Chapter –II

Gaseous State

Contents:

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Postulates of kinetic theory of gases

Kinetic theory of gases considers the atoms or molecules of a gas as a constantly moving point masses, with huge inter-particle distance and may undergo perfectly elastic collisions.
Implications of these assumptions are –

i) Particles

Gas is a collection of a large number of atoms or molecules.

ii) Point Masses

Atoms or molecules making up the gas are very small particles like a point (dot) on a paper with a small mass.

iii) Negligible Volume Particles

Particles are generally far apart such that their inter-particle distance is much larger than the particle size and there is large free unoccupied space in the container. Compared to the volume of the container, the volume of the particle is negligible (zero volume).

iv) Nil Force of Interaction

Particles are independent. They do not have any (attractive or repulsive) interactions among them.

v) Particles in Motion

The particles are always in constant motion. Because of lack of interactions and the free space available, the particles randomly move in all directions but in a straight line.

vi) Volume of Gas

Because of motion, gas particles, occupy the total volume of the container whether it is small or big and hence the volume of the container to be treated as the volume of the gases.

vi) Mean Free Path

This is the average distance a particle travels to meet another particle.

vii) Kinetic Energy of the Particle

Since the particles are always in motion, they have average kinetic energy proportional to the temperature of the gas.

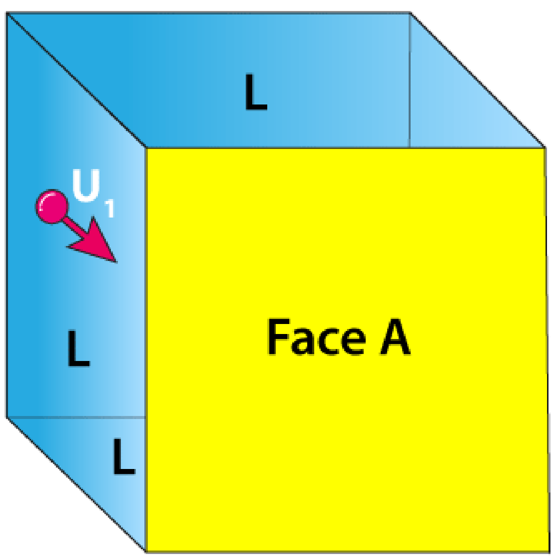
viii) Constancy of Energy / Momentum

Moving particles may collide with other particle or container. But the collisions are perfectly elastic. Collisions do not change the energy or momentum of the particle.

ix) Pressure of Gas

Collision of the particles on the walls of the container exerts a force on the walls of the container. Force per unit area is the pressure. The pressure of the gas is thus proportional to the number of particles colliding (frequency of collisions) in unit time per unit area on the wall of the container.

Kinetic gas equation:-



Kinetic gas equation

Let us consider an ideal gas contained in a cubical container of length ***'l '*** filled with gas molecules each having mass ***'m'*** and let ***'N'*** be the total number of gas molecules in the container. Due to the influence of temperature, the gas molecules move in random directions with a velocity '**V'**

If there are 'N' molecules each having mass 'm' ,the total mass (m) of the container will be,

M= m x N

The pressure of the gas molecules is the force exerted by the gas molecule per unit area of the wall of the container and is given by the equation,

P=F/A

Let us consider a gas molecule moving in the X-direction towards face 'A. '

The molecule hits the wall with a velocity V_x and rebounds back with the same velocity V_x,

The **momentum** of the molecule before it strikes surface,

p= m.V_x

the momentum after impact/collision = **m (-V_x)**

and thus experience a **change of momentum** due to one impact which is equal to

$\Delta p = - mV_x-(-mV_x)$

Therefore $\Delta p = -2mV_X$

By the law of **conversation of momentum** the momentum transferred by the molecule A_1 to the wall will be,

(**Law of conservation of momentum:** It states that the total momentum of an isolated system remains the same. The momentum which means motion remains unchanged in an isolated collection of objects. Momentum is the product of the mass of the object and the velocity at which it is travelling and is also equal to the total force required to bring the object to rest.)

$\Delta p = +2mV_X$ ---------------------------------(1)

For a total of 'N' number of gas molecules in the container, all such **change in momentum** is given by,

Δp= -2NmVx --- (2)

After the collision, the molecule travels a distance of '2*l'* before colliding again with wall '1'. Thus, the time taken is given by,

$$\text{Time} = \frac{\text{Distance travelled}}{Velocity}$$

Time = 2l/ Vx-----------------------------------(3)

These continuous collisions carry a force, given by

$$F = \frac{\text{Change in momenum } (\Delta\text{p})}{change\ in\ time\ \ (\Delta t)} \text{ -- } (4)$$

Therefore, substituting the values from equation (3) and (4), we get

$$F = \frac{-2\text{NmVx}}{2l/\ Vx} \text{ ------------------------------------- } (5)$$

$$Force\ exerted\ by\ 'n'\ number\ of\ molecules\ \ 'F' = \frac{-\text{NmV}^2\text{x}}{l} \text{ ----------------}(6)$$

$$'F'wall = \frac{\text{NmV}^2\text{x}}{l} \text{ ----------------}(7)$$

But pressure is the force per unit area.

Pressure 'P'$= \frac{\text{Force on wall (F)}}{Area\ (A)}$

$$\text{Pressure}'\text{P}' = \frac{2\text{NmV}^2\text{x/l}}{l^2} \text{ -------------------------}(8)$$

Hence PV= NmV^2x -------------------------(9)

Since V_x, V_y and V_Z are independent speed in three directions and if we consider the gas molecules in bulk, then

$V^2x=V^2y=V^3z$

Hence,

$V^2=3V^2x$

Substituting the above condition in eq (9), we get,

$$PV = \frac{\text{NmV}^2}{3}$$

Therefore,

$$\mathbf{PV} = \frac{1}{3}\ mNV^2$$

This equation above is known as the kinetic theory equation.

Important Laws:

At constant T and n; V α 1/p Boyle's Law

At constant p and n; V α T Charles' Law

At constant p and T ; V α n Avogadro Law

Deduction of gas laws:

A) Boyle's law:-Boyle's law states the relation between volume and pressure at constant temperature and mass, **it states that under a constant temperature when the pressure on a gas increases its volume decreases**. In other words according to Boyle's law **volume is inversely proportional to pressure when the temperature and the number of molecules are constant.**

V α 1/P at constant temp.

The K.E.of 'N' molecules are equal to 1/2 mnu^2.

We know that kinetic gas postulates K.E. is directly proportional to the temp.

Therefore, 1/2 mnu^2 α T

1/2 mnu^2 = KT--------- (1) where 'K' is proportionality constant.

We know the Kinetic gas equation PV= $\frac{1}{3}mNu^2$ if we put the value of K.E.u^2 in this equation and rewriting kinetic gas equation we get, PV= 2/3 .(1/2) mNu^2

Putting the value of 1/2 mnu^2 from equation 1. We get,

PV= 2/3 K T-------(2) Therefore PV= constant, which is representation of Boyles law.

B) Charles law:- According to Charles law Volume is directly proportional to the temperature of gas **Vα T**

Alternatively, at constant volume, pressure is directly proportional to temperature.

P α T (at constant V)

Rearranging equation (2) we get, PV= 2/3 KT

Therefore V= 2/3 K/P.T

at constant pressure, V=K'T----------------(3) where K'=2/3 K/P

Therefore, **Vα T which is the representation of Charles law.**

C) Avogadro's hypothesis: - According to Avogadro's "equal volumes of gases at the same temperature and pressure contain the same number of molecules".

Let us consider two different gases. The kinetic gas equation can be written as,

$P_1V_1 = 1/3m_1n_1u_1^2$……..(4)

and $P_2V_2 = 1/3m_2n_2u_2^2$ --------------(5) at constant temp. $P_1V_1 = P_2V_2$

Therefore, $1/3\ m_1n_1u_1^2 = 1/3m_2n_2u_2^2$ ----------(6)

If these two gases are at same temp., the kinetic energies of the molecules will be the same, that is, $1/3\ m_1u_1^2 = 1/3\ m_2u_2^2$ --------------(7) ,

Substituting in equation (6) we get; $\mathbf{n_1 = n_2}$ **Hence Avogadro's law has been deduced.**

D) Grahams Law of diffusion:- According to Graham's " at constant temperature and pressure the rates of diffusion of various gases are inversely proportional to the square roots of their densities or molecular weights"

R (Rate of diffusion) $\boldsymbol{\alpha} \frac{1}{\sqrt{d}}$ or $\frac{\sqrt{u_1}}{\sqrt{u_2}} = \frac{\sqrt{\rho_2}}{\sqrt{\rho_1}} = \frac{\sqrt{m_2}}{\sqrt{m_1}}$

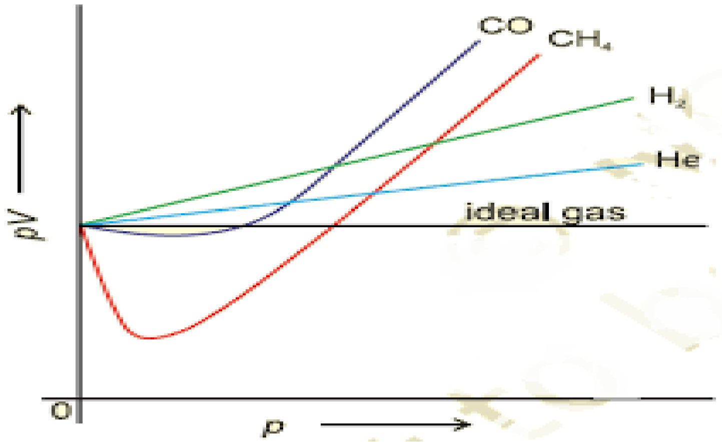
Consider equation (6)……. $1/3\ m_1n_1u_1^2 = 1/3m_2n_2u_2^2$

$u_1^2/u_2^2 = n_2m_2/n_1m_1$ if $n_1 = n_2 = N$ then, $u_1^2/u_2^2 = Nm_2/Nm_1 = M_2/M_1$

but $M_1/V = d_1$ and $M_2/V = d_2$ therefore , $\mathbf{u_1^2/u_2^2 = d_1/d_2}$ ---------(8)

Deviation from ideal behavior: - Ideal gas obeys the gas laws for all values of pressure and temp.,in reality, all gases obey the gas laws only over a range of pressure and temp. And not for all values of pressure and temp., hence real gases can be described in terms of the deviations from the gas laws.

Deviations from Boyle's law: - If we plot 'PV' against 'P', for an ideal gas should be straight line parallel to the X axis .This indicates that for an ideal gas PV should remain constant at constant temp. For real gas, such a straight line will not obtain. Gases like hydrogen, nitrogen shows positive deviations, for these gases product PV increases with increase in pressure. Some gases like methane and carbon dioxide show product PV is found to be decreases. Small deviations from the Boyles law are observed only to low pressures.



Deviations from Charles law: - for a given amount of gas at constant pressure the volume of a gas increases or decreases by 1/273 times its volume at 0^{o}C, for every degree rise of fall in temperature.1/273 or 0.003661 is the temp. Coefficient of the gas. This remains same for all gases for all range of pressure and temp.

Reasons for the deviations from ideal behavior:- There are two main faulty assumptions, these postulates are,

1) The volume of gas molecules that is the actual volume occupied by the gas molecules is negligible in comparison with the volume available to them that is the volume of the container.
2) Therefore the actual volume of gas = volume of container – Volume of the molecules
3) Molecules of the gas don't exert any force of attraction over one another. In reality molecules of real gases exerts force of attractions with each other, as distance between two molecules increases force of attraction increases. Hence deviations from the ideal behavior are expected at high pressure.
4) K.E. of molecules increases, some of K.E.is used to overcome the intermolecular force, hence the gas behaves ideally, but as temp.is lowered, the average K.E. of gas molecule will decreased.it may not be sufficient to overcome the force of attraction. Hence, a deviation from ideality may be observed.

Van-der Waals equation of state: - it is an equation which shows relation between all the variables at the given state is called equation of state. For gases state 'P', 'V' 'T' and 'n' are variables that defines the states. PV= n RT is also an equation of state, but this is not obeyed by real gases for all the values of pressure, volume and temperature .hence some parameters has to be taken into account to explain the behavior of real gas. The Vander waals equation of state is,

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

There are two faulty assumptions of kinetic theory of gases these are,

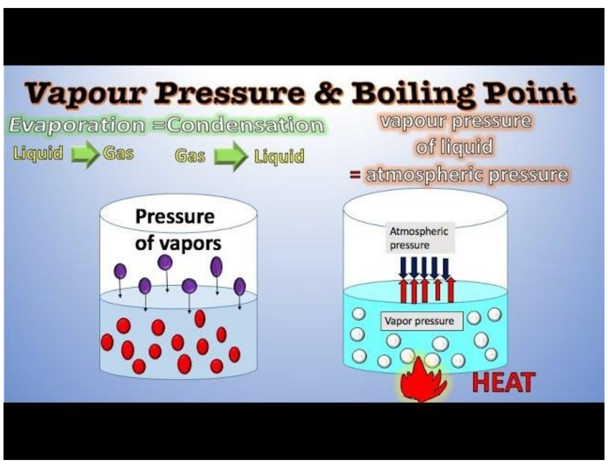
A) the volume of gas molecules is negligible in comparison with volume occupied by them.

B) No intermolecular force of attraction is present in the gaseous state. Van- der Waals provided an equation of state that will be obeyed by all real gases, at all values of pressure and temperature.

Critical Phenomenon: PV isotherms of real gases:-

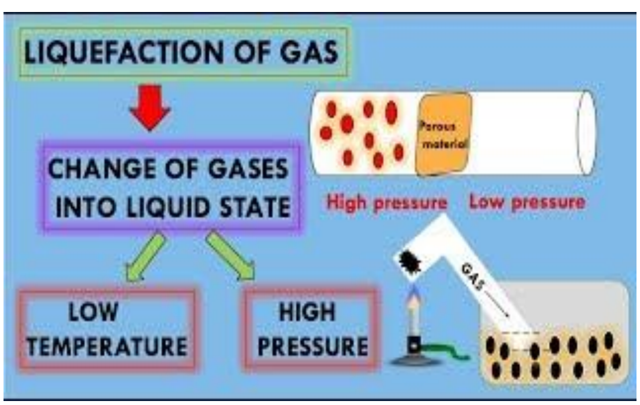
Critical phenomena:-

Boiling Point:-



When a liquid is heated in an open vessel, the vapor pressure of liquid increases. At its boiling point, vapor pressure becomes equal to atmospheric pressure, and then liquid boils, that temp.is called as boiling point.

Liquification:-



Liquification will be done by,

1) On decreasing the temperature of the gas.

2) Secondly by increasing the pressure of the gas.

- The essential condition for the liquefaction of the gas is **described by the study of critical temperature, critical pressure and critical volume and their inter relationships**.
- When a gaseous system is transformed to its liquid state, there is a tremendous decrease in the volume.
- The ideal gas law assumes that a gas is composed of randomly moving, non-interacting point particles. This law sufficiently approximates gas behavior in many calculations; real gases shows complex behavior that deviate from the ideal model., however as shown by graph (isotherms refers to the different curve so he graphs, which represent a gas state at different pressure and volume conditions but at constant temperature.
- Iso- means same and thermo means temperature –hence isotherm.

- **PV isotherms of real gases:-**
- Critical phenomenon can be studied from PV curve, curve expected to be hyperbola. The isotherms obtained at 40 atm. and above 40 atm. temperatures are hyperbolas.
- At low temp. Isotherms show inflection (change).e.g. at temp.31.04 deg. isotherm shows a point of inflection (point '**P**'in fig.1 or point **E** in fig.2).The isotherm at temp.13 deg. and 21.5 deg. Shows horizontal portion which represents no change of pressure for a large change in volume.
- As temp.is increased, the flat portion of the isotherm is found to decrease in length until it converges into a single point at point 31.10 deg.
- But when liquid is heated in a sealed tube, initially liquid and vapor will be in equilibrium.
- On raising temp. more and more amount of the liquid will vaporize, hence, pressure inside tube increases.
- At every stage there is a line of demarcation (boundary) between the liquid and vapor phase.
- **Critical Temp. Or Critical point:** At a particular temp. the liquid meniscus will disappear i.e. the line of separation between the two phases disappears and physical

properties of the liquid and the gas become identical. This temp.is called critical temp. and the liquid is said to be at the critical point.('P'or'E')

- On heating the tube further, no trace of the liquid can be found.
- The total mass remains in the gaseous state even on increasing the pressure externally. Hence, it can be concluded that no liquid can exit at a temp. Greater than its critical temp.

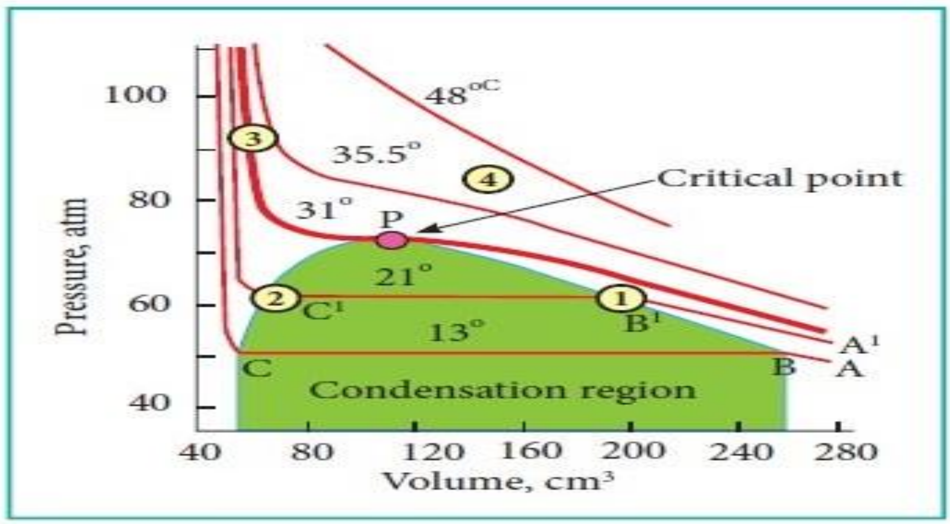
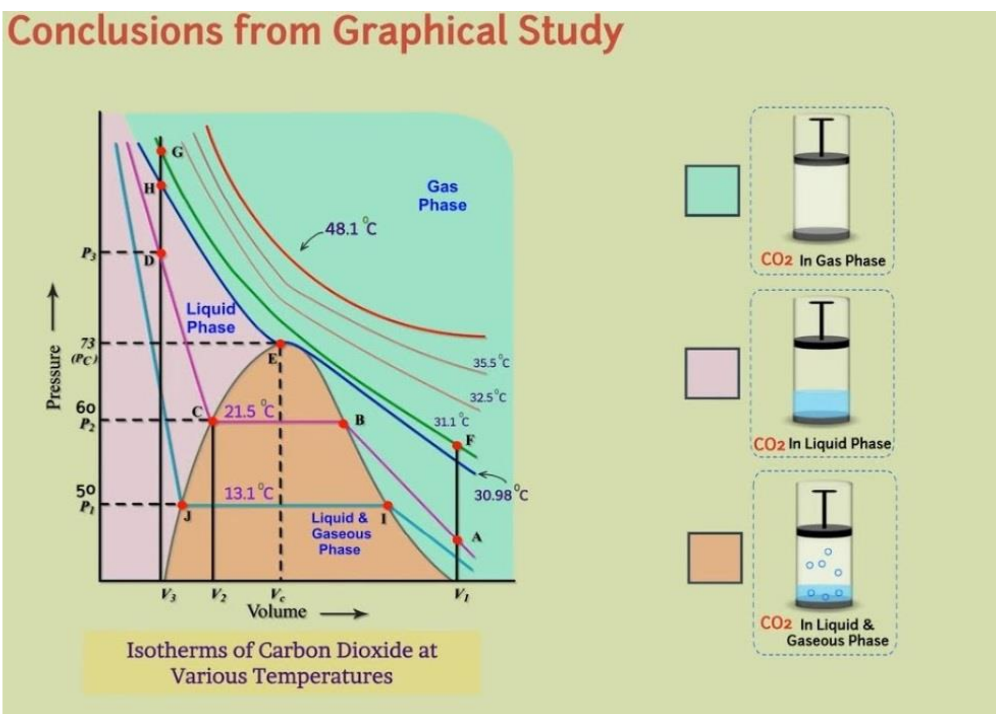


Figure. Isotherms of Carbon dioxide at different tempeartures



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Department of Chemistry

Question Bank

Class: B.Sc. Semester –II

Name of Paper: Physical Chemistry (Paper –IV) CHE-204

Title of Chapter: Gaseous State.

Questions:

1. What are the fundamentals of Kinetic theory of gases?

2. Derive the expression for gas equation from kinetic consideration.

3. Deduce Charles's law, Boyle's law and Graham's law from kinetic equation.

4. Explain Critical Phenomenon and PV isotherms of real gases

5. Discuss reasons for the deviations from idea behavior.

6. Define mean free path

7. State the gas laws and explain the type of deviations produced by real gases.

8. Which factor is mainly responsible for real gases to show deviation from ideal gases?

Ans: Intermolecular force of attraction between the molecules of real gas molecules is mainly responsible for the deviation from the ideal behavior.

2. How does the kinetic energy varies with temperature?

Ans: Kinetic energy increases linearly with increase in temperature and this direct proportionality can be given by the following relation $\varepsilon = 3/2\ (kT)$ where 'ε' is the kinetic energy, 'k' is Boltzmann constant; 'T' is temperature of the gas.

3. With increase in pressure temperature of a gas will decrease -True or False?

Ans : With increase in pressure temperature of a gas will decrease -this statement is False.

Multiple choice questions:

1. Which one of the following statements is wrong for gases?

a. The kinetic energy of the molecules decreases.

b. The pressure increases.

c. The kinetic energy of the molecules remains the same.

d. The number of molecules of the gas increases.

2. In deriving the kinetic gas equation, use is made of the root mean square velocity of the molecules because it is

a. The square root of the average square velocity of the molecules

b. The most probable velocity of the molecules

c. The most accurate form in which velocity can be used in these calculations

d. The average velocity of the molecules

3. Gas deviates from ideal gas nature because molecules

a. Attract each other

b. Are colorless

c. Contain covalent bond

d. Show Brownian movement

4. In the equation of sate of an ideal gas PV = nRT, the value of the universal gas constant would depend only on

a. The nature of the gas

b. The units of the measurement

c. The pressure of the gas

d. None of these

5. If a gas is expanded at constant temperature

a. The kinetic energy of the molecules remains the same

b. The kinetic energy of the molecules decreases

c. The number of molecules of the gas increases

d. The pressure increases

6. At constant temperature, in a given mass of an ideal gas

a. Pressure always remains constant

b. The ratio of pressure and volume always remains constant

c. Volume always remains constant

d. The product of pressure and volume always remains constant

7. With increase of pressure, the mean free path

a. becomes zero

b. Decreases

c. Does not change.

d. Increases

8. A container with a pin-hole contains equal moles of $H_{2(g)}$ and $O_{2(g)}$. Find the fraction of oxygen gas escaped at the same time when one-fourth of hydrogen gas escapes

a.1/16 b.1/4 c.1/2 d.1/8

9. What are the conditions for gas like Carbon monoxide to obey the ideal gas laws?

a. low temperature and low pressure

b. low temperature and high pressure

c. high temperature and low pressure

d. high temperature and high pressure

10. If the temperature is doubled, the average velocity of a gaseous molecule increases by

a.4 b.1.4 c.2 d.2.8

11. At the same temperature, the average molar kinetic energy of N_2 and CO is

a. $KE_1 = KE_2$ b. $KE_1 < KE_2$ c. $KE_1 > KE_2$ d. Insufficient information given

12. If a gas is expanded at constant temperature

a. The pressure increases

b. The number of molecules of the gas increases

c. The kinetic energy of the molecules decreases

d. The kinetic energy of the molecules remains the same

13. Which one of the following statements is wrong for gases?

a. Volume of the gas is equal to the volume of the container confining the gas

b. Mass of the gas cannot be determined by weighing a container in which it is enclosed

c. Gases do not have a definite shape and volume

d. Confined gas exerts uniform pressure on the walls of its container in all directions

14. At the same temperature and pressure, which of the following gases will have the highest kinetic energy per mole

a. Hydrogen b. All the same c. Methane d. Methane

15. In the equation of sate of an ideal gas PV = nRT, the value of the universal gas constant would depend only on

a. The pressure of the gas

b. The units of the measurement

c. None of these

d. The nature of the gas

16. Molecular weight of a gas that diffuses twice as rapidly as the gas with molecular weight 64 is

a.6.4 b. 64 c. 8 d.**16**

17. At constant temperature, in a given mass of an ideal gas

a. The ratio of pressure and volume always remains constant

b. The product of pressure and volume always remains constant

c. Pressure always remains constant

d. Volume always remains constant

18. In the equation of sate of an ideal gas PV = nRT, the value of the universal gas constant would depend only on

a. None of these

b. The pressure of the gas

c. The nature of the gas

d. The units of the measurement.

19. How will you separate mixture of two gases?

a. Osmosis

b. Chromatography

c. Fractional distillation technique

d. Grahams law of diffusion technique

20. Gas deviates from ideal gas nature because molecules

a. Attract each other

b. Show Brownian movement

c. Are colorless

d. Contain covalent bond

21. Which set of conditions represents easiest way to liquefy a gas?

a. Low temperature and low pressure

b. High temperature and low pressure

c. Low temperature and high pressure

d. High temperature and high pressure

22. Who among the following scientists has not done any important work on gases?

a. Avogadro b. Boyle c. Faraday d. Charles

23. When an ideal gas undergoes unrestrained expansion, no cooling occurs because the molecules?

a. Exert no attractive force on each other

b. Collide without loss of energy

c. Do work equal to loss in kinetic energy

d. Are above the inversion temperature

24. Maximum deviation from ideal gas is expected from

a.H_2(g) b.N_2(g) c.CH_4(g) d.NH_3(g)

25. If a gas expands at constant temperature, it indicates that:

a. Number of the molecules of gas increases

b. Kinetic energy of molecules decreases

c. Pressure of the gas increases

d. Kinetic energy of molecules remains the same

26. 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 %

27. One mole of oxygen at 273 k and one mole of sulphur dioxide at 546 k are taken in two separate containers, then,

a. kinetic energy of O_2 > kinetic energy of SO_2 .

b. kinetic energy of O_2 < kinetic energy of SO_2

c. kinetic energy of both are equal.

d. kinetic energy of both are equal.

28. Which one of the following statements is NOT true about the effect of an increase in temperature on the distribution of molecular speeds in a gas?

a. The most probable speed increases

b. The fraction of the molecules with the most probable speed increases

c. The distribution becomes broader

d. The area under the distribution curve remains the same as under the lower temperature

29. 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. Vrms values will be same

b. kinetic energy per/mol will be same

c. total kinetic energy will same

d. pressure will be same

30. 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 273K?

a. 0.071 g b. 0.071 g c. 0.02 mole d. 6.023 × 1021 molecules

31. The vapor pressure of water at 300 K in a closed container is 0.4 atm. If the volume of container is doubled, its vapor pressure at 300 K will be

a. 0.8 atm

b. 0.2 atm

c. 0.4 atm

d. 0.6 atm

Explanation: Vapor pressure depends on 'T' only and it does not depend on container volume

32. Name the liquid with higher vapor pressure in the following pairs:

(a) Alcohol, glycerin (b) Petrol, kerosene (c) mercury, water.

a. Alcohol, Water, Petrol

b. Petrol, Water, Alcohol

c. Alcohol, Petrol, Water

d. None of these

Explanation: The vapor pressure of the liquid is inversely proportional to the magnitude of the intermolecular forces of attraction present. Based on this, the liquid with higher vapor pressure in the different pairs is: (a) Alcohol, (b) Petrol, (c) Water.

33. The rate of diffusion methane is twice that of ‘X’. The molecular mass of ‘X’ is

<u>a. 64.0</u>

b. 32.0

c. 40

d. 80

Explanation: Let rate of diffusion of gas ‘x’, r_1 = a

Therefore, rate of diffusion of methane, r_2 = 2 a

According to Grahams Law of Diffusion,

(r1/r2) = (√M2/M1)

M_1 = Molecular mass of gas ‘x’

M_2 = Molecular mass of Methane = 16 g

Therefore, (a/2a) = (√16/M2)

Squaring both the sides, (14) = (16/M2)

or, $M_2 = 16 \times 4 = 64$ g

34. Which of the following statement is wrong for gases?

a. Gases do not have definite shape and volume

b. Volume of the gas is equal to the volume of the container confining the gas

c. Confined gas exert uniform pressure on the wall of the container in all directions

<u>d. Mass of the gas cannot be determined by weighing a container in which it is contained</u>

Explanation: Mass of the gas = mass of the cylinder including gas – mass of empty cylinder. So mass of a gas can be determined by weighing the container in which it is enclosed. Thus, the statement (d) is wrong for gases.

35. The rates of diffusion of gases are inversely proportional to square root of their densities. This statement refers to:

a. Daltons Law

<u>b. Grahams Law</u>

c. Avogadros Law

d. None of the Above

36. The law, which states that at constant temperature, the volume of a given mass of gas is inversely proportional is pressure, is known as:

<u>a. Boyles law</u>

b. Charles law

c. Combine gas law

d. Avogadros law

37. If helium and methane are allowed to diffuse out of the container under the similar conditions of temperature and pressure, then ratio of rate of diffusion of helium to methane is:

(a) 2 : 1 (b) 1 : 2 (c) 3 : 5 (d) 4 : 1

Explanation: According to Grahams law

$(r_1/r_2) = (\sqrt{M1/M2})$

$(r_{He} / r_{CH4}) = (\sqrt{16/4})$

= (1/2)

38. When you heat a sample of gas, what happens to the particles that make up the gas?

a. The particles move faster.

b. The particles break apart

c. The particles get smaller

d. The particles become more dense

Explanation: There is a great deal of empty space between particles, which have a lot of kinetic energy. The particles move very fast and collide into one another when the gas is heated up, causing them to diffuse, or spread out, until they are evenly distributed throughout the volume of the container.

39. Which of the following is false about gases?

a. The molecules possess random movement in all directions

b. Gases intermix freely without the help of external agency

c. They are highly compressible

d. They possess definite volume.

40. Two gases X and Y are at same temperature and pressure. The reduced temperature of X is below unity while that of Y is above unity. Thus,

a. X can be liquefied by compression but not Y

b. Y can be liquefied by compression but not X

c. both X and Y can be liquefied by compression

d. none of the statement is correct

41. Liquification of gases cannot be achieved by

a. cooling

b. compressing the gas at all temperatures.

c. compressing the gas as well as cooling

d. compressing the gas below critical temperature.

42. Which of the following statement is false?

a. The product PV for fixed amount of gas is independent of temperature.

b. Molecules of different gases have same KE at a given temperature.

c. The gas equation is not valid at high pressure and low temperature.

d. The gas constant per molecule is known as Boltzman constant.

43. At constant volume for a fixed number of gas moles, the pressure of the gas increases with the rise in temp. Because of

a. Increase in average molecular speed

b. Increased rate of collisions amongst molecules

c. Increase in molecular attraction

d. Decrease in mean free path

44. The bottle of liquid ammonia is cooled before opening the seal so as to lower its

a. Vapor pressure

b. Surface tension

c. Viscosity

d. Extent of H-bonding.

45. Which of the following do not pertain to the postulates of kinetic theory of gases?

a. Molecular collisions are perfectly elastic

b. Gas molecules move at random with ever changing speeds

c. Molecular collision against the wall are responsible of gas pressure.

d. KE of a gas is given by the sum of 273 and temperature in celcius scale.

46. The temperature of ideal gas can be increased by

a. Decreasing the volume and pressure but keeping the amount constant

b. Increasing the pressure but keeping the volume and amount constant

c. Decreasing the amount but keeping the volume and pressure constant

d. Any of 'b' or 'c' operation

47. The densities of two gases are in the ratio of 1: 16. The ratio of their rates of diffusion is

a. 16: 1 b. 4: 1 c. 1: 4 d. 1: 16.

48. When ideal gas undergoes unstrained expansion, no cooling occurs because the molecules

a. are above inversion temperature

b. exert no attractive force on each other

c. work equal to loss in kinetic energy

d. collide without loss of energy

49.The Kinetic theory of gases predicts that the total K.E. of a gas depends on,

a. Pressure ,temperature and Volume of gas

b. Temperature f the gas

c. Pressure of the gas

d. Volume of the gas

50. Rate of diffusion of a gas is directly proportional to……

a. Square of its molecular mass

b. Its density

c. Its molecular mass

d. Inversly proportional to the square root of its density.

51.A gas such as Carbon monoxide would be most likely to…..

a. High temperature and low pressure

b. Low temperature and high pressure

c. High temperature and high pressure

d. Low temperature and low pressure

52.Maximun deviation from ideal gas is expected from….

a.$H_{2(g)}$ b.$N_{2(g)}$ c.$CH_{4(g)}$ d.$NH_{3(g)}$

53.A curve drawn at constant temp. is called isotherm, this shows relationship between…..

a. P and V b. V and 1/P c. PV and V d. P and 1/V

53.An idea gas is one which obeys…

a. Boyle's law b. Charle's law c. All gas laws d. Avogadro's law.

54. The density of the gas is equal to…

a. Pm/RT b. M/V c. P/RT d. n.P

55. The temperature at which real gases obey the ideal gas laws over a wide range of pressure is called…

a. Critical temperature

b. Reduces temperature

c. Boyle temperature

d. Inversion temperature

56.Which of these is the unit of constant 'b' in vander Waals equation?

a. cm^3 b. m^3 c. litre/mole d. all of these

57. The vander Waals force in hydrogen and Helium are…..

a. Very strong b. Strong c. Weak d. None of these

58.When …..is passed through diluted blood,it imparts Cherry-red color to it…

a.CO b.NH_3 c.CO_2 d.$COCl_2$

59.When 600 cc of gas is compressed to 500cc at a pressure of 750 mm. Given the temp.is kept constant, the pressure would increases by,

a.350mm b.250mm c.450mm d. 150mm

60.Which of these is vander Waals equation for a real gas?

a. $(P + a/V_2)$ (V-b) = RT

b. $P = nRT/V\text{-}nB\text{-} an^2/V^2$

c.$(P=n^2a/V^2)$ (V-nb) = nRt

d. All of these.

61. vanderWaals equation reduces to …… at high pressure.

a. PV= RT b. PV=RT + Pb c. PV=RT d. $PV=RT – a/V^2$

62. Beans cook faster in a pressure cooker because……

a. The extra pressure softens the beans.

b. When pressure increases, the B.P. also increases.

c. When pressure increases, B.P. decreases.

d. Internal energy does not get lost while cooking.

63. Which of these is the reason why an ideal gas does not liquefy?

a. Its molecules are smaller in size.

b. There is negligible force between its molecules.

c. It solidifies. d. Its temp.is above 0^oC

64. ……..makes CO_2 obey the ideal gas laws

a. High temperature and low pressure

b. Low temperature and high pressure

c. High temperature and high pressure

d. Low temperature and low pressure

65.All gases except He and H_2 exhibit …..at lower temperature.

a. Positive deviation

b. Positive deviation and negative deviation

c. Negative deviation

d. None of these.

66. "Air at sea level is dense" – it is a practical application of………

a. Charle's law

b. Dalton's law

c. Boyle's law

d. Avogadro's law

67……….. is the % of gas which remains in an open container when it is heated from 300K to 400 K.

a.100 % b.75% c.50% d.25%

68.Which of these will have the highest rate of diffusion, if they are in the same container and at the same temperature?

a. 56 gm of N_2 b.4 gm of H_2 c.22 gm of CO_2 d.32 gm of O_2

69. Which of these is the unit of constant 'a' in Vander Waals equation?

a. dyne $cm^4/mole^2$

b. newton m^4/mol^2

c. atm $litre^2/mol^2$

d. All of these

70. All of the following are properties of ideal gases except

a. Gas molecules do not interact with each other except during collisions

b. Collisions between gas molecules are completely elastic

c. Volume occupied by molecules is negligible compared to the volume occupied by the gas

d. Small amounts of energy are lost during collisions between gas molecules

71. Gases can be defined by the following statement:

a. Gases freely flow to fill the container they are in.

b. Gases have neither a defined volume nor shape.

c. Gases are highly compressible.

d. All of the above

72. The relationships between the following four variables are known as the gas laws

a. pressure (P), depth (D, in cm), temperature (T), and amount (n, in moles)

b. pressure (P), volume (V), temperature (T), and amount (n, in moles)

c. height (H, in cm), volume (V), temperature (T), and amount (n, in moles)

d. pressure (P), volume (V), length (L, in cm), and amount (n, in moles)

73. Gas molecules are incredibly far apart and often interact with each other.

a. True b. False

74. The scientific principle that, so long as temperature is kept constant, the volume (V) of a fixed amount of gas is inversely proportional to its pressure (P) is called:

a. Boyles's Law

b. Charles's Law

c. Avogadro's Law

d. Ideal Gas Equation

75. In 1811, Avogadro put forth a hypothesis stating that

a. Atoms combine in whole-number ratios to form molecules.

b. Gases increase their volume in the same amount when their temperature is increased by the same degree.

c. Equal volumes of different gases have different numbers of molecules.

d. Equal volumes of different gases have an equal number of molecules.

76. Suppose you have two identical birthday balloons, with one filled with the gas helium and the other blown up by you. Assuming they're both filled to the same amount, these balloons will have the same number of molecules.

a. True b. False

77. When real gases are chilled to very low temperatures, they exert a (n) _____ amount of pressure in a container as compared to an ideal gas

a. greater b. equal c. lesser d. phase change

78. 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

79. An ideal gas can't be liquefied because

a. Its critical temperature is always above 0^oC

b Its molecules are relatively smaller in size

c. It solidifies before becoming a liquid

d. Forces operative between its molecules are negligible

80. However great the pressure, a gas cannot be liquefied above its

a. Boyle temperature

b. Inversion temperature

c. Critical temperature

d. Room temperature

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

a. Its temperature is more than critical temperature Tc

b. Its pressure is more than critical pressure Pc

c. Its pressure is more than Pc at a temperature less than Tc

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

82. A gas can be liquefied

a. above its critical temperature

b. At its critical temperature

c. Below its critical temperature

d. At any temperature

83. Which of the following is correct for critical temperature

a. It is the highest temperature at which liquid and vapor can coexist

b. beyond the critical temperature, there is no distinction between the two phases and a gas cannot be liquefied by compression

c. At critical temperature (Tc) the surface tension of the system is zero

d. At critical temperature the gas and the liquid phases have different critical densities

84. The Vander Waal's equation explains the behavior of

a. Ideal gases b. Real gases c. Vapor d. Non-real gases

85. Gases deviate from the ideal gas behaviors because their molecules

a. Possess negligible volume

b. Have forces of attraction between them

c. are polyatomic

d. are not attracted to one another

86. Any gas shows maximum deviation from ideal gas at

a. 0^oC and 1 atmospheric pressure

b. 100^oC and 2 atmospheric pressure

c. -100^oC and 5 atmospheric pressure

d. 500^0C and 1 atmospheric pressure

87. 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 high pressure

88. Vander Waal's constants 'a' and 'b' are related with..... respectively

a. Attractive force and bond energy of molecules

b. Volume and repulsive force of molecules

c. Shape and repulsive forces of molecules

d. Attractive force and volume of the molecules

89. The Vander Waal's equation reduces itself to the ideal gas equation at

a. High pressure and low temperature

b. Low pressure and low temperature

c. Low pressure and high temperature

d. High pressure and high temperature

90. The compressibility factor for an ideal gas is

a.1.5 b. 1.0 c.2.0 d. ¥

Explanation: Z=PV/ RT; for ideal gas PV = RT; so Z = 1

91. 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

92. Consider a mixture of SO_2 and O_2 kept at room temperature. Compared to the oxygen molecule, the SO_2 molecule will hit the wall with

a. smaller average speed

b. Greater average speed

c. Greater kinetic energy

d. Greater mass

93. At constant volume, for a fixed number of moles of a gas, the pressure of the gas increases with increase in temperature due to

a. Increase in the average molecular speed

b. Increased rate of collision amongst molecules

c. Increase in molecular attraction

d. Decrease in mean free path

94. 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

95. The density of a gas An is three times that of a gas B. if the molecular mass of A is M, the molecular mass of B is

a.3 M b. $\sqrt{3}$M c. M/3 d. M/$\sqrt{3}$

Explanation: d∝M Þ d1/d2=M1/M2; 3d/d = M/M2 ; M2=M/3.

96. At the same temperature and pressure, which of the following gases will have the highest kinetic energy per mole

a. Hydrogen b. Oxygen c. Methane <u>d. All the same</u>

97. Absolute zero is defined as the temperature

<u>a. At which all molecular motion ceases</u>

b. At which liquid helium boils

c. At which ether boils

d. All of the above

Explanation: K.E. per mole =3/2RT so all will have K.E.at same temperature.

98. Gas equation PV=nRT is obeyed by

a. Only isothermal process

b. Only adiabatic process

<u>c. Both A and B</u>

d. None of these

99. 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 <u>c. P/RT</u> d. RT/P

Explanation: PV = nRT ∴n/V=P/ RT

100. Kinetic energy of molecules is highest in..

a. solids b. liquids c. gasees d. solutions.

101. Which of the following exhibits the weakest intermolecular forces

a.NH_3 <u>b. He</u> c.H_2O d. HCl

Nobel gases has no intermolecular forces due to inertness.

102. Which of the following gases would behave the least ideally?

a. Ne <u>b.HF</u> c.O_2 d.He

For a gas to behave ideally, is should have a low mass and/or weak intermolecular forces. Contrastingly, non-ideal gasses should have very large masses and/or have strong intermolecular forces. Therefore, the correct answer is HF which has very strong intermolecular forces, hydrogen bonds. Nonpolar gasses such as oxygen and other diatomic gasses have very weak intermolecular forces and thus behave ideally.

Assertion and Reason Type questions:

103. Assertion (A): At critical temperature liquid passes into gaseous state imperceptibly and continuously.

Reason (R) : The density of liquid and gaseous phase is equal to critical temperature.

(i) Both A and R are true and R is the correct explanation of A.

(ii) Both A and R are true but R is not the correct explanation of A.

(iii) A is true but R is false.

(iv) A is false but R is true

104. Assertion (A): Gases do not liquefy above their critical temperature, even on applying high pressure.

Reason (R) : Above critical temperature, the molecular speed is high and intermolecular attractions cannot hold the molecules together because they escape because of high speed.

(i) Both A and R are true and R is the correct explanation of A.

(ii) Both A and R are true but R is not the correct explanation of A.

(iii) A is true but R is false.

(iv) A is false but R is true.

105. Assertion (A): The temperature at which vapour pressure of a liquid is equal to the external pressure is called boiling temperature.

Reason (R) : At high altitude atmospheric pressure is high.

(i) Both A and R are true and R is the correct explanation of A.

(ii) Both A and R are true but R is not the correct explanation of A.

(iii) A is true but R is false.

(iv) A is false but R is true.

106. Assertion (A): At constant temperature, pV vs V plot for real gases is not a straight line.

Reason (R) : At high pressure all gases have $Z > 1$ but at intermediate pressure most gases have $Z < 1$.

(i) Both A and R are true and R is the correct explanation of A.

(ii) Both A and R are true but R is not the correct explanation of A.

(iii) A is true but R is false.

(iv) A is false but R is true.

Matching Type questions:

107. Match the following gas laws with the equation representing them.

(i) Boyle's law (a) V ∝ n at constant T and p

(ii) Charle's law (b) pTotal = p1 + p2 + p3+...... at constant T, V

(iii) Dalton's law (c) = Constant p V T

(iv) Avogadro law (d) V ∝ T at constant n and p (e) p V ∝ 1 at constant n and T

108. A person living in Shimla observed that cooking food without using pressure cooker takes more time. The reason for this observation is that at high altitude:

a. pressure increases

b. temperature decreases

<u>c. pressure decreases</u>

d. temperature increases

109. As the temperature increases, average kinetic energy of molecules increases. What would be the effect of increase of temperature on pressure provided the volume is constant?

<u>a. increases.</u> b. decreases c. remains same d. becomes half

110. Atmospheric pressures recorded in different cities are as follows: Consider the above data and mark the place at which liquid will boil first.

<u>a. Shimla</u> b. Bangalore c. Delhi d. Mumbai

111. Increase in kinetic energy can overcome intermolecular forces of attraction. How will the viscosity of liquid be affected by the increase in temperature?

a. Increase b. No effect <u>c. Decrease</u> d. No regular pattern will be followed.

112. Which of the following changes decrease the vapor pressure of water kept in a sealed vessel?

a. Decreasing the quantity of water

<u>b. Adding salt to water</u>

c. decreasing the volume of the vessel to one-half

<u>d. decreasing the temperature of water</u>

113. Which of the following will occur as the speed of the molecules in a substance increases?

a. The substance will become cooler

b. The substance will begin to take up less space.

c. The force of attraction between the molecules will decrease.

d. The force of attraction that draws objects to Earth will increase.

114. At higher altitudes…..

a. Boiling point of a liquid increases

b. Boiling point of a liquid decreases

c. Boiling point of a liquid decreases

d. Melting point of solid increase

115. Seema visited a Natural Gas Compressing Unit and found that the gas can be liquefied under specific conditions of temperature and pressure. While sharing her experience with friends she got confused. Help her to identify the correct set of conditions

a. Low temperature, low pressure

b. High temperature, low pressure

c. Low temperature, high pressure

d. High temperature, high pressure

116. In high pressure condition, the real gases conform more closely with

a. van der Waals equation

b. ideal gas equation

c. both a. and b.

d. none of the above

117. A pressure cooker reduces cooking time because

a. Heat is uniformly distributed

b. A large flame is used

c. Boiling point of water rises

d. Vapor pressure of liquid reduces

118. Gases become ideal at.

a. Low pressure and high temperatures

b. Low temperature and low pressures

c. High pressures and low temperatures   d. High temperatures and high pressure

119. Real gases do not behave as ideal gases as there exist attractive forces between molecules the nature of force are.

a. Adhasive forces

b. Cohesive forces

c. Repulsive forces

<u>d. Van der Waal's forces</u>

120. When water freezes at O C its density decrease due to

a.Cubic structure of ice

b. Change of bond lengths

c. Change of bond angles

<u>d. Empty space present in the structure of ice</u>

121. The internal resistance of liquid to flow is called:

a. vapour pressure <u>b. Viscosity</u> c. Surface tension d. Capillary action

122. The pressure above a liquid in a sealed container caused by the collision of vaporized particles with the walls of their container is called

a) Kinetic energy <u>b) Vapor pressure</u> c) Atmospheric pressure d) Sublimation

123. Which of the following phase changes is NOT endothermic?

<u>a) Condensation</u> b) Evaporation c) Melting d) Sublimation

124. When the atmospheric pressure is equal to the vapor pressure of a liquid, the liquid will a) Condense b) Freeze <u>c) Boil</u> d) Melt

125. If you wanted to make water boil at 75ºC, instead of 100ºC, you would have to

a) Add more heat.

b) Increase air pressure.

c) Decrease the volume of water you are boiling.

<u>d) Heat the water at a higher altitude.</u>

126. A weather balloon is heated from room temperature to 58ºC. As a result, the gas inside the weather balloon increases in volume. Which gas law explains this phenomenon?

a) Gay-Lussac's Law b) Boyle's Law <u>c) Charles' Law</u> d) Combined Gas Law

127. Why does the pressure inside a container of gas increase if more gas is added to the container?

a) There is an increase in the number of particles striking the wall of the container in the same period of time.

b) An increase in gas causes an increase in temperature, which then increases pressure.

c) As the volume of gas increases, the force of the collisions between particles and the container increases.

d) As the gas pressure increases, the volume of gas decreases.

128. A balloon is filled with 2.33 L of helium at 304 K. If the balloon is moved indoors where the temperature is 293 K, what will be the new volume of the balloon? Assume that pressure remains unchanged.

a) 2.41 L b) 2.24 L c) 2.17 L d) 1.50 L

129. At same temp.,the K.E. of one mole of H2 and O2 separated by,

a. Same b. Zero c. None of these d. different

130.Gases deviate from ideal behavior because molecules…….

a. Contains covalent bond

b. Attract each other

c. Repeal each other

d. None of the above

131.Most of the universe consists of matter in ….

a. Solid state b. Gaseous state c. Liquid state d. Plasma sate

132.If absolute temperature of gas is doubled and pressure is reduced to one half, the volume of the gas will,

a. Remains unchanged b. increase four times c. Be doubled d. reduced to ¼

133.Kinetic theory of gases was put forward by,

a. Bernoulli b. Maxwell c. Newton d. Coulomb.

134. According to kinetic molecular theory of gases, molecule increase in the K.E. when they are,

a. Mixed with other molecules at low temp. b. Frozen into solid

c. Melted from a solid to liquid state. d. Condensed into liquid.

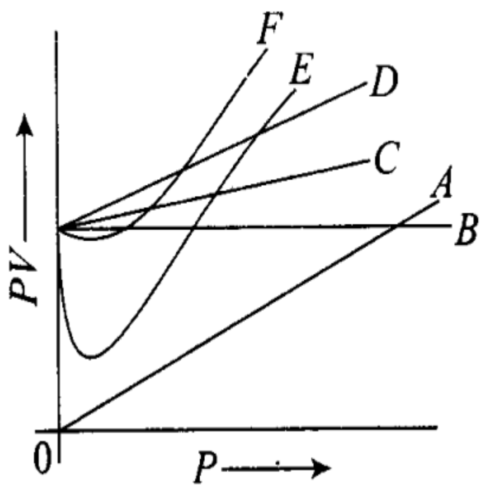
135. The movement of gas molecules from a region of high pressure to vacuum is called….

a. Conduction b. Diffusion c. Effusion d. Evaporation.

136. All gases can be compressed by..

a. Decreasing pressure b. keeping constant pressure c. Increasing pressure. d. None of the above.

137. Which curve in figure represents the curve of ideal gas?



a. B only b. C and D only c. E and F only d. A and B only

138. CO_2 can be easily liquified and even solidified because…

a. It has comparatively more force of attraction than other gases.

b. It is present in atmosphere.

c. It has weak force of attraction

d. All of the above.

139.When we put some crystals of $KMnO_4$ in a beaker containing water, we observe that after sometime ,whole water has turned pink, this is due to…

a. Diffusion b. Boiling c. Sublimation of crystals d. M.P. of $KMnO_4$ crystals.

140.A bottle of ammonia and a bottle of dry HCl connected through a long tube are opened simultaneously at both ends,the while ammonium chloride ring first found will be…

a. Near the HCL bottle

b. throughout the length of the tube.

c. At the center of the tube.

d. Near the ammonia bottle.

141.Rate of diffusion depends on….

a. Surface area b. Temperature c. Both temp. and surface area d.None of these.

142. In the gas equation PV=nRT, the value of R depends upon…

a. Nature of gas

b. The pressure of gas

c. Unit of measurement

d. Temp. Of gas

143. At the same temp. and pressure, which of the following gases will have the highest kinetic energy per mole..

a. Hydrogen b. Oxygen c. Methane d. all the same

144.Pressue of a gas is due to…

a. Collisions of gas molecules

b. Random movement of gas molecules

c. Intermolecular forces of attraction between the gas molecules.

145. Which is not true in case of an ideal gas

a. It cannot be converted into liquid

b. There is no interaction between the molecules.

c. All molecules of the gas move with same speed.

d. At a given temp. PV is proportional to the amount of gas.

146.The temp.at which real gases obeys the ideal gas laws over a wide range of pressure is called…

a. Critical temperature b. Boyes temp. c. inversion temp. d. reduced temp.

147. An ideal gas cannot be liquefied because…

a. Its critical temp.is always 0^oC

b. Its molecules are relatively smaller in size.

c. It solidifies before becoming a liquid.

d. Forces operative between its molecules are negligible.

148. Which of the following element is not a gas?

a.H_2 b.O_2 c. Hg d.N_2

149. Gases have low density than that of solids and liquids because of ___________

a.no thermal energy b. higher intermolecular energy

c. both intermolecular energy and thermal energy are the same d. higher thermal energy

150. What can you say about particles motion in gases?

a. only vibratory

b. very slow

c. both vibratory and irregular

d. too Rapid and random

Explanation: A particle's motion in the gaseous state is too rapid and random while in solids it's restricted to vibratory motion and in liquids, it's very slow. This is one of the very basic properties of substances in the gaseous state.

151. At STP conditions how much volume does one mole of a gas comprise of _________

a. 22.4 liters

b. 24 liters

c. depends on the molecular weight of the gas

d. depends on some other conditions

Explanation: Every one Mole of gas at STP consists of 22.4 liters of volume, that is at 0° Celsius of temperature and one-atmosphere pressure or 76 mm of Mercury pressure. Also, note that one mole of a gas is the amount of gas in weight divided by the molecular weight of the gas.