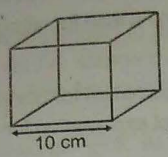
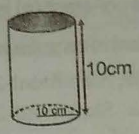
9.22 There are three closed containers in which equal amount of the gas are filled.



(I)

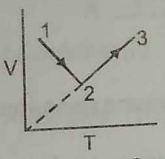


(II)

(III)

If the containers are placed at the same temperatures then find the correct options :
(A) Pressure of the gas is minimum in (III) container
(B) Pressure of the gas is equal in (I) & (II) container
(C) Pressure of the gas is maximum in (I)
(D) The ratio of pressure in II and III container is 3 : 4

9.23 Following graph is constructed for the fixed amount of the gas.



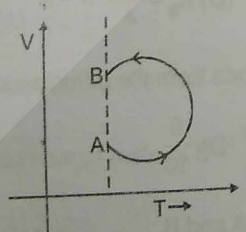
(A) From 1 - 2 pressure will increase
(B) From 2 - 3 pressure remains constant
(C) Gas pressure at (3) is greater at state (1)
(D) From 1 - 2 pressure will decrease

9.24 A gaseous organic compound has a density of 2.5 kg/m^3 at 2 atm and at 273°C. The molecular formula of the compound can be :
(A) $C_3H_4O_2$ (B) C_4H_4 (C) C_3H_4O (D) C_4H_8

9.25 Two flask A and B have equal volumes. Flask A contains hydrogen at 600 K while flask B has same mass of CH_4 at 300 K. Then choose the correct options.
(A) In flask A the molecules move faster than B
(B) In flask B the molecules move faster than A
(C) Flask A contains greater number of molecules than B
(D) Flask B contains more molecules than A

9.26 Which of the following statements is/are true :
(A) The ratio of the mean speed to the rms speed is independent of temperature of gas.
(B) The square of the mean speed of the molecules is equal to the mean squared speed at a certain temperature.
(C) Mean translational kinetic energy of the gas molecules at any given temperature is independent of the molecular mass of gas.
(D) The difference between rms speed and mean speed at any temperature for different gases diminishes as larger and yet larger molar masses are considered.

9.27



With reference to the above graph, choose the correct alternatives
(A) $P_B > P_A$ (B) $P_A > P_B$
(C) Pressure first increases then decreases (D) Pressure first decreases then increases

SECTION - III : ASSERTION AND REASON TYPE

9.28 **STATEMENT-1 :** The value of vander waal's constant (a) is larger for ammonia than for nitrogen.
STATEMENT-2 : Hydrogen bonding is present in ammonia.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

9.29 **Statement-1 :** In a container containing gas 'A' at temperature 400 K, some more gas A gas at temperature 300 K is introduced. The pressure of the system increases.
Statement-2 : Increase in gaseous particles increases the number of collisions among the molecules, hence the pressure increases.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

9.30 **STATEMENT-1 :** The area under the maxwell distribution molecular speed curve remains same irrespective of temperature of gas.
STATEMENT-2 : The fraction of molecules with most probable speed increases with increase of temperature.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

SECTION - IV : COMPREHENSION TYPE

Comprehension # 2

Gas 'A' (Molar Mass of A = 128 g mol^{-1}) is taken in a closed container at the initial total pressure of 1000 mm of Hg. Pressure of the gas decreases to 900 mm in 5 seconds due to the diffussion through square cross section. Another similar size container is taken in which gaseous mixture of A and B are taken. (Molar mass of the mixture is $\frac{472}{5}$) at the total pressure of 5000 mm (molar mass of B = 72 g mol^{-1}). A rectangular cross-section is made in this container and gases are allowed to diffuse. Width of this rectengular cross-section is same as the side of the square cross section and length of the rectangular cross-section is 50% more than the width. Assume that the gases A and B are non reacting and rate of diffusion of the gases are only dependent upon the initial total pressure and it is independent of the change in the pressure due to diffusion. Assume all other conditions to be identical.

9.31 Gas diffused out initially from 2nd container has composition :

(A) $\frac{1}{A}=\frac{3}{7}$ (B) $X_B=\frac{3}{5}$ (C) $X_A=\frac{1}{3}$ (D) $X_B=\frac{1}{4}$

9.32 Ratio of the number of moles of A and B left in the container after 10 seconds from the diffusion starts is :

(A) $\frac{7}{9}$ (B) $\frac{2}{3}$ (C) $\frac{8}{11}$ (D) $\frac{9}{13}$

9.33 What is the time after which container will have same number of moles of A and B :

(A) 15 sec. (B) 50 sec. (C) 25 sec. (D) $\frac{50}{3}$ sec.

Comprehension # 1

The system shown in the figure is in equilibrium, where A and B are isomeric liquids and form an ideal solution at TK. standard vapour pressure of A and B are $P_A°$ and $P_B°$ respectively at TK. We collect the vapour of A and B in two container of volume V, first container is maintained at 2TK and second container is maintained at $\frac{3T}{2}$ K. At the temperature greater than TK, both A and B exist in only gaseous form. Total vapour pressure of the system at TK is given as

$$P = P_A°X_A + P_B°X_B$$

where X_A and X_B are the mole fraction of A and B in a liquid mixture.

In container (1)

We assume that collected gases behave ideally at 2TK and there can take place isomerisation reaction in which A converted into B by first order kinetics

Reaction is given as

$$A \xrightarrow{K} B$$

In container (II)

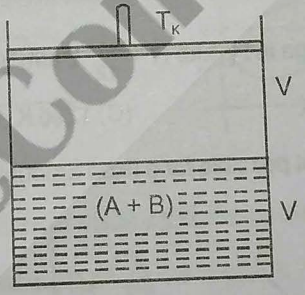
At the given temperature $\frac{3T}{2}$, A and B are ideal in nature and non mixing in nature. A small pin hole is made into container. We can determine the initial rate of effusion of both gases in vaccum by the expression

$$r = \frac{kp}{\sqrt{m}}$$

Where P = pressure difference between system and surrounding

K = positive constant

M = Molecular weight of the gas.



9.34 If partial vapour pressure of A is twice that of partial vapour presure of B and total V.P. is equal to 2 at T = 50 K and V = 8.21 lit, then number of mole of A and B in vapour phase is :

(A) $\frac{8}{3}, \frac{4}{3}$ (B) 3, 1 (C) 2, 2 (D) 1, 3

9.35 Vapour is collected and passed into a container of volume 8.21 lit, maintainer at 100 K and after 5 min number of mole of B = $\frac{8}{3}$. Then calculate pressure develop into the container after two half lives.

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

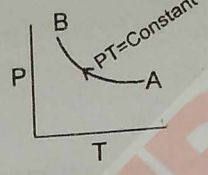
9.36 If vapour is collected in container of volume 8.21 lit maintained at 75 K then ratio of initial rate of effusion of Gas A and B is given as :

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

Comprehension # 3

When a sample of ideal gas is changed from an initial state to a final state, various curves can be plotted for the process like P–V curve, V–T curve, P–T curve etc.
For example, P–V curve for a fixed amount of an ideal gas at constant temperature is a rectangular hyperbola, V–T curve for a fixed amount of an ideal gas at constant pressure is a straight line and P–T curve for a fixed amount of an ideal gas at constant volume is again a straight line. However, the shapes may vary if the constant parameters are also changed.
Now, answer the following questions :

9.37 Which of the following statements is correct regarding a fixed amount of ideal gas undergoing the following process :



(A) Root mean square (RMS) speed of gas molecules increases during the process A → B.

(B) Density of the gas increases during the process A → B.

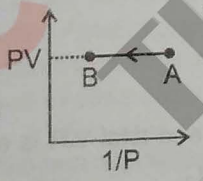
(C) Such a graph is not possible.

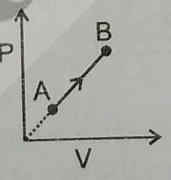
(D) If $P_B = 4P_A$, then $V_A = 4V_B$ (where P_A, V_A, P_B & V_B represent pressure and volume values at states A and B).

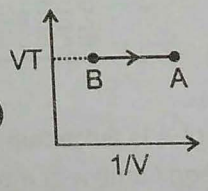
9.38 Two moles of an ideal gas is changed from its initial state (16 atm, 6L) to final state (4 atm, 15L) in such a way that this change can be represented by a straight line in P–V curve. The maximum temperature attained by the gas during the above change is : (Take $R = \frac{1}{12}$ L atm K^{-1} mol^{-1})

(A) 324 K (B) 648 K (C) 1296 K (D) 972 K

9.39 Which of the following graphs is not possible for a fixed amount of ideal gas upon moving from initial state A to final state B :

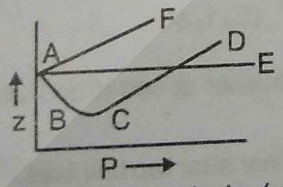
(A)


(B)


(C)


(D) None of these

9.40 The figure shows the effect of pressure on the compressibility factor, Z of a gas :



The wrong conclusion(s) is/are -

(A) The curve AE can be explained by PV = RT

(B) The curve AF and CD can be explained by PV = RT + Pb

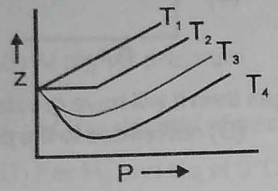
(C) The curve AB can be explained by $PV = RT - \frac{a}{V}$

(D) All the three curves AF, AE and AD shows the real behaviour

9.41 Two vander waals gases have same value of 'a' but different value of b which of the following statement is correct.
(A) The smaller the value of b larger will be compressibility
(B) The larger the value of b, larger will be compressibility
(C) Both have same compressibility
(D) The gas with smaller value of b will occupy larger volume

9.42 Two Vander waals gases have same value 'b' but different 'a' value then which of the following statement is correct under similar condition.
(A) Both gases will occupy same volume
(B) Gas having a larger value of 'a' will occupy lesser volume
(C) Gas having a larger value of 'a' will occupy larger valume
(D) Can not be predicted

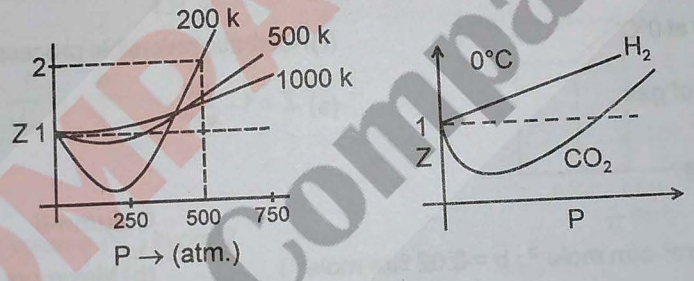
9.43 From the given plot between Z and P for a real gas the correct is :



(A) $T_1 = \frac{2a}{Rb}$ (B) $T_2 = \frac{a}{Rb}$ (C) $T_3 = \frac{a}{Rb}$ (D) $T_4 = \frac{2a}{Rb}$

Comprehension # 5

Sketch shows the plot of Z v/s P for of a hypothetical gas for one mole at three distinct temperature.



Boyle's temperature is the temperature at which a gas shows ideal behaviour over a pressure range in the low pressure region. Boyle's temperature $(T_b) = \frac{a}{Rb}$. If a plot is obtained at temperatures well below Boyle's temperature then the curve will show negative deviation, in low pressure region and positive deviation in the high pressure region. Near critical temperature the curve is more likely as CO_2 and the temperature well above critical temperature curve is more like H_2 at 0^0C as shown above. At high pressure suppose all the constant temperature curve varies linearly with pressure according to the following equation: $Z = 1 + \frac{Pb}{RT}$

$(R = 2 \text{ cal mol}^{-1} K^{-1})$.

9.44 Which of the following is correct :

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

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

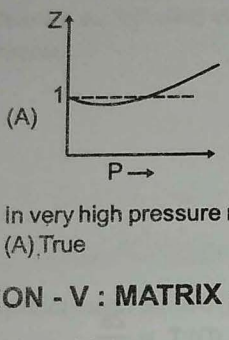
9.45 For 500 K plot value of Z changes from 2 to 2.2 if pressure is varied from 1000 atm to 1200 atm (high pressure) then the value of $\frac{b}{RT}$ will be

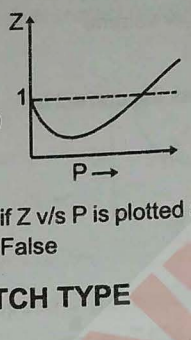
(A) 10^{-3} atm^{-1} (B) 2×10^{-3} atm^{-1} (C) 5×10^{-4} atm^{-1} (D) 10^{-4} atm^{-1}

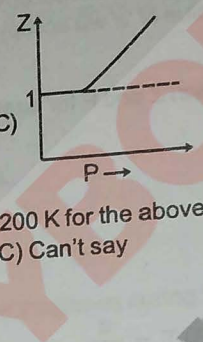
9.46 As shown in the figure at 200 K and 500 atm value of compressibility factor is 2 (approx). Then volume of the gas at this point will be

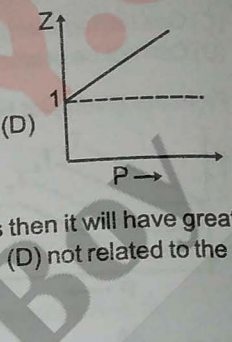
(A) 0.01 L (B) 0.09 L (C) 0.065 L (D) 0.657 L

9.47 Plot at Boyle's temperature for the gas will be

(A) 

(B) 

(C) 

(D) 

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

(A) True (B) False (C) Can't say (D) not related to the paragraph

SECTION - V : MATRIX - MATCH TYPE

9.49 **Match List**

Column- I	**Column- II**
(A) PV^{γ} = Constant	(p) Expansion of ideal gas in vacuum
(B) $\Delta T = O$	(q) $Z = 1 - \frac{a}{V_m RT}$
(C) For H_2 and He at 0°C	(r) Adiabatic reversible process
(C) At low density of gas	(s) $Z = 1 + \frac{pb}{RT}$

9.50 Match the following :

Column-I	**Column-II**
(A) H_2 ($a = 0.244$ litre^2-atm mole^{-2} ; $b = 0.02$ litre mole^{-1})	(p) Maximum boiling point
(B) He ($a = 0.03412$ litre^2-atm mole^{-2} ; $b = 0.02370$ litre mole^{-1})	(q) Minimum boiling point
(C) CO_2 ($a = 3.592$ litre^2-atm mol^{-2} ; $b = 0.0426$ litre mole^{-1})	(r) Crictial temperature < Boyle temp.
(D) H_2O ($a = 5.464$ litre^2-atm mol^{-2} ; $b = 0.03049$ litre mole^{-1})	(s) Minimum critical temperature
	(t) Minimum Boyle temperature

9.51 Single option match maxtix :

Column-I	**Column-II**
(A) $(V_m - b)\left(P + \frac{a}{V_m^2}\right) = RT$	(p) Isotherm
(B) R/N	(q) Isobar
(C) Molar volume	(r) Equation for real gases.
(D) Graph between P and V at constant temperature	(s) 22.4 litre at STP
(E) Graph between V and T at constant pressure	(t) Boltzmann's constant.

9.52

Column I	Column II
(A) An unknown gas at STP having Boyle's temperature 0°C	(p) Behaves as an ideal gas
(B) He gas at NTP having density less than $\frac{1}{5.6}$ g/L.	(q) Attractive tendencies are dominant between molecules
(C) H_2 gas at NTP	(r) Gas is less compressible with respect to an ideal gas
(D) O_2 gas at NTP having density $\frac{10}{7}$ g/L	(s) For gas, Critical temperature < Boyle's temperature
	(t) Molar volume of gas is greater than 22.4 L

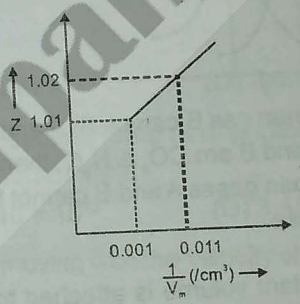
9.53

Column – I	Column – II
(A) At low pressure	(p) $Z = 1 + \frac{pb}{RT}$
(B) At higher pressure	(q) $Z = 1 - \frac{a}{V_m RT}$
(C) At low density of gas	(r) gas is more compressible than ideal gas
(D) For H_2 and He at 0°C	(s) gas is less compressible than ideal gas

SECTION - VII : SUBJECTIVE ANSWER TYPE

9.54 Consider the following graph of Z vs $\frac{1}{V_m}$ drawn at low pressure and inversion temperature, using the virial form of vanderwaal's equation :

$$Z = 1 + \left(b - \frac{a}{RT}\right)\frac{1}{V_m} + \frac{b^2}{V_{m^2}} + \frac{b^3}{V_{m^3}} + \ldots\ldots\ldots$$

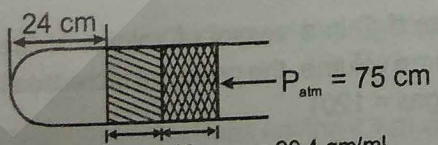


Find critical molar volume (V_c) in cm^3?

9.55 Consider the following figure at 500 K. Assuming ideal gas behaviour, calculate the total pressure if the barriers are removed from the compartment. Assume that the volume of barriers is negligible .

Gas A	Gas B	Gas C	Gas D
1 L	1.5 L	2.5 L	2 L
1 atm	2 atm	4 atm	3 atm

9.56



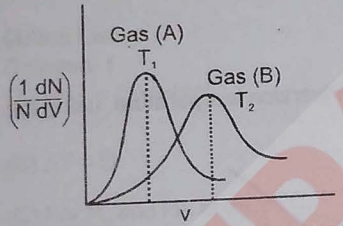
If above tube is placed vertically with the open end upward then find the length of the air column.

9.57 In a tyre of "Ferrari" car of Mr. Obama, a tube having a volume of 12.3 litres is filled with air at a pressure of 4 atm at 300 K. Due to travelling, the temperature of the tube and air inside it raised to 360 K and pressure reduced to 3.6 atm in 20 minutes. If the porosity (number of pores per unit area) of the tube material is 5×10^5 pores/cm² and each pore can transfer air from inside to outside of the tube with the rate of 6.023×10^8 molecules per minute. Calculate the total surface area (m²) of the tube. (R = 0.082 Lt - atm / mole - K)
Give your answer divide by 100.

9.58 2 moles of Ne gas and 5 moles of He gas, both samples having average velocity 7×10^2 m/s, are mixed. Find the average translational kinetic energy per mole of the given gas mixture (in joules). Report your answer as 'X' where X = (Average translational KE in joules) × 0.002. The reported answer should be upto nearest integer.

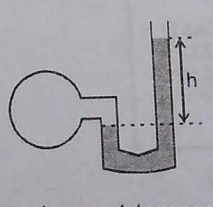
9.59 Two glass bulbs of equal volume and filled with an ideal gas at 500 K and pressure of 76 cm of Hg, are connected by a narrow tube. One of the bulb is then placed in a water bath maintained at 700 K and the other bulb is maintained at 500 K. What is the new value of the pressure (in cm of Hg) inside the bulbs ? The volume of the connecting tube is negligible. Report your answer after multiplying by $\frac{6}{7}$.

9.60 According to Maxwell's distribution of molecular speeds, the following graph has been drawn for two different samples of gases A and B at temperature T_1 and T_2 respectively. Then, give the correct set of INCORRECT statements : Report your answer as sum of the numbers of incorrect statements.
For example, if statements (1) & (2) are incorrect, then report answer as (1 + 2) = 3.



(1) If $T_1 = T_2$, then gas B can be SO_2 and gas A can be CO_2.
(2) If gases A and B are CO_2 & N_2O, then $T_1 > T_2$.
(3) If $T_1 < T_2$, then gases A and B cannot be CO_2 and SO_2 respectively
(4) None of these

9.61 A bulb of constant volume is attached to a manometer tube open at other end as shown in figure. The manometer is filled with a liquid of density (1/3)rd that of mercury. Initially h was 228 cm. Through a small hole in the bulb gas leaked causing pressure decrease as $\frac{dp}{dt} = -kP$. If value of h is 114 cm after 7 minutes. Calculate value of k in units of hour^{-1}. (Report answer in multiple of 10^{-1})
[Use : ln (4/3) = 0.28 & density of Hg = 13.6 g/ml]



9.62 The pressure exerted by 12 g of an ideal gas at temperature t° C in a vessel of volume V litre is one atm.When the temperature is increased by 10 degree at the same volume, the pressure increases by 10%. Calculate the temperature t in kelvin. (Molecular weight of the gas = 120)

9.63 A 4:1 molar mixture of He and CH_4 is contained in a vessel at 20 bar pressure. Due to a hole in the vessel, the gas mixture leaks out. What is the composition of the mixture effusing out initially?

TOPIC 10

10.1 The wave mo
electron in the

(A) –3.4 eV

10.2 For a hypo
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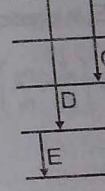

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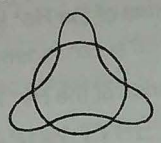
10.8

10.9

TOPIC 10

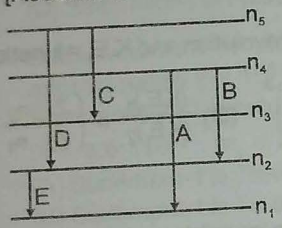
ATOMIC STRUCTURE

10.1 The wave motion of electron in a Bohr's orbit of hydrogen is as shown in diagram. The potential energy of electron in the given orbit of hydrogen atom is :



(A) –3.4 eV (B) + 3.4 eV (C) –3.02 eV (D) –1.51 eV

10.2 For a hypothetical H like atom which follows Bohr's model, some spectral lines were observed as shown. If it is known that line 'E' belongs to the visible region, then the lines possibly belonging to ultra violet region will be (n_1 is not necessarily ground state)
[Assume for this atom, no spectral series shows overlap with other series in the emmission spectrum]



(A) B and D (B) D only (C) C only (D) A only

10.3 The number of photons emitted in 10 hours by a 60 W sodium lamp (λ of photon = 6000 Å)
[Take hc = 12400 eVÅ, h = Planck's constant, c = speed of light]
(A) 6.50×10^{24} (B) 6.40×10^{23} (C) 8.40×10^{23} (D) 3.40×10^{23}

10.4 The De-broglie wavelength of a tennis ball of mass 66 g moving with the velocity of 10 metre per second is approximately :
(A) 10^{-35} metres (B) 10^{-33} metres (C) 10^{-31} metres (D) 10^{-36} metres

10.5 The photon emitted due to electronic transition from 5^{th} excited state to 2^{nd} excited state in Li^{2+}, is used to excite He^+ already in first excited state. He^+ ion after absorbing the photon reaches in an orbit having total energy equal to :
(A) –3.4eV. (B) –13.6eV. (C) –6.8eV. (D) –27.2eV.

10.6 A proton accelerated from rest through a potential difference of 'V' volts has a wavelength λ associated with it. An alpha particle in order to have the same wavelength must be accelerated from rest through a potential difference of
(A) V volt (B) 4V volt (C) 2V volt (D) $\frac{V}{8}$ volt

10.7 The ionization energy of hydrogen atom in terms of Rydberg constant (R_H) is given by the expression
(A) $R_H hc$ (B) $R_H c$ (C) $2R_H hc$ (D) $R_H N_A hc$

10.8 Number of electrons having $\ell + m$ value equal to zero in $_{26}Fe$ may be
(A) 13 (B) 14 (C) 7 (D) 12

10.9 The ratio of the "e/m" (specific charge) values of a electron and an α-particle is
(A) 2 : 1 (B) 1 : 1 (C) 1 : 2 (D) None of these

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

10.10 Which of the following statement is correct for $3d_{xy}$ orbitals?
(A) The orbitals drawn has two nodal planes, xz and yz.
(B) The minimum probability point lie along $\theta = 45°$.
(C) + ve and – ve signs represent sign of amplitude of electron wave.
(D) It is a non-axial orbital.

10.11 If the wave number of 1st line of Balmer series of H-atom is 'x' then :
(A) Wave number of 1st line of lyman series of the He^+ ion will be $\frac{108\,x}{5}$
(B) Wave number of 1st line of lyman series of the He^+ ion will be $\frac{36x}{5}$
(C) The wave length of 2nd line of lyman series of H-atom is $\frac{5}{32x}$
(D) The wave length of 2nd line of lyman series of H-atom is $\frac{32x}{5}$

10.12 Electrons are revolving around the nucleus in n_1^{th} orbit of an atom, have atomic number Z_1, and in the n_2^{th} orbit of other atom, have atomic number Z_2, then
[Where P = Linear momentum, L = Angular momentum, f = frequency of revolution and K.E. = kinetic energy]
(A) $\frac{L_1}{L_2} = \frac{n_1}{n_2}$ (B) $\frac{P_1}{P_2} = \frac{Z_1 n_2}{Z_2 n_1}$ (C) $\frac{f_1}{f_2} = \left(\frac{Z_2}{Z_1}\right)^2 \left(\frac{n_1}{n_2}\right)^3$ (D) $\frac{(K.E.)_1}{(K.E.)_2} = \left(\frac{Z_1}{Z_2}\cdot\frac{n_2}{n_1}\right)^2$

10.13 Which of the following statements is/are INCORRECT :
(A) All spectral lines belonging to Balmer series in hydrogen spectrum lie in visible region.
(B) If a light of frequency ν falls on a metal surface having work function $h\nu$, photoelectric effect will take place only if $\nu \le \nu_0$.
(C) The number of photoelectrons ejected from a metal surface in photoelectric effect depends upon the intensity of incident radiations.
(D) The series limit wavelength of Balmer series for H-atom is $\frac{4}{R}$, where R is Rydberg's constant.

10.14 Select the correct statement(s) :
(A) The value of spin only magnetic moment of Co^{3+} ion (in BM) = $\sqrt{24}$
(B) The number of radial nodes in a 3p-orbital = 1
(C) The number of electrons with (m = 0) in Mn^{2+} ion = 11
(D) The orbital angular momentum for the unpaired electron in $V^{4+} = \frac{\sqrt{6}\,h}{4\pi}$

10.15* Select the correct statement (s) :
(A) Radial function [R(r)] a part of wave function is dependent on quantum number n only
(B) Angular function depends only on the direction and is independent to the distance from the nucleus
(C) $\Psi^2(r, \theta, \phi)$ is the probability density of finding the electron at a particular point in space
(D) Radial distribution function $(4\pi r^2 R^2)$ gives the probability of the electron being present at a distance r from the nucleus

10.16 In a hydrogen like sample two different types of photons A and B are produced by electronic transition. Photon B has it's wavelength in infrared region if photon A has more energy than B, then the photon A may belong to the region.
(A) ultraviolet (B) visible (C) infrared (D) None

10.17 Hydrogen atoms in a particular excited state 'n', when all returned to ground state, 6 different photons are emitted. Which of the following is/are incorrect.
(A) out of 6 different photons only 2 photons have speed equal to that of visible light.
(B) If highest energy photon emitted from the above sample is incident on the metal plate having work function 8 eV, KE of liberated photo-electron may be equal to or less than 4.75 eV.
(C) Total number of radial nodes in all the orbitals of n^{th} shell is 14.
(D) Total number of angular nodes in all the orbitals in $(n-1)^{th}$ shell is 13.

10.18 In a H-like sample electrons make transition from 4^{th} excited state to 2^{nd} state then
(A) 10 different spectral lines are observed
(B) 6 different spectral lines are observed
(C) number of lines belonging to the balmer series is 3
(D) Number of lines belonging to paschen series is 2.

SECTION - III : ASSERTION AND REASON TYPE

10.19 **Statement-1 :** e/m ratio in case of anode ray experiment is different for different gases.
Statement-2 : The ion of gases formed after the ejection of electron are different if gas is different.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

10.20 **Statement-1 :** If an electron is located within the range of 0.1 Å then the uncertainty in velocity is approximately 6×10^6 m/s.
Statement-2 : Trajectory (path of motion) of above electron can be defined.
[$h = 6.6 \times 10^{-34}$, $m_e = 9.1 \times 10^{-31}$ kg]
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

SECTION - IV : COMPREHENSION TYPE

Comprehension # 3

DEFINITION VALID FOR SINGLE ELECTRON SYSTEM :

Ground state :
Lowest energy state of any atom or ion is called ground state of the atom. It is n = 1.

Excited State :
States of atom other than the ground state are called excited states.

Ionisation energy (IE) :
Minimum energy required to move an electron from ground state to $n = \infty$ is called ionisation energy of the atom or ion.

Ionisation Potential (I.P.) :
Potential difference through which a free electron must be accelerated from rest, such that its kinetic energy becomes equal to ionisation energy of the atom is called ionisation potential of the atom.

Excitation Energy :
Energy required to move an electron from ground state of the atom to any other state of the atom is called excitation energy of that state.

Excitation Potential :
Potential difference through which an electron must be accelerated from rest to so that its kinetic energy become equal to excitation energy of any state is called excitation potential of that state.

Binding Energy 'or' Seperation Energy :
Energy required to move an electron from any state to $n = \infty$ is called binding energy of that state.

The wavelength of the photon emitted upon an electronic transition from n_2 to n_1 orbit in a H-like species is given by the formula :

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Now answer the following questions :

10.21 If the binding energy of II excited state of a H-like species is 13.6 eV, then :
(A) The atomic number Z of given H-like species is 2.
(B) A photon of energy 30 eV can ionise an electron from I excited state of given H-like species.
(C) Upon de-excitation from n = 4 to n = 2 in given H-like species, the emitted photon has wavenumber

$\bar{\nu} = \frac{3R}{16}$ (R = Rydberg's constant)

(D) Ionisation potential of given H-like species is 122.4 V.

10.22 If the wavelength of photon emitted from an electron jump n = 4 to n = 2 in a H-like species is 1216 Å, then the species is :
(A) H-atom (B) He^+ ion (C) Li^{2+} ion (D) Be^{3+} ion

10.23 If the I excitation potential of a hypothetical H-like atom is 162 V, then the value of II excitation energy is about :
(A) 192 eV (B) 30 eV (C) 216 eV (D) 40.5 eV

Comprehension # 1

If hydrogen atoms (in the ground state) are passed through an homogeneous magnetic field, the beam is split into two parts. This interaction with the magnetic field shows that the atoms must have magnetic moment. However, the moment cannot be due to the orbital angular momentum since $\ell = 0$. Hence one must assume existence of intrinsic angular momentum, which as the experiment shows, has only two permitted orientations.

Spin of the electron produces angular momentum equal to $s = \sqrt{s(s+1)}\frac{h}{2\pi}$ where $s = +\frac{1}{2}$.

Total spin of an atom = $+\frac{n}{2}$ or $-\frac{n}{2}$

where n is the number of unpaired electron.
The substance which contains species with unpaired electrons in their orbitals behave as paramagnetic substances. The paramagnetism is expressed in terms of magnetic moment.
The magnetic moment of an atom

$$\mu_s = \sqrt{s(s+1)}\frac{eh}{2\pi mc} = \sqrt{\frac{n}{2}\left(\frac{n}{2}+1\right)}\frac{eh}{2\pi mc} \qquad s = \frac{n}{2}$$

$$\Rightarrow \quad \mu_s = \sqrt{n(n+2)}\ \text{B.M.}$$

n – number of unpaired electrons

$$1.\ \text{B.M. (Bohr magneton)} = \frac{eh}{4\pi mc}$$

If magnetic moment is zero the substance is diamagnetic.

10.24 Which of the following ion has highest magnetic moment ?
(A) Fe^{2+} (B) Mn^{2+} (C) Cr^{3+} (D) V^{3+}

10.25 If an ion of $_{25}Mn$ has a magnetic moment of 3.873 B.M. Then Mn is in which state.
(A) + 2 (B) + 3 (C) + 4 (D) + 5

10.26 Which of the following is a paramagnetic substance.
(A) Mg^{2+} (B) Cu^{+} (C) Mn^{+7} (D) Ti^{+2}

10.27 The number of unpaired electrons in Mn^{4+} (Z = 25) is -
(A) Four (B) Two (C) Five (D) Three

Comprehension # 2

The French physicist Louis de Broglie in 1924 postulated that matter, like radiation, should exhibit a dual behaviour. He proposed the following relationship between the wavelength λ of a material particle, its linear momentum p and planck constant h.

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

The de Broglie relation implies that the wavelength of a particle should decrease as its velocity increases. It also implies that for a given velocity heavier particles should have shorter wavelength than lighter particles. The waves associated with particles in motion are called matter waves or de Broglie waves. These waves differ from the electromagnetic waves as they
(i) have lower velocities
(ii) have no electrical and magnetic fields and
(iii) are not emitted by the particle under consideration.
The experimental confirmation of the de Broglies relation was obtained when Davisson and Germer, in 1927, observed that a beam of electrons is diffracted by a nickel crystal. As diffraction is a characteristic property of waves, hence the beam of electron behaves as a wave, as proposed by de broglie.

10.28 If proton, electron and α-particle are moving with same kinetic energy then the order of their de-Broglie's wavelength.
(A) $\lambda_p > \lambda_e > \lambda_\alpha$ (B) $\lambda_\alpha > \lambda_p > \lambda_e$ (C) $\lambda_\alpha < \lambda_p < \lambda_e$ (D) $\lambda_e = \lambda_p < \lambda_\alpha$

10.29 Using Bohr's theory, the transition, so that the electrons de-Broglie wavelength becomes 3 times of its original value in He^{+} ion will be
(A) $2 \longrightarrow 6$ (B) $2 \longrightarrow 4$ (C) $1 \longrightarrow 4$ (D) $1 \longrightarrow 6$

10.30 De-Broglie wavelength of an electron travelling with speed equal to 1% of the speed of light
(A) 400 pm (B) 120 pm (C) 242 pm (D) 375 pm

Comprehension # 3

Paragraph for Question Nos. 10.27 to 10.29

Instead of principal quantum number (n), Azimuthal quantum number (ℓ) and magnetic quantum number (m), a set of new quantum number S, t and u was introduced with similar logic but different values as defined below :

S = 1, 2, 3.....∞ (all +ve integral values).
$t = (S^2 - 1^2), (S^2 - 2^2), (S^2 - 3^2)$..... No negative values.

$u = -\frac{t+1}{2}$ to $\frac{t+1}{2}$ (Including zero, if t has odd value) in integral steps.

Each orbital can have maximum four electrons. (S + t) rule is defined similar to $(n + \ell)$ rule.

Now answer the following questions :

10.31 The number of subshells present in third shell is equal to :
(A) 1 (B) 3 (C) 5 (D) 7

10.32 Number of electrons that can be accomodated in S = 2 and S = 3 shell respectively are :
(A) 14, 38 (B) 28, 76 (C) 8, 28 (D) None of these

10.33 Number of electrons belongs to S = 2, t = 3 for an element with atomic number Z = 24 is :
(A) 8 (B) 4 (C) 0 (D) None of these

SECTION - V : MATRIX - MATCH TYPE

10.34 Match the following :

B.E. – Binding energy

I.E. – Ionization energy :

Column I	Column II
(A) B.E. of He^+ atom in an excited state	(p) Infrared region
(B) $7 \rightarrow 3$ transition in H-atom	(q) 3.4 ev
(C) $5 \rightarrow 1$ transition in H-atom	(r) 13.6 ev
(D) series limit of Balmer series in H-atom	(s) 10 Spectral lines observed
	(t) Ultra violet region

10.35

Column-I Species	Column-II Characteristics
(A) Co^{3+} (Z = 27)	(p) Total number of fully filled orbitals is nine.
(B) Sc^{3+} (Z = 21)	(q) The value of magnetic moment (spin only) is greater than or equal to 3.87BM.
(C) Cr^{3+} (Z = 24)	(r) Number of electrons with $(n + \ell = 3)$ is eight.
(D) Ni^{2+} (Z = 28)	(s) Number of electrons with (m = 0) may be either 11 or 12.
	(t) No unpaired electron.

10.36 $n \rightarrow$ Orbit no., $z \rightarrow$ Atomic no. $\Rightarrow$ $r_{n,z} \rightarrow$ Radius $v_{n,z} \rightarrow$ Velocity

$T_{n,z} \rightarrow$ Time period of Revolution $\Rightarrow$ $k_{n,z} \rightarrow$ kinetic energy of the electron

Column- I (for single electron species)	Column- II (Ratio)
(A) $r_{2,1} : r_{1,2}$	(P) 9 : 1
(B) $V_{1,3} : V_{3,1}$	(Q) 8 : 1
(C) $T_{1,2} : T_{2,1}$	(R) 16 : 1
(D) $K_{1,2} : K_{2,1}$	(S) 1 : 32

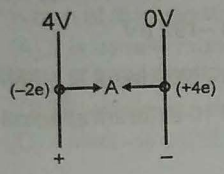
10.37 Match the following :

List-I	List-II
(A) $n = 6 \rightarrow n = 3$ (In H-atom)	(p) 10 lines in the spectrum
(B) $n = 7 \rightarrow n = 3$ (In H-atom)	(q) Spectral lines in visible region
(C) $n = 5 \rightarrow n = 2$ (In H-atom)	(r) 6 lines in the spectrum
(D) $n = 5 \rightarrow n = 1$ (In H-atom)	(s) Spectral lines in infrared region
	(t) Spectral lines in U.V. region

SECTION - VI : INTEGER TYPE

10.38 If n_1 and n_2 are the boundary value principal quantum numbers of a portion of spectrum of emission spectrum of H atom, determine the wavelength (in metre) corresponding to last line (longest λ). Given : $n_1 + n_2 = 7$, $n_2 - n_1 = 3$, and $R_H = 1.097 \times 10^7\ m^{-1}$. (Give your answer in multiple of 10^{-6})

10.39 In the assembly as shown below, the potential difference across the plates is 4 volts. A positive particle of charge +4e is projected from the negative plate with an initial kinetic energy of 4eV and the negative particle of charge (–2e) is projected from the positive plate. Both the particles reach point 'A' with zero kinetic energy. Find the initial kinetic energy of the negative particle in eV.



10.40 Electrons in a sample of H–atoms make transitions from state n = x to some lower excited state. The emmission spectrum from the sample is found to contain only the lines belonging to a particular series. If one of the photons had an energy of 0.6375 eV. Then find the value of x. [Take 0.6375 eV = $\frac{3}{4} \times 0.85$eV]

10.41 An element undergoes a reaction as shown :

$X + e^- \rightarrow X^-$ Energy released = 30.876 eV

The energy released, is used to dissociate 8 g of H_2 molecules equally into H^+ and H^*, where H^* is in an excited state, in which the electron travels a path length equal to four times its debroglie wavelength.

(a) Determine the least amount (moles) of 'X' that would be required.

Given: I.E. of H = 13.6 eV/atom

Bond energy of H_2 = 4.526 eV/molecule.

(b) Why is the amount of X calculated in the above question 'least'?

10.42 A hydrogen like atom (atomic number Z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies 10.20 eV and 17.00 eV respectively. Alternatively, the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energy 4.25 eV and 5.95 eV respectively. Determine the values of n and Z (ionisation energy of hydrogen atom = 13.6 eV)

Give your answer as (Z + n)

10.43 In a sample of hydrogen atom in ground state electrons make transition from ground state to a particular excited state where path length is five times de-broglie wavelength, electrons make back transition to the ground state producing all possible photons. If photon having 2nd highest energy of this sample used to excite the electron in a particular excited state of Li^{2+} ion then find the final excited state of Li^{2+} ion.

10.44 A chemist has one mole of X-atoms. He finds that on absorption of 410 kJ, half of X-atoms transfer one electron to the other half. If all the resulting X^- ions are subsequently converted to X^+ ions, an addition of 735 kJ is required. Find the electron affinity of X.

10.45 The famous alien Jadu on his visit to our planet earth brought a sample containing 100 identical H-like atoms (hypothetical atoms, Z can be fractional) from his planet. He gave these atoms to Rohit (Hritik Roshan) asking him to analyze them. He further gave Rohit the following informations :

1. Out of the given atoms, some are in ground state and some others are in a higher energy level (n = x) and the potential energy of electron in the ground state of given atom is –192 eV.
2. When the sample is exposed to radiations of wavelength 155 nm, the electrons jump to another higher energy level (n = x + 3). Upon back-transition upto ground state, a total of 10 different spectral lines are produced.

Then, Jadu asked Rohit two questions in terms of $\frac{(b)}{(a)}$:

(a) "What is the final state in which the electrons move after absorbing photons of wavelength 155 nm ?"

(b) "What is the maximum number of atoms which had their electron in ground state initially ?"

Surprisingly, Rohit answered the questions correctly.

Instead of Rohit, if you were asked the same questions by Jadu, what would have been your answers for the two questions ? Take hc = 12400 eV Å.

TOPIC 11

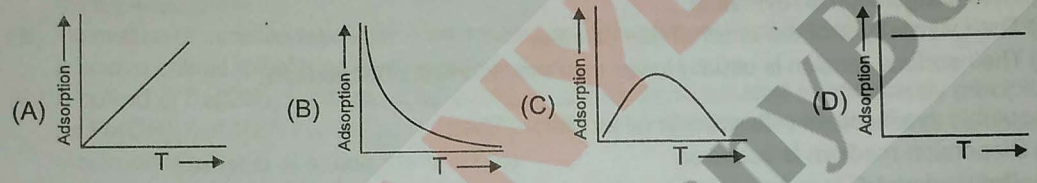
SURFACE CHEMISTRY

SECTION - I : STRAIGHT OBJECTIVE TYPE

11.1 When a graph is plotted between log x/m and log p, it is straight line with an angle 45° and intercept 0.3010 on y-axis. If initial pressure is 0.3 atm, what will be the amount of gas adsorbed per gm of adsorbent :
(A) 0.4 (B) 0.6 (C) 0.8 (D) 0.1

11.2 Which of the following statements about physical adsorption is not correct ?
(A) It is usually monolayer
(B) It is reversible in nature
(C) It involves van der Waals interactions between adsorbent and adsorbate
(D) It involves small value of adsorption

11.3 Following is the variation of physical adsorption with temperature:



11.4 Finally divided catalyst has greater surface area and has greater catalytic activity then the compact solid. If a total surface area of 6291456 cm^2 is required for adsorption of gaseous reaction in a catalysed reaction, then how many splits should be made of cube exactly 1 cm in length. [Given : One split of a cube gives eight cubes of same size].
(A) 60 (B) 80 (C) 20 (D) 22

11.5 Gold number of a lyophilic sol is such property that:
(A) The larger its value, the greater is the peptising power
(B) The lower its value, the greater is the peptising power
(C) The lower its value, the greater is the protecting power
(D) The larger its value, the greater is the protecting power

11.6 For the coagulation of 200 mL of As_2S_3 solution, 10 mL of 1 M NaCl is required. What is the coagulating value of NaCl.
(A) 200 (B) 100 (C) 50 (D) 25

11.7 At CMC, the surfactant molecules :
(A) Decomposes (B) Become completely soluble
(C) Associate (D) Dissociate

11.8 Which of the following ions will be most effective in coagulating the As_2S_3 sol :
(A) Fe^{3+} (B) Ba^{2+} (C) Cl^- (D) PO_4^{3-}

11.9 Coagulation value of the electrolytes $AlCl_3$ and NaCl for As_2S_3 sol are 0.093 and 52 repectively. How many times $AlCl_3$ has greater coagulating power than NaCl.
(A) 930 (B) 520 (C) 560 (D) None of these

11.10 Which of the following is wrong :
(A) Enthalpy (numerical value) of physisorption is greater than that of chemisorption.
(B) Physisorption is not very specific but chomisorption is highly specific.
(C) Chemisorption takes place at relatively high temperatures.
(D) In physisorption generally multi–molecular layers are formed on the adsorbent.

11.11 Select correct statement (s) :
(A) hydrophilic colloid is a colloid in which there is a strong attraction between the dispersed phase and water
(B) hydrophobic colloid is a colloid in which there is a lack of attraction between the dispersed phase and water
(C) hydrophobic sols are often formed when a solid crystallises rapidly from a chemical reaction or a supersaturated solution
(D) all of the above

11.12 Gold number of haemoglobin is 0.03. Hence, 100 mL of gold sol will require haemoglobin so that gold is not coagulated by 10 mL of 10% NaCl solution :
(A) 0.03 mg (B) 30 mg (C) 0.30 mg (D) 3 mg

11.13 Which one of the following statements is false for hydrophilic sols ?
(A) They do not require electrolytes for stability
(B) Their coagulation is reversible
(C) Their viscosity is of the order of that of water
(D) Their surface tension is usually lower than that of dispersion medium.

11.14 Oil soluble dye is mixed with water in oil emulsion. Then :
(A) Dispersion medium is coloured (B) Different phase is coloured
(C) Both coloured (D) None is coloured

11.15 Which of the following can adsorb larger volume of hydrogen gas :
(A) Colloidal solution of palladium (B) Finely divided nickel
(C) Finely divided platinum (D) Colloidal $Fe(OH)_3$.

11.16 **Consider the following statements and arrange in the order of true/false as given in the codes.**
S_1 : Colour of a colloidal solution depends upon the size and shape of sol particles.
S_2 : Brownian motion is due to continuous bombardment of sol particles by molecules of disperson medium.
S_3 : When negatively charged smoke comes in contact with positively charged clouds, rain fall takes place.
S_4 : For a positive sol, flocculation values are in the order $NaCl > K_2SO_4 > Na_3PO_4 > K_4[Fe(CN)_6]$.
(A) TTTT (B) TTFF (C) TFTF (D) FFFF

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

11.17 The correct statement(s) pertaining to the adsorption of a gas on a solid surface is/are:
(A) Adsorption is always exothermic
(B) Physisorption may transform into chemisorption at high temperature
(C) Physisorption increases with increasing temperature but chemisorption decreases with increasing temperature
(D) Chemisorption is more exothermic than physisorption, however it is very slow due to higher energy of activation.

11.18 In the aqueous solution of soaps above CMC (Critical Micelle Concentration) :
(A) The cations assoicate to form the aggregates.
(B) The anions associate to form the clusters of colloidal dimension
(C) The polar ends forming the clusters are directed towards water
(D) The non polar (Hydrocarbon) ends are directed towards water