Unit 6C: Stoichiometry Study Guide Name: B-C-A Answer Key Date:

1. Balance and determine the reaction type:
   a. 2 Mg + 1 O_2 → 2 MgO Rxn Type: SYN
   b. 1 Mg + 1 $Co(NO_3)_2$ → 1 Co + 1 $Mg(NO_3)_2$ Rxn Type: SR
   c. 1 $Sr(OH)_2$ + 2 HCl → 1 $SrCl_2$ + 2 H_2O Rxn Type: DR | Neutralization
   d. 2 C_2H_6 + 7 O_2 → 4 CO_2 + 6 H_2O Rxn Type: Combus

2. $2\ Na + Cl_2 \rightarrow 2\ NaCl$ $\Delta H = -411.12$ kJ
   a. Is the reaction endothermic or exothermic?
   exothermic
   b. How many grams of chlorine gas is needed to produce 0.75 moles of sodium chloride?

Step1

	$2Na + Cl_2 \rightarrow$	$2NaCl$
B:	? g	0.75 mol
C:	$+0.75 mol\left(\frac{1}{2}\right)$	-0.75 mol
A:	0.375 mol Cl_2	∅

Step2

$$0.375\ mol\ Cl_2 \left| \frac{70.90\ g\ Cl_2}{1\ mol\ Cl_2} \right. = \boxed{27\ g\ Cl_2}$$

   c. How many particles of NaCl will be produced when 35 grams of Na reacts with excess chlorine?

Step1

$$35\ g\ Na \left| \frac{1\ mol\ Na}{22.99\ g} \right. = 1.522\ mol\ Na$$

Step2

	$2Na + Cl_2 \rightarrow$	$2NaCl$
B:	1.522 mol	? particles
C:	-1.522 mol	$+1.522 mol\left(\frac{2}{2}\right)$
A:	∅	1.522 mol NaCl

Step3

$$1.522\ mol\ NaCl \left| \frac{6.02 \times 10^{23}\ particles\ NaCl}{1\ mol\ NaCl} \right.$$

$= 9.16 \times 10^{23}$ particles NaCl

$\boxed{= 9.2 \times 10^{23}\ particles\ NaCl}$

3. $CaCO_3 \rightarrow CaO + CO_2$ $\Delta H = +176.8$ kJ

a. Is the reaction endothermic or exothermic?

endothermic

b. How many liters of carbon dioxide are produced at STP when 25.0 g (3SF) of calcium carbonate decompose?

Step 1

$$25.0\text{g } CaCO_3 \left| \frac{1\text{mol } CaCO_3}{100.09\text{g } CaCO_3} \right. = 0.2498\text{mol } CaCO_3$$

Step 2

	$CaCO_3$	$\rightarrow$	CaO	+	CO_2
B:	0.02498 mol				? L
C:	−0.02498 mol				$+0.02498\text{ mol}\left(\frac{1}{1}\right)$
A:	Ø				0.02498 mol CO_2

Step 3

$$0.02498\text{mol } CO_2 \left| \frac{22.4\text{L } CO_2}{1\text{mol } CO_2} \right.$$

5.60 L CO_2

c. How many grams of $CaCO_3$ are required to produce 4.11 (3SF) grams of CaO?

Step 1

$$4.11\text{g } CaO \left| \frac{1\text{mol } CaO}{56.08\text{g } CaO} \right. = 0.07329\text{mol } CaO$$

Step 2

	$CaCO_3$	$\rightarrow$	CaO	+	CO_2
B:	Ø		0.07329 mol		
C:	$+0.07329\text{mol}\left(\frac{1}{1}\right)$		−0.07329 mol		
A:	0.07329 mol $CaCO_3$		Ø		

Step 3

$$0.07329\text{mol } CaCO_3 \left| \frac{100.09\text{g } CaCO_3}{1\text{mol } CaCO_3} \right.$$

= 7.34 g $CaCO_3$

4. $C(s) + 2\,H_2(g) \rightarrow CH_4(g) + 74.3$ kJ

a. Is the reaction endothermic or exothermic?

exothermic

b. How many liters of CH_4 will be produced when 31 (2SF) grams of carbon react with excess hydrogen at STP?

Step 1

$$31\text{g C} \left| \frac{1\text{mol C}}{12.01\text{g C}} \right. = 2.581\text{mol C}$$

Step 2

	C	+	$2H_2$	$\rightarrow$	CH_4
B:	2.581 mol				? L
C:	−2.581 mol				$+2.581\text{ mol}\left(\frac{1}{1}\right)$
A:	Ø				2.581 mol C

Step 3

$$2.581\text{ mol C} \left| \frac{22.4\text{L}}{1\text{mol C}} \right.$$

58 L CH_4

5. $2\ Al + 3\ Cl_2 \rightarrow 2\ AlCl_3$

Aluminum reacts with chlorine to produce aluminum chloride according to the equation above. 4.25×10^{22} atoms of aluminum are mixed with 18.23 grams of chlorine gas and allowed to react.

a. What is the limiting reactant? Aluminum
b. What is the excess reactant? Chlorine
c. How many grams of the excess reactant remain after the reaction?
d. What is the maximum mass (theoretical yield) of aluminum chloride that will be made?
e. What is the percent yield if 7.48 g of aluminum chloride is produced in lab?

Step 1

$$\frac{4.22\times10^{22}\ \text{atom Al} \mid 1\ \text{mol Al}}{6.02\times10^{23}\ \text{atom Al}} = 0.0706\ \text{mol Al}$$

$$\frac{18.23\text{g } Cl_2 \mid 1\ \text{mol } Cl_2}{70.90\text{g } Cl_2} = 0.257\ \text{mol } Cl_2$$

Step 2

	$2\ Al$	$+\ 3Cl_2$	$\rightarrow$	$2\ AlCl_3$
B:	0.0706 mol	0.257 mol		$\emptyset$
C:	-0.0706 mol	$-0.0706\text{ mol}\left(\frac{3}{2}\right)$		$+0.0706\text{ mol}\left(\frac{2}{2}\right)$
A:	$\emptyset$	used: 0.1059 mol Cl_2		0.0706 mol $AlCl_3$

(B) $0.257\ \text{mol } Cl_2\text{(start)} - 0.1059\ \text{mol } Cl_2\text{(used)} = 0.1511\ \text{mol } Cl_2$ extra

$$\frac{0.1511\ \text{mol } Cl_2 \mid 70.90\text{g } Cl_2}{1\ \text{mol } Cl_2} = \boxed{10.7\text{g excess } Cl_2}$$

(D) $$\frac{0.0706\ \text{mol } AlCl_3 \mid 133.33\text{g } AlCl_3}{1\ \text{mol } AlCl_3} = \boxed{9.41\text{g } AlCl_3}$$

(E) $\%\ \text{yield}: \left(\frac{A}{T}\right)\times100 = \left(\frac{7.48\text{g}}{9.41\text{g}}\right)\times100 = \boxed{79.5\%}$

4 c. How many grams of carbon are required to react with 4.22×10^{24} molecules of H_2? (3SF)

Step 1

$$\frac{4.22\times10^{24}\ \text{molecules } H_2 \mid 1\text{ mol } H_2}{6.02\times10^{23}\ \text{particles } H_2} = 7.010\text{ mol } H_2$$

Step 2

	C +	$2H_2$ →	CH_4
B:	? g	7.010 mol	
C:	$+7.010\text{mol}\left(\frac{1}{2}\right)$	−10 mol	X
A:	3.505 mol	∅	

Step 3

$$\frac{3.505\text{mol C} \mid 12.01\text{g C}}{1\text{mol C}} = \boxed{42.1\text{g C}}$$

4 d. 55 liters of H_2 at STP react with excess carbon. How many moles of CH_4 will be produced? (2SF)

Step 1

$$\frac{55\text{ L } H_2 \mid 1\text{mol } H_2}{22.4\text{ L } H_2} = 2.455\text{ mol } H_2$$

Step 2

	C +	$2H_2$ →	CH_4
B:	X	2.455 mol	? mol
C:		−2.455 mol	$+2.455\text{mol}\left(\frac{1}{2}\right)$
A:		∅	1.2275 mol CH_4

$$\boxed{1.2\text{ mol } CH_4}$$