– PROBLEM OF THE UNIT –

Reactions and Stoichiometry HP

(1) Copper metal reacts with nitric acid to form copper (II) nitrate, water, and nitrogen monoxide.

(a) Give the *balanced* chemical equation for this reaction.

$$3\,Cu + 8\,HNO_3 \rightarrow 3\,Cu(NO_3)_2 + 4\,H_2O + 2\,NO$$

3 Cu 3
8 H 8
8 N 8
24 O 24

(b) A small piece of copper (density 8.95 g/cm^3) with a volume of 2.00 cm^3 is placed in the reaction container. What is the mass of the copper?

$$2.00\ cm^3 \times \frac{8.95\ g}{1\ cm^3} = 17.9\ g\ Cu$$

17.9 g Cu

(c) Calculate the number of moles of copper.

$$17.9\ g\ Cu \times \frac{1\ mol}{63.55\ g\ Cu} = 0.282\ mol\ Cu$$

0.282 mol Cu

(d) There are 5.00x10^{23} molecules of nitric acid present in the reaction vessel. How many moles of nitric acid are present?

$$5.00 \times 10^{23}\ molec\ HNO_3 \times \frac{1\ mol\ HNO_3}{6.02 \times 10^{23}\ molec} =$$

0.831 mol HNO_3

(e) (ii) What mass of copper (II) nitrate would theoretically be produced in the reaction?

$$0.282\ mol\ Cu \times \frac{3\ mol\ Cu(NO_3)_2}{3\ mol\ Cu} \times \frac{187.57\ g\ Cu(NO_3)_2}{1\ mol\ Cu(NO_3)_2} = 52.9\ g\ Cu(NO_3)_2$$

$$0.831\ mol\ HNO_3 \times \frac{3\ mol\ Cu(NO_3)_2}{8\ mol\ HNO_3} \times \frac{187.57\ g\ Cu(NO_3)_2}{1\ mol\ Cu(NO_3)_2} =$$

(ii) The reaction actually produced 40.0 g of copper (II) nitrate. Calculate the percent yield for the reaction.

$$\frac{40.0\ g}{52.9\ g} \times 100 =$$

75.6%

(f) What volume of water would be produced by the reaction? (note: water has a density of 1.00 g/mL)

$$40.0\ g\ Cu(NO_3)_2 \times \frac{1\ mol\ Cu(NO_3)_2}{187.57\ g\ Cu(NO_3)_2} \times \frac{4\ mol\ H_2O}{3\ mol\ Cu(NO_3)_2} \times \frac{18.02\ g\ H_2O}{1\ mol\ H_2O} \times \frac{1\ mL}{1.00\ g} = 5.12\ mL$$

(g) How many molecules of nitrogen monoxide would be produced in the reaction?

$$40.0\ g\ Cu(NO_3)_2 \times \frac{1\ mol\ Cu(NO_3)_2}{187.57\ g\ Cu(NO_3)_2} \times \frac{2\ mol\ NO}{3\ mol\ Cu(NO_3)_2} \times \frac{6.02 \times 10^{23}}{1\ mol\ NO} =$$

$= 8.56 \times 10^{22}$ molecules