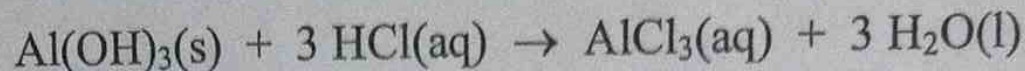


## 4 • Chemical Equations and Stoichiometry

### STOICHIOMETRY PROBLEMS

#### General Stoichiometry

1. Several brands of antacid tablets use aluminum hydroxide to neutralize excess acid.

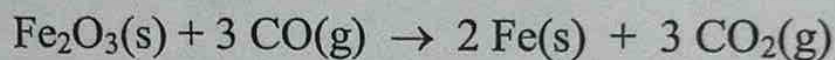


[Molar masses:            78.01            36.46            133.4            18.02]

What quantity of HCl, in grams, can a tablet with 0.750 g of  $\text{Al(OH)}_3$  consume? What quantity of water is produced?

2. If 10.0 g of carbon is combined with an exact, stoichiometric amount of oxygen (26.6 g) to produce carbon dioxide, what mass, in grams, of  $\text{CO}_2$  can be obtained? That is, what is the theoretical yield of  $\text{CO}_2$ ? [Molar masses: C: 12.011     $\text{O}_2$ : 32.00     $\text{CO}_2$ : 44.01]

3. The equation for one of the reactions in the process of reducing iron ore to the metal is

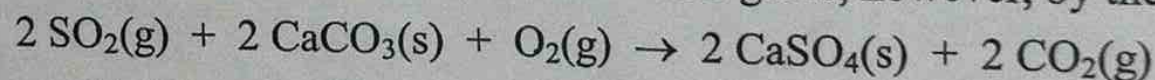


[Molar masses:            159.7            28.01            55.85            44.01]

(a) What is the maximum mass of iron, in grams, that can be obtained from 454 g (1.00 lb) of iron(III) oxide?

(b) What mass of CO is required to reduce the iron(III) oxide to iron metal?

4. Burning coal and oil in a power plant produces pollutants such as sulfur dioxide,  $\text{SO}_2$ . The sulfur-containing compound can be removed from other waste gases, however, by the following reaction:



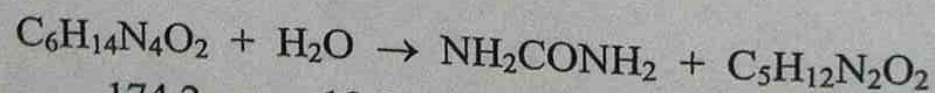
[Molar masses: 64.07            100.1            32.00            136.2            44.01]

(a) Name the compounds involved in the reaction.

(b) What mass of  $\text{CaCO}_3$  is required to remove 155 g of  $\text{SO}_2$ ?

(c) What mass of  $\text{CaSO}_4$  is formed when 155 g  $\text{SO}_2$  is consumed completely?

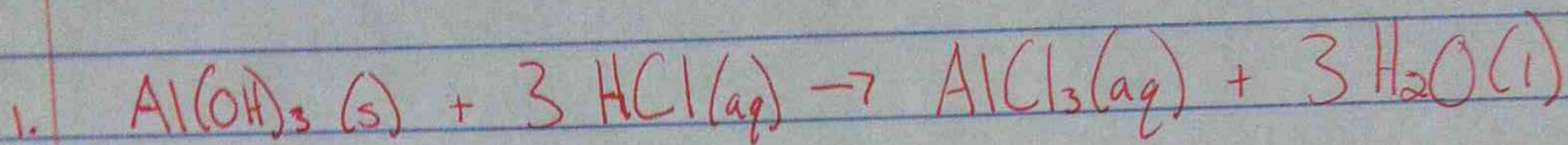
5. Your body deals with excess nitrogen by excreting it in the form of urea,  $\text{NH}_2\text{CONH}_2$ . The reaction producing it is the combination of arginine ( $\text{C}_6\text{H}_{14}\text{N}_4\text{O}_2$ ) with water to give urea and ornithine ( $\text{C}_5\text{H}_{12}\text{N}_2\text{O}_2$ ).



[Molar masses:            174.2            18.02            60.06            132.2]

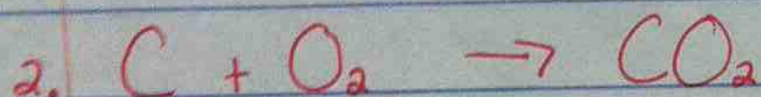
If you excrete 95 mg of urea, what quantity of arginine must have been used? What quantity of ornithine must have been produced?

## General Stoichiometry



$$\frac{.750\text{g Al(OH)}_3}{1} \times \frac{1\text{mol Al(OH)}_3}{78.01\text{g}} \times \frac{3\text{mol HCl}}{1\text{mol Al(OH)}_3} \times \frac{36.46\text{g HCl}}{1\text{mol HCl}} = \boxed{1.05\text{g HCl}}$$

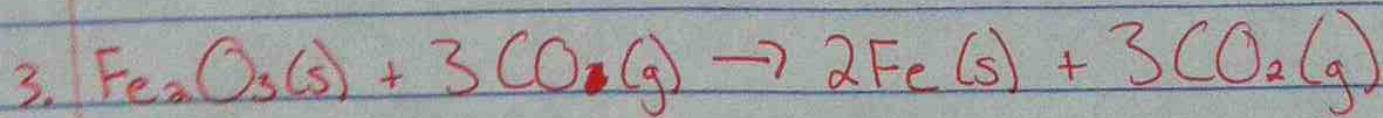
$$\frac{.750\text{g Al(OH)}_3}{1} \times \frac{1\text{mol Al(OH)}_3}{78.01\text{g}} \times \frac{3\text{mol H}_2\text{O}}{1\text{mol Al(OH)}_3} \times \frac{18.0\text{g H}_2\text{O}}{1\text{mol}} = \boxed{.519\text{g H}_2\text{O}}$$



$$\frac{10\text{g C}}{1} \times \frac{1\text{mol C}}{12.011\text{g}} \times \frac{1\text{mol CO}_2}{1\text{mol C}} \times \frac{44.01\text{g CO}_2}{1\text{mol CO}_2} = \boxed{36.6\text{g CO}_2}$$

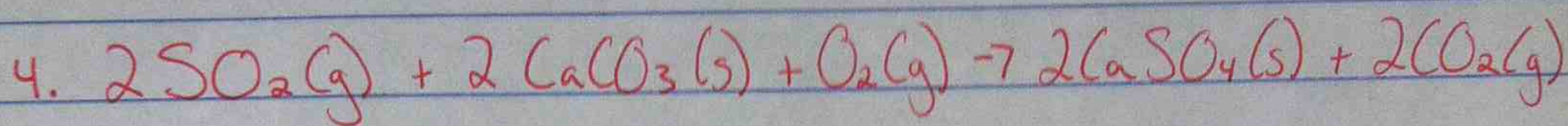
} theoretical yield

$$\frac{26.6\text{g O}_2}{1} \times \frac{1\text{mol O}_2}{32.00\text{g}} \times \frac{1\text{mol CO}_2}{1\text{mol O}_2} \times \frac{44.01\text{g CO}_2}{1\text{mol CO}_2} = 36.6\text{g CO}_2$$



$$\frac{454\text{g Fe}_2\text{O}_3}{1} \times \frac{1\text{mol Fe}_2\text{O}_3}{159.7\text{g}} \times \frac{2\text{mol Fe}}{1\text{mol Fe}_2\text{O}_3} \times \frac{55.85\text{g Fe}}{1\text{mol Fe}} = \boxed{318\text{g Fe}}$$

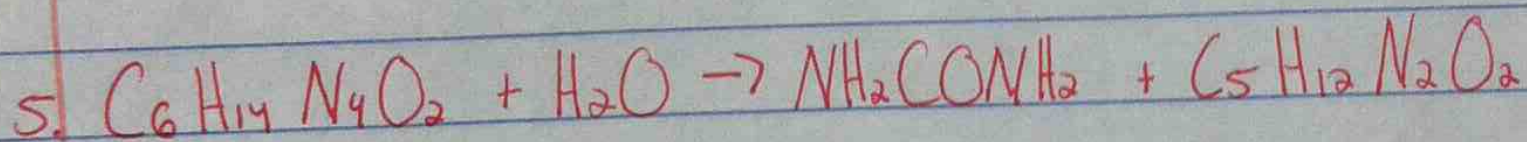
$$\frac{454\text{g Fe}_2\text{O}_3}{1} \times \frac{1\text{mol Fe}_2\text{O}_3}{159.7\text{g}} \times \frac{3\text{mol CO}}{1\text{mol Fe}_2\text{O}_3} \times \frac{28.01\text{g CO}}{1\text{mol CO}} = \boxed{239\text{g CO}}$$



a. sulfur dioxide  $\text{SO}_2$                       oxygen  $\text{O}_2$                       carbon dioxide  $\text{CO}_2$   
 calcium carbonate  $\text{CaCO}_3$                       calcium sulfate  $\text{CaSO}_4$

$$b. \quad \frac{155 \text{ g SO}_2}{1} \times \frac{1 \text{ mol SO}_2}{64.07 \text{ g}} \times \frac{2 \text{ mol CaCO}_3}{2 \text{ mol SO}_2} \times \frac{100.1 \text{ g}}{1 \text{ mol CaCO}_3} = \boxed{242 \text{ g CaCO}_3}$$

$$c. \quad \frac{155 \text{ g SO}_2}{1} \times \frac{1 \text{ mol SO}_2}{64.07 \text{ g}} \times \frac{2 \text{ mol CaSO}_4}{2 \text{ mol SO}_2} \times \frac{136.2 \text{ g}}{1 \text{ mol CaSO}_4} = \boxed{329 \text{ g CaSO}_4}$$



$$\frac{95 \text{ mg}}{1} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ mol NH}_2\text{CONH}_2}{60.06 \text{ g}} \times \frac{1 \text{ mol C}_6\text{H}_{14}\text{N}_4\text{O}_2}{1 \text{ mol NH}_2\text{CONH}_2} \times \frac{174.2 \text{ g}}{1 \text{ mol C}_6\text{H}_{14}\text{N}_4\text{O}_2} = \boxed{.28 \text{ g C}_6\text{H}_{14}\text{N}_4\text{O}_2}$$

$$\frac{95 \text{ mg}}{1} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ mol NH}_2\text{CONH}_2}{60.06 \text{ g}} \times \frac{1 \text{ mol}}{1 \text{ mol}} \times \frac{132.2 \text{ g}}{1 \text{ mol C}_5\text{H}_{12}\text{N}_2\text{O}_2} = \boxed{.21 \text{ g C}_5\text{H}_{12}\text{N}_2\text{O}_2}$$