## Single Correct Answer Type

1. The root mean square velocity of an ideal gas to constant pressure varies with density (d) as
   a) d^2
   b) d
   c) $\sqrt{d}$
   d) $1/\sqrt{d}$

2. A gas of volume 100 cc is kept in a vessel at pressure 10.4 Pa maintained at temperature 24°C. Now, if the pressure is increased to 105 Pa, keeping the temperature constant, then the volume of the gas becomes
   a) 10 cc
   b) 100 cc
   c) 1 cc
   d) 1000 cc

3. For the non-zero value of the force of attraction between gas molecules, gas equation will be
   a) $PV = nRT - \dfrac{n^2 a}{V}$
   b) $PV = nRT + nbP$
   c) $PV = nRT$
   d) $P = \dfrac{nRT}{V - b}$

4. The compressibility factor for definite amount of van der Waal's gas at 0°C and 100 atm is found to be 0.5. Assuming the volume of gas molecules negligible, the van der Waals' constant a for a gas is
   a) $1.256 \text{ L}^2 \text{ mol}^{-2} \text{ atm}$
   b) $0.256 \text{ L}^2 \text{ mol}^{-2} \text{ atm}$
   c) $2.256 \text{ L}^2 \text{ mol}^{-2} \text{ atm}$
   d) $0.0256 \text{ L}^2 \text{ mol}^{-2} \text{ atm}$

5. A 3:2 molar mixture of N_2 and CO is present in a vessel at 500 bar pressure. Due to hole in the vessel, the gas mixture leaks out. The composition of mixture effusing out initially is
   a) $n_{N_2} : n_{CO} :: 1:2$
   b) $n_{N_2} : n_{CO} :: 6:1$
   c) $n_{CO} : n_{N_2} :: 1:2$
   d) $n_{CO} : n_{N_2} :: 2:3$

6. Boltzmann constant (k) is given by
   a) $k = R \times N_A$
   b) $k = 1.3807 \times 10^{-21} \text{J K}^{-1}$
   c) $k = N_A/R$
   d) $k = R/N_A$

7. The compressibility factor for an ideal gas is
   a) 1.5
   b) 1.0
   c) 2.0
   d) ∞

8. At 400 K, the root mean square (rms) speed of a gas X (molecular weight $= 40$) is equal to the most probable speed of gas Y at 60 K. The molecular weight of the gas Y is
   a) 2
   b) 4
   c) 6
   d) 8

9. The value of van der Waals constant a for the gases O_2, N_2, NH_3, and CH_4 are 1.360, 1.390, 4.170, and 2.253 $\text{L}^2 \text{ atm mol}^{-2}$, respectively. The gas which can most easily be liquefied is
   a) O_2
   b) N_2
   c) NH_3
   d) CH_4

10. A spherical air bubble is rising from the depth of a lake when pressure is P atm and temperature is T K. The percentage increase in the radius when it comes to the surface of a lake will be (Assume temperature and pressure at the surface to be, respectively, $2T$ K and $P/4$)
    a) 100%
    b) 50%
    c) 40%
    d) 200%

11. If χ_M, χ_P and χ_V are mole fraction, pressure fraction and volume fraction respectively of a gaseous mixture, then:
    a) $\chi_M = \dfrac{1}{\chi_P} = \dfrac{1}{\chi_V}$
    b) $\dfrac{1}{\chi_M} = \chi_P = \dfrac{1}{\chi_V}$
    c) $\chi_M = \chi_P = \chi_P$
    d) $\dfrac{1}{\chi_M} = \dfrac{1}{\chi_P} = \dfrac{1}{\chi_V}$

12. For the non-zero volume of the molecules, real gas equation for n mol of the gas will be
    a) $\left(P + \dfrac{a}{V^2}\right)V = RT$
    b) $PV = nRT + nbP$
    c) $P(V - nb) = nRT$
    d) Both (b) and (c) are true

13. The quantity $(PV/K_B T)$ represents
    a) Number of molecules in the gas
    b) Mass of the gas
    c) Number of moles of the gas
    d) Translational energy of the gas

14. The SI unit of the coefficient of viscosity is
    a) $\text{N s}^{-1}\text{m}^{-1}$
    b) N s m^{-2}
    c) $\text{N s}^{-2}\text{m}^{-2}$
    d) $\text{N s}^{-1}\text{m}^{-2}$

15. A quantity of gas is collected in a graduated tube over the mercury. The volume of the gas at 20°C is 50.0

mL and the level of the mercury in the tube is 100 mm above the outside mercury level. The barometer reads 750 mm. Volume at STP is

a) 39.8 mL   b) 40 mL   c) 42 mL   d) 60 mL

16. X mL of H_2 gas effuses through a hole in a container in 5 s. The time taken for the effusion of the same volume of the gas specified below, under identical conditions, is

a) 10 s, He   b) 20 s, O_2 c) 25 s, CO   d) 55 s, CO_2

17. O_2 gas at STP contained in a flask was replaced by SO_2 under same conditions. The weight of SO_2 will be

a) Equal to that of O_2 b) Half that of O_2 c) Twice that of O_2 d) One-fourth of O_2

18. Which expression gives average speed of gas molecules?

a) $\sqrt{\dfrac{8RT}{M}}$ b) $\dfrac{3RT}{M}$ c) $\left[\dfrac{8RT}{\pi M}\right]^{1/2}$ d) $\dfrac{8RT}{3.14M}$

19. The rate of diffusion of methane at a given temperature is twice that of a gas X. The molecular weight of X is

a) 64.0   b) 32.0   c) 4.0   d) 8.0

20. Under similar conditions, which of the following gas will have same value of μ_{rms} as CO_2?

a) NO   b) C_3H_8 c) CO   d) N_2

21. The pressure of a gas is due to
a) Rapid intermolecular collisions
b) Molecular impacts against the walls of vessel
c) Voids between the gas molecules
d) Ideal behaviour of gases

22. The rate of diffusion of a gas is
a) Directly proportional to its density
b) Directly proportional to its molecular weight
c) Directly proportional to the square root of its molecular weight
d) Inversely proportional to the square root of its molecular weight

23. Which gas shows real behaviour?
a) 8g O_2 at STP occupies 5.6L
b) 1g H_2 in 0.5L flask exerts a pressure of 24.63 atm at 300K
c) 1mol NH_3 at 300K and 1atm occupies volume 22.4L
d) 5.6L of CO_2 at STP is equal to 11g

24. Number of N_2 molecules present in L vessel at NTP when compressibility factor is 1.2 is

a) 2.23×10^{24} b) 2.23×10^{22} c) 2.7×10^{22} d) 2.7×10^{24}

25. A gas in an open container is heated from 27°C to 127°C. The fraction of the original amount of the gas escaped in the container will be

a) 3/4   b) 1/2   c) 1/4   d) 1/8

26. Which of the following statements is not correct about the three states of matter, i.e., solid, liquids and gas?
a) Molecules of a solid possess least energy whereas those of a gas possess highest energy
b) The density of a solid is highest whereas that of gases is lowest
c) Gases like liquids possess definite volumes
d) Molecules of a solid possess vibratory motion

27. Relative humidity of air is 60° and the saturation vapour pressure of water vapour in air is 3.6 kPa. The amount of water vapours present in 2 L air at 300 K is

a) 52 g   b) 31.2 g   c) 26 g   d) 5.2 g

28. At constant volume, for a fixed number of moles of a gas, the pressure of the gas increases with the rise in temperature due to
a) Increase in average molecular speed
b) Increase in the rate of collisions among the molecules
c) Increase in the molecular attraction
d) Decrease in the mean free path

29. Which of the following expression at constant pressure represents Charles' law?

a) $V \propto \dfrac{1}{T}$ b) $V \propto \dfrac{1}{T^2}$ c) $V \propto T$ d) $V = d$

30. At 25°C and 730 mm pressure, 730 mL of dry oxygen was collected. If the temperature is kept constant what volume will oxygen gas occupy at 760 mm pressure?

a) 701 mL   b) 449 mL   c) 569 mL   d) 621 mL

31. Distribution of molecules with velocity is represented by the curve
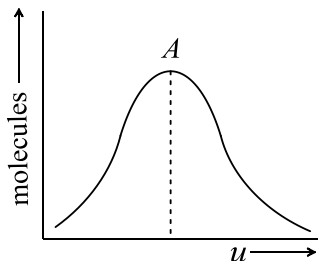
Velocity corresponding to point A is

a) $\sqrt{\dfrac{3RT}{M}}$ b) $\sqrt{\dfrac{2RT}{M}}$ c) $\sqrt{\dfrac{8RT}{\pi M}}$ d) $\sqrt{\dfrac{RT}{M}}$

32. The kinetic theory of gases predicts that total kinetic energy of a gaseous assembly depends on

a) Pressure of the gas
b) Temperature of the gas
c) Volume of the gas
d) Pressure, temperature, and volume of the gas

33. For 1 mol of an ideal gas, $V_1 > V_2 > V_3$ in Fig. (I), $T_1 > T_2 > T_3$ in Fig. (II), $P_1 > P_2 > P_3$ in Fig. (III), and $T_1 > T_2 > T_3$ in Fig. (IV), then which curves are correct
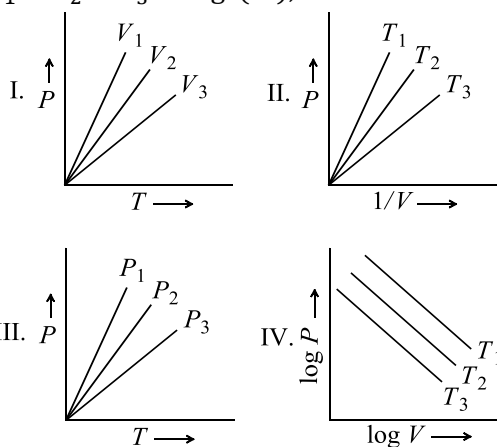
a) I, II   b) I, II, III   c) II, IV   d) I, III, IV

34. The density of neon gas will be highest at

a) STP   b) 0°C, 2 atm   c) 273°C, 1 atm   d) 273°C, 2 atm

35. A bottle of dry ammonia and a bottle of dry hydrogen chloride connected through a long tube are opened simultaneously at both ends. The white ammonium chloride ring first formed will be

a) At the centre of the tube   b) Near the hydrogen chloride bottle
c) Near the ammonia bottle   d) Throughout the length of the tube

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

a) 1:2   b) 1:1   c) 1:16   d) 15:16

37. Which of the following statements is wrong for gases?

a) Gases do not have a definite shape and volume
b) Volume of the gas is equal to volume of container confining the gas
c) Confining gas exerts uniform pressure on the walls of container in all directions
d) Mass of gas cannot be determined by weighing a container in which it is enclosed

38. A vessel is filled with a mixture of oxygen and nitrogen. At what ratio of partial pressures will the mass of gases be identical?
   a) $P(O_2) = 0.785P(N_2)$ b) $P(O_2) = 8.75P(N_2)$ c) $P(O_2) = 11.4P(N_2)$ d) $P(O_2) = 0.875P(N_2)$

39. The van der Waals equation for one mol of CO_2 gas at low pressure will be
   a) $\left(P + \dfrac{a}{V^2}\right)V = RT$ b) $P(V - b) = RT - \dfrac{a}{V^2}$ c) $P = \dfrac{RT}{V - b}$ d) $P = \left(\dfrac{RT}{V - b} - \dfrac{a}{V^2}\right)$

40. At STP, the order of mean square velocity of molecules of H_2, N_2, O_2, and HBr is
   a) $H_2 > N_2 > O_2 > HBr$ b) $HBr > O_2 > M_2 > H_2$ c) $HBr > H_2 > O_2 > N_2$ d) $N_2 > O_2 > H_2 > HBr$

41. 2 mol 'H_2 is mixed with 2 gm of H_2. The molar heart capacity at constant pressure for the mixture is
   a) $\dfrac{17R}{6}$ b) $\dfrac{11R}{6}$ c) $4R$ d) $\dfrac{3R}{2}$

42. If v is the volume of one molecule of a gas under given conditions, then van der Waals constant b is
   a) $4v$ b) $4v/N_0$ c) $N_0/4v$ d) $4vN_0$

43. When an ideal gas undergoes unrestrained expansion, no cooling occurs because the molecules
   a) Are above the inversion temperature
   b) Exert no attractive forces on each other
   c) Do work equal to loss in kinetic energy
   d) Collide without losing energy

44. A gas obeys $P(V - b) = RT$. Which of the following are correct about this gas?
   1. Isochoric curves have slope $= \dfrac{R}{V - b}$
   2. Isobaric curves have slope $\dfrac{R}{P}$ and intercept b
   3. For the gas compressibility factor $= 1 + \dfrac{Rb}{RT}$
   4. The attraction forces are overcome by repulsive forces
   a) I   b) II, III   c) III   d) I, II, III, IV

45. The compressibility of a gas is less than unity at STP; therefore,
   a) $V_m > 22.4$ L   b) $V_m < 22.4$ L   c) $V_m = 22.4$ L   d) $V_m = 44.8$ L

46. At the top of the mountain, the thermometer reads 0°C and the barometer reads 710 mrn Hg. At the bottom of the mountain the temperature is 30°C and the pressure is 760 mm Hg. The ratio of the density of air at the top with that at the bottom is
   a) 1:1   b) 1.04:1   c) 1 : 1.04   d) 1 : 1.5

47. A liquid is in equilibrium with its vapour at its boiling point. On average, the molecules in the two phases have equal
   a) Intermolecular forces   b) Potential energy   c) Kinetic energy   d) Total energy

48. There is a depression in the surface of the liquid in a capillary when
   a) The cohesive force is smaller than the adhesive force
   b) The cohesive force is greater than the adhesive force
   c) The cohesive and adhesive force are equal
   d) None of the above is true

49. 3.2 g oxygen is diffused in 10 min. In similar conditions, 2.8 g nitrogen will diffuse in
   a) 9.3 min   b) 8.2 min   c) 7.6 min   d) 11.8 min

50. Virial equation is: $PV_M = RT\left[A + \dfrac{B}{V_M} + \dfrac{C}{V_{M^2}} + \cdots\right]$, where $A, B, C, \ldots$ are first second, third,... virial coefficient, respectively, For an ideal gas
   a) $A =$ unity and B, C are zero
   b) A, B, C are all equal to unity
   c) A is dependent of temperature
   d) All A, B, C depend on temperature

51. A sample of gas occupies 100 mL at 27°C and 740 mm pressure. When its volume is changed to 80 mL at 740 mm pressure, the temperature of the gas will be
   a) 21.6°C   b) 240°C   c) -33°C   d) 89.5°C

52. The temperature to which a gas must be cooled before it can be liquefied by compression is called
   a) Boyle's temperature
   b) Critical temperature
   c) Liquefaction temperature
   d) Inversion temperature

53. The rms velocity of hydrogen is $\sqrt{7}$ times the rms velocity of nitrogen. If T is the temperature of the gas,

then

a) $T_{H_2} = T_{N_2}$ b) $T_{H_2} > T_{N_2}$ c) $T_{H_2} < T_{N_2}$ d) $T_{H_2} = \sqrt{7}T_{N_2}$

54. Ideal gas equation in terms of KE per unit volume, E, is

a) $\dfrac{3}{2}RT$ b) $\dfrac{2}{3}E$ c) $\dfrac{2}{3}RT$ d) $\dfrac{3}{2}E$

55. A quantity of heat is confined in a chamber of constant volume. When the chamber is immersed in a bath of melting ice, the pressure of the gas is 1000 torr. Final temperature when the pressure manometer indicates an absolute pressure of 400 torr is

a) 109 K   b) 273 K   c) 373 K   d) 0 K

56. The pressure exerted by 1 mol of CO_2 at 273 K is 34.98 atm. Assuming that volume occupied by CO_2 molecules is negligible, the value of van der Waals' constant for attraction of CO_2 gas is

a) 3.59 dm^6 atm mol^{-2} b) 2.59 dm^6 atm mol^{-2} c) 1.25 dm^6 atm mol^{-2} d) 1.59 dm^6 atm mol^{-2}

57. At what temperature will the molar kinetic energy of 0.3 mol of 'He' be the same as that of 0.4 mol of argon at 400 K?

a) 700 K   b) 500 K   c) 800 K   d) 400 K

58. Among the plots of P vs V, as given below, which one corresponds to Boyle's law?

a)   b)   c)   d)
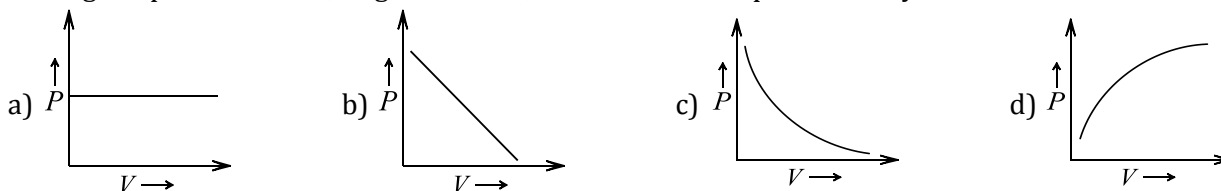
59. Which among of the following has least surface tension?

a) Benzene   b) Acetic acid   c) Diethyl ether   d) Chlorobenzene

60. A balloon filled with ethyne is pricked with a sharp point and quickly dropped in a tank of H_2 gas under identical conditions. After a while the balloon will

a) Shrink   b) Enlarge

c) Completely collapse   d) Remain unchanged in size

61. For an ideal gas, the value of compressibility factor $Z\left(= \dfrac{pV_m}{RT}\right)$ is

a) 0   b) 1   c) $>$ d) Between 0 and 1

62. At what temperature will hydrogen molecules have the same KE as nitrogen molecules at 280 K?

a) 280 K   b) 40 K   c) 400 K   d) 50 K

63. According to kinetic theory of gases, for a diatomic molecule

a) The pressure exerted by the gas is proportional to the mean velocity of the molecules

b) The pressure exerted by the gas is proportional to the root mean square velocity of the molecules

c) The root mean square velocity is inversely proportional to the temperature

d) The mean transitional kinetic energy of the molecules is proportional to the absolute temperature

64. NH_3 gas is liquefied more easily than N_2. Hence

a) Van der Waals constants a and b of NH_3 >that ofN_2

b) Van der Waals constant a and$b$of NH_3 <that ofN_2

c) $a(NH_3) > a(N_2)$but$b(NH_3) < b(N_2)$

d) $a(NH_3) < a(N_2)$but $b(NH_3) > b(N_2)$

65. When the temperature is increased, surface tension of water

a) Increases   b) Decreases

c) Remains constant   d) Shows irregular behavior

66. For a monoatomic gas kinetic energy $= E$. The relation with rms velocity is

a) $u = \left(\dfrac{2E}{m}\right)^{1/2}$ b) $u = \left(\dfrac{3E}{2m}\right)^{1/2}$ c) $u = \left(\dfrac{E}{2m}\right)^{1/2}$ d) $u = \left(\dfrac{E}{3m}\right)^{1/2}$

67. The critical temperature of water is higher than that of O_2 because the H_2O molecule has

a) Fewer electrons than O_2 b) Two covalent bonds

c) V-shape   d) Dipole moment

68. Which of the following contains greatest number of N atoms?
    a) 22.4 L nitrogen gas at STP
    b) 500 mL of 2.00 M NH_3
    c) 1.00 mol of NH_4Cl
    d) 6.02×10^{23} molecules of NO_2
69. 15 L of gas at STP is subjected to four different conditions of temperature and pressure as shown below. In which case the volume will remain unaffected?
    a) 273 K, 2 bar pressure
    b) 273°C, 0.5 atm pressure
    c) 546°C, 1.5 atm pressure
    d) 273°C and 2 atm pressure
70. Actual graph for the given parameters. For the non-zero volume of the molecules, real gas equation for n mol of the gas will be
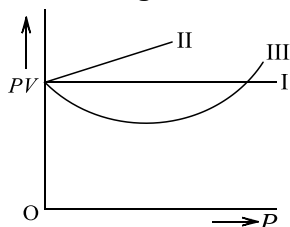

    a) I,III
    b) I,II
    c) II
    d) I
71. 1 of N_2 and 7/8 L of O_2 at the same temperature and pressure were mixed together. What is the relation between the masses of the two gases in the mixture?
    a) $M_{N_2} = 3\,M_{O_2}$
    b) $M_{N_2} = 8\,M_{O_2}$
    c) $M_{N_2} = M_{O_2}$
    d) $M_{N_2} = 16\,M_{O_2}$
72. At 100°C and 1 atm, if the density of the liquid water is 1.0 g cm^{-3} and that of water vapour is 0.0006 g cm^{-3}, then the volume occupied by water molecules in 1 L of steam at this temperature is
    a) 6 cc
    b) 60 cc
    c) 0.6 cc
    d) 0.06 cc
73. A gas will approach ideal behaviour at
    a) Low temperature and low pressure
    b) Low temperature and high pressure
    c) High temperature and low pressure
    d) High temperature and high pressure
74. At what temperature will both celsius and fahrenheit scales read the same value?
    a) 100°
    b) 180°
    c) 40°
    d) −40°
75. According to the kinetic theory of gases, for a diatomic molecule
    a) The pressure exerted by the gas is proportional to the mean velocity of the molecule
    b) The pressure exerted by the gas is proportional to the root mean velocity of the molecule
    c) The root mean square velocity of the molecule is inversely proportional to the temperature
    d) The mean translational kinetic energy of the molecule is proportional to the absolute temperature
76. The average velocity of an ideal gas molecule at 27°C is 0.3 m s^{-1}. The average velocity at 927°C will be
    a) 0.6 m s^{-1}
    b) 0.3 m s^{-1}
    c) 0.9 m s^{-1}
    d) 3.0 m s^{-1}
77. The ratio of root mean square velocity to average velocity of a gas molecule at a particular temperature is
    a) 1.086:1
    b) 1:1.086
    c) 2:1.086
    d) 1.086:2
78. If a gas is expended at constant temperature
    a) The pressure decreases
    b) The kinetic energy of the molecules remains the same
    c) The kinetic energy of the molecules decreases
    d) The number of molecules of the gas increases
79. The volume of helium is 44.8 L at
    a) 100°C and 1 atm
    b) 0°C and 1 atm
    c) 0°C and 0.5 atm
    d) 100°C and 0.5 atm
80. The temperature at which a real gas obeys the ideal gas laws over a wide range of pressure is called
    a) Critical temperature
    b) Boyle temperature
    c) Inversion temperature
    d) Reduced temperature
81. According to Graham's law, at a given temperature, the ratio of the rates of diffusion r_A/r_B of gases A and

B is given by

a) $\left(\frac{P_A}{P_B}\right)\left(\frac{M_A}{M_B}\right)^{1/2}$
b) $\left(\frac{M_A}{M_B}\right)\left(\frac{P_A}{P_B}\right)^{1/2}$
c) $\left(\frac{P_A}{P_B}\right)\left(\frac{M_B}{M_A}\right)^{1/2}$
d) $\left(\frac{M_A}{M_B}\right)\left(\frac{P_B}{P_A}\right)^{1/2}$

82. When is deviation more in the behavior of a gas from the ideal gas equation $PV = nRT$?
   a) At high temperature and low pressure
   b) At low temperature and high pressure
   c) At high temperature and high pressure
   d) At low temperature and low pressure

83. The density of neon will be highest at
   a) STP
   b) 0°C, 2 atm
   c) 273°C, 1 atm
   d) 273°C, 2 atm

84. It is eaiser to liquefy oxygen than hydrogen because
   a) Oxygen has a higher critical temperature and lower inversion temperature than hydrogen
   b) Oxygen has a lower critical temperature and higher inversion temperature than hydrogen
   c) Oxygen has a higher critical temperature and higher inversion temperature than hydrogen
   d) The critical temperature and inversion temperature of oxygen is very low

85. The density of a gas at 27°C and 1 atm is d. Pressure remaining constant, at which of the following temperature will its density become $0.75d$?
   a) 20°C
   b) 30°C
   c) 400 K
   d) 300 K

86. Equal weights of methane and hydrogen are mixed in an empty container at 25°C. The fraction of the total pressure exerted by hydrogen is
   a) $\frac{1}{2}$
   b) $\frac{8}{9}$
   c) $\frac{1}{9}$
   d) $\frac{16}{17}$

87. A helium atom is two times heavier than a hydrogen molecule. At 298 K, the average kinetic energy of a helium atom is
   a) Two times that of a hydrogen molecule
   b) Same as that of a hydrogen molecule
   c) Four times that of a hydrogen molecule
   d) Half that of a hydrogen molecule

88. At low pressures, the van der Waals equation is written as $\left[P + \frac{a}{V^2}\right]V = RT$

   The compressibility factor is then equal to
   a) $\left(1 - \frac{a}{RTV}\right)$
   b) $\left(1 - \frac{RTV}{a}\right)$
   c) $\left(1 + \frac{a}{RTV}\right)$
   d) $\left(1 + \frac{RTV}{a}\right)$

89. Which of the following expressions correctly represents the relationship between the average molar kinetic energy, KE of CO_2 and N_2 molecules at the same temperature?
   a) $KE_{CO} = KE_{N_2}$
   b) $KE_{CO} > KE_{N_2}$
   c) $KE_{CO} < KE_{N_2}$
   d) Cannot be predicted unless volumes of the gases are given

90. To an evacuated vessel with movable piston under external pressure of 1 atm, 0.1 mole of He and 1.0 mole of an unknown compound (vapour pressure 0.68 atm at 0°C) are introduced. Considering the ideal gas behaviour, the total volume (in litre) of the gases at 0°C is close to
   a) 3
   b) 5
   c) 7
   d) 9

91. What weight of hydrogen at STP could be contained in a vessel that holds 4.8 g oxygen at STP?
   a) 4.8 g
   b) 3.0 g
   c) 0.6 g
   d) 0.3 g

92. A gas in an open container is heated from 27°C to 127°C. The fraction of the original amount of the gas remaining in the container will be
   a) 3/4
   b) 1/2
   c) 1/4
   d) 1/8

93. Which of following correctly represents the relation between capillary rise h ad capillary radius r?
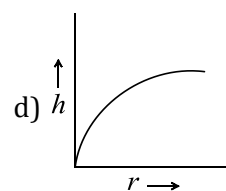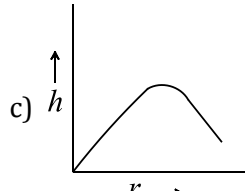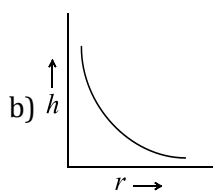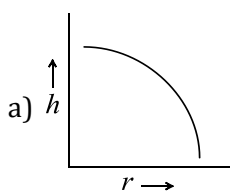

94. V vs T curves at different pressures P_1 and P_2 for an ideal gas are shown below:
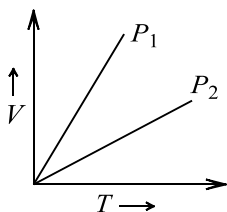
Which one of the following is correct?

a) $P_1 > P_2$ b) $P_1 < P_2$ c) $P_1 = P_2$ d) $P_2/P_1 = 1/2$

95. Equal weights of methane and oxygen are mixed in an empty container at 25°C. The fraction of the total pressure exerted by oxygen is

a) $\dfrac{1}{3}$ b) $\dfrac{1}{2}$ c) $\dfrac{2}{3}$ d) $\dfrac{1}{3} \times \dfrac{273}{298}$

96. The ratio between the root mean square speed of H_2 at 50 K and that of O_2 at 800 K is

a) 4   b) 2   c) 1   d) 1/4

97. A graph is plotted between $\log V$ and $\log T$ for 2 mol of gas at constant pressure of 0.0821 atm. V and T are in litre and K. Which of the following statements are not correct?

1.   The curve is straight line with slope -1
2.   The curve is straight line with slope $+1$
3.   The intercept on Y-axis is equal to 2
4.   The intercept on Y-axis is equal to 0.3010

a) I, II   b) III, IV   c) II, IV   d) I, III

98. A mixture of SO_2 and O_2 in the molar ratio 16:1 is diffused through a pin hole for successive effusions three times to give a molar ratio 1:1 of diffused mixture. Which one are not correct if diffusion is made at same P and T in each operation?

1.   Eight operation are needed to get 1:1 molar ratio
2.   Rate of diffusion for $SO_2 : O_3$ after eight operations in 0.707
3.   Six operations are needed to get 2:1 molar ratio for SO_2 and O_2 in diffusion mixture
4.   Rate of diffusion for SO_2 and O_2 after six operations is 2.41

a) I,II,III   b) II,III   c) I,III   d) IV

99. Which of the following is not a correct postulate of kinetic theory of gases?

a) The molecules of a gas are continuously moving in different directions with different velocities

b) The average kinetic energy of the gas molecules is directly proportional to the absolute temperature of the gas

c) The volume of the gas is due to the large number of molecules present in it

d) The pressure of the gas is due to the collision of the molecules on the walls of the container

100. In van der Waals equation of state for a non-ideal gas, the term that accounts for intermolecular forces is

a) $V - b$ b) RT c) $p + \dfrac{a}{V^2}$ d) $(RT)^{-1}$

101. In the van der Waals equation

a) b is the volume occupied by the gas molecules

b) b is four times the volume occupied by the gas molecules

c) b is the correction factor for intermolecular attraction

d) None of these

102. An ideal gas obeying kinetic theory of gases can be liquefied, if

a) Its temperature is more than critical temperature T_c

b) Its pressure is more than critical pressure P_c

c) Its pressure is more than P_c at a temperature less than T_c

d) It cannot be liquefied at any value of P and T

103. The term that corrects for the attractive forces present in a real gas in the van der Waals' equation is

a) nb b) $n^2 a/V^2$ c) $-(n^2 a/V^2)$ d) $-nb$

104. Which of the following is true about gaseous state?

a) Thermal energy = Molecular attraction   b) Thermal energy $\gg$ Molecular attraction

c) Thermal energy $\ll$ Molecular attraction   d) Molecular forces $\gg$ Those in liquids

105. A quantity of hydrogen gas occupies a volume of 30.0 mL at a certain temperature and pressure. What volume would half this mass of hydrogen occupy at triple the absolute temperature if the pressure were one-ninth that of the original gas?

     a) 270 mL   b) 90 mL   c) 405 mL   d) 137 mL

106. I, II, and III are three isotherms, respectively, at T_1, T_2, and T_3. Temperature will be in order
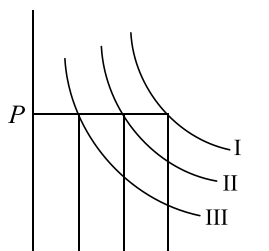

     a) $T_1 = T_2 = T_3$ b) $T_1 < T_2 < T_3$ c) $T_1 > T_2 > T_3$ d) $T_1 > T_2 = T_3$

107. Surface tension does not vary with

     a) Temperature   b) Vapour pressure   c) The size of surface   d) Concentration

108. The value of PV for 5.6 L of an ideal gas is…. RT at NTP

     a) 0.25   b) 0.30   c) 1.0   d) 0.45

109. The average molecular speed is greatest in which of the following gas samples?

     a) 1.0 mol N_2 at 560 K   b) 0.50 mol of Ne at 500 K

     c) 0.20 mol of CO_2 at 440 K   d) 2.0 mol of Ke at 140 K

110. Select one correct statement. In the gas equation, $PV = nRT$

     a) n is the number of molecules of a gas

     b) n moles of the gas have a volume V

     c) V denotes volume of one mole of the gas

     d) P is the pressure if the gas when only one mole of gas is present

111. A flask containing 12 g of a gas of relative molecular mass 120 at a pressure of 100 atm was evacuated by means of a pump until the pressure was 0.01 atm. Which of the following is the best estimate of the number of molecules left in the flask ($N_0 = 6 \times 10^{23}$ mol^{-1})?

     a) 6×10^{19} b) 6×10^{18} c) 6×10^{17} d) 6×10^{13}

112. Which of the following has the maximum value of mean free path?

     a) CO_2 b) H_2 c) O_2 d) N_2

113. A gaseous mixture contains oxygen and nitrogen in the ratio of 1:8 by mass. The ratio of their respective number of molecules $\left(N_{O_2} : N_{H_2}\right)$ is

     a) 1:8   b) 1:1   c) 7:64   d) 1:2

114. The density of a gas A is twice that of a gas B at the same temperature. The molecular mass of gas B is thrice that of A. The ratio of the pressure acting on A and B will be

     a) 1:6   b) 7:8   c) 2:5   d) 1:4

115. The ratio of the rate of diffusion of helium and methane under identical condition of pressure and temperature will be

     a) 4   b) 0.2   c) 2   d) 0.5

116. The pressure of real gas is less than the pressure of an ideal gas because of

     a) Increase in collisions   b) Increase in intermolecular forces

     c) Infinite size of molecules   d) Statement is incorrect

Multiple Correct Answers Type

117. The compressibility factor(s) for an ideal gas is/are:

     a) Unity at all temperatures

     b) Unity at all pressures

c) Unity at the critical temperature

d) Unity at Boyle's temperature

118. Which statement(s) is/are correct?

a) Molar volume of every gas at SATP is 24.45 litre

b) Molar volume of every gas at STP is 22.4 litre

c) All gases have same kinetic energy at a given temperature

d) Under critical conditions compressibility factor is $\frac{3}{8}$

119. Which of the following gases is/are heavier than dry air?

a) Moist air   b) Oxygen   c) Moist nitrogen   d) Hydrogen sulphide

120. The given graph represents the variation of Z (compressibility factor) $vs. P$ for three real gases A, B and C. Identify the correct statements
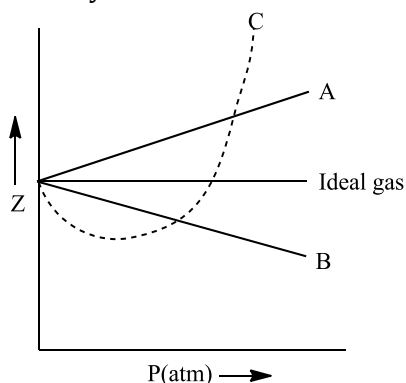
a) For the gas $A, a = 0$ and its dependence on P I linear at all pressure

b) For the gas $B, b = 0$ and its dependence on P is linear at all pressure

c) For the gas C, which is typical real gas for which a $\neq 0$, b $\neq 0$. By knowing the minima and the point of intersection with $Z \neq 1, a$ and b can be calculated

d) At high pressure, the slope is positive for all real gases

121. Which of the following is/are correct about Charles' law?

a) $(\partial V/\partial T)_P =$ Constant   b) $V \propto T$ at constant P and n

c) $V \propto P$ at constant T, n d) $V \propto T$ is constant at constant P, n

122. A mixture of SO_2 and O_2 in the molar ratio $16 : 1$ is diffused through a pin hole for successive effusions three times to give a molar ratio $1 : 1$ of diffused mixture. Which of the following are not correct if diffusion is made at same P and T in each operation?

a) Eight operations are needed to get $1 : 1$ molar ratio

b) Rate of diffusion for $SO_2 : O_2$ after 8 operations is 0.707

c) Six operations are needed to get $2 : 1$ molar ratio for SO_2 and O_2 in diffusion mixture

d) Rate of diffusion for SO_2 and O_2 after 6 operations is 2.41

123. Which of the following statements is/are true?

a) Hydrogen diffuses four times faster than oxygen

b) The temperature of a real gas changes when it expands adiabatically in vacuum

c) An ideal gas undergoes cooling effect when it suffers an adiabatic expansion in vacuum

d) The Joule-Thomson coefficient $\left(\frac{dT}{dP}\right)_H$ of an ideal gas is zero

124. Consider a collision between an oxygen molecule and a hydrogen molecule in a mixture of oxygen and hydrogen kept at room temperature. Which of the following is/are possible?

a) The kinetic energies of both the molecules increase

b) The kinetic energies of both the molecules decrease

c) The kinetic energy of the oxygen molecule increases and that of the hydrogen molecule decreases

d) The kinetic energy of the hydrogen molecule increases and that of the oxygen molecule decreases

125. The compressibility factor of a gas is greater than unity at STP. Therefore

a) $V_m > 22.4$ L   b) $V_m < 22.4$L

c) $V_m = 22.4$ L   d) The gas will become less liquefiable

126. At very high pressure, the van der-Waals equation reduces to

 a) $PV = RT + Pb$ b) $PV = \dfrac{aRT}{V^2}$ c) $P = \dfrac{RT}{V-b}$ d) $PV = RT - \dfrac{a}{V}$

127. The value(s) of R is/are:

 a) $1.99 \text{ cal deg}^{-1} \text{ mol}^{-1}$

 b) $0.0821 \text{ litre} - \text{atm deg}^{-1} \text{ mol}^{-1}$

 c) $9.8 \text{ kcal deg}^{-1} \text{ mol}^{-1}$

 d) $8.3 \text{ joule deg}^{-1} \text{ mol}^{-1}$

128. At very high pressures the van der Waals' gas equation reduces to:

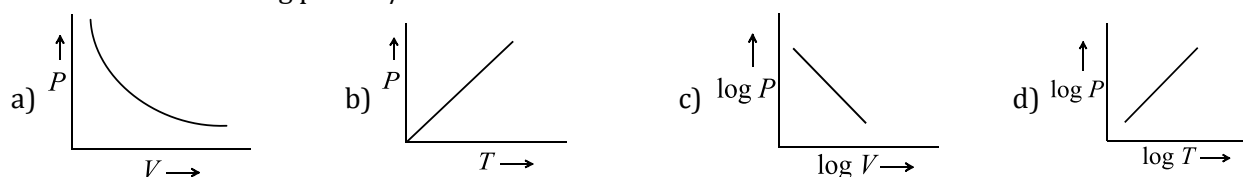 a) $PV = RT + Pb$ b) $P = \dfrac{RT}{V-b}$ c) $PV + \dfrac{aRT}{V^2}$ d) $PV = RT - \dfrac{a}{V}$

129. Frenkel defects generally appears in

 a) AgI b) AgBr c) NaCl d) ZnS

130. According to Charles' law

 a) $(dV/dT)_P = K$ b) $(dV/dT)_P = -K$ c) $(dV/dT)_P = -K/T$ d) $V \propto T$

131. Which of the following plots is/are correct?

132. Which of the following statements is/are correct?

 a) All real gases are less compressible than ideal gases at high pressure

 b) Hydrogen and helium are more compressible than ideal gases for all values of pressure

 c) Except H_2 and He, the compressibility factor $Z \left(= \dfrac{PV}{nRT}\right) < 1$ for all gases at low pressure

 d) The compressibility factor of real gases is independent of temperature

133. Which of the following plots is/are correct?
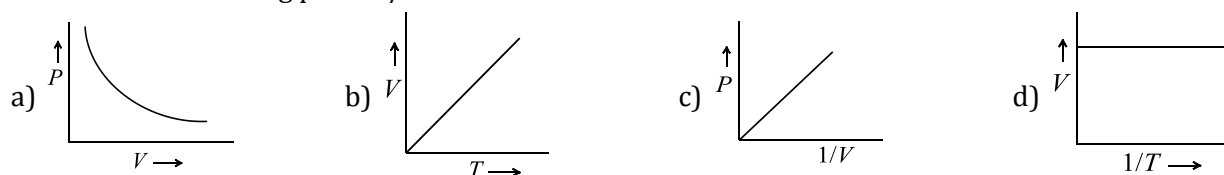
134. The root mean square velocity of an ideal gas in a closed container of fixed volume is increased from $5 \times 10^4 \text{ cm s}^{-1}$ to $10 \times 10^4 \text{ cm s}^{-1}$. Which of the following statements correctly explains how the change is accomplished?

 a) By heating the gas, the temperature is doubled

 b) By heating the gas, the pressure is quadrupled

 c) By heating the gas, the temperature is quadrupled

 d) By heating the gas, the pressure is doubled

135. In van der Waals equation of gases, the kinetic equation for gas is modified with respect to

 a) Repulsive forces

 b) Attractive forces between the gaseous molecules

 c) Actual volume of the gas

 d) Pressure of the molecules

136. Which of the following crystals have 8 : 8 coordination?

 a) NH_4Br b) NH_4Cl c) MnO d) AlFe

137. If a gas expands at constant temperature

 a) The pressure decreases

 b) The kinetic energy of the molecules remains the same

 c) The kinetic energy of the molecules decreases

 d) The number of molecules of the gas increases

138. A gas described by van der Waals' equation:
    a) Behaves similar to an ideal gas in the limit of large molar volumes
    b) Behaves similar to an ideal gas in the limit of large pressure
    c) Is characterised by van der Waals' coefficients that are dependent on the identity of gas but are independent of the temperature
    d) Has the pressure that is lower than the pressure exerted by the same gas behaves ideally

139. At extremely low pressures, the van der Waals' gas equation for 1 mole of a gas may be written as:
    a) $PV = RT + Pb$
    b) $PV = RT$
    c) $P + \dfrac{a}{V^2} = \dfrac{RT}{V}$
    d) $PV = RT - \dfrac{a}{V}$

140. Which of the following statements is/are correct?
    a) The van der Waals constant a is a measure of attractive force
    b) The van der Waals constant b is also called co-volume or excluded volume
    c) b is expressed in L mol^{-1}
    d) b is one-third of critical volume

141. On expanding a gas at constant temperature:
    a) The pressure decreases
    b) The kinetic energy of gas molecules remains same
    c) The volume of gas decreases
    d) The number of molecules of the gas decreases

142. Which of the value of R?
    a) 1.99 cal deg^{-1} mol^{-1}
    b) 0.0821 L atm deg^{-1} mol
    c) 9.8 kcal deg^{-1} mol^{-1}
    d) 8.3 J deg^{-1} mol^{-1}

143. Which are correct for an ideal gas:
    a) $\left(\dfrac{\partial P}{\partial V}\right)_T \cdot \left(\dfrac{\partial V}{\partial T}\right)_P \cdot \left(\dfrac{\partial E}{\partial P}\right)_V = 0$
    b) $\left(\dfrac{\partial P}{\partial V}\right)_T \cdot \left(\dfrac{\partial V}{\partial T}\right)_P \cdot \left(\dfrac{\partial E}{\partial P}\right)_V = -1$
    c) $\left(\dfrac{\partial P}{\partial T}\right)_V \cdot \left(\dfrac{\partial T}{\partial V}\right)_P \cdot \left(\dfrac{\partial V}{\partial P}\right)_T = -1$
    d) $\dfrac{\text{Thermal expansion of gas}}{\text{Isothermal compressibility}} = \dfrac{P}{T}$

144. Precisely 1 mol of helium and 1 mol of neon are placed in a container. Indicate the correct statements about the system
    a) Molecules of the two gases strike the wall of the container with same frequency
    b) Molecules of helium strike the wall more frequently
    c) Molecules of helium have greater average molecular speed
    d) Helium exerts larger pressure

145. The average momentum of a molecule in a sample of an ideal gas does not depends on:
    a) Pressure
    b) Number of mole
    c) Volume
    d) Temperature

146. Which of the following is/are true?
    a) Higher the value of a, weaker is intermolecular force of attraction
    b) At low pressure, $Z = 1 - \dfrac{a}{V_m RT}$, for ideal gas
    c) $\dfrac{V_1}{V_2} = \left(\dfrac{T_2}{T_1}\right)^{3/2}$, for reversible adiabatic expansion
    d) A gas can be liquified below critical temperature at high pressure

147. Which forces of attraction are responsible for liquefaction of H_2?
    a) Coulombic forces
    b) Dipole forces
    c) Hydrogen bonding
    d) Van der Waals forces

148. Which of the following possesses rock salt type structure?
    a) CaO
    b) CsBr
    c) KBr
    d) BeS

149. According to Charles' law:
    a) $(\partial V/\partial T)_P = K$
    b) $(\partial V/\partial T)_P = -K$
    c) $(\partial V/\partial T)_P = -K/T$
    d) $V \propto T$ at constant n, P

150. In the fluorite structure if the radius ratio is $(\sqrt{3}/2 - 1)$, how many ions does each cation touch?

    a) 8 cations   b) 4 cations   c) 12 cations   d) No cation

151. Which of the following statement(s) is/are incorrect?

    a) The volume of a gas always increases when the temperature is increased

    b) Equal volumes of gases under the same conditions of temperature and pressure contain the same number of molecules

    c) The kinetic energy of a molecule is zero at 0°C

    d) A gas in a closed container exerts higher pressure at the bottom than at the top due to gravity

152. If 10 g of a gas at atmospheric pressure is cooled from 273°C to 0°C, keeping the volume constant, its pressure would become

    a) 1/273 atm   b) 2 atm   c) $\frac{1}{2}$ atm   d) $5.05 \times 10^4 \text{N m}^{-2}$

153. If the rms velocities of nitrogen and oxygen molecules are same at two different temperature and same pressure then

    a) Most probable velocity of molecules is also equal

    b) Average speed of molecules is also some

    c) Number of moles of each gas is also equal

    d) Density of nitrogen and oxygen is also equal

154. In the equation $PV = RT$, the value of R will not depend upon

    a) The nature of the gas   b) The temperature of the gas

    c) The pressure of the gas   d) Units of measurement

155. A 5-L flask containing 1.0 g of hydrogen is heated from 300 K to 600 K. Which of the following statement(s) is/are correct?

    a) The pressure of the gas increases

    b) The rate of collision increases

    c) The energy of the gaseous molecules increases

    d) The number of mole of the gas increases

156. Boyle's law may be expressed as

    a) $\left(\dfrac{dp}{dV}\right)_T = \dfrac{K}{V}$ b) $\left(\dfrac{dp}{dV}\right)_T = -\dfrac{K}{V^2}$ c) $\left(\dfrac{dp}{dV}\right)_T = \dfrac{K^2}{V}$ d) $V \propto \dfrac{1}{p}$

157. Boyle's law may be expressed as

    a) $(dP/dV)_T = K/V$ b) $(dP/dV)_T = -K/V^2$ c) $(dP/dV)_T = -K/V$ d) $V \propto 1/P$

158. Molecular attraction and size of the molecules in a gas are not negligible at

    a) Critical point   b) High pressure

    c) High temperature and low pressure   d) Low temperature and high pressure

159. Boyle's law may be expressed as:

    a) $(\partial P/\partial V)_T = K/V$

    b) $(\partial P/\partial V)_T = -K/V^2$

    c) $(\partial P/\partial V)_T = -KP^2$

    d) $V \propto 1/P$ at constant n, T

160. Select the correct statements

    a) Vapour may be condensed to liquid by the application of pressure

    b) To liquefy a gas one must lower the temperature below T_c and apply pressure

    c) At T_c, there is no distinction between liquid and vapour states

    d) At the T_c, density of liquid is very high as compared to its gaseous state

161. According to the kinetic theory of gases

    a) Pressure of a gas is due to collisions of molecules with each other

    b) Kinetic energy is proportional to square root of the temperature

    c) Pressure of a gas is due to collisions of molecules against the sides of the container

    d) There is no force of attraction between gas molecules

162. Consider the quantity $\frac{MkT}{PV}$ of an ideal gas where M is the mass of gas. It does not depend on the:
    a) Temperature of the gas
    b) Volume of the gas
    c) Pressure of the gas
    d) Nature of the gas

163. A gas can be liquefied if:
    a) Forces of attraction are low under ordinary conditions
    b) Forces of attraction are high under ordinary conditions
    c) Forces of attraction are zero under ordinary conditions
    d) Forces of attraction either high or low under ordinary conditions

164. Which of the following statements are incorrect for the internal pressure of a van der Waals' gas?
    a) It is independent of molar volume
    b) It is directly proportional to molar volume
    c) It is directly proportional to square of molar volume
    d) It is inversely proportional to square of molar volume

165. For two gases A and B with molecular weights M_A and M_B, respectively, it is observed that at a certain temperature T, the mean velocity of A is equal to the V_{rms} of B. Thus, the mean velocity of A can be made equal to the mean velocity of B, if
    a) A is at temperature T and B is at T' such that $T > T'$
    b) Temperature of A is lowered to T_2 while B is at T such that $T_2 < T$
    c) Both A and B are raised to a higher temperature
    d) Heat energy supplied to A

166. To raise the volume of the gas by four times, which of the following methods are correct?
    a) Temperature is doubled and pressure is halved
    b) Temperature is doubled and pressure is also doubled
    c) Temperature is constant and pressure is one fourth
    d) Keeping pressure constant, temperature raised by four times

167. Which are correct for an ideal gas?
    a) $\left(\frac{\partial P}{\partial V_M}\right)_{T_c} = 0$
    b) $\left(\frac{\partial E}{\partial V}\right)_T = 0$
    c) $\left(\frac{\partial E}{\partial P}\right)_T \neq 0$
    d) $\left(\frac{\partial n}{\partial V}\right)_{P,T} \neq 0$

168. If for two gases of molecular weights M_A and M_B at temperature T_A and T_B, respectively, $T_A M_B = T_B M_A$, then which property has the same magnitude for both the gases?
    a) PV if mass of gases taken are same
    b) Pressure
    c) KE per mole
    d) V_{rms}

169. Which of the following pair of gases will have same rate of diffusion under similar conditions?
    a) H_2 and He
    b) CO_2 and N_2O
    c) CO and C_2H_4
    d) NO and CO

170. In the equation $PV = RT$, the value of R will not depend on:
    a) The nature of the gas
    b) The temperature of the gas
    c) The pressure of the gas
    d) Units of measurement

171. Which of the following is/are the characteristics of a real gas?
    a) The molecules attract each other
    b) It shows deviations from the ideal gas law
    c) It obeys the gas law at low temperature and high pressure
    d) The mass of the molecules is negligible

172. Which of the following is/are correct unit of viscosity?
    a) $Nm^{-2}s$
    b) Dyne $cm^{-2}s$
    c) Poise
    d) NKm^{-2}

173. Which of the following statements is/are true?
    a) The ratio of the mean speed to the rms speed is independent of the temperature

b) The square of the mean speed of the molecules is equal to the square of the rms speed at a certain temperature

c) Mean kinetic energy of the gas molecules at any given temperature is independent of the mean speed

d) The difference between the rms speed and the mean speed at any temperature for different gases diminishes as larger, and yet larger molar masses are considered

174. One mole of which of the following will have 22.7 L at STP(1 bar, 273.15K)?

a) SO_2 b) He   c) H_2O d) CCl_4

175. To which of the following mixtures Dalton's law is not applicable?

a) CO_2 and CO at room temperature

b) Ammonia and hydrogen chloride at room temperature

c) NH_3 and steam at room temperature

d) He and H_2

176. Which of the following statements is/are correct about real gases?

a) The molecules do cause attractive forces on each another

b) They obey gas laws at low temperature and high pressure

c) They show deviations from ideal behaviour

d) The molecules have negligible mass

177. A graph plotted between $\log V$ and $\log T$ for 2 moles of gas at constant pressure of 0.0821 atm. V and T are in litre and K. Which of the following statements are not correct?

a) The curve is straight line with slope -1

b) The curve is straight line with slope $+1$

c) The intercept on Y-axis is equal to 2

d) The intercept on Y-axis is equal to 0.3010

178. Select the correct statement?

1. Greater is humidity, lesser will be rate of evaporation of water
2. Greater is the humidity, lesser will be density of air
3. If room temperature= dew point, relative humidity $= 100\%$
4. Dew point is the temperature at which the gas a given atmospheric condition becomes saturated with H_2O (v)

a) I, II   b) II, IV   c) All   d) None

179. Which of the following processes would lead to an increase in the average speed of the molecules of an ideal gas system?

a) Decreasing the temperature of the system

b) Compressing the gas with a piston

c) Expanding the gas into a vacuum

d) Heating the system keeping V and P constant

180. Chemical laws obeyed by all gases is/are:

a) Avogadro's law

b) Graham's law

c) Dulong and Petit's law

d) Boyle's law

181. Point A in the given curve shifts to higher value of velocity if
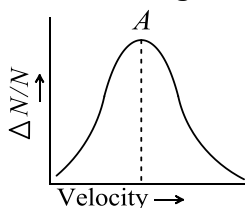
a) T is increased   b) P is decreased

c) V is decreased   d) Molecular weight M is decreased

182. The gas constant has units

a) L atm $K^{-1}mol^{-1}$ b) L atm$^{-1}K^{-1}mol^{-1}$ c) atm $cm^3K^{-1}mol^{-1}$ d) erg K^{-1}

183. Which of the following quantities is/are the same for all ideal gases at the same temperature?
    a) The kinetic energy of 1 mole
    b) The kinetic energy of 1 g
    c) The number of molecules in 1 mole
    d) The number of molecules in 1 g

184. According to kinetic theory of gases:
    a) Collisions are always elastic
    b) Heavier molecules transfer more momentum to the wall of the container
    c) Only a small number of molecules have very high velocity
    d) Between collisions, the molecules move in straight lines with constant velocities

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 185 to 184. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

185

Statement 1:	At low pressure, van der Waals' equation is reduced to $\left[P + \frac{a}{V^2}\right]V = RT$.
Statement 2:	The compressibility factor corresponding to low pressure is given by $1 - \frac{RTV}{a}$.

186

Statement 1:	Most probable velocity is the velocity possessed by maximum fraction of molecules at the same temperature
Statement 2:	On collision, more and more molecules acquire higher speed at the same temperature

187

Statement 1:	SO_2 gas is easily liquefied while H_2 is not
Statement 2:	SO_2 has low critical temperature while H_2 has high critical temperature

188

Statement 1:	On cooling, the brown colour of nitrogen dioxide disappears
Statement 2:	On cooling, NO_2 undergoes dimerization resulting in the pairing of the odd electron in NO_2

189

Statement 1:	The pressure of a fixed amount of an ideal gas is proportional to its temperature
Statement 2:	Frequency of collisions and their impact both increase in proportion of the square root of temperature

190

Statement 1: The value of van der Waals constant a is larger for ammonia than for nitrogen

Statement 2: Hydrogen bonding is present in ammonia

191

Statement 1: The hot air balloons in sports and for meteological observations is an application Charles law.

Statement 2: Hot air is less dense and hence gases expand on heating.

192

Statement 1: Helium shows only positive deviations from ideal behaviour

Statement 2: Helium is an inert gas

193

Statement 1: The pressure of a fixed amount of an ideal gas is proportional to its temperature

Statement 2: Frequency of collisions and their impact both increase in proportion to the square root of temperature

194

Statement 1: A lighter gas diffuse more rapidly than a heavier gas

Statement 2: At a given temperature, the rate of diffusion of a gas is inversely proportional to the square root of its density

195

Statement 1: Andrew's worked on a temporary gas (so called at that time) and derived the condition to liquefy the permanent gases (so called at that time).

Statement 2: Andrew studied isotherms of CO_2 and obtained the required condition for liquefaction of gas as $T_{gas} < T_c$ (critical temperature).

196

Statement 1: $\frac{1}{4}$Of the gas is expelled if air present in an open vessel is heated from 27°C to 127°C.

Statement 2: Rate of diffusion of a gas is inversely proportional to the square root of its molecular mass.

197

Statement 1: Compressibility factor (Z) for non ideal gases is always greater than 1

Statement 2: Non-ideal gases always exert higher pressure than expected

198

Statement 1: The compressibility factor less than one is due to the van der Waals' constant $'a'$ of a real gas

Statement 2: The compressibility factor less than one is due to excluded volume of the gas

199

Statement 1: H_2 and He show same ideal gas behaviour

Statement 2: All real gases deviate from ideal gas behaviour at low temperature and high pressure

200

Statement 1: Van der Waals equation is applicable only to non-ideal gases

Statement 2: Ideal gases obey the equation $PV = nRT$

201

Statement 1: The value of van der Waals' constant $'a'$ is larger for NH_3 than for N_2.

Statement 2: H-bonding is present in NH_3.

202

Statement 1: $\frac{n^2a}{V^2}$ in van der Waals' equation is a measure of the inter molecular forces

Statement 2: Easily condensable gases have comparatively higher values of the van der Waals' parameter 'a'

203

Statement 1: Doping of silicon with P or Al increases the conductivity

Statement 2: P gives rise to holes while Al gives rise to extra electrons

204

Statement 1: Gases are easily absorbed on the surface of metals, especially transition metals

Statement 2: Transition metals have free valencies

205

Statement 1: Ideal gas does not show Joule-Thomson effect as well as they cannot be liquefied.

Statement 2: $\left(\frac{\partial E}{\partial V}\right)_T$ and $\left(\frac{\partial T}{\partial P}\right)_H$ for ideal gas is zero.

206

Statement 1: The heat absorbed during the isothermal expansion of an ideal gas against vacuum is zero

Statement 2: The volume occupied by the molecules of an ideal gas is zero

207

Statement 1: The Poisson's ratio for diatomic gases is more than for monoatomic gases.

Statement 2: Diatomic gases possess more degree of freedom.

208

Statement 1: Compressibility factor z for non ideal gases is always greater than .

Statement 2: Non ideal gases always exert higher pressure than 1.

209

Statement 1: When the temperature is raised, the viscosity of the liquid decreases

Statement 2: Increase in temperature increases the average kinetic energy of molecule which overcome the attractive force between them

210

Statement 1: CO_2 above 31.1 °C and 600 bar pressure is used to remove caffeine from coffee beans.

Statement 2: CO_2 is gaseous in nature.

211

Statement 1: All molecules of an ideal gas more with the same speed

Statement 2: There is no attraction between the molecules in an ideal gas

212

Statement 1: $C_P - C_V = R$ for an ideal gas

Statement 2: $\left(\frac{\partial E}{\partial V}\right)_T = 0$ for an ideal gas

213

Statement 1: The plot of volume (V) versus pressure (P) at constant temperature is a hyperbola in the first quadrant

Statement 2: $V \propto 1/P$ at constant temperature

214

Statement 1: In the Schottky defect equal number of extra cations and electrons are present in the interstitial sites

Statement 2: In schottky defect equal number of cations and anions are missing

215

Statement 1: On compressing a gas to half the volume, the number of molecules is halved

Statement 2: The number of moles present decreases with decrease in volume

216

Statement 1: Noble gases can be liquefied

Statement 2: Attractive forces can exist between non-polar molecules

217

Statement 1: Greater the value of van der Waal's constant 'a' greater is the liquefication of gas.

Statement 2: 'a' indirectly measures the magnitude of attractive forces between the molecules.

218

Statement 1: In van der Waals equation
$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$
Pressure correction (a/V^2) is due to the force of attraction between molecules

Statement 2: Volume of gas molecule cannot be neglected due to force of attraction

219

Statement 1: If H_2 and Cl enclosed separately in the same vessel exert pressure of 100 and 200 mm respectively, their mixture in the same vessel at the same temperature will exert a pressure of 300 mm

Statement 2: Dalton's law of partial pressure states that total pressure is the sum of partial pressures

220

Statement 1: The conductivity of semiconductor increases with increase in temperature

Statement 2: The ionic solids conduct electricity due to presence of ions

221

Statement 1: The compressibility factor for H_2 and He is $\left[1 + \frac{Pb}{RT}\right]$

Statement 2: The compressibility factor for H_2 and He can be derived from van der Waals' equation.

222

Statement 1: At absolute zero temperature, vapour pressure, kinetic energy, and heat content of the gas reduce to zero

Statement 2: At absolute zero, temperature velocity reduces to zero

223

Statement 1: Molar specific heat at constant volume of an ideal diatomic gas is $\left[\frac{3}{2}R + R\right]$.

Statement 2: On heating an ideal diatomic gas at constant pressure, the increase in internal energy of gas is $\frac{7}{2}R$.

224

Statement 1: Nitrogen is unreactive at room temperature but becomes reactive at elevated temperature (on heating or in the presence of catalysts)

Statement 2: In nitrogen molecule, there is extensive delocalization of electrons

225

Statement 1: Sulphur dioxide and chlorine are bleaching agents

Statement 2: Both are reducing agents

226

Statement 1: At constant temperature, if pressure on the gas is doubled, density is also doubled

Statement 2: At constant temperature, molecular mass of a gas is directly proportional to the density and inversely proportional to the pressure

227

Statement 1: The numerical values of P_c, V_c, T_c are $\frac{a}{27b^2}, 3b$ and $\frac{8a}{27Rb}$ respectively.

Statement 2: The compressibility factor z at critical conditions is $\frac{3}{8}$.

228

Statement 1: Under similar conditions of temperature and pressure,O_2 diffuses 1.4 times faster than SO_2

Statement 2: Density of SO_2 is 1.4 times greater than that of O_2

229

Statement 1: In van der Waals' equation of gases, the kinetic equation of gas is modified

Statement 2: This modification is carried out with respect to actual volume of molecules and attractive forces between the gaseous molecules

230

Statement 1: A lighter gas diffuses more rapidly than a heavier gas

Statement 2: At a given temperature, the rate of diffusion of a gas is inversely proportional to the square root of its density

231

Statement 1: A gas can be easily liquefied at any temperature below its critical temperature

Statement 2: Liquification of a gas takes place when the average kinetic energy of the molecules is low

232

Statement 1: At 300K, kinetic energy of 16 g of methane is equal to the kinetic energy of 32 g of oxygen.

Statement 2: At constant temperature, kinetic energy of one mole of all gases is equal.

233

Statement 1: The numerical value of a for H_2O is higher than C_6H_6.

Statement 2: H_2O has H-bonding.

234

Statement 1: Crystalline solids are anisotropic

Statement 2: Crystalline solids are not as closely packed as amorphous solids

235

Statement 1: The solid NaCl is a bad conductor of electricity

Statement 2: In solid NaCl there is no velocity of ions

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

236. Match the items of columns I and II

<table>
<tr><td align="center">Column-I</td><td align="center">Column- II</td></tr>
</table>

(A)	Bar L mol^{-1}	(p)	Most probable speed
(B)	$(2RT/M)^{1/2}$	(q)	a/Rb
(C)	Boyle's temperature	(r)	$\propto P^{-1}$ at constant n and T
(D)	Mean free path	(s)	$\propto P^2$ at constant T
(E)	Collision frequency	(t)	Unit of ratio a/b

CODES :

	A	B	C	D	E
a)	p	t	r	s	q
b)	r	s	t	p	q
c)	q	r	p	q	q
d)	t	p	q	r	q

237. van der Waals' equation for

	Column-I		Column- II
(A)	High pressure	(p)	$PV = RT + Pb$
(B)	Low pressure	(q)	$PV = RT - \dfrac{a}{V}$
(C)	Force of attraction is negligible	(r)	$PV = RT + \dfrac{a}{V}$
(D)	Volume of molecules is negligible	(s)	$\left(P + \dfrac{a}{V^2}\right)(V - b) = RT$

CODES :

	A	B	C	D
a)	(i)	(iv)	(i)	(ii)
b)	(i)	(ii)	(iii)	(iv)
c)	(iv)	(iii)	(ii)	(i)
d)	(iv)	(ii)	(iii)	(i)

238. Match the items of columns I and II

	Column-I		Column- II
(A)	Critical temperature	(p)	Gas can be liquefied
(B)	Boyle's temperature	(q)	Deviate from ideal gas equation
(C)	Compressibility factor$(Z) < 1$	(r)	Gas follows the ideal gas equation
(D)	High temperature and low pressure	(s)	Assumption of no intermolecular force of attraction is valid

CODES :

	A	B	C	D
a)	r	s	p	q
b)	p	r	q	s
c)	s	q	r	p
d)	q	p	s	r

239. Match the items of columns I and II

Column-I		Column- II
(A)	Attractive tendency dominate	(p) $Z = 3/8$
(B)	At Boyle's temperature in the high pressure region	(q) $Z < 1$
(C)	For a gas at very low pressure and at very high temperature	(r) $Z > 1$
(D)	At the critical point	(s) $Z = 1$

CODES :

	A	B	C	D
a)	q	r	s	p
b)	r	q	p	s
c)	s	p	q	r
d)	p	s	r	q

240. Match the items of columns I and II

Column-I		Column- II
(A)	Unit of van der Waals constant a	(p) $dyn\ cm^{-2}s$
(B)	Unit of van der Waals constant b	(q) $dyn\ cm^{-1}$
(C)	Unit of R	(r) $J\ K^{-1}mol^{-1}$
(D)	Unit of surface tension (r)	(s) $atm\ L^2\ mol^{-2}$
(E)	Unit of coefficient of viscocity n	(t) $L\ mol^{-1}$

CODES :

	A	B	C	D	E
a)	t	s	p	q	r
b)	r	p	q	s	r
c)	s	t	r	q	r
d)	p	q	t	r	r

241. Match the items of columns I and II

Column-I	Column- II
(A) Boyle's law	(p)
(B) Charles' law	(q)
(C) Gay-Lussac's law	(r)
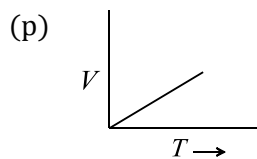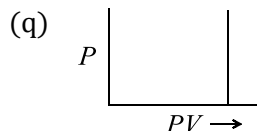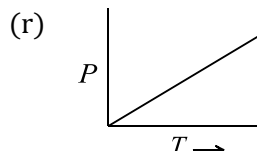
CODES :

	A	B	C	D
a)	q	p	r	
b)	p	r	q	
c)	r	q	p	
d)	q	r	p	

242. Match the items of columns I and II

Column-I	Column- II
(A) Z for ideal gas	(p) $3/8$
(B) Z for real gas at low P	(q) $\left(1 + \dfrac{Pb}{RT}\right)$
(C) Z for real gas at high P	(r) 1
(D) Z for critical state	(s) $\left(1 - \dfrac{a}{RTV}\right)$

CODES :

	A	B	C	D
a)	p	q	s	r
b)	r	s	q	p
c)	q	p	r	s
d)	s	r	p	q

243.

Column-I	Column- II
(A) Boyle's temperature	(1) $\dfrac{8a}{27Rb}$

(B) Reduced temperature $\qquad$ (2) $\dfrac{a}{Rb}$

(C) Inversion temperature $\qquad$ (3) $\dfrac{2a}{Rb}$

(D) Critical temperature $\qquad$ (4) $\dfrac{T}{T_c}$

CODES:

	A	B	C	D
a)	4	3	1	2
b)	2	4	3	1
c)	1	2	3	4
d)	3	1	2	4

244. Match the items of columns I and II

Column-I	Column- II
(A) Co-volume	**(p)** Molar volume of ideal gas
(B) Compressibility factor	**(q)** Van der Waals constant b
(C) Work done degree^{-1}mol^{-1}	**(r)** Depends on T and nature of liquid
(D) 22.7 L at STP	**(s)** PV/nRT
(E) Vapour pressure of liquid	**(t)** Universal gas constant

CODES:

	A	B	C	D	E
a)	p	q	r	s	t
b)	t	r	s	q	t
c)	q	s	t	p	t
d)	r	t	p	s	t

245. Match the items of columns I and II

Column-I	Column- II
(A) Diffusion of gas	**(p)** High when molecular mass is low
(B) Compressibility of gas $(Z) < 1$	**(q)** $V_{real} < V_{ideal}$
(C) V_{rms}	**(r)** Increases with increase in temperature
(D) Liquification of gas	**(s)** Attractive force dominates

CODES:

	A	B	C	D

a)	q	p	s	r
b)	r	s	q	p
c)	p	q	r	s
d)	s	r	p	q

246.

Column-I	Column- II
(A) Kinetic energy of 1 mole gas	(1) $\sqrt{2\,KE/M}$
(B) Root mean square speed	(2) $\dfrac{3PV}{2}$
(C) Average speed	(3) $\sqrt{\dfrac{8P}{\pi d}}$
(D) Most probable speed	(4) $\sqrt{4\,KE/3M}$

CODES :

	A	B	C	D
a)	2	1	3	4
b)	4	2	3	1
c)	1	2	3	4
d)	3	4	1	2

247. Match the items of columns I and II

Column-I	Column- II
(A) Boyle's law	(p) $V \propto T$
(B) Charles' law	(q) $P_{\text{total}} = P_A + P_B + \cdots$
(C) Gay-Lussac's law	(r) $V \propto 1/P$
(D) Dalton's law	(s) $P \propto T$

CODES :

	A	B	C	D
a)	s	q	p	r
b)	r	p	s	q
c)	p	r	q	p
d)	q	s	r	s

248. Match the items of columns I and II

	Column-I		Column- II
(A)	Graham's law of diffusion	(p)	$\left(P + \dfrac{an^2}{V^2}\right)(V - nb) = nRT$
(B)	Ideal gas law	(q)	$V \propto n$
(C)	Avogadro gas law	(r)	$PV = nRT$
(D)	Van der Waals gas equation	(s)	$r \propto \sqrt{1/M}$

CODES :

	A	B	C	D
a)	s	r	q	p
b)	r	p	s	q
c)	p	q	r	s
d)	q	s	p	r

Linked Comprehension Type

This section contain(s) 33 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 249 to -249

Sketch shows the plot of Z vs p for a $hypothetical$ gas for one $mole$ at
three distinct temperature
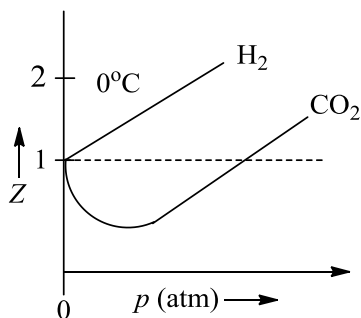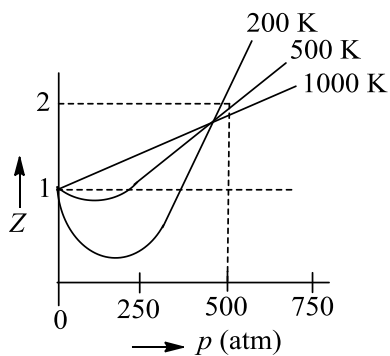
Boyle's temperature is the temperature at which a gas shows ideal behaviour over a pressure range in the low pressure region. Boyle's temperature $(T_b) = \dfrac{a}{Rb}$. If a plot is obtained at temperature below Boyle's temperature then the curve will show negative deviation in low pressure region and positive deviation in the high pressure region. Near critical temperature, the curve is more likely as CO_2 and the temperature above critical temperature curve is more like H_2 at $0°C$

249. For 500 K plot value of Z changes from 2 to 2.2 if pressure is varied from 1000 atm to 1200 atm (high pressure) then the value of $\frac{b}{RT}$ will be

a) 10^{-4} atm^{-1} b) 10^{-3} atm^{-1} c) 10^{-5} atm^{-1} d) 0.10 atm^{-1}

Paragraph for Question Nos. 250 to - 250

The pressure volume relationship for gases helps to explain the mechanics of breathing. When we breathe in, the diaphragm is lowered and the chest wall is expanded, increasing the volume of the chest cavity. Boyle's law tells us that the pressure inside the cavity must decrease outside air enters the lungs because it is at a higher pressure than the air in the chest cavity. When we breathe out the diaphragm rises and the chest will contract decreasing the volume of chest cavity

250. A 15.0 L cylinder of Ar gas is connected to an evacuated 235.0 L tank. If the final pressure is 750 mm Hg. What have been the original gas pressure in the cylinder?

a) 76 atm b) 12.56 atm c) 16.45 atm d) 23 atm

Paragraph for Question Nos. 251 to - 251

Van der Waals' equation for calculating the pressure of a non ideal gas is

$$\left(p + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

Van der Waals' suggested that the pressure exerted by an ideal gas, p_{ideal} is related to the experimentally measured pressure, p_{real} by the equation,

$$p_{\text{ideal}} = p_{\text{real}} + \frac{an^2}{V^2}$$

Constant $'a'$ is measure of intermolecular interaction between gaseous molecules that gives rise to non-ideal behaviour depends on how frequently any two molecules approach each other closely. Another correction concerns the volume occupied by the gas molecules. In the ideal gas equation, V represents the volume of the container. However each molecules does occupy a finite although small, intrinsic volume, so the effective volume of the gas becomes $(V - nb)$, where n is the number of moles of the gas and b is a constant

251. Which of the following represents a plot of compressibility factor (Z) vs p at room temperature for He?
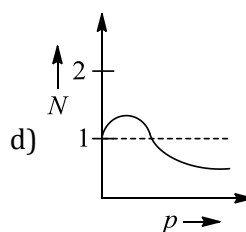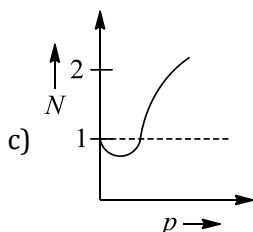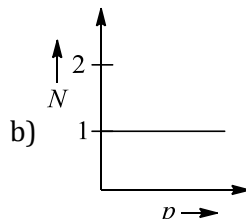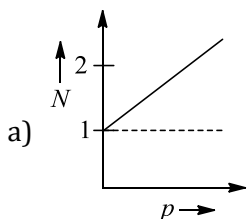
Paragraph for Question Nos. 252 to - 252

In simple cubic lattice, the spheres are packed in the form of a square array by laying down a base of spheres and then piling upon the base other layers in such a way that each sphere is immediately above the other sphere. In this structure, each sphere is in contact with six nearest neighbours. The percentage of occupied volume in this structure can be calculated as follows

The edge length 'a' of the cube will be twice the radius of the sphere, $ie, a = 2r$. Since, in the primitive cubic lattice, there is only one sphere present in the unit lattice, the volume occupied by the sphere is
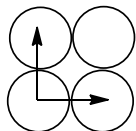
$V = \frac{4}{3}\pi r^3$ or $V = \frac{4}{3}\pi \left(\frac{a}{2}\right)^3$

The fraction of the total volume occupied by the sphere is

$\phi = \dfrac{\frac{4}{3}\pi \left(\frac{a}{2}\right)^3}{a^3} = \dfrac{\pi}{6} = 0.5236 \ or \ 52.36\%$

252. In a simple cubic cell, an atom at the corner contributes to the unit cell

    a) $\frac{1}{4}$ part   b) $\frac{1}{2}$ part   c) 1 part   d) $\frac{1}{8}$ part

Paragraph for Question Nos. 253 to - 253

While dealing with X-ray diffraction, it is more convenient to express higher order reflections in terms of the first order reflection from planes of higher (hkl). For example, a second order reflection from (111) planes may be considered equivalent to the first order reflection from (222) planes. Similarly a third order reflection from (111) planes may be considered as the first order reflection from (333) planes. This fact can be introduced into the Bragg equation $n\lambda = 2d \sin \theta$ by rewriting it as

$\lambda = 2\left(\frac{d}{n}\right) \sin \theta$

$= 2d_{hkl} \sin \theta$

Where, d_{hkl} is the perpendicular distance between adjacent planes having the indices (hkl)

253. (hkl) represents

   a) Crystal faces   b) Lattice parameter   c) Crystal systems   d) Miller indices

Paragraph for Question Nos. 254 to - 254

The figure given below shows three glass chambers that are connected by valves of negligible volume. At the outset of an experiment, the valves are closed and the chambers contain the gases as detailed in the diagram. All the chambers are at the temperature of 300 K and external pressure of 1.0 atm

$P_{ext} = 1.0$ atm

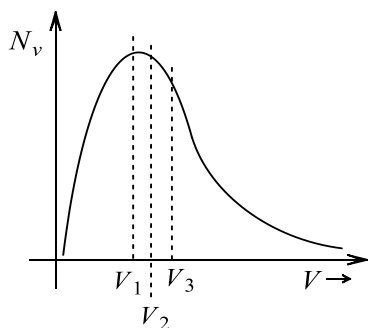$P_{ext} = 1.0$ atm   Throughout $T = 300$ K
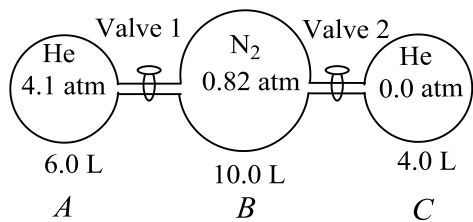
254. What will be the work done by N_2 gas when valve 2 is opened and value 1 remains closed?
    a) 8.2 L atm   b) -8.2 atm   c) 0   d) -3.28 L atm

Paragraph for Question Nos. 255 to - 255

The distribution of the molecular velocities of gas molecules at any temperature T is shown below. (The plot below is known as **Maxwell's distribution of molecular speeds.)**

Where
v is molecular velocity
n is number of molecules having velocity v
Let us define ΔN_v, which is equal to the number of molecules between the velocity range v and $v + \Delta v$, given by
$\Delta N_v = 4\pi N a^3 e^{-bv^2} v^2 \Delta v$
Where
N is total number of molecules
$a = \sqrt{\dfrac{M_0}{2\pi RT}}$ and $b = \sqrt{\dfrac{M_0}{2RT}}$
R is universal gas constant
T is temperature of the gas
M_0 is molecular weight of the gas

255. SI units of a are
    a) M^3 b) $m^{-1}s$ c) $m^2 s^{-2}$ d) $m\, s^2$

Paragraph for Question Nos. 256 to - 256

Two flasks A and B have equal volume. A is maintained at 300 K and B at 600 K. While A contains H_2 gas, B has an equal mass of CH_4 gas. Assuming ideal behaviours for both the gases, answer the following:

256. Flask containing greater number of molecules
    a) A b) B c) Both A and B d) None

Paragraph for Question Nos. 257 to - 257

The van der Waals constant for gases $A, B,$ and C are as follows:

Gas	$a(\text{dm}^6 \text{ kPa mol}^{-2})$	$b(\text{dm}^3 \text{ mol}^{-1})$
A	405.3	0.027
B	1215.9	0.030
C	607.95	0.032

Answer the following:

257. Which gas has the highest critical temperature?
   a) A b) B c) C d) None

Paragraph for Question Nos. 258 to - 258

For the given ideal gas equation $PV = nRT$, answer the following questions:

258. In the above equation, the value of universal gas constant depends only upon
   a) The nature of the gas   b) The pressure of the gas
   c) The temperature of the gas   d) The units of measurement

Paragraph for Question Nos. 259 to - 259

Using van der Waals equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, answer the following equations:

259. The van der Waals equation explains the behaviour of
   a) Ideal gases   b) Real gases   c) Vapours   d) Non-real gases

Paragraph for Question Nos. 260 to - 260

Compressibility factor $Z = \frac{PV}{RT}$. Considering ideal gas, real gas, and gases at critical state, answer the following questions:

260. The compressibility factor of an ideal gas is
   a) 0   b) 1   c) 2   d) 3

Paragraph for Question Nos. 261 to - 261

Two gaseous molecules A and B are traveling towards each other. Let the mean free path of the molecule be σ and Z be the collision number with other molecules at pressure 1 atm. Answer the following questions

261. The free path of a gas molecule is the distance
   a) Between the two opposite walls of the container
   b) That molecules travel in the second
   c) Through which a molecule moves between two successive collisions

d) None of these

Paragraph for Question Nos. 262 to - 262

The constant motion and high velocities of gas particles lead to some important practical consequences. One such consequence is that gases mix rapidly when they come in contact. Take the stopper off a bottle of perfume, for instance, and the odour will spread rapidly through the room as perfume molecules mix with the molecules in the air. This mixing of different gases by random molecular motion and with frequent collision is called diffusion. A similar process in which gas molecules escape without collision through a tiny hole into a vaccum is called effusion. Both the processes follow Graham's law which is mathematically put as $r \propto \sqrt{1/d}$. The average distance travelled by molecules between successive collisions is called mean free path
Answer the following questions on the basis of the above information:

262. The stopcocks of the bulbs X (containing NH_3) and Y (containing HCl), both under identical conditions, are opened simultaneously. White fumes of NH_4Cl, are formed at point B. If AB =36.5 cm, then BC is approximately

White fumes

$$NH_3 \quad A \quad C$$
$$X \quad B \quad Y$$
HCl
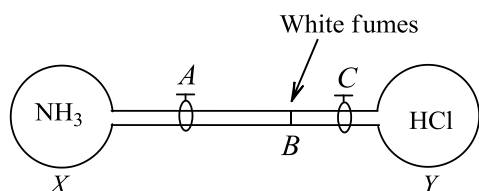
a) 18.0 cm   b) 25.0 cm   c) 20.0 cm   d) 36.5 cm

Paragraph for Question Nos. 263 to - 263

The behaviour of ideal gas is governed by various gas laws which are described by mathematical statements as given below:
1. $PV = k$ (constant) at constant n and T
2. $V/T = k_2$ (constant) at constant n and P
3. $V/n = k_3$ (constant) at constant T and P
4. $PV = nRT$
5. $P/T = k_4$ (constant) at constant n and V
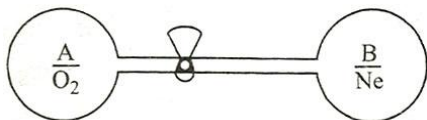Answer the following

263. The value of k_2 is
    a) Independent of nature and amount of gas
    b) Depends on temperature and pressure conditions
    c) Depends on pressure and amount of gas
    d) Depends only on nature of gas

Paragraph for Question Nos. 264 to - 264
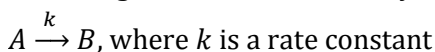
Consider the adjacent diagram. Initially, flask A contained oxygen gas at 27°C and 950 mm of Hg, and flask B contained neon gas at 27°C and 900 mm. Finally, two flask were joined by means of a narrow tube of negligible volume equipped with a stopcock and gases were allowed to mixup freely. The final pressure in the combined system was found to be 910 mm of Hg

264. Which of the following statements concerning oxygen and neon gas is true in the beginning, when the stopcock was just opened?
    a) O_2 moved at faster rate toward flask B
    b) Ne moved at faster rate towards flask A
    c) Both O_2 and Ne gases moves at equal rate
    d) Insufficient information to compare the rate of effusion

Paragraph for Question Nos. 265 to - 265

The system shown in the figure is in equilibrium, where A and B are isomeric liquids and form an ideal solution at T K. Standard vapour pressures of A and B are P_A^0 and P_B^0, respectively, at T K. We collect the vapour of A and B in two containers of volume V, first container is maintained at $2T$ K and second container is maintained at $3T/2$. At the temperature greater than T K, both A and B exist in only gaseous form
We assume than collected gases behave ideally at $2T$ K and there may take place an isomerization reaction in which A gets converted into B by first-order kinetics reaction given as:
$A \xrightarrow{k} B$, where k is a rate constant
In container (II) at the given temperature $3T/2$, A and B are ideal in nature and non reacting in nature. A small pin hole is made into container. We can determine the initial rate of effusion of both gases in vacuum by the expression
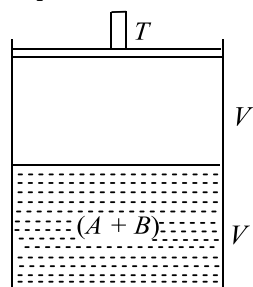
$$r = K \cdot \frac{P}{\sqrt{M_0}}$$

Where, P =pressure difference between system and surrounding
K =positive constant
M_0 =molecular weight of the gas

265. If partial vapour pressure of A is twice that of partial vapour pressure of B and total pressure 2 atm at T K, where $T = 50$ K and $V = 8.21$ L, then the number of moles of A and B in vapour phase is:
    a) $\frac{8}{3}, \frac{4}{3}$
    b) $\frac{4}{3}, \frac{1}{3}$
    c) $\frac{2}{3}, \frac{1}{4}$
    d) $\frac{10}{3}, \frac{4}{3}$

Paragraph for Question Nos. 266 to - 266

200 g of gas $'X'(c_p = 0.125$ cal/g and $c_v = 0.075$ cal/g) is placed in a container of 5 litre volume at pressure P and temperature 27°C. The gas is heated from 27°C to 327°C. It shows positive deviation, $i.e., Z > 1$ at high pressure.

266. Which of the following statement is wrong about the gas?
   a) The gas is monoatomic
   b) The gas is He
   c) The gas is a rare gas or inert gas
   d) The number of molecules of gas in 10 g $= 1.506 \times 10^{23}$

Paragraph for Question Nos. 267 to - 267

Ideal gas obey $PV = nRT$ at all the conditions of P and T. At STP all the gases deviate from ideal behaviour. All gases are thus real gases, however they behave ideally at Boyle's temperature $T_B = \frac{a}{Rb}$. van der Waals' suggested a modified gas equation to describe the behaviour of real gases over wider range of pressure and temperature. The van der Waals' equation for one mole of gas is written as:

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

If n moles of gas are present in volume V; the volume of one mole of gas would be $\frac{V}{n}$. So, van der Waals' equation changes to

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

where, P, V and T are the observed pressure, volume and temperature for the gas under study. $'a'$ and $'b'$ are van der Waals' parameters, ($i.e.$, constant of attraction and constant of volume respectively) which vary from gas to gas. The parameters a and b take care of the intermolecular forces and size of the molecules respectively.

267. At high pressure, the van der Waals' equation is reduced to
   a) $\left(P + \frac{n^2 a}{V^2}\right) = nRT$ b) $P(V - b) = nRT$ c) $P(V - nb) = nRT$ d) $PV = nRT$

Integer Answer Type

268. Root mean square speed of a gas is 5 ms^{-1}. If some molecules out of 10 molecules in all are moving with 7 ms^{-1} and rest all the molecules moving with 3 m sec^{-1}, then number of molecules moving with higher speed is ...

269. A certain gas is at a temperature of 350 K. If the temperature is raised to 700 K, the average translational kinetic energy of the gas will increase by
   a) 2   b) 3   c) 4   d) 5

270. The value of compressibility factor (Z) for an ideal gas is
   a) 2   b) 1   c) 3   d) 4

271. A cylinder containing 5 litre of O_2 at 25°C was leaking. When the leakage was detected and checked, the pressure inside cylinder was reduced from 8 atm to 2 atm. The ratio of amount of O_2 initially present to that left after leakage is equal to ...

272. A gas having molecular formula O_n. If its vapour density is 24. The value of n is ...

273. The rate of diffusion of methane is twice that of X. The molecular mass of X is divided by 32. What is value of x is?
   a) 1   b) 2   c) 3   d) 4

274. What is the ratio of diffusion of gas A and B. The molecular mass of A is 11 and molecular mass of B is 44
   a) 1   b) 2   c) 3   d) 4

275. 16 mL of He gas effuse through a pin hole in 4 sec from a container having P_{He} equal to 1 atm. If same container is filled with CH_4 having pressure 2 atm, how much volume (in mL) of CH_4 will be leaked through same pin hole in 2 sec.

276. The ratio of excluded volume (b) to molar volume of a gas molecule is
    a) 1   b) 2   c) 3   d) 4
277. Molecular weight of air is 28.80. The volume of N_2 (in mL) in 10 mL of sample of this air is…
278. The ratio of rate of diffusion of He (at 4 atm) and CH_4 (1 atm) through same pin hole at constant temperature is …
279. Calculate the moles of an ideal gas at pressure 2 atm and volume 1 L at a temperature of 97.5 K
    a) 1   b) 2   c) 3   d) 4
280. The mass of molecule A is twice the mass of molecule B. The rms speed of A is twice the rms speed of B. If two samples of A and B contain same number of molecule, the ratio of pressure of gas samples of A and B in separate containers of equal volume is ….
281. What is the average speed of a molecule, having a molecular mass of 529.5 g mol^{-1}. At temperature 100 K
    a) 1   b) 2   c) 3   d) 4
282. A bulb is having ideal gas at 27°C. On heating the bulb to 227°C, 2 litre of gas measured at 227°C is expelled out. The volume of bulb in litre is …
283. The ratio of the inversion temperature of a gas to its Boyle temperature is
    a) 1   b) 2   c) 3   d) 4
284. A metallic carbonyl $M(CO)_X$, is in gaseous state. The rate of diffusion of CH_4 is 3.31 time faster than this gas under identical conditions. If at. weight of metal is 63.29, the closest integer value of X is …
285. At 400 K, the root mean square speed of a gas (molecular weight $= 40$) is equal to the most probable speed of gas y at 60 K. The molecular weight of the gas y is:
286. Initial volume of a gas is 1 L at temperature 100 K. What is the volume of a gas at 300 K
    a) 1   b) 2   c) 3   d) 4
287. U_{rms} of CH_4 at TK is 6 times of U_{mp} of SO_2 at T_1K. The temperature of CH_4 gas is … times of SO_2 is ..
288. To an evacuated vessel with movable piston under external pressure of 1 atm.,0.1 mole of He and 1.0 mol of an unknown compound (vapour pressure 0.68 atm. at 0°C) are introduced. Considering the ideal gas behaviour, the total volume (in litre) of the gases at 0°C is close to …
289. 5 mL of a liquid [$V.P. = 8$ cm at 400 K] having density 0.02 g/mL is placed in a container of 4 litre. It is connected to another empty container of 4 litre at 400 K. The resultant pressure of liquid shown is …
290. A 10 L box contains 41.4 g of a mixture of gases C_xH_8 and C_xH_{12}. The total pressure at 44°C in flask is 1.56 atm. Analysis revealed that the gas mixture has 87% total C and 13% total H. Find out the value of x
    a) 1   b) 3   c) 5   d) 2

: ANSWER KEY :

Q	A	Q	A	Q	A	Q	A
1)	d	2)	a	3)	a	4)	a
5)	d	6)	d	7)	b	8)	b
9)	c	10)	a	11)	a	12)	d
13)	a	14)	b	15)	a	16)	b
17)	c	18)	c	19)	a	20)	b
21)	b	22)	d	23)	c	24)	b
25)	c	26)	c	27)	b	28)	a
29)	c	30)	a	31)	b	32)	d
33)	c	34)	b	35)	b	36)	d
37)	d	38)	d	39)	a	40)	a
41)	a	42)	d	43)	b	44)	d
45)	b	46)	b	47)	c	48)	b
49)	a	50)	a	51)	c	52)	d
53)	c	54)	b	55)	a	56)	a
57)	d	58)	c	59)	c	60)	b
61)	b	62)	a	63)	d	64)	c
65)	b	66)	a	67)	d	68)	a
69)	d	70)	c	71)	c	72)	c
73)	c	74)	d	75)	d	76)	a
77)	a	78)	a	79)	c	80)	b
81)	c	82)	b	83)	b	84)	c
85)	c	86)	b	87)	b	88)	a
89)	a	90)	c	91)	d	92)	a
93)	b	94)	b	95)	a	96)	c
97)	c	98)	a	99)	c	100)	c
101)	b	102)	d	103)	b	104)	b
105)	c	106)	c	107)	c	108)	a
109)	d	110)	b	111)	b	112)	b
113)	c	114)	a	115)	c	116)	b

Q	A	Q	A	Q	A	Q	A
1)	a,b	2)	a,b,c,d	3)	b,d	4)	a,c,d
5)	a,b,c,d	6)	a,b,c	7)	a,d	8)	
9)	a,d	10)	a,c	11)	a,b,d	12)	a,b
13)	a,b,d	14)	a,d	15)	a,b,c,d	16)	a,c
17)	a,b,c	18)	b,c	19)	c,d	20)	a,b,d
21)	a,b	22)	a,c,d	23)	c,d	24)	a,b,c,d
25)	a,b,c	26)	a,b,d	27)	b,c,d	28)	b,c
29)	a,b,c	30)	b,c,d	31)	b,d	32)	a,c
33)	a,d	34)	a,c	35)	a,c,d	36)	c,d
37)	a,b,d	38)	a,b,c	39)	a,b,c	40)	b,d
41)	b,d	42)	a,b,d	43)	b,c,d	44)	a,b,c
45)	c,d	46)	a,b,c	47)	a,b,d	48)	a,b,c
49)	a,d	50)	a,c,d	51)	a,b,d	52)	a,d
53)	b,c	54)	a,b,c	55)	a,b	56)	a,b,c
57)	a,c,d	58)	a	59)	b,c	60)	a,c
61)	b,d	62)	a,b	63)	b,d	64)	a,b,d
65)	a,d	66)	a,c	67)	a,c	68)	a,b,c,d

Q	A	Q	A	Q	A	Q	A
1)	a	2)	c	3)	c	4)	a
5)	c	6)	a	7)	a	8)	b
9)	d	10)	b	11)	c	12)	b
13)	e	14)	c	15)	b	16)	b
17)	c	18)	b	19)	c	20)	a
21)	c	22)	b	23)	b	24)	d
25)	a	26)	b	27)	d	28)	b
29)	a	30)	d	31)	e	32)	a
33)	a	34)	c	35)	d	36)	c
37)	c	38)	a	39)	d	40)	c
41)	c	42)	c	43)	d	44)	c
45)	a	46)	a	47)	a	48)	a
49)	b	50)	a	51)	a		

Q	A	Q	A	Q	A	Q	A
1)	d	2)	a	3)	b	4)	a
5)	c	6)	a	7)	b	8)	b
9)	c	10)	c	11)	a	12)	b
13)	a						

Q	A	Q	A	Q	A	Q	A
1)	b	2)	c	3)	a	4)	d
5)	d	6)	c	7)	b	8)	a
9)	b	10)	d	11)	b	12)	b
13)	c	14)	b	15)	b	16)	b
17)	a	18)	b	19)	c		

Q	A	Q	A	Q	A	Q	A
1)	4	2)	a	3)	b	4)	4
5)	3	6)	b	7)	b	8)	8
9)	d	10)	8	11)	8	12)	d
13)	8	14)	b	15)	3	16)	b
17)	4	18)	4	19)	c	20)	6
21)	7	22)	8	23)	c		

: HINTS AND SOLUTIONS :

1 **(d)**

The expression of root mean square speed is

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

$$= \sqrt{\frac{3p}{M/V_m}} = \sqrt{\frac{3p}{\rho}}$$

2 **(a)**

Given

$V_1 = 100$ mL

$P_1 = 10.4$ Pa

$V_2 = ?$

$P_2 = 105$ Pa

$P_1 V_1 = P_2 V_2$

$\therefore V_2 = \dfrac{P_1 V_1}{P_2} = \dfrac{105 \times 100}{10.4} = 10$ mL

3 **(a)**

For n mol of a real gas

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

When volume of molecules can't be neglected,

$P(V - nb) = nRT$

$PV = nRT + nbp$

when $\frac{n^2 a}{V^2} \neq 0$

$$\left(P + \frac{n^2 a}{V^2}\right) V = nRT$$

$$PV + \frac{n^2 a}{V} = nRT$$

$$PV = nRT - \frac{n^2 a}{V}$$

4 **(a)**

$Z = \dfrac{PV}{nRT} = 0.5$

Now, $\left[P + \frac{n^2 a}{V^2}\right][V - nb] = nRT$

$\left[P + \frac{n^2 a}{V^2}\right][V] = nRT$ (b is negligible)

$PV^2 - nRTV + n^2 a = 0$

$\therefore V = \dfrac{nRT \pm \sqrt{n^2 R^2 T^2 - 4n^2 a \times b}}{2P}$

Since, V is constant at given P and T, thus, discriminant is 0

$\therefore n^2 R^2 T^2 = 4n^2 aP$ or $a = \dfrac{R^2 T^2}{4P}$

$= \dfrac{(0.0821)^2 \times (273)^2}{4 \times 100}$

$= 1.256$ L mol^{-2} atm

5 **(d)**

Molar ratio of N_2 and CO is 3:2, i.e., 300 bar and 200 bar, respectively

$$\frac{n_{N_2}}{n_{CO}} = \sqrt{\frac{m_{CO}}{m N_2}} \times \frac{P_{N_2}}{P_{CO}} = \frac{300}{200} = \frac{3}{2}$$

7 **(b)**

Compressibility factor

$$Z = \frac{PV}{nRT}$$

For ideal gas, $PV = nRT$, so $Z = 1$

8 **(b)**

$$V_{rms} = V_{mps}$$

$$\sqrt{\frac{3RT}{M(X)}} = \sqrt{\frac{2RT'}{M(Y)}}$$

$$\Rightarrow \sqrt{\frac{3R \times 400}{40}} = \sqrt{\frac{2R \times 60}{M(Y)}}$$

$$\Rightarrow \quad M(Y) = 4$$

9 **(c)**

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

The van der Waals constant a is used in presence correction, and its value depends upon the intermolecular forces between the gas molecules The larger the value of a for a gas, the more easily that gas van be liquefied

10 **(a)**

$\dfrac{P_1 V_1}{T_1} = \dfrac{P_2 V_2}{T_2}$; $\begin{bmatrix} V_1 = \text{inital} \\ V_2 = \text{final volume} \end{bmatrix}$

$\dfrac{PV_1}{T} = \dfrac{P}{4} \times \dfrac{V_2}{2T} \Rightarrow V_1 = \dfrac{V_2}{8} \Rightarrow V_2 = 8V_1$

11 **(a)**

$$\chi_M = \frac{P_M}{P'} = \frac{1}{\chi_M} \frac{V_M}{V'}$$

$$\therefore \chi_M = \frac{1}{\chi_M} = \frac{1}{\chi_M}$$

12 **(d)**

For n mol of a real gas

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

When volume of molecules can't be neglected,

$P(V - nb) = nRT$

$PV = nRT + nbp$

13 **(a)**

$PV = nRT$

$n = \dfrac{PV}{RT}$

Number of molecules $= N_A \dfrac{PV}{RT}$

$= \dfrac{PV}{(R/N_A)T} = \dfrac{PV}{RT}$

Where $K_B =$ Boltzman constant

15 **(a)**

Effective pressure$= 750 - 100 = 650$ torr

Use $\dfrac{P_1 V_1}{T_1} = \dfrac{P_2 V_2}{T_2}$

16 **(b)**

For the same volume diffused,

$t \propto M$ (Graham's law)

$\dfrac{t_1}{t_2} = \sqrt{\dfrac{M_1}{M_2}}$

1. $\quad \dfrac{5}{10} \neq \sqrt{\dfrac{2}{4}}$

2. $\quad \dfrac{5}{20} = \sqrt{\dfrac{2}{32}}$

3. $\quad \dfrac{5}{25} \neq \sqrt{\dfrac{2}{28}}$

4. $\quad \dfrac{5}{55} \neq \sqrt{\dfrac{2}{44}}$

17 **(c)**

1 mol of $O_2 = 1$ mol SO_2

32 g $O_2 = 64$ g SO_2

18 **(c)**

$\mu_{av} = \sqrt{\dfrac{8RT}{\pi M}}$

19 **(a)**

$\dfrac{r_{methane}}{r_{gas}} = \sqrt{\dfrac{M_{gas}}{M_{ethane}}}$ (Graham's law)

Or $2 = \sqrt{\dfrac{M_{gas}}{16}}$

Or $M_{gas} = 64$

20 **(b)**

$\mu_{rms} = \sqrt{\dfrac{3\,RT}{M}}$

$M_{CO_2} = 44$ g

$M_{C_3H_8} = 44$ g

$\therefore (\mu_{rms})_{CO_2} = (\mu_{rms})_{C_3H_8}$

22 **(d)**

According to Graham's law of diffusion, the rate at which a gas diffuses is inversely proportional to

the density of the gas. The movement of gas molecules from one place to the other along the concentration gradient is called diffusion. When they are allowed to escape through a tiny hole under pressure, this phenomenon is called effusion

Rate of diffusion of gas

$= \dfrac{\text{Volume of the gas diffusion}}{\text{Time taken}}$

$r \propto \dfrac{1}{\sqrt{d}}$

$\dfrac{r_1}{r_2} = \sqrt{\dfrac{d_2}{d_1}}$

Since the vapour density is $M/2$ (molar mass)

$\dfrac{r_1}{r_2} = \sqrt{\dfrac{M_2}{M_1}}$

23 **(c)**

For real behaviour, $\dfrac{PV}{RT} \neq 1$

24 **(b)**

$Z = \dfrac{PV}{nRT} \Rightarrow n = \dfrac{PV}{nRT} = \dfrac{1 \times 1}{1.2 \times 0.0821 \times 273}$

$\qquad\qquad = 0.037$

$\therefore$ Number of molecules $= 0.037 \times 6.023 \times 10^{23}$

$= 2.23 \times 10^{22}$

25 **(c)**

$P_1 V_1 = n_1 RT_1$

$P_2 V_2 = n_2 RT_2$

$\dfrac{n_2}{n_1} = \dfrac{T_1}{T_2} = \dfrac{300}{400} = \dfrac{3}{4}$

$n_2 = \dfrac{3}{4} n_1$

Escaped $= \dfrac{1}{4}$

26 **(c)**

Gases and liquid do not posses definite volume

27 **(b)**

$PV = \dfrac{w}{m} RT$ (for vapours of H_2O)

$P = 3.6 \times 10^3 \, \text{Pa}; V = 2 \times 10^{-3} \text{m}^3; T = 300$ K

$\therefore w_{H_2O} = \dfrac{3.6 \times 10^3 \times 18 \times 2 \times 10^{-3}}{8.314 \times 300 = 0.052}$

$w_{H_2O} = 52$ g

Since, relative humidity $= 60\%$, therefore, amount of $H_2O = 52 \times 0.6 = 31.2$ g

28 **(a)**

Pressure on the walls of the container is equal to the change of momentum per unit area. At constant volume, for a fixed number of moles of a gas, the pressure increases with rise in temperature due to increase in average molecular speed. This increases the change in momentum

during collisions

29 (c)

Charles' law $V \propto T$

30 (a)

$P_1 = 730$ mm

$V_1 = 730$ mL

$V_2 = ?$

$P_2 = 760$ mm

$\therefore P_1 V_1 = P_2 V_2$

$V_2 = \dfrac{P_1 V_1}{P_2} = \dfrac{730 \times 730}{760} = 701$ mL

31 (b)

Point A represents the most probable distribution of molecules. Hence, the most probable velocity is $\sqrt{2RT/M}$

32 (d)

$KE = \dfrac{3}{2}RT$ or $\dfrac{3}{2}PV$

33 (c)

$PV = RT$ if $P_1 > P_2, V_1 < V_2$

Also $\log P = -\log V + \log RT$

34 (b)

$P = \dfrac{n}{V} RT = \dfrac{w}{mV} = RT$

$P = \dfrac{dRT}{m}$

$d \propto \dfrac{P}{T}$

35 (b)

NH_3 and HCl

From opposite ends of a tube

$NH_3 \rightarrow$ | B C | $\leftarrow$ HCl

A

Mid-point

NH_3 being lighter than HCl diffuses faster (according to Graham's law). So a white ring of NH_4Cl fumes is formed by the reaction between NH_3 and HCl in the region C of the tube

36 (d)

Let 30 g of both be mixed

Moles of $H_2 = \dfrac{30}{2} = 15$

Moles of $C_2H_6 = \dfrac{30}{30} = 1$

Mole fraction of $H_2 = \dfrac{15}{1+15} = \dfrac{15}{16}$

Which is also the fraction of total pressure executed by H_2

38 (d)

$PV = nRT$

$PV = \dfrac{w}{m}RT$

$P_{O_2}V = \dfrac{w}{32}RT$ ...(i)

$P_{O_2}V = \dfrac{w}{28}RT$ ...(ii)

$\dfrac{P_{O_2}}{P_{N_2}} = \dfrac{28}{32}$

$P_{O_2} = 0.875\, P_{N_2}$

39 (a)

$\left(P + \dfrac{a}{V^2}\right)(V - b) = RT$

At low pressure, volume is high and b may be ignored. So van der Waals equation becomes

$\left(P + \dfrac{a}{V^2}\right)V = RT$

Hence, the answer is (a)

40 (a)

$\mu_{rms} = \sqrt{\dfrac{3\,RT}{M}}$ or $\mu_{rms} \propto \sqrt{\dfrac{1}{M}}$

Hence, $He > N_2 > O_2 > HBr$

41 (a)

C_{P_1} for 'He' $= \dfrac{5}{2}R : C_{P_2}$ for $H_2 = \dfrac{7}{2}R$

$n_{He} = 2; n_{H_2} = 1$

$C_p = \dfrac{n_1 C_{P_1} + n_2 C_{P_1}}{n_1 + n_2} = \dfrac{2 \times \dfrac{5}{2}R + 1 \times \dfrac{7}{2}R}{3}$

$= \dfrac{17R}{6}$

42 (d)

b is equal to 4 times the volume of molecules in one mole of a gas (N_0 molecules)

Volume of one molecule $= v$

Volume of N_0 molecule $= vN_0$

Hence, $b = 4v\, N_0$

43 (b)

When a non-ideal gas suddenly expands from a high pressure to a low pressure, there is a temperature change. This is called Joule-Thomson effect. It is an adiabatic effect. The temperature of a real gas is either decreased or increased by letting the gas expand freely at constant enthalpy. When a real gas expands freely at constant enthalpy, the temperature may either decrease or increase, depending on the initial temperature and pressure. For any given pressure, a real gas has an inversion temperature above which the expansion at constant enthalpy causes the temperature to rise, and below which the expansion at constant enthalpy causes cooling. For most gases at atmospheric pressure, the inversion temperature is fairly high (above room

temperature), and so most gases at those temperature and pressure conditions are cooled by is isenthalpic expansion. For an ideal gas, there are no intermolecular forces, so no temperature change is expected when the distance between the molecules changes

44 **(d)**

$P(V - b) = RT$

$d = \dfrac{R}{(V - b)}. T \Rightarrow$ slope $= \dfrac{R}{V - b}$

$PV - Pb = RT$

$V = \dfrac{RT}{P} + b$ slope $= \dfrac{R}{P}$ and intercept b

$V = \dfrac{PV}{RT} = 1 + \dfrac{Pb}{RT}; Z > 1$

i.e., repulsive forces predominate

45 **(b)**

$Z = \dfrac{PV}{nRT}$ = compressibility factor for ideal gases,

$V = 22.4$ L and $Z = 1$ for 1 mol

For $Z > 1$, at NTP, $V_m < 22.4$ L

Only when the equations are satisfied

46 **(b)**

$PV = nRT = \dfrac{w}{m} RT$

$P = \dfrac{dRT}{m}$

$d \propto \dfrac{P}{T}$

$\dfrac{d_{(top)}}{d_{(bottom)}} = \dfrac{710}{273} \times \dfrac{303}{760} = 1.04 : 1$

48 **(b)**

Depression in the surface takes place when intermolecular attraction force of liquid called cohesive force dominates the force of attraction between the liquid and the capillary called adhesive force

49 **(a)**

Rate of diffusion $\propto \sqrt{\dfrac{1}{M}}$

$\therefore \dfrac{\frac{1}{t_{O_2}}}{\frac{1}{t_{N_2}}} = \sqrt{\dfrac{M_{N_2}}{M_{O_2}}} = \sqrt{\dfrac{2.8}{3.2}} = 0.93$

Or $\dfrac{t_{N_2}}{t_{O_2}} = 0.93$

$\therefore t_{N_2} = 0.93 \times 10 = 9.3$ min

50 **(a)**

$PV = RT$ for ideal gases

51 **(c)**

$V_1 = 100$ mL, $T_1 = 27°C = 300$ K

$P_1 = 740$

$V_2 = 80$ mL

$T_2 = ?$

$P_2 = 740$ mm

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

$\therefore T_2 = \dfrac{V_2 \times T_1}{V_1} = \dfrac{80 \times 300}{100} = 240$ K

Or $T_2 = -33°C$

53 **(c)**

$\sqrt{\dfrac{3RT_{H_2}}{2}} = \sqrt{7} \sqrt{\dfrac{3RT_{N_2}}{28}}$

$\dfrac{T_{H_2}}{2} = 7 \dfrac{T_{N_2}}{28}$

$T_{N_2} = 2T_{H_2}$

54 **(b)**

$KE = \dfrac{3}{2} RT$

$PV = RT = \dfrac{2}{3}$ (KE)

55 **(a)**

Melting point of ice = 273 K

$\dfrac{P_1 V_1}{T_1} = \dfrac{P_2 V_2}{T_2}$

$\dfrac{1000}{273} = \dfrac{400}{T_2}$ (at constant V)

$T_2 = 109.2$

56 **(a)**

$\left[P + \dfrac{a}{V^2}\right] [V - b] = RT$

$\therefore \left[P + \dfrac{a}{V^2}\right] V = RT$

Or $V^2 P - RTV + a = 0$

$V = \dfrac{+RT \pm \sqrt{R^2 T^2 - 4Pa}}{2P}$

Since, V is constant at given P and T, V can have only one value or discriminant = 0

$\therefore R^2 T^2 = 4Pa$ or $a = \dfrac{R^2 T^2}{4P}$

$= \dfrac{(0.821)^2 \times (273)^2}{4 \times 34.98}$

$= 3.59$ dm^6 atm mol^{-2}

57 **(d)**
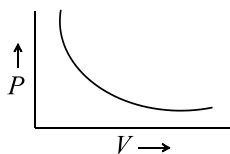
$KE = \dfrac{3}{2} nRT$

$n = 1$, for molar kinetic energy

$\left(\dfrac{3}{2} \times 1 \times R \times T\right)_{Helium} = \left(\dfrac{3}{2} \times 1 \times R \times 400\right)_{Argon}$

$T = 400$ K

58 **(c)**

Boyle's law
$PV = K$ (constant)

60 (b)

H_2 gas is greater than diffuses into balloon because rate of diffusion of H_2 is greater than the rate of diffusion of ethyne. Hence, it is enlarged

62 (a)

$KE = \dfrac{3}{2}RT$

$KE \propto T$

63 (d)

$KE = \dfrac{3}{2}RT$

$Or KE \propto T$

64 (c)

Gases which can be liquefied easily have high value of a and low value of b. So the answer is (c)

65 (b)

On increasing the temperature, mobility of the molecules increases or vaporization increases. Thus, the surface tension decreases

66 (a)

RMS velocity $u_{rms} = \sqrt{\dfrac{3pV}{M}}$ ... (i)

and $pV = nkT$ ($k \rightarrow$ Boltzmann's constant)

For a molecule $n = 1$

$$pV = kT$$

So, $u_{rms} = \sqrt{\dfrac{3kT}{m}}$ ... (ii)

Kinetic energy $(E) = \dfrac{3}{2}kT$ or $kT = \dfrac{2}{3}E$

$$u_{rms} = \sqrt{\dfrac{3 \times \frac{2}{3}E}{m}} = \sqrt{\dfrac{2E}{m}}$$

68 (a)

a. 22.4 L N_2 gas at STP = 1 mol N_2

= N_0 molecules of N_2

= $2N_0$ atoms of N

b. $\dfrac{500 \times 2}{1000} = 1$ mol of NH_3

= N_0 molecules of NH_3

= N_0 atoms of N

c. 1 mol of $NH_4Cl = N_0$ atoms of N

d. 6.02×10^{23} NO_2 molecules = 6.02×10^{23} atoms of N

69 (d)

$V_1 = 15$
$P_1 = 1$ atm
$T_1 = 0°C$ or 273.15 K
$P_2 = 2$ atm
$T_2 = 273°C$ or 546.15 K
$V_2 = ?$

$\therefore V_2 = \dfrac{P_1V_1}{T_1} \times \dfrac{T_2}{P_2} = \dfrac{1 \times 15}{273.15} \times \dfrac{546.15}{2} = 15$ L

70 (c)

As P increases, PV also increases, hence graph II

71 (c)

$PV = \dfrac{M}{m}RT$

$P \times 1 = \dfrac{M_{N_2}}{28}RT$

$P \times \dfrac{7}{8} = \dfrac{M_{O_2}}{32}RT$

Dividing equation (i) by (ii), we get

$M_{N_2} = M_{O_2}$

72 (c)

For water vapours, P = 0.0006 g cc^{-1}

$0.0006 = \dfrac{Mass}{Volume} = \dfrac{Mass}{1000}$

Mass = $1000 \times 0.0006 = 0.6$ g
Density of liquid water = 1 g cc^{-1}

Volume occupied by water = $\dfrac{Mass}{Density} = \dfrac{0.6}{1} = 0.6$ cc

73 (c)

A real gas approaches ideal behaviour at high temperature and low pressure. Both a/V^2 and b can be neglected under these conditions

74 (d)

$\dfrac{F - 32}{180} = \dfrac{C}{100}$

$t - 32 = \dfrac{9t}{5}$

$t = -40°$

75 (d)

Kinetic energy per mole or per molecule of a gas depends only on temperature and not on the nature of the gas

KE per molecule = $\dfrac{3}{2}RT$

76 (a)

$$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$$

$T_1 = 27°C = 300 \text{ K}$

$T_2 = 927°C = 1200 \text{ K}$

$V_1 = 0.3 \text{ m s}^{-1}$

$$V_2 = \sqrt{\frac{T_2}{T_1}} \times V_1 = \sqrt{\frac{1200}{300}} \times 0.3 = 0.6 \text{ m s}^{-1}$$

77 **(a)**

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$v_{average} = \sqrt{\frac{8RT}{\pi M}}$$

$$\frac{v_{rms}}{v_{average}} = \sqrt{\frac{3}{8\pi}} = 1.086$$

78 **(a)**

According to Boyle's law, $V \propto \frac{1}{P}$ at constant T

79 **(c)**

Use $PV = RT$

80 **(b)**

The temperature at which the real gas behaves ideally is called Boyle's temperature. At Boyle's temperature, the value of Z remains nearly equal to unity over a good range of pressure

Boyle's temperature, $T_b = \frac{a}{bR}$

81 **(c)**

Rate of diffusion is directly proportional to the pressure and inversely proportional to the mass of the gas. Hence,

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

82 **(b)**

At low temperature and high pressure, gases deviate more from ideal condition

83 **(b)**

Density

$$\rho = \frac{PM}{RT}$$

For maximum density, P/T will be maximum which is for option (b)

84 **(c)**

$$\mu_{rms}(H_2) = \sqrt{\frac{T}{M}} = \sqrt{\frac{50}{2}} = 5$$

$$\mu_{rms} \text{ of } O_2 \propto \sqrt{\frac{T}{M}} = \sqrt{\frac{800}{32}} = 5$$

Therefore, the ratio is 1

85 **(c)**

$(d)_1 = d$

$(d)_2 = 0.75 \, d$

$P_1 = 1 \text{ atm}; T_1 = 27°C = 300 \text{ K}$

$P_2 = 1 \text{ atm}; T_2 = ?$

$$\left(\frac{d_1}{d_2}\right) = \frac{P_1 \times T_2}{T_1 \times P_2} \text{ or } \frac{T_2}{T_1}$$

$$\therefore T_2 = \frac{d_1}{d_2} \times T_1 = \frac{d}{0.75d} \times 300 = 400 \text{ K}$$

86 **(b)**

Let 16 g of both be mixed

Moles of $H_2 = \frac{16}{2} = 8$

Moles of $CH_4 = \frac{16}{16} = 1$

Mole fraction of $H_2 = \frac{8}{1+8} = \frac{8}{9}$

Which is also the fraction of total pressure executed by H_2

87 **(b)**

Kinetic energy per mole or per molecule of a gas depends only on the temperature and not on the nature of the gas

$$KE = \frac{3}{2}RT$$

88 **(a)**

$$\left[P + \frac{a}{V^2}\right]V = RT$$

$$PV + \frac{a}{V} = RT$$

$$\frac{PV}{RT} + \frac{a}{RTV} = 1$$

$\frac{PV}{RT} = Z$ (compressibility factor)

$$= \left(1 - \frac{a}{RTV}\right)$$

89 **(a)**

$KE_{CO} = KE_{N_2}$

Because $KE = \frac{3}{2}RT$. It only depends upon temperature

90 (c)

Since, the external pressure is 1.0 atm, the gas pressure is also 1.0 atm as piston is movable. Out of this 1.0 atm partial pressure due to unknown compound is 0.68 atm.

Therefore, partial pressure of He=1.00-0.68=0.32 atm.

$$\Rightarrow \text{Volume} = \frac{n(\text{He})RT}{p(\text{He})}$$

$$= \frac{0.1 \times 0.082 \times 273}{0.32} = 7\text{L}$$

$\Rightarrow$ Volume of container = Volume of He.

91 (d)

$$4.8 \text{ g O}_2 = \frac{4.8}{32} \text{ mol O}_2 = \frac{4.8}{32} \times 2 \text{ g H}_2 = 0.3 \text{ g}$$

92 (a)

$PV = nRT$

$n_1 T_1 = n_2 T_2$

$$n_2 = \frac{T_1}{T_2} = \frac{3}{4}$$

93 (b)

Capillary rise decreases with increase in the radius of tube

95 (a)

Let 32 g of each gas be present

Moles of $O_2 = 32/32 = 1$

Moles of $CH_4 = \frac{32}{16} = 2$

Mole of fraction of $O_2 = \frac{1}{1+2} = \frac{1}{3}$

Which is same as fraction of pressure

96 (c)

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

For H_2 at 50 K,

$$v_1 = \sqrt{\frac{3R \times 50}{2}}$$

For O_2 at 800 K,

$$v_2 = \sqrt{\frac{3R \times 800}{32}}$$

$$\therefore \frac{v_1}{v_2} = \frac{\sqrt{\frac{3R \times 50}{2}}}{\sqrt{\frac{3R \times 800}{32}}} = 1$$

97 (c)

$PV = nRT$ or $\log V = \log T + \log \frac{nR}{P}$

Slope $= \tan\theta = \tan 45° = 1$

Intercept $= \log \frac{nR}{P} = \log\left[\frac{2 \times 0.0821}{0.0821}\right] = 0.3010$

98 (a)

$(f_1)^X = \frac{n'_{SO_2}}{n'_{O_2}} \times \frac{n_{O_2}}{n_{SO_2}}$, where n_{SO_2} and n_{O_2} are moles present initially

Or $X \log f_1 = \log\left[\frac{n'_{SO_2}}{n'_{O_2}} \times \frac{n_{O_2}}{n_{SO_2}}\right]$

$\therefore X \log \sqrt{\frac{M_{O_2}}{M_{SO_2}}} = \log\left[\frac{n'_{SO_2}}{n'_{O_2}} \times \frac{n_{O_2}}{n_{SO_2}}\right]$

$X \log \sqrt{\frac{32}{64}} = \log \frac{1}{1} \times \frac{1}{16}$

$\therefore X = 8$; also $\frac{n_1}{n_2} = \frac{r_1}{r_2} = \sqrt{\frac{32}{64}} = 0.707$

If $X = 6$, then $6 \log \sqrt{\frac{32}{64}} = \log\left[\frac{n'_{SO_2}}{n'_{O_2}} \times \frac{n_{O_2}}{n_{SO_2}}\right]$

$= \log\left[\frac{n'_{SO_2}}{n'_{O_2}} \times \frac{1}{16}\right]$

$\frac{n'_{SO_2}}{n'_{O_2}} = 2:1$

Rate of diffusion is $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$, i.e., 0.707 in each operation

100 (c)

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

The above equation is called van der Waals equation, $[p + a/V^2]$ represents the pressure correction, where a is constant

101 (b)

$b(\text{co-volume}) = 4\left(\frac{4}{3}\pi r^3\right)$

$= 4$ (Volume occupied by gaseous molecule)

102 (d)

Ideal gas has no force of attraction and has negligible volume. Hence, it cannot be liquefied at any T and P

103 (b)

In the van der Waals' equation :

$$\left(p + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

The pressure correction factor $(n^2 a/V^2)$ accounts for intermolecular attraction in real gas.

104 (b)

Thermal energy $\gg$ Molecular attraction

105 (c)

$P_1 V_1 = n_1 R T_1$

$$P_2 V_2 = n_2 R T_2$$

$$\frac{P_2 V_2}{P_1 V_1} = \frac{n_2 T_2}{n_1 T_1}$$

$$\frac{P_1}{9P_1} \frac{V_2}{30} = \frac{1}{2} \frac{n_1}{n_1} \frac{3T_1}{T_1}$$

$$V_2 = 405 \text{ mL}$$

106 (c)

Draw a line at constant P parallel to volume axis.
Take volume corresponding to each temperature
From volume axis, $V_1 > V_2 > V_3$
Hence, $T_1 > T_2 > T_3$

108 (a)

$$V_{\text{ideal}} = 22.4 \text{ L}$$

$$\therefore PV_{\text{ideal}} = \frac{5.6}{22.4} RT = 0.25RT$$

109 (d)

$$\bar{u} = \sqrt{\frac{8 RT}{\pi m}}$$

$$\bar{u} \propto \sqrt{\frac{T}{M}}$$

1. $\bar{u} \propto \sqrt{\frac{560}{28}} = \sqrt{20}$

2. $\bar{u} \propto \sqrt{\frac{500}{20}} = \sqrt{25}$

3. $\bar{u} \propto \sqrt{\frac{440}{44}} = \sqrt{11}$

4. $\bar{u} \propto \sqrt{\frac{140}{4}} = \sqrt{35}$

110 (b)

$$PV = nRT$$

n moles of the gas have a volume V

111 (b)

$$P_1 V_1 = n_1 R T_1$$

$$P_2 V_2 = n_2 R T_2$$

$$\frac{n_2}{n_1} = \frac{P_2}{P_1}$$

$$n_2 = 0.1 \times \frac{0.01}{100} = 10^{-5} \text{mol} = 6 \times 10^{18} \text{molecules}$$

112 (b)

Mean free path is the average distance travelled
by a particle between two collisions

$$\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 N}$$

Where σ is collision, N is the number of molecules
per unit volume
So, λ will be the highest for small value of σ
H_2 will have small σ

Hence, the answer is (b)

114 (a)

$$Pm = dRT$$

$$\frac{P_A m_B}{P_B m_B} = \frac{d_A RT}{d_B RT}$$

$$\frac{P_A}{P_B} \times \frac{1}{3} = 2$$

$$P_A : P_B = 6 : 1$$

115 (c)

By Graham's diffusion law,

$$\frac{r_{\text{He}}}{r_{\text{CH}_4}} = \sqrt{\frac{M_{\text{CH}_4}}{M_{\text{He}}}}$$

$$M_{\text{CH}_4} = 12 + 4 = 16$$

$$M_{\text{He}} = 4$$

$$\frac{r_{\text{He}}}{r_{\text{CH}_4}} = \sqrt{\frac{16}{4}} = \sqrt{\frac{4}{1}} = 2$$

Thus, the ratio of rate of diffusion of He and CH_4 is 2.

121 (a,b)

Charles' law, $V \propto T$

123 (a,d)

Hint: $r \propto \frac{1}{\sqrt{M}}$

$$\therefore \frac{r_{\text{H}_2}}{r_{\text{O}_2}} = \sqrt{\frac{M_{\text{O}_2}}{M_{\text{H}_2}}} = \sqrt{\frac{16}{1}} = 4$$

$$\therefore r_{\text{H}_2} = 4 \times r_{\text{O}_2}$$

$$\left(\frac{\partial T}{\partial P}\right)_{\text{H}} = 0 \text{ (for ideal gas)}$$

Because $T \propto P$ (for ideal gas)

$$\therefore \frac{T}{P} = K \text{ (constant)}$$

125 (a,d)

$$Z_{\text{real gas}} > 1$$

$$\therefore V_m > 22.4 \text{ L} \quad (\text{Because } V_{\text{ideal}} = 22.4 \text{ L})$$

Hence, when volume is higher, the gases are far
apart and, therefore, difficult to liquefy

126 (a,c)

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT, \text{ at high pressure}$$

$$P \gg \frac{an^2}{V^2}$$

129 (a,b,d)

Frenkel defect occurs in compounds with low
coordination number and possesses cations and
anions of different sizes

130 (a,d)

Charles' law, $V \propto T$ $\therefore \left(\frac{\partial V}{\partial T}\right)_P = K$

134 (b,c)

Hint: $\mu_{\text{rms}} = \sqrt{\frac{3RT}{M}}$ or $\sqrt{\frac{3PV}{M}}$

$(\mu_{\text{rms}})_1 = 5 \times 10^4$ cm s^{-1}

$(\mu_{\text{rms}})_2 = 10 \times 10^4$ cm s^{-1}

$\therefore$ $P_1 = \frac{(\mu_{\text{rms}})_1^2 \times M}{3V} = (5 \times 10^4)^2 \times \frac{M}{3V}$

$P_2 = \frac{(\mu_{\text{rms}})_2^2 \times M}{3V} = (10 \times 10^4)^2 \times \frac{M}{3V}$

Or $\frac{P_2}{P_1} = \frac{(10 \times 10^4)^2}{(5 \times 10^4)^2} = \frac{100}{25} = 4$

$\therefore$ $P_2 = 4 \times P_1$

Similarly, $T_2 = 4 \times T_1$

135 (c,d)

Volume and pressure of gas

136 (a,b,d)

It is bcc arrangement NH_4^+ and Cl^- ions have 8:8 coordination. Each unit cell has only one NH_4Cl unit

137 (a,b)

According to Boyle's law, when a gas is expanded at constant temperature, its pressure decreases. Kindly energy is a function of temperature only, *so* it remains the same

144 (b,c)

Hint: Helium gas has lower molecular mass and hence it moves faster than neon and strikes the wall more frequently

$\mu_{\text{av}} = \sqrt{\frac{8\,RT}{\pi\,M}}$

$\mu_{\text{av}} \propto \left(\frac{1}{M}\right)^{1/2}$

Hence, He has higher speed than neon

146 (b,c,d)

$\frac{V_1}{V_2} = \left(\frac{T_2}{T_1}\right)^{3/2}$ for reversible adiabatic expansion.

According to van der Waals' equation

$\left(p + \frac{a}{V_m^2}\right)(V_m - b) = RT$

At low pressure V_m is high so 'b' can be neglected

$pV_m + \frac{a}{V_m} = RT$

$\frac{pV_m}{RT} = \frac{a}{V_m RT} = 1$

$Z + \frac{a}{V_m RT} = 1$

$Z = 1 - \frac{a}{V_m RT}$

147 (b,d)

Dipole and van der Waals force

148 (a,c)

KBr and CaO possess rock salt type structure. CsBr has CsCl type structure while BeS has zinc blende (ZnS) type structure

150 (a,c)

In fluorite structure, cations form the lattice and anions occupy each of tetrahedral voids

152 (c,d)

Hint: Given,

$T_1 = 273°$ or 546.15K

$P_1 = 1$ atm

$T_2 = 0°C$ or 273.15 K

$P_2 = ?$

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

$\therefore$ $P_2 = \frac{P_1 \times T_2}{T_1} = \frac{1 \times 273.15}{546.15}$

$= \frac{1}{273.1}$ atm or 5.05×10^4 N m^{-2}

153 (a,b,d)

$(v_{\text{rms}})_{N_2} = (v_{\text{rms}})_{O_2}$

$\sqrt{\frac{3RT_{N_2}}{M_{N_2}}} = \sqrt{\frac{3RT_{O_2}}{M_{O_2}}}$

$\frac{T_{N_2}}{M_{N_2}} = \frac{T_{O_2}}{M_{O_2}}$

Then $v_{\text{av}} \left(\frac{\sqrt{8RT}}{\pi m}\right)$ and $v_{\text{mps}} \left(\frac{\sqrt{2RT}}{M}\right)$ is also same

$d_{N_2} = \frac{p_{N_2} M_{N_2}}{RT_{N_2}}$

and $d_{O_2} = \frac{p_{O_2} M_{N_2}}{RT_{O_2}}$

if $p_{N_2} = p_{O_2}$ then $d_{N_2} = d_{O_2}$

154 (a,b,c)

R(gas constant) depends only upon the units of measurement

156 (b,d)

According to Boyle's law

$V \propto \frac{1}{p}$ or $p \propto \frac{1}{V}$

$p = \frac{K}{V}$ ...(i)

differenting Eq.(i) w.r.t V at constant T

$\left(\frac{dp}{dV}\right)_T = -\frac{K}{V^2}$

157 (b,d)

Boyle's law $P \propto \frac{1}{V}$ $\therefore \left(\frac{\partial P}{\partial V}\right)_T = -K/V^2$

158 (a,b,d)

Hint: At critical point, the gases can be liquefied and hence there is force of attraction

At high pressure and low temperature, gases are

close to each other and hence they experience force of attraction

164 (a,b,c)

From van der Waals' equation

$$\left(p + \frac{a}{V^2}\right)(V - b) = RT$$

Internal pressure is due to van der Waals' force

$$p = \frac{a}{V^2} \text{ or } p \propto \frac{1}{V^2}$$

165 (a,d)

Hint: $\mu_{av} = \sqrt{\frac{8RT}{\pi M}}$ and $\mu_{rms} = \sqrt{\frac{3RT}{M}}$

166 (a,c,d)

From $\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$

If $V_2 = 4V_1$, then ratio $\frac{p_2}{T_2}$ may be changed in

following ways :

(i) $T_1 = 2T_1$ and $p_2 = \frac{1}{2}p_1$

(ii) $T_2 = T_1$ and $p_2 = \frac{1}{4}p_1$

(iii) $T_2 = 4T_1$ and $p_2 = p_1$

168 (a,d)

Hint: When $\frac{T_A}{M_A} = \frac{T_B}{M_B}$ or $T_A M_B = T_B M_A$

$(PV)_A = nRT$ or $\frac{W_A}{M_A} RT_A$

and $(PV)_B = nRT$ or $\frac{W_B}{M_B} RT_B$

∴ When $W_A = W_B$

$(PV)_A = (PV)_B$

$\mu_{rms} = \sqrt{\frac{3RT}{M}}$

∴ $\mu_A = \sqrt{\frac{3RT_B}{M_A}}$

$\mu_B = \sqrt{\frac{3RT_B}{M_B}}$

∴ $\mu_A = \mu_B \left(\frac{T_A}{M_A} = \frac{T_B}{M_B}\right)$

169 (b,c)

Because molecular mass is almost same

172 (a,b,c)

Viscosity is expressed in dynes/ cm² s, called poise. In MKS system viscosity is expressed as kg m⁻¹s⁻¹ or Nm⁻²s

173 (a,c,d)

Hint: $\frac{\mu_{av}}{\mu_{rms}} = \sqrt{\frac{8RT}{\pi M}} \bigg/ \sqrt{\frac{3RT}{M}} = \sqrt{\frac{8}{\pi 3}}$

Hence the ratio of μ_{av} and μ_{rms} is independent of temperature.

$KE_{av} = \frac{3}{2}RT$ (hence, it is independent of mean

174 (a)

SO_2 gas

175 (b,c)

These gas mixtures react with each other

176 (a,c)

Real gases have volume and force of attraction

178 (a,b)

$Z = \frac{P_C V_C}{RT_C} = \frac{3}{8}$; each molecule moves with altogether different speed

179 (b,d)

Hint: Average speed $\mu_{av} \propto T$

181 (a,d)

Hint: Average speed $\mu_{av} = \sqrt{\frac{8RT}{\pi M}}$

∴ $\mu_{av} \propto \frac{T}{M}$

182 (a,c)

$R = \frac{PV}{nT}$ ∴ R(unit)

$= $ L atm K⁻¹mol⁻¹ and atm cm³K⁻¹mol⁻¹

185 (a)

$PV + \frac{a}{V} = RT$

∴ $PV = RT - \frac{a}{V}$; Thus, $z = \frac{PV}{RT} = \left[1 - \frac{a}{RTV}\right]$
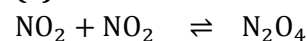
186 (c)

Collision is perfectly elastic in nature. In such a case, gas molecules neither loss nor gain energy

187 (c)

H_2 has weak intermolecular attraction. Hence, H_2 is not easily liquefied

188 (a)

$NO_2 + NO_2 \ \rightleftharpoons \ N_2O_4$

(Brown colour) (Colourless)

189 (c)

$P \propto T$

190 (a)

Both assertion and reason are correct and reason is the correct explanation for assertion. The value of van der Waals constant a is larger for ammonia than for nitrogen

Nitrogen is a non- polar molecule. Ammonia is a polar molecule and it shows hydrogen bonding

191 (a)

According to Charles' law; $V \propto T$

So, hot air is less dense.

192 **(b)**

For He, $Z > 1$

193 **(d)**

Assertion is true; reason is true; reason is not the correct explanation for assertion

The pressure of a fixed amount of an ideal gas is proportional to its temperature

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

Collision frequency is directly proportional to v_{rms}. On increasing the collision frequency, the pressure increases

194 **(b)**

Rate of diffusion $\propto \sqrt{\dfrac{1}{\text{Molecualr mass}}}$. Hence lighter gas moves rapidly than heavier gas molecules

195 **(c)**

Andrew's studied isotherms of CO_2 and found that even CO_2 (the so called temporary gas at that time) cannot be liquefied above 31.1℃, the critical temperature of CO_2, although pressure may be increased manifolds.

196 **(b)**

$\dfrac{V_1}{V_2} = \dfrac{T_1}{T_2}$ or $\dfrac{V_1}{V_2} = \dfrac{300}{400} = \dfrac{3}{4}$

So, air expelled $= 1 - \dfrac{3}{4} = \dfrac{1}{4}$

According to Graham's law of diffusion $r \propto \dfrac{1}{\sqrt{M}}$

197 **(e)**

$Z_{\text{real}} <> 1$

198 **(c)**

In van der Waals' equation of state

$\left(p + \dfrac{a}{V^2}\right)(V - b) = RT$

If we neglect b

$Z = 1 - \dfrac{a}{VRT}$

that is $Z < 1$

It we neglect a

$Z = 1 + \dfrac{pb}{RT}$

that is $Z > 1$

199 **(b)**

Hydrogen and helium have weak van der Waals' forces of attraction. The intermolecular forces of attraction increases and volume occupied by gas molecules becomes appreciable and can't be neglected

200 **(b)**

The van der Waals equation is applicable to real gases only, while $PV = nRT$ is applicable to ideal gases

201 **(c)**

The higher value of $'a'$ for NH_3 than N_2 is due to H-bonding in NH_3.

202 **(b)**

'a' measures intermolecular forces. The distance between molecules of an easily condensable gas will least

203 **(c)**

Doping of Si with P gives extra electrons while doping with Al gives rise to holes

204 **(a)**

Because of free valencies of transition metal, gases easily gets absorbed on the surface of metal

205 **(c)**

Internal energy of an ideal gas depends only on temperature and since, they have no attractions among their molecules.

$\left(\dfrac{\delta T}{\delta P}\right)_H$ is zero. i.e., $\mu_{j.T} = 0$

206 **(b)**

$(dU/\partial V)_T = 0$ (for ideal gas), because heat depends upon temperature

207 **(b)**

$\dfrac{C_p}{C_v} = 1.40$ for diatomic gases and 1.66 for monoatomic gases. No doubt degree of freedom for a gas is given by $3n$, where n is no. of atoms in molecule.

208 (d)

Z is greater than 1 or less than 1. Non ideal gases exert less pressure than expected due to backward pull by other molecules.

209 (a)

With increase in temperature, viscosity of liquid decreases as the average kinetic energy of the molecules increases

210 (b)

CO_2 above 31.1°C and 600 bar pressure acts is super critical fluid, which dissolves many organic substances (alkaloids-caffeine) and hence used for separation of mixture.
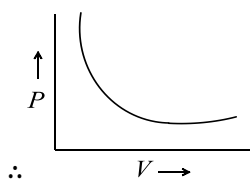
211 (d)

Speed of gases depend upon molecular mass of gas. Therefore, all ideal gas does not move with same speed

212 (b)

Both are correct, but reason is not the correct explanation of assertion

$C_P - C_V = R$

Or $\left(\frac{\partial H}{\partial T}\right)_P - \left(\frac{\partial U}{\partial T}\right)_V = R$

213 (a)

According to Charles' law, $V \propto \frac{1}{P}$

$\therefore$

214 (d)

In schottky defect equal number of cations and anions are missing

215 (e)

Number of molecules is independent of pressure, and moles number is independent of volume

216 (a)

Noble gases also have force of attraction and can be liquefied

217 (a)

Considering the attractive force, pressure in ideal gas equation $(pV = nRT)$ is corrected by introducing a factor of $\frac{an^2}{V^2}$ where $'a'$ is van der Waals' constant.

218 (c)

Volume is independent of the force of attraction

219 (d)

$P_{\text{total}} = P_1 + P_2 + P_3 + \cdots$

Partial pressure $= x \times P_{\text{total}}$

Where $x =$ mole fraction

220 (c)

Ionic solids conduct electricity not due to presence of ions but due to presence of defects

221 (c)

$\left[P + \frac{a}{V^2}\right][V - b] = RT$; for H_2 and He, a is very small because of low mol. wt. Thus, $PV = RT + Pb$. Now

$$z = \frac{PV}{RT} = \left[1 + \frac{Pb}{RT}\right]$$

222 (a)

At absolute zero (0 K) temperature, the thermal motion of gas molecules becomes negligible and hence their KE and vapour pressure also reduce to zero

223 (d)

$C_v = \frac{3}{2}R$ and $C_p = \frac{3}{2}R + X = \frac{3}{2}R + R$; $(R = X)$. Also

Average energy of diatomic molecule at constant $V = \frac{5}{2}RT$

Average energy of diatomic molecule at constant $P = \frac{7}{2}RT$

$\therefore$ Increase in internal energy for diatomic gas at constant P

$$\frac{7}{2}R(T + 1) - \frac{7}{2}RT = \frac{7}{2}R$$

224 (c)

In N_2, Nitrogen atoms are bonded with covalent bond and there is no delocalization of electrons

225 (c)

Both are not reducing agents, chlorine is oxidizing

agent

226 (c)
Molecular mass does not depend upon T, P

227 (d)
$\frac{RT_c}{P_c \cdot V_c} = \frac{R \times 8a \times 27b^2}{27Rb \times a \times 3b} = \frac{8}{3}$.

228 (c)
O_2 diffuse 1.4 times faster than SO_2 because M_{SO_2} is higher than M_{O_2}

229 (a)
In the van der Waals' equation. 'a' refers to the attractive forces between the molecules and 'b' is the volume correction

230 (a)
Rate of diffusion $\propto \sqrt{\frac{1}{\text{Molecular mass}}}$

231 (a)
Above critical temperature(T_c), gas cannot be liquefied. On cooling, the average energy of molecules decreases

232 (a)
Kinetic energy for one mole gas is given by equation,

$E = \frac{3}{2} kT$ (where, $k =$ Boltzmann's constat)

$\therefore \ E \propto T$

Thus, at constant temperature kinetic energy of one mole of any gas is equal.

233 (b)
a is more for C_6H_6 due to high mol. wt. of C_6H_6.

234 (a)
Crystalline solids possess the properties of rigidity. They are anisotropic and undergo a clean cleavage. The constituent particles are arranged in a definite and orderly pattern through the entire three dimensional space

235 (a)
Solid NaCl is a bad conductor of electricity because ions are not free to move

237 (a)
$\left[P + \frac{a}{V^2}\right](V - b) = RT$

At high P, $\frac{a}{V^2}$ is negligible
$\therefore P(V - b) = RT$ or $PV = RT + Pb$
At low P, Neither a nor b are negligible
At 'a' is negligible $P[V - b] = RT$ or $PV = RT + Pb$
At 'b' is negligible $\left[P + \frac{a}{V^2}\right]V = RT$ or $PV = RT \frac{a}{V}$
Thus, $A - I, B - IV, C - I, D - II$

239 (a)
Attractive forces: $Z < 1$; in high-pressure region, $Z > 1$

At critical points $Z = 3/8$ for gas at low pressure and very high temperature $Z = 1$

242 (b)
$(\mathbf{a} \to \mathbf{r})$

$Z = \frac{PV}{RT}$; for ideal gas $Z = 1$

$(\mathbf{b} \to \mathbf{s})$ van der Waals equation

$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$

For 1 mol gas,

$\left(P + \frac{a}{V^2}\right)(V - b) = RT$

At low pressure, gas equation becomes

$P(V - b) = RT$

$PV - Pb = RT$

Or $PV = RT + Pb$

Dividing by RT, we get

$\frac{PV}{RT} = \frac{RT}{RT} + \frac{Pb}{RT}$

Or $Z = 1 + \frac{Pb}{RT}$

$(\mathbf{c} \to \mathbf{q})$ van der Waals equation for 1 mol gas

$\left(P + \frac{a}{V^2}\right)(V - b) = RT$

At high pressure, b $<< V$; hence, equation becomes

$\left(P + \frac{a}{V^2}\right)V = RT$

Or $PV + \frac{a}{V} = RT$

Or $PV = RT - \frac{a}{V}$

Dividing by RT, we get

$\frac{PV}{RT} = \frac{RT}{RT} - \frac{a}{VRT}$

Or $Z = 1 - \frac{a}{VRT}$

(d →p)

$Z = \frac{P_c V_c}{RT_c} = \frac{3}{8}$

245 (c)

(a →p) because diffusion r proportion to $\sqrt{1/M}$.
Therefore, low molar mass has high rate of
diffusion

249 (b)

We know that
In the high pressure region
$Z = 1 + \frac{pb}{RT}$
$2 = 1 + \frac{1000b}{RT}$ ...(i)
$2.2 = 1 + \frac{1200b}{RT}$ ...(ii)
Solving both the equation we get $\frac{b}{RT} = 10^{-3}$ atm^{-1}

250 (c)

From Boyle's law
$p_1 V_1 = p_2 V_2$
$p_1 = \frac{p_2 V_2}{V_1} = \frac{750 \times 250}{16}$
$= 12500$ mm Hg $= 16.45$ atm

251 (a)

Graph given in option (a) correct, for helium

252 (d)

An atom on the corner contributes to the unit cell
$= \frac{1}{8}$ part

253 (d)

(hkl) represents Miller indices of a plane

254 (c)

Work done during the expansion of N_2 at 0.82 atm
to chamber B at $P = 0$
$\therefore w = PV = 0 \times 4 = 0$

255 (b)

m^{-1}s

256 (a)

Let n_A be the amount of H_2 and n_B be the amount
the CH_4

We know that
$n_A = \frac{m}{2}; n_B = \frac{m}{16}$
Where m is the mass of the gas of two flasks A and
B
$\therefore \frac{n_A}{n_B} = \frac{m}{2} / \frac{m}{16} = 8$
Now, the number of molecules in these flasks are
given as
$N_A = \frac{m}{2} \cdot N, N_B = \frac{m}{16} N,$
Where N is Avogadro's constant
$\therefore \frac{N_A}{N_B} = 8$
$\Rightarrow N_A > N_B$

257 (b)

Since, $T_c = \frac{8a}{27Rb}$
Hint: Gas B has the highest value of a, therefore, it
has the highest critical temperature
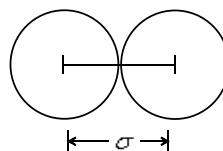
258 (d)

The units of measurement

259 (b)

Real gas

260 (b)

$Z = \frac{PV}{RT}$ $\therefore$ $Z_{ideal} = 1$

261 (c)

σ = distance between two successive collisions

262 (b)

$\frac{r_{HCl}}{r_{NH_3}} = \frac{\mu_{HCl}}{\mu_{NH_3}} = \sqrt{\frac{17}{36.5}} = 0.682$

$\therefore \mu_{HCl} = 0.682 \times \mu_{NH_3}$
$\therefore$ Average distance travelled by HCl = 0.682 $\times$
Average distance travelled by NH_3
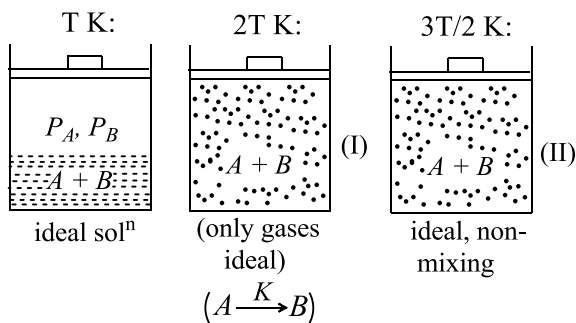$0.682 \times 36.5 = 24.9 \approx 25.0$ cm

263 (b)

Depends only on T and P

264 (b)

At $t = 0, \frac{r_{O_2}}{r_{Ne}} = \frac{\rho_{O_2}}{\rho_{Ne}} \sqrt{\frac{M_{Ne}}{M_{O_2}}} = \frac{950}{900} \sqrt{\frac{20}{32}} < 1$

Therefore, Ne will diffuse at faster rate

265 (a)

| T K: | 2T K: | 3T/2 K: |

ideal sol^n (only gases ideal)   ideal, non-mixing

$\left(A \xrightarrow{K} B\right)$

$\dfrac{n_A}{n_B} = \dfrac{P_A}{P_B} = 2$; Total V. P. $= 2$ atm

$PV = nRT \Rightarrow 2 \times 8.21 = (n_A + n_B) \times 0.0821 \times 50$

$\Rightarrow n_A + n_B = 4$

266 (b)

$C_p = 0.125$ cal/g, $C_v = 0.075$

$\therefore C_p - C_v = \dfrac{R}{M}$ or $M = \dfrac{2}{0.125 - 0.075} = 40$

Also $\dfrac{C_p}{C_v} = \dfrac{0.125}{0.075} = \dfrac{5}{3} = 1.66$, thus, gas is monoatomic

The monoatomic gas with mol. wt. 40 is Ar.

267 (c)

$\left[P + \dfrac{n^2 a}{V^2}\right](V - nb) = nRT$

At high pressure, volume of molecules being appreciably significant in comparison to volume of gas as well as gases show positive deviations which is possible only when

$P[V - nb] = nRT$ or $PV = nRT + Pb$

or $PV > nRT$ or $Z > 1 \left[Z = 1 + \dfrac{Pb}{RT}\right]$

269 (a)

$T_i = 350$ K; $T_f = 700$ K

$KE_{avg}(\text{Translation}) = \dfrac{3}{2}KT$

$\therefore$ KE increase by a factor of $\dfrac{700}{350} = 2$

270 (b)

$Z_{(\text{ideal gas})} = \dfrac{V_m}{V_{\text{ideal}}} = 1$

273 (b)

$r_{CH_4} = 2r_X$, we know $r = \sqrt{\dfrac{1}{\text{Molecular mass}}}$

$\therefore \dfrac{r_{CH_4}}{r_X} = \sqrt{\dfrac{M_X}{M_{CH_4}}} \Rightarrow \dfrac{2r_X}{r_X} = \sqrt{\dfrac{M_X}{16}}$

Or $M_X = 64$

Given Molecular mass is divided by 32 therefore,

$X = \dfrac{M_X}{32} = \dfrac{64}{32} = 2$

274 (b)

Rate of diffustion $= \sqrt{\dfrac{1}{\text{Molecular mass}}}$

$\therefore \dfrac{r_A}{r_B} = \sqrt{\dfrac{44}{11}} = \sqrt{4} = 2$

276 (d)

$b = 4(\text{volume of gas molecule})$

$\therefore \dfrac{b}{\text{Volume of gas molecule}} = 4$

279 (d)

$PV = nRT; n = \dfrac{RT}{PV} = \dfrac{0.082 \times 97.5}{2 \times 1} = \dfrac{8}{2} = 4$

281 (b)

$u_{av} = \sqrt{\dfrac{8\,RT}{\pi M}}, T = 100$ K; $M = 529.5$ g mol^{-1}

$= \sqrt{\dfrac{8 \times 8.314 \times 100}{3.14 \times 529.5}} = 2$

$\therefore$ Average speed of molecule is 2 or (b)

283 (b)

Inversion temperature $(T_i) = \dfrac{2a}{Rb}$

Boyle's temperature $(T_b) = \dfrac{a}{Rb}$

$\therefore \dfrac{T_i}{T_b} = 2$

286 (c)

Given $V_1 = 1$ L; $T_1 = 100$ K; $T_2 = 300$ K; $V_2 = ?$

We know, $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2} \Rightarrow V_2 = \dfrac{V_1 T_2}{T_1}$

$\therefore V_2 = \dfrac{1 \times 300}{100} = 3$

288 (7)

Saturated vapours do not obey gas laws except Dalton's law of vapour pressure)

290 (c)

Given, $P = 1.56$ atm; $V = 10$ L

$T = 317$ K; $R = 0.082$

Total moles $(n) = \dfrac{PV}{RT} = \dfrac{1.56 \times 10}{0.082 \times 317} = 0.6$ mol

Let $C_x H_8$ be a mol, therefore moles of

$C_x H_{12} = (0.6 - a)$ mol; mass of C in a mol of

$C_x H_{12} = 12ax$ g; mass of C in $(0.6 - a)$ mol of

$C_x H_{12} = 12 \times (0.6 - a)$g

$\therefore$ Total mass of C in mixture $= 12ax + 12x(0.6 - a)$g

$= 41.4$ g

% of C in mixture $= \dfrac{7.2\,x}{41.4} \times 100$

Given % of $C = 87\%$

Or $\dfrac{720x}{41.4} = 87$ or $x = 5$