Gaseous State

By
Nitesh Jain (B.tech, IIT Bombay)

Q4) A Compound contains 28% N and 72% of a metal by weight. Three atoms of metal combine with two atoms of nitrogen. find atomic wt of Metal

a) 24 b) 20 c) 36 d) 48

Solution:

$$3M + 2N \longrightarrow M_3N_2$$

$(3x + 28)$ g M_3N_2 has metal $= 3x$

$$100\text{ g} \longrightarrow = \frac{100 \times 3x}{3x + 28}$$

$$\frac{100 \times 3x}{3x + 28} = 72, \quad x = 24.$$

Q5) When 400g of a 20%. solution by weight was cooled., 50 g of solute precipitated. what is the Percentage concentration of remaining solution.

a) 8.75 %. b) 10.75 %. c) 2.50%. d) 5.25%.

Solution: Weight of solution = 400 g

Weight of solute $= \frac{20 \times 400}{100} = 80$ g

Weight of solute precipitated = 50 g

Weight of solute remained in solution = 80 − 50 = 30 g

Weight of solution remained = 400 − 50 = 350 g

% by weight $= \frac{30}{350} \times 100 = 8.57\ \%$.

9. What volume of 0.010M $NaOH_{(aq)}$ is required to react completely with 30g of an aqueous acetic acid solution in which mole fraction of acetic acid is 0.15

(A) 18.55 litre (B) 43.25 litre (C) 4.25 litre (D) 72.68 litre

Ans: (A)

12. The equivalent weight of HNO_3 in the following reaction is .....

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

(A) 63 (B) 84 (C) 47.25 (D) 31.5

Ans: (B)

$$8N^{+5} \rightarrow 6N^{+5} + 2N^{2+} + 6e^-$$

13. Which of the following statements are correct

(A) The n factor of $K_4\left[Fe(CN)_6\right]$ in the reaction

$K_4\left[Fe(CN)_6\right] \rightarrow Fe^{3+} + CO_2 + NO_3^-$ is 41

(B) The equivalent weight of HCl in the reaction is 71

$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

(C) The n factor of H_2SO_4 in the reaction is 65.33

$H_2SO_4 + KOH \rightarrow K_3H(SO_4)_2$

(D) The n factor of FeS_2 is is II in the reaction

$FeS_2 + O_2 \rightarrow Fe_2O_3 + SO_2$

PROBLEM 51 *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.*

PROBLEM 53 *What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of He^+ spectrum?* **(IIT 1993)**

Solution For He^+, $$\frac{1}{\lambda} = R_H \cdot Z^2 \left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

For H, $$\frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

Since λ is same

$$\therefore \quad Z^2 \left[\frac{1}{2^2} - \frac{1}{4^2}\right] = \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\because \quad Z = 2$$

$$\therefore \quad \left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\therefore \quad \mathbf{n_1 = 1} \quad \text{and} \quad \mathbf{n_2 = 2}$$

PROBLEM 84 *Energy required to stop the ejection of electrons from Cu plate is* 0.24 *eV. Calculate the work function when radiations of* $\lambda = 253.7$ *nm strikes the plate.*

Solution Energy of photon = work function + $1/2\, mu^2$

Energy of photon = work function + eV_0 ... (1)

where e is electronic charge and V_0 is stopping potential and eV_0 is equal to energy required to stop the ejection of electron.

$$\therefore \quad E_{\text{photon}} = \frac{hc}{\lambda} = \frac{6.625\times 10^{-34} \times 3.0\times 10^{8}}{253.7\times 10^{-9}} = 7.834\times 10^{-19}\ \text{J}$$

$$= \frac{7.834\times 10^{-19}}{1.602\times 10^{-19}}\ \text{eV} = 4.89\ \text{eV}$$

$\therefore$ By Eq. (1) 4.89 = work function + 0.24

Work function = **4.65 eV**

9) In hydrogen atom an orbit has a diameter of about 16.92 Å what is the maximum no of electrons that can be accomodated

a) 8 b) 32 c) 50 d) 72

$D = 16.92$

$r = 8.46 \text{ Å}$

$$r = \frac{0.53\, n^2}{Z}$$

$$8.46 = 0.13 \times n^2$$

$$n = 4$$

$$2n^2 = 32$$

Q The KE of an electron in the second bohrs orbit of a hydrogen atom is .

[a_0 is Bohrs radius]

a) $\frac{h^2}{4\pi^2 m a_0^2}$

b) $\frac{h^2}{16\pi^2 m a_0^2}$

c) $\frac{h^2}{32\pi^2 m a_0^2}$

D) $\frac{h^2}{64\pi^2 m a_0^2}$

Q) In a collection of H atoms, when electrons make a transition from 5th excited state to 2nd excited state then maximum number of different types of photons observed are

A) 3 B) 4 C) 6 D) 15

Q) The reaction $2C + O_2 \longrightarrow 2CO$ is carried out by taking 24g C and 96g O_2 find out.

a) LR b) wt of left Reactant.

c) wt of CO formed

d) How many gm of other reactant should be taken so that nothing is left at the end of reaction.

Solution

$2C + O_2 \longrightarrow 2CO$

$\frac{24}{12}$ $\quad$ $\frac{96}{32}$

$2/2$ $\quad$ $3/1$

LR ① $\quad$ 3

0 $\quad$ 2 $\quad$ 2

a) LR = C

b) 2 mole of O_2 = 64g

c) 2 mole of CO = 56g

d) To use O_2 completely 6 mole of Carbon or 72g Carbon is needed.

$2 - 1$

$6 \rightarrow 6/2 = 3$

Q) 2.5 mole of N_2H_4 looses 25 moles of e^- to form a compound Y. Assuming that all the nitrogen appears in the new compound what will be the OS of nitrogen in Y a) +3 b) +5 c) -3 d) +1

Solução

$N_2H_4 \longrightarrow (2N)^a + 10e^-$

-4

$-4 = 2a - 10$, $2a = +6$

$a = +3$

Q) a) $MnO_4^- + FeC_2O_4 \longrightarrow Mn^{+2} + Fe^{3+} + CO_2$

1 mole MnO_4^- reacts with x mole of FeC_2O_4

b) $MnO_4^- + Fe_2(C_2O_4)_3 \longrightarrow Mn^{2+} + Fe^{3+} + CO_2$

1 mole MnO_4^- reacts with y mole of $Fe_2(C_2O_4)_3$

find out the ratio of $\frac{x}{y}$

Solution :

$$3\,MnO_4^- + 5\,FeC_2O_4 \longrightarrow Mn^{2+} + Fe^{3+} + CO_2$$

+7 +2 (+3)2 +2 +3 (+4)2

5(R) 3(O)

$3\,MnO_4^- \longrightarrow 5\,FeC_2O_4$

$1\,MnO_4^- \longrightarrow \frac{5}{3}\,FeC_2O_4$

$x = \frac{5}{3}$

$$6\,MnO_4^- + 5\,Fe_2(C_2O_4)_3 \longrightarrow Mn^{2+} + Fe^{3+} + CO_2$$

+7 (+3)2 (+3)6 +2 +3 +4

5(R)

↓

6(O)

$y = \frac{5}{6}$

$6\,MnO_4^- \longrightarrow 5\,Fe_2(C_2O_4)_3$

$1 \longrightarrow \frac{5}{6}\,Fe_2(C_2O_4)_3$

$\frac{x}{y} = \frac{2}{1}$

Q)) A Metal weighing 0.43 g was dissolved in 50 ml / N H_2SO_4. the Unreacted H_2SO_4 required 14.2 ml / N NaOH. for neutralisation. calculate EW of Metal is

Ans 12.

Q.4 If the radius of first Bohr's orbit is a, then a de-Borglie wavelength of electron in 3rd orbit is

(A) $6\pi a$ (B) $3\pi a$ (C) $2\pi a$ (D) $2a$

Q) A Cylinder Contains Nitrogen gas and small amount of Liquid water. at 25°c The P_T Inside cylinder is 600 mm Hg (a_q T water = 23.8 mm at 25°c) The Piston in Cylinder is Pushed downwards to reduce volume to half of its Initial volume at Constant Temp. Calculate The Pressure at this Condition.

P_T (moist gas) $= P_{N_2} + P_{H_2O} = 600$

$P_{H_2O} = 23.8$

$P_{N_2} = 576.2$ ✓

Apply $P_1V_1 = P_2V_2$

$P_2 = 1152.4$ ✓

$P_T = 23.8 + 1152.4 = 1176.2$ ✓

A gas cylinder containing cooking gas can withstand a pressure of 14.9 atmosphere. The pressure gauge of the cylinder indicates 12 atmosphere at 27°C. Due to a sudden fire in the building the temperature starts rising. At what temperature will the cylinder explode ?

(A) 273 K (B) 99.5°C (C) 273°C (D) None of These

A balloon blown up with 1 mole of gas has a volume of 480 mL at 5°C. the balloon is filled to (7/8)th of its maximum capacity the minimum temperature at which it will burst.

(A) 55^0C (B) 100^0C (C) 44.67^0C (D) 34.67^0C

X ml of H_2 gas effuses through a hole in a container in 5 seconds. The time taken for the effusion of the same volume of the gas specified below under identical conditions is :

(A) 10 seconds : He

(B) 20 seconds : O_2

(C) 25 seconds : CO

(D) 35 seconds : CO_2

Solution : **(B)**

$\frac{r_{H_2}}{r_{He}} = \sqrt{\frac{4}{2}} = \sqrt{2} \Rightarrow \therefore$ (A) is incorrect $\frac{r_{H_2}}{r_{O_2}} = \sqrt{\frac{32}{2}} = 4$

(B) is correct $\frac{r_{H_2}}{r_{\ldots}} = \sqrt{\frac{28}{2}} = \sqrt{14}$ (C) is incorrect $\frac{r_{H_2}}{r_{CO}} = \sqrt{\frac{2}{44}} = \sqrt{\frac{1}{22}}$ (D) is incorrect

In a gaseous mixture at 20°C, the total pressure = 775 torr. If the sum of the partial pressures of H_2 and CO_2 is 350 torr and the partial volume of hydrogen 19.4%, what is the partial pressure of CO_2

(A) 225 torr (B) 300 torr (C) 275 torr (D) 200 torr

O_2 and He are taken in equal weights in a vessel. The pressure exerted by Helium in the mixture is

(A) 1/8 th of total pressure

(B) 1/9th of total pressure

(C) 2/9 th of total pressure

(D) 8/9th of total pressure

Equal volumes of two jars contain HCl, NH_3 gases respectively at constant temperature and pressure P. When one of the jars is inverted over another jar so that they mix up, the pressure in either of the jars is

(A) 1 atm (B) Equal to P (C) Becomes Zero (D) P+P = 2P

2 grams of Helium diffuses from a porous plate in 4min. How many grams of CH_4 would diffuse through the same plate in same time under similar conditions?

(A) 4g (B) 16g (C) 8g (D) 2g