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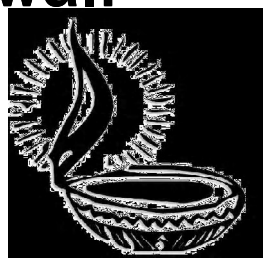

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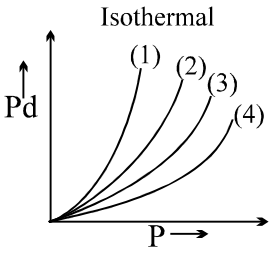
SITTING–1

Q.1 At 273 K, Pd v/s P is plotted for various gases & numbered 1,2,3,4. Assuming ideal behaviour and four gases to be N_2, He, CO_2 & H_2 respectively. The correct sequence is (where P denotes Pressure in atmosphere & d denotes density in gm/L)



(A) 2,1,3,4 (B) 4,1,2,3
(C) 4,3,2,1 (D) 2,3,1,4

Q.2 If X is the total number of collision which a gas molecule registers with others per unit time under partcular conditions, then the collison frequency of the gas containing N molecules/ unit volume is
(A) X / N (B) NX (C) 2NX (D) NX / 2

Q.3 Which of the following statement is(are) true in the context of photoelectric effect?
(A) The kinetic energy of ejected electrons is independent of the photon intensity of radiation.
(B) The threshold frequency is same for all metals.
(C) The number of photoelectrons ejected depends on the frequency of the incident radiation
(D) The kinetic energy of the emitted electrons depends on the frequency of the incident radiation

Q.4 A certain gas diffuses from two different vessels A and B. The vessel A has a circular orifice while vessel B has square orifice of edge length equal to the radius of the orifice of vessel A. The ratio of the rates of diffusion of the gas form vessel A to vessel B, assuming same temperature and pressure is (Assume rate of effusion directly proportional to area of orifice)
(A) π (B) $1/\pi$ (C) 1 : 1 (D) 2 : 1

Q.5 a moles of X reacts with b moles of Y according to the reaction in which the stoichiometric ratio of X : Y equals to c : b where (a > c), then quantity left behind after complete reaction is
(A) X(a – c) Y(0) (B) X (0) Y (c – a) (C) X (0) Y (a – c) (D) X (c – a) Y (0)

Q.6 In an auto engine with no pollution controls, about 5% of the fuel (C_8H_{18}) is unburned. Molar ratio of CO and C_8H_{18} emitted in the exhaust gas is:
(A) 100 (B) 152 (C) 50 (D) 5

Q.7 A mixture of two gases A and B in the mole ratio 2 : 3 is kept in a 2 litre vessel. A second 3 litre vessel has the same two gases in the mole ratio 3 : 5. Both gas mixtures have the same temperature and same pressure. They are allowed to intermix and the final temperature and pressure are the same as the initial values, the final volume being 5 litres. Given that the molar masses are M_A and M_B, what is the mean molar mass of the final mixture?

(A) $\frac{77M_A + 123M_B}{200}$ (B) $\frac{123M_A + 77M_B}{200}$

(C) $\frac{77M_A + 123M_B}{250}$ (D) $\frac{123M_A + 77M_B}{250}$

Q.8 Give the correct order of initials **T** (true) or **F** (false) for following statements.
(I) N^{3-} and Mg^{2+} are isoelectronic species
(II) The transition elements lose the ns electrons before they begins to lose the (n–1)d electrons
(III) $X(g) + e^- \longrightarrow X^-(g)$, this process may be endothermic or exothermic depend on the element
(IV) Three quantum numbers are sufficient to characterize an orbital.
(A) TTTT (B) TTFF (C) FFTT (D) TFTT

Q.9 Give the correct order of initials **T** (true) or **F** (false) for following statements.
(I) Lother Mayer plotted a graph between atomic volume versus atomic weight.
(II) Representative elements belong to f block

(III) Number of elements presents in the fifth period of the periodic table are 32.
(IV) Noble (Inert) character is favoured by a high heat of sublimation and high ionization energy.
(A) TFTT (B) TFFT (C) FFTF (D) TTFF

Q.10 A real gases X an ideal gas Y both undergo experiments involving their compression or expansion. Mark the option(s) in which **observation** made is correctly matched with its **interpretation** regarding dominance of 'a' & 'b' as given Vander Waal's equation.

	Observation	**Interpretation**
(A)	On expansion X underwent larger dip in pressure as compared to Y, other parameter being same.	the parameter 'a' is more influential then 'b'
(B)	On compression X underwent larger rise in presence as compared to Y, other parameter being same.	the parameter 'b' is more influential then 'a'
(C)	At some temperature the behaviour of X was similar to that of Y for low pressure region.	the temperature must be Boyle's temperature
(D)	Plot of Z vs P for the gas X at room temperature showed a dip (<1) at low pressure & then increased as pressure increased.	the value of 'a' is not small for gas X.

Q.11 The ground state electronic configurations of the elements, U, V, W, X and Y (these symbols do not have any chemical significance) are as follows

U $1s^2 2s^2 2p^3$
V $1s^2 2s^2 2p^6 3s^1$
W $1s^2 2s^2 2p^6 3s^2 3p^2$
X $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$
Y $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$

Determine which sequence of elements satisfy the following statements
(i) element-has highly reactive nature
(ii) element-is d-block element most likely to form coloured ionic compounds
(iii) element-has largest atomic radius
(iv) element-forms only acidic oxide
(A) V W Y U (B) V X Y W (C) V W Y X (D) V X W U

Q.12 Which of the following set of quantum number is valid/invalid. In case of valid set write the symbol of the orbital it represents [may have more than one answers] & in case it is invalid mention the reason.

	n	*l*	m
(i)	3	not known (but less than 3)	0
(ii)	–2	–1	+1
(iii)	4	2	–1

Q.13 Calculate IE_8 of oxygen atom.

Q.14 Calculate molality of a solution containing 72 gm Buckminster Fullerene (C_{60}) in one kg water.

Q.15 Find the number of spectral lines in Paschen series emitted by atomic H, when electron is excited from ground state to n^{th} energy level returns back.

Direction for Q.16 to Q.22

In each of the following questions two statements are given as **Assertion (A)** and **Reason (R)**. Examine the statements carefully and answer the questions according to the instructions given below:

(A) if both **A** and **R** are correct and **R** is the correct reason of **A**.
(B) if both **A** and **R** are correct and **R** is not the correct reason of **A**.
(C) if **A** is correct and **R** is wrong.
(D) if **A** is wrong and **R** is correct.
(E) if both **A** and **R** are wrong.

Q.16 **Assertion:** The value of van der Waal constant a is higher for NH_3 than for N_2.
Reason: NH_3 molecules are associated with H-bonds.

Q.17 **Assertion:** K.E. of all the gases approach zero as their temperature approach zero kelvin.
Reason. Molecular motion ceases at absolute zero.

Q.18 **Assertion:** Helium shows only positive deviation from ideal behaviour.
Reason: Helium is chemically inert noble gas.

Q.19 **Assertion:** α-particles have quite less penetrating power.
Reason: α-particles are di-positive ions having appreciable mass.

Q.20 **Assertion:** Isotopes of an element can be identified with the help of a mass spectrograph.
Reason: A mass spectrograph can differentiate between ions having different charge to mass (e/m) ratio.

Q.21 **Assertion:** F atom has less electron affinity than Cl atom.
Reason: Additional electrons are repelled more strongly by 3p-electrons in Cl atom than by 2p-electrons in F atom.

Q.22 **Assertion:** The spin of 6 & 7 electron in O atom is in same but that of 7 & 8 electron is in opposite direction.
Reason: Pairing of electrons in orbitals of same energy can occur only once all orbitals have one electron at least with same spin.

SITTING–II

Q.1 A tube of uniform cross-section of length 100 cm is divided into two parts by a weightless and frictionless piston. One part contains 4 moles of hydrogen at 2 atm at equilibrium and other part contains 1 mole of nitrogen at the same temperature. Assume volume of piston to be negligible.
(a) Calculate the length of each compartment if the tube was placed horizontally.
(b) The tube is then held at angle of 45° with the horizontal keeping the nitrogen end upwards. Find the length of each compartment.

Q.2 Calculate compressibility factor (Z) for 0.02 moles of a Van der Waals gas at pressure of 0.1 atm. Assume the size of gas molecules is negligible.
Given: RT = 20 L-atm-mol^{-1} (T = Temperature of gas), a = 1000 atm-L^2-mol^{-2}

Q.3 The 'atom utilization' is obtained by dividing molar mass of the desired product by the sum of the molar masses of all substances produced according to the reaction equations. The "E factor" is the amount (in kg) of by product per kg of products. Calculate "atom utilization" and "E factor". Identify X, the desired product.
$(NH_4)_2S_2O_8 + MnSO_4 + 2H_2O \longrightarrow (NH_4)_2SO_4 + \underline{X} + 2H_2SO_4$.

Q.4 When 2.71 gm $HgCl_2$ is allowed to react with 4.98 gm of KI, Nesseler's reagent is formed, which in turn reacts with excess NH_3 and KOH to give a brown coloured compound by the following synthesis route. Find out the weight of brown coloured compound formed. (Consider all reactions taking place in 1 vessel only)

$$HgCl_2 + KI \longrightarrow HgI_2 + KCl$$
$$HgI_2 + KI \longrightarrow K_2HgI_4$$
$$K_2HgI_4 + NH_3 + KOH \longrightarrow O\begin{matrix}Hg\\Hg\end{matrix}NH_2I + KI + H_2O + NH_4I$$

brown coloured compd.

Q.5 5 gm of a mixed carbonate of magnesium and calcium is dissolved in 100 ml, 2M HCl and the CO_2 that is formed is boiled off. The unreacted acid needs 97.15 ml of 1M NaOH for neutralisation. Calculate the fraction of Mg^{2+} ions in the total cations formed in the reaction. Consider ions produced in salts only.

Q.6 8 gm O_2 gas is taken at 320 K in 3.01 L vessel. The mean free path is $\sqrt{\frac{8.314}{3.14}}$ pm, then calculate

(i) No. of collisions made by any one molecule in unit time assuming all molecule are moving

(ii) Total no. of bimolecular collision in unit time per unit volume (Collision frequency) in the sample of O_2 gas.

(iii) No. of collision made by any one molecule assuming all other are stationary.

Q.7 $K_2Cr_2O_7$ is obtained in the following steps:

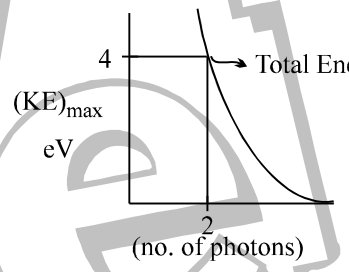
$2FeCrO_4 + 2Na_2CO_3 + O \longrightarrow Fe_2O_3 + 2Na_2CrO_4 + 2CO_2$

$2Na_2CrO_4 + H_2SO_4 \longrightarrow Na_2Cr_2O_7 + H_2O + Na_2SO_4$

$Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$

Calculate the number of moles of 50% pure $FeCrO_4$ required to get 0.25 mol of $K_2Cr_2O_7$.

Q.8(a) A light radiation is subjected to a metal sheet such that total energy subjected is constant & number of photons subjected are varying. Show that the graph of Stopping Potential vs number of photons subjected is a hyperbola. Also calculate work function of the metal from the graph. Assume 100% absorption of photons.



(b) Suppose the potential energy between electron and proton at a distance r is given by $U = Ke^2 \log r$, using Bohr's theory, obtain the energy levels of such a hypothetical hydrogen atom (K = constant). Justify that the force acting in this case is also attractive.

Q.9 Three ideal gas samples in separate equal volume containers are taken and following data is given:

	Pressure	Temperature	Mean free paths	Mol. wt.
Gas A	1 atm	1600 K	0.16 nm	20
Gas B	2 atm	200 K	0.16 nm	40
Gas C	4 atm	400 K	0.04 nm	80

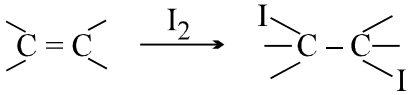
Calculate ratio (A : B : C) of following for the three gases.

(a) Collision frequencies (Z_{11}).

(b) Number of collision by one molecule per sec. (Z_1).

(c) Average velocities.

Q.10 The relative degree of unsaturation in a fat or oil is expressed as an Iodine number. Olive oil for instance is highly unsaturated and has an I_2 number of 172 while butter is much less unsaturated and has an I_2 number of 37. Defined as the number of grams of I_2 absorbed per 100 g of fats, based on the fact that the carbon – carbon double bonds in fats and oils undergo an addition reaction with I_2. The larger the number of double bonds, the larger the amount of I_2 that reacts.



To determine an I_2 number, a known amount of fat is treated with a known amount of I_2. When the reaction is complete, the amount of excess I_2 is determined by titration with $Na_2S_2O_3$ according to the

given equation.

$$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$$

Knowing both the amount of I_2 originally added and the amount remaining after reaction, the I_2 number can be calculated. Cow's milk is very good for the development of finer tissues of the brain and which helps in better understanding of higher level topics. Assume that 0.5 g of cow's milk is allowed to react with 25 ml of 0.2 M I_2 solution and that 81.99 ml of 0.1 M $Na_2S_2O_3$ is required for complete reaction with excess I_2.

(a) What is the iodine number of cow's milk fat?

(b) Assuming a molecular mass of 800 amu, how many double bonds does an average molecule of milk fat contains?

ANSWER KEY

SITTING–I

Q.1	D	Q.2	D	Q.3	A, D	Q.4	A	Q.5	A
Q.6	B	Q.7	B	Q.8	A	Q.9	B		
Q.10	A,B,C,D	Q.11	B						

Q.12 (i) Valid, $3s/3p_x/3p_y/3p_z/3d_{x^2-y^2}/3d_{z^2}/3d_{xy}/3d_{xz}/3d_{yz}$

(ii) Invalid 'n' cannot be negative

(iii) Valid $4d_{x^2-y^2}/4d_{z^2}/4d_{xy}/4d_{xz}/4d_{yz}$

Q.13	870 eV	Q.14	0.1 m	Q.15	(n–3)	Q.16	A	Q.17	A
Q.18	B	Q.19	A	Q.20	A	Q.21	A	Q.22	A

SITTING–II

Q.1 Both cases H_2 end is 80 cm and N_2 end is 20 cm Q.2 0.01

Q.3 0.13, 0.85 Q.4 2.8 gm Q.5 0.17

Q.6 (i) $\sqrt{8}\times10^{14}$ (ii) $5\sqrt{2}\times10^{36}$ (iii) 2×10^{14} Q.7 1 mol

Q.8(a) 2eV (b) $E_n = \frac{1}{2}Ke^2\left(1+\log\frac{n^2h^2}{4\pi^2e^2mK}\right)$

Q.9 (a) 1 : 4 : 16, (b) 4 : 1 : 4, (c) 4 : 1 : 1 Q.10 46, 1.4

