Stage 3 - Set 5 Answers: Percentage composition and yield

1. a) $M(Fe_2O_3) = 159.7$ g mol-1

$$\%Fe: \frac{111.7}{159.7} x100$$
$$= 69.9\%$$

b)
$$\%Heamatite: \frac{65.0}{69.9} x100$$
$$= 92.9\%$$

2. $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$

m(remaining) = m(Cu)
= 0.630 g

m(Zn) = 2.71 – 0.630
= 2.08 g

$$\%Zn: \frac{2.08}{2.71} x100$$
$$= 76.8\%$$

3. a)
$$n(Br_2) = \frac{125}{79.9x2}$$
$$= 0.782 \text{ mol}$$

$$n(C_6H_6) = \frac{60.0}{78.108}$$
$$= 0.768 \text{ mol}$$

1 mol of Br_2 requires 1 mol of C_6H_6
0.782 mol of Br_2 requires 0.782 mol of C_6H_6

$n(C_6H_6$ required) > $n(C_6H_6$ available)
C_6H_6 is LR
$n(C_6H_5Br) = n(C_6H_6)$
= 0.768 mol
$m(C_6H_5Br) = 0.768 \times 157$
= 121 g

b)
$$\%yield: \frac{93.2}{121} x100$$
$$= 77.3\%$$

4. a) $Ca(OH)_2 \rightarrow CaO + H_2O$

b)
$$\%CaO: \frac{4.33}{5.67} x100$$
$$= 76.4\%$$

5. a) $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
$n(Ba^{2+}) = n(CuSO_4.5H_2O)$

b) $$n(CuSO_4.5H_2O) = \frac{1.11}{249.69}$$
$$= 4.45 \times 10^{-3} \text{ mol}$$
$$= n(BaC\ell_2)$$
$$m(BaC\ell_2) = (4.45 \times 10^{-3}) \times (137.3 + 70.9)$$
$$= 0.926 \text{ g}$$

c) $n(CuC\ell_2.2H_2O) = n(BaC\ell_2 \text{ used})$
$$= 4.45 \times 10^{-3} \text{ mol}$$
$$m(CuC\ell_2.2H_2O) = (4.45 \times 10^{-3}) \times 170.482$$
$$= 0.758 \text{ g}$$
$$\%\text{yield} : \frac{0.345}{0.758} \times 100$$
$$= 45.5\ \%$$

6. $n(Na_2S_2O_7) = \frac{1}{2}\ n(S)$
$$n(S) = \frac{17500}{32.06}$$
$$= 5.46 \times 10^2 \text{ mol}$$
$$n(Na_2S_2O_7) = \frac{1}{2}\ (5.46 \times 10^2)$$
$$= 2.73 \times 10^2 \text{ mol}$$
$$m(Na_2S_2O_7) = (2.73 \times 102) \times (45.98+64.12+112)$$
$$= 6.06 \times 10^4 \text{ g}$$
$$\%\text{yield} : \frac{50000}{60617} \times 100$$
$$= 82.5\ \%$$

7. let $x = m(NaHCO_3)$
$y = m(Na_2CO_3)$

$x + y = 100$
$y = 100 - x$

$$n(Na_2CO_3) = \frac{90.7}{106}$$
$$= 0.856 \text{ mol}$$

$n(Na_2CO_3 \text{ total}) = \frac{1}{2}\ n(NaHCO_3 \text{ initial}) + n(Na_2CO_3 \text{ initial})$
$$= \left(\frac{1}{2} \times \frac{x}{84.01}\right) + \frac{y}{100}$$
$$0.856 = \frac{x}{168} + \frac{100 - x}{106}$$
$$62x = 1556.352$$
$$x = 25.1 \text{ g}$$
$$y = 74.9 \text{ g}$$

$$\%Na_2CO_3 = \frac{74.9}{100} \times 100$$
$$= 74.9\ \%$$