Chapter 4: Atomic Weight

Q1.

Sol: Let W is the atomic weight of Cd.

$\therefore$ Mol. Wt of $CdCl_2$ = Wt + 2 × 35.5 = (W + 71) g

$\therefore$ (W + 71) g of $CdCl_2$ contains W g of Cd

$\therefore$ 1 ———————— $\frac{w}{w+71}$

$\therefore$ 1.5276 ———————— $\frac{w}{(w+71)} \times 1.5276$

A/q, $\frac{w}{(w+71)} \times 1.5276 = 0.9367$

$1.5276\ W = 0.9367\ (W+71)$

$0.591\ W = 0.9367 \times 71$

$W = \frac{0.9367 \times 71}{0.591} = 112.4\ g/mole$

$\therefore$ Atomic wt of Cd = 112.4 amu / atom or 112.4 g/ mole

Q2.

Sol: Let W is the atomic weight of X.

$$X + O_2 \longrightarrow XO_2$$

	X	O_2	XO_2
Given moles	1	1	1
Weight	W	32g	(W+32)g

$\therefore$ W g of X reacts with 32 g of O_2

$\therefore$ 1 ———————— $\frac{32}{w}$

$\therefore$ A/q, $\frac{32}{w} = 0.696$

$w = \frac{32}{0.696} = 46\ g/mole$

$\therefore$ At wt of X = 46 amu/atom = 46 g/ mole **Ans**

Q3.

Sol: $BaBr_2 + Cl_2 \longrightarrow BaCl_2 + Br_2$

1.5 $\longrightarrow$ 1.05 g

Let w is the atomic wt of Ba,

$\therefore$ Mol wt of $BaBr_2$ = w + 2 × 80= (w + 160) g

Mol wt of $BaCl_2$ =(w+ 2 × 35.5) = (w+71) g

According to balanced chemical reaction

1 mole of $BaBr_2$ ≡ 1 mole of $BaCl_2$

Mole of $BaBr_2$ = mole of $BaCl_2$

$$\frac{1.5}{w+160} = \frac{1.05}{w+71}$$

$1.5\,w + 106.5 = 1.05\,w + 168$

$0.45\,w = 61.5$

$w = \frac{61.5}{0.45} = 136.67\,g/mole$ **Ans**

Q4.

Sol: Let % of 1st isotope (B^{10}) is x

$\therefore$ % of 2nd isotope (B^{11}) is (100 – x)

$\therefore$ Av. Atomic weight $= \frac{x + 10.1 + (100 - x) \times 11.01}{100}$

$10.81 = \frac{11.01 \times 100 - 1.01x}{100}$

$1081 = 1101 - 1.01\,x$

$1.01\,x = 1101 - 1081 = 20$

$X = 20\%$

% of B^{10} = 20 % **Ans**

% of B^{11} = 80% **Ans**

Q5.

Sol: $2CuO + CO \longrightarrow Cu_2O + CO_2$

0.88 g

Let w is the atomic weight of carbon, then moles of CO_2 produced $= \frac{0.88}{(w + 32)}$

A/q, weight loss of Cu – oxide = 0.3232 g

From the balanced chemical reaction

Moles of CuO reacted = 2 × moles of CO_2

Moles of Cu_2O produced = moles of CO_2

$\therefore$ Wt loss = moles of CuO × Mol. wt CuO — moles of Cu_2O produced × mole wt. Cu

$0.3232 = \frac{2 \times 0.88}{w + 32} \times 79.5 - \frac{0.88}{w + 32} \times 143$

$0.3232w + 10.3424 = 139.92 - 125.84$

$0.3232w = 14.08 - 10.3424 = 3.7376$

$w \frac{3.7376}{0.32} = 11.8 \approx 12$ **Ans**

Q6.

Sol: Let the atomic weight of K = X

------------------------------ Cl = Y

------------------------------ Ag = Z

$KClO_3 \longrightarrow KCl + \frac{3}{2}O_2$

4.008 g 2.438 g

$\therefore$ Wt of O_2 produced = 4.008 – 2.438 = 1.57

A/q, Above eq-n

moles of $O_2 = \frac{3}{2} \times$ moles of KCl

$$\frac{1.57}{32} = \frac{3}{2} \times \frac{2.438}{x+y}$$

$\Rightarrow x + y = 74.54$ ----------------(1)

$KCl + AgNO_3 \longrightarrow AgCl + KNO_3$

2.438 g 4.678g

moles of KCl = moles of AgCl

$$\frac{2.438}{x+y} = \frac{4.678}{Z+y} \text{------(2)}$$

Also moles of Ag in AgCl (4.678 g) = $\frac{3.531}{Z}$

$$\therefore \frac{4.678}{Z+y} = \frac{3.531}{Z} \Rightarrow \frac{4.678}{3.531} Z = Z + y \Rightarrow 1.325 Z - Z = y$$

$$Z = \frac{y}{0.325} \text{------(3)}$$

From (2) & (3)

$$\Rightarrow \frac{2.438}{x+y} = \frac{4.678}{\frac{y}{0.325}+y} = \frac{1.52}{1.325y}$$

$$\Rightarrow \frac{2.438 \times 1.325 \ y}{1.52} = x + y$$

$2.126 y = x - y$ -------------- (4)

From (1) & (4) $\Rightarrow 2.126 y = 74.54 \Rightarrow Y = 35.5$

$\therefore x = 74.54 - 35.5 = 39.04$

$$Z = \frac{35.5}{0.325} = 108.8 \ y$$

At. Wt. of K = 39 g / At. Wt. of Cl = 35.5 g / At. Wt. of Ag = 108.8 **Ans**

Q7.

Sol:

(1) Vapour density = 14

$\therefore$ Mol. wt = $2 \times$ V.d = 28 g

If W is the at wt of carbon.

$$28 \times 42.8\% = w$$

$$28 \times \frac{42.8}{100} = W$$

Similarly in other case ---

(II) $38 \times 2 \times \frac{15.8}{100} = W \Rightarrow W = 12 \text{ gm}$

(I (III) $14 \times 2 \times \frac{85.7}{100} = 2W \Rightarrow W = 12 \text{ gm}$

(IV) $22 \times 2 \times \frac{81.4}{100} = 3W \Rightarrow W = 12 \text{ g}$

(V) $39 \times 2 \times \frac{92.3}{100} = 6W \Rightarrow W = 12\text{g}$

Q8.

Sol: Vapour density of chloride = 74.6

$\therefore$ Mol. wt of chloride $= 74.6 \times 2 = 149.2$

We know that

At. wt. X Sp. heat = 6.4

$$\text{At. Wt.} = \frac{6.4}{0.88} = 7.2$$

Note:- [In question, sp. Heat of metal is given 0.55. it should be actually **0.88**]

Now if the formula of metal chloride is MClx

Then $7.2 + X \times 35.5 = 149.2$

$$x \times 35.5 = 149.2 - 7.2 = 142$$

$$x = \frac{142}{35.5} = 4$$

$\therefore$ Molecular formula of chloride = MCl_4

Q9.

Sol: We have,

At. Wt. of metal $\times$ sp. heat = 6.4

$$\text{At. wt. of metal} = \frac{6.4}{\text{sp.heat}} = 112$$

Let the metal chloride is MCl_x

$$MCl_x + xAgNO_3 \longrightarrow X\,AgCl + M(NO_3)_x$$

0.22g . 0.51 g

moles of $AgNO_3$ required = x moles of MClx

$$\frac{0.51}{108+14+16\times 3} = \frac{0.22x}{112+35.5x}$$

$\Rightarrow 0.0136\,(112 + 35.5\,x) = x$

$\Rightarrow 1.527 + 0.484\,x = x \quad \Rightarrow 1.527 = 0.5159\,x$

$$\Rightarrow X = \frac{1.527}{0.5159} = 2.96 = 3.$$

$\therefore$ Molecular formula = MClx = MCl_3

Q10.

Ans: At wt of metal $\times$ Sp. Heat = 6.4

$$\text{At. wt. of metal } \frac{6.4}{\text{sp.heat}} = \frac{6.4}{3.242} = 26.45\,g$$

Let the molecular formula of hydrated sulphate

$$= M_2(SO_4)_X \cdot yH_2O$$

$$\text{Then \% of metal} = \frac{52.9}{52.0 + 96x + 18y} \times 100 = 8.1$$

$$96x + 18y = 600 \quad -(1)$$

% of sulphate = $\frac{96x}{92.9+96x+18y}\times 100 = 43.2$

$\frac{96x}{52.9+600}\times 100 = 43.2$ [from (1)]

$96\,x = \frac{43.2\times 652.9}{100}$

$X = 3$

$\therefore$ From (1) $96\times 3+18y=600 \Rightarrow y=\frac{318}{18}=17.8=18$

Integral value is taken for x & y

$\therefore$ Molecular formula = $M_2(SO_4)_3.\ 18\ H_2O$. **Ans**

Q11.

Ans: Let the at wt of Sn(tin) = W

Also valancy of Sn = 4

$\therefore$ Molecular formula of stannic chloride = $SnCl_4$

$\therefore$ Mol. wt= $W + 4\times 35.5 = (W+142)g$

A/q, $\frac{142}{w+142}\times 100 = 54.6$

$W + 142 = 260$

$W = 118$ g; **Ans**

Q12.

Ans: Sp. heat of Metal = 0.055

At. Wt. x sp. heat = 6.4

At. Wt. = $\frac{6.2}{0.055} = 116.36g$

(Is diff-^{n} from the answer because it is an approximate way ☺ The exact way is written below)

For 1st chloride

If the molecular formula is MClx

Then wt of Cl in compound = 35.5x

$\frac{35.5x}{149.2}\times 100 = 23.6$

$X = 1$

Molecular formula = MCl.

Also Mol. Wt. of chloride = $W + 35.5\times 1 = 149$

$W = 149.2 - 35.5 = 113.8$ g **Ans**

Similarly for 2nd chloride

Mol. wt = $2\times 92.9 = 185.8$ g

If the molecular formula is MClx

$\frac{35.5x}{185.5}\times 100 = 38.2$

$X = 2$

$\therefore$ Molecular formula = MCl_2

$\therefore$ W + 71 = 185.8 $\Rightarrow$ M = 114.8 g **Ans** (M is the at wt of Metal)

Similarly for 3rd chloride

Mol .wt = $2\times110.6 = 221.2g$

If the Mole formula is Mds

$$\frac{35.5x}{221.2}\times100=47.3 \Rightarrow x=\frac{106.8}{35.5}=3$$

$\therefore$ Molecular formula = MCl_3

$W + 35.5\times3 = 22.12$

$W + 106.5 = 221.2 \Rightarrow W = 114.7$ g **Ans**

Q13.

Sol: % of sulphur in Cu_2S . = 20.14%

$$\frac{x}{127+x}\times100=20.14 \text{ (At.wt.of s=x(say))}$$

$\Rightarrow$ 100 x = 2557.78 + 20.14 x

$$x=\frac{2557.78}{79.86}=32$$

% of sulphur in Ag_2S = 12.94%

Let the at. wt. of Ag = w

$$\frac{32}{2w+32}\times100=12.94 \Rightarrow \frac{1600}{w+16}=12.94$$

$1600 = 12.94\ w + 12.94\times16$

$12.94W = 1600 - 12.94\times16 = 1392.96$

$$W=\frac{1392.96}{12.94}=107.7\approx108g$$ **Ans**

Q14.

Sol: Let the at. wt. of Ti is W.

Since it is isomorphous with SnO_2

$\therefore$ So Molecular formula = TiO_2

A/q, % of oxygen = 39.95%

$$\frac{16\times2}{w+16\times2}\times100=39.95$$

$3200 = 39.95\ w + 1278.4 \Rightarrow 39.95\ w = 1921.6$

$$w=\frac{1921.6}{39.95}=48.1g$$ **Ans**

Q15.

Sol: $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$

6.2984 g 8.438 g

From the reaction

moles of Na_2CO_3 = moles of Na_2SO_4

$$\Rightarrow \frac{6.2984}{46+12+16\times3} = \frac{8.438}{46+x+16\times4} \quad \text{(where, x = At wt of S)}$$

$$\frac{6.2984}{106} = \frac{8.438}{110+x}$$

$$\Rightarrow 110 + x = \frac{8.438}{6.2984} \times 106 = 142$$

$\Rightarrow x = 142-110 = 32$ g

$\therefore$ At wt of S = 32 g **Ans**

Q16.

Sol: $ZrBr_4 \xrightarrow[\text{steps}]{\text{several}} AgBr$

12.5843 Contain 13.216 g of Ag.

$\therefore$ Mol wt of AgBr = 188 g

Wt of silver present in 1889 of AgBr = 108 g

$\therefore$ 108g of Ag present in 1889 g.

$\therefore$ 1 ———— $\frac{188}{108}$

$\therefore$ 13.216 ———— $\frac{188}{108}\times 13.216 = 23$ g

By POAC

Mole of Br in $ZrBr_4$ = mole of Br in AgBr

$4\times$ moles of ZrBr

$$4\times\frac{12.5843}{w+320} = \frac{23}{188}$$

$$W + 320 = \frac{4\times12.5843}{0.1223} = 411.5$$

$W = 411.5 - 320 = 91.45$ g **Ans**

Q 17:

Sol: $VOCl_3 \xrightarrow[\text{Steps}]{\text{Several}} AgCl$

2.8934 g 7.1801 g

B y POAC

Moles of Cl in $VOCl_3$ = mole of Cl in AgCl

$3\times$ moles of $VOCl_3$ = moles of AgCl

$$\frac{3\times 2.8934}{w+16+35.5\times3} = \frac{7.1801}{108+35.5}$$

$$\frac{8.6802}{W+122.5} = \frac{7.1801}{143.5}$$

$W + 122.5 = 173.48 \Rightarrow W = 50.96$ g **Ans**