STATES OF MATTER

FACT/DEFINITION TYPE QUESTIONS

1. Which of the following is not a type of van der Waal's forces?
(a) Dipole - dipole forces
(b) Dipole - induced dipole forces
(c) Ion - dipole forces
(d) London forces

2. Who proposed the concept of dispersion force ?
(a) Heitler and London (b) van der Waal
(c) Gay Lussac (d) Fritz London

3. Which of the following option correctly represents the relation between interaction energy and distance between two interacting particles (r) for London forces ?
(a) $\frac{1}{\sqrt{r}}$ (b) $\frac{1}{r^6}$
(c) $\frac{1}{r^{12}}$ (d) $\frac{1}{r^3}$

4. The interaction energy of London force is inversely proportional to sixth power of the distance between two interacting particles but their magnitude depends upon
(a) charge of interacting particles
(b) mass of interacting particles
(c) polarisability of interacting particles
(d) strength of permanent dipoles in the particles.

5. London forces are always ...I... and interaction energy is inversely proportional to the ...II... power of the distance between two interacting particles.
Here, I and II refer to
(a) I → repulsive, II → sixth
(b) I → attractive, II → fourth
(c) I → attractive, II → sixth
(d) I → repulsive, II → fourth

6. Dipole-dipole forces act between the molecules possessing permanent dipole. Ends of dipoles possess 'partial charges'. The partial charge is
(a) more than unit electronic charge
(b) equal to unit electronic charge
(c) less than unit electronic charge
(d) double the unit electronic charge

7. Dipole-dipole interaction is stronger than the London forces but is weaker than ion-ion interaction because
(a) only partial charges are involved
(b) only total charges are involved
(c) both (a) and (b)
(d) sometimes (a) and sometimes (b)

8. Induced dipole moment depend upon the
I. dipole moment present in the permanent dipole.
II polarisability of the electrically neutral molecules.
Identify the correct option.
(a) I is correct but II is wrong
(b) I is wrong and II is correct
(c) Both I and II are wrong
(d) Both I and II are correct

9. Dipole-induced dipole interactions are present in which of the following pairs :
(a) Cl_2 and CCl_4 (b) HCl and He atoms
(c) SiF_4 and He atoms (d) H_2O and alcohol

10. Which of the following exhibits the weakest intermolecular forces ?
(a) NH_3 (b) HCl
(c) He (d) H_2O

11. Strength of the hydrogen bond is determined by interaction between the
I. lone pair of the electronegative atom and the hydrogen atom of other atom.
II. bond pair of the electronegative atom and the hydrogen atom of other atom.
Identify the correct option.
(a) Only I is correct
(b) Only II is correct
(c) Both I and II are correct
(d) Neither I nor II are correct

12. Which of the following statements regarding thermal energy is correct?
(a) Thermal energy is the measure of average kinetic energy of the particles of the matter and is thus responsible for movement of particles.
(b) Intermolecular forces tend to keep the molecules together but thermal energy of the molecules tends to keep them apart.
(c) Three states of matter are the result of balance between intermolecular forces and the thermal energy of the molecules.
(d) All of the above

13. Which of the following is the correct order of thermal energy in three states of matter ?
(a) Solid < Liquid < Gas (b) Liquid < Gas < Solid
(c) Liquid < Solid < Gas (d) Gas < Solid < Liquid

14. Which of the following are arrangement in the correct order?
I. Gas > Liquid > Solid (Thermal energy)
II. Solid > Liquid > Gas (Intermolecular force)
Select the correct option.
(a) I only (b) II only
(c) Both I and II (d) None of these

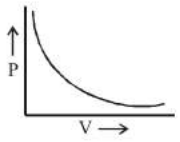
15. Which one of the following statements is not correct about the three states of matter i.e., solid, liquid and gaseous ?
(a) Molecules of a solid possess least energy whereas those of a gas possess highest energy.
(b) The density of solid is highest whereas that of gases is lowest
(c) Gases like liquids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

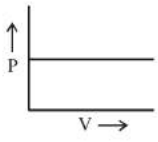
16. Which of the following is true about gaseous state ?
(a) Thermal energy = Molecular attraction
(b) Thermal energy >> Molecular attraction
(c) Thermal energy << Molecular attraction
(d) Molecular force >> Those in liquids

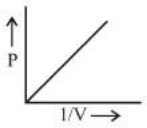
17. The first reliable measurement on properties of gases was made by _____
(a) Gay Lussac (b) Jacques charles
(c) Robert Boyle (d) Avogadro

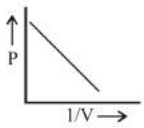
18. At constant temperature, for a given mass of an ideal gas
(a) the ratio of pressure and volume always remains constant.
(b) volume always remains constant.
(c) pressure always remains constant.
(d) the product of pressure and volume always remains constant.

19. Which of following graph(s) represents Boyle's law

I. 

II. 

III. 

IV. 

(a) Only I (b) II and IV
(c) I and III (d) Only III

20. Which of the following represents Boyle's law in terms of density ?
(a) $d \cdot p = k'$ (b) $\frac{d}{p} = k'$
(c) $\frac{dp}{2} = k'$ (d) $d = k'\sqrt{p}$
(Here d = density, p = pressure, k' = constant)

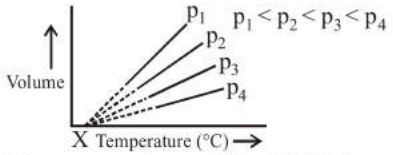
21. Boyle's law states that the
(a) pressure of a gas is directly proportional to the temperature at constant volume
(b) pressure of a gas is inversely proportional the volume at constant temperature
(c) volume is directly proportional to the temperature at constant pressure
(d) None of the above

22. 600 c.c. of a gas at a pressure of 750 mm of Hg is compressed to 500 c.c. Taking the temperature to remain constant, the increase in pressure, is
(a) 150 mm of Hg (b) 250 mm of Hg
(c) 350 mm of Hg (d) 450 mm of Hg

23. The lowest hypothetical or imaginary temperature at which gases are supposed to occupy zero volume is called _____
(a) Kelvin temperature (b) absolute zero
(c) Charle's temperature (d) constant temperature

24. 500 ml of nitrogen at 27°C is cooled to –5°C at the same pressure. The new volume becomes
(a) 326.32 ml (b) 446.66 ml
(c) 546.32 ml (d) 771.56 ml

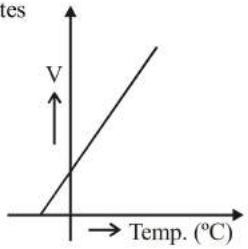
25. What is the value of X in °C for given volume vs temperature curve ?



(a) 0° C (b) 273.15° C
(c) –273.15° C (d) 300° C

26. Which of the following expression at constant pressure represents Charle's law?
(a) $V \propto \frac{1}{T}$ (b) $V \propto \frac{1}{T^2}$
(c) $V \propto T$ (d) $V \propto d$

27. The following graph illustrates



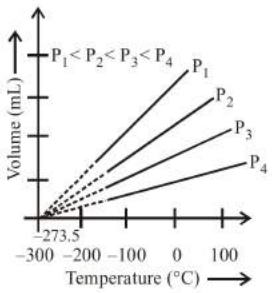
(a) Dalton's law
(b) Charle's law
(c) Boyle's law
(d) Gay-Lussac's law

28. Air at sea level is dense. This is a practical application of
(a) Boyle's law (b) Charle's law
(c) Kelvin's law (d) Brown's law

29. Use of hot air balloons in sports and meteorological observations is an application of
(a) Boyle's law (b) Charle's law
(c) Kelvin's law (d) Gay-Lussac's law

30. An ideal gas will have maximum density when
(a) P = 0.5 atm, T = 600 K (b) P = 2 atm, T = 150 K
(c) P = 1 atm, T = 300 K (d) P = 1 atm, T = 500 K

31.



Arrange the pressures P_1, P_2, P_3 and P_4 in the increasing order which are shown in the graphs.
(a) $P_1 < P_2 < P_3 < P_4$ (b) $P_4 < P_3 < P_2 < P_1$
(c) $P_1 = P_2 = P_3 = P_4$ (d) $P_4 = P_3 < P_2 = P_1$

32. On a ship sailing in pacific ocean where temperature is 23.4°C, a balloon is filled with 2 L air. What will be the volume of the balloon when the ship reaches Indian ocean, where temperature is 26.1°C ?
(a) 2.018 L (b) 2.8 L
(c) 3.5 L (d) 1.5 L

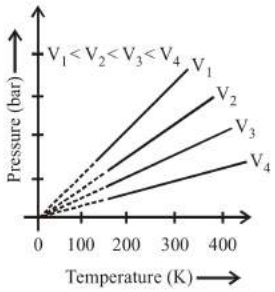
33. Which of the following represents Gay Lussac's law ?

I. $\frac{P}{T}$ = constant II. $P_1T_2 = P_2T_1$

III. $P_1V_1 = P_2V_2$

Choose the correct option.
(a) I, II and III (b) II and III
(c) I and III (d) I and II

34.



The relationship which is shown in the figure is derived from
I. Boyle's law.
II. Avogadro law.
III. Charles' law.
Which of the following is the correct option ?
(a) I and II (b) II and III
(c) I and III (d) Only I

35. Which of the following represents Avogadro law ?
(a) V = kn (b) $V = k\frac{m}{M}$
(c) M = kd (d) All of these

36. At STP molar volume of an ideal gas or a combination of ideal gases is _____
(a) 22.71098 L mol^{-1} (b) 20.71098 L mol^{-1}
(c) 22.4139 L mol^{-1} (d) 24.78 L mol^{-1}

37. 4.4 g of a gas at STP occupies a volume of 2.24 L, the gas can be
(a) O_2 (b) CO
(c) NO_2 (d) CO_2

38. An ideal gas is one which obeys the gas laws under
(a) a few selected experimental conditions
(b) all experimental conditions
(c) low pressure alone
(d) high temperature alone

39. For an ideal gas, number of moles per litre in terms of its pressure *P*, gas constant *R* and temperature *T* is
(a) *PT/R* (b) *PRT*
(c) *P/RT* (d) *RT/P*

40. Select one correct statement. In the gas equation, $PV = nRT$
(a) *n* is the number of molecules of a gas
(b) *V* denotes volume of one mole of the gas
(c) *n* moles of the gas have a volume *V*
(d) *P* is the pressure of the gas when only one mole of gas is present.

41. Correct gas equation is
(a) $\frac{V_1T_2}{P_1} = \frac{V_2T_1}{P_2}$ (b) $\frac{P_1V_1}{P_2V_2} = \frac{T_1}{T_2}$
(c) $\frac{P_1T_2}{V_1} = \frac{P_2V_2}{T_2}$ (d) $\frac{V_1V_2}{T_1T_2} = P_1P_2$

42. The correct value of the gas constant 'R' is close to :
(a) 0.082 litre-atmosphere K
(b) 0.082 litre-atmosphere K^{-1} mol^{-1}
(c) 0.082 litre – atmosphere^{-1} K mol^{-1}
(d) 0.082 litre $^{-1}$ atmosphere $^{-1}$ K mol

43. If P, V, M, T and R are pressure, volume, molar mass, temperature and gas constant respectively, then for an ideal gas, the density is given by

(a) $\frac{RT}{PM}$ (b) $\frac{P}{RT}$

(c) $\frac{M}{V}$ (d) $\frac{PM}{RT}$

44. Pure hydrogen sulphide is stored in a tank of 100 litre capacity at 20° C and 2 atm pressure. The mass of the gas will be
(a) 34 g (b) 340 g
(c) 282.68 g (d) 28.24 g

45. At N.T.P the volume of a gas is found to be 273 ml. What will be the volume of this gas at 600 mm of Hg and 273°C?
(a) 391.8 ml (b) 380 ml
(c) 691.6 ml (d) 750 ml

46. Pressure of a mixture of 4 g of O_2 and 2 g of H_2 confined in a bulb of 1 litre at 0°C is
(a) 25.215 atm (b) 31.205 atm
(c) 45.215 atm (d) 15.210 atm

47. Gas equation $PV = nRT$ is obeyed by
(a) Only isothermal process
(b) Only adiabatic process
(c) Both (a) and (b)
(d) None of these

48. The total pressure of a mixture of two gases is :
(a) the sum of the partial pressures
(b) the difference between the partial pressures
(c) the product of the partial pressures
(d) the ratio of the partial pressures

49. If three unreactive gases having partial pressures P_A, P_B and P_C and their moles are 1, 2 and 3 respectively then their total pressure will be

(a) $P = P_A + P_B + P_C$ (b) $P = \frac{P_A + P_B + P_C}{6}$

(c) $P = \frac{\sqrt{P_A + P_B + P_C}}{3}$ (d) None of these

50. Dalton's law of partial pressure will not apply to which of the following mixture of gases
(a) H_2 and SO_2 (b) H_2 and Cl_2
(c) H_2 and CO_2 (d) CO_2 and Cl_2

51. Pressure exerted by saturated water vapour is called
(a) Aqueous tension (b) Partial pressure
(c) Total pressure (d) Both (a) and (b)

52. The pressure exerted by 6.0g of methane gas in a 0.03 m^3 vessel at 129°C is (Atomic masses : C = 12.01, H = 1.01 and R = 8.314 JK^{-1} mol^{-1})
(a) 31684 Pa (b) 215216 Pa
(c) 13409 Pa (d) 41648 Pa

53. A gaseous mixture was prepared by taking equal mole of CO and N_2. If the total pressure of the mixture was found 1 atmosphere, the partial pressure of the nitrogen (N_2) in the mixture is
(a) 0.5 atm (b) 0.8 atm
(c) 0.9 atm (d) 1 atm

54. A bubble of air is underwater at temperature 15°C and the pressure 1.5 bar. If the bubble rises to the surface where the temperature is 25°C and the pressure is 1.0 bar, what will happen to the volume of the bubble ?
(a) Volume will become greater by a factor of 1.6.
(b) Volume will become greater by a factor of 1.1.
(c) Volume will become smaller by a factor of 0.70.
(d) Volume will become greater by a factor of 2.5.

55. A mixture contains 64 g of dioxygen and 60 g of neon at a total pressure of 10 bar. The partial pressures in bar of dioxygen and neon are respectively (atomic masses O = 16, Ne = 20)
(a) 4 and 6 (b) 6 and 4
(c) 5 and 5 (d) 8 and 2

56. 500 mL of air at 760 mm pressure were compressed to 200 mL. If the temperature remains constant, what will be the pressure after compression?
(a) 1800 mm (b) 1900 mm
(c) 2000 mm (d) 1500 mm

57. Value of universal gas constant (R) depends upon
(a) Number of moles of gas
(b) Volume of gas
(c) Temperature of gas
(d) None of these

58. Two vessels of volumes 16.4 L and 5 L contain two ideal gases of molecular existence at the respective temperature of 27°C and 227°C and exert 1.5 and 4.1 atmospheres respectively. The ratio of the number of molecules of the former to that of the later is
(a) 2 (b) 1

(c) $\frac{1}{2}$ (d) $\frac{1}{3}$

59. 56 g of nitrogen and 96 g of oxygen are mixed isothermally and at a total pressure of 10 atm. The partial pressures of oxygen and nitrogen (in atm) are respectively
(a) 4, 6 (b) 5, 5
(c) 2, 8 (d) 6, 4

60. If 10^{-4} dm^3 of water is introduced into a 1.0 dm^3 flask at 300 K, how many moles of water are in the vapour phase when equilibrium is established ?
(Given : Vapour pressure of H_2O at 300 K is 3170 Pa; $R = 8.314$ JK^{-1} mol^{-1})
(a) 5.56×10^{-3} mol (b) 1.53×10^{-2} mol
(c) 4.46×10^{-2} mol (d) 1.27×10^{-3} mol

61. The total pressure of a mixture of two gases is
(a) the sum of the partial pressures
(b) the difference between the partial pressures
(c) the product of the partial pressures
(d) the ratio of the partial pressures

62. Ideal gas equation is the combination of
I. Boyle's law
II. Charles's law
III. Avogadro law
IV. Dalton's law of partial pressure
Choose the correct option.
(a) Only I and II (b) I, II and III
(c) II and III (d) I, III aor IV

63. According to the kinetic theory of gases, in an ideal gas, between two successive collisions a gas molecule travels
(a) in a wavy path
(b) in a straight line path
(c) with an accelerated velocity
(d) in a circular path

64. Gases consist of large number of identical particles (atoms or molecules) that are so small and so far apart on the average that the actual volume of the molecules is negligible in comparison to the empty space between them.
Above given statement explain which property of gases ?
(a) Gases occupy all the space available to them.
(b) Gases has fixed shape.
(c) Compressibility of gases.
(d) None of these.

65. If there were loss of kinetic energy, the motion of gas molecules will ____A____ and gas will ____B____.
(a) A = increase, B = collide
(b) A = stop, B = settle down
(c) A = increase,
B = exert more pressure on walls of container
(d) A = decrease, B = get liquified

66. Which of the following assumption of kinetic molecular theory states that gases do not have fixed shape ?
(a) Particles of a gas move in all possible directions in straight line.
(b) Particles of a gas are always in constant and random motion.
(c) Total energy of molecules before and after the collision remains same.
(d) None of these

67. Which of the following assumption of kinetic theory if hold good than the pressure vs volume graph of experimental data (real gas) and that of theoretically calculated from Boyle's law (ideal gas) should coincide ?
(i) There is no force of attraction between the molecules of a gas.
(ii) Volume of the molecules of a gas is negligibly small in comparison to the space occupied by the gas.
(a) (i) only (b) (ii) only
(c) Both (i) and (ii) (d) None of these

68. Kinetic theory of gases proves
(a) only Boyle's law (b) only Charles' law
(c) only Avogadro's law (d) All of these

69. Which one of the following is the wrong assumption of kinetic theory of gases ?
(a) Momentum and energy always remain conserved.
(b) Pressure is the result of elastic collision of molecules with the container's wall.
(c) Molecules are separated by great distances compared to their sizes.
(d) All the molecules move in straight line between collision and with same velocity.

70. When is deviation more in the behaviour 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

71. In van der Waal's equation of state of the gas law, theconstant 'b' is a measure of
(a) volume occupied by the molecules
(b) intermolecular attraction
(c) intermolecular repulsions
(d) intermolecular collisions per unit volume

72. In van der Waal's equation of state for a non-ideal gas, the term that accounts for intermolecular forces is
(a) $(V-b)$ (b) RT
(c) $\left(P+\frac{a}{V^2}\right)$ (d) $(RT)^{-1}$

73. The values of van der Waal's constant 'a' for the gases O_2, N_2, NH_3 and CH_4 are 1.360, 1.390, 4.170 and 2.253 L^2 atm mol^{-2} respectively. The gas which can most easily be liquified is
(a) O_2 (b) N_2
(c) NH_3 (d) CH_4

74. A gas described by van der Waal's equation
(i) behaves similar to an ideal gas in the limit of large molar volume
(ii) behaves similar to an ideal gas in the limit of large pressure
(iii) is characterised by van der Waal's coefficients that are dependent on the identity of the gas but are independent of the temperature
(iv) has the pressure that is lower than the pressure exerted by the same gas behaving ideally
(a) (i) and (ii) (b) (i) and (iii)
(c) (i), (ii) and (iii) (d) (ii) and (iv)

75. The units of constant a in van der Waal's equation is
(a) dm^6 atm mol^{-2} (b) dm^3 atm mol^{-1}
(c) dm atm mol^{-1} (d) atm mol^{-1}

76. The van der Waal's constant 'a' for four gases P, Q, R and S are 4.17, 3.59, 6.71 and 3.8 atm L^2 mol^{-2} respectively. Therefore, the ascending order of their liquefaction is
(a) R < P < S < Q (b) Q < S < R < P
(c) Q < S < P < R (d) R < P < Q < S

77. At low pressure the van der Waal's equation is reduced to

(a) $Z = \frac{pV_m}{RT} = 1 - \frac{ap}{RT}$ (b) $Z = \frac{pV_m}{RT} = 1 + \frac{b}{RT}p$

(c) $pV_m = RT$ (d) $Z = \frac{pV_m}{RT} = 1 - \frac{a}{RT}$

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

(a) $1 + \frac{RT}{pb}$ (b) 1

(c) $1 + \frac{pb}{RT}$ (d) $1 - \frac{pb}{RT}$

79. The gas with the highest critical temperature is

(a) H_2 (b) He

(c) N_2 (d) CO_2

80. A gas is said to behave like an ideal gas when the relation PV/T = constant. When do you expect a real gas to behave like an ideal gas ?

(a) When the temperature is low

(b) When both the temperature and pressure are low

(c) When both the temperature and pressure are high

(d) When the temperature is high and pressure is low

81. An ideal gas can't be liquefied because

(a) its critical temperature is always above 0°C

(b) Its molecules are relatively smaller in size

(c) it solidifies before becoming a liquid

(d) forces between its molecules are negligible

82. Gases possess characteristic critical temperature which depends upon the magnitude of intermolecular forces between the particles. Following are the critical temperature of some gases.

Gases	H_2	He	O_2	N_2
Critical temperature in Kelvin	33.2	5.3	154.3	126

From the above data what would be the order of liquefaction of these gases ?

Start writing the order from the gas liquefying first

(a) H_2, He, O_2, N_2 (b) He, O_2, H_2, N_2

(c) N_2, O_2, He, H_2 (d) O_2, N_2, H_2, He

83. Above Boyle point, real gases show _____X_____ from ideality and Z values are _____Y_____ than one.

(a) X = Negative deviation, Y = Less

(b) X = Negative deviation, Y = Greater

(c) X = Positive deviation, Y = Less

(d) X = Positive deviation, Y = Greater

84. Select the one that when used would be considered as best condition for liquification of a gas.

(a) Increasing the temperature.

(b) Decreasing the pressure.

(c) Increasing the pressure and decreasing the temperature.

(d) Decreasing the pressure and increasing the temperature.

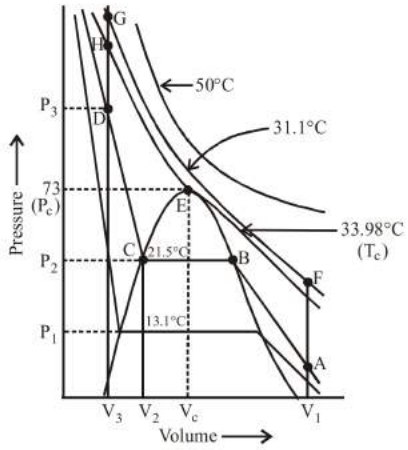
85. Following table represents critical temperature of some gases. Arrange these gases in their increasing order of liquifaction.

Gas	T_c / K
H_2	33.2
He	5.3
N_2	126
O_2	154.3

(a) $He < N_2 < H_2 < O_2$ (b) $H_2 < He < N_2 < O_2$

(c) $He < H_2 < N_2 < O_2$ (d) $O_2 < N_2 < H_2 < He$

86. Choose the correct statement based on the following isotherms of carbon dioxide at various temperature.



(i) We can move from point A to F vertically by increasing the temperature.

(ii) We can reach the point G by compressing the gas at constant temperature.

(iii) We can move down from G towards D by increasing the temperature.

(iv) As soon as we cross the point D on the critical isotherm we get liquid.

(a) (i) and (ii) (b) (i), (ii) and (iii)

(c) (i), (ii) and (iv) (d) (i), (ii), (iii) and (iv)

87. At 1 atm pressure boiling temperature is called _____X_____. If pressure is 1 bar then the boiling point is called _____Y_____ of the liquid.

(a) X = Standard boiling point, Y = Normal boiling point

(b) X = Normal boiling point, Y = Standard boiling point

(c) X = Critical boiling point, Y = Normal boiling point

(d) X = Critical boiling point, Y = Standard boiling point

88. Which of the following statement is incorrect ?

(a) Standard boiling point of liquid is slightly lower than the normal boiling point.

(b) 1 atm pressure is slightly less than 1 bar pressure

(c) The normal boiling point of water is 100°C and its standard boiling point is 99.6°C

(d) None of the above

89. A liquid can exist only
(a) between triple point and critical temperature
(b) at any temperature above the melting point
(c) between melting point and critical temperature
(d) between boiling and melting temperature

90. The kinetic energy of molecules in gaseous state is
(a) more than those in the liquid state
(b) less than those in the liquid state
(c) equal to those in the liquid state
(d) less than those in solid state

91. A pin or a needle floats on the surface of water, the reason for this is
(a) surface tension (b) less weight
(c) upthrust of liquid (d) None of the above

92. The spherical shape of rain-drop is due to
(a) density of the liquid (b) surface tension
(c) atmospheric pressure (d) gravity

93. Which of the following phenomena is caused by surface tension ?
(a) Particles at the bottom of river remain separated but they stick together when taken out.
(b) A liquid rise in a thin capillary.
(c) Small drops of mercury from spherical bead instead of spreading on the surface.
(d) All of the above

94. A drop of oil is placed on the surface of water. Which of the following statement is correct ?
(a) It will remain on it as a sphere
(b) It will spread as a thin layer
(c) It will be partly as spherical droplets and partly as thin film
(d) It will float as a distorted drop on the water surface

95. When the temperature increases, the viscosity of
(a) gases decreases and viscosity of liquids increases
(b) gases increases and viscosity of liquids decreases
(c) gases and liquids increases
(d) gases and liquids decreases

96. The surface tension of which of the following liquid is maximum?
(a) C_2H_5OH (b) CH_3OH
(c) H_2O (d) C_6H_6

97. In which phenomena water changes into water vapour below its B.P. ?
(a) Evaporation (b) Condensation
(c) Boiling (d) No such phenomena exist

98. The liquid which has the highest rate of evaporation is
(a) petrol (b) nail-polish remover
(c) water (d) alcohol

99. The correct order of viscosity of the following liquids will be
(a) Water < methyl alcohol < dimethyl ether < glycerol
(b) methyl alcohol < glycerol < water < dimethyl ether
(c) dimethyl ether < methyl alcohol < water < glycerol
(d) glycerol < dimethyl ether < water < methyl alcohol

STATEMENT TYPE QUESTIONS

100. Which of the following statement(s) is/are true for London force ?
(i) These forces are always attractive.
(ii) These forces are important for long distance too.
(iii) Their magnitude depends on the polarisability of the particle.
(a) (i) and (ii) (b) (i) only
(c) (iii) only (d) (i) and (iii)

101. Choose the correct sequence of T and F for following statements. Here T stands for true and F stands for false statement.
(i) Dipole - dipole forces act between the molecules possessing permanent dipole.
(ii) Partial charge possessed by these dipoles is always equal to unit electronic charge.
(iii) Dipole - dipole interaction is weaker than London forces and ion - ion interaction.
(a) TTF (b) TFF
(c) TTT (d) TFT

102. Which of the following statements are correct ?
(i) Hydrogen bonding is a special case of dipole - dipole interaction.
(ii) Energy of hydrogen bond varies between 10 to 100 kJ mol^{-1}.
(iii) Hydrogen bonds are powerful force in determining the structure and properties of compounds like proteins, nucleic acids etc.
(iv) Strength of the hydrogen bond is determined by the coulombic interaction between the lone-pair electrons of the electronegative atom of one molecule and the hydrogen atom of other molecule.
(a) (i) and (ii) (b) (i), (ii) and (iii)
(c) (ii), (iii) and (iv) (d) All of these

103. Which of the following statements are correct regarding the characteristic of gases ?
(i) Gases are highly compressible.
(ii) Gases exert pressure equally in all directions.
(iii) Gases have much higher density than the solids and liquids.
(iv) Gases mix evenly and completely in all proportion without any mechanical aid.
Choose the correct option.
(a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)
(c) (i), (ii) and (iv) (d) (i), (ii), (iii) and (iv)

104. Read the following statements and choose the correct option. Here T stands for true and F stands for false statement.

(i) Equation : $V = \frac{nRT}{P}$ will be applicable to any gas, under those conditions when behaviour of the gas approaches ideal behaviour.

(ii) Value of universal gas constant at 0° C and 1 atm pressure is 8.20578×10^{-2} L atm K^{-1} mol^{-1}

(iii) Ideal gas equation describes the state of any gas, therefore it is also called equation of state.

(iv) Value of R in units of Pa m^3 K^{-1} mol^{-1} is 8.314×10^{-2}

(a) T T T T (b) T T T F

(c) T F T F (d) T F F T

105. Choose the correct sequence of T and F for following statements. Here T stands for true and F stands for false.

(i) There may be exchange of energy between colliding molecules, their individual energies may change, but the sum of their energies remains constant.

(ii) At any particular time, different particles in the gas have different speeds and hence different kinetic energies.

(iii) Particles of a gas move in all possible directions in straight lines. During their random motion, they collide with each other and with the walls of the container.

(iv) In kinetic theory it is assumed that average kinetic energy of the gas molecules is directly proportional to the absolute temperature.

(a) TTTT (b) TTTF

(c) TFTT (d) TFFT

106. Which of the following statements are correct ?

(i) Real gases show deviations from ideal gas law because molecules interact with each other.

(ii) Due to interaction of molecules the pressure exerted by the gas is given as :

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

(iii) Value of 'a' is measure of magnitude of intermolecular attractive forces within the gas and depends on temperature and pressure of gas.

(iv) At high pressure volume occupied by the molecules also becomes significant because instead of moving in volume *V*, these are now restricted to volume (*V-nb*)

(a) (i) and (iv) (b) (i), (ii) and (iii)

(c) (i), (iii) and (iv) (d) (i) and (iii)

107. Choose the correct sequence of true and false for following statements. Here T represents true and F represents false statement.

(i) Greater the viscosity, the more slowly the liquid flows.

(ii) Glass is an extremely viscous liquid.

(iii) Viscosity of liquid increases as the temperature rise.

(a) TFF (b) FFT

(c) TFT (d) TTF

MATCHING TYPE QUESTIONS

108. Match the columns

	Column-I		Column-II
(A)	Attractive force that operates between the polar molecules having permanent dipole and the molecule lacking permanent dipole	(p)	Dipole-dipole force
(B)	Interaction in which interaction energy between stationary polar molecules is proportional to $\frac{1}{r^3}$	(q)	London force
(C)	Force that are important only at short distances (~ 500 pm)	(r)	Dipole-induced dipole force

(a) A – (r), B – (p), C – (q)

(b) A – (p), B – (r), C – (q)

(c) A – (r), B – (q), C – (p)

(d) A – (q), B – (r), C – (p)

109. Match the columns

	Column-I		Column-II
(A)	Volume of a fixed mass of a gas at constant pressure is directly proportional to its absolute temperature	(p)	Boyle's Law
(B)	At constant volume, pressure of a fixed amount of a gas varies directly with the temperature.	(q)	Avogadro's Law
(C)	Equal volumes of all gases under the same conditions of temperature and pressure contain equal number of molecules.	(r)	Charle's Law
(D)	At constant temperature, the pressure of a fixed amount (i. e., number of moles *n*) of gas varies inversely with its volume.	(s)	Gay Lussac's Law

(a) A – (s), B – (r), C – (q), D – (p)

(b) A – (r), B – (s), C – (q.), D – (p)

(c) A – (r), B – (q), C – (p), D – (s)

(d) A – (q), B – (p), C – (s), D – (r)

110. Match the columns

Column-I	Column-II
(A) Boyle's law	(p) $V \propto n$ at constant T and P
(B) Charle's law	(q) $p_{total} = p_1 + p_2 + p_3 + ...$ at constant T, V
(C) Dalton's law	(r) $\frac{pV}{T} = \text{Constant}$
(D) Avogadro law	(s) $V \propto T$ at constant n and p
	(t) $p \propto \frac{1}{V}$ at constant n and T

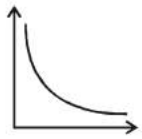
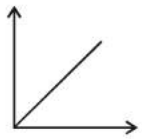
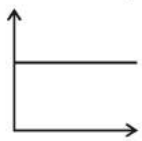
(a) A – (t), B – (s), C – (q), D – (p)
(b) A – (s), B – (q), C – (p), D – (t)
(c) A – (r), B – (t), C – (q), D – (p)
(d) A – (t), B – (q), C – (s), D – (r)

111. Match the graphs between the following variables (Column-I) with their names (Column-II) :

Column-I (Graphs)	Column-II (Names)
(A) Pressure vs temperature graph at constant molar volume.	(p) Isotherms
(B) Pressure vs volume graph at constant temperature	(q) Constant temperature curve
(C) Volume vs temperature graph at constant pressure	(r) Isochores
	(s) Isobars

(a) A – (p), B – (r), C – (s)
(b) A – (r), B – (p), C – (s)
(c) A – (r), B – (q), C – (p)
(d) A – (s), B – (q), C – (r)

112. Match the following graphs of ideal gas (Column-I) with their co-ordinates (Column-II) :

Column-I (Graphical representation)	Column-II (x and y co-ordinates)
(A) 	(p) pV vs. V
(B) 	(q) p vs. V
(C) 	(r) p vs. $\frac{1}{V}$

(a) A – (r), B – (p), C – (q)
(b) A – (r), B – (q), C – (p)
(c) A – (q), B – (r), C – (p)
(d) A – (p), B – (r), C – (q)

ASSERTION-REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

113. **Assertion :** Three states of matter are the result of balance between intermolecular forces and thermal energy of the molecules.
Reason : Intermolecular forces tend to keep the molecules together but thermal energy of molecules tends to keep them apart.

114. **Assertion :** Gases expand and occupy all the space available to them
Reason : There is no force of attraction between the particles of a gas at ordinary temperature and pressure.

115. **Assertion :** Gases do not liquefy above their critical temperature, even on applying high pressure.
Reason : Above critical temperature, the molecular speed is high and intermolecular attractions cannot hold the molecules together because they escape because of high speed.

116. **Assertion :** At critical temperature liquid passes into gaseous state imperceptibly and continuously.
Reason : The density of liquid and gaseous phase is equal to critical temperature.

117. **Assertion :** The temperature at which vapour pressure of a liquid is equal to the external pressure is called boiling temperature.
Reason : At high altitude atmospheric pressure is high.

118. **Assertion :** Liquids tend to have maximum number of molecules at their surface.
Reason : Small liquid drops have spherical shape.

CRITICAL THINKING TYPE QUESTIONS

119. Arrange the following in increasing order their intermolecular interaction
(A) HCl (B) SF_6 and (C) NaCl
(a) A, B, C (b) A, C, B
(c) B, A, C (d) B, C, A

120. When a sample of gas is compressed at constant temperature from 15 atm to 60 atm, its volume changes from 76 cm^3 to 20.5 cm^3. Which of the following statements are possible explanations of this behaviour?

(1) The gas behaves non-ideally

(2) The gas dimerises

(3) The gas is adsorbed into the vessel walls

(a) 1, 2 and 3 (b) 1 and 2 only

(c) 2 and 3 only (d) 1 only

121. Three different gases X, Y and Z of molecular masses 2, 16 and 64 were enclosed in a vessel at constant temperature till equilibrium is reached. Which of the following statement is correct?

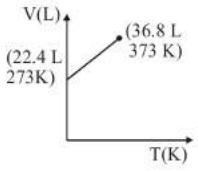
(a) Gas Z will be at the top of the vessel

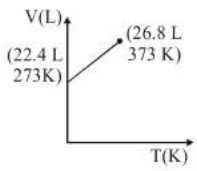
(b) Gas Y will be at the top of the vessel

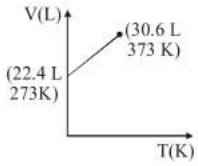
(c) Gas Z will be at the bottom and X will be at the top

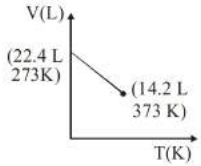
(d) Gases will form homogenous mixture

122. Which of the following volume (V) - temperature (T) plots represents the behaviour of one mole of an ideal gas at one atmospheric pressure ?

(a) 

(b) 

(c) 

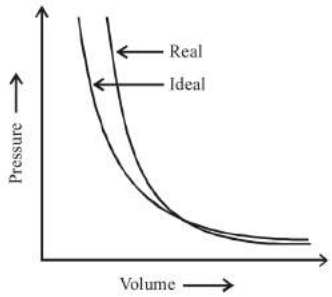
(d) 

123. Consider the case of hot air balloon, density of air at 20° C is 1.2Kg/m^3, if the air was heated to 99°C, density of air becomes 0.94kg/m^3. What would be the volume (in m^3) at 20°C if the volume at 99°C is 2800 m^3 and how much air (in kg) has been escaped at 99°C , if the air in inflated balloon was heated to 99°C (if the inflated volume of balloon was found to be 2800m^3) respectively are

(a) 2243, 728 (b) 3495.3, 596

(c) 2687, 593 (d) 2956, 771

124. From the given figure what can be said about the gases does not deviate much from ideal gases at



(a) Higher pressure and low volume.

(b) Low pressure and low volume.

(c) High pressure and high volume.

(d) Low pressure and high volume.

125. 16 g of oxygen and 3 g of hydrogen are mixed and kept at 760 mm of Hg pressure and 0° C. The total volume occupied by the mixture will be nearly

(a) 22.4 litres (b) 33.6 litres

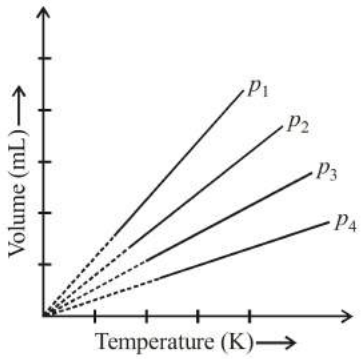
(c) 448 litres (d) 44800 ml

126. The density of neon will be highest at

(a) S.T.P. (b) 0°C, 2 atm

(c) 273°C, 1 atm. (d) 273°C, 2 atm.

127. A plot of volume (V) versus temperature (T) for a gas at constant pressure is a straight line passing through the origin. The plots at different values of pressure are shown in figure. Which of the following order pressure is correct for this gas ?



(a) $p_1 > p_2 > p_3 > p_4$ (b) $p_1 = p_2 = p_3 = p_4$

(c) $p_1 < p_2 < p_3 < p_4$ (d) $p_1 < p_2 = p_3 < p_4$

128. At constant temperature, for a given mass of an ideal gas

(a) The ratio of pressure and volume always remains constant.

(b) Volume always remains constant.

(c) Pressure always remains constant.

(d) The product of pressure and volume always remains constant.

129. If 500 ml of gas A at 400 torr and 666.6 ml of B at 600 torr are placed in a 3 litre flask, the pressure of the system will be

(a) 200 torr (b) 100 torr

(c) 550 torr (d) 366 torr

130. What is the partial pressure (mmHg) of nitrogen if total atmospheric pressure is 760mmHg ?

(a) 159 (b) 300

(c) 592.8 (d) 230

131. Cyclopropane and oxygen at partial pressures 170 torr and 570 torr respectively are mixed in a gas cylinder. What is the ratio of the number of moles of cyclopropane to the number of moles of oxygen (nC_3H_6/nO_2)?

(a) $\frac{170\times 42}{570\times 32}=0.39$ (b) $\frac{170}{42}\Big/\left(\frac{170}{42}+\frac{570}{32}\right)\approx 0.19$

(c) $\frac{170}{740}=0.23$ (d) $\frac{170}{570}=0.30$

132. An evacuated glass vessel weights 50 g when empty, 144.0 g when filled with a liquid of density 0.47 g ml^{-1} and 50.5 g when filled with an ideal gas at 760 mm Hg at 300 K. The molar mass of the ideal gas is
(Given R = 0.0821 L atm K^{-1} mol^{-1})

(a) 61.575 (b) 130.98

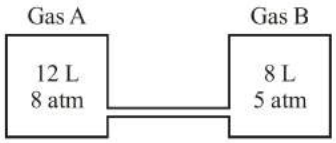
(c) 123.75 (d) 47.87

133. The pressure of a 1:4 mixture of dihydrogen and dioxygen enclosed in a vessel is one atmosphere. What would be the partial pressure of dioxygen ?

(a) 0.8×10^5 atm (b) 0.008 Nm^{-2}

(c) 8×10^4 Nm^{-1} (d) 0.25 atm

134. Two vessels containing gases A and B are interconected as shown in the figure. The stopper is opened, the gases are allowed to mix homogeneously. The partial pressures of A and B in the mixture will be, respectively



(a) 8 and 5 atom (b) 9.6 and 4 atm

(c) 4.8 and 2 atm (d) 6.4 and 4 atm

135. A neon-dioxygen mixture contains 70.6 g O_2 and 167.5 g neon. If pressure of the mixture of gases in the cylinder is 25 bar. What is the partial pressure of O_2 and Ne in the mixture respectively ?

(a) 5.25 bar, 10 bar (b) 19.75 bar, 5.25 bar

(c) 19.75 bar, 10 bar (d) 5.75 bar, 19.75 bar

136. 0.5 mole of each H_2, SO_2 and CH_4 are kept in a container. A hole was made in the container. After 3 h, the order of partial pressures in the container will be

(a) $p_{SO_2} > p_{CH_4} > p_{H_2}$ (b) $p_{H_2} > p_{SO_2} > p_{CH_4}$

(c) $p_{H_2} > p_{CH_4} > p_{SO_2}$ (d) $p_{SO_2} > p_{H_2} > p_{CH_4}$

137. For a person travelling to the peak of the mountain which of the following statement(s) is/are correct ?

(i) Oxygen level goes on decreasing.

(ii) Gas law can be applied to this situation.

(a) Both (i) and (ii)

(b) Only (i)

(c) Only (ii)

(d) Neither (i) nor (ii)

138. Pressure in well inflated tyres of automobiles is almost constant, but on a hot summer day this increases considerably and tyre may burst if pressure is not adjusted properly. During winters, on a cold morning one may find the pressure in the tyres of a vehicle decreased considerably. Which of the following law explain the above observations?

(a) Charle's Law (b) Avogadro Law

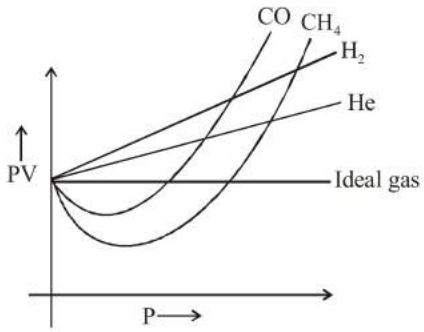
(c) Boyle's Law (d) Gay Lussac's Law

139. What is the ratio of pressure of the 2gm of hydrogen to that of 4 gm of helium at temperature of 298K, 20ml volume? (consider the ideal behaviour)

(a) 1 : 2 (b) 2 : 1

(c) 1 : 1 (d) 2 : 2

140. In case of CO and CH_4 curve goes to minima then increases with increase in pressure but in case of H_2 and He the curve is linear because:



(a) Intermolecular interactions for H_2 and He are very low.

(b) Molecular size or atomic size for H_2 and He is small.

(c) Both (a) and (b)

(d) Neither (a) nor (b)

141. Which among the following has lowest surface tension ?

(a) Hexane (b) Water

(c) CH_3OH (d) CH_3CH_2OH

142. Water droplets was not able to maintain its spherical shape in the presence of gravity but mercury does, why ?

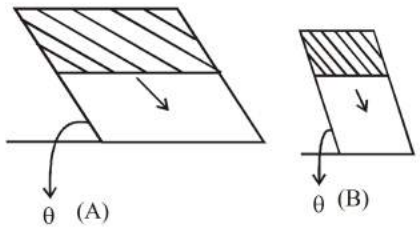
(a) Force of attraction between atoms of mercury is very high than that of molecules in case of water.

(b) Surface tension of mercury is very high.

(c) Both (a) and (b)

(d) Neither (a) nor (b)

143. Consider the case of honey flowing over a slope for this situation which of the following statement(s) is/are correct ?



(i) Velocity with which honey is flowing is slower in A than B (θ being same in both cases)

(ii) Velocity increases with increase in temperature.

(a) (i) and (ii) (b) Only (i)

(c) Only (ii) (d) Neither (i) nor (ii)

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. (c) Attractive forces between an ion and a dipole are known as ion - dipole forces and these are not van der Waals forces.

2. (d) Fritz London explained the concept of dispersion force.

3. (b) Interaction energy $\propto \frac{1}{r^6}$

4. (c)

5. (c) London forces are always attractive and interaction energy is inversely proportional to the sixth power of the distance between two interacting particles.

6. (c)

7. (a) Dipole-dipole interaction is stronger than the London forces but is weaker than ion-ion interaction because only partial charges are involved e.g., HCl molecules. The attractive force decreases with the increase of distance between the dipoles.

8. (d) Induced dipole moment depends upon the dipole moment present in the permanent dipole and the polarisability of the electrically neutral molecule. Molecules of large size can be easily polarized. High polarisability increases the strength of attractive interactions.

9. (b) This type of attractive force operates between the polar molecules having permanent dipole and the molecules lacking permanent dipole.

HCl is polar ($\mu \neq 0$) and He is non polar ($\mu = 0$), thus gives dipole-induced dipole interaction.

10. (c) Nobel gases has no intermolecular forces due to inertness.

11. (a) Strength of the hydrogen bond is determined by coulombic interaction between lone pair electrons of the electronegative atom of one molecule and the hydrogen atom of the other molecule.

12. (d) **13. (a)**

14. (c) Gaseous state of substance has the maximum thermal energy.

15. (c) Gases do not have definite shape and volume. Their volume is equal to the volume of the container.

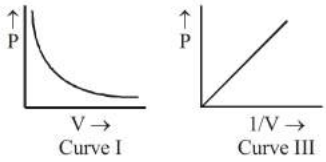
16. (b) It is characteristic of gases i.e., Thermal energy >> molecular attraction.

17. (c) Robert Boyle made first reliable measurement on properties of gases.

18. (d) According to Boyle's law at constant temperature,

$$V \propto \frac{1}{P} \text{ or } PV = \text{constant}$$

19. (c)



Curve I Curve III

Both these graphs represents Boyle's law.

20. (b) According to Boyle's Law

$pv = k$

$$p\frac{m}{d} = k$$

$$\frac{p}{d} = \frac{k}{m} = k'$$

21. (b) Boyle's law

$$P \propto \frac{1}{V}$$

$$P = \frac{K}{V}$$

$$PV = K$$

22. (a) Given initial volume (V_1) = 600 c.c.; Initial pressure (P_1) = 750 mm of Hg and final volume (V_2) = 500 c.c. according to Boyle's law,

$P_1V_1 = P_2V_2$

or $750 \times 600 = P_2 \times 500$

or $P_2 = \frac{750 \times 600}{500} = 900$ mm of Hg

Therefore increase of pressure = (900 – 750) = 150 mm of Hg

23. (b) The lowest hypothetical or imaginary temperature at which gases are supposed to occupy zero volume is called **absolute zero**.

24. (b) Given initial volume (V_1) = 500 ml ; Initial temperature (T_1) = 27°C = 300 K and final temperature (T_2) = –5°C = 268 K.

From Charle's law :

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \text{ or } \frac{500}{300} = \frac{V_2}{268}$$

Where V_2 = New volume of gas

$$V_2 = \frac{500}{300} \times 268 = 446.66 \text{ ml.}$$

25. (c) At any given pressure, graph of volume vs temperature (in °C) is a straight line and on extending to zero volume each line intercepts the temperature axis at – 273.15° C.

26. **(c)** According to Charle's law $V \propto T$ or $\frac{V}{T} = k$

27. **(b)** Charle's law $V \propto T$ at constant P.

28. **(a)** $d \propto p$, Boyle's law, $\left(d = \frac{MP}{RT}\right)$. At sea level pressure is more, hence density of air is more.

29. **(b)** Hot air is lighter due to less density (Charle's law) $\left(d = \frac{MP}{RT}\right)$

30. **(b)** Higher P, lower T, greater the density. $\left(d = \frac{MP}{RT}\right)$

31. **(a)** Order of pressure, $p_1 < p_2 < p_3 < p_4$.

32. **(a)** $V_1 = 2\,L,\ T_2 = (26.1 + 273)\,K = 299.1\,K, V_2 = ?$
$T_1 = (23.4 + 273)\,K = 296.4\,K$

From Charle's law, $\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow V_2 = \frac{V_1 T_2}{T_1}$

$\Rightarrow V_2 = \frac{2L \times 299.1K}{296.4K} = 2L \times 1.009$
$= 2.018\,L$

33. **(d)** $\frac{P}{T} =$ constant (Gay Lussac's law)

$\Rightarrow \frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow P_1T_2 = P_2T_1$
$PV =$ constant
$P_1V_1 = P_2V_2$ [Boyle's law]

34. **(c)** This relationship is derived from Boyle's and Charles' law.

35. **(d)** All of the given relations are true for Avogadro's law.

36. **(a)** At STP molar volume of an ideal gas or a combination of ideal gases is 22.71098 L mol^{-1}.

37. **(d)** 44g at STP occupies volume 22.4 litre which is molecular mass of CO_2. Molecular mass occupies 22.4 litre at STP.

38. **(b)** An ideal gas obeys the gas laws under all experimental conditions.

39. **(c)** $PV = nRT$
$\therefore n/V = P/RT$.

40. **(c)** In the equation $PV = nRT$, n moles of the gas have volume V.

41. **(b)** $\frac{PV}{T} =$ constant or $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\Rightarrow \frac{P_1V_1}{P_2V_2} = \frac{T_1}{T_2}$

42. **(b)** $R = 0.0082$ litre atm K^{-1} $mole^{-1}$.

43. **(d)** $PV = nRT = \frac{m}{M}RT$

or $PM = \frac{m}{V}RT = dRT \Rightarrow d = \frac{PM}{RT}$

44. **(c)** $n = \frac{PV}{RT} = \frac{m}{M}$

$m = \frac{MPV}{RT} = \frac{34 \times 2 \times 100}{0.082 \times 293} = 282.68gm$

45. **(c)** $V_2 = \frac{P_1V_1}{T_1}\frac{T_1}{P_2} = \frac{760}{600} \times \frac{546}{273} \times 273 = 691.6\,ml$

46. **(a)** Total moles

$= \frac{4}{32} + \frac{2}{2} = 1.125;\ PV = nRT$

$\Rightarrow P = 1.125 \times .0821 \times 273$

$P = 25.215$ atm

47. **(c)** PV = nRT is for an ideal gas which follows both isothermal and adiabatic processes.

48. **(a)** By Dalton's law of partial pressures, the total pressure of a mixture of two gases is the sum of the partial pressures of components of the mixture.

49. **(a)**

50. **(b)** Because H_2 & Cl_2 gases may react with each other to produce HCl gas hence Dalton's law is not applicable.

51. **(a)** Pressure exerted by saturated water vapour is called aqueous tension.

52. **(d)** $P = \frac{nRT}{V} = \frac{6}{16.02}\frac{\times 8.314 \times 402}{0.03} \simeq 41648\,Pa$

53. **(a)** Given $n_{CO} = n_{N_2}$

$P_{CO} + P_{N_2} = 1$ atm

Partial pressure of a gas = mole fraction of gas × total pressure

$\therefore\ P_{N_2} = \frac{n_{N_2}}{n_{CO} + n_{N_2}} \times 1 = \frac{n_{N_2}}{2n_{N_2}} \times 1 = \frac{1}{2} = 0.5$ atm.

54. **(a)** Given
$P_1 = 1.5$ bar $T_1 = 273 + 15 = 288$ K $V_1 = V$
$P_2 = 1.0$ bar $T_1 = 273 + 25 = 298$K $V_2 = ?$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{1.5 \times V}{288} = \frac{1 \times V_2}{298}$

$V_2 = 1.55\,V$ i.e., volume of bubble will be almost 1.6 time to initial volume of bubble.

55. **(a)** Partial pressure = total pressure × mole fraction

Moles of oxygen $= \frac{64}{32} = 2$

Moles of neon $= \frac{60}{20} = 3$

Mole fraction of oxygen $= \frac{2}{2+3} = \frac{2}{5}$

$P_{O_2} = \frac{2}{5} \times 10 = 4$ bar

Mole fraction of neon $= \frac{3}{2+3} = \frac{3}{5}$

$P_{Ne} = \frac{3}{5} \times 10 = 6$ bar

56. (b) $P_1V_1 = P_2V_2$

$760 \times 500 = P_2 \times 200.$

$P_2 = \frac{760 \times 500}{200} = 1900\text{mm Hg}$

57. (d) Value of gas constant depends only upon units of measurement.

58. (a) Given conditions

$V_1 = 16.4\text{ L}, V_2 = 5\text{ L}$

$P_1 = 1.5\text{ atm}, P_2 = 4.1\text{ atm}$

$T_1 = 273 + 27 = 300\text{ K},$

$T_2 = 273 + 227 = 500\text{ K}$

Applying gas equation, $\frac{P_1V_1}{P_2V_2} = \frac{n_1T_1}{n_2T_2}$

$\frac{n_1}{n_2} = \frac{P_1V_1T_1}{P_2V_2T_2}$

$\therefore \frac{1.5 \times 16.4 \times 500}{4.1 \times 5 \times 300} = \frac{2}{1}$

59. (d) On applying Dalton's law,

Partial pressure of a component

= Mole fraction × Total pressure

Given, mass of $N_2 = 56$ g, mass of $O_2 = 96$ g

Total pressure = 10 atm

$^{n}N_2 = \frac{56}{28} = 2, \quad ^{n}O_2 = \frac{96}{32} = 3$

$^{x}N_2 = \frac{^{n}N_2}{^{n}N_2 + ^{n}O_2} = \frac{2}{2+3} = 0.4,$

$^{x}O_2 = \frac{^{n}O_2}{^{n}N_2 + ^{n}O_2} = \frac{3}{2+3} = 0.6$

$\therefore {}^{P}N_2 = 0.4 \times 10 = 4\text{ atm}, {}^{P}O_2 = 0.6 \times 10 = 6\text{ atm}$

60. (d) From the ideal gas equation :

$PV = nRT$

or $n = \frac{PV}{RT} = \frac{3170 \times 10^{-3}}{8.314 \times 300} = 1.27 \times 10^{-3}$

61. (a) By Dalton's law of partial pressures, the total pressure of a mixture of two gases is the sum of the partial pressures.

62. (b) An ideal gas equation is the combination of Boyle's law, Charles' law and Avogadro law.

63. (b) According to kinetic theory the gas molecules are in a state of constant rapid motion in all possible directions colloiding in a random manner with one another and with the walls of the container and between two successive collisions molecules travel in a straight line path but show haphazard motion due to collisions.

64. (c) Given statement explain the great compressibility of gases.

65. (b) If there were loss of kinetic energy, the motion of molecule will stop and gases will settle down.

66. (b) Particles of a gas are always in constant and random motion. If the particles were at rest and occupy fixed positions, then a gas would have a fixed shape which is not observed.

67. (b) If assumption (ii) is correct, the pressure vs volume graph of experimental data (real gas) and that of theoretically calculated for Boyle's law (ideal gas) should coincide.

68. (d) Kinetic theory of gases proves all the given gas laws.

69. (d) Molecules move very fast in all directions in a straight line by colliding with each other but with different velocity.

70. (b) At low temperature and high pressure.

71. (a) In van der waals equation 'b' is for volume correction

72. (c) $\left(P + \frac{a}{V^2}\right)(V - b) = RT$; Here $\left(P + \frac{a}{V^2}\right)$ represents the intermolecular forces.

73. (c) 'a' is directly related to forces of attraction. Hence greater the value of 'a', more easily the gas gets liquified.

74. (b)

(i) At very large molar volume

$P + \frac{a}{V_m^2} \approx P \text{ and } V_m - b = V_m$

(iii) According to van der Waals equation 'a' and 'b' are independent of temperature.

75. (a) $P = \frac{n^2a}{V^2}; \; a = \frac{PV^2}{n^2} = \text{atm dm}^6\text{ mol}^{-2}$

76. (c) Easily liquefiable gases have greater intermolecular forces which is represented by high value of 'a'. The greater the value of 'a' more will be liquefiability.

So, the order is Q < S < P < R.

77. (a) When pressure is low 'b' can be neglected, thus

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

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

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

$\frac{PV}{RT} = \frac{RT}{RT} - \frac{a}{VRT}$

$Z = \frac{PV}{RT} = 1 - \frac{a}{VRT}$

78. **(c)** $\left(P+\frac{a}{V^2}\right)(V-b)=RT$ at high pressure $\frac{a}{V^2}$ can be neglected

$PV-Pb=RT$ and $PV=RT+Pb$

$\frac{PV}{RT}=1+\frac{Pb}{RT}$

$Z=1+\frac{Pb}{RT}$; $Z>1$ at high pressure

79. **(d)** CO_2 has highest critical temperature of 304.2 K

80. **(d)** *At low pressure and high temperature:* At low pressure volume correction for 1 mole of a gas in negligible, i.e b =0

thus the gas equation becomes

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

or $Z=\frac{PV_m}{RT}=1-\frac{a}{V_mRT}$

At higher pressure, the pressure correction for 1 mole of gas in negligible i.e $\frac{a}{V^2}=0$

or $(P+0)(V-b)=RT$
or $P(V_m-b)=RT$
or $PV_m=RT+Pb$

or $Z=\frac{PV_m}{RT}=1+\frac{Pb}{RT}$

81. **(d)** In the ideal gas, the intermolecular forces of attraction are negligible and hence it cannot be liquefied.

82. **(d)**

83. **(d)** Above Boyle point, real gases show positive deviation from ideality and Z values are greater than one.

84. **(c)**

85. **(c)** More will be critical temperature easier is the liquifaction of the gas. Hence correct order will be $He<H_2<N_2<O_2$

86. **(a)** For statement (iii), we can move down from G towards D by lowering the temperature.
For statement (iv), we get liquid as soon as we cross point H.

87. **(b)** At 1 atm pressure boiling temperature is called normal boiling point. If pressure is 1 bar than the boiling point is called standard boiling point of the liquid.

88. **(b)** 1 bar pressure is slightly less than 1atm pressure.

89. **(d)** A substance exists as a liquid above its m. pt. and below its b. pt.

90. **(a)** The kinetic energy of molecules in gaseous state is more than those in the liquid state as the molecules in gaseous state can move freely (with higher speed) as compared in liquid state.

91. **(a)** **92.** **(b)**

93. **(d)** All these phenomena are caused by surface tension.

94. **(b)** **95.** **(b)**

96. **(c)** Due to intermolecular H-bonding the surface tension of H_2O is more than other liquid. One H_2O molecule is joined with 4 another H_2O molecule through H–bond. Hydrogen bonding is in order $H_2O > C_2H_5OH > CH_3OH$.

97. **(a)** Boiling point of water is 100°C whereas evaporation of water into water vapours occurs at room temperature.

98. **(a)** As intermolecular forces are least in case of petrol. Thus, it has highest rate of evaporation.

99. **(c)** The correct order of viscosity of the given liquids is dimethyl ether < methyl alcohol < water < glycerol.

STATEMENT TYPE QUESTIONS

100. **(d)** These forces are important only at short distances (~500 pm)

101. **(b)** For statement (ii), partial charge possessed by these dipoles is always less than the unit electronic charge. For statement (iii), dipole - dipole interaction is stronger than London forces but weaker than ion - ion interaction.

102. **(d)** All of the given statements are correct for hydrogen bond.

103. **(c)** Gases have much lower density than the solids and liquids.

104. **(b)** Value of $R=8.314\ Pa\ m^3\ K^{-1}\ mol^{-1}$

105. **(a)** All the given statements are true.

106. **(a)** For statement (ii), $p_{real}=p_{ideal}-\frac{an^2}{V^2}$

For statement (iii), value of 'a' is independent of temperature and pressure.

107. **(d)** Viscosity of liquid decreases as temperature rise.

MATCHING TYPE QUESTIONS

108. **(a)** **109.** **(b)** **110.** **(a)** **111.** **(b)** **112.** **(c)**

ASSERTION-REASON TYPE QUESTIONS

113. **(a)**

114. **(a)** Gases expand and occupy all the space available to them because there is no force of attraction between the particles of a gas at ordinary temperature and pressure.

115. **(a)** **116.** **(a)**

117. **(c)** At high altitude atmospheric pressure is low.

118. **(d)**

CRITICAL THINKING TYPE QUESTIONS

119. (c) In case of HCl molecules their is dipole-dipole interaction which is stronger than London forces as in case of SF_6. Now between HCl and NaCl the ion-ion interaction present in NaCl is far more stronger than dipole-dipole interaction of HCl.

120. (d) Given, $P_1 = 15$ atm, $P_2 = 60$ atm
$V_1 = 76\ cm^3$, $V_2 = 20.5\ cm^3$.
If the gas is an ideal gas, then according to Boyle's law, it must follow the equation,
$P_1V_1 = P_2V_2$
$P_1 \times V_1 = 15 \times 76 = 1140$
$P_2 \times V_2 = 60 \times 20.5 = 1230$
$\therefore P_1V_1 \neq P_2V_2$
$\therefore$ The gas behaves non-ideally.
The given information is not sufficient to comment on other statements.

121. (d) All the gases occupy the available volume and will form homogeneous mixture.

122. (c) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ at const. pressure

$\Rightarrow \frac{22.4}{273} = \frac{V_2}{373}$, $V_2 = 30.6$ litre

123. (a) Since atmospheric pressure remain constant

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow \frac{V_1}{298K} = \frac{2800m^3}{372K}$$

$V_1 = 2243\ m^3$
2800 m^3 volume of inflated balloon.
Mass of air in inflated ballon = 2800 m^3 × 0.94 kg m^{-3}
= 2632 kg
Keeping the volume same = 2800 m^3
The mass of air, which occupies it with density (1.2 kg/m^3) is 2800 × 1.2 = 3360 kg
Amount of air which had been escaped = 3360 – 2632
= 728 kg

124. (d)

125. (d) n of $O_2 = \frac{16}{32} = \frac{1}{2}$

n of $H_2 = \frac{3}{2}$

Total no. of moles $= \frac{3}{2} + \frac{1}{2} = 2$

$$V = \frac{nRT}{P} = \frac{2 \times .082 \times 273}{1} = 44.8lit = 44800\ ml$$

126. (b) $d = \frac{PM}{RT}$

It means density of gas is directly proportional to pressure and inversely proportional to temperature.
Density of neon will be maximum at highest pressure and lowest temperature.

127. (c)

128. (d) According to Boyle's law at constant temperature,

$V \propto \frac{1}{P}$ or PV = constant

129. (a) Applying Boyle's law $P_1V_1 = P_2V_2$ for both gases

$$\frac{500}{1000} \times 400 = P \times 3 \Rightarrow P = \frac{200}{3}$$

$$600 \times \frac{666.6}{1000} = P' \times 3 \Rightarrow P' = \frac{400}{3}$$

$$\Rightarrow P_T = P + P' = \frac{200}{3} + \frac{400}{3} = \frac{600}{3} = 200 \text{ tor}$$

130. (c) Percentage of nitrogen in atmosphere is 78% .Partial pressure of N_2 = 0. 78 × 760

131. (d) By Ideal gas equation

$P_1V = n_1RT$

$n_1 \propto P_1$ and $n_2 \propto P_2$

$$\frac{n_1}{n_2} = \frac{P_1}{P_2} \Rightarrow \frac{n_1}{n_2} = \frac{170}{570} = 0.30$$

132. (a) Given weight of empty glass vessel = 50 g
Weight of vessel filled with liquid = 144 g
$\therefore$ Weight of liquid = 144 – 50 = 94 g.
Volume of liquid = Mass/density = 94/0.47
= 200 ml = 200 × 10^{-3} L.
Given, pressure of ideal gas = 760 mm Hg = 1 atm
Temperature = 300 K
R = 0.0821 L atm K^{-1} mol^{-1}
Mass of ideal gas = 50.5 – 50 = 0.5 g
According to ideal gas equation,

$PV = nRT = \frac{w}{M}RT$

$$1 \times 200 \times 10^{-3} = \frac{0.5}{M} \times 0.0821 \times 300$$

$$M = \frac{0.5 \times 0.0821 \times 300}{200 \times 10^{-3}} = 61.575$$

133. (d) $p_1 = 1.5$ atm, $T_1 = 15°C = (15 + 273)K = 288$ K
$p_2 = 1$ atm, $T_2 = 25°C = (25 + 273)K = 298$ K

$$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$

$$\frac{p_1T_2}{T_1p_2} = \frac{V_2}{V_1} \Rightarrow \frac{V_2}{V_1} = \frac{1.5 \times 298}{288 \times 1} = 1.55$$

134. (c) Moles of A, $(n_A) = \frac{p_A v_A}{RT} = \frac{8 \times 12}{RT} = \frac{96}{RT}$

Moles of B, $(n_B) = \frac{p_B v_B}{RT} = \frac{8 \times 5}{RT} = \frac{40}{RT}$

Total pressure × total volume = $(n_A + n_B) \times RT$

$$p \times (12 + 8) = \frac{1}{RT}(96 + 40)RT$$

$$p = 6.8$$

Partial pressure of A = p × mole fraction of A

$$= 6.8\left(\frac{96}{RT} \Big/ \frac{96+40}{RT}\right)$$

$$= 4.8 \text{ atm}$$

Partial pressure of B = 6.8 – 4.8 = 2 atm.

135. (d) Number of moles of $O_2 = \frac{70.6\text{g}}{32\text{g mol}^{-1}} = 2.21 \text{ mol}$

Number of moles of Ne $= \frac{167.5\text{g}}{20\text{g mol}^{-1}} = 8.375 \text{ mol}$

Mole fraction of $O_2 = \frac{2.21}{2.21 + 8.375} = 0.21$

Mole fraction of Ne = 1 – 0.21 = 0.79

Partial pressure of a gas = Mole fraction × total pressure

Partial pressure of O_2 = 0.21 × 25 = 5.25 bar

Partial pressure of Ne = 0.79 × 25 = 19.75 bar

136. (a) Extent of diffusion $H_2 > CH_4 > SO_2$ because rate of diffusion $\propto \frac{1}{\text{molar mass}}$

Order of partial pressure after diffusion is

$p_{SO_2} > p_{CH_4} > p_{H_2}$

137. (a) As the height increases, atmospheric pressure decreases, so now the volume of the gas increases and gas tends to become less denser, hence the concentration of oxygen decreases.

138. (d) The mathematical relationship between pressure and temperature was given by Gay Lussac's law.

139. (c) Number of moles, temperature and volume are same.

140. (c) Due to small size of these species (H_2 and He) intermolecular interactions (van der Waal forces) are very low, therefore it is difficult to compress these .

141. (a) Since surface tension depends on the attractive forces between the molecules, and hydrogen bonding a special type of dipole-dipole interactions in (b), (c) and (d) which is stronger than London forces of attraction in hexane.

142. (c)

143. (a) Force is required to maintain the flow of layer which is inversely proportional to the area of contact of layer therefore flow in B is greater than that in A as the area of contact is greater in A. Also viscosity of the fluid decreases with increase in temperature therefore liquid flow increases.