Stoichiometry with Solutions

Consider the following equation;

$$2KI_{(aq)} + Pb(NO_3)_{(aq)} \rightarrow PbI_{2(s)} + 2KNO_{3(aq)}$$

If 75.5ml of a 2.00 mol/L solution of KI reacts, what mass of PbI_2 will precipitate?

We can first work out the number of moles of KI which will react from the volume and molarity of the KI solution…

1) C = 2.00 mol/L
   V = 0.0755 L

$$C = \frac{n_{KI}}{V} \qquad 2.00\ mol/L = \frac{n_{KI}}{0.0755\ L}$$

$$n_{KI} = 0.151\ mol\ KI$$

$\therefore$ 0.151 moles of KI will react

2) now we can determine how many moles of PbI_2 will be produced by deriving a conversion factor from the balanced equation…

2 mol KI = 1 mol PbI_2 (c.f.)

$$0.151\ mol\ KI \times \frac{1\ mol\ PbI_2}{2\ mol\ KI} = 0.0755\ mol\ PbI_2$$

$\therefore$ 0.0755 moles of PbI_2 will be produced

3)now we can determine the mass of PbI_2 produced by using the molar mass of PbI_2 as a conversion factor…

$$M_{PbI_2} = 202.7g/mol + 2(126.9)g/mol$$

$$\approx 461g/mol$$

$$0.755\ mol\ PBI_2 \times \frac{461g\ PbI_2}{1\ mol\ PbI_2} = 34.81g\ PbI_2$$

$\therefore$ 34.81g of PbI_2 will be produced

50ml of an unknown concentration of $CuCl_2 \cdot 2H_2O$ reacts with excess Al to produce 0.56g of Cu. Determine the initial concentration of

[$CuCl_2 \cdot 2H_2O$]. The balanced chemical equation is…

$$3CuCl_2 \cdot 2H_2O + 2Al \rightarrow 2AlCl_3 + 3Cu + 6H_2O$$

We need to get to how many moles of a reactant and have been given how much mass of a product. We will have to convert the mass of product to moles using the molar mass of the product then use the balanced chemical equation to derive a conversion factor from moles of product to moles of reactant and then work out the concentration using the moles of reactant divided by the volume of its solution. There is our plan so lets get started…

1) $M_{Cu} = 63.55 g/mol$

$$0.56g\ Cu \times \frac{1\ mol\ Cu}{63.55g\ Cu} = 0.0088\ mol\ Cu$$

2) 3 moles $CuCl_2 \cdot 2H_2O$ = 3 moles Cu (c.f. from balanced equation)

note: we use this pair because we were given Cu and asked to find the concentration of the compound it came from…

$$0.0088\ mol\ Cu \times \frac{3\ mol\ CuCl_2 \cdot 2H_2O}{3\ mol\ Cu} = CuCl_2 \cdot 2H_2O$$

3) v = 0.050L

n =0.0088 mol

C = ?

$$C = \frac{n}{V} \quad C = \frac{0.0088mol}{0.050L} = 0.176\ mol/L\ CuCl_2 \cdot 2H_2O$$

∴ the initial concentration of $CuCl_2 \cdot 2H_2O$ was 0.176mol/L