Answer on Question #53168 – Chemistry – Inorganic Chemistry

Question 1:
Consider the reaction: $MnO_2 + 4\ HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$
If 0.86 mole of MnO_2 and 48.2 g of HCl react, which reagent will be used up first? How many grams of Cl_2 will be produced?

Answer 1:
Given
$n(MnO_2) = 0.86$ mole
$m(HCl) = 48.2$ g
$M(HCl) = 36.5$ g/mole, $M(Cl_2) = 71$ g/mole

$n(HCl) = m(HCl)/M(HCl) = 48.2/36.5 = 1.32$ mole
From the chemical equation: 1 mole of MnO_2 reacts with 4 moles of HCl.
Thus, 0.86 mole of MnO_2 require $4 \cdot 0.86 = 3.44$ moles of HCl to react with (but only 1.32 mole are present). This means there is deficiency of HCl in terms of amount of MnO_2, and HCl will be used up first.
From the chemical equation: 1 mole of Cl_2 is produced when 4 moles of HCl react. So, we can write the following proportion:

$4\text{mole} \cdot 36.5\ \text{g/mole (HCl)} - 1\text{mole} \cdot 71\text{g/mole}(Cl_2)$
$48.2\ \text{g (HCl)} - m(Cl_2)$

$m(Cl_2) = 71 \cdot 48.2/(4 \cdot 36.5) = 23.4$ g

Answer: HCl will be used up first.
23.4 g of Cl_2 will be produced.

Question 2:
Titanium(VI) oxide (TiO_2) is a white substance produced by the action of sulfuric acid on the mineral ilmenite ($FeTiO_3$):
$FeTiO_3 + H_2SO_4 \rightarrow TiO_2 + FeSO_4 + H_2O$
Its opaque and nontoxic properties make it suitable as a pigment in plastics and paints. In one process, $8.00 \cdot 10^3$ kg of $FeTiO_3$ yielded $3.67 \cdot 10^3$ kg of TiO_2. What is the percent yield of the reaction?

Answer 2:
Given
$m(FeTiO_3) = 8.00 \cdot 10^3$ kg
$m(TiO_2) = 3.67 \cdot 10^3$ kg
$M(FeTiO_3) = 151.71$ g/mole, $M(TiO_2) = 79.87$ g/mole

As is clear from the chemical equation, 1 mole of TiO_2 is produced when 1 mole of $FeTiO_3$ react.
So, we can write the following proportion:

$151.71\ \text{g/mole}\ (FeTiO_3) - 79.87\ \text{g/mole}\ (TiO_2)$
$8.00 \cdot 10^3\ \text{kg}\ (FeTiO_3) - m(TiO_2)(\text{theoretical})$

$m(TiO_2)(\text{theoretical}) = 79.87 \cdot 8.00 \cdot 10^3/151.71 = 4.21 \cdot 10^3$ kg
$\%\text{Yield}(TiO_2) = m(TiO_2)/m(TiO_2)(\text{theoretical}) \cdot 100\% = 3.67 \cdot 10^3/4.21 \cdot 10^3 \cdot 100\% = 87.17\%$

Answer: $\%\text{Yield}(TiO_2) = 87.17\%$