Answer on Question #85043 – Chemistry – Other

Task:

A sample of $CaCO_3$ of mass 2.8 g was reacted with 75 cm^3 of 1.0 mol/dm^3 hydrochloride acid. The resulting solution was completely transferred into 250 cm^3 of volumetric flask and the mixture made up to the mark with distilled water. 25 cm^3 of this solution needed 20.05 cm^3 of 1.0 mol/dm^3 of NaOH to neutralize the excess acid. Calculate the percentage of $CaCO_3$ present in the sample.

Solution:

Reaction of neutralization of excess hydrochloric acid:

$$HCl + NaOH = NaCl + H_2O$$

According to the chemical reaction equation:

$$n(HCl) = n(NaOH)$$
$$n(HCl) = C(NaOH) * V(NaOH)$$

Then,

$$n_{excess}(HCl) = 1.0\,{}^{mol}\!/_{dm^3} * 0.02005 dm^3 = 0.02005 mol$$
$$n_{excess}(HCl) = 0.02005 mol$$

Correcting for the aliquoting/dilution factor, you have:

$$n^0{}_{excess}(HCl) = \frac{V_f}{V_a} * n_{excess}(HCl) = \frac{250\,cm^3}{25\,cm^3} * 0.02005 mol = 0.2005 mol$$
$$n^0{}_{excess}(HCl) = 0.2005 mol$$

$$n_{total}(HCl) = C(HCl) * V_{total}(HCl) = 1.0\,{}^{mol}\!/_{dm^3} * 0.075\,dm^3 = 0.075 mol$$

$$n_{total}(HCl) < n^0{}_{excess}(HCl) = 0.075 mol < 0.2005 mol$$

There is a error with the way the question is presented because according to the above calculations, there is more HCl left over (in excess) than there was originally added.

$$n(HCl) = n_{total}(HCl) - n^{0}{}_{excess}(HCl)$$

Reaction of $CaCO_3$ with hydrochloric acid:

$$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$$

According to the chemical reaction equation:

$$n(CaCO_3) = \frac{n(HCl)}{2} = \frac{n_{total}(HCl) - n^{0}{}_{excess}(HCl)}{2};$$

$$m(CaCO_3) = n(CaCO_3) * M(CaCO_3) = (\frac{n_{total}(HCl) - n^{0}{}_{excess}(HCl)}{2}) * M(CaCO_3)$$

Then,

$$m^{o}(CaCO_3) = 2.8g$$

$$\%\, yield = \frac{m(CaCO_3)}{m^{o}(CaCO_3)} * 100\% = \frac{m(CaCO_3)}{2.8g} * 100\%$$

Answer: Error in the task. Problem is that more HCl left over (0.2005 moles) than was originally present (0.075 moles).