Limiting and Excess Reactants Practice Name:**ANSWER KEY**

General Chemistry Date:____________________Hour_______

Balance the chemical equation showing the combination reaction between solid iron and oxygen gas. Using the information about the reactants, complete the BCA tables. Use the BCA table to identify the limiting reactant and determine how much excess reactant remains. *All answers will be in moles on this page.*

$4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$

1) 10 moles of Fe and 12 moles of O_2

	Fe	O_2	Fe_2O_3
B	***10 mol***	***12 mol***	***0 mol***
C	***- 10 mol***	***- 7.5 mol***	***+ 5 mol***
A	***0 mol***	***4.5 mol***	***5 mol***

What is the maximum amount of moles of iron (III) oxide molecules that can be made? ***5 mol***
What is the limiting reactant? ***Fe Iron*** How much excess reactant remains? ***4.5 mol***

2) 8 moles of Fe and 5 moles of O_2 VIDEO

	Fe	O_2	Fe_2O_3
B	***8 mol***	***5 mol***	***0 mol***
C	***- 6.67 mol***	***- 5 mol***	***+ 3.33 mol***
A	***1.33 mol***	***0 mol***	***3.33 mol***

What is the maximum amount of moles of iron (III) oxide molecules that can be made? ***3.33 mol***
What is the limiting reactant? ***Oxygen*** How much excess reactant remains? ***1.33 mol Fe***

3) 20 grams of Fe and 32 moles of O_2,

	Fe	O_2	Fe_2O_3
B	***0.36 mol***	***32 mol***	***0 mol***
C	***-0.36 mol***	***-0.27 mol***	***+0.18 mol***
A	***0 mol***	***31.73 mol***	***0.18 mol***

What is the maximum amount of moles of iron (III) oxide molecules that can be made? ***0.18 mol***

What is the limiting reactant? ***Iron*** How much excess reactant remains? ***31.73 mol Oxygen***

$6\ Li + N_2 \rightarrow 2\ Li_3N$

4) 10.6g of Li and 3.83g of N_2 react to form Li_3N. ***Need to convert grams to moles.***

$$\left(\frac{10.6\ g\ Li}{1}\right)\left(\frac{1\ mol\ Li}{6.94\ g\ Li}\right) = \underline{1.5273}775\ldots \quad 1.5274\ mol\ Li$$

$$\left(\frac{3.83\ g\ N2}{1}\right)\left(\frac{1\ mol\ N2}{28.014\ g\ N2}\right) = 0.\underline{13671}735\ldots\ 0.13672\ mol\ N_2$$

	Li	N_2	Li_3N
B	***1.5274 mol***	***0.13672 mol***	***0 mol***
C	***- 0.822 mol***	***- 0.13672 mol***	***+ 0.274 mol***
A	***0.708 mol***	***0 mol***	***0.274 mol***

a) What is the maximum amount of moles of lithium nitride that can be made? ***0.274 moles of Li_3N***

b) What is the maximum amount of molecules of lithium nitride that can be made? ***$1.65x10^{23}$ molecules Li_3N***

$$\left(\frac{0.274\ mol\ Li3N}{1}\right)\left(\frac{6.02x10^{23} molecules\ Li3N}{1\ mol\ Li3N}\right) = \underline{1.64}948x10^{23} \rightarrow 1.65x10^{23}\ molecules\ Li_3N$$

c) What is the limiting reactant? ***Nitrogen (N_2)***

d) How many moles of limiting reactant are used? ***0.137 moles N_2***

e) How many particles of limiting reactant are used? ***$8.25x10^{22}$ molecules N_2***

$$\left(\frac{0.137\ mol\ N2}{1}\right)\left(\frac{6.02x10^{23} particles\ N2}{1\ mol\ N2}\right) = \underline{8.24}74x10^{22}\ molecules\ N_2$$

f) How many grams of limiting reactant are used? ***3.84 grams N_2***

$$\left(\frac{0.137\ mol\ N2}{1}\right)\left(\frac{28.014\ g\ N2}{1\ mol\ N2}\right) = \underline{3.83}7918\ grams\ N_2$$

g) What is the excess reactant? ***Lithium (Li)***

h) How much excess reactant remains in moles? ***0.708 moles of Li***

i) How much excess reactant remains in grams? ***4.91 grams of Li***

$$\left(\frac{0.708\ mol\ Li}{1}\right)\left(\frac{6.94\ g\ Li}{1\ mol\ Li}\right) = \underline{4.91}352\ grams$$

Read This!

When chemical reactions take place in a laboratory, we do not always make the amount of product we intend to. Mistakes happen! There are so many ways in which an error can occur and affect a scientist's data. Here are some vocabulary words we use to help explain how successful our lab was:

- "If everything goes perfectly in our lab, *theoretically*, we should be able to make this much product…" This is known as **theoretical yield** - the maximum amount of product that could be formed from given amounts of reactants. **The BCA table tells us the theoretical yield of our products.**
- **Actual yield** - the amount of product that *actually* forms when a chemical reaction occurs.
- **Percent yield** - the ratio of the actual yield to the theoretical yield expressed as a percent. Percent yield can be calculated using this formula: $percent\ yield = \frac{actual\ yield}{theoretical\ yield} x100$

We will practice calculating percent yield in the following reactions...

$$C_3H_{8\,(g)} + 5\ O_{2\,(g)} \rightarrow 3\ CO_{2\,(g)} + 4\ H_2O_{(g)}$$

5) 2.54 grams of tricarbon octahydride gas combusts with 20.02 grams of oxygen

$$\left(\frac{2.54\ g\ C3H8}{1}\right)\left(\frac{1\ mol\ C3H8}{44.11\ g\ C3H8}\right) = 0.0575833144\ldots \quad 0.057583\ mol\ C_3H_8$$

$$\left(\frac{20.02\ g\ O2}{1}\right)\left(\frac{1\ mol\ O2}{32.00\ g\ O2}\right) = 0.625664104\ldots \quad 0.62566\ mol\ O_2$$

	C_3H_8	O_2	CO_2	H_2O
B	***0.057583 mol***	***0.62566 mol***	***0 mol***	***0 mol***
C	***- 0.057583 mol***	***- 0.285 mol***	***+ 0.171 mol***	***+ 0.228mol***
A	***0 mol***	***0.3407 mol***	***0.171 mol***	***0.228 mol***

a) What is the theoretical yield of CO_2? (*from your BCA table*) ***0.171 moles CO_2***

b) How many grams of CO_2 can be made?

$$\left(\frac{0.171\ mol\ CO2}{1}\right)\left(\frac{44.11\ g\ CO2}{1\ mol\ CO2}\right) = 7.525539\ldots \quad 7.53\ grams\ CO_2$$

c) If 2.00 g of CO_2 are *actually* made in this reaction, what is the percent yield?

$$\left(\frac{2.00\ g\ CO2}{7.53\ g\ CO2}\right) x\ 100 = 26.5604\ldots \quad 26.6\ \%\ Yield$$

***VIDEO* (21 minutes long, but it goes over everything!)**

$$2\ Al_{(s)} + 3\ CuCl_{2\ (aq)} \rightarrow 2\ AlCl_{3\ (aq)} + 3\ Cu_{(s)}$$

6) 412.3 g of solid aluminum reacts with 422.6 g of copper (II) chloride

$$\left(\frac{412.3\ g\ Al}{1}\right)\left(\frac{1\ mol\ Al}{26.98\ g\ Al}\right) = \underline{15.28}169014\ldots \quad 15.28\ mol\ Al$$

$$\left(\frac{422.6\ g\ CuCl2}{1}\right)\left(\frac{1\ mol\ CuCl2}{134.452\ g\ CuCl2}\right) = \underline{3.143}129146\ldots \quad 3.143\ mol\ CuCl_2$$

	Al	$CuCl_2$	$AlCl_3$	Cu
B	***15.28 mol***	***3.143 mol***	***0 mol***	***0 mol***
C	***- 2.095 mol***	***- 3.143 mol***	***+ 2.095 mol***	***+ 3.143 mol***
A	***13.185 mol***	***0 mol***	***2.095 mol***	***3.143 mol***

d) What is the limiting reactant? ***$CuCl_2$ Copper (II) Chloride***
e) How much excess reactant remains? ***13.185 moles Al***
f) What is the theoretical yield of Cu metal? (*from your BCA table*) ***3.143 moles Cu***
g) How many atoms of Cu can be made? ***1.892×10^{24} atoms Cu***

$$\left(\frac{3.143\ mol\ Cu}{}\right)\left(\frac{6.02x10^{23}\ atoms\ Cu}{1\ mol\ Cu}\right) = \underline{1.892}086 \times 10^{24}\ atoms\ Cu$$

h) How many grams of Cu metal can be made? ***199.7 grams Cu***

$$\left(\frac{3.143\ mol\ Cu}{}\right)\left(\frac{63.546\ grams\ Cu}{1\ mol\ Cu}\right) = \underline{199.7}25078\ g\ Cu$$

i) If 200.0 g of Cu are *actually* made in this reaction, what is the percent yield? ________________
Show your work.

$$\left(\frac{200.0\ g\ Cu}{199.7\ g\ Cu}\right) x\ 100 = \underline{100.1}5022\ldots \qquad 100.2\ \%\ Yield$$

j) If a scientist determines their percent yield was 76.4%, how many grams of Cu metal was *actually* produced? Show your work. ***152.6 grams Cu***

$$\left(\frac{x\ g\ Cu}{199.7\ g\ Cu}\right) x\ 100 = 76.4\ \% \qquad \underline{152.5}708\ g\ Cu$$