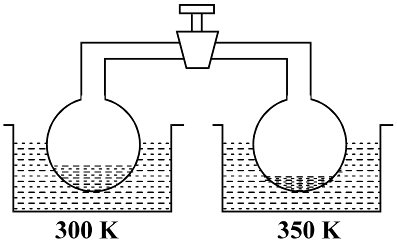
CLASS : CC -AD

Revision Worksheet Gaseous State (Ideal + Real)

Single correct :

Q.1 Two container each containing liquid water are connected as shown in diagram.



Given that vapour pressure of $H_2O(l)$ at 300 K & 350 K are 22 mm of Hg and 40 mm of Hg. The final pressure in each container if valve is opened while keeping the containers at the given temperature is

(A) 22 mm of Hg (B) 40 mm of Hg (C) 31 mm of Hg (D) 62 mm of Hg

Q.2 Which of the following options will have a gas in which mean free path will have maximum value?

(A) H_2 gas at 2 atm & 300 K (B) N_2 gas at 4 atm & 300 K

(C) H_2 gas at 1.5 atm & 270 K (D) N_2 gas at 6 atm & 200 K

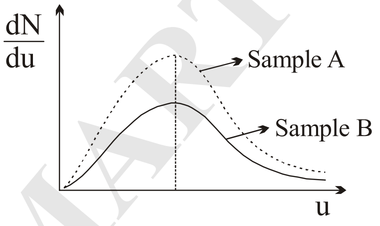
Q.3 Which of the following graphs correctly represents distribution of speeds for two samples A and B, if

Sample A $\Rightarrow$ O_2 at 2 atm, 22.4 l and 273 K

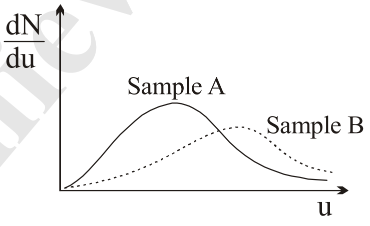
Sample B $\Rightarrow$ SO_2 at 1 atm, 22.4 l and 546 K

(Assume ideal gas behaviour of O_2 and SO_2 and symbols have usual meaning dN = Number of molecules with speed between u to u + du).

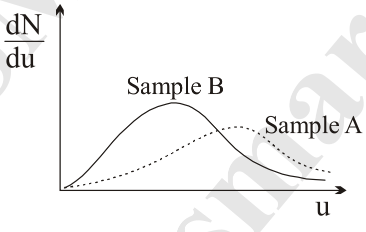
(A)



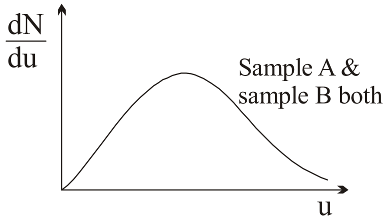
(B)



(C)



(D)



Q.4 For a real gas (mol. mass = 30) if density at critical point is 0.40 g/cm^3 and its $T_c = \dfrac{2\times10^5}{821}$ K, then Vander Waal's constant a (in atm L^2mol^{-2}) is

(A) 5.695 (B) 1.6875 (C) 0.1687 (D) None

Q.5 Calculate compressibility factor of one mole of a Vanderwaal gas at a temperature of 400K if a = 3.284 atm-litre^2/mol^2 and b = 0.1 litre/mole if volume of the container is 0.4 litre.

[**Given :** $\left.\frac{\partial PV}{\partial P}\right)_{T=T_B}$ = 0 only if P < 50 atm, where is T_B is Boyle's temperature]

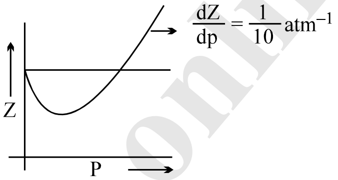
(A) Z =1 (B) $Z = \frac{13}{12}$ (C) $Z = \frac{12}{13}$ (D) $\frac{17}{16}$

Q.6 The number of effusion steps required to convert a mixture of H_2 and O_2 from 240 : 1600 (by mass) to 3072 : 20 (by mass) is

(A) 2 (B) 4 (C) 5 (D) 6

Q.7 The graph of compressibility factor (Z) vs P for one mole of a real gas is shown in following diagram.

The graph is plotted at constant temperature 273 K. If the slope of graph at very high pressure $\left(\frac{dZ}{dp}\right)$ is $\frac{1}{10}$ atm^{-1}, the volume of one molecule of real gas in cm^3 is :



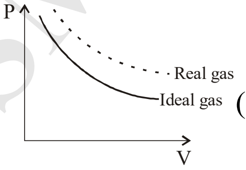
[**Given :** $R = \frac{22.4}{273}$ L atm K^{-1} mol^{-1} and $N_A = 6 \times 10^{23}$]

(A) 9.3×10^{-23} (B) 3.7×10^{-20} (C) 9.3×10^{-22} (D) 5.6×10^{-20}

Q.8 If the number of molecules of SO_2 (M = 64) effusing through an orifice of unit area of cross section in unit time at 0°C and 1atm pressure is **'n'**.The number of He molecules (M = 4) effusing in unit time under similar conditions at 273°C and 0.25 atm is :

(A) $\frac{n}{\sqrt{2}}$ (B) $\frac{n}{2}$ (C) 2n (D) $\sqrt{2}$ n

Q.9 Which of the following graph is correct for ideal and real gas if fixed amount of gas is subjected to change in pressure and volume at constant temperature.

(A)


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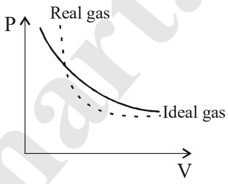
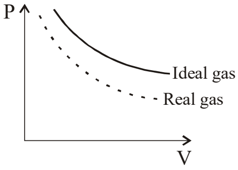
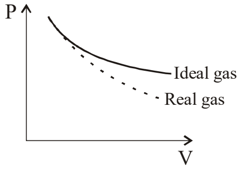


(C)


(D)


Q.10 Which occurs when a substance is converted from liquid to gas at the normal boiling point?

I. Potential energy of the system increases
II. The distance between molecules increases
III. The average kinetic energy of the molecules increases

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

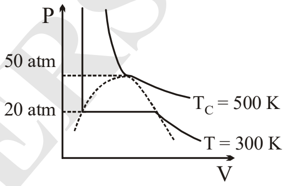
Q.11 The compressibility factor for 1 mole of a Vander Waal's gas at Boyle temperature is

(A) $1+\dfrac{b^2}{V(V-b)}$ (B) $1-\dfrac{b}{V}$ (C) $1+\dfrac{b}{V}$ (D) $1-\dfrac{b^2}{V^2}$

Q.12 U_{avg} of O_2 at a pressure of 10π bar in a 8 litre vessel containing 2 moles is :

(A) $\sqrt{2\times10^3}$ m/sec (B) $\sqrt{10^3}$ m/sec (C) 10^3 m/sec (D) $\sqrt{2\times10^6}$ m/sec

Q.13 For a real gas the P–V curve was experimentally plotted and it had the following appearance. With respect to liquification, choose the **correct** statement.



(A) At T = 500 K, P = 40 atm, the state will be liquid
(B) At T = 300 K, P = 50 atm, the state will be gas.
(C) At T < 300 K, P > 20 atm, the state will be gas
(D) At 300 K < T < 500 K, P > 50 atm, the state will be liquid.

Paragraph for question nos. 14 to 15

Flask-1 contain two ideal gases A and B and their root mean square speeds are 800 and 500 ms^{-1} respectively. Now this flask was connected to another flask-2 [containing only A with root mean square speed 500 m s^{-1}] by a narrow tube of negligible volume and gases in the two flask were allowed to mix up to attain same final temperature.

Q.14 Which of the following statement regarding molar masses of A and B is true.
(A) molar mass of A is greater than molar mass B
(B) molar mass of B is greater than molar mass A
(C) molar mass of A can be either greater or less than molar mass B
(D) None of these

Q.15 In the combined system
(A) A will be moving at U_{rms} less than 800 ms^{-1}, but B will be continue moving at its original U_{rms}.
(B) U_{rms} of A will decrease but U_{rms} of B will increase.
(C) U_{rms} of A & B both will decrease below to 500 ms^{-1}
(D) U_{rms} of A will decrease below 800 ms^{-1} and U_{rms} of B will decrease below to 500 ms^{-1}

<u>More than one correct :</u>

Q.16 Identify the statements which are correct regarding ideal gas as per KTG.
(A) At same temperature a lighter gas molecule may have greater momentum as compared to heavier gas molecule.
(B) In a closed rigid container if temperature increases then distribution pattern will become more uniform.
(C) Average relative speed of approach can be taken as $\sqrt{2}u_{avg}$.
(D) The fraction of molecules having speed U_{rms} will be more as compared to those having speed U_{avg}.

Q.17 A student collected two values of $P.V_m$ for a gas at two different temperatures (V_m is the molar volume of gas)

$P.V_m$ (l – atm)	20	40
Temperature(°C)	30	300

He considered the gas ideal. Which of the following **correct** values, he will get on applying ideal gas equation?

(A) 0 K = –273°C (B) 0 K = –240°C
(C) R = 0.0821 *l*-atm/K-mol (D) R = 0.0741 *l*-atm/K-mol

Q.18 Which of the following statements is / are correct with respect to behaviour of real gas.
(A) For every Vander Waal gas at critical condition, attractive forces will be dominant.
(B) The liquid and gaseous state can be distinguished only if the temperature is below the gas's critical temperature.
(C) At very high pressures, real gases occupy greater volume as compared to ideal gas having same moles at same temperature and exerting same pressure.
(D) For a real gas the 'y' intercept of $\frac{PV_m}{T}$ vs P curve where 'P' represents pressure (in atm) , V_m represents molar volume and 'T' represents temperature in kelvin is equal to 0.0821 atm-litre/mol-Kelvin.

Q.19 A real gas obeying Vander Waal equation has a = 6.72 atm-lit^{2}mol^{-2} and b = 0.273 lit mol^{-1}. At what temperatures substance will exist only in gaseous state irrespective of pressure.
(A) 400 K (B) 200 K (C) 90 K (D) 150 K

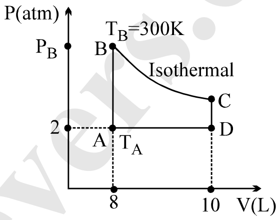
Q.20 An ideal gas having 2 moles (fixed) is subjected to the changes as shown is (P–V) diagram. Select the correct option(s) from the following diagram.

(A) Temperature at "A" $\left(\frac{16}{R}\right)$; Pressure at "C" (60 R)

(B) Temperature at "D" $\left(\frac{10}{R}\right)$; Pressure at "B" (75 R)

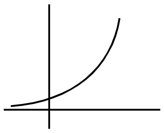
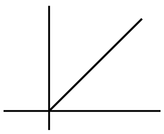
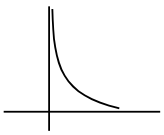
(C) Temperature at "A" $\left(\frac{8}{R}\right)$; Pressure at "B" (75 R)

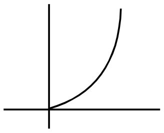
(D) Temperature at "D" $\left(\frac{5}{R}\right)$; Pressure at "C" (60 R)



Match the column :

Q.21 Match the description in **Column I** with graph provided in **Column II**. For n moles of ideal gas at temperature 'T'.

Column I	**Column II**
(A) $\frac{P}{V}$ vs P	(P) 
(B) $\frac{P}{V}$ vs V	(Q) 
(C) $\frac{V}{P}$ vs P^{-2}	(R) 

(D) $\frac{P}{V}$ vs $\log P$ (S) 

Q.22 Consider gas to be characterised by Vander Waal's equation.

	Column - I		**Column - II**
(A)	Free volume	(P)	Depends upon nature of gas
(B)	Critical temperature	(Q)	Constant quantity for a particular gas
(C)	Boyle's temperature	(R)	Depends upon pressure for a particular gas
(D)	Compressibility factor	(S)	Depends upon the radius of gas molecule

Subjective :

Q.23 Two ideal gas samples are taken in separate equal volume container. Answer the following question using given data.

		Pressure	**Temperature**	σ	**Mol. wt.**
Gas	**A**	8 atm	1600 K	0.16 nm	20
Gas	**B**	1 atm	200 K	0.32 nm	40

(i) If $(z_{11})_A = x\,(z_{11})_B$: find x = ?

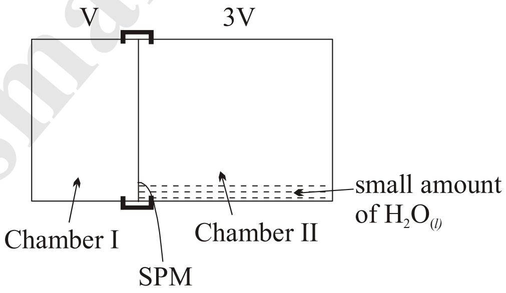
(ii) If $(z_1)_A = y\,(z_1)_B$: find y = ?

(iii) If $(u_{rms})_A = z\,(u_{rms})_B$: find z = ?

Represent your answer in OMR sheet as '0xyz'.

Q.24 Calculate pressure exerted by 1 mole of a vander-Waal gas at a temperature of $\frac{8}{0.0821}$ K if volume of the molecule is assumed to be negligible and vander -Waal constant a = 2 atm-lit^{2}mole^{-2}.
Express answer in atm.

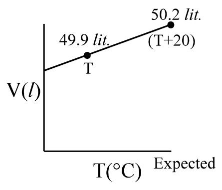
Q.25 A container is divided into two parts in the ratio 1 : 3 by a **fixed semi permeable membrane (SPM)** (which permits movement of NO_2 only) as shown. At temperature 'T' Kelvin **chamber I** consists of undissociated N_2O_4 at a pressure of 20 mm and **chamber II** contains small amount of li&Quid H_2O. The chambers are now heated to the temperature
'1.2 T' Kelvin at which N_2O_4 dissociates by 50%.



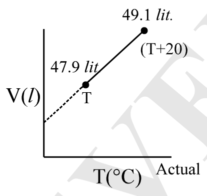
Given : The vapour pressure of water at 'T' Kelvin is 20 mm of Hg and the vapour pressure at '1.2T' Kelvin is 30 mm of Hg.
Assume H_2O does not completely evaporate at 'T' or '1.2T' Kelvin.

Calculate abcd where
ab = two digit number representing pressure (in mm) in chamber I at '1.2T' Kelvin.
cd = two digit number representing pressure (in mm) in chamber II at '1.2T' Kelvin.

Q.26 An ideal gas present in a container connected to frictionless, weightless piston is present at a fixed pressure P. The expected graph for the variation of volume with temperature was to be like as in (i), however actual observations revealed that the graph between V & T to be like (ii). The deviation was attributed to dissociation of gas as $D_m(g) \rightleftharpoons mD(g)$. If it is known that the above reaction gives only 60% yield. Find the value of m.



(i)



(ii)

Q.27 A faulty barometer has some trapped air above the mercury column due to which it does not give the correct reading. When the atmospheric pressure is 760 mm of Hg, the barometer reads 750 mm of Hg and when the pressure is 800 mm of Hg it reads 770 mm of Hg. Calculate actual pressure (in mm of Hg) if barometer reads 760 mm of Hg.

Q.28 The temperature and relative humidity of air on a certain day is 27°C and 80%. If the temperature of 10L of air sample is decreased to 7°C, the mass percent of water vapour which will condense, is (Vapour pressures of water at 27°C and 7°C are 25 mm Hg and 14 mm Hg, respectively.)

Q.29 A 50 litre vessel is equally divided into three parts with the help of two stationary semi permeable membrane (SPM). The vessel contains 60 g H_2 gas in the left chamber, 160 g O_2 in the middle & 140 g N_2 in the right one. The left SPM allows transfer of only H_2 gas while the right one allows the transfer of both H_2 & N_2. Calculate the final ratio of pressure in the three chambers.

Q.30 How many of the following cases will have **Z (compressibility factor) > 1** at the specified conditions.

(1) **H_2 gas** at room temperature and normal pressure.
(2) **He gas** at a temperature less than its critical temperature at low pressures.
(3) **NH_3 gas** at room temperature and extremely high pressure.
(4) **He gas** at room temperature and normal pressure.
(5) **CH_4 gas** at room temperature and very high pressure.
(6) **H_2 gas** at a temperature less than its critical temperature at low pressures.
(7) **CO_2 gas** at room temperature and low pressures.
(8) **N_2 gas** at its critical condition.
(9) **H_2 gas** at its critical condition.
(10) **CH_4 gas** at low to moderate pressure and at a temperature greater than Boyle's temperature.

REVISION FLOW CHART

Gaseous State

- **Ideal Gas**
  - *Ideal Gas Laws*
    - Boyle's law
    - Charle's law (G) + (N)
    - Gay lussac's law
    - Avogadro's law
    - Amagat's law
    - Dalton's law of partial pressure
    - Graham's law of diffusion/effusion
      - Variable rate of diffusion (N)
      - Isotopic separation factor (N)
  - *Kinetic Theory of gases*
    - Postulates of KTG (T)
    - Kinetic gas equations
    - Different type of velocities (U_{avg}, U_{mp}, U_{rms})
    - Kinetic energy calculation
  - *Maxwell's speed distribution law* (T)+(G)
    - Variation of graph with temperature and molecular mass
  - *Collisions in gases* (T)
    - Collision diameter
    - Collision frequency(Z_1 & Z_{11})
    - Mean free path
- **Real Gas**
  - *Vanderwaal's Equation*
    - Significance of a & b (N)+(T)
    - Approximation in vanderwaal's equation in different conditions of temperature and pressure
  - *Compressibility factor(Z)* (T)
    - Variation of Z with P at normal temperature (G)
    - Variation of Z with P at very low temperature
    - Variation of Z with P and T for different gases
    - Boyle's temperature
  - *Liquefaction of gases*(T)+(G)
    - Critical constants
  - *Reduced perameters (P_r, V_r & T_r) & law of corresponding states*
  - *Other equations*
    - Berthelot's equation
    - Virial equation
    - Dieterici equation

(G) → represents topic of graphical importance

(T) → represents topic of theoretical importance

(N) → represents topic of numerical importance

GASEOUS STATE

Gas Constant : $R = 0.0821$ L-atm/mole-K

$= 8.314$ J/mole-K

$= 1.98$ cal/mole-K

$= 8.314 \times 10^7$ ergs/mole

Boltzmen's constant $K = \dfrac{R}{N_A}$

Pressure conversion

$1 \text{ atm} = 1.01325 \times 10^5 \text{ N/m}^2$ or pascal $= 760$ mm of Hg $= 760$ torr $= 76$ cm of Hg

$= 1.01325 \text{ bar} = 1.01325 \times 10^6 \text{ dyne/cm}^2$

Volume Conversion

$1 \text{ m}^3 = 10^3 \text{ L} = 10^3 \text{ dm}^3 = 10^6 \text{ cm}^3 = 10^6 \text{ ml}$

Temp Conversion

T (in Kelvin) $= t(^\circ C) + 273$; $\dfrac{F-32}{9} = \dfrac{C}{5}$

LIST OF IMPORTANT FORMULAS

Graham's Law of diffusion / effusion:

$\dfrac{r_1}{r_2} = \sqrt{\dfrac{M_2}{M_1}}$ (at const P & T) $\dfrac{r_1}{r_2} = \dfrac{P_1}{P_2}\sqrt{\dfrac{M_2}{M_1}}$ (at const T)

$$\frac{r_1}{r_2} = \frac{P_1}{P_2}\sqrt{\frac{M_2T_2}{M_1T_1}}$$

Variable rate of diffusion :

$-\dfrac{dP}{dt} = k\dfrac{P}{\sqrt{M}}$ (at const T) $\ln\dfrac{P_2}{P_1} = \dfrac{k}{\sqrt{M}}t$

Isotopic separation factor :

$\dfrac{\dfrac{n_{f\,LG}}{n_{f\,HG}}}{\dfrac{n_{i\,LG}}{n_{iHG}}} = \left(\dfrac{M_{HG}}{M_{LG}}\right)^{P/2}$ M ⇒ Molar mass LG ⇒ Lighter gas HG ⇒ Heavier gas

P ⇒ No. of steps reqd. n_i = initial mole n_f = final mole

Degree of dissociation :

$\alpha = \dfrac{D-d}{(n-1)d}$ $\alpha \Rightarrow$ degree of dissociation

$D \Rightarrow$ Theoritical V.D.

$d \Rightarrow$ observed V.D.

Kinetic theory of gases :

$U_{rms} = \sqrt{\dfrac{3PV}{M}} = \sqrt{\dfrac{3RT}{M_o}} = \sqrt{\dfrac{3P}{d}}$ $M \Rightarrow$ total mass of gas taken

$U_{mp} = \sqrt{\dfrac{2RT}{M_0}} = \sqrt{\dfrac{2PV}{M}} = \sqrt{\dfrac{2P}{d}}$ $M_0 \Rightarrow$ Molar mass of gas

$U_{avg} = \sqrt{\dfrac{8RT}{\pi M_o}} = \sqrt{\dfrac{8PV}{\pi M}} = \sqrt{\dfrac{8P}{\pi d}}$ K.E. of n moles = $\dfrac{3}{2}$ nRT

Maxwell's speed distribution law :

- $dN_u = 4\pi N\left(\dfrac{M_o}{2\pi RT}\right)^{3/2} u^2 e^{-\frac{M_0u^2}{2RT}} du$

Collisions in gases :

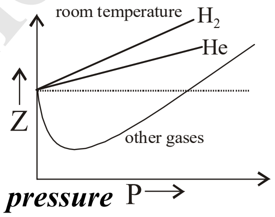
(Mean free path) $\lambda = \dfrac{1}{\sqrt{2}\pi\sigma^2 N^*}$ (N^* = No. of molecules per unit volume)

$Z_1 = \sqrt{2}\pi\sigma^2 N^* \; U_{avg}$ (Z_1 = No. of collision made by one molecule in one second)

$Z_{11} = \dfrac{1}{\sqrt{2}}\pi\sigma^2 (N^*)^2 \; U_{avg}$ (Z_{11} = No. of collision occuring per unit volume per second)

Vander Waal's equation:

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



at high pressure

$P(V - nb) = nRT$

at low pressure

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

For H_2/He

$P(V–nb) = nRT$

Critical constants :

$T_c = \dfrac{8a}{27Rb}$ $P_c = \dfrac{a}{27b^2}$ $V_c = 3b$

at critical condition

LAST MOMENT REVIEW

GASEOUS STATE

Theory : ....

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Exercise - 1 : Question ....

Exercise - 2 : Question ....

Exercise - 3 : Question ....

Exercise - 4 : Question ....

DPPs : ....

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Other Sources : ....

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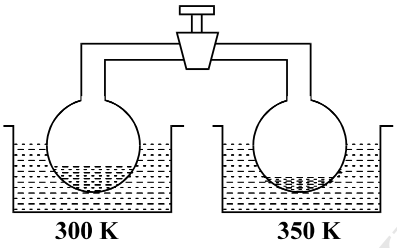
CLASS : CC -AD

Revision Worksheet Gaseous State (Ideal + Real)

Single correct :

Q.1 Two container each containing liquid water are connected as shown in diagram.



Given that vapour pressure of $H_2O(l)$ at 300 K & 350 K are 22 mm of Hg and 40 mm of Hg. The final pressure in each container if valve is opened while keeping the containers at the given temperature is

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(C*) H_2 gas at 1.5 atm & 270 K (D) N_2 gas at 6 atm & 200 K

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Sample A ⇒ O_2 at 2 atm, 22.4 *l* and 273 K

Sample B ⇒ SO_2 at 1 atm, 22.4 *l* and 546 K

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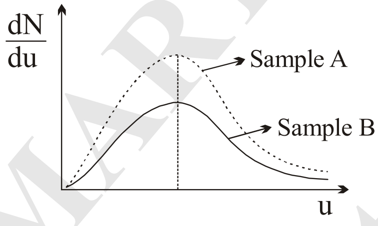
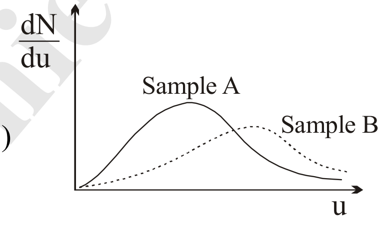
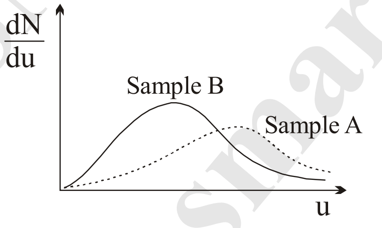
(A*)



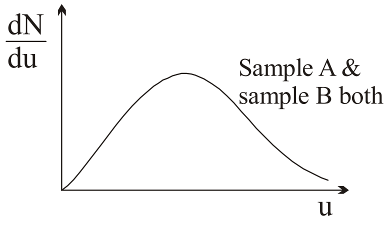
(B)



(C)



(D)



Q.4 For a real gas (mol. mass = 30) if density at critical point is 0.40 g/cm^3 and its $T_c = \frac{2\times10^5}{821}$ K, then Vander Waal's constant a (in atm L^2mol^{-2}) is

(A) 5.695 (B*) 1.6875 (C) 0.1687 (D) None

Q.5 Calculate compressibility factor of one mole of a Vanderwaal gas at a temperature of 400K if a = 3.284 atm-litre^2/mol^2 and b = 0.1 litre/mole if volume of the container is 0.4 litre.

[**Given :** $\left.\dfrac{\partial PV}{\partial P}\right)_{T=T_B} = 0$ only if P < 50 atm, where is T_B is Boyle's temperature]

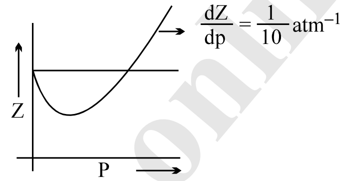
(A) Z =1 (B*) $Z = \dfrac{13}{12}$ (C) $Z = \dfrac{12}{13}$ (D) $\dfrac{17}{16}$

Q.6 The number of effusion steps required to convert a mixture of H_2 and O_2 from 240 : 1600 (by mass) to 3072 : 20 (by mass) is

(A) 2 (B) 4 (C*) 5 (D) 6

Q.7 The graph of compressibility factor (Z) vs P for one mole of a real gas is shown in following diagram.

The graph is plotted at constant temperature 273 K. If the slope of graph at very high pressure $\left(\dfrac{dZ}{dp}\right)$ is $\dfrac{1}{10}$ atm^{-1}, the volume of one molecule of real gas in cm^3 is :



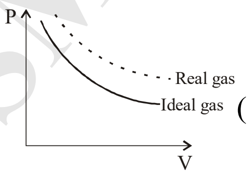
[**Given :** $R = \dfrac{22.4}{273}$ L atm K^{-1} mol^{-1} and $N_A = 6 \times 10^{23}$]

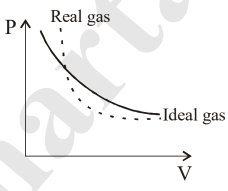
(A) 9.3×10^{-23} (B) 3.7×10^{-20} (C*) 9.3×10^{-22} (D) 5.6×10^{-20}

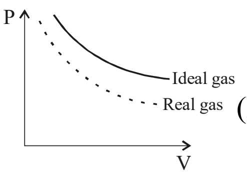
Q.8 If the number of molecules of SO_2 (M = 64) effusing through an orifice of unit area of cross section in unit time at 0°C and 1atm pressure is **'n'**. The number of He molecules (M = 4) effusing in unit time under similar conditions at 273°C and 0.25 atm is :

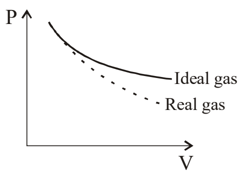
(A*) $\dfrac{n}{\sqrt{2}}$ (B) $\dfrac{n}{2}$ (C) 2n (D) $\sqrt{2}\,n$

Q.9 Which of the following graph is correct for ideal and real gas if fixed amount of gas is subjected to change in pressure and volume at constant temperature.

(A)


(B*)


(C)


(D)


Q.10 Which occurs when a substance is converted from liquid to gas at the normal boiling point?

I. Potential energy of the system increases
II. The distance between molecules increases
III. The average kinetic energy of the molecules increases

(A) II only (B*) I and II only (C) II and III only (D) I, II and III

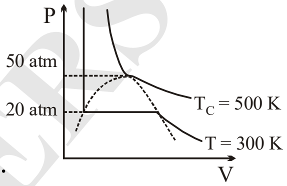
Q.11 The compressibility factor for 1 mole of a Vander Waal's gas at Boyle temperature is

(A*) $1 + \dfrac{b^2}{V(V-b)}$ (B) $1 - \dfrac{b}{V}$ (C) $1 + \dfrac{b}{V}$ (D) $1 - \dfrac{b^2}{V^2}$

Q.12 U_{avg} of O_2 at a pressure of 10π bar in a 8 litre vessel containing 2 moles is :

(A) $\sqrt{2\times10^3}$ m/sec (B) $\sqrt{10^3}$ m/sec (C*) 10^3 m/sec (D) $\sqrt{2\times10^6}$ m/sec

Q.13 For a real gas the P–V curve was experimentally plotted and it had the following appearance. With respect to liquification, choose the **correct** statement.



(A) At T = 500 K, P = 40 atm, the state will be liquid

(B) At T = 300 K, P = 50 atm, the state will be gas.

(C) At T < 300 K, P > 20 atm, the state will be gas

(D*) At 300 K < T < 500 K, P > 50 atm, the state will be liquid.

Paragraph for question nos. 14 to 15

Flask-1 contain two ideal gases A and B and their root mean square speeds are 800 and 500 ms^{-1} respectively. Now this flask was connected to another flask-2 [containing only A with root mean square speed 500 $m\,s^{-1}$] by a narrow tube of negligible volume and gases in the two flask were allowed to mix up to attain same final temperature.

Q.14 Which of the following statement regarding molar masses of A and B is true.

(A) molar mass of A is greater than molar mass B

(B*) molar mass of B is greater than molar mass A

(C) molar mass of A can be either greater or less than molar mass B

(D) None of these

Q.15 In the combined system

(A) A will be moving at U_{rms} less than 800 ms^{-1}, but B will be continue moving at its original U_{rms}.

(B) U_{rms} of A will decrease but U_{rms} of B will increase.

(C) U_{rms} of A & B both will decrease below to 500 ms^{-1}

(D*) U_{rms} of A will decrease below 800 ms^{-1} and U_{rms} of B will decrease below to 500 ms^{-1}

More than one correct :

Q.16 Identify the statements which are correct regarding ideal gas as per KTG.

(A*) At same temperature a lighter gas molecule may have greater momentum as compared to heavier gas molecule.

(B*) In a closed rigid container if temperature increases then distribution pattern will become more uniform.

(C*) Average relative speed of approach can be taken as $\sqrt{2}u_{avg}$.

(D) The fraction of molecules having speed U_{rms} will be more as compared to those having speed U_{avg}.

Q.17 A student collected two values of $P.V_m$ for a gas at two different temperatures (V_m is the molar volume of gas)

$P.V_m$ (l – atm)	20	40
Temperature(°C)	30	300

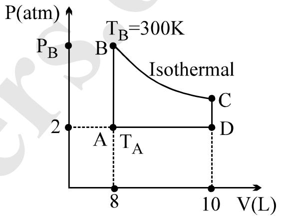
He considered the gas ideal. Which of the following **correct** values, he will get on applying ideal gas equation?

(A) 0 K = –273°C (B*) 0 K = –240°C
(C) R = 0.0821 l-atm/K-mol (D*) R = 0.0741 l-atm/K-mol

Q.18 Which of the following statements is / are correct with respect to behaviour of real gas.
(A*) For every Vander Waal gas at critical condition, attractive forces will be dominant.
(B*) The liquid and gaseous state can be distinguished only if the temperature is below the gas's critical temperature.
(C*) At very high pressures, real gases occupy greater volume as compared to ideal gas having same moles at same temperature and exerting same pressure.
(D*) For a real gas the 'y' intercept of $\frac{PV_m}{T}$ vs P curve where 'P' represents pressure (in atm), V_m represents molar volume and 'T' represents temperature in kelvin is equal to 0.0821 atm-litre/mol-Kelvin.

Q.19 A real gas obeying Vander Waal equation has a = 6.72 atm-lit^{2}mol^{-2} and b = 0.273 lit mol^{-1}. At what temperatures substance will exist only in gaseous state irrespective of pressure.
(A*) 400 K (B*) 200 K (C*) 90 K (D*) 150 K

Q.20 An ideal gas having 2 moles (fixed) is subjected to the changes as shown is (P–V) diagram. Select the correct option(s) from the following diagram.



(A) Temperature at "A" $\left(\frac{16}{R}\right)$; Pressure at "C" (60 R)

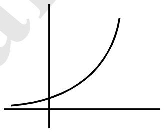
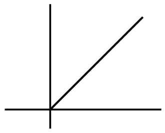
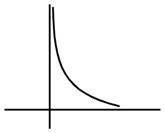
(B*) Temperature at "D" $\left(\frac{10}{R}\right)$; Pressure at "B" (75 R)

(C*) Temperature at "A" $\left(\frac{8}{R}\right)$; Pressure at "B" (75 R)

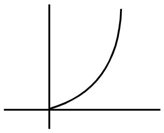
(D) Temperature at "D" $\left(\frac{5}{R}\right)$; Pressure at "C" (60 R)

Match the column :

Q.21 Match the description in **Column I** with graph provided in **Column II**. For n moles of ideal gas at temperature 'T'.

Column I	**Column II**
(A) $\frac{P}{V}$ vs P	(P) 
(B) $\frac{P}{V}$ vs V	(Q) 
(C) $\frac{V}{P}$ vs P^{-2}	(R) 

(D) $\frac{P}{V}$ vs $\log P$ (S)



[Ans. (A) S; (B) R, (C) Q; (D) P]

Q.22 Consider gas to be characterised by Vander Waal's equation.

	Column - I		Column - II
(A)	Free volume	(P)	Depends upon nature of gas
(B)	Critical temperature	(Q)	Constant quantity for a particular gas
(C)	Boyle's temperature	(R)	Depends upon pressure for a particular gas
(D)	Compressibility factor	(S)	Depends upon the radius of gas molecule

[Ans. (A) P,R,S (B) P,Q,S (C) P,Q,S (D) P,R,S]

Subjective :

Q.23 Two ideal gas samples are taken in separate equal volume container. Answer the following question using given data.

		Pressure	Temperature	σ	Mol. wt.
Gas	**A**	8 atm	1600 K	0.16 nm	20
Gas	**B**	1 atm	200 K	0.32 nm	40

(i) If $(z_{11})_A = x\,(z_{11})_B$: find x = ?

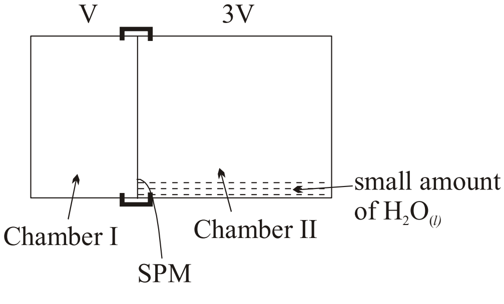
(ii) If $(z_1)_A = y\,(z_1)_B$: find y = ?

(iii) If $(u_{rms})_A = z\,(u_{rms})_B$: find z = ?

Represent your answer in OMR sheet as '0xyz'. [Ans. 0114]

Q.24 Calculate pressure exerted by 1 mole of a vander-Waal gas at a temperature of $\frac{8}{0.0821}$ K if volume of the molecule is assumed to be negligible and vander -Waal constant a = 2 atm-lit^{2}mole^{-2}.
Express answer in atm. [Ans. 8]

Q.25 A container is divided into two parts in the ratio 1 : 3 by a **fixed semi permeable membrane (SPM)** (which permits movement of NO_2 only) as shown. At temperature 'T' Kelvin **chamber I** consists of undissociated N_2O_4 at a pressure of 20 mm and **chamber II** contains small amount of li&Quid H_2O. The chambers are now heated to the temperature '1.2 T' Kelvin at which N_2O_4 dissociates by 50%.



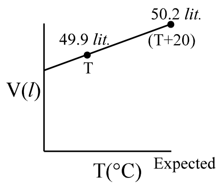
Given : The vapour pressure of water at 'T' Kelvin is 20 mm of Hg and the vapour pressure at '1.2T' Kelvin is 30 mm of Hg.
Assume H_2O does not completely evaporate at 'T' or '1.2T' Kelvin.

Calculate abcd where

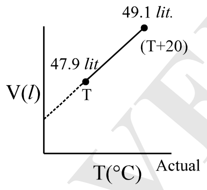
ab = two digit number representing pressure (in mm) in chamber I at '1.2T' Kelvin.

cd = two digit number representing pressure (in mm) in chamber II at '1.2T' Kelvin. [Ans. 1836]

Q.26 An ideal gas present in a container connected to frictionless, weightless piston is present at a fixed pressure P. The expected graph for the variation of volume with temperature was to be like as in (i), however actual observations revealed that the graph between V & T to be like (ii). The deviation was attributed to dissociation of gas as $D_m(g) \rightleftharpoons mD(g)$. If it is known that the above reaction gives only 60% yield. Find the value of m.



(i)



(ii)

[Ans. 6]

Q.27 A faulty barometer has some trapped air above the mercury column due to which it does not give the correct reading. When the atmospheric pressure is 760 mm of Hg, the barometer reads 750 mm of Hg and when the pressure is 800 mm of Hg it reads 770 mm of Hg. Calculate actual pressure (in mm of Hg) if barometer reads 760 mm of Hg. [Ans. 0775]

Q.28 The temperature and relative humidity of air on a certain day is 27°C and 80%. If the temperature of 10L of air sample is decreased to 7°C, the mass percent of water vapour which will condense, is (Vapour pressures of water at 27°C and 7°C are 25 mm Hg and 14 mm Hg, respectively.) [Ans. 0025]

Q.29 A 50 litre vessel is equally divided into three parts with the help of two stationary semi permeable membrane (SPM). The vessel contains 60 g H_2 gas in the left chamber, 160 g O_2 in the middle & 140 g N_2 in the right one. The left SPM allows transfer of only H_2 gas while the right one allows the transfer of both H_2 & N_2. Calculate the final ratio of pressure in the three chambers. [Ans. 4 : 7 : 5]

Q.30 How many of the following cases will have **Z (compressibility factor) > 1** at the specified conditions.

(1) **H_2 gas** at room temperature and normal pressure.

(2) **He gas** at a temperature less than its critical temperature at low pressures.

(3) **NH_3 gas** at room temperature and extremely high pressure.

(4) **He gas** at room temperature and normal pressure.

(5) **CH_4 gas** at room temperature and very high pressure.

(6) **H_2 gas** at a temperature less than its critical temperature at low pressures.

(7) **CO_2 gas** at room temperature and low pressures.

(8) **N_2 gas** at its critical condition.

(9) **H_2 gas** at its critical condition.

(10) **CH_4 gas** at low to moderate pressure and at a temperature greater than Boyle's temperature.

[Ans. 0005]

REVISION FLOW CHART

Gaseous State

- **Ideal Gas**
  - *Ideal Gas Laws*
    - Boyle's law
    - Charle's law (G) + (N)
    - Gay lussac's law
    - Avogadro's law
    - Amagat's law
    - Dalton's law of partial pressure
    - Graham's law of diffusion/effusion
      - Variable rate of diffusion (N)
      - Isotopic separation factor (N)
  - *Kinetic Theory of gases*
    - Postulates of KTG (T)
    - Kinetic gas equations
    - Different type of velocities (U_{avg}, U_{mp}, U_{rms})
    - Kinetic energy calculation
  - *Maxwell's speed distribution law* (T)+(G)
    - Variation of graph with temperature and molecular mass
  - *Collisions in gases* (T)
    - Collision diameter
    - Collision frequency(Z_1 & Z_{11})
    - Mean free path
- **Real Gas**
  - *Vanderwaal's Equation*
    - Significance of a & b (N)+(T)
    - Approximation in vanderwaal's equation in different conditions of temperature and pressure
  - *Compressibility factor(Z)* (T)
    - Variation of Z with P at normal temperature (G)
    - Variation of Z with P at very low temperature
    - Variation of Z with P and T for different gases
    - Boyle's temperature
  - *Liquefaction of gases*(T)+(G)
    - Critical constants
  - *Reduced perameters (P_r, V_r & T_r) & law of corresponding states*
  - *Other equations*
    - Berthelot's equation
    - Virial equation
    - Dieterici equation

(G) → represents topic of graphical importance

(T) → represents topic of theoretical importance

(N) → represents topic of numerical importance

GASEOUS STATE

Gas Constant : $R = 0.0821$ L-atm/mole-K

$= 8.314$ J/mole-K

$= 1.98$ cal/mole-K

$= 8.314 \times 10^7$ ergs/mole

Boltzmen's constant $K = \dfrac{R}{N_A}$

Pressure conversion

1 atm $= 1.01325 \times 10^5$ N/m^2 or pascal $= 760$ mm of Hg $= 760$ torr $= 76$ cm of Hg

$= 1.01325$ bar $= 1.01325 \times 10^6$ dyne/cm^2

Volume Conversion

1 m^3 $= 10^3$ L $= 10^3$ dm^3 $= 10^6$ cm^3 $= 10^6$ ml

Temp Conversion

T (in Kelvin) = t(ºC) + 273 ; $\dfrac{F-32}{9} = \dfrac{C}{5}$

LIST OF IMPORTANT FORMULAS

Graham's Law of diffusion / effusion:

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \text{ (at const P \& T)} \qquad \frac{r_1}{r_2} = \frac{P_1}{P_2}\sqrt{\frac{M_2}{M_1}} \text{ (at const T)}$$

$$\frac{r_1}{r_2} = \frac{P_1}{P_2}\sqrt{\frac{M_2T_2}{M_1T_1}}$$

Variable rate of diffusion :

$$-\frac{dP}{dt} = k\frac{P}{\sqrt{M}} \text{ (at const T)} \qquad \ln\frac{P_2}{P_1} = \frac{k}{\sqrt{M}}t$$

Isotopic separation factor :

$$\frac{\dfrac{n_{f\,LG}}{n_{f\,HG}}}{\dfrac{n_{i\,LG}}{n_{iHG}}} = \left(\frac{M_{HG}}{M_{LG}}\right)^{P/2}$$

M ⇒ Molar mass LG ⇒ Lighter gas HG ⇒ Heavier gas

P $\Rightarrow$ No. of steps reqd. n_i = initial mole n_f = final mole

Degree of dissociation :

$$\alpha = \frac{D-d}{(n-1)d}$$

$\alpha \Rightarrow$ degree of dissociation

D $\Rightarrow$ Theoritical V.D.

d $\Rightarrow$ observed V.D.

Kinetic theory of gases :

$$U_{rms} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3RT}{M_o}} = \sqrt{\frac{3P}{d}}$$

M $\Rightarrow$ total mass of gas taken

$$U_{mp} = \sqrt{\frac{2RT}{M_0}} = \sqrt{\frac{2PV}{M}} = \sqrt{\frac{2P}{d}}$$

$M_0 \Rightarrow$ Molar mass of gas

$$U_{avg} = \sqrt{\frac{8RT}{\pi M_o}} = \sqrt{\frac{8PV}{\pi M}} = \sqrt{\frac{8P}{\pi d}}$$

K.E. of n moles = $\frac{3}{2}$ nRT

Maxwell's speed distribution law :

- $$dN_u = 4\pi N\left(\frac{M_o}{2\pi RT}\right)^{3/2} u^2 e^{-\frac{M_0 u^2}{2RT}} du$$

Collisions in gases :

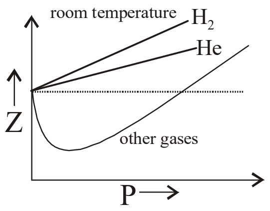
(Mean free path) $\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 N^*}$ (N* = No. of molecules per unit volume)

$Z_1 = \sqrt{2}\pi\sigma^2 N^* \; U_{avg}$ (Z_1 = No. of collision made by one molecule in one second)

$Z_{11} = \frac{1}{\sqrt{2}}\pi\sigma^2 (N^*)^2 \; U_{avg}$ (Z_{11} = No. of collision occuring per unit volume per second)

Vander Waal's equation:

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



at high pressure

$$P(V-nb)=nRT$$

at low pressure

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

For H_2/He

$P(V–nb) = nRT$

Critical constants :

$$T_c=\frac{8a}{27Rb}\qquad P_c=\frac{a}{27b^2}\qquad V_c=3b$$

at critical condition

$$\left(\frac{\partial P}{\partial V}\right)_{T_c}=0\quad\left(\frac{\partial^2 P}{\partial V^2}\right)_{T_c}=0$$

Boyle's Temperature :

$$T_b=\frac{a}{Rb}$$

at T_B $\left[\frac{\partial(PV)}{\partial P}\right]_{T_B}=0$ or $\left[\frac{\partial(PV)}{\partial V}\right]_{T_B}=0$

(For low pressure region)

LAST MOMENT REVIEW

GASEOUS STATE

Theory : ....

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Exercise - 1 : Question ....

Exercise - 2 : Question ....

Exercise - 3 : Question ....

Exercise - 4 : Question ....

DPPs : ....

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Other Sources : ....

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