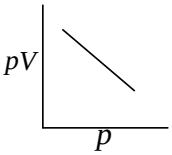
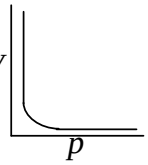
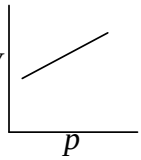
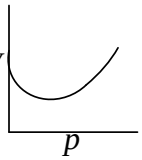
STATES OF MATTER

Single Correct Answer Type

1. In the calcium fluoride structure, the coordination number of the cation and anion are respectively
   a) 4, 4 b) 6, 6 c) 4, 8 d) 8, 4
2. The rate of diffusion of hydrogen is about
   a) One half that of helium
   b) 1.4 times that of helium
   c) Twice that of helium
   d) Four times that of helium
3. For hydrogen gas $C_p - C_v = a$, and for oxygen gas $C_p - C_v = b$, so the relation between a and b is:
   a) $a = 16b$ b) $16a = b$ c) $a = 4b$ d) $a = b$
4. Two identical cylinders contain helium at 2.5 atm and argon at 1 atm respectively. if both the gases are filled in one of the cylinders, the pressure would be:
   a) 3.5 atm b) 1.75 atm c) 1.5 atm d) 1 atm
5. 32 g of O_2, 2 g of H_2 and 28 g of N_2 at STP occupy separately a volume of
   a) 1 L b) 2 L c) 22.4 L d) 2.24 L
6. If Z is the number of atoms in the unit cell that represents the closest packing sequence….. $ABC\ ABC$ ….. , the number of tetrahedral voids in the unit cell is equal to
   a) Z b) $2Z$ c) $\frac{Z}{2}$ d) $\frac{Z}{4}$
7. Select correct statement(s)
   a) The standard boiling temperature is the temperature at which the vapour pressure of the substance is 1 bar
   b) The normal boiling temperature is the temperature at which the vapour pressure of the substance is 1 atm
   c) Substances for which $T > T_c$ and $p > p_c$ are called super critical fluids
   d) All the above are correct statements
8. Longest mean free path under similar conditions of P and T stands for:
   a) N_2 b) O_2 c) H_2 d) Cl_2
9. For an ideal gas, number of mol per litre in terms of its pressure p, temperature T and gas constant R is
   a) pT/R b) pRT c) p/RT d) RT/p
10. A closed vessel contains equal number of nitrogen and oxygen molecules at a 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
11. A 4 : 1 mixture of helium and methane is contained in a vessel at 10 bar pressure. Due to a hole in the vessel, the gas mixture leaks out. The composition of mixture effusing out initially is
    a) 8 : 1 b) 8 : 3 c) 4 : 1 d) 1 : 1
12. Which of the following is a Boyle's plot at very low pressure?
    a) 

    b) 

c) 

d) 

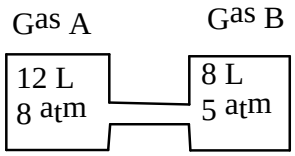
13. At what temperature will the volume of a gas at 0°C double itself, pressure remaining constant?
    a) −546°C b) 273 K c) 546°C d) 546 K
14. When air is blown to balloon (at constant temperature) its pressure and volume both increases. This violates:
    a) Boyle's law b) Charles' law c) Gas law d) None of these
15. The most unsymmetrical crystal system is
    a) hexagonal b) Triclinic c) Cubic d) orthorhombic
16. The ratio of rate of diffusion of helium and methane under identical conditions of pressure and temperature is:
    a) 4 b) 2 c) 1 d) 0.5
17. A flask is of a capacity one litre. What volume of air will escape out from it on heating from 27°C to 37°C? Assume pressure constant:
    a) 1.033 litre b) 33.3 mL c) 33.3 litre d) None of these
18. The temperature at which the second virial coefficient of a real gas is zero is called:
    a) Critical temperature b) Eutectic point c) Boiling point d) Boyle's temperature
19. For a real gas, deviations from ideal gas behaviour are maximum at:
    a) −10°C and 5.0 atm b) −10°C and 2.0 atm c) 0°C and 1.0 atm d) 100°C and 2.0 atm
20. Equal volumes of two gases are kept in separate containers at the same temperature and pressure. Then:
    a) Masses of the two gases are same
    b) Molecular structure of two gases would be similar
    c) The two gases contain the same number of molecules
    d) The two gases, if allowed to diffuse would do so at the same rate
21. In which one of the following does the given amount of chlorine exert the least pressure in a vessel of capacity 1 dm^3 at 273 K?
    a) 0.0355g b) 0.071
    c) 6.023×10^{21} molecules d) 0.02 moles
22. Which of the following will increase with the increase in temperature?
    a) Surface tension b) Viscosity c) Molality d) Vapour pressure
23. If the pressure is halved and absolute temperature doubled the volume of the gas will be:
    a) 4 b) 2 c) Same d) 8
24. An alloy of Cu, Ag and Au is found to have Cu forming the simple cubic close packed lattice. If the Ag atoms occupy the face centres and Au is present at the body centre, the formula of the alloy will be
    a) Cu_4Ag_4Au b) $CuAg_3Au$ c) CuAgCu d) Cu_4Ag_2Au
25. A mixture of helium and argon contains 3 mole of He for every 2 mole of Ar. The partial pressure of argon is:
    a) 2/3 the total pressure
    b) 1/3 the total pressure
    c) 2/5 the total pressure
    d) 1/5 the total pressure
26. The three states of matter are solid, liquid and gas. Which of the following statements is/ are true about them?

a) Gases and liquids have viscosity as a common property
b) The molecules in all the three states posses random translational motion
c) Gases cannot be converted into solids without passing through the liquid phase
d) Solids and liquids have vapour pressure as a common property

27. If volume containing gas is compressed to half, how many moles of gas remained in the vessel?
a) Just double b) Just half c) Same d) More than double
28. The unit of van der Waals' constant $'a'$ is:
a) atm litre^2 mol^2 b) dyne cm^4 mol^{-2} c) newton m^4 mol^{-2} d) All of these
29. Normal temperature and pressure (NTP) of gases refers to:
a) 273 K and 760 mm Hg
b) 273°C and 760 mm Hg
c) 273 K and 76 mm Hg
d) 273°C and 76 mm Hg
30. A vessel has two equal compartments A and B containing H_2 and O_2 respectively, each at 1 atm pressure. If the wall separating the compartment is removed, the pressure:
a) Will remain unchanged in A and B
b) Will increase in A and decrease in B
c) Will decrease in A and increase in B
d) Will increase in both A and B
31. The strength of van der Waals' forces increases with:
a) Increase in molecular size
b) Increase in the number of electrons in the molecule
c) Increases in molecular weight
d) All of the above
32. To which of the following gaseous mixtures is Dalton's law not applicable?
a) Ne + He + SO_2 b) NH_3 + HCl + HBr c) $O_2 + N_2 + CO_2$ d) $N_2 + H_2 + O_2$
33. At a constant temperature what should be the percentage increase in pressure for a 5% decrease in the volume of gas?
a) 5% b) 10% c) 5.26% d) 4.26%
34. An example of fluorite structure is
a) NaF b) $AlCl_3$ c) SrF_2 d) SiF_4
35. The edge of unit cell of fcc Xe crystal is 620 pm. The radius of Xe atom is
a) 189.37 pm b) 209.87 pm c) 219.25 pm d) 235.16 pm
36. Oxygen gas is collected by downward displacement of water in a jar. The level of water inside the jar is adjusted to the height of water outside the jar. When the adjustment is made, the pressure exerted by the oxygen is:
a) Equal to the atmospheric pressure
b) Equal to the vapour pressure of oxygen at that temperature
c) Equal to atmospheric pressure plus aqueous tension at that temperature
d) Equal to atmospheric pressure minus aqueous tension at that temperature
37. A and B are two identical vessels. A contains 15 g of ethane at 298 K and 1 atm. The vessel B contains 75 g gas X_2 at the same temperature and pressure. The vapour density of X_2 is:
a) 75 b) 150 c) 37.5 d) 300
38. If 1 litre of a gas A at 600 mm and 0.5 litre of gas B at 800 mm are taken in a 2 litre bulb. The resulting pressure is:
a) 1500 mm b) 1000 mm c) 2000 mm d) 500 mm
39. In zinc blende structure, the coordination number of Zn^{2+} ion is

a) 2 b) 4 c) 6 d) 8

40. Gay-Lussac's law of gaseous volumes is derived from:
    a) Law of reciprocal proportions
    b) Law of multiple proportions
    c) Experimental observations
    d) None of the above
41. In which of the following substances the carbon atom is arranged in a regular tetrahedral structure?
    a) Diamond b) Benzene c) Graphite d) Carbon black
42. The inversion temperature (T_i) for a gas is given by:
    a) $\frac{a}{Rb}$ b) $\frac{2a}{Rb}$ c) $\frac{Rb}{a}$ d) $\frac{2Rb}{a}$
43. A flask of methane (CH_4) was weighed. Methane was then pushed out and the flask again weighed when filled with oxygen at the same temperature and pressure. The mass of oxygen would be:
    a) The same as the methane
    b) Half of the methane
    c) Double of that of methane
    d) Negligible in comparison to that of methane
44. Two vessels containing gases *A* and *B* are interconnected 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 atm b) 9.6 and 4 atm c) 4.8 and 2 atm d) 6.4 and 4 atm
45. In face centred cubic unit cell edge length is
    a) $2r$ b) $\frac{\sqrt{3}}{2}r$ c) $\frac{4}{\sqrt{3}}r$ d) $\frac{4}{\sqrt{2}}r$
46. The rms speed of gas molecules at a temperature 27 K and pressure 1.5 bar is 1×10^4 cm/sec. If both temperature and pressure are raised three times, the rms speed of the gas will be:
    a) 9×10^4cm/sec b) 3×10^4cm/sec c) 1×10^4cm/sec d) $\approx 1 \times 10^4$cm/sec
47. Which of the following is ferroelectric compound?
    a) $BaTiO_3$ b) Pb_2O_3 c) $PbZrO_3$ d) $K_4[Fe(CN)_6]$
48. Which of the following pair of gases contain the same number of molecules?
    a) 16 g O_2, 14g N_2 b) 8g O_2, 22g N_2 c) 28g N_2, 22g CO_2 d) 32g O_2, 32g N_2
49. If the value of ionic radius ratio $\left(\frac{r_c}{r_a}\right)$ is 0.52 in an ionic compound, the geometrical arrangement of ions in crystal is
    a) Planar b) Pyramidal c) Tetrahedral d) Octahedral
50. Which type of solid crystals will conduct heat and electricity?
    a) Ionic b) Covalent c) Molecular d) Metallic
51. A flask filled with CCl_4 was weighed at a temperature and pressure. The flask was then filled with oxygen at the same temperature and pressure. The mass of CCl_4 vapour would be about:
    a) The same as that of the oxygen
    b) One-fifth as heavy as oxygen
    c) Five times as heavy as oxygen
    d) Twice as heavy as oxygen

52. Calculate the ionic radius of a Cs^+ ion, assuming that the cell edge length for CsCl is 0.4123 nm and that the ionic radius of a CI^- ion is 0.181 nm
    a) 0.352 nm b) 0.116 nm c) 0.231 nm d) 0.176 nm
53. The pressure and temperature of $4dm^3$ of carbon dioxide gas are doubled, then the volume of carbon dioxide gas would be
    a) 2 dm^3 b) 3 dm^3 c) 4 dm^3 d) 8 dm^3
54. One mole of a gas is defined as:
    a) The number of molecules in one litre of gas
    b) The number of molecules in 2.24 litre of a gas
    c) The number of atoms contained in 12g of C^{14} isotope
    d) The number of molecules in 22.4 litre of a gas at STP
55. During the evaporation of liquid
    a) The temperature of the liquid will rise b) The temperature of the liquid will fall
    c) May rise or fall depending on the nature d) The temperature remains unaffected
56. If 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) 2500 K d) 25°C
57. If the concentration of water vapour in the air is 1% and the total atmospheric pressure equals 1 atm then the partial pressure of water vapour is:
    a) 0.1 atm b) 1 mm Hg c) 7.6 mm Hg d) 100 atm
58. CsBr crystal has bcc structure. It has an edge length of 4.3 Å. The shortest interionic distance between Cs^+ and Br^- ions is
    a) 1.86 Å b) 2.86 Å c) 3.72 Å d) 4.72 Å
59. Graham's law deals with the relation between
    a) Pressure and volume b) Density and rate of diffusion
    c) Rate of diffusion and volume d) Rate of diffusion and viscosity
60. The quantity $pV/(k_BT)$ represents the
    a) Number of molecules in the gas b) Mass of the gas
    c) Number of moles of the gas d) Translation energy of the gas
61. 2 g of hydrogen diffuses from a container in 10 minute. How many gram of oxygen would diffused through the same container in the same time under similar conditions?
    a) 5 g b) 4 g c) 6 g d) 8 g
62. 1.0 L of N_2 and 7/8 L of O_2 at the same temperature and pressure were mixed together. What is the relation between the masses of the two gases in the mixture?
    a) $M_{N_2} = 3M_{O_2}$ b) $M_{N_2} = 8M_{O_2}$ c) $M_{N_2} = M_{O_2}$ d) $M_{N_2} = 16M_{O_2}$
63. All the three states H_2O, *i. e.*, the triple point for H_2O the equilibrium,
    Ice ⇌ Water ⇌ Vapour exist at:
    a) 3.85 mm and 0.0981°C
    b) 4.58 mm and 0.0098°C
    c) 760 mm and 0°C
    d) None of the above
64. Consider an ideal gas contained in a vessel. If the intermolecular interactions suddenly begins to acts, which of the following will happen?
    a) The pressure decrease b) The pressure increase
    c) The pressure remains unchanged d) The gas collapses
65. At what temperature will hydrogen molecules have the same kinetic energy as nitrogen molecules have at 35°C ?

a) $\frac{28 \times 35}{2}$°C b) $\frac{2 \times 35}{28}$°C c) $\frac{2 \times 28}{35}$°C d) 35°C

66. If the distance between Na^+ and CI^- ions in sodium chloride crystal is x pm, the length of the edge of the unit cell is

a) $\frac{x}{2}$pm b) $\frac{x}{4}$pm c) $2x$ pm d) $4x$ pm

67. X- ray analysis shows that the unit cell length in NaCl is 562.8 pm. Calculate the density you would expect on this basis, $N_A = 6.023\ x10^{23} mol^{-1}$

a) 0.3216 g cm^{-3} b) 2.179 g cm^{-3} c) 1.859 g cm^{-3} d) 2.346 g cm^{-3}

68. Which of the given sets of temperature and pressure will cause a gas to exhibit the greatest deviation from ideal gas behavior?

a) 100°C and 4 atm b) 100°C and 2 atm c) −100°C and 4 atm d) 0°C and 2 atm

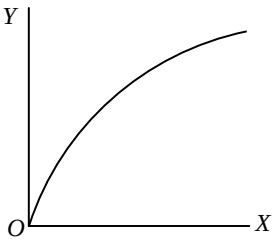
69. Piezoelectric crystals are used in

a) TV b) Radio c) Freeze d) Record player

70. In two vessels of 1 L each at the same temperature 1 g of H_2 and 1 g of CH_4 are taken, for these

a) V_{rms} values will be same b) Kinetic energy per mol will be same
c) Total kinetic energy will be same d) Pressure will be same

71. Which one of the following represents the graph between $\log p$ (on $Y-$ axis)and $\frac{1}{T}$ (on $X-$ axis)? ($p =$ vapour pressure of a liquid, $T =$ absolute temperature)

a)


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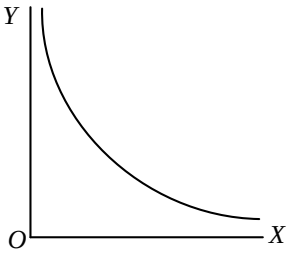

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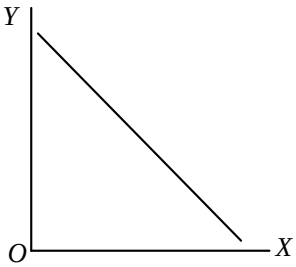

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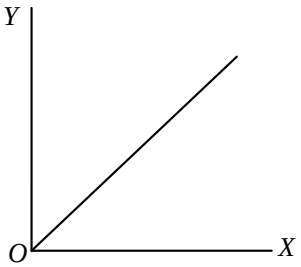


72. At 20°C and 1.00 atm partial pressure of hydrogen, 18 mL of hydrogen, measured at STP, dissolves in 1 L of water. If water at 20°C is exposed to a gaseous mixture having total pressure of 1400 torr (excluding the vapour pressure of water) and containing 68.5% H_2 by volume, find the volume of H_2, measured at STP, which will dissolve in 1 L of water

a) 18 mL b) 12 mL c) 23 mL d) 121 mL

73. Dalton's law of partial pressure is not applicable to

a) H_2 and N_2 mixture b) H_2 and Cl_2 mixture c) H_2 and CO_2 mixture d) None of these

74. A bubble of volume V_1 is in the bottom of a pond at 15°C and 1.5 atm pressure when it comes at the surface it observes a pressure of 1 atm at 25°C and have volume V_2 , give $\frac{V_2}{V_1}$

a) 15.5 b) 0.155 c) 155.0 d) 1.55

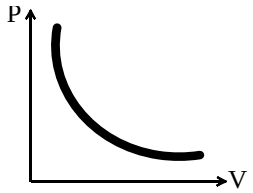
75. Slope between pV and p at constant temperature is

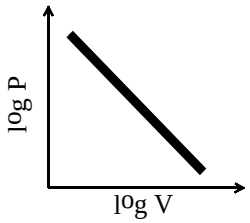
a) Zero b) 1 c) $\frac{1}{2}$ d) $\frac{1}{\sqrt{2}}$

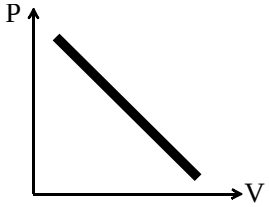
76. One gram mole of a gas at NTP occupies 22.4 L as volume. This fact was derived from

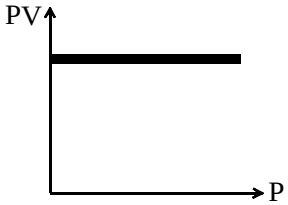
a) Dalton's theory
b) Avogadro's hypothesis
c) Berzelius hypothesis
d) Law of gaseous volumes

77. Which curve does not represent Boyle's law?

a) 

b) 

c) 

d) 

78. Frenkel defect is caused due to
a) The shift of a positive ion from its normal lattice site to an interstitial site
b) An ion missing from the normal lattice site creating a vacancy
c) An extra positive ion occupying an interstitial position in the lattice
d) An extra negative ion occupying an interstitial position in the lattice

79. Which set of conditions represents easiest way to liquefy a gas?
a) Low temperature and high pressure
b) High temperature and low pressure
c) Low temperature and low pressure
d) High temperature and high pressure

80. A curve drawn at constant temperature is called an isotherm. This shows the relationship between
a) p and $\frac{1}{V}$ b) pV and V c) V and $\frac{1}{p}$ d) p and V

81. Which gas when passed through dilute blood will impart a cherry red colour to the solution?
a) CO_2 b) $COCl_2$ c) NH_3 d) CO

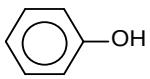
82. In a mixture of a light gas and a heavy gas in a closed container, the light gas will:
a) Have a lower average speed per molecule than the heavy gas
b) Have a higher average speed per molecule than the heavy gas
c) Rise to the top of the container
d) All are wrong

83. The characteristic features of solids are
a) Definite shape
b) Definite size
c) Definite shape and size
d) Definite shape, size and rigidity

84. Which gas has the, same rate of diffusion as that of CO_2 at same P and T?
a) N_2O b) NO_2 c) N_2 d) CO

85. An ideal gas is allowed to expand both reversibly and irreversibly in an isolated system. If T_i is the initial temperature and T_f is the final temperature, which of the following statements is correct?
a) $(T_f)_{\text{irrev}} > (T_f)_{\text{rev}}$
b) $T_f > T_i$ for reversible process but $T_f = T_i$ for irreversible process
c) $(T_f)_{\text{rev}} = (T_f)_{\text{irrev}}$
d) $T_f = T_i$ for both reversible and irreversible processes

86. To raise the volume of a gas by four times, the following method may be adopted. Which of the method is wrong?
a) T is doubled and P is also doubled
b) Keeping P constant, T is raised by four times
c) Temperature is doubled and pressure is halved
d) Keeping temperature constant, pressure is reduced to 1/4 of its initial value

87. If a gas is expanded at constant temperature:
    a) Number of molecules of the gas decreases
    b) The kinetic energy of the molecules decreases
    c) The kinetic energy of the molecules remains the same
    d) The kinetic energy of the molecules increases
88. The root mean square speed of hydrogen molecules at room temperature is 2400 ms^{-1}. At room temperature the root mean square speed of oxygen molecules would be:
    a) 400 ms^{-1} b) 300 ms^{-1} c) 600 ms^{-1} d) 1600 ms^{-1}
89. Four particles have speed 2,3,4 and 5 cm/s respectively. Their rms speed is:
    a) 3.5 cm/s b) (272) cm/s c) $\sqrt{54}$ cm/s d) $\left(\sqrt{54}/2\right)$ cm/s
90. At what temperature would the volume of a given mass of a gas at constant pressure be twice to its volume at 0°C ?
    a) 100°C b) 273°C c) 373°C d) 446°C
91. The ratio of cationic radius to anionic radius in an ionic crystal is greater than 0.732. Its coordination number is
    a) 1 b) 4 c) 6 d) 8
92. Ratio of average to most probable velocity is
    a) 1.128 b) 1.224 c) 1.0 d) 1.112
93. Which is not true in case of an ideal gas?
    a) It cannot be converted into a liquid
    b) There is no interaction between the molecules
    c) All molecules of the gas move with same speed
    d) At a given temperature pV is proportional to the amount of the gas
94. At 400 K, the root mean square (rms) speed of a gas X (molecular weight = 40) is equal to the most probable speed of gas Y at 60 K. The molecular weight of the gas Y is
    a) 2 b) 4 c) 6 d) 8
95. A metallic element has a cubic lattice. Each edge of the unit cell is 2Å. Thedensity of the metal is 2 g cm^{-3}. The unit cells in 200 g of the metal are
    a) 1×10^{25} b) 1×10^{24} c) 1×10^{22} d) 1×10^{20}
96. Which has maximum vapour pressure at a given temperature?
    a) $CH_3CH_2CH_2OH$ b)  c) $CH_3 - O - CH_3$ d) CH_3COOH
97. The relative rates of diffusion of $U^{235}F_6$ and $U^{238}F_6$ are:
    a) 1.0043 b) 1.2 c) 1.4 d) 1.6
98. Sodium metal crystallizes as a body centred cubic lattice with the cell edge 4.29 Å. What is the radius sodium atom?
    a) 1.857×10^{-8}cm b) 2.371×10^{-7}cm c) 3.817×10^{-8}cm d) 9.312×10^{-7}cm
99. Consider 1 cm^3 sample of air at absolute temperature T_0 at sea-level and another 1 cm^3 sample of air at a height where the pressure is one third atmosphere. The absolute temperature T of the sample at the height is :
    a) Equal to $T_0/3$
    b) Equal to T_0
    c) Equal to $3T_0$
    d) Cannot be determined in terms of T_0 from the above data
100. A vogadro's hypothesis states that
    a) The ideal gas consists of a large number of small particles called molecules.

b) Under the same conditions of temperature and pressure equal volumes of gases contain the same number of molecules.
c) Volume of definite quantity of gas at constant pressure is directly proportional to absolute temperature.
d) A given mass of gas at constant pressure is directly proportional to absolute temperature.

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

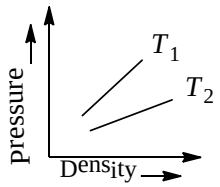
102. By what ratio the average velocity of the molecule in a gas change when the temperature is raised from 50 to 200°C?
a) $\frac{1.21}{1}$ b) $\frac{1.46}{1}$ c) $\frac{1.14}{1}$ d) $\frac{4}{1}$

103. If two molecules of A and B having mass 100 kg and 64 kg and rate of diffusion of A is 12×10^{-3}, then what will be the rate of diffusion of B?
a) 15×10^{-3} b) 64×10^{-3} c) 5×10^{-3} d) 46×10^{-3}

104. In CsCl structure, the coordination number of Cs^+ is
a) Equal to that of CI^-, that is 6
b) Equal to that of CI^-, that is 8
c) Not equal to that of CI^-, that is 6
d) Not equal to that of CI^-, that is 8

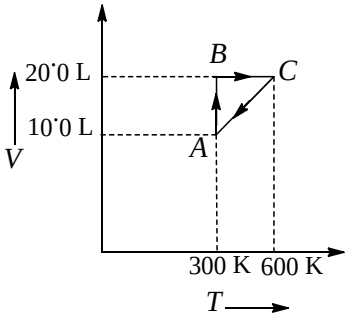
105. At room temperature the rms speed of the molecules of a certain diatomic gas is found to be 1930 m/s. The gas is:
a) H_2 b) F_2 c) O_2 d) Cl_2

106. Figure shows graphs of pressure *versus* density for an ideal gas at two temperatures T_1 and T_2. Which is correct?



a) $T_1 > T_2$ b) $T_1 = T_2$ c) $T_1 < T_2$ d) None of these

107. This graph expresses the various steps of the system containing 1 mole of gas. Which type of process, system has when it moves from C to A?



a) Isochoric b) Isobaric c) Isothermal d) Cyclic

108. The rates of diffusion of SO_2, CO_2, PCl_3 and SO_3 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) $CO_2 > SO_2 > SO_3 > PCl_3$

109. The ratio of molar heats of vaporization and boiling point of a liquid is constant. This is known as
a) Ostwald's rule b) Phase rule c) Van't Hoff rule d) Trouton's rule

110. What is the ratio of diffusion rate of oxygen and hydrogen?

a) 1 : 4 b) 4 : 1 c) 1 : 8 d) 8 : 1

111. The rms velocity of an ideal gas at constant pressure varies with density (d) as
a) $\frac{1}{\sqrt{d}}$ b) d c) $\sqrt{d}$ d) d^2

112. Volume occupied by molecules of one mole gas at NTP, each having radius of 10^{-8} cm is:
a) 22.0 litre b) 22.4 litre c) 10.09 mL d) 10.09 litre

113. If a gas is heated at constant pressure, its density
a) Will decrease b) Will increase
c) May increase or decrease d) Will remain unchanged

114. An example of a non-stoichiometric compound is
a) PbO b) NiO_2 c) Al_2O_3 d) Fe_3O_4

115. The pressure of gas having 2 mole in 44.8 litre vessel at 540 K is:
a) 1 atm b) 2 atm c) 3 atm d) 4 atm

116. The excluded volume of a molecule in motion is... times the actual volume of a molecule in rest
a) 2 b) 4 c) 3 d) 0.5

117. 10 mL of oxygen and 10 mL of hydrogen is kept at the same temperature and pressure, which is correct about number of molecules?
a) $No_2 > N_{H_2}$ b) $No_2 < N_{H_2}$ c) $No_2 = 16N_{H_2}$ d) $No_2 = N_{H_2}$

118. The number of unit cells in 58.5 g of NaCl is nearly
a) 0.5×10^{24} b) 1.5×10^{23} c) 3×10^{22} d) 6×10^{20}

119. The rates of diffusion of O_2 and H_2 at same P and T are in the ratio:
a) 1 : 4 b) 1 : 8 c) 1 : 16 d) 4 : 1

120. A gas behaves most like an ideal gas under conditions of:
a) High pressure and low temperature
b) High temperature and high pressure
c) Low pressure an high temperature
d) Low pressure and low temperature

121. In order to increase the volume of a gas by 10%, the pressure of the gas should be
a) Increased by 10% b) Increased by 1% c) Decreased by 10% d) Decreased by 1%

122. 380 mL of a gas at 27°C, 800 mm of Hg weighs 0.455 g. The molecular weight of gas is
a) 46 b) 38 c) 28 d) 24

123. Cooking is fast in a pressure cooker, because
a) Food particles are effectively smashed
b) Water boils at higher temperature inside the pressure cooker
c) Food is cooked at constant volume
d) Loss of heat due to radiation is minimum

124. If the absolute temperature of a gas is doubled and the pressure is reduced to one half, the volume of the gas will
a) Remain unchanged b) Be doubled
c) Increase four fold d) Be halved

125. Boyle's law may be expressed as:
a) $(\partial P/\partial V)_T = K/V$ b) $(\partial P/\partial V)_T = -K/V^2$ c) $(\partial P/\partial V)_T = -K/V$ d) None of these

126. One mole of CO_2 contains:
a) 6.02×10^{23} atoms of C
b) 6.02×10^{23} atoms of O
c) 3.01×10^{23} molecules of CO_2

d) None of the above

127. A gas is heated from 0°C to 100°C at 1.0 atm pressure. If the initial volume of the gas is 10 litre, its final volume would be:
a) 7.32 litre b) 10.0 litre c) 13.66 litre d) 20.0 litre

128. Which solid will have the weakest intermolecular forces?
a) P b) Naphthalene c) NaF d) Ice

129. The temperature of an ideal gas is increased from 140 K to 560 K. If at 140 K the root mean square velocity of the gas molecules is V, at 560 K it becomes:
a) 5 V b) 2 V c) $V/2$ d) $V/4$

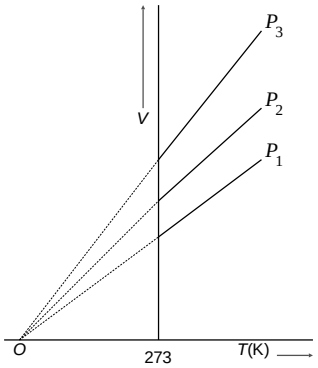
130. Which gas is most soluble in water?
a) H_2S b) NH_3 c) SO_2 d) CO_2

131. Which one, among the following, is the van der Waals' equation, describing the behaviour of one mole of a real gas over wide ranges of temperature and pressure?
a) $\left(p+\frac{a}{V^2}\right)(V-b)=RT$ b) $\left(p-\frac{a}{V^2}\right)(V-b)=RT$
c) $\left(p+\frac{a}{V^2}\right)(V-b)=\frac{R}{T}$ d) $\left(p+\frac{a}{V^2}\right)(V+b)=RT$

132. The molecular velocities of two gases at the same temperature are u_1 and u_2 and their masses are m_1 and m_2 respectively. Which of the following expressions are correct?
a) $\frac{m_1}{u_1^2}=\frac{m_2}{u_2^2}$ b) $m_1u_1=m_2u_2$ c) $\frac{m_1}{u_1}=\frac{m_2}{u_2}$ d) $m_1u_1^2=m_2u_2^2$

133. According to kinetic theory of gases for a diatomic molecule
a) The pressure exerted by the gas is proportional to the mean square speed of the molecules
b) The pressure exerted by the gas is proportional to the root mean square speed of the molecules
c) The root mea square speed is inversely proportional to the temperature
d) The mean translational KE of the molecule is directly proportional to the absolute temperature

134. The volume-temperature graphs of a given mass of an ideal gas at constant pressures are shown below. What is the correct order of pressures?



a) $p_1>p_3>p_2$ b) $p_1>p_2>p_3$ c) $p_2>p_3>p_1$ d) $p_2>p_1>p_3$

135. A mixture of 0.50 mole of H_2 and 0.50 mole of SO_2 is introduced into a 10.00 L container at 25°C. The container has a pinhole leak. After a period of time, the partial pressure of H_2 in the remaining mixture
a) Exceeds that of SO_2 b) Is equal to that of SO_2
c) Is less than that of SO_2 d) Is the same as in the original mixture

136. Potassium crystallizes in a bcc lattice, hence the coordination number of potassium metal is
a) 0 b) 4 c) 6 d) 8

137. The interionic distance for cesium chloride crystal will be
a) a b) $\frac{a}{2}$ c) $\frac{2a}{\sqrt{3}}$ d) $\frac{\sqrt{3}}{2}a$

138. The van der Waals' equation for a real gas is given by the formula $\left(p + \frac{n^2a}{V^2}\right)(V - nb) = nRT$, where p, V, T and n are the pressure, volume, temperature and the number of moles of the gas. Which one is the correct interpretation for the parameter a?
   a) The parameter a accounts for the finite size of the molecule, not included temperature in the ideal gas law.
   b) The parameter a accounts for the shape of gas phase molecules.
   c) The parameter a accounts for intermolecular interaction's present in the molecule.
   d) The parameter a has no physical significance and van der Waals' introduced it as a numerical correction factor only.

139. Schottky defect in crystals is observed when
   a) Density of crystal is increased
   b) An ion leaves its normal site and occupies an interstitial site
   c) Equal number of cations and anions are missing from the lattice
   d) Unequal number of cations and anions are missing from the lattice

140. A flask containing air is heated from 300 K to 500 K. The percentage of air escaped to the atmosphere is nearly
   a) 40% b) 30% c) 80% d) 60%

141. If the intermolecular forces vanish away, the volume occupied by the molecules contained in 4.5 kg water at STP will be:
   a) 5.6 m^3 b) 4.5 m^3 c) 11.2 litre d) 11.2 m^3

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

143. Surface tension vanishes at
   a) Boiling point b) Critical point c) Condensation point d) Triple point

144. While He is allowed to expand through a small jet under adiabatic condition heating effect is observed. This is due to the fact that:
   a) Helium is an inert gas
   b) Helium is a noble gas
   c) Helium is an ideal gas
   d) The inversion temperature of helium is very low

145. The flame colours of metal ions are due to
   a) Schottky defect b) Frenkel defect
   c) Metal excess defect d) Metal deficiency defect

146. Which is not a surface phenomenon?
   a) Surface tension b) Viscosity c) Evaporation d) All of these

147. Potassium fluoride has NaCl type structure. What is the distance between K^+ and F^- ions if cell edge is a cm?
   a) $\frac{a}{2}$ cm b) $\frac{a}{4}$ cm c) $2a$ cm d) $4a$ cm

148. Which represents the largest amount of energy?
   a) Calorie b) Joule c) Erg d) Electron-volt

149. Surface tension of water is 73 dyne cm^{-1} at 20°C. If surface area is increased by 0.10 m^2, work done is
   a) 7.3 erg b) 7.3×10^4 erg c) 73 J d) 0.73 J

150. 0.44 g of a colourless oxide of nitrogen occupies 224 mL at STP. The compound is:
a) N_2O b) NO c) N_2O_2 d) NO_2

151. For a monoatomic gas kinetic energy $= E$. The relation with rms velocity is
a) $u = \left(\frac{2E}{m}\right)^{1/2}$ b) $u = \left(\frac{3E}{2m}\right)^{1/2}$ c) $u = \left(\frac{E}{2m}\right)^{1/2}$ d) $u = \left(\frac{E}{3m}\right)^{1/2}$

152. A fcc unit cell of aluminium contains the equivalent of how many atoms?
a) 1 b) 2 c) 3 d) 4

153. What is the temperature at which the kinetic energy of 0.3 mole of helium is equal to the kinetic energy of 0.4 mole of argon at 400 K?
a) 400 K b) 873 K c) 533 K d) 300 K

154. At lower temperatures, all gases except H_2 and He show
a) Negative deviation b) Positive deviation
c) Positive and negative deviation d) None of the above

: ANSWER KEY :

1)	d	2)	b	3)	d	4)	a	5)	c	6)	b	7)	d	8)	c
9)	c	10)	c	11)	a	12)	d	13)	d	14)	d	15)	b	16)	c
17)	b	18)	d	19)	a	20)	c	21)	a	22)	d	23)	a	24)	b
25)	c	26)	a	27)	c	28)	d	29)	a	30)	a	31)	d	32)	b
33)	c	34)	c	35)	c	36)	d	37)	a	38)	d	39)	b	40)	c
41)	a	42)	b	43)	c	44)	c	45)	d	46)	d	47)	a	48)	a
49)	a	50)	d	51)	c	52)	d	53)	c	54)	d	55)	b	56)	a
57)	c	58)	c	59)	b	60)	a	61)	d	62)	c	63)	b	64)	a
65)	d	66)	c	67)	b	68)	c	69)	d	70)	b	71)	c	72)	c
73)	b	74)	d	75)	a	76)	b	77)	c	78)	a	79)	a	80)	d
81)	d	82)	b	83)	d	84)	a	85)	a	86)	a	87)	c	88)	c
89)	d	90)	b	91)	d	92)	a	93)	c	94)	b	95)	d	96)	c
97)	a	98)	a	99)	d	100)	b	101)	a	102)	c	103)	a	104)	b
105)	a	106)	a	107)	b	108)	d	109)	d	110)	a	111)	a	112)	c
113)	a	114)	d	115)	b	116)	b	117)	d	118)	b	119)	a	120)	c
121)	c	122)	c	123)	b	124)	c	125)	b	126)	a	127)	c	128)	d
129)	b	130)	b	131)	a	132)	d	133)	d	134)	a	135)	c	136)	d
137)	d	138)	c	139)	c	140)	d	141)	a	142)	c	143)	b	144)	d
145)	c	146)	b	147)	a	148)	a	149)	b	150)	a	151)	a	152)	d
153)	c	154)	a											

: HINTS AND SOLUTIONS :

2 **(b)**

$$\frac{r_{\mathrm{H}}}{r_{\mathrm{He}}} = \sqrt{\frac{M_{He}}{M_H}}$$

$$= \sqrt{\frac{2}{1}}$$

$$\frac{r_{\mathrm{H}}}{r_{\mathrm{He}}} = 1.414$$

3 **(d)**

$C_p - C_v = R$ for each gas.

4 **(a)**

$P_m = P_1 + P_2 = 1 + 2.5 = 3.5$

5 **(c)**

Gram molecular weight (=1 mol) of any gas contains the volume = 22.4 L

6 **(b)**

Number of tetrahedral voids in the unit cell =2 × no. of atoms

$= 2Z$

8 **(c)**

Smaller size of H_2 molecule and mean free path $\propto \frac{1}{(\text{radius})^2}$

9 **(c)**

Ideal gas equation

$pV = nRT$

If $V = 1$ L

$$n = \frac{p}{RT}$$

10 **(c)**

$P \propto n(V, T$ constant)

11 **(a)**

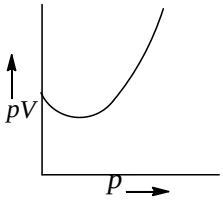
The rate of effusion of He and CH_4

$$\frac{r_{\mathrm{He}}}{r_{\mathrm{CH_4}}} = \sqrt{\frac{M_{\mathrm{CH_4}}}{M_{\mathrm{He}}}} = \sqrt{\frac{16}{4}} = 2:1$$

If 4 : 1 mixture of He and CH_4 contained in a vessel, then the composition of mixture of He and CH_4 effusing out initially is 8 : 1.

12 **(d)**

At very low pressure, Boyle's plot is represented as



13 **(d)**

$\frac{V_1}{T_1} = \frac{V_2}{T_2}; \frac{V}{273} = \frac{2V}{T_2};$

$\therefore T_2 = 546$ K

14 **(d)**

Both P and V increase due to increase in moles of air.

16 **(b)**

$$\frac{r_{He}}{r_{CH_4}} = \sqrt{\frac{M_{CH_4}}{M_{He}}} = \sqrt{\frac{16}{4}} = 2$$

17 **(b)**

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ and, then $(V_1 - V_2)$

18 **(d)**

The viral equation for gaseous state is $PV = \left(A + \frac{B}{V} + \cdots\right)$ at Boyle's temperature, gas shows ideal gas behaviour, $i.e., PV = RT$ which is possible only when $A = RT$ and $B = 0$.

19 **(a)**

Maximum deviations are noticed at low T and high P.

20 **(c)**

This is Avogadro's hypothesis.

21 **(a)**

Ideal gas equation is

$$Vp = nRT$$

When V and T are same,

$$p \propto n$$

Thus, when number of moles, $i.e., n$ is least, it will exert least pressure.

(a) $n = \frac{\text{wt.}}{\text{mol. wt.}} = \frac{0.0355}{33.5} = 1 \times 10^{-3}$ mol

(b) $n = \frac{0.071}{33.5} = 2 \times 10^{-3}$ mol

(c) $n = \frac{\text{number of molecules}}{N_A}$

$= \frac{6.023 \times 10^{21}}{6.023 \times 10^{23}} = 0.01$ mol

(d) $n = 0.02$ mol

Thus, 0.0335 g chlorine will exert the least pressure.

22 **(d)**

As the temperature rises, the kinetic energy of the molecules increases. Due to which the molecules can leave the liquid surface easily. In other words the vapour pressure increases. However, surface tension and viscosity decrease with rise in temperature. Molality is the ratio of moles of solute to weight of solvent, hence it does not depend upon the temperature.

23 **(a)**

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

24 **(b)**

Cu atoms are at eight corners of the cube. Therefore, the number of Cu atoms in the unit cell $= \frac{8}{8} = 1$

Ag atoms are at the face-centre of six faces. Therefore, its share in the unit cell $= \frac{6}{2} = 3$

Au atoms are at the body centre

$\therefore$ the number of Au atoms $= 1$

$\therefore$ The formula of the alloy is $CuAg_3Au$

25 **(c)**

$$P'_{\text{Argon}} = \frac{2}{2+3} \times P_M = \frac{2P_M}{5}$$

26 **(a)**

Both gases and liquids posses fluidity and hence, viscosity. Molecules in the solid state do not have translational motion

27 **(c)**

A gas is not escaped or injected, so, number of moles remain the same. When volume of gas is compressed to half, no change will occur in the vessel.

28 **(d)**

$a = P \times V^2 =$ atm litre^2 mol^{-2} = dyne cm^{4}mol^{-2} = Newton m^{4}mol^{-2} = atm dm^{6}mol^{-2}

29 **(a)**

The conditions for which NTP signifies.

30 **(a)**

Initially the product PV in compartments A and $B = 1 \times V + 1 \times V = 2V$ if volume of compartment is V. Now $PV =$ constant at constant temperature and if wall is removed, then V becomes $2V$, thus, pressure should be 1 atm to have PV constant.

31 **(d)**

These are the three factors on which van der Waals' forces depends.

32 **(b)**

In case of ($NH_3 + HCl + HBr$) mixture, the Dalton's law is not applicable

33 **(c)**

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

$$\frac{P_1}{P_2} = \frac{V_2}{V_1}$$

also, $V_2 = \left[V_1 - \frac{5V_1}{100}\right]$

Find P_2 and calculate percent change.

35 **(c)**

$$r = \frac{a}{2\sqrt{2}} = \frac{620}{2\sqrt{2}} = 219.25 \text{ pm}$$

36 **(d)**

$P_{\text{dry } O_2} + P_{\text{water vapour}} = P_{\text{wet } O_2}$

37 **(a)**

$P_1V_1 = \frac{w_1}{30}RT_1; (w_1 = 15)$

$P_2V_2 = \frac{w_2}{M}RT_2; (w_2 = 75)$

if $P_1 = P_2, V_1 = V_2, T_1 = T_2$ then $M = 150$ also; VD = M/2

38 **(d)**

Use $PV = nRT$; find n for A and B separately; Now again use $PV = nRT$ for mixture using $V =$ 2 litre

39 **(b)**

Zinc blende (ZnS) has fcc structure and is an ionic crystal having 4 : 4 coordination number

40 **(c)**

Gay-Lussac's were derived from the experiments facts.

42 **(b)**

$T_i = \dfrac{2a}{Rb}$

43 **(c)**

At constant P, V and $T, w \propto m$.

44 **(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 $= (n_A + n_B) \times RT$

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

$$p = 6.8$$

$\therefore$ Partial pressure of $A = p \times$ mole fraction of A

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

$$= 4.8 \text{ atm}$$

$\therefore$ Partial pressure of $B = p \times$ mole fraction of B

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

$$= 2 \text{ atm.}$$

45 **(d)**

For fcc arrangement,

$4r = \sqrt{2}a$

$a = \dfrac{4r}{\sqrt{2}}$

46 **(d)**

$$u_{\text{rms}} = \sqrt{\left[\frac{3RT}{M}\right]}$$

47 **(a)**

The dipoles in certain solids are spontaneously aligned in a particular direction, even in the absence of electric field. Such substances are called ferroelectric substances. Barium titanate ($BaTiO_3$) and potassium hydrogen phosphate (KH_2PO_4) are ferroelectric solids

48 **(a)**

Mole of $O_2 = \dfrac{16}{32}$; mole of $N_2 = \dfrac{14}{28}$

49 **(d)**

The value of ionic radius ratio is 0.52 which is between $0.414 - 0.732$, then the geometrical arrangement of ions in crystal is octahedral

50 **(d)**

Metallic crystals are good conductor of heat and current due to the presence of free electrons in them

51 **(c)**

At constant P, V and $T, w \propto m$.

52 **(d)**

CsCl has a bcc lattice. So, $d_{\text{body}} = a\sqrt{3}$

or $d_{\text{body}} = \sqrt{3} \times 0.4123 \text{ nm} = 0.7141 \text{ nm}$

The sum of the ionic radii of Cs^+ and Cl^- ions is half this distance *ie*

$r_{Cs^+} + r_{Cs^-} = \frac{d_{body}}{2} = \frac{0.7141}{2}$ nm

$= 0.3571$ nm

Ionic radius of $Cs^+ = 0.3571 - 0.181 = 0.1761$

53 **(c)**

Given, $\frac{p_2}{p_1} = 2, \frac{T_2}{T_1} = 2, V_1 = 4\ dm^3, V_2 = ?$

From gas equation

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

$or\ \frac{V_1}{V_2} = \frac{p_2}{p_1} \times T_1/T_2$

$\therefore\ \frac{4}{V_2} = 2 \times \frac{1}{2} = 1$

$\therefore\ V_2 = 4\ dm^3$

54 **(d)**

Follow Avogadro's hypothesis.

55 **(b)**

During evaporation, molecule having high energy leave the surface of liquid. As a result average kinetic energy of liquid decreases

$\because$ KE $\propto T$

$\therefore$ Temperature of liquid falls

56 **(a)**

$T_2 = T_1 + 1;\ \ P_2 = P_1 + \frac{0.4\ P_1}{100}$

Now use, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

assuming $V_1 = V_2$

57 **(c)**

$P'_{H_2O} = P_M \times \frac{1}{100} = 760 \times \frac{1}{100}$

$= 7.6$ mm of Hg

58 **(c)**

Closest approach in bcc lattice

$= \frac{1}{2}$ of body diagonal $= \frac{1}{2} \times \sqrt{3}a$

$= \frac{\sqrt{3}}{2} \times\ 4.3 = 3.72$ Å

59 **(b)**

Graham's law of diffusion of gases

$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} = \sqrt{\frac{d_2}{d_1}}$

61 **(d)**

Use $\frac{w_1}{w_2} = \sqrt{\left[\frac{M_1}{M_2}\right]}$

62 **(c)**

At constant temperature and pressure, the masses of two gases in a mixture are same, so

$M_{N_2} = M_{O_2}$

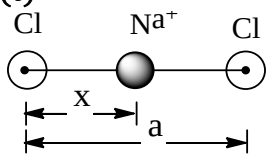
63 **(b)**

The conditions for triple point of H_2O.

65 **(d)**

$KE \propto T$

66 **(c)**



Or, $a = \frac{2d}{\sqrt{3}} = \frac{2 \times 4.52}{\sqrt{3}} = 5.219\text{Å} = 522 \text{ pm}$

$\therefore a = 2x$

67 **(b)**

Destiny, $d = \frac{Z\,M}{a^3 N_A}$

$= \frac{4(58.5)\text{g mol}^{-1}}{(5.628 \times 10^{-8}\text{cm})^3(6.023 \times 10^{23}\text{mol}^{-1})}$

$= 2.179 \text{ g cm}^{-3}$

68 **(c)**

Greatest deviation from ideal behaviour is exhibited by real gases at low temperature and high pressure.

From the given choices it is clear that choice (c) has lowest temperature and highest pressure.

70 **(b)**

KE= $\frac{3}{2}\,kT$

Where, k is constant.

KE $\propto T$

Here the temperature is same. Hence, for 1 g of H_2 and 1 g of CH_4 which are taken in two vessels, of 1 L each at same temperature, the kinetic energy per mole will be the same.

71 **(c)**

According to Clausis-Clapeyron, if a graph is plotted between $\log p$ and $\frac{1}{T}$, a straight line is obtained with negative slope.

72 **(c)**

$p(H_2) = \frac{1400 \times 68.5}{100}\text{torr}$

$= 959 \text{ torr} = 959/760 \text{ atm}$

$= 1.26 \text{ atm}$

According to Henry's law,

amount of gas absorbed is directly proportional to pressure

Hence, $\frac{V}{18 \text{ mL}} = \frac{1.26 \text{ atm}}{1 \text{ atm}}$

$V = 23 \text{ mL}$

73 **(b)**

Dalton's law of partial pressure is not applicable to gases which react chemically and produce different number of moles of products than the reactants. Some gases which do not obey this law are

$SO_2 + Cl_2, CO + Cl_2, NO + O_2, NH_3 + HCl$ and $H_2 + Cl_2$

74 **(d)**

$pV = nRT$ (Ideal gas equation)

or $V = \frac{nRT}{p}$

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

$\frac{V_1}{V_2} = \frac{273 + 15}{273 + 25} \times \frac{1}{1.5}$

$\frac{V_1}{V_2} = \frac{288}{298} \times \frac{1}{1.5}$

or $\frac{V_1}{V_2} = \frac{1}{1.55}$

or $\frac{V_2}{V_1} = 1.55$

75 **(a)**

According to Boyle's law

$pV =$ constant

The plot of pV against p is straight line parallel to x- axis

$\therefore$ Slope is zero.

76 **(b)**

One gram mole of a gas at NTP occupies 22.4 L as volume. This fact was derived from Avogadro's hypothesis

77 **(c)**

According to Boyle's law $V = \frac{K}{P}$

78 **(a)**

Frenkel's defect is due to shift of an ion from the normal lattice site (creating a vacancy) and occupy interstitial spaces

79 **(a)**

Lowering of temperature decreases kinetic energy and increase of pressure increases forces of attractions.

81 **(d)**

CO reacts with red colouring haemoglobin molecules in blood to form a complex of cherry red colour.

82 **(b)**

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

84 **(a)**

Both CO_2 and N_2O have same mol. wt.

85 **(a)**

$(T_f)_{\text{irrev}} > (T_f)_{\text{rev}}$

86 **(a)**

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

87 **(c)**

Kinetic energy depends on temperature only.

88 **(c)**

$\frac{u_{H_2}}{u_{O_2}} = \sqrt{\left[\frac{M_{O_2}}{M_{H_2}}\right]}$ if T is constant.

89 **(d)**

$$u_{\text{rms}} = \sqrt{\frac{2^2 + 3^2 + 4^2 + 5^2}{4}} = \frac{\sqrt{54}}{2}\text{cm/s}$$

90 **(b)**

$V_1/V_2 = T_1/T_2$

91 **(d)**

When radius ratio between 0.732 – 1.000, then coordination number is 8 and the structural arrangement is body centred cubic

92 **(a)**

Average speed of gas molecules

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

Most probable speed of gas molecules

$$= \sqrt{\frac{2RT}{M}}$$

$$\therefore v_{\text{av}} : v_{\text{mp}} = \sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{2RT}{M}}$$

$$= \sqrt{\frac{8}{\pi}} : \sqrt{2}$$

$$= 1.128 : 1$$

94 **(b)**

$$V_{\text{rms}} = V_{\text{mps}}$$

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

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

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

95 **(d)**

Edge length of the unit cell $= 2\ \text{Å} = 2 \times 10^{-8}\text{cm}$

Volume of the unit cell $= (2 \times 10^{-8})^3\ \text{cm}^3$

$= 8 \times 10^{-24}\ \text{cm}^3$

Mass of unit cell = volume × density

$= 8 \times 10^{-24} \times 2.5\ \text{g}$

No. of unit cells in 200 g of the metal

$$= \frac{\text{mass of metal}}{\text{mass of unit cell}} = \frac{200}{8 \times 10^{-24} \times 2.5}$$

$= 1 \times 10^{25}$

96 **(c)**

CH_3OCH_3 lacks H-bonding hence, it is most volatile, so it has maximum vapour pressure

97 **(a)**

$$\frac{r_1}{r_2} = \sqrt{\left[\frac{M_2}{M_1}\right]}$$

98 **(a)**

Radius of Na(if bcc lattice)$= \frac{\sqrt{3}a}{4} = \frac{\sqrt{3} \times 4.29}{4}$ Å

99 **(d)**

Mass of the gas is not known.

101 **(a)**

As constant volume, pressure of the gases increases on increasing temperature due to increase in average molecular speed

102 **(c)**

$$\frac{(v_{av})_1}{(v_{av})_2} = \sqrt{\frac{T_1}{T_2}}$$

Given, $T_1 = 150 + 273 = 423$ K

$T_2 = 50 + 273 = 323$ K

$$\therefore \frac{(v_{av})_1}{(v_{av})_2} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{423}{323}} = \frac{1.14}{1}$$

103 **(a)**

According to Graham's law of diffusion

Rate of diffusion $(r) \propto \frac{1}{\sqrt{d}}$

Molecular weight $(M) = 2 \times$ vapour density

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

$$M_A = \left(\frac{100}{2}\right) \text{ kg/molecule}$$

$$M_B = \left(\frac{64}{2}\right) \text{ kg/molecule}$$

$r_A = 12 \times 10^{-3}$ and $r_B = ?$

$$\frac{r_A}{r_B} = \sqrt{\frac{d_B}{d_A}} = \sqrt{\frac{M_B}{M_A}}$$

$$\frac{12 \times 10^{-3}}{r_B} = \sqrt{\frac{64/2}{100/2}} = \sqrt{\frac{64}{100}} = \frac{8}{10}$$

$$r_B = \frac{12 \times 10^{-3} \times 10}{8}$$

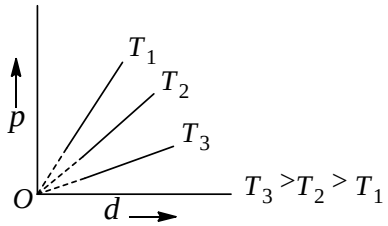
$$= 15 \times 10^{-3}$$

105 **(a)**

Find mol. wt. of gas by $u_{rms} = \sqrt{\frac{3RT}{M}}$ and notice the gas.

106 **(a)**

At constant temperature, density of a gas is directly proportional to its pressure and inversely proportional to its volume



107 **(b)**

At A → temperature $= T$, volume $= V$, pressure $= p_1$

At C → temperature $= 2T$ volume $= 2V$, pressure $= p_2$

$$\frac{p_1 V}{T} = \frac{p_2 \times 2V}{2T}$$

$p_1 = p_2$, *ie*, system is isobaric

108 **(d)**

Rate of diffusion is inversely proportional to the molecular weight

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

So, the order of rate of diffusion is

$CO_2 > SO_2 > SO_3 > PCl_3$

109 **(d)**

According to Trouton's rule,

$$\frac{\Delta H_{vap}}{T_b} = 21 \text{ cal K}^{-1} \text{ mol}^{-1}$$

110 **(a)**

According to Graham's law

$$\frac{r_{O_2}}{r_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}}$$

$$= \sqrt{\frac{2}{32}}$$

$$= \frac{1}{4}$$

$\therefore r_{O_2} : r_{H_2} = 1 : 4$

111 **(a)**

Kinetic gas equation, for one mole gas is

$$pV = \frac{1}{3} Mu^2$$

Where, $p =$ pressure of gas

$V =$ volume of gas

$M =$ molecular mass of gas

$u =$ root mean square velocity

$$\Rightarrow \frac{Mu^2}{3} = pV$$

or $u = \sqrt{\frac{3pV}{M}}$

or $u = \sqrt{\frac{3p}{d}}$

If pressure is constant, then

$$u \propto \sqrt{\frac{1}{d}}$$

112 **(c)**

Volume of molecules in one mole

$$= 4 \times N \times V = 4 \times N \times \frac{4}{3}\pi r^3$$

$$= 4 \times 6.023 \times 10^{23} \times \frac{4}{3} \times \frac{22}{7} \times (10^{-8})^3$$

$$= 10.09 \text{ mL}$$

114 **(d)**

Fe_3O_4 is a non-stoichiometric compound because in it, the ratio of the cations to the anions becomes different from that indicated by the chemical formula

115 **(b)**

$$P = \frac{nRT}{V} = \frac{2 \times 0.0821 \times 540}{44.8} = 2 \text{ atm}$$

116 **(b)**

The volume of a molecule in motion is four times the actual volume of a molecule in rest

$b = 4Vm$

117 **(d)**

From ideal gas equation,

$pV = nRT$

Since, p, V and T are same for both O_2 and H_2, therefore their number of moles(n) are also equal.

Hence, number of molecules will be equal for O_2 and H_2.

118 **(b)**

58.5 g NaCl =1 mol = 6.023×10^{23} NaCl units

One unit cell contains 4 NaCl units

Hence, number of unit cell present

$$= \frac{6.023 \times 10^{23}}{4} = 1.5 \times 10^{23}$$

119 **(a)**

$$\frac{r_1}{r_2} = \sqrt{\left[\frac{M_2}{M_1}\right]} = \sqrt{\frac{2}{32}} = \frac{1}{4}$$

120 **(c)**

Deviation are maximum under high P and low T.

121 **(c)**

According to Boyle's law,

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

Hence, in order to increase the volume of a gas by 10%, the pressure of the gas should be decreased by 10%.

122 **(c)**

$$pV = \frac{w}{M}RT$$

$$M = \frac{wRT}{pV}$$

$$= \frac{0.455 \times 0.0821 \times 300 \times 760 \times 1000}{800 \times 380}$$

$= 28.0$ g

123 **(b)**

Water boils at higher temperature inside the pressure cooker because pressure is high in the pressure cooker and therefore, cooling becomes fast.

124 **(c)**

For a gas,

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ $\left(\text{where}, T_2 = 2T_1, p_2 = \frac{1}{2}p_1, V_2 = ?\right)$

$\frac{p_1V_1}{T_1} = \frac{1}{2}\frac{p_1 \times V_2}{2T_1}$

$V_1 = \frac{V_2}{4}$

$V_2 = 4V_1$

125 **(b)**

$PV =$ constant; on differentiating.

$$PdV + VdP = 0$$

or $$\frac{dP}{dV} = -\frac{P}{V} = -\frac{K}{V^2} \qquad (\because PV = K)$$

126 **(a)**

1 mole $CO_2 = N$ molecule $CO_2 = N$ atoms of $C = 2\,N$ atoms of O.

127 **(c)**

At constant pressure

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

$\therefore \frac{10}{273} = \frac{V}{373}$

$\therefore V = 13.66$ litre

129 **(b)**

$u_{\text{rms}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3R \times 140}{M}}$ at 140 K

$u'_{\text{rms}} = \sqrt{\frac{3R \times 560}{M}}$ at 560 K

$\therefore u'_{\text{rms}} = 2 \times u_{\text{rms}}$

130 **(b)**

Due to H-bonding.

131 **(a)**

The van der Waals' equation for n moles of a gas is

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

For one mole $(n = 1)$

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

132 **(d)**

$\frac{u_1}{u_2} = \sqrt{\frac{m_2}{m_1} \times \frac{T_1}{T_2}}$

$\because\ T_1 = T_2$

So, $\frac{u_1^2}{u_2^2} = \frac{m_2}{m_1}$ or $u_1^2 m_1 = u_2^2 m_2$

134 **(a)**

The correct order of pressure is $p_1 > p_3 > p_2$

135 **(c)**

$$H_2 \quad \rightleftharpoons \quad SO_2$$

Initial 0.5 mol 0.5 mol

After a period of time H_2 being lighter, effuse faster and hence, in larger amount. Thus, it will remain less than SO_2

136 **(d)**

For bcc lattice, the coordination number is 8

137 **(d)**

CsCl has body centred arrangement, thus,

Interionic distance, $d = \frac{\sqrt{3a}}{2}$

138 **(c)**

In van der Waals' equation

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

Where, $p =$ pressure, $V =$ volume

$T =$ temperature, $n =$ moles of the gas

and parameter a accounts for intermolecular interactions present in the molecule.

139 **(c)**

Schottky defect is due to missing of equal number of cations and anions

140 **(d)**

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

$\frac{V_1}{300} = \frac{V_2}{500}, V_2 = 1.66$ V

Volume escape= $1.66\ V - V = 0.66$ V

$= 66\%$

141 **(a)**

Mole of water evaporated $= \frac{4.5 \times 10^3}{18}$;

Now, calculate volume of vapours assuming 1 mole occupies 22.4 litre $= 22.4 \times 10^{-3}\text{m}^3$

142 **(c)**

Gas equation is valid for isothermal and adiabatic conditions both.

143 **(b)**

At critical point, the meniscus between the liquid and vapour disappears, thus the surface tension of liquid becomes zero.

144 **(d)**

Heating effect is noticed on subjecting a gas for Joule-Thomson effect above its inversion temperature.

145 **(c)**

In metal excess defect when holes created by missing of anions are occupied by electrons, there sites are called F-centres and are responsible for colour in the crystal

147 **(a)**

Distance between K^+ and F^- $= \frac{1}{2} \times$ length of the edge

148 **(a)**

$1 \text{ cal} = 4.18 \text{ J} = 4.18 \times 10^7 \text{erg} = \dfrac{4.18 \times 10^7}{1.602 \times 10^{-19}} \text{eV}$

149 **(b)**

Work done = surface tension × increase in area

$= 73 \text{ dyne cm}^{-1} \times 0.10 \text{ m}^2$

$= 73 \text{ dyne cm}^{-1} \times 0.10 \times 10^4 \text{ cm}^2$

$= 7.3 \times 10^4$ ergs

150 **(a)**

Find mol. wt. of oxide as,

$M = \frac{0.44 \times 22400}{224} = 44$ and notice the gas.

151 **(a)**

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

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

For a molecule $n = 1$

$$pV = kT$$

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

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

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

152 **(d)**

$\frac{1}{8} \times$ 8 (at corners)= 1

$\frac{1}{2} \times$ 6(at face center)= 3

$Z = 1 + 3 = 4$ (total number of atoms)

153 **(c)**

Number of moles of helium = 0.3

Number of moles of argon = 0.4

We know that KE $= nRT$

KE of helium $= 0.3 \times R \times T$ ... (i)

KE of argon $= 0.4 \times R \times 400$ ... (ii)

According to question

KE of helium = KE of argon

$0.3 \times R \times T = 0.4 \times R \times 400$

$$T = 533 \text{ K}$$

Assertion - Reasoning Type

This section contain(s) 16 questions numbered 1 to 16. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1
b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1
c) Statement 1 is True, Statement 2 is False
d) Statement 1 is False, Statement 2 is True

1 **Statement 1:** The compressibility factor less than one is due to the van der Waals' constant $'a'$ of a real gas
Statement 2: The compressibility factor less than one is due to excluded volume of the gas

2 **Statement 1:** Compressibility factor z for non ideal gases is always greater than .
Statement 2: Non ideal gases always exert higher pressure than 1.

3 **Statement 1:** $\frac{n^2a}{V^2}$ in van der Waals' equation is a measure of the inter molecular forces
Statement 2: Easily condensable gases have comparatively higher values of the van der Waals' parameter 'a'

4 **Statement 1:** CO_2 above 31.1 °C and 600 bar pressure is used to remove caffeine from coffee beans.
Statement 2: CO_2 is gaseous in nature.

5 **Statement 1:** When the temperature is raised, the viscosity of the liquid decreases
Statement 2: Increase in temperature increases the average kinetic energy of molecule which overcome the attractive force between them

6 **Statement 1:** The hot air balloons in sports and for meteological observations is an application Charles law.
Statement 2: Hot air is less dense and hence gases expand on heating.

7 **Statement 1:** Doping of silicon with P or Al increases the conductivity
Statement 2: P gives rise to holes while Al gives rise to extra electrons

8 **Statement 1:** Crystalline solids are anisotropic
Statement 2: Crystalline solids are not as closely packed as amorphous solids

9 **Statement 1:** In the Schottky defect equal number of extra cations and electrons are present in the interstitial sites
Statement 2: In schottky defect equal number of cations and anions are missing

10 **Statement 1:** Greater the value of van der Waal's constant 'a' greater is the liquefication of gas.
Statement 2: 'a' indirectly measures the magnitude of attractive forces between the molecules.

11 **Statement 1:** H_2 and He show same ideal gas behaviour
Statement 2: All real gases deviate from ideal gas behaviour at low temperature and high pressure

12 **Statement 1:** At 300K, kinetic energy of 16 g of methane is equal to the kinetic energy of 32 g of oxygen.
Statement 2: At constant temperature, kinetic energy of one mole of all gases is equal.

13 **Statement 1:** The solid NaCl is a bad conductor of electricity
Statement 2: In solid NaCl there is no velocity of ions

14 **Statement 1:** The conductivity of semiconductor increases with increase in temperature
Statement 2: The ionic solids conduct electricity due to presence of ions

15 **Statement 1:** In van der Waals' equation of gases, the kinetic equation of gas is modified
Statement 2: This modification is carried out with respect to actual volume of molecules and attractive forces between the gaseous molecules

16 **Statement 1:** $\frac{1}{4}$Of the gas is expelled if air present in an open vessel is heated from 27°C to 127°C.
Statement 2: Rate of diffusion of a gas is inversely proportional to the square root of its molecular mass.

: ANSWER KEY :

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

: HINTS AND SOLUTIONS :

1 **(c)**

In van der Waals' equation of state

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

If we neglect b

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

that is $Z < 1$

It we neglect a

$Z = 1 + \frac{pb}{RT}$

that is $Z > 1$

2 **(d)**

Z is greater than 1 or less than 1. Non ideal gases exert less pressure than expected due to backward pull by other molecules.

3 **(b)**

'a' measures intermolecular forces. The distance between molecules of an easily condensable gas will least

4 **(b)**

CO_2 above 31.1°C and 600 bar pressure acts is super critical fluid, which dissolves many organic substances (alkaloids-caffeine) and hence used for separation of mixture.

5 **(a)**

With increase in temperature, viscosity of liquid decreases as the average kinetic energy of the molecules increases

6 **(a)**

According to Charles' law; $V \propto T$

So, hot air is less dense.

7 **(c)**

Doping of Si with P gives extra electrons while doping with Al gives rise to holes

8 **(a)**

Crystalline solids possess the properties of rigidity. They are anisotropic and undergo a clean cleavage. The constituent particles are arranged in a definite and orderly pattern through the entire three dimensional space

9 **(d)**

In schottky defect equal number of cations and anions are missing

10 **(a)**

Considering the attractive force, pressure in ideal gas equation ($pV = nRT$) is corrected by introducing a factor of $\frac{an^2}{V^2}$ where 'a' is van der Waals' constant.

11 **(b)**

Hydrogen and helium have weak van der Waals' forces of attraction. The intermolecular forces of attraction increases and volume occupied by gas molecules becomes appreciable and can't be neglected

12 **(a)**

Kinetic energy for one mole gas is given by equation,

$E = \frac{3}{2}\,kT$ (where, k = Boltzmann's constat)

$\therefore\ E \propto T$

Thus, at constant temperature kinetic energy of one mole of any gas is equal.

13 **(a)**

Solid NaCl is a bad conductor of electricity because ions are not free to move

14 **(c)**

Ionic solids conduct electricity not due to presence of ions but due to presence of defects

15 **(a)**

In the van der Waals' equation. 'a' refers to the attractive forces between the molecules and 'b' is the volume correction

16 **(b)**

$\frac{V_1}{V_2} = \frac{T_1}{T_2}$ or $\frac{V_1}{V_2} = \frac{300}{400} = \frac{3}{4}$

So, air expelled $= 1 - \frac{3}{4} = \frac{1}{4}$

According to Graham's law of diffusion $r \propto \frac{1}{\sqrt{M}}$