EXPERIMENT 3B NOTES: A SAMPLE CALCULATION

Example problem:

Determine which of the following reactions is best supported by the experimental data given.

$$2Fe + O_2 \rightarrow 2FeO \quad (1) \quad \text{(iron(II) oxide product)}$$

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3 \quad (2) \quad \text{(iron(III) oxide product)}$$

50,0 g of iron is reacted with sufficient oxygen. 71.5 g of an iron oxide are recovered

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Fe: 55,85 g Fe = mol Fe

$$50.0\,g\,Fe \times \frac{mol\ Fe}{55.85\,g\,Fe} = 0.8952551\ mol\ Fe\ \text{reacted}$$

In reaction (1), 2 moles of Fe are consumed for every 2 moles FeO formed

2 mol Fe = 2 mol FeO

$$0.8952551\ mol\ Fe \times \frac{2\ mol\ FeO}{2\ mol\ Fe} = 0.8952551\ mol\ FeO$$

Convert to grams and compare to the actual weight of the iron oxide product collected

FeO: Fe 1 x 55.85
O 1 x 16.00
71.85 g FeO = mol FeO

$$0.8952551\ mol\ FeO \times \frac{71.85\,g\,FeO}{mol\ FeO} = 64.3\,g\,FeO$$

$64.3\,g \neq 71.5\,g$ This isn't even close! FeO is not the product!

Now, check the other reaction.

In reaction (2), 4 moles of Fe are consumed for every 2 moles Fe_2O_3 formed

$$4 \text{ mol Fe} = 2 \text{ mol } Fe_2O_3$$

$$0.8952551 \text{ mol Fe} \times \frac{2 \text{ mol } Fe_2O_3}{4 \text{ mol Fe}} = 0.4476276 \text{ mol } Fe_2O_3$$

Convert to grams and compare to the actual weight of the iron oxide product collected

$$Fe_2O_3: \quad \begin{array}{l} Fe: 2 \times 55.85 \\ O: 3 \times 16.00 \\ \hline 159.70 \text{ g } Fe_2O_3 = \text{mol } Fe_2O_3 \end{array}$$

$$0.4476276 \text{ mol } Fe_2O_3 \times \frac{159.70 \text{ g } Fe_2O_3}{\text{mol } Fe_2O_3} = \boxed{71.5 \text{ g } Fe_2O_3}$$

This value matches the amount of product observed in the experiment, so it's likely that reaction (2) is the correct one and that the iron oxide product is iron(III) oxide.

In Experiment 3B, the math is a little easier than our example problem. In all three possible reactions, the number of moles of starting material equals the number of moles of solid product:

A) $BaCl_2 \cdot 2H_2O(s) \longrightarrow \underline{BaCl_2 \cdot H_2O(s)} + H_2O(g)$

B) $BaCl_2 \cdot 2H_2O(s) \longrightarrow \underline{BaCl_2(s)} + 2H_2O(g)$

C) $BaCl_2 \cdot 2H_2O(s) \longrightarrow \underline{BaO(s)} + 2HCl(g) + H_2O(g)$

To find out which product you have, you will need to calculate the expected weights of each solid product that could be produced in each reaction: (A), (B), and (C). As an example, let's say that you start the experiment with 2.50 g of barium chloride dihydrate:

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Find our how many moles of dihydrate you have:

$$BaCl_2 \cdot 2H_2O : \begin{array}{l} Ba: 1 \times 137.33 \\ Cl: 2 \times 35.45 \\ H: 4 \times 1.008 \\ O: 2 \times 16.00 \\ \hline 244.26\,g\ BaCl_2 \cdot 2H_2O = mol\ BaCl_2 \cdot 2H_2O \end{array}$$

Include the water molecules!

$$2.5\,g\ BaCl_2 \cdot 2H_2O \times \frac{mol\ BaCl_2 \cdot 2H_2O}{244.26\,g\ BaCl_2 \cdot 2H_2O} =$$

$$= 0.0102349\ mol\ BaCl_2 \cdot 2H_2O$$

If reaction (A) is correct, one mole of barium chloride dihydrate will produce one mole of barium chloride monohydrate. In other words, the moles of barium chloride monohydrate equals the moles of barium chloride dihydrate.

$$0.0102349\ mol\ BaCl_2 \cdot H_2O$$

Convert moles to mass using the formiula weight

$$BaCl_2 \cdot H_2O : 226.25\,g\ BaCl_2 \cdot H_2O = mol\ BaCl_2 \cdot H_2O$$

$$0.0102349\ mol\ BaCl_2 \cdot H_2O \times \frac{226.25\,g\ BaCl_2 \cdot H_2O}{mol\ BaCl_2 \cdot H_2O} =$$

$$= 2.32\,g\ BaCl_2 \cdot H_2O$$

... so if reaction (A) is the right one, we should collect about 2.32 g of solid product after the reaction is complete.

If reaction (B) is correct, one mole of barium chloride dihydrate will produce one mole of barium chloride. The moles of barium chloride equals the moles of barium chloride dihydrate.

$$0.0102349 \text{ mol } BaCl_2$$

Convert moles to mass using the formiula weight

$$BaCl_2: 208.23 \text{ g } BaCl_2 = \text{mol } BaCl_2$$

$$0.0102349 \text{ mol } BaCl_2 \times \frac{208.23 \text{ g } BaCl_2}{\text{mol } BaCl_2} =$$

$$= 2.13 \text{ g } BaCl_2$$

... so if reaction (B) is the right one, we should collect about 2.13 g of solid product after the reaction is complete.

If reaction (C) is correct, one mole of barium chloride dihydrate will produce one mole of barium oxide..

$$0.0102349 \text{ mol } BaO$$

Convert moles to mass using the formiula weight

$$BaO: 153.33 \text{ g } BaO = \text{mol } BaO$$

$$0.0102349 \text{ mol } BaO \times \frac{208.23 \text{ g } BaO}{\text{mol } BaO} =$$

$$= 1.57 \text{ g } BaO$$

... so if reaction (C) is the right one, we should collect about 1.57 g of solid product after the reaction is complete.

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Using the chart format the lab manual uses, the results of our caculations would look like this:

This is the mass of STARTING MATERIAL (before heating!)

Substance	Formula Wt	Moles	Mass (g)
$BaCl_2 \cdot 2H_2O$	244.26	0.0102349	$\boxed{2.50}$
$BaCl_2 \cdot H_2O$	226.25	0.0102349	2.32
$BaCl_2$	208.23	0.0102349	2.13
BaO	153.33	0.0102349	1.57

The rest of the masses are of PRODUCTS (after heating)

Compare the calculated masses for barium chloride monohydrate, barium chloride, and baroum oxide with your actual product mass.

The actual product of the reaction is the substance whose calculated mass most closely matches the actual product mass you observed during the experiment!