

surface tension of water.

Answer: A::C

19. Precisely 1 mol of He and 1 mol of Ne are placed in a container. Select

correct statements about the system-

A. molecules of He strike the wall more frequently

B. molecules of He have greater average molecular speed

C. molecule of the two gases strike the wall of the container with

same frequency

D. He exists larger pressure

Answer: A::B

20. Which of the following are correct for different gases under the same condition of pressure and temperature-

    A. hydrogen diffuses 6 times faster than oxygen

    B. hydrogen diffuses 2.83 times faster than methane

    C. helium escapes at a rate 2 times as fast as sulphur dioxide does

    D. helium escapes at a rate 2 times as fast as methane does

Answer: B::D

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Exercise Very Short Type Questions

1. What is torr? How many torr are equal to 1 atm?

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2. Why is the pressure of a given amount of gas increased when the temperature of the gas is raised at constant volume?

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3. What are the parameters in the equation, PV=nRT, taken to be constant, when we explain Avogadro's law from this equation?

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4. The pressure of a certain amount of gas is 1 atm. At what temperature will be concentration of this gas be $1 \, mol \cdot L^{-1}$?

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5. What is the value of Boltzmann constant in the unit of calorie?

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6. What types of intermolecular forces of attraction are there in N_2 and HCl gases?

7. How is the rate of effusion of a gas at a given temperature related to its pressure and molar mass?

8. Why is the PV vs P plot for an ideal gas at a given temperature parallel to P axis?

9. What is the slope of the plot of log P vs log V for a given amount of an ideal gas at a givem temperature?

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10. Give an application of effusion.

> ▶ Watch Video Solution

11. Expansibility of a gas is much greater than that of a liquid or solid why?

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12. Which one is used to calculate the average kinetic energy of gas molecules, average speed or root mean square speed?

> ▶ Watch Video Solution

13. Of the gases CO_2 and SO_2, whose molecules possess greater most probable velocity at a given temperature?

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14. Give the expression of kinetic gas equation for n mol of ideal gas.

▶ Watch Video Solution

15. What is the valuue of the compressibility factor of an ideal gas?

▶ Watch Video Solution

16. Write the units of van der waals constants 'a' and 'b'.

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17. Give definition: (i) critical pressure (ii) critical volume of a gas.

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18. Why liquid has no definite shape?

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19. What is the vapour presure of a liquid?

Watch Video Solution

20. What do you mean by the normal boiling point of a liquid?

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21. What do you mean by the surface tension of a liquid?

22. The surface tension of mercury is much greater than water why?

23. What is capillary action?

24. What do you mean by the viscosity coefficient of a liquid?

Exercise Fill In The Blanks

1. 0.1 ATM=_____Pa=_____torr.

2. The plot of pressure (P) versus temperature (T) for an ideal gas will be a straight line passing through the origin if _____and _____remain constant.

3. At a given temperature and pressure, the density of CO_2 gas is greater than N_2 gas, because the ____of CO_2 is greater than N_2

4. The density of CO_2 at ____temperature and standard atmospheric pressure is 1.788 $g \cdot L^{-1}$.

5. The velocity of the gas molecules having average kinetic energy is called_____.

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6. At a particular temperature, the average kinetic energies of SO_2 molecule and H_2 molecule are_____.

> ▶ Watch Video Solution

7. The most probable velocity of He atoms at $127°C$ is _____.

> ▶ Watch Video Solution

8. The value of 1 mole of a gas at STP is smaller than 22.4 L. the compressibility factor of that gas at STP is ____ one.

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9. In van der waals equation, _____is a measure of the effective size of the gas molecules.

10. At a low pressure and at a particular temperature, the pressure of 1 mol of an ideal gas is____ that of 1 mol real gas.

11. Due to the _____ property, freely fallling liquid drop becomes spherical.

12. The aqueous solution of soaps cann spread like a thin film because the surface tension of aqueous solution of soap is ___ than water.

13. At a particular temperature, the viscosity coefficient of ethyl alcohol is ____ than dimethyl ether.

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1. According to Charles' law, at constant pressure volume of a given mass of gas at $-273°C$ is zero. How far is this statement true?

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2. At two different temperature T_1 and $T_2, (T_2 > T_1)$, draw two PV-P graphs for a definite amount of an ideal gas.

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3. There are three tyres, one of which is filled with H_2 gas, the second one with air and the third one with N_2 gas. In what sequence are these tyres to be refilled with their respective gases?

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4. Explain why dalton's law of partial pressures is not applicable to a mixture of NH_3 and HCl gases.

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5. How is molar weight of a gas calculated using ideal gas equation?

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6. Using Boyle's law, show how the density of a gas changes with pressure at constant temperature.

▶ Watch Video Solution

7. Establish the relationship between the density (d) and absolute temperature (T) of an ideal gas at constant pressure.

▶ Watch Video Solution

8. What do you mean by diffusion of gases ? State Graham's law of diffusion. Give an example of its practical application.

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9. Prove that the rate of diffusion of a gas is inversely proportional to the square root of its density.

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10. Give the value of universal gas constant (R) in SI unit. Draw the graphs (i) P vs V PV vs P for a gas obeying Boyle's law.

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11. for a given mass of an ideal gas at constant temperature draw and explain the graphs (i) PV^2 vs V (ii) P^2V vs V.

> ▶ Watch Video Solution

12. Which increases with rise in temperature. (ii) $c_{rms}/\bar{c}$

(ii) $c_{rms} - \bar{c}$?

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13. The quantity of air necessary to inflate the tyre of motor car in the summer is less than that required in the winter why?

14. We know, $c_{rms} = \sqrt{\dfrac{3P}{d}}$, so the value of c_{rms} increases with increase in temperature. Is this statement correct?

15. Write the kinetic gas equation and explain the various terms involved in the equation.

16. Establish Boyle's law with the help of kinetic theory of gases.

17. State Graham's law of diffusion and deduce the relationship between the rate of diffusion and molecular weight.

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18. Deduce Avogadro's hypothesis from kinetic gas equation.

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19. If the pressure is very high, will the value of PV for 1 mole of a real gas be greater or less than RT?

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20. What does the PV vs P curve of a real gas look like above its Boyle temperature?

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21. Write the units of van der waals constants 'a' and 'b',- what are the significances of 'a' and 'b' ?

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22. Using van der waals equation, explain why real gases behave like an ideal gas at very low pressures and high temperature.

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23. Why do liquids diffuse very slowly in comparison to gases?

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24. Why is temperature of a liquid decreased during evaporation?

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25. Rate of evaporation of a liquid increases with rise in temperature-explain.

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26. how can a pressure cooker cook faster?

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27. Boiling of liquid decreaseds with lowering of external pressure-why?

▶ **Watch Video Solution**

28. How the small insects can walk on water without sinking?

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29. Why the surface of water in a glass capillary tube is concave whereas it is convex in case mercury?

30. Why water has a very high surface tension value among the commonly known liquids?

31. Give molecular interpretation of the surface tension of liquid.

Exercise Numberical Problems

1. At $10^{-3}mm$ pressure and 300 K, a 2L flask contains equal numbers of moles of N_2 and water vapour. (i) what is the total number of moles of N_2

and water vapour in the mixture ? (ii) what is the total mass of the mixture?

2. At constant temperature and 1 atm pressure, an ideal gas occupies a volume of $3.25m^3$. Calculate the final presure of the gas in the units of atm, torr and Pa if the its volume is reduced to $1.25m^3$ while its temperature is kept constant.

3. Density of a gas at $27°C$ and 1 atm is $15g \cdot mL^{-1}$. At what temperature, will density of that gas be $10g \cdot mL^{-1}$, at the same pressure?

4. Density of a gas at $30°C$ and 1.3 atm pressure is 0.027 $g \cdot mL^{-1}$. What is the molar mass of the gas?

5. 0.0286g of a gas at $25°C$ and 76 cm presure occupies a volume of $50cm^3$. What is molarr mass of the gas?

6. Density of a gas at $-135°C$ and 50.66 atm pressure is $2g \cdot cm^{-3}$. What is the density of the gas at STP?

7. A gaseous mixture contains $336cm^3$ of H_2 and $224cm^3$ of He at STP. The mixture shows a pressure of 2 atm when it is kept in a container at $27°C$.

Calculate the volume of the gas?

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8. At $100°C$ a 2 litre flask contains 0.4 g of O_2 and 0.6 g of H_2. What is the total pressure of this gas mixture in the flask?

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9. 1.0 g of benzene is burnt completely in presence of 4.0g O_2 in a completely evacuated bomb calorimeter of volume 1L. What is the pressure inside the bomb at $30°C$, if the volume and pressure of water vapour produced are neglected?

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10. A closed vessel of fixed volume is filled with 3.2g O_2 at a pressure of P atm and at a temperature of TK. The container is then heated to a

temperature of (T+30)K. to maintain the pressure of P atm inside the container at (T+30)K, a certain amount of gas is removed from the container. the gas removed is found to have a volume of 246 mL at 1 atm and $27° C$. calculate T.

11. The temperature of an ideal gas is 340 K. the gas is heated to a temperature at constant pressure. As a result, its volume increases by 18%. What is the final temperature of the gas?

12. What is the density of air at STP? Assume that air contains 78% N_2 and $22 \% \ O_2$ by masses.

13. At $100°C$ and 1 atm pressure, the densities of water and water and water vapour are 1.0 $g \cdot mL^{-1}$ and 0.0006 $g \cdot mL^{-1}$ respectively. What is the total volume of water molecules in 1 litre of steam at $100°C$?

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14. The volume of 0.44 g of a colourless oxide of N_2 is 224 mL at $273°C$ and 1530 mm pressure. What is the compound?

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15. A spherical balloon is filled with air at 2 atm pressure. What pressure is to exerted on the balloon from outside so that its diameter will be reduced to half of its initial diameter?

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16. If 3.2 g of sulphur is heated to a temperature, the sulphur vapour produced occupies a volume of 780 mL at 723 mm pressure and $450°C$. What is the molecular formula of sulphur at this state?

17. Determine partial pressures of O_2 and N_2 in air at $0°C$ and 760 mm Hg pressure. Air contains 78% N_2 and 22 % O_2 by volume.

18. 200 cm^3 of N_2 gas is collected over water at $20°C$ and 730 mm pressure. At this temperature, aqueous tension is 14.20 mm. what is the mass of N_2 gas collected?

19. 0.5 g O_2 gas is collected over water at $20°C$ and 730 mm pressure. If aqueous tension at that temperature be 14.20 mm, what is the volume of O_2 gas collected?

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20. A vessel contains equal masses of CH_4 and H_2 gas at $25°C$. What part of the total pressure inside the vessel is equal to the partial pressure of H_2 gas?

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21. 8g O_2 and some quantity of CO_2 are introduced at $30°C$ into an emtpy flask of volume 10L. If the total pressure of the, mixture in the flask be 1520mm. Find the amount of CO_2 gas taken.

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22. Partial pressures of the component gases in a gas-mixture are: $H_2 = 300mm : CH_4 = 150mm : N_2 = 250$ mm. what is the percentage of N_2 gas by volume in the mixture?

23. At constant temperature 2L of N_2 gas at 750 mm Hg pressure I mixed with 3L of O_2 gas. As a result the pressure and volume of the gas mixture are found to be 732 mm Hg and 5 L respectively. What is the initial pressure of O_2 gas?

24. The respective mole fractions of N_2 and O_2 is dry air are 0.78 and 0.21 gt if the atmospheric presure and temperature are 740 torr and $20°C$ respectively, then what will be the mass of N_2 and O_2 present in a room of volume of $3000ft^3$? (Assuming the relative humidity of air as zero)

25. $300 \ cm^3$ of H_2 gas diffusses through a fine orifice in 1 minute. At the same temperature annd pressure, what volume of CO_2 gas will diffuse through the same orifice in 1 minute?

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26. At constant temperature and pressure, the rates of diffusion of two gases A and B are in the ratio of 1:2 . In a mixture of A and B gases if the mass ratio of A and B be 2:1, the find the mole fraction ratio of A and B in the mixture?

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27. Average velocity of the molecules of a gas is $400 m \cdot s^{-1}$. At the same temperature, what will be rms velocity o the molecules?

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28. At a constant temperature and at 1 atm pressure, the density of O_2 gas is 0.0081 $g \cdot moL^{-1}$. At the same temperature, calculate average velocity, root mean square velocity and most probable velocity of O_2 molecules.

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29. A certain gas of mass 6.431 g occupies a volume of 5 L at a definite temperature and 750 mm pressure. At the same temperature, what will be the rms velocity of the molecules of that gas?

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30. What is the ratio of average velocity and root mean square velocity of the molecules of a gas?

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31. At what temperature will the rms velocity of SO_2 molecules be equal to the rms velocity of O_2 molecules at $25°C$?

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32. Show the the rms velocity of O_2 molecules at $50°C$ is not equal to the rms velocity of N_2 molecules at $25°C$.

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33. Average kinetic energy of the atom of Hg vapour is 1000 $cal \cdot mol^{-1}$. What will be the value of its rms velocity?

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34. In a container of volume 1L, there are 10^{23} gas molecules, each of which has a mass of 10^{-22} g. at a certain temperature, if the rms velocity

of these molecules is $10^5 cm \cdot s^{-1}$, then what would be the pressure at the temperature inside the container?

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35. At a constant temperature, a vessel of 1 litre capacity contains $10^{23} N_2$ molecules. If the rms velocity of the molecules be $10^3 m/s$, then determine the total kinetic energy of the molecules and the temperature of the gas.

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36. At $0°C$ the kinetic energy of $1O_2$ molecule is 5.62×10^{-14} erg. Determine avogadro's number.

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37. The volume of 2 moles of SO_2 at $30°C$ and 55 atm pressure is 680 mL. what is the value of compressibility factor of the gas? What is the nature of deviation of the gas from ideal behaviour?

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38. Compressibility factor of a real gas at $0°C$ and 100 atm pressure is 0.927. at this temperature and pressure, how much of this real gas is required to fill a vessel of 100 L [molar mass=$40g \cdot mol^{-1}$] ?

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39. For a van der waals gas, $b = 5.0 \times 10^{-2}L \cdot mol^{-1}$. What is the diameter of a molecule of this gas?

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40. Volume of 2 moles of CO_2 gas at $27°C$ is 0.001 m^3. What will be the pressure of this gas (i) according to van der waals equation and (ii) according to ideal gas equation?

[Given

$a(CO_2) = 0.364 \quad N \cdot m^4 \cdot mol^{-2}$ and $b(CO_2) = 4.27 \times 10^{-5} m^3 \cdot mol^{-}$

]

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41. The equation of state for 1 mole of a gas is P(V-b)=RT.

At STP, 1 mole of this gas occupies a volume of 28L.

Calculate the compressibility factor of the gas at STP.

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42. Compressibility factor of 2 mol of NH_3 gas at $27°C$ and 9.18 atm pressure is 0.931. if the volume of the gas molecules is not taken into

consideration, then what is the value of van der waals constant 'a' for NH_3 gas?

43. Pressure exerted by 12g of an ideal gas at $t°C$ in a vessel of volume VL is 1 atm. When the temperature is increased by $10°C$ at the same volume, the pressure increased by 10%. Calculate the temperature 't' and volume V (molar mass of gas=120).

44. An open vessel contains air at $27°C$. At what temperature should the vessel be heated so that 1/4h of air escapes from the vessel? Assume that volume of the vessel remains same on heating.

45. A container of fixed volume 0.4 L contains 0.56 g of a gas at $27°C$. The pressure of the gas at this temperature is 936 mmHg. If the amount of the gas is increased to 2.1g and its temperature is decreased to $17°C$, then what will be the pressure of the gas? Assuming gas behaves ideally.

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46. A cylinder capable of holding 3L of water contains H_2 gas at $27°C$ and a pressure of P atom. At STP, it is possible to fill up 10 balloons, each of which has a radius of 10 cm, with the gas present in the cylinder. Find the value of P.

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47. At room temperature $2NO + O_2 \rightarrow 2NO_2 \rightarrow N_2O_4$ reaction proceeds near to completion. The dimer, N_2O_4, solidified at 262K. A 250 mL flask and a 100 mL flask are separated by a stop-cock. At 300K, nitric oxide in the longer flask exerts a presure of 1.053 atm and and the smaller

one contains oxygen at 0789 atm. the gases are mixed by opening the stopcock and after the end off the reaction the flasks are cooled to 220K. Neglecting vapour pressure of the dimer, find out pressure and composition of the gas remaining at 220 K (assume that the gases behave ideally).

48. An LPG cylinder weighs 18.4 kg when empty when full, it weighs 29.0 kg and shows a presure of 2.5 atm. In the course of use $27°C$, the mass of the full cylinder is reduced to 23.2 kg. find out the volume of the gas is cubic meters used up at the normal usage conditions, and the final pressure inside the cylinder. assume LPG to be n-butane with normal boiling pont of $0°C$.

49. An evacuated vessel weighs 50.0g when empty, 148g when filled with a liquid (d=0.98g · mL^{-1}) & 50.5g when filled with an ideal gas at 760 mm

Hg at 300K. Determine molar mass of the gas.

50. A gas mixture composed of N_2 and O_2 gases has a density of $1.17g \cdot L^{-1}$ at $27°C$ and 1 atm pressure. Calculate the mass percents of N_2 and O_2 in the mixture. Assume that the gas mixture behaves like an ideal gas.

51. One mole of nitrogen gas at 0.8 atm takes 38s to diffuse through a pin-hole, whereas one mole of an unknown compound of xenon with fluorine at 1.6 atm takes 57s to diffuse through the same hole. Determine the molecular formula of the compound.

52. A gas bulb of 1L capacity contains 2.0×10^{21} molecules of nitrogen exerting a pressure of $7.57 \times 10^3 N \cdot m^{-2}$. Calculate the rms velocity and temperature off the gas. If ratio of most probable speed to the root mean square speed in 0.82, calculate the most probable speed of the molecules at this temperature.

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53. Composition of the equilibrium mixture $(Cl_2 \Leftrightarrow 2Cl)$. Which is attained at $1200°C$, is determined by measuring rate of effusion through a pin-hole. It is observed that at 1.80 mmHg pressure, the mixture effuses 1.16 times as fast as Kryptom effuses under the same conditions. calculate the fraction of chlorine molecules dissociated into atoms. (Relative atomic mass of Kr=84).

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54. Density of the vapour of a substance at 1 atm and 500K is 0.36 $Kg \cdot m^{-3}$. The vapour effuses through a hole at a rate of 1.13 times faster than O_2 under same conditon. (i) Determine (a) molar mass (b) molar volume (c) compression factor (Z) of the vapour nand (d) which forces among the gas molecules are dominating-attractive or repulsive? (ii) if vapour behaves ideally at 1000K, find average translational kinetic energy of a molecule.

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55. Compressibility factor for 1 mole of a van er waals gas at $0°C$ and 100 atms pressure is 0.5 assuming that volume of a gas molecule is negligible, calculate the van der waals constant, a.
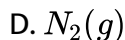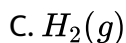
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56. The rpessure in a bulb dropped from 2000 to 1500 mm of Hg is 47 min when the contained oxygen leaked through a small hole. The bulb was

then evacuated. A mixture of oxygen and another gas off molar mass 79 in the molar ratio of 1:1 at a total pressure of 4000 mm of Hg was introduced. find the molar ratio of two gases remaining in the bulb after a period of 74 min.

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Practice Set

1. Maximum deviation from ideal gas is expected in case of-

A. $CH_4(g)$

B. $NH_3(g)$

C. $H_2(g)$

D. $N_2(g)$

Answer:

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2. Pressure of a gas increases when its temperature is increased at constant volume. This is because, with increase in temperature -

A. collision frequency of the gas molecules increases.

B. motions of the gas molecules become more random

C. gas molecules make more collision with the walls of the container

D. compresesibility factor of the gas increases.

Answer:

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3. Which of the following does not change during compression of a gas at constant temperature

A. density of a gas

B. distance between molecules

C. average speed of molecules

D. the number of collisions

Answer:

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4. The average velocity of the molecules of a gas at $T_1 K$ will be the same as the most probable velocity of the molecules of the gas at $T_2 K$ when-

A. $T_1 > T_2$

B. $T_2 > T_1$

C. $T_1 = T_2$

D. $T_1 > T_2$

Answer:

5. For a definite mass of an ideal gas at constant pressure, V versus $\dfrac{1}{P}$ plot is a-

A. parabola

B. straight line

C. hyperbola

D. rectangular hyperbola

Answer:

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6. A 15.0 L vessel containing 5.6g of N_2 is connected to a 5.0 L vessel containing 8.0g of O_2 by means of a valve. After the valve is opened and the gases are allowed to mix, what will be the partial pressure of each gas in the mixture at $27^\circ C$?

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7. (a) Which of the gases under the given conditions, exhibit real gas behaviour ? (1) 0.25 mol CO_2, $T = 1200K$,

P=24.63 atm, V=1L

(2) 1.0 mol of SO_2, T=300K, P=50atm V=0.35 L.

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8. At constant pressure for a given amount of an ideal gas, will the graphs obtained by plotting V vs $t°C$ and V vs TK be different?

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9. An evacuated vessel weighs 50.0g when empty, 148g when filled with a liquid (d=0.98 $g \cdot mL^{-1}$) and 50.5g when filled with an ideal gas at 760 mm Hg at 300K. Determine molar mass of the gas.

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10. (a) State Dalton's law of partial pressure.

(b) The value of van der waals constant 'a' for N_2 and NH_3 are 1.37 and $4.30 L^2 \cdot atm \cdot mol^{-2}$ respectively. Explain the difference in values.

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