Solution

BASIC CONCEPTS IN CHEMISTRY

Class 11 - Chemistry

1. SI unit of mass is **kilogram (kg).**
   Definition: One kilogram (1 kg) is defined as the mass equal to the mass of the international prototype of the kilogram.
2. The atomic masses of most elements are fractional because they exist as a mixture of isotopes of different masses and their atomic masses are the average relative atomic masses of the isotopes depending on their abundance. For example, The atomic mass of chlorine (35.5 u) is average of stable isotope i.e. ^{35}Cl and ^{37}Cl in ratio 3:1.
3. The substance Z is a compound. This is because
   I. heat is evolved during the formation of Z.
   II. the properties of Z are different from those of X and Y.
4. Finding mass of diamond in kg
   1 carat = 3.08647 grains
   $\therefore$ 0.700 carat = 0.700 $\times$ 3.08647 grains = 2.16 grains
   Also, 1 gram = 15.4324 grains
   $\therefore$ 1grain = $\frac{1}{15.4324}$ = 0.064799 grams
   and 2.16 grains = 216 $\times$ 0.064799 = 01399 grams
   1 gram = 10^{-3} $\Rightarrow$ 0.1399 g = 1.399 $\times$ 10^{-2} kg
   Total mass of the ring in kg
   = 1.399 $\times$ 10^{-2} kg + 5 $\times$ 10^{-3}kg = 1.899 $\times$ 10^{-2} kg
5. Here, Molecular mass of H_2O = 2 $\times$H +1 $\times$ O = 2 $\times$ 1 + 1 $\times$16 =2 +16 =18 g/mol.
   18 g of water $\equiv$1 g molecule
   $\therefore$ 576 g of water = $\frac{1}{18} \times 576$ = 32 g molecule
6. We know that, Molecular formula = n $\times$(Empirical formula). Here, The compound is glucose. Molecular formula of glucose is 6 times of its empirical formula because Its molecular formula is $C_6H_{12}O_6$ and empirical formula is CH_2O.
7. We know that molality of solution is number of moles of solute present per kg of solvent. As molality is expressed in mass therefore, molality (m) of the solution is not affected by temperature.
8. Precision means the closeness of various measurements for the same quantity. Accuracy is the agreement of a particular value to the true value of the result.
9. Stoichiometry deals with the calculations of masses of reactants and products involved in a chemical reaction.
   For example: In the formation of water ,exactly two molecules of hydrogen(H_2) reacts with one molecule of oxygen (O_2) to produce two molecules of H_2O.
   $2H_2 + O_2 \rightarrow 2H_2O$.
   So here, Stoichiometry between molecules of hydrogen , oxygen and water is 2:1:2.
10. Suppose both read the same value as x.
    Then as $^oC = \frac{5}{9}$ (^oF - 32)
    $\therefore$ x = $\frac{5}{9}$(x - 32) or 9x = 5x - 160
    or 4x = -160 or x = -40^o
11. Step 1
    The chemical equation for the reaction of Ag NO_3 with NaCl is represented stoichiometrically as :
    $$\underset{23\ +35.5\ =\ 58.5\ g}{AgNO_3 + NaCl} \rightarrow \underset{108\ +35.5\ =\ 143.5\ g}{AgCl + NaNO_3}$$
    Let the masses of NaCl and KCl in the mixture be "a" g and "b" g, respectively.
    $\therefore$ a + b = 0.93 g, (given)
    (i) For NaCl - Since, 58.5 g of NaCl give AgCl = 143.5 g
    $\therefore$ "a" g of NaCl will give AgCl = [{(143.5 g) / (58.5 g)} $\times$ a] g
    (ii) For KCl, Similarly, 74.5 g of KCl gives AgCl = 143.5 g
    (as ,Gram molar mass of KCl = (39 + 35.5) = 74.5 g)
    "b" g of KCl will give AgCl = [{ (143.5 g) / (74.5 g) } $\times$ b] g

Step 2
But mass of AgCl actually formed = 1.865 g (given)
$\therefore \frac{143.5\times a}{58.5}+\frac{143.5\times b}{74.5}$= 1.865 g [since, b = (0.93 - a) g]
$\Rightarrow$ 2.453 a + 1.93 (0.93 - a) = 1.865 $\Rightarrow$ 2.453 a + 1.795 - 1.93 a = 1.865
$\Rightarrow$ 0.523 a = 0.07 g
$\therefore$ a = [0.07 / 0.523] g
= 0.14 g
Mass of NaCl in the mixture = 0.14 g
Mass of KCl in the mixture = (0.93 - 0.14) = 0.79 g
Hence, "The mass of NaCl in 10 ml of this solution is 0.14 g"

12. Vapour density of the mixture of NO_2 and N_2O_4 = 38.3. (given)
Molecular mass of the mixture =2 $\times$ 38.3 = 76.6 u = 76.6 g, (since molecular mass = 2 x vapour density)
Mass of the mixture = 100 g
No. of moles of the mixture = $\frac{100}{76.6}$ ie. ,(number of moles = given weight / molecular weight) eqn. (i)
Let the mass of NO_2 it the mixture = x g
$\therefore$ Mass of N_2O_4 in the mixture = (100 - x) g
Molar mass of NO_2 = 14 + 32 = 46 u = 46 g
Molar mass of N_2O_4 = 28 + 64 = 92 u = 92 g
No. of moles of NO_2=$\frac{x}{46}$
No. of moles of N2O4 = $\frac{(100-x)}{92}$
Total No. of moles in the mixtue = $\frac{x}{46}+\frac{(100-x)}{92}$....eqn. (ii)
Equating (i) and (ii) we get,
$\frac{x}{46}+\frac{(100-x)}{92}=\frac{100}{76.6}$
or,92x + 46(100 - x) = $\frac{100}{76.6}\times 46\times 92$
46 x = (5524.80 - 4600) = 924.80
therefore, x = [924.80 /46] = 20.10
Hence , the mass of NO_2 in the mixture is 20.10 g

13. Given - Mass of $CaCO_3$ = 1000g
Concentration of HCl in 250 ml is 0.1M
Moles of HCl = 250 mL$\times\frac{0.1M}{1000}=0.025$mol
Given Mass of $CaCO_3$ = 1000 g
Moles of $CaCO_3$ = $\frac{1000g}{100g}=10mol$
According to given equation $CaCO_3$(s) + 2HCl (aq) → $CaCl_2$(aq) + CO_2(g) + H_2O(l)
1 mole of $CaCO_3$ required for 2 mole of HCl
So for 10 mole $CaCO_3$ = 10$\times\frac{2}{1}$ = 20 mole HCl (aq)
According to reaction 20 mole of HCl required but we have only 0.025 mol HCl (aq), hence, **HCl (aq) is limiting reagent.**
So, the amount of $CaCl_2$ formed will depend on the amount of HCl only.
2 mol HCl (aq) forms 1 mol of $CaCl_2$, therefore,
0.025 mol of HCl (aq) will form = 0.025 $\times\frac{1}{2}$ = 0.0125 mol of $CaCl_2$
or 0.0125 $\times$ molar mass of $CaCl_2$ = 0.0125 $\times$ 111 = 1.4 g

14. Number of moles in a drop of water:-
Volume of a drop of water = 0.05 mL
Mass of a drop of water
= (Volume $\times$ density)
= (0.05 mL) $\times$ (1.0 g/mL)
= 0.05 g
Gram molecular mass of water
(H_2O) = 2$\times$1 + 16

= 18 g

$\therefore$ 18g of water = 1 mol

& 0.05 g of water

= $\frac{1\,mol}{(18\,g)} \times (0.05)$ g

= 0.0028 mol

No. of molecules present:-

1 mole of water contains number of molecules

= 6.022×10^{23}

0.0028 mole of water contain molecules

= $6.022 \times 10^{23} \times 0.0028 = 1.68 \times 10^{21}$ molecules.

= 1.68×10^{21} molecules

Thus, a drop of water with its volume equal to 0.05 mL would contain 1.68×10^{21} molecules

15. Calculation of mass of nickel (Ni) in the alloy.

Volume of the alloy = (10.0 cm) $\times$ (20.9 cm) $\times$ (15.0 cm) = 3000 cm^3

Mass of the alloy piece = Density $\times$ volume

= (8,.17 g cm^{-3}) $\times$ (300 cm^3) = 24510 g

Mass of Ni in the alloy = (24510 g) $\times \frac{45.8}{100}$

= 11225.6 g

Calculation of number of Nickel (Ni) atoms in the alloy

The gram atomic mass of Ni = 58.69

So, 58.69 g of Ni have atoms = 6.022×10^{23}; (as per Avogadro's hypothesis)

11225.6 g of Ni have atoms = ($6.022 \times 10^{23} \times$ 11225.6 / 58.69)

= 1.15×10^{26} atoms

Thus, the number of nickel atoms in an alloy of given dimensions is 1.15 x 10^{26}

16. i. a. C_6H_6
b. H_2O_2
c. $C_6H_{12}O_6$

ii. Molecular mass of anhydrous $ZnSO_4$

= 65.5 + 32 + 4 $\times$ 16 = 161.5

1.615 g of anhydrous ZnSO4 combine with water = 1.260 g

161.5 g of anhydrous ZnSO4 combine with = $\frac{1.260}{1.615} \times 161.5$

= 126 G

17. i. 1 mole of silver (Ag) atom = 108 g = 6.022×10^{23} atoms.

Mass of 6.022×10^{23} atoms of silver (Ag)= 108 g.

Therefore, Mass of 1 atom of silver (Ag) = $\left(\frac{108}{6.022 \times 10^{23}}\right)$= 1.793×10^{-22} g

ii. Mass of 1 g atom of nitrogen (N) = gram atomic mass of nitrogen (N) = 14.0 g.

iii. Mass of a mole of calcium (Ca) = Gram Atomic mass of calcium (Ca)= 40.0 g.

iv. Mass of 1 mole of carbon (C) atom = 12 g = 6.023×10^{23} atoms.

Mass of 6.023×10^{23} atoms of carbon (C) = 12 g.

Therefore, Mass of 10^{23} atoms of carbon (C) =$\left(\frac{12}{6.023 \times 10^{23}}\right) \times 10^{23} = 1.992$g

v. Mass of iron (Fe) = 1.0 g.

Hence, the required order of increasing masses is,

one atom of silver (Ag) < one gram of iron (Fe) < 10^{23} atoms of carbon (C) < one-gram atom of nitrogen (N) < one mole of oxygen (O) < one mole of calcium (Ca).

18. i. The average atomic mass of CI

= $\frac{75.77 \times 34.9689 + 24.23 \times 36.9659}{100}$

= 35.453

ii. a. 1 mole of C_2H_6 contains 2 moles of carbon

$\therefore$ Number of moles of carbon in 3 moles of C_2H_6 = 6

b. 1 mole of C2H6 contain 6-mole atoms of hydrogen

$\therefore$ Number of moles of hydrogen atoms in 3 moles of $C_2H_6 = 3 \times 6 = 18$

c. 1 mole of $C_2H_6 = 6.022 \times 10^{23}$ molecules

$\therefore$ Number of molecules in 3 months of

C2H6 = $3 \times 6.022 \times 10^{23}$

= 1.807×10^{24} molecules

19. i. Volume of a drop of water = 0.05 mL.

Mass of a drop of water = volume $\times$ density = (0.05 mL) x (1.0 g / mL) = 0.05 g

Gram molecular mass of water (H_2O) = $2\times$ H + $1\times$O = $2 \times 1 + 1\times16$ = 18 g/mol

Here, 18 g of water = 1 mol

$\therefore$ 0.05 g of water = $\frac{1\text{mol}}{(18\text{g})} \times (0.05\text{g})$= 0.0028 mol

1 mole of water contains molecules = 6.022×10^{23}

0.0028 mole of water will contain molecules = $6.022\times 10^{23} \times 0.0028 = 1.68 \times 10^{21}$ molecules

ii. Volume of the alloy = (10.0 cm)$\times$ (20.0 cm) $\times$ (15.0 cm)= 3000 cm^3.

Mass of the alloy = density $\times$ volume = (8.17 g cm^{-3}) $\times$ (3000 cm^3) = 24510 g

Percentage of nickel (Ni) in an alloy = 45.8 %

Mass of nickel (Ni) in an alloy = $(24510\text{g}) \times \frac{45.8}{100}$= 11225.6 g

Gram atomic mass of nickel (Ni) = 59 g

Therefore, 59 g Ni contains = 6.022×10^{23} atoms

11225.6 g of Ni contains = $6.022 \times 10^{23} \times \frac{(11225.6\text{g})}{(59.0\text{g})}$ = 1.15×10^{20} atoms

Therefore, the number of Ni atoms present = 1.15×10^{20} atoms