SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. If the pressure of a gas contained in a closed vessel is increased by 0.4 % when heated by 1 C its initial temperature must be :
(A) 250 K (B) 250 C (C) 25 C (D) 25 K

2. If a mixture containing 3 moles of hydrogen and 1 mole of nitrogen is converted completely into ammonia, the ratio of initial and final volume under the same temperature and pressure would be :
(A) 3 : 1 (B) 1 : 3 (C) 2 : 1 (D) 1 : 2

3. SO_2 at STP contained in a flask was replaced by O_2 under identical conditions of pressure, temperature and volume. Then the weight of O_2 will be _____ of SO_2 :
(A) half (B) one fourth (C) twice (D) four times

4. According to Charle's law :
(A) $\left(\frac{dV}{dT}\right)_P$ = k (constant) (B) $\left(\frac{dV}{dT}\right)_P = P$ (C) $\left(\frac{dV}{dT}\right)_P = V$ (D) $\left(\frac{dV}{dT}\right) = T$

5. A sample of gas at 35 C & 1 atm pressure occupies a volume of 3.75 litres. At what temp. should the gas be kept if it is required to reduce the volume to 3 litres at the same pressure :
(A) –26.6 C (B) 0 C (C) 3.98 C (D) 28 C

6. Equal weights of methane and hydrogen are mixed in an empty container at 25 C. The fraction of total pressure exerted by hydrogen is :
(A) 1/2 (B) 8/9 (C) 16/19 (D) 1/9

7. The best vaccum so far attained in laboratory is 10^{-10} mm of Hg. The number of molecules of gas remain per cm^3 at 20 C in this vaccum is :
(A) 3.29 10^4 molecules (B) 3.29 10^5 molecules (C) 3.29 10^6 molecules (D) 3.29 10^7 molecules

8. A hydrocarbon contains 10.5 g of carbon per gm of H. One litre vapours of hydrocarbon at 127 C and 1 atm pressure weighs 2.8 g. The molecular formula of hydrocarbon is :
(A) C_6H_8 (B) C_7H_8 (C) C_5H_{12} (D) C_8H_4

9. A 0.5 dm^3 flask contains gas A and 1 dm^3 flask contains gas B at the same temperature. If density of A = 3 g/dm^3 and that of B = 1.5 g/dm^3 and the molar mass of A = 1/2 of B, the ratio of pressure exerted by gases is :
(A) $\frac{P_A}{P_B} = 2$ (B) $\frac{P_A}{P_B} = 1$ (C) $\frac{P_A}{P_B} = 4$ (D) $\frac{P_A}{P_B} = 3$

10. 120 g of an ideal gas of molecular weight 40 are confined to a volume of 20 litre at 400 K, then the pressure of gas is :
(A) 490 atm (B) 4.92 atm (C) 2236 atm (D) 22.4 atm

11. A cylinder contains acetylene gas at 27 C and 4.05 M Pa. The pressure in the cylinder after half the mass of gas is used up and temperature has fallen to 12 C will be :
(A) 4.05 M Pa (B) 2.025 M Pa (C) 3.84 M Pa (D) 1.92 M Pa

12. The weight of 350 mL of a diatomic gas at 0 C and 2 atm pressure is 1 g. The weight in g of one atom at NTP is :
(A) 2.64 10^{-23} g (B) 2.64 10^{-22} g (C) 5.28 10^{-23} g (D) 0.82 10^{-22} g

13. Oxygen is present in a litre flask at a pressure of 7.6 10^{-10} mm of Hg. The number of oxygen molecules in the flask at 0 C is :
(A) 2.7 10^9 molecules (B) 2.7 10^{10} molecules (C) 2.7 10^{11} molecules (D) 2.7 10^{12} molecules

14. Assuming that O_2 molecule is spherical in shape with radius 2 Å, the percentage of the volume of O_2 molecules to the total volume of gas at S.T.P. is :

(A) 0.09 % (B) 0.9 % (C) 0.009 % (D) 0.045 %

15. The r.m.s. velocity of hydrogen at 27 C, R = 8.314 J mol^{-1} K^{-1} is :

(A) 1.934 m/s (B) 19.34 m/s (C) 193.4 m/s (D) 1934 m/s

16. Temperature at which r.m.s. speed of O_2 is equal to that of neon at 300 K is :

(A) 280 K (B) 480 K (C) 680 K (D) 180 K

17. The most probable velocity of a neutron at 20 C is nearby :

(A) 220 m/s (B) 2200 m/s (C) 22200 m/s (D) 22 m/s

18. The R.M.S. speed of the molecules of a gas of density 4 kg m^{-3} and pressure 1.2 10^5 N m^{-2} is :

(A) 120 m s^{-1} (B) 300 m s^{-1} (C) 600 m s^{-1} (D) 900 m s^{-1}

19. The mass of molecule A is twice that of molecule B. The root mean square velocity of molecule A is twice that of molecule B. If two containers of equal volume have same number of molecules, the ratio of pressure P_A/P_B will be :

(A) 8 : 1 (B) 1 : 8 (C) 4 : 1 (D) 1 : 4

20. The R.M.S. velocity of a gas whose each molecule weighs 10^{-12} g and at temperature 27 C is :

(A) 0.70 cm/s (B) 0.35 cm/s (C) 0.35 m/s (D) 0.70 m/s

21. The average speed of an ideal gas molecule at 27 C is 0.3 m sec^{-1}. The average speed at 927 C :

(A) 0.15 m sec^{-1} (B) 0.6 m sec^{-1} (C) 1.2 m sec^{-1} (D) 0.6 cm sec^{-1}

22. The temperature at which CO_2 has the same R.M.S. speed to that of O_2 at S.T.P. is/are :

(A) 375.38 K (B) 102.38 C (C) 275.38 K (D) 202.38 C

23. The temperature at which the most probable speed of CO_2 molecules be twice as that of 50 C is :

(A) 200 C (B) 1292 K (C) 100 C (D) 646 K

24. What is the total translational and rotational energy of 1 mole of oxygen at 300 K.
R = 8.314 J mol^{-1} K^{-1} :

(A) 6235.5 J (B) 623.25 J (C) 62.325 J (D) 6.2325 J

25. The kinetic energy of N molecules of O_2 is x joule at –123 C. Another sample of O_2 at 27 C has a kinetic energy of 2 x. The later sample contains _____ molecules of O_2 :

(A) N (B) N/2 (C) 2 N (D) 3 N

26. The average kinetic energy in joules of molecules in 8.0 gm of methan at 27 C is :

(A) 6.21 10^{-20} J/molecule (B) 6.21 10^{-21} J/molecule

(C) 6.21 10^{-22} J/molecule (D) 3.1 10^{-22} J/molecule

27. The ratio of rates of diffusion of CO_2 and SO_2 at the same pressure and temperature is :

(A) 4 : $\sqrt{11}$ (B) 11 : 4 (C) 1 : 4 (D) 1 : 6

28. 20 L of SO_2 diffuses through a porous partition in 60 seconds. Volume of O_2 diffuse under similar conditions in 30 seconds will be :

(A) 12.14 L (B) 14.14 L (C) 18.14 L (D) 28.14 L

29. Three footballs are respectively filled with nitrogen, hydrogen and helium. If the leaking of the gas occurs with time from the filling hole, then the ratio of the rate of leaking of gases $(r_{N_2} : r_{H_2} : r_{He})$ from three footballs (in equal time interval) is :

(A) $\left(1 : \sqrt{14} : \sqrt{7}\right)$ (B) $\left(\sqrt{14} : \sqrt{7} : 1\right)$ (C) $\left(\sqrt{7} : 1 : \sqrt{14}\right)$ (D) $\left(1 : \sqrt{7} : \sqrt{14}\right)$

30. NH_3 & SO_2 gases are being prepared in two corners of a laboratory. The gas that will be detected first in the middle of the laboratory is :

(A) NH_3 (B) SO_2 (C) both at the same time (D) can't determine

31. Consider an ideal gas contained in a vessel. If the intermolecular interaction suddenly begins to act, which of the following will happen :

(A) the observed pressure decreases (B) the observed pressure increases

(C) the observed pressure remains same (D) none of these

32. A real gas obeying Vander Waals equation will resemble ideal gas, if the :

(A) constants a & b are small (B) a is large & b is small

(C) a is small & b is large (D) constant a & b are large

33. Calculate the compressibility factor for CO_2, if one mole of it occupies 0.4 litre at 300 K and 40 atm. Comment on the result :

(A) 0.40, CO_2 is more compressible than ideal gas

(B) 0.65, CO_2 is more compressible than ideal gas

(C) 0.55, CO_2 is more compressible than ideal gas

(D) 0.62, CO_2 is more compressible than ideal gas

34. Calculate the radius of He atoms if its Vander Waal's constant 'b' is 24 ml mol^{-1} :

(Note ml = cubic centimeter)

(A) 1.355 Å (B) 1.314 Å (C) 1.255 Å (D) 0.355 Å

35. The critical constant for water are 374 C, 218 atm and 0.0566 litre mol^{-1}. Calculate a & b.

(A) a = 1.095 $litre^2$ atm mol^{-2}, b = 0.0185 litre mol^{-1}

(B) a = 1.92 $litre^2$ atm mol^{-2}, b = 0.185 litre mol^{-1}

(C) a = 2.095 $litre^2$ atm mol^{-2}, b = 0.0189 litre mol^{-1}

(D) a = 2.95 $litre^2$ atm mol^{-2}, b = 0.1185 litre mol^{-1}

36. 10 mL of gaseous hydrocarbon on combustion gives 40 mL of CO_2 & 50 mL of H_2O. The hydrocarbon is :

(A) C_4H_6 (B) C_4H_8 (C) C_8H_{10} (D) C_4H_{10}

37. The volume of oxygen required for complete oxidation of 2 litre of methane at NTP is :

(A) 12.25 L (B) 4 L (C) 1 L (D) 3 L

38. LPG is a mixture of n-butane & iso-butane. The volume of oxygen needed to burn 1 kg of LPG at NTP would be :

(A) 2240 L (B) 2510 L (C) 1000 L (D) 500 L

39. Stronge inter-molecular forces exist in :

(1) gases (2) liquids (C) amorphous solids (D) crystalline solids

40. Association of molecules in water is due to :

(A) covalent bonding (B) hydrogen bonding (C) ionic bonding (D) van der Waals' forces

41. Which of the following statements is wrong ?

(A) Evaporation is a spontaneous process

(B) Evaporation is a surface phenomenon

(C) Vapour pressure decreases with increase of temperature

(D) The vapour pressure of a solution is always less than the vapour pressure of a pure solvent.

42. Normal boiling point of a liqiud is that temperature at which vapour pressure of the liquid is equal to :

(A) zero (B) 380 mm of Hg (C) 760 mm of Hg (D) 100 mm of Hg

43. Water boils at lower temperature on high altitudes because :
(A) atmospheric pressure is low there (B) atmospheric pressure is high there
(C) water is weakly hydrogen bonded there (D) water in pure form is found there

44. When a student was given aviscometer, the liquid was sucked with difficulty; the liquid may be :
(A) benzene (B) toluene (C) water (D) glycerine

45. Mark the satement which is correct ?
(A) Surface tension of a liquid increases with temperature
(B) Addition of chemicals reduces the surface tension of a liquid
(C) Stalagmometer is used for measuring viscosity of the liquid
(D) Viscosity of the liquid does not depend on intermolecular forces

46. With the increasng molecular mass of a liquid, the viscosity :
(A) decreases (B) increases (C) no effect (D) all wrong

47. The viscosity of a which liquid is the maximum ?
(A) water (B) glycol (C) acetone (D) ethanol

48. The rise of a liquid in a capillary tube is due to :
(A) visosity (B) osmosis (C) diffusion (D) surface tension

49. With increase in temperature, the fluidity of liquids ;
(A) increases (B) decreases (C) remains constant
(D) may increase or decrease

50. If η_1 and η_2 are the coefficients of viscosity of two liquids, d_1 and d_2 their densities and t_1 and t_2 the flow times in Ostwald viscometer, then :
(A) $\frac{\eta_1}{\eta_2}=\frac{d_1t_2}{d_2t_1}$ (B) $\frac{\eta_1}{\eta_2}=\frac{d_2t_2}{d_1t_1}$ (C) $\frac{\eta_1}{\eta_2}=\frac{d_1t_1}{d_2t_2}$ (D) $\frac{\eta_1}{\eta_2}=\frac{d_2t_1}{d_1t_2}$

51. Which of the following expressions regarding due the unit of coefficient of viscosity is not ture ?
(A) dyne cm^{-2} sec (B) dyne cm^2 sec^{-1} (C) Nm^{-2} sec (D) 1 poise = 10^{-1} Nm^{-2} sec

52. The boiling point of water, ethyl alcohol anddiethyl ether are 100 C, 78.5 C and 34.6 C respectively. The intermolecular forces will be in the order of :
(A) water > ethyl alcohol > diethyl ether (B) ethyl > alcohol > water > diethyl ether
(C) diethyle > ethyl alcohol > water (D) diethyl ether > water > ethyl alcohol

53. Which one is the amorphous solid ?
(A) diamond (B) graphite (C) common salt (D) glass

54. Viscosity of a liquid is increased by :
(A) increase in temperature. (B) decrease in molecular size.
(C) increase in molecular size. (D) none of the above.

55. Which of the following statements is correct if the intermolecular forces in liquids A, B and C are in the order A < B < C ?
(A) B evaporates more readily than A (B) B evaporates less readily than C.
(C) A and B evaporate at the same rate. (D) A evaporates more readily than C.

56. 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.

CHECK YOUR GRASP						ANSWER KEY							EXERCISE -1		
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	A	C	A	A	A	B	C	B	C	B	D	A	B	A	D
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	B	B	B	A	B	B	A	B	A	A	B	A	B	A	A
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans.	A	A	B	A	C	D	B	B	D	B	C	C	A	D	B
Que.	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**				
Ans.	B	B	B	A	C	C	A	D	C	D	D				

SELECT THE CORRECT ALTERNATIVES (ONE OR MORE THEN ONE CORRECT ANSWERS)

1. Consider the following statements :

The coefficient B in the virile equation on state

$$PV_m = RT\left(1+\frac{B}{V_m}+\frac{C}{V_m^2}+.....\right)$$

a : is independent of temperature

b : is equal to zero at boyle temperature

c : has the dimension of molar volume

Which of the above statements are correct.

(A) a and b (B) a and c (C) b and c (D) a, b and c

2. Consider the following statements : If the vander Waal's parameters of two gases are given as

	a (atm lit^2 mol^{-2})	b (lit mol^{-1})
Gas X :	6.5	0.056
Gas Y :	8.0	0.011

then a : V_C (X) < V_C (Y)

b : P_C (X) < P_C (Y)

c : T_C (X) < T_C (Y)

Select correct alternate :

(A) a alone (B) a and b (C) a,b and c (D) b and c

3. At low pressures, the vander Waal's 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) $\left(1+\frac{RTV}{a}\right)$

4. NH_3 gas is liquefied more easily than N_2. Hence :

(A) vander Waal's constants 'a' and 'b' of NH_3 > that of N_2

(B) vander Waal's constants 'a' and 'b' of NH_3 < that of N_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)

5. For the non-zero values of force of attraction between gas molecules, gas equation will be :

(A) $PV = nRT - \frac{n^2a}{V}$ (B) PV = nRT + nbP (C) PV = nRT (D) $P = \frac{nRT}{V-b}$

6. Compressibility factor for H_2 behaving as real gas is :

(A) 1 (B) $\left(1-\frac{a}{RTV}\right)$ (C) $\left(1+\frac{Pb}{RT}\right)$ (D) $\frac{RTV}{(1-a)}$

7. Equal masses of methane and oxygen are mixed in an empty container at 25 C. The fraction of the total pressure exerted by oxygen is :

(A) 1/3 (B) 1/2 (C) 2/3 (D) (1/3) (273/298)

8. The temperature at which a real gas obeys the ideal gas laws over a wide range of pressure is :

(A) critical temperature (B) Boyle temperature (C) boiling temperature (D) reduced temperature

9. 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 molecules (B) same as that of a hydrogen molecules

(C) four times that of a hydrogen molecules (D) half that of a hydrogen molecules

10. In vander Waal's equation of state for a non-ideal gas the term that accounts for intermolecular forces is :

(A) (V – b) (B) $\left(p+\frac{a}{v^2}\right)$ (C) RT (D) $(RT)^{-1}$

11. 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) $V_m \geq 44.8$ L

12. If two moles of an ideal gas at 546 K occupies a volume of 44.8 litres, the pressure must be :

(A) 2 atm (B) 3 atm (C) 4 atm (D) 1 atm

13. At STP the order of root mean square velocity of molecules of H_2, N_2, O_2 and HBr is :

(A) $H_2 > N_2 > O_2 > HBr$(B) $HBr > O_2 > N_2 > H_2$(C) $HBr > H_2 > O_2 > N_2$(D) $N_2 > O_2 > H_2 > HBr$

14. The density of a gas at 27 C and 1 atm is d. Pressure remaining constant at which of the following temperatures will its density become 0.75 d?

(A) 20 C (B) 30 C (C) 400 K (D) 300 K

15. At 27 C the ratio of rms velocities of ozone to oxygen is :

(A) $\sqrt{3/5}$ (B) $\sqrt{4/3}$ (C) $\sqrt{2/3}$ (D) 0.25

16. A real gas most closely approaches the behaviour of an ideal gas at :

(A) 15 atm and 200 K (B) 1 atm and 273 K

(C) 0.5 atm and 500 K (D) 15 atm and 500 K

17. The temperature at which the second virial coefficient of a real gas is zero is called :

(A) Critical temperature (B) Boyle's temperature (C) Boiling point (D) none of these

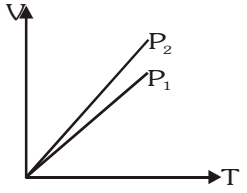
18. V vs T curves at constant P_1 and P_2 for an ideal gas are shown in figure. Which is correct :

(A) $P_1 > P_2$

(B) $P_1 < P_2$

(C) $P_1 = P_2$

(D) all



19. At STP, 2.8 litres of hydrogen sulphide were mixed with 1.6 litres of sulphur dioxide and the reaction occurred according to the equation :

$2H_2S\ (g) + SO_2\ (g) \longrightarrow 2H_2O\ (l) + 3S\ (s)$

Which of the following shows the volume of the gas remaining after the reaction?

(A) 0.2 litres of SO_2 (g) (B) 0.4 litres of H_2 (g)

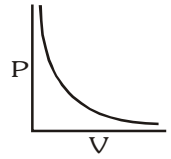
(C) 1.2 litres of H_2S (g) (D) 1.2 litres of SO_2 (g)

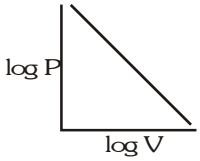
20. The rates of diffusion of SO_3, CO_2, PCl_3 and SO_2 are in the following order :

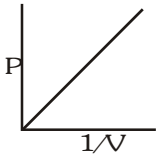
(A) $PCl_3 > SO_3 > SO_2 > CO_2$ (B) $CO_2 > SO_2 > PCl_3 > SO_3$

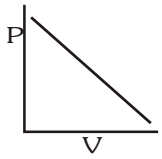
(C) $SO_2 > SO_3 > PCl_3 > CO_2$ (D) $CO_2 > SO_2 > SO_3 > PCl_3$

21. Which of the following curves does not represent Boyle's law :

(A) 

(B) 

(C) 

(D) 

22. A closed vessel contains equal number of nitrogen and oxygen molecules at pressure of P mm. If nitrogen is removed from the system, then the pressure will be :

(A) P (B) 2P (C) P/2 (D) P^2

23. The ratio of average molecular kinetic energy of PCl_5 to that of O_2 both at 300 K is :

(A) 1 : 1 (B) 7 : 2 (C) 176 : 1 (D) 2 : 7

24. The correct order of normal boiling points of O_2, N_2, NH_3 and CH_4 for whom the values of vander waals constant 'a' are 1.360, 1.390, 4.170 and 2.253 $L^2.atm.mol^{-2}$ respectively, is :

(A) $O_2 < N_2 < NH_3 < CH_4$ (B) $O_2 < N_2 < CH_4 < NH$

(C) $NH_3 < CH_4 < N_2 < O_2$ (D) $NH_3 < CH_4 < O_2 < N_2$

25. A molecule in a cube of length ℓ has a velocity v_x in the x direction. The number of collisions with one face per second for this molecule with be given by which one of the following :

(A) v_x/ℓ (B) $v_x/2\ell$ (C) ½ ℓ (D) $N\ mv^2/3\ell$

26. The rate of diffusion of methane at a given temperature is twice that of gas X. The molecule weight of X is :

(A) 64.0 (B) 32.0 (C) 4.0 (D) 8.0

27. For a fixed volume of a gas the pressure is increases when the temperature increases. This is due to :

(A) increase in the average molecular speed (B) increase in the rate of collisions

(C) increase in the molecular attraction (D) decrease in the mean free path

28. The ratio, $\frac{\text{rms velocity of } SO_2}{\text{rms velocity of He}}$, of sulphur dioxide and helium gases at 30 C is equal to :

(A) 4 (B) 0.25 (C) 0.10 (D) 8

29. A certain volume of argon gas (Mol Wt. 40) requires 45 s to effuse through a hole at a certain pressure and temperature. The same volume of another gas of unknown molecular weight requires 60 s to pass through the same hole under the same conditions of temperature and pressure. The molecular weight of the gas is :

(A) 53 (B) 35 (C) 71 (D) 120

30. On the surface of the earth at 1 atm pressure, a balloon filled with H_2 gas occupies 500 mL. This volume 5/6 of its maximum capacity. The balloon is left in air. It starts rising . The height above which the balloon will burst if temperature of the atmosphere remains constant and the pressure decreases 1 mm for every 100 cm rise of height is :

(A) 120 m (B) 136.67 m (C) 126.67 m (D) 100 m

31. A chemist has synthesized a greenish yellow gaseous compound of chlorine and oxygen and finds that its density is 7.71 g/L at 36 C and 2.88 atm. Then the molecular formula of the compound will be :

(A) ClO_3 (B) ClO_2 (C) ClO (D) Cl_2O_2

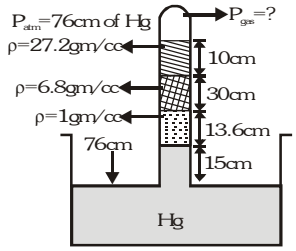
32. In the following arrangement the pressure of the confined gas will be :

(A) 15 cm of Hg

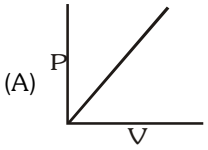
(B) 25 cm of Hg

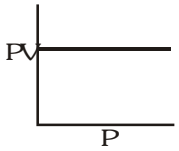
(C) 35 cm of Hg

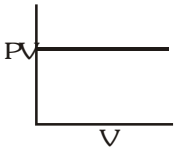
(D) 45 cm of Hg

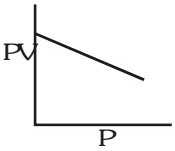


33. Which of the following graphs represent Boyle's law :

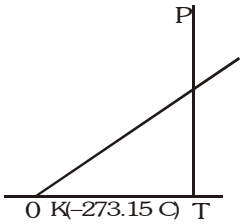
(A) 

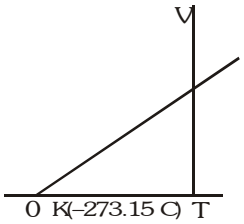
(B) 

(C) 

(D) 

34. What conclusions would you draw from the following graphs :





(A) As the temperature is reduced, the volume as well as pressure increase.

(B) As the temperature is reduced, the volume becomes zero and the pressure reaches infinity.

(C) As the temperature is reduced, the volume as well as the pressure decrease.

(D) A point is reached where theoretically, the volume as well as the pressure become zero.

35. Which of the following statements are correct :

(A) Helium diffuses at a rate 8.65 times as much as CO does

(B) Helium escapes at a rate 2.65 times as fast as CO does.

(C) Helium escapes at a rate 4 times as fast as CO_2 does.

(D) Helium escapes at a rate 4 times as fast as SO_2 does.

36. When a gas is expanded 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 decreases

37. Which of the following are correct statements :

(A) vander waals constant 'a' is a measure of attractive force

(B) vander waals constant 'b' is also called co-volume or excluded volume

(C) 'b' is expressed in L mol^{-1}

(D) 'a' is expressed in atm L^2 mol^{-2}

38. Which of the following statements are incorrect :

(A) Molar volume of every gas at STP is 22.4 L

(B) Under critical states compressibility factor is 1

(C) All gases will have equal value of average KE at a given temperature

(D) At absolute zero, KE is $\frac{3}{2}R$.

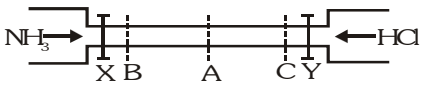
39. At what temperature will the total KE of 0.3 mol of He be the same as the total KE of 0.40 mol of Ar at 400 K :

(A) 533 K (B) 400 K (C) 346 K (D) 300 K

40. If molecules of the gas are spherical of radius 1 Å, the volume occupied by the molecules in 1 mol of a gas is :

(A) 22400 mL (B) 22.4 L (C) 2.52 mL (D) 4.22 mL

41. See the figure :



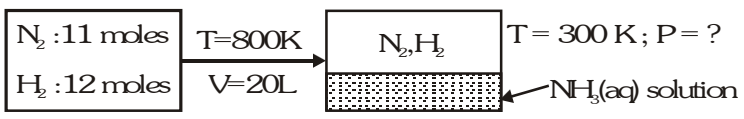
The valves of X and Y are opened simultaneously. The white fumes of NH_4Cl will first form at :

(A) A (B) B (C) C (D) A,B and C simultaneously

42. Calculate γ (ratio of C_p and C_v) for triatomic linear gas at high temperature. Assume that the contribution of vibrational degree of freedom is 75% :

(A) 1.222 (B) 1.121 (C) 1.18 (D) 1.33

43. 11 moles N_2 and 12 moles of H_2 mixture reacted in 20 litre vessel at 800 K. After equilibrium was reached, 6 mole of H_2 was present. 3.58 litre of liquid water is injected in equilibrium mixture and resultant gaseous mixture suddenly cooled to 300 K. What is the final pressure of gaseous mixture ? Negative vapour pressure of liquid solution. Assume (i) all NH_3 dissolved in water (ii) no change in volume of liquid (iii) no reaction of N_2 and H_2 at 300 K :



Initial condition

(A) 18.47 atm (B) 60 atm (C) 22.5 atm (D) 45 atm

44. Two closed vessel A and B of equal volume containing air at pressure P_1 and temperature T_1 are connected to each other through a narrow open tube. If the temperature of one is now maintained at T_1 and other at T_2 (where $T_1 > T_2$) then that what will be the final pressure ?

(A) $\frac{T_1}{2P_1T_2}$ (B) $\frac{2P_1T_2}{T_1+T_2}$ (C) $\frac{2P_1T_2}{T_1-T_2}$ (D) $\frac{2P_1}{T_1+T_2}$

45. A balloon containing 1 mole air at 1 atm initially is filled further with air till pressure increases to 4 atm. The initial diameter of the balloon is 1 m and the pressure at each stage is proportion to diameter of the balloon. How many no. of moles of air added to change the pressure from 1 atm to 4 atm :

(A) 80 (B) 257 (C) 255 (D) 256

46. What is the density of wet air with 75% relative humidity at 1 atm and 300 K? Given : vapour pressure of H_2O is 30 torr and average molar mass of air is 29 g mol^{-1} :

(A) 1.614 g/L (B) 0.96 g/L (C) 1.06 g/L (D) 1.164 g/L

47. Calculate minimum number of balloons each of volume 82.1 L required to lift a mass of 1 kg to a height of 831 m. Given : molar mass of air = 29 g/mol, temperature is constant at 290 K and mass of each balloons is 40 g. [Use $e^{-0.1} = 0.9$, pressure at sea level = 1 atm, acceleration due to gravity (g) = 10 m/s^2] :

(A) 10 (B) 20 (C) 25 (D) 50

48. If a real gas following equation P(V – nb) = nRT, at low pressure then find the intercept and slope of graph between $\frac{d}{p}$ v/s P are respectively :

(A) $\frac{MR}{T}, \frac{M(RT)^2}{b}$ (B) $\frac{M}{RT}, -\frac{Mb}{(RT)^2}$ (C) $\frac{Mb}{RT}, -\frac{M}{(RT)^2}$ (D) $\frac{RT}{M}, -\frac{b}{M(RT)^2}$

BRAIN TEASERS — ANSWER KEY — EXERCISE -2

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	D	A	C	A	C	A	B	B	B	B	A	A	C	C
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	C	B	A	A	D	D	C	A	B	B	A	A	B	C	C
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	B	B	B,C	C,D	B,D	A,B	All	B,D	A	C	C	C	C	B	C
Que.	46	47	48												
Ans.	D	B	B												

EXERCISE–03 MISCELLANEOUS TYPE QUESTIONS

TRUE / FALSE

1. The volume occupied by 32 g of oxygen is greater than that occupied by 16 g of methane, both being at the same T and P.

2. A real gas can be liquefied if its temperature is greater than its critical temperature.

3. Kinetic energy of gaseous molecules is zero at 0 C.

4. The term V_m – b in vander waals equation represents the available volume where molecules of the gas can move.

5. The average speed of a gas varies linearly with increases of temperature.

6. A mixture of ideal gaseous is cooled upto liquid helium temperature (4.22 K) to form an ideal solution.

7. For a vander waals gas V_C = 3b, P_C = a/27 b^2, T_C = 8a/27b R. Numerically the compressibility factor of a vander waals gas at the critical points is Z = 0.375.

FILL IN THE BLANKS

1. The value of PV for 5.6 L of an ideal gas is ..... RT at STP.

2. The density of an ideal gas ..... with increase in temperature of the gas, provided the pressure remains constant.

3. The unit of vander waals constant 'a' in SI units is ..... .

4. 0.5 L of a certain gas at STP weighs 0.58 g. Its molar mass is .....g mol^{-1}.

5. The root means square speed of methane gas will be ..... that of helium gas both having the same temperature and pressure.

6. (i) The rate of diffusion of a gas is ..... proportional to ..... or square root of molecular mass.

   (ii) The total energy of one mole of gas (ideal monoatomic) at 27 C is ..... calorie.

   (iii) Equal masses of SO_2 and O_2 are kept in a vessel at 27 C. The total pressure is 2 atm. The partial pressure of SO_2 is ..... .

7. (i) There is no effect of ..... on the motion of gas molecules.

   (ii) If the density of a gas at 27 C and 1 atmospheric pressure is 1.8 g lit^{-1}, its molecular mass is ..... .

   (iii) If the speed of a molecule at 27 C is 0.25 metre sec^{-1}, its speed at 927 C will be ..... .

   (iv) A steel vessel of capacity 22.4 litre contains 2 g of hydrogen, 8g of oxygen and 22 g of carbon dioxide at a temperature of 0 C. The total pressure of the gas is ..... .

8. A gas has a volume of 580 cm^3 at a certain pressure. If its pressure is increased by 0.96 atm, its volume becomes 100 cm^3. The new pressure of the gas is ..... .

MATCH THE COLUMN

1.

	Column-I		Column-II
(A)	$P_1V_1 = P_2V_2 = P_3V_3 = ...$	(p)	Dalton's law of partial pressures at constant temperature.
(B)	$\frac{V_1}{T_1} = \frac{V_2}{T_2} = \frac{V_3}{T_3} =$..... at constant pressure.	(q)	Kinetic equation of ideal gases.
(C)	$r \propto \sqrt{\frac{1}{d}}$	(r)	22.4 litre
(D)	$P = P_1 + P_2 + P_3 + ...$	(s)	Isotherm
(E)	$(V - b)\left(P + \frac{a}{V^2}\right) = RT$	(t)	Isobar
(F)	R/N	(u)	Charles' law
(G)	Molar volume	(v)	Graham's law
(H)	$PV = \frac{1}{3} mnc^2$	(w)	Boyle's law
(I)	Graph between P and V at constant temperature.	(x)	Equation for real gases.
(J)	Graph between V and T at constant pressure.	(y)	Boltzmann's constant

ASSERTION & REASON

These questions contains, Statement I (assertion) and Statement II (reason).

(A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.

(B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I

(C) Statement-I is true, Statement-II is false

(D) Statement-I is false, Statement-II is true

1. **Statement-I :** Plot of P Vs. 1/V (volume) is a straight line.
   Because
   Statement-II : Pressure is directly proportional to volume.

2. **Statement-I :** Absolute zero is a theoretically possible temperature at which the volume of the gas becomes zero.
   Because
   Statement-II : The total kinetic energy of the molecule is zero at this temperature.

3. **Statement-I :** Pressure exerted by a mixture of reacting gases is equal to the sum of their partial pressures.
   Because
   Statement-II : Reacting gases react to form a new gas having pressure equal to the sum of both.

4. **Statement-I :** Critical temperature of the gas is the temperature at which it occupies 22.4 L of volume.
   Because
   Statement-II : Molar volume of every gas at NTP is 22.4 L.

5. **Statement-I :** Excluded volume or co-volume equals to (v–nb) for n moles.
   Because
   Statement-II : Co-volume depends on the effective size of gas molecules.

6. **Statement-I :** Carbondioxide has greater value of root mean square velocity u_{rms} than carbon monoxide.
   Because
   Statement-II : u_{rms} is directly proportional to molar mass.

7. **Statement-I :** Most probable velocity is the velocity possessed by maximum fraction of molecules at the same temperature.

Because

Statement-II : On collision, more and more molecules acquire higher speed at the same temperature.

8. **Statement-I :** The effusion rate of oxygen is smaller than that of nitrogen.

Because

Statement-II : Molecular size of nitrogen is smaller than that of oxygen.

COMPREHENSION BASED QUESTIONS

Comprehension # 1

The rate of change of pressure (p) of a gas at constant temperature and constant external pressure due to effusion of gas from a vessel of constant volume is related to rate of change of number of molecules present by

$$\frac{dp}{dt} = \frac{kT}{V}\frac{dN}{dt}$$

where k = Boltzmann constant, T = temperature, V = volume of vessel & N = No. of molecules and $\frac{dN}{dt} = \frac{-pA_0}{(2\pi mkT)^{1/2}}$, where A_0 = area of orifice and m = mass of molecule.

1. Time required for pressure inside vessel to reduce to $1/e$ of its initial value in ($\ln e = 1$)

(A) $\left(\frac{2\pi m}{kT}\right)^{1/2}\frac{V}{A_0}$ (B) $\left(\frac{kT}{2\pi m}\right)^{1/2}\frac{V}{A_0}$ (C) $\left(\frac{2\pi mkT}{A_0}\right)^{1/2}$ (D) $\frac{2\pi m}{kT}\frac{V}{A_0}$

2. If the gas inside the vessel had molecular weight 9 times the gas in previous example and area of orifice was doubled and temperature maintained at 4T, time required for pressure to fall to $1/e$ times of its initial value would be (t = answer of previous option)

(A) 1.33 t (B) 4.24 t (C) 0.75 t (D) 1.125 t

3. The incorrect statement (s) is/are.

[I] Pressure will not fall to zero in infinite time.

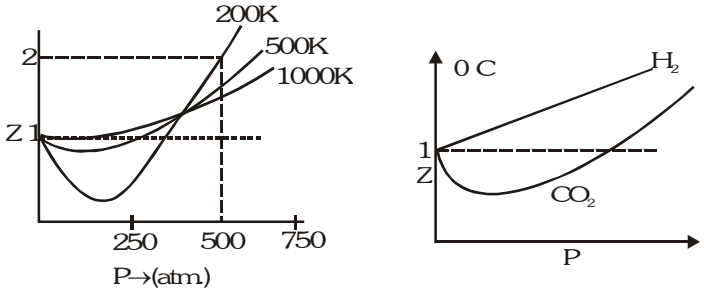
[II] Time required for pressure to decrease to half its initial value is independent of initial pressure.

[III] The relations given above are true for real gases also.

(A) I (B) II (C) III (D) I and III

Comprehension # 2

Sketch shows the plot of Z v/s 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 $(T_b) = \frac{a}{Rb}$. If a plot is obtained at temperatures well 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 well above critical temperature curve is more like H_2 at 0 C as shown above. At high pressure suppose all the constant temperature curve varies linearly with pressure according to the following equation $Z = 1 + \frac{Pb}{RT}$ ($R = 2$ cal mol^{-1} K^{-1})

1. Which of the following is correct :

(A) $\frac{a}{b} < 0.4$ k cal mol^{-1} (B) 0.4 k cal $mol^{-1} < \frac{a}{b} < 2$ k cal mol^{-1}

(C) $\frac{a}{b} > 0.4$ k cal mol^{-1} (D) $\frac{a}{b} = 1$ K cal mol^{-1}

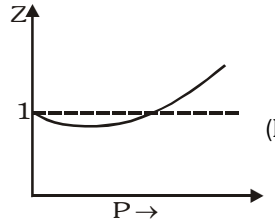
2. For 500 K plot value of Z changes from 2 to 2.2 if pressure is varied from 1000 atm to 1200 atm (high pressure) then the value of $\frac{b}{RT}$ will be :-

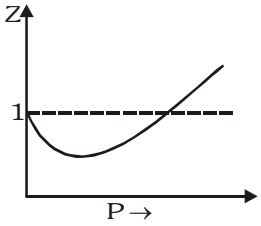
(A) 10^{-3} atm^{-1} (B) 2 10^{-3} atm^{-1} (C) 5 10^{-4} atm^{-1} (D) 10^{-4} atm^{-1}

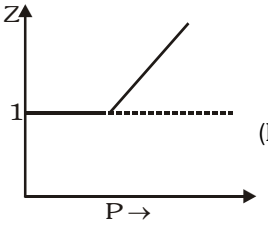
3. As shown in the figure at 200 K and 500 atm value of compressibility factor is 2 (approx). Then volume of the gas at this point will be :-

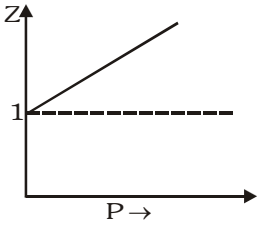
(A) 0.01 L (B) 0.09 L (C) 0.065 L (D) 0.657 L

4. Plot at Boyle's temperature for the gas will be :

(A) 

(B) 

(C) 

(D) 

5. In very high pressure region if Z v/s P is plotted at 1200 K for the above gas then it will have greatest slope.

(A) true (B) false

(C) can't say (D) not related to the paragraph

MISCELLANEOUS TYPE QUESTION **ANSWER KEY** EXERCISE -3

- ***True / False***

1. F **2.** F **3.** F **4.** T
5. F **6.** F **7.** T

- ***Fill in the Blanks***

1. 0.25 **2.** decreases **3.** Pa m^6 mol^{-2} **4.** 26
5. One half **6.** (i) inversely, square root of density, (ii) 900, (iii) 2/3
7. w (i) gravity (ii) 44.33 (iii) 0.5 m/s (iv) 1.75 atm **8.** 1.16 atm

- ***Match the Column***

1. A - (w), B - (u), C - (v), D - (p), E - (x), F - (y), G - (r), H - (q), I - (s), J - (t)

- ***Assertion - Reason Questions***

1. C **2.** B **3.** E **4.** D
5. D **6.** E **7.** C **8.** C

- ***Comprehension Based Questions***

Comprehension #1 : 1. (A) **2.** (C) **3.** (C)
Comprehension #2 : 1. (B) **2.** (A) **3.** (C) **4.** (C) **5.** (B)

1. 3.6 g of an ideal gas was injected into a bulb of internal volume of 8 L at pressure P atm and temp T K. The bulb was then placed in a thermostat maintained at (T + 15)K 0.6 g of the gas was let off to keep the original pressure. Find P and T if mol weight of is 44.

2. A toy balloon originally held 1.0 g of He gas and had a radius 10 cm. During the night, 0.25 g of the gas effused from the balloon. Assuming ideal gas behaviour, under these constant P and T conditions, what was the radius of the balloon the next morning.

3. If a scuba diver is to remain submerged for 1 hr, what pressure must be applied to force sufficient air into the tank to be used. Assume 0.5 dm^3 of air per breath at standard atmospheric pressure, a respiration rate of 38 breaths per minute, and a tank capacity of 30 dm^3.

4. While resting, the average human male use 0.2 dm^3 of O_2 per hour at STP for each kg of body mass. Assume that all this O_2 is used to produce energy by oxidising glucose in the body. What is the mass of glucose required per hour by a resting male having mass 60 kg. What volume, at STP of CO_2 would be produced.

5. 12 g N_2, 4 g H_2 and 9 g O_2 are put into a one litre container at 27 C. What is the total pressure.

6. 1.0 10^{-2} kg of hydrogen and 6.4 10^{-2} kg of oxygen are contained in a 10 10^{-3} m^3 flask at 473 K. Calculate the total pressure of the mixture. If a spark ignities the mixture, What will be the final pressure.

7. At room temp, NH_3 gas at one atm & HCl gas at "P" atm are allowed to effuse through identical pin holes to the opposite ends of a glass tube 1 m long & uniform cross-section. A white deposit is observed at a distance of 60 cm from the HCl end. What is "P".

8. A gas mixture contains equal number of molecules of N_2 and SF_6, some of it is passed through a gaseous effusion apparatus. Calculate how many molecules of N_2 are present in the product gas for every 100 molecules of SF_6.

9. Two gases NO and O_2 were introduced at the two ends of a one metre long tube simultaneously (tube of uniform cross-section). At what distance from NO gas end, Brown fumes will be seen.

10. At 20 C two balloons of equal volume and porosity are filled to a pressure of 2 atm, one with 14 kg N_2 & other with 1 kg H_2. The N_2 balloon leaks to a pressure of $\frac{1}{2}$ atm in one hour. How long will it take for H_2 balloon to leaks to a pressure of $\frac{1}{2}$ atm.

11. Pure O_2 diffuses through an aperture in 224 sec, where as mixture of O_2 and another gas containing 80% O_2 diffuses from the same in 234 sec. What is molecular weight of the gas.

12. A space capsule is filled with neon gas 1.00 atm and 290 K. The gas effuses through a pin - hole into outer space at such a rate that the pressure drops by 0.3 torr/sec.

(a) If the capsule were filled with ammonia at the same temperature and pressure, what would be the rate of pressure drop.

(b) If the capsule were filled with 30.0 mol % helium, 20.0 mol% oxygen & 50.0 mol% nitrogen at a total pressure of 1.00 atm & a temp of 290 K, what would be the corresponding rate of pressure drop.

13. Show that the height at which the atmospheric pressure is reduced to half its value is given by $h = \frac{0.693RT}{Mg}$.

14. Calculate the pressure of a barometer on an aeroplane which is at an altitude of 10 Km. Assume the pressure to be 101.325 kPa at sea level & the mean temperature 243 K. Use the average molar mass of air (80% N_2, 20% O_2)

15. An iron cylinder contains helium at a pressure of 250 kPa and 27 C. The cylinder can withstand a pressure of 1 10^6 Pa. The room in which cylinder is placed catches fire. Predict whether the cylinder will blow up before it metls or not. [melting point of cylinder = 1800 K]

16. Determine the molar mass of a gas if its pressure is to fall to one-half of its value in a vertical distance of one meter at 298 K.

17. The time taken for a given volume of gas E to effuse through a hole is 75 sec. Under identical conditions the same volume of a mix of CO & N_2 (containing 40% of N_2 by volume) effused in 70 sec. Calculate

(i) the relative mol mass of E, and

(ii) the RMS velocity (in ms^{-1} units) of E at 0 C.

18. At what temperature in C, the U_{rms} of SO_2 is equal to the average velocity of O_2 at 27 C.

19. The density of CO at 273 K and 1 atm is 1.2504 kg m^{-3}. Calculate (a) root mean square speed (b) the average speed and (c) most probable speed.

20. Calculate the temperature values at which the molecules of the first two members of the homologous series C_nH_{2n+2} will have the same rms speed as CO_2 gas at 770 K. The normal b.p. of n-butane is 273 K. Assuming ideal gas behaviour of n-butane upto this temperature, calculate the mean velocity and the most probable velocity of its molecules at this temperature.

21. Calculate the temperature at which the root mean square velocity, average velocity and most probable velocity of oxygen gas are all equal to 1500 ms^{-1}.

22. Calculate the fraction of N_2 molecules at 101.325 kPa and 300 K whose speeds are in the range of u_{mp} – 0.005 u_{mp} to u_{mp} + 0.005 u_{mp}.

23. What is the ratio of the number of molecules having speeds in the range of $2u_{mp}$ and $2u_{mp}$ + du to the number of molecules having speeds in the range of u_{mp} and u_{mp} + du ?

24. The density of mercury is 13.6 g/cm^3. Estimate the b value.

25. Calculate the pressure exerted by 22 g of carbon dioxide in 0.5 dm^3 at 298. 15 K using :

(a) the ideal gas law and (b) vander waals equation. Given :

[a = 363.76 kPa dm^6 mol^{-2} and b = 42.67 cm^3 mol^{-1}]

26. The compressibility factor for N_2 at –50 C and 800 atm pressure is 1.95 and at 100 C and 200 atm, it is 1.10. A certain mass of nitrogen occupied one litre at –50 C and 800 atm. Calculate the volume occupied by the same quantity of N_2 at 100 C and 200 atm.

27. At 273.15 K and under a pressure of 10.1325 MPa, the compressibility factor of O_2 is 0.927. Calculate the mass of O_2 necessary to fill a gas cylinder of 100 dm^3 capacity under the given conditions.

28. The vander waals constant for O_2 are a = 1.36 atm L^2 mol^{-2} and b = 0.0318 L mol^{-1}. Calculate the temperature at which O_2 gas behaves, ideally for longer range of pressure.

29. The vander waals constants for gases A,B and C are as follows :

Gas	a/dm^6 kPa mol^{-2}	b/dm^3 mol^{-1}
A	405.3	0.027
B	1215.9	0.030
C	607.95	0.032

Which gas has (i) the highest critical temperature , (ii) the largest molecular volume, and (iii) most ideal behaviour around STP?

30. A commercial cylinhder contains 6.91 m^3 of O_2 at 15.18 M Pa and 21 C. The critical constants for O_2 are T_C = –118.4 C, P_C = 50.1 atm. Determine the reduced pressure and reduced temperature for O_2 under these conditions.

31. Show that at low densities, the vander waals equation

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

and the Dieterici's equation $P(V_m - b) = RT \exp(-a/RTV_m)$ given essential the same value of p.

32. Calculate from the vander waal's equation, the temperature at which 192 g of SO_2 would occupy a vol. of 10 dm^3 at 15 atm pressure. [a = 6.7 atm L^2 mol^2, b = 0.0564 L mol^{-1}]

33. Calculate the pressure of 15 mol neon at 30 C in a 12 litre container using

(i) the ideal gas equation

(ii) the vander waals equation

[a = 0.2107 atm L^2 mol^2, b = 0.0171 L mol^{-1}]

34. What will be the temperature difference needed in a hot air balloon to lift 1.0 kg of mass? Assume that the volume of balloons is 100 m^3, the temperature of ambient air is 25 C, the pressure is 1 bar, and air is an ideal gas with an average molar mass of 29 g mol^{-1}(hot and cold both).

35. One mole of a non linear triatomic gas is heatted in a closed rigid container from 500 C to 1500 C. Calculate the amount of energy required if vibrational degree of freedom become effective only above 1000 C.

CONCEPTUAL SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(A)

1. P = 0.062 atm, T = 75 k
2. 9.08 cm
3. 3.8 10^3 kPa
4. 16.07 g, 12 dm^3
5. 66.74 atm
6. P_{total} = 27.54 10^5 N/m^2 , P_{final} = 19.66 10^5 N/m^2
7. 2.19 atm
8. 228
9. 50.8 cm
10. 16 min
11. 46.6
12. (a) 0.32 Torr/sec (b) 0.29 Torr/sec
13.
14. 25.027 kPa
15. Yes
16. 175.133 kg mol^{-1}
17. 32.14 g/mol, 460.28 m/s
18. 236 C
19. U_{RMS} = 493 m/s, U_{mp} = 403 m/s, U_{av} = 454.4 m/s
20. 280 K, 525 K, 3.157 10^2 m/s, 2.798 10^2 m/s
21. R_{RMS} 2886 K, T_{av} = 3399 K, T_{mp} = 4330 K
22. 8.303 10^{-3}
23. 0.199
24. 58.997 cm^3
25. (a) 2.479 10^3 kPa (b) 2225.55 kPa
26. 3.77 L
27. 15.40 kg
28. 521 K
29. (i) B (ii) C (iii) A
30. Pr = 2.99, Tr = 1.90
32. 350.5 C
33. (i) 31.1 atm (ii) 31.4 atm
34. 2.53 C
35. 4500 RJ

1. The respiration of a suspension of yeast cells was measured by determining the decrease in pressure of the gas above the cell suspension. The apparatus was arranged so that the gas was confined to a constant volume, 16 cm^3 and the entire pressure change was caused by uptake of oxygen by the cells. The pressure was measured in a monometer, the fluid of which had density of 1.034 g/cm^3. The entire apparatus was immersed in a thermostat at 37 C. In a 30 minute observation period the fluid in the open side of the manometer dropped 37 mm. Neglecting the solubility of oxygen in the yeast suspension, compute the rate oxygen consumption by the cells in mm^3 of O_2 (STP) per hour.

2. In a basal metabolism measurement timed at 6 minutes, a patient exhaled 52.5 L of air measured over water at 20 C. The vapour pressure of water at 20 C is 17.5 torr. The barometric pressure was 750 torr. The exhaled air analyzed 16.75 volume % oxygen and the inhald air 20.32 volume % oxygen. Both on a dry basis neglecting any solubility of the gases in water and any difference in the total volumes of inhaled and exhaled air, calculate the rate of oxygen consumption by the patient in mL (STP) per minute.

3. The temperature and the relative humidity of air are 20 C and 80% on a certain day. Find the fraction of the mass of water vapour that will condense if the temperature falls to 5 C. Saturation vapour pressures at 20 C and 5 C are 17.5 mm and 6.5 mm of Hg respectively.

4. 6.0 g of He having average velocity 4 10^2 ms^{-1} is mixed with 12.0 g of Ne^{20} having the same average velocity. What is the average kinetic energy per mole in the mixture?

5. Molar volume of He at 10.1325 MPa and 273 K is 0.011075 times its molar volume at 101.325 kPa. Calculate radius of He atom assuming negligible 'a'.

6. The Viral equation for ethane gas is given by PV = RT + BP. At 0 C, B = –0.1814 L/mol. Calculate volume of one mole of ethane at 10 atm, and 'a'.

7. Pressure of He gas confined in a steel chamber drops from 4.0 to 1.0 atmosphere in 4.0 hours due to diffusion through a pin-hole in the steel chamber. If an equimolar mixture of He and methane gas at 20 atmosphere and the same temperature are confined in the same chamber, what will be the parital pressure of He and methane after 1.0 hour. Assume rate of diffusion to be linear function of gas pressure and inverse function of square root of molar masses.

8. A one litre flask containing NH_3 (g) at 2.0 atmoshpere and 300 K is connected to another 800 mL flask containing HCl (g) at 8.0 atmosphere and 300 K by means of a narrow tube of negligible volume and gases were allowed to react quantitatively as :

$$NH_3\ (g) + HCl\ (g) \longrightarrow NH_4Cl\ (s)\ ;\ \Delta H = -\ 43\ kJ/mol$$

If heat capacity of HCl (g) C_V is 20 $JK^{-1}\ mol^{-1}$, determine final pressure inside the flask assuming negligible heat capacity of flask and negligible volume of solid NH_4Cl.

9. Calculate the value of σ, λ, Z_1 and Z_{11} for nitrogen molecules at 25 C and at pressure of 10^{-3} mm Hg. Given that b for nitrogen is 39.1 $cm^3\ mol^{-1}$.

10. The mean free path of the molecule of a certain gas at 300 K is 2.6 10^{-5} m. The collision diameter of the molecule is 0.26 nm. Calculate

    (a) pressure of the gas, and

    (b) number of molecules per unit volume of the gas.

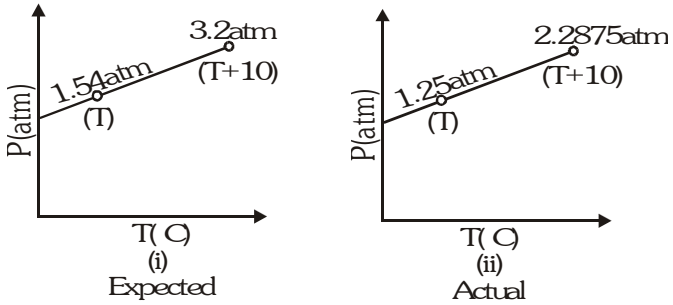
11. There are two vessels of same consisting same no of moles of two different gases at same temperature. One of the gas is CH_4 & the other is unknown X. Assuming that all the molecules of X are under random motion whereas in CH_4 except one all are stationary. Calculate Z_1 for X in terms of Z_1 of CH_4. Given that the collision diameter for both gases are same & $(U_{rms})_x = \frac{1}{\sqrt{6}}(Uav)_{CH_4}$.

12. A mixture of CH_4 & O_2 is used as an optimal fuel if O_2 is present in thrice the amount required theoretically for combustion of CH_4. Calculate number of effusions steps required to convert a mixture containing 1 part of CH_4 in 193 parts mixture (parts by volume). If calorific value (heat evolved when 1 mole is burnt) of CH_4 is 100 cal/mole & if after each effusion 90% of CH_4 is collected. find out what initial mole of each gas in initial mixture required for producing 1000 cal of energy after processing.
[Given $(0.9)^5 = 0.6$]

13. A closed vessel of known volume containing known amount of ideal gaseous substance 'A' was observed for variation of pressure with temperature. The expected graph was to be like as in (i) However actual observations revealed the graph to be like. (ii) The deviation was attributed to polymerisation of gas molecules an $nA\ (g) \rightleftharpoons A_n(g)$. If it is known that the above reaction given only 50% yield.

(a) Calculate the ratio of $\frac{n_{experiment}}{n_{theoritical}}$ (where $n_{exp.}$ = Total no. of gaseous mole actually present
$n_{theoritical}$ = Total no. of mole original taken)

(b) Find the value of n to which the gas A is being polymerised into



14. During one of his adventure, Chacha chaudhary got trapped in an underground cave which was sealed two hundred year back. The air inside the cave was poisonous, having some amount of carbon monoxide in addition to O_2 and N_2. Sabu, being huge could not enter into the cave, so in order to save chacha choudhary be started sucking the poisonous air out of the cave by mouth. Each time, he filled his lunge with cave air and exhaled it out in the surroundings. In the mean time fresh air from surrounding effused into the cave till the pressure was again one atmosphere. Each time sabu sucked out some air, the pressure in the cave dropped to half of its initial value of one atmosphere.
If the initial sample of air from the cave contain 5% by volume CO.
If the safe level of CO in the atmosphere is less than 0.001% by volume how many times does Sabu need to such out air in order to save Chacha choudhary.

15. A closed vertical cylinder is divided into two parts by a frictionless piston, each part contains 1 mole of air. At 27 C the volume of the upper part is 4 times than that of the lower part. Calculate the temperature when volume of the upper part will be three times that of the lower part.

16. A water gas mixture has the composition by volume of 50% H_2, 40% CO and 5% CO_2.

(i) Calculate the volume in litres at STP of the mixture which on treatment with excess steam will contain 5 litres of H_2. The stoichiometry for the water gas shift reaction is
$CO + H_2O \rightarrow CO_2 + H_2$

(ii) Find the density of the water gas mixture in kg/m^3.

(iii) Calculate the moles of the absorbants KOH, $Ca(OH)_2$ and ethanolamine.
$HO - CH_2 - CH_2 - NH_2$ required respectively to collect the CO_2 gas obtained.

17. A gas present in a container connected to frictionless, weightless piston operating always at one atmosphere pressure such that it permits flow of gas outside (with no adding of gas). The graph of n vs T (Kelvin) was plotted & was found to be a straight line with co-ordinates of extremen points as (300, 2) & (200, 3). Calculate :

(i) relationship between n & T

(ii) relationship between V & T

(iii) Maxima or minima value of 'V'

18. Find the critical constant (P_c , V_c and T_c) in terms of A and B, also find compressibility factor (z) for the following equation of state.

$$PV = RT - \frac{A}{V} + \frac{2B}{V^2}$$

where A and B are constant, P = pressure and V = molar volume.

19. Calculate the volume occupied by 14.0 g N_2 at 200 K and 8.21 atm prressure if $\frac{P_C V_C}{RT_C} = \frac{3}{8}$ and $\frac{P_r V_r}{T_t} = 2.2$.

BRAIN STORMING SUBJECTIVE EXERCISE **ANSWER KEY** **EXERCISE-4(B)**

1. 100 mm^3/hr **2.** 280 mL/min **3.** 0.51 **4.** 807.84 J

5. 134 pm **6.** 0.918, a = 3.77 bar L^2 mol^{-2} **7.** $P_{He} = 7.07$ atm, $P_{CH_4} = 8.4$ atm

8. 10.3 atmosphere **9.** 314 pm, 7.015 cm, 6742 s^{-1}, 1.09 10^{17} cm^{-3} s^{-1}

10. (a) 1.281 10^{23} m^{-3} (b) 5.306 10^2 Pa **11.** $\frac{2\sqrt{2}}{3\sqrt{\pi}} Z_1$

12. 10 Steps, 27.78 mol CH_4, 5333.3 mol O_2 **13.** (a) 0.625, (b) 4 **14.** 13

15. 421.9 K

16. (i) 5.263 L, (ii) 0.7kg/m^3, (iii) KOH = 0.2348 moles, $Ca(OH)_2$ = 0.1174 moles, ethanolamine = 0.2348 moles

17. $n = \frac{-T}{100} + 5$, $V = \frac{-RT^2}{100} + 5RT$, 51.3125 ℓ

18. $V_C = \frac{6B}{A}$, $T_C = \frac{A^2}{6RB}$, $P_C = \frac{A^3}{108B^2}$, compressibility factor $= \frac{P_C V_C}{RT_C} = \frac{1}{3}$ **19.** 0.825 L

EXERCISE–05 (A) PREVIOUS YEARS QUESTIONS

1. The no. of moles per litre in the equation PV = nRT is expressed by : **[AIEEE-02]**

(1) $\frac{P}{RT}$ (2) $\frac{PV}{RT}$ (3) $\frac{RT}{PV}$ (4) None

2. The correct value of R is - **[AIEEE-02]**

(1) R = 0.082 litre atm (2) R = 8.314 10^7 erg $-K^{-1}$ mol^{-1}

(3) R = $2K^{-1}$ mol^{-1} (4) None

3. According to the kinetic theory of gases, in an ideal gas, between two successive collisions a gas molecule travels - **[AIEEE-03]**

(1) In a straight line path (2) with an accelerated velocity

(3) In a circular path (4) In a wavy path

4. What volume of hydrogen gas, at 273K and 1 atm, pressure will be consumed in obtaining 21.6g of elemental boron (atomic mass = 10.8) from the reduction of boron trichloride by hydrogen ? **[AIEEE-03]**

(1) 44.8 L (2) 22.4 L (3) 89.6 L (4) 67.2 L

5. As the temperature is raised from 20 C to 40 C, the average kinetic energy of neon atoms changes by factor of which of the following ? **[AIEEE-04]**

(1) 1/2 (2) $\sqrt{(313/293)}$ (3) 313/293 (4) 2

6. In vanderwaals equation of state of the gas law, the constant 'b' is a measure of : **[AIEEE-04]**

(1) intermolecular repulsions (2) intermolecular attraction

(3) volume occupied by the molecules (4) intermolecular collisions per unit volume

7. An ideal gas expands in volume from 1 10^{-3} m^3 to 1 10^{-2} m^3 at 300 K against a constant pressure of 1 10^5 Nm^{-2}. The work done is - **[AIEEE-04]**

(1) – 900 J (2) – 900 K (3) 2710 kJ (4) 900 kJ

8. For which of the following parameters the structural isomers C_2H_5OH and CH_3OCH_3 would be expected to have the same values ? (Assume ideal behavior)

(1) Heat of vaporization **[AIEEE-05]**

(2) vapour pressure at the same temperature

(3) Boiling points

(4) Gaseous densities at the same temperature and pressure

9. Equal masses of methane and oxygen are mixed in an empty container at 25 C. The fraction of the total pressure exerted by oxygen is - **[AIEEE-06]**

(1) 2/3 (2) $\frac{1}{3}\times\frac{273}{298}$ (3) $\frac{1}{3}$ (4) $\frac{1}{2}$

PREVIOUS YEAR QUESTIONS ANSWER KEY EXERCISE-05(A)

Que.	1	2	3	4	5	6	7	8	9
Ans	1	2	1	4	3	3	1	4	3

EXERCISE–05 (B) PREVIOUS YEARS QUESTIONS

1. A mixture of ideal gases is cooled upto liquid He temperature (4.22 K) to form an ideal solution. Is this statement **true** or **false**. Justify your answer in not more than two lines. **[JEE 1996]**

2. The ratio between the r.m.s. velocity of H_2 at 50 K and that of O_2 at 800 K is. **[JEE 1996]**

(A) 4 (B) 2 (C) 1 (D) 1/4

3. X ml H_2 gas effuses through a hole in a container in 5 sec. The time taken for the effusion of the same volume of the gas specified below under identical conditions is **[JEE 1996]**

(A) 10 sec, He (B) 20 sec, O_2 (C) 25 sec, CO (D) 55 sec, CO_2

4. One mole of N_2O_4 (g) at 300 K is kept in a closed container under one atm. It is heated to 600 K when 20% by mass of N_2O_4 (g) decomposes to NO_2 (g). The resultant pressure is. **[JEE 1996]**

(A) 1.2 atm (B) 2.4 atm (C) 2.0 atm (D) 1.0 atm

5. The absolute temperature of an ideal gas is ..... to/than the average kinetic energy of the gas molecules. **[JEE 1997]**

6. One way of writing the equation for state for real gases is,

$$P\bar{V} = RT\left[1 + \frac{B}{\bar{V}} + ...\right]$$ where B is constant.

Derive an approximate expression for 'B' in terms of Vander Waals constant 'a' & 'b'. **[JEE 1997]**

7. Calculate the total pressure in a 10 litre cylinder which contains 0.4 g He, 1.6 g oxygen and 1.4 g nitrogen at 27 C. Also calculate the partial pressure of He gas in the cylinder. Assume ideal behavious for gases. **[JEE 1997]**

8. According to Graham's law, at a given temperature the ratio of the rates of diffusion $\frac{r_A}{r_B}$ of gases A and B is given by. **[JEE 1997]**

(A) $\frac{P_A}{P_B}\left(\frac{M_A}{M_B}\right)^{1/2}$ (B) $\left(\frac{M_A}{M_B}\right)\left(\frac{P_A}{P_B}\right)^{1/2}$ (C) $\frac{P_A}{P_B}\left(\frac{M_B}{M_A}\right)^{1/2}$ (D) $\frac{M_A}{M_B}\left(\frac{P_B}{P_A}\right)^{1/2}$

9. An evacuated glass vessel weighs 50.0 g when empty, 148.0 g when filled with a liquid of density 0.98 g /mL and 50.5 g when filled with an ideal gas at 760 mm Hg at 300 K. Determine the molecular weight of the gas. **[JEE 1998]**

10. Using Vander Waals equation, calculate the constant "a" when 2 moles of a gas confined in a 4 litre flask exerts a pressure of 11.0 atm at a temperature of 300 K. The value of "b" is 0.05 litre mol^{-1}. **[JEE 1998]**

11. The pressure exerted by 12 g of an ideal gas at temperature t C in a vessel of volume V is one atm. When the temperature is increased by 10 degrees at the same volume, the pressure increases by 10%. Calculate the temperature 't' and volume 'V'. [molecular weight of gas = 120] **[JEE 1999]**

12. One mole of N_2 gas at 0.8 atm takes 38 sec to diffuse through a pin hole, whereas one mole of an unknown compound of Xenon with F at 1.6 atm takes 57 sec to diffuse through the same hole. Calculate the molecular formula of the compound. **[JEE 1999]**

13. A gas will approach ideal behaviour at : **[JEE 1999]**

(A) low temperature and low pressure (B) low temperature and high pressure

(C) low pressure and high temperature (D) high temperature and high pressure

14. The compressibility of a gas is less than unity at STP. Therefore : **[JEE 2000]**

(A) $V_m > 22.4$ L (B) $V_m < 22.4$ L (C) $V_m = 22.4$ L (D) $V_m = 44.8$ L

15. The r.m.s. velocity of hydrogen is $\sqrt{7}$ times the r.m.s. velocity of nitrogen. If T is the temperature of the gas : **[JEE 2000]**

(A) $T(H_2) = T(N_2)$ (B) $T(H_2) > T(N_2)$ (C) $T(H_2) < T(N_2)$ (D) $T(H_2) = \sqrt{7}\ T(N_2)$

16. The pressure of a fixed amount of an ideal gas is proportional to its temperature. Frequency of collision and their impact both increase in proportion to the square root of temperature. True/False. **[JEE 2000]**

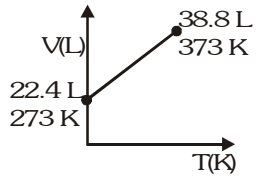
17. Calculate the pressure exerted by one mole of CO_2 gas at 273 K, if the Vander Waals constant a = 3.592 dm^6 atm mol^{-2}. Assume that the volume occupied by CO_2 molecules is negligible. **[JEE 2000]**

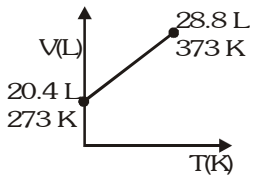
18. The root mean square velocity of an ideal gas at constant pressure varies with density as : **[JEE 2001]**

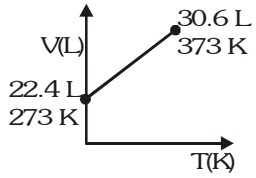
(A) d^2 (B) d (C) $d^{1/2}$ (D) $1/d^{1/2}$

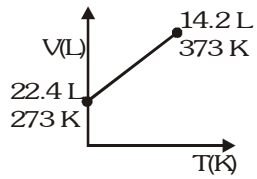
19. The compression factor (compressibility factor) for one mole of a vander Waals gas at 0 C and 100 atmosphere pressure is found to be 0.5. Assuming that the volume of a gas molecule is negligible, calculate the vander waals constant 'a'. **[JEE 2001]**

20. Which one of the following V, T plots represents the behaviour of one mole of an ideal gas at one atm? **[JEE 2002]**

(A) 

(B) 

(C) 

(D) 

21. The density of the vapour of a substance at 1 atm pressure and 500 K is 0.36 Kg m^{-3}. The vapour effuse through a small hole at a rate of 1.33 times faster than oxygen under the same condition. **[JEE 2002]**

(a) Determine

(i) mol. wt. ; (ii) molar volume ; (iii) compressibility factor (z) of the vapour

(iv) which forces among the gas molecules are dominating the attractive or the repulsive.

(b) If the vapour behaves ideally at 1000 K, determine the average translational K.E. of a molecule.

22. The average velocity of gas molecules is 400 m/sec. Calculate its (rms) velocity at the same temperature. **[JEE 2003]**

23. C_v value of He is always 3R/2 but C_v value of H_2 is 3R/2 at low temperature and 5R/2 at moderate temperature and more than 5R/2 at higher temperature explain in two to three lines. **[JEE 2003]**

24. Positive deviation from ideal behaviour takes place because of. **[JEE 2003]**

(A) molecular interaction between atoms and $\frac{PV}{nRT} > 1$

(B) molecular interation between atoms and $\frac{PV}{nRT} < 1$

(C) finite size of atoms and $\frac{PV}{nRT} > 1$

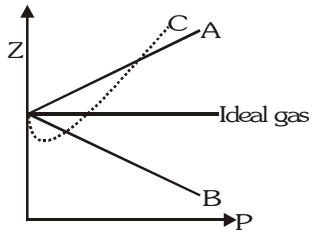
(D) finite size of atoms and $\frac{PV}{nRT} < 1$

25. For a real gas obeying vander Waal's equation a graph is plotted between PV_m (y-axis) and P(x-axis) where V_m is molar volume. Find y-intercept of the graph. **[JEE 2005]**

26. The ratio of the rate of diffusion of helium and methane under identical condition of pressure and temperature will be : **[JEE 2005]**

(A) 4 (B) 2 (C) 1 (D) 0.5

27.



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

a = Vander Waal's constant for pressure correction

b = Vander Waal's constant for volume correction

Pick the only incorrect statement

(A) for gas A, if a = 0, the compressibility factor is directly proportional to pressure

(B) for gas B, if b = 0, the compressibility factor is directly proportional to pressure

(C) for gas C, $a \neq 0$, $b \neq 0$, it can be used to calculate a and b by giving lowest P value and its intercept with Z = 1.

(D) slope for all three gases at high pressure (not shown in graph) is positive. **[JEE 2006]**

PREVIOUS YEARS QUESTIONS — ANSWER KEY — EXERCISE -5(B)

1. Yest it is false statement **2.** C **3.** B **4.** B

5. directly proportional **6.** $B = \left(b - \frac{a}{RT}\right)$ **7.** 0.492 atm, 0.246 atm

8. C **9.** 123 **10.** 6.46 atm L^2 mol^{-2} **11.** –173 C, 0.82 L

12. XeF_6 **13.** C **14.** B **15.** C

16. both statements are correct **17.** 0.99 atm **18.** D

19. 1.2544 atm L^2 mol^{-2} **20.** C

21. **(a)** (i) 18.1 g/mol (ii) 50.25 L mol^{-1} (iii) 1.224 (iv) repulsive **(b)** 2.07 10^{-20} J **22.** 434.17 m/sec

23. Since H_2 is diatomic and He is monoatomic degree of freedom for mono is 3 and only translational but for diatomic, vibrational and rotational are also to be considered.

24. C **25.** RT **26.** B **27.** B