Answers Questions 9.2

1. Complete the table below for the equation $2Al + 3S \rightarrow Al_2S_3$

Element or Compound	Al	S	Al_2S_3
Number of atoms/molecules	$2*6.02x10^{23}$	$3*6.02x10^{23}$	6.02×10^{23}
Number of moles	2.0	3.0	1.0
Number of grams	54.0	96.0	150.0

2. Answer the questions below about the reaction $N_2 + 3\ H_2 \rightarrow 2\ NH_3$

A. If 5.00 moles of hydrogen gas were reacted with 2.00 moles of nitrogen gas how many moles of ammonia would be produced?

$$5.00 \text{ moles } H_2 * \frac{2 \text{ moles } NH_3}{3 \text{ moles } H_2} = 3.33 \text{ moles } NH_3$$

$$2.00 \text{ moles } N_2 * \frac{2 \text{ moles } NH_3}{1 \text{ mole } N_2} = 4.00 \text{ moles } NH_3$$

Would the reaction run out of hydrogen gas or nitrogen gas first?

Hydrogen gas runs out first, producing a smaller amount of ammonia

B. How many moles of nitrogen gas would be needed to react completely with 1.50 moles of hydrogen gas with no nitrogen gas left over?

$$1.5 \text{ moles } H_2 * \frac{1 \text{ mole } N_2}{3 \text{ moles } H_2} = 0.5 \text{ mole } N_2$$

3. Answer the questions below about the reaction
$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$.

A. If 63.5 grams of copper metal reacted with 231.9 grams of silver nitrate, what mass of silver metal would be produced? Which reactant would run out first?

$$63.5 \text{ g Cu} * \frac{1 \text{ mole Cu} * 2 \text{ mole Ag} * 107.9 \text{ g Ag}}{3.5 \text{ g Cu} \quad 1 \text{ mole Cu} \quad 1 \text{ mole Ag}} = 215.8 \text{ g Ag}$$

$$231.9\text{g } AgNO_3 * \frac{1 \text{ mole } AgNO_3 * 2 \text{ mole Ag} * 107.9 \text{ g Ag}}{169.\text{g } AgNO_3 \quad 2 \text{ mole } AgNO_3 \quad 1 \text{ mole Ag}} = 148 \text{ g Ag}$$

B. If 107.9 grams of silver were produced in a reaction, how many grams of cupric nitrate would be produced?

$$107.9\text{g Ag} * \frac{1 \text{ mole Ag} * 1 \text{ mole } Cu(NO_3)_2 * 187.5 \text{ g } Cu(NO_3)_2}{107.9\text{g Ag} \quad 2 \text{ mole Ag} \quad 1 \text{ mole } Cu(NO_3)_2} = 93.8\text{g } Cu(NO_3)_2$$

C. If you wanted to produce 10.79 grams of silver metal, what minimum number of grams of copper metal and silver nitrate would you have to start the reaction with?

$$10.79 \text{ g Ag} * \frac{1 \text{ mole Ag} * 1 \text{ mole Cu} * 63.5\text{g Cu}}{107.9\text{g Ag} \quad 2 \text{ mole Ag} \quad 1 \text{ mole Cu}} = 3.175 \text{ g Cu}$$

$$10.79\text{gAg} * \frac{1 \text{ mole Ag} * 1 \text{ mole } AgNO_3 * 169.9\text{g } AgNO_3}{107.9\text{g Ag} \quad 1 \text{ mole Ag} \quad 1 \text{ mole } AgNO_3} = 16.99\text{g } AgNO_3$$

4. 275 grams of calcium carbonate is heated to produce calcium oxide and carbon dioxide gas. What mass of carbon dioxide gas and calcium oxide are produced?

$CaCO_3 \rightarrow CaO + CO_2$

$$275g\ CaCO_3 * \frac{1\ mole\ CaCO_3}{100.1g\ CaCO_3} * \frac{1\ mole\ CaO}{1\ mole\ CaCO_3} * \frac{56.1g\ CaO}{1\ mole\ CaO} = 154g\ CaO$$

Total mass of reactants = total mass of products

Mass CO_2 = mass $CaCO_3$ - mass CaO = 275g - 154g = 121g CO_2

5. Ferric oxide can be converted to iron metal and carbon dioxide gas by heating with carbon.

A. What mass of carbon is needed to completely convert 385 grams of ferric oxide ?

$2\ Fe_2O_3 + 3\ C \rightarrow 4\ Fe + 3\ CO_2$

$$385g\ Fe_2O_3 * \frac{1\ mole\ Fe_2O_3}{159.6g\ Fe_2O_3} * \frac{3\ mole\ C}{2\ mole\ Fe_2O_3} * \frac{12.0g\ C}{1\ mole\ C} = 43.4g\ C$$

B. How many grams of iron metal are produced?

$$385g\ Fe_2O_3 * \frac{1\ mole\ Fe_2O_3}{159.6g\ Fe_2O_3} * \frac{4\ mole\ Fe}{2\ mole\ Fe_2O_3} * \frac{55.8g\ Fe}{1\ mole\ Fe} = 269g\ Fe$$

6. Why is the theoretical yield of a chemical reaction is always greater than the actual yield ?

The reactants may not be pure
The reaction may not occur completely
Some loss of product can occur in the lab process

7. 80.6 grams of magnesium oxide is reacted with unlimited water to produce magnesium hydroxide.

A. Write and balance the equation for the reaction.

$MgO + H_2O \rightarrow Mg(OH)_2$

B. How many grams of magnesium hydroxide should be produced ? (show your work)

$$80.6g\ MgO * \frac{1\ mole\ MgO}{40.3g\ MgO} * \frac{1\ mole\ Mg(OH)_2}{1\ mole\ MgO} * \frac{58.3g\ Mg(OH)_2}{1\ mole\ Mg(OH)_2}$$

$= 117g\ Mg(OH)_2$

C. If 105 grams of magnesium hydroxide is actually produced, what is the percent yield for the reaction ? (show your work)

$$\%\ yield = \frac{actual\ mass\ in\ lab}{calculated\ mass\ expected} = \frac{105g}{117g} = 89.7\%$$