

Name: _____

Class: _____

Date: _____

Instructions: Answer the following questions. Show ALL work for problems to receive full credit. Make sure to include proper units and significant figures for all answers.

- [3 pt] 1. What is the molecular weight of $\text{Al}(\text{C}_2\text{H}_3\text{O}_2)_3$

$$\begin{aligned}\text{Al} &= 1 (26.950) \\ \text{C} &= 6 (12.011) \\ \text{O} &= 6 (15.9954) \\ \text{H} &= 9 (1.0079) \text{ MW} = 204.081 \text{ g/mol}\end{aligned}$$

- [3 pt] 2. What is the molecular weight of $\text{Sc}_2(\text{C}_2\text{O}_4)_3$

$$\begin{aligned}\text{Sc} &= 2(44.96) \\ \text{C} &= 6(12.011) \\ \text{O} &= 12 (15.9954) \\ \text{MW} &= 353.98 \text{ g/mol}\end{aligned}$$

- [5 pt] 3. What is the molecular weight of $(\text{NH}_4)_2\text{CO}_3$

3. 96.086 g/mol

- [3 pt] 4. What is the Molecular Weight of $\text{Ca}_3(\text{PO}_4)_2$?

4. 310.174 g/mol

$$\begin{aligned}3 \text{ Ca} &= 3 (40.078) \text{ g/mol} \\ 2 \text{ P} &= 2 (30.974) \text{ g/mol} \\ 8 \text{ O} &= 8 (15.999) \text{ g/mol} \\ &310.174 \text{ g/mol}\end{aligned}$$

- [4 pt] 5. How many mols of $\text{Ca}_3(\text{PO}_4)_2$ are in 100.0 grams of $\text{Ca}_3(\text{PO}_4)_2$?

5. 0.3224 mol

- [5 pt] 6. How much (in milligrams) does 25.5 mols of $\text{Ca}_3(\text{PO}_4)_2$ weigh?

6. 791,000 mg

- [5 pt] 7. How many grams does 3.7×10^{24} molecules of $\text{Ca}_3(\text{PO}_4)_2$ weigh?

7. 1900 g

- [5 pt] 8. How many atoms of Oxygen are in 130.5 grams of $\text{Ca}_3(\text{PO}_4)_2$

8. 2.026×10^{24} atoms

- [4 pt] 9. How many mols of $\text{Ca}_3(\text{PO}_4)_2$ are in 125.0 grams of $\text{Ca}_3(\text{PO}_4)_2$?

9. 0.4030 mol $\text{Ca}_3(\text{PO}_4)_2$

$$\frac{125.0 \text{ g}}{310.174 \text{ g}} \times \frac{1 \text{ mol}}{\text{mol}} =$$

- [4 pt] 10. How much (in milligrams) does 12.5 mols of $\text{Ca}_3(\text{PO}_4)_2$ weigh?

10. 388,000 mg $\text{Ca}_3(\text{PO}_4)_2$

$$\frac{12.5 \text{ mol}}{\text{mol}} \times \frac{310.174 \text{ g}}{0.001 \text{ g}} =$$

- [4 pt] 11. How many grams does 2.4×10^{25} molecules of $\text{Ca}_3(\text{PO}_4)_2$ weigh?

11. 12,000 g $\text{Ca}_3(\text{PO}_4)_2$

$$\frac{2.4 \times 10^{25} \text{ molec.}}{6.02 \times 10^{23} \text{ molec.}} \times \frac{1 \text{ mol}}{1 \text{ mol}} \times \frac{310.174 \text{ g}}{1 \text{ molec.}} = 12365.74$$

- [5 pt] 12. How many atoms of Oxygen are in 240.5 grams of $\text{Ca}_3(\text{PO}_4)_2$

12. 3.734×10^{24} O atoms

$$\frac{240.5 \text{ g}}{310.274 \text{ g}} \times \frac{1 \text{ mol}}{1 \text{ mol}} \times \frac{6.02 \times 10^{23} \text{ molec.}}{1 \text{ molec.}} \times \frac{8 \text{ O atoms}}{1 \text{ molec.}} =$$

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[5 pt] 13. What is the Molecular Weight of $\text{Al}_2(\text{SO}_4)_3$?

13. 342.11 g/mol

- Al 2(26.95)
S 2(32.07)
O 12(15.999)

[5 pt] 14. How many mols of $\text{Al}_2(\text{SO}_4)_3$ are in 195.0 grams of $\text{Al}_2(\text{SO}_4)_3$?

14. 0.5700 mol

$$\frac{195.0 \text{ g } \text{Al}_2(\text{SO}_4)_3}{342.11 \text{ g } \text{Al}_2(\text{SO}_4)_3} \times \frac{1 \text{ mol}}{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3}$$

[5 pt] 15. How much (in kilograms) does 125 mols of $\text{Al}_2(\text{SO}_4)_3$ weigh?

15. 42.8 kg

$$\frac{125 \text{ mol } \text{Al}_2(\text{SO}_4)_3}{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3} \times \frac{342.11 \text{ g } \text{Al}_2(\text{SO}_4)_3}{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3} \times \frac{1 \text{ kg}}{1000 \text{ g}}$$

[5 pt] 16. How many grams does 2.87×10^{25} molecules of $\text{Al}_2(\text{SO}_4)_3$ weigh?

16. 16300 g

$$\frac{2.87 \times 10^{25} \text{ molec. } \text{Al}_2(\text{SO}_4)_3}{6.02 \times 10^{23} \text{ molec. } \text{Al}_2(\text{SO}_4)_3} \times \frac{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3}{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3} \times \frac{342.11 \text{ g } \text{Al}_2(\text{SO}_4)_3}{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3}$$

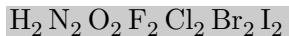
[5 pt] 17. How many mols of Sulfur are in 15.0 mL of Sulfur?

17. 0.968 mol S

$$\frac{15.0 \text{ mL S}}{1 \text{ mL S}} \times \frac{2.07 \text{ g S}}{32.07 \text{ g S}} \times \frac{1 \text{ mol S}}{1 \text{ mol S}}$$

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[2 pt] 18. List the 7 elements that are always found as diatomics.



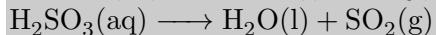
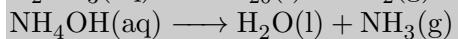
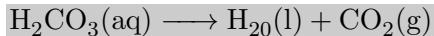
[2 pt] 19. List the (5) elements commonly found as gases (do not include the Noble gases) and (2) liquids.

Gasses: H₂ N₂ O₂ F₂ Cl₂ and Liquids: Hg Br₂

[2 pt] 20. List the 8 small stable **molecular compounds** commonly found as gases.



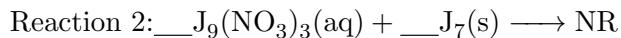
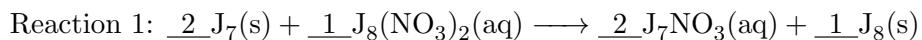
[6 pt] 21. Write the complete chemical reaction for the 3 common decomposition reactions.



[5 pt] 22. List 5 signs that a chemical reaction has occurred (on paper or in lab).

1. Formation of PPT (aq) → (s)
2. Formation of Gas (aq) → (g)
3. Formation of Water
4. Disappearance of a Solid/PPT
5. Color Change
6. Temperature Change (Endothermic or Exothermic)
7. Misc. - Smell, A/B CO₂ways happen?

[4 pt] 23. Jay was busy last night and discovered 3 more new elements (J₇, J₈, and J₉). Given the following 2 reactions determine where they belong in the Activity Series. Explain.

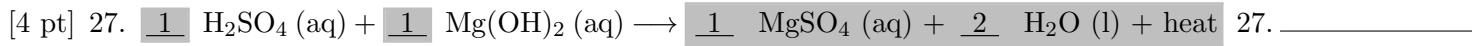
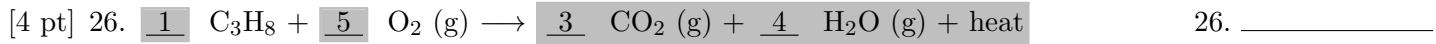
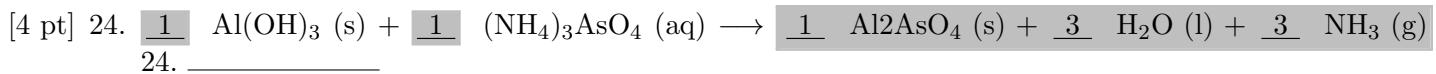


In Reaction 1: J₇ > J₈ because a reaction occurs (E wants to form a compound)

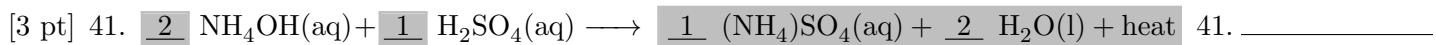
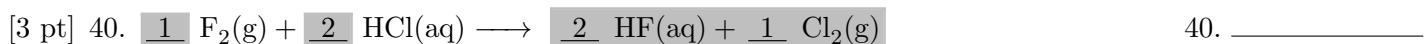
In Reaction 2: J₉ > J₈ because NR occurs (E is CO₂ ready in compound)

Therefore: J₉ > J₇ > J₈.

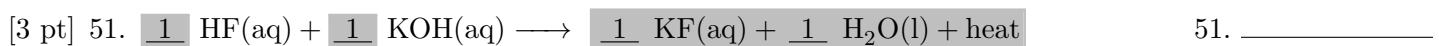
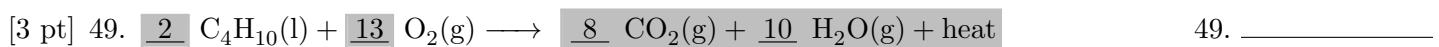
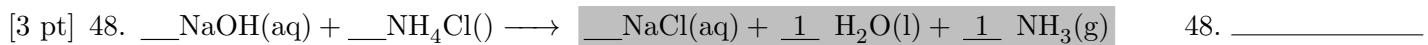
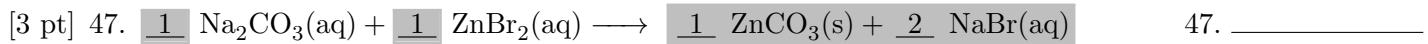
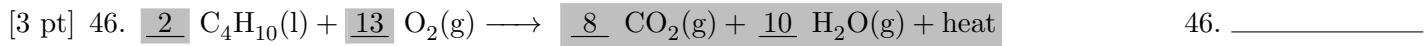
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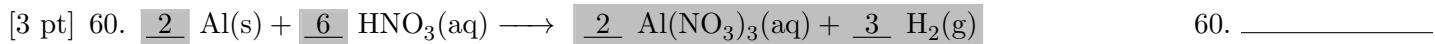
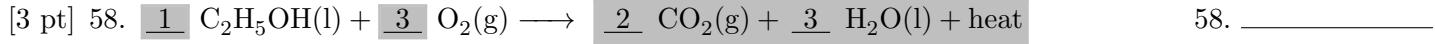
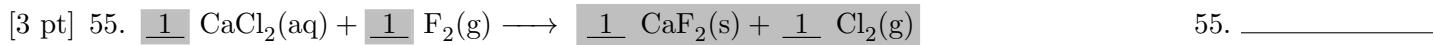
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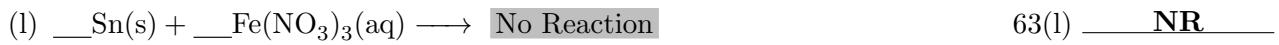
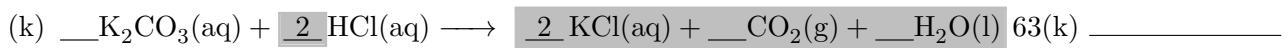
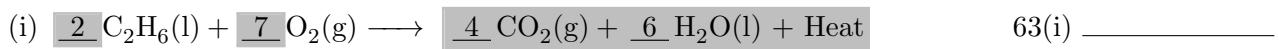
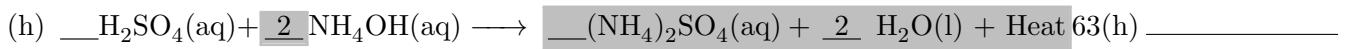
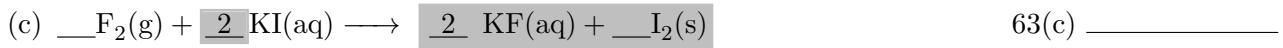
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- [6 pt] 64. You work in sandwich shop! You have the following ingredients available: 35 slices of bread, 21 slices of ham, 50 slices of turkey and 15 slices of cheese. The following wonderful recipe is being used to make amazingly good sandwichs:

2 slices bread + 3 slices ham + 2 slice turkey + 1 slice of cheese → 1 amazing sandwich.

- (a) What is the limiting ingredient? 64(a) Ham
- (b) Amount of Bread left: 64(b) 21 slices
- (c) Amount of Ham left: 64(c) 0
- (d) Amount of Turkey left: 64(d) 36 slices
- (e) Amount of Cheese left: 64(e) 8 slices
- (f) Number of amazing sandwichs made: 64(f) 7

Finding the LR (amount of Ingredients → amount Product (least amount made determines the Limiting Reactant. When you are done baking you are out of the Limiting Reactant (0 left)

$$\frac{35 \text{ slices bread}}{2 \text{ slices bread}} \times \frac{1 \text{ Sandwich}}{1 \text{ Sandwich}} = 17.5 \text{ Sandwich}$$

$$\frac{20 \text{ slices ham}}{3 \text{ slices ham}} \times \frac{1 \text{ Sandwich}}{1 \text{ Sandwich}} = 7 \text{ Sandwich}$$

$$\frac{50 \text{ slices turkey}}{2 \text{ slices turkey}} \times \frac{1 \text{ Sandwich}}{1 \text{ Sandwich}} = 25 \text{ Sandwich}$$

$$\frac{15 \text{ slices cheese}}{1 \text{ slice cheese}} \times \frac{1 \text{ Sandwich}}{1 \text{ Sandwich}} = 15 \text{ Sandwich}$$

Now find the ER left over: (amount LR → amount of ER Used. (Start-Used= Left Over)

$$\frac{21 \text{ slices ham}}{3 \text{ slices ham}} \times \frac{2 \text{ slices turkey}}{1 \text{ slices ham}} = \text{slices USED} \text{ Start } 50 - \text{Used } 14 = 36 \text{ Left Over}$$

$$\frac{21 \text{ slices ham}}{3 \text{ slices ham}} \times \frac{2 \text{ slices bread}}{1 \text{ slices ham}} = 14 \text{ slices bread USED} \text{ Start } 35 - \text{Used } 14 = 21 \text{ Left Over}$$

$$\frac{21 \text{ slices ham}}{3 \text{ slices ham}} \times \frac{1 \text{ slice cheese}}{1 \text{ slice cheese}} = 36 \text{ cups Moz USED} \text{ Start } 15 - \text{Used } 7 = 18 \text{ Left Over}$$

- [6 pt] 65. Jay is baking apple pies using the following recipe: 3 Apples + 2 cups sugar + 5 teaspoons Cinnamon + 4 cups Flour → 2.5 apple pies. In my cupboard I have the following: 24 apples, 10 cups of Sugar, 30 teaspoons of Cinnamon and 25 cups of Flour. Answer the following questions:

- (a) What is the limiting ingredient? 65(a) Sugar
- (b) Amount of Apples left: 65(b) 9 apples
- (c) Amount of Sugar left: 65(c) 0
- (d) Amount of Cinnamon left: 65(d) 5 teaspoons
- (e) Amount of Flour left: 65(e) 5 cups
- (f) Number of pies made: 65(f) 12.5 pies

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Find the LR:

$$\frac{24 \text{ apples}}{3 \text{ apples}} \times \frac{2.5 \text{ pies}}{1 \text{ apple}} = 20 \text{ pies}$$

$$\frac{10 \text{ cups Sugar}}{2 \text{ cups Sugar}} \times \frac{2.5 \text{ pies}}{1 \text{ cup Sugar}} = 12.5 \text{ pies}$$

$$\frac{30 \text{ teaspoons Cinnamon}}{5 \text{ teaspoons Cinnamon}} \times \frac{2.5 \text{ pies}}{1 \text{ teaspoon Cinnamon}} = 15 \text{ pies}$$

$$\frac{25 \text{ cups Flour}}{4 \text{ cups Flour}} \times \frac{2.5 \text{ pies}}{1 \text{ cup Flour}} = 15.6 \text{ pies}$$

Sugar produces the least number of pies therefore is the limiting ingredient.

Calculating ER Left Over:

$$\frac{10 \text{ cups Sugar}}{2 \text{ cups Sugar}} \times \frac{3 \text{ apples}}{1 \text{ cup Sugar}} = 15 \text{ apples used } (24-15=9 \text{ left})$$

$$\frac{10 \text{ cups Sugar}}{2 \text{ cups Sugar}} \times \frac{5 \text{ teaspoons Cinnamon}}{1 \text{ cup Sugar}} = 25 \text{ teaspoons Cinnamon used } (30-25=5 \text{ left})$$

$$\frac{10 \text{ cups Sugar}}{2 \text{ cups Sugar}} \times \frac{4 \text{ cups Flour}}{1 \text{ cup Sugar}} = 20 \text{ cups Flour used } (25-20=5 \text{ left})$$

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- [6 pt] 66. You work in pizza shop! You have the following available: 35 cups Pepperoni, 30 cups Italian sausage, 50 cups Mozzarella and 12 onions. The following wonderful recipe is being used to make amazingly good pizza:

2.5 cups Pepperoni + 1.5 cup Italian sausage + 3 cups Mozzarella + 1 onion \longrightarrow 5 amazing pizza's.

- (a) What is the limiting ingredient? 66(a) Onions
- (b) Amount of Pepperoni left: 66(b) 5 cups
- (c) Amount of Italian sausage left: 66(c) 12 cups
- (d) Amount of Mozzarella left: 66(d) 14 cups
- (e) Amount of Onions left: 66(e) 0
- (f) Number of amazing pizza's made: 66(f) 60

Finding the LR (amount of Ingredients \longrightarrow amount Product (least amount made determines the Limiting Reactant. When you are done baking you are out of the Limiting Reactant (0 left)

$$\frac{35 \text{ cups Pepperoni}}{5 \text{ Pizza}} \times \frac{5 \text{ Pizza}}{2.5 \text{ cups Pepperoni}} = 70 \text{ pizza}$$

$$\frac{30 \text{ cups Sausage}}{5 \text{ Pizza}} \times \frac{5 \text{ Pizza}}{1.5 \text{ cups Sausage}} = 100 \text{ pizza}$$

$$\frac{50 \text{ cups Moz}}{5 \text{ Pizza}} \times \frac{5 \text{ Pizza}}{3 \text{ cups Moz}} = 83.3 \text{ pizza}$$

$$\frac{12 \text{ cups Onion}}{5 \text{ Pizza}} \times \frac{5 \text{ Pizza}}{1 \text{ Onion}} = 60 \text{ pizza}$$

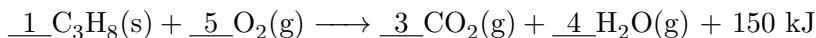
Now find the ER left over: (amount LR \longrightarrow amount of ER Used. (Start-Used= Left Over)

$$\frac{12 \text{ cups Onion}}{2.5 \text{ cups Pepperoni}} \times \frac{2.5 \text{ cups Pepperoni}}{1 \text{ Onion}} = 30 \text{ cup Pepperoni USED Start } 35 - \text{Used } 30 = 5 \text{ Left Over}$$

$$\frac{12 \text{ cups Onion}}{1.5 \text{ cups Sausage}} \times \frac{1.5 \text{ cups Sausage}}{1 \text{ Onion}} = 18 \text{ cups Sausage USED Start } 30 - \text{Used } 18 = 12 \text{ Left Over}$$

$$\frac{12 \text{ cups Onion}}{3 \text{ cups Moz}} \times \frac{3 \text{ cups Moz}}{1 \text{ Onion}} = 36 \text{ cups Moz USED Start } 50 - \text{Used } 36 = 14 \text{ Left Over}$$

- [30 pt] 67. You perform a reaction in lab starting with 25.0 g of C₃H₈ and 50.0 g O₂. Some useful MW: C₃H₈ = 44.1 g/mol, O₂ = 32.0 g/mol, CO₂ = 44.0 g/mol and H₂O = 18.0 g/mol. Show CO₂l calculations in the space provided.



- (a) What is the limiting reactant? 67(a) O₂

$$\frac{25.0 \text{ g C}_3\text{H}_8}{44.1 \text{ g C}_3\text{H}_8} \times \frac{1 \text{ mol C}_3\text{H}_8}{1 \text{ mol C}_3\text{H}_8} \times \frac{3 \text{ mol CO}_2}{1 \text{ mol C}_3\text{H}_8} \times \frac{44.0 \text{ g CO}_2}{1 \text{ mol CO}_2} = 74.8$$

$$\frac{50.0 \text{ g O}_2}{32.0 \text{ g O}_2} \times \frac{1 \text{ mol O}_2}{5 \text{ mol O}_2} \times \frac{3 \text{ mol CO}_2}{1 \text{ mol O}_2} \times \frac{44.0 \text{ g CO}_2}{1 \text{ mol Fe}} = 41.3$$

Smaller amount of product is made therefore O₂ is the LR and 41.3 grams of CO₂ are made

- (b) How many grams of the excess reagent will be left over? 67(b) 11.2 g C₃H₈

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$$\frac{50.0 \text{ g O}_2}{32.0 \text{ g O}_2} \times \frac{1 \text{ mol O}_2}{5 \text{ mol O}_2} \times \frac{1 \text{ mol C}_3\text{H}_8}{1 \text{ mol CO}_2} \times \frac{44.1 \text{ g CO}_2}{1 \text{ mol CO}_2} = 13.8$$

Start - End = Left Over
25.0 - 13.8 = 11.2

- (c) What is the theoretical yield in grams of CO₂ in grams? 67(c) 41.3 g CO₂
See part (a)
- (d) What is the percent yield if you performed the reaction and produced 23.0 67(d) 55.7 % grams of CO₂?

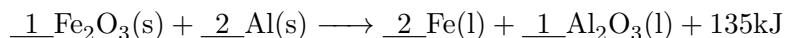
$$\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$
$$\frac{23.0}{41.3} \times 100 = 55.7$$

- (e) How many Joules of heat will be released? 67(e) 46,900 J
- $$\frac{50.0 \text{ g O}_2}{32 \text{ g CO}_2} \times \frac{1 \text{ mol O}_2}{5 \text{ mol O}_2} \times \frac{150 \text{ kJ}}{1 \text{ mol O}_2} \times \frac{1000 \text{ J}}{1 \text{ kJ}} = 46,875$$
- (f) How much H₂O will be produced? 67(f) 22.5 g H₂O
- $$\frac{50.0 \text{ g O}_2}{32.0 \text{ g O}_2} \times \frac{1 \text{ mol O}_2}{5 \text{ mol O}_2} \times \frac{4 \text{ mol H}_2\text{O}}{1 \text{ mol O}_2} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 22.5$$
- (g) Does the reaction obey the Law of Conservation of Mass. Explain/prove your answer. 67(g) Yes

$$\begin{aligned} \text{Start} &= \text{End} \\ 25 + 50 &= 11.2 + 41.3 + 22.5 \\ 75 &= 75 \end{aligned}$$

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[15 pt] 68. You perform a reaction in lab starting with 60.0 g of Fe_2O_3 and 50.0 g Al. Show all calculations in the space provided.



- (a) What is the limiting reactant?

68(a) Fe_2O_3

$$\frac{60.0 \text{ g Fe}_2\text{O}_3}{159.7 \text{ g Fe}_2\text{O}_3} \times \frac{1 \text{ mol Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{2 \text{ mol Fe}}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{55.845 \text{ g Fe}}{1 \text{ mol Fe}} = 42.0$$

$$\frac{50.0 \text{ g Al}}{26.982 \text{ g Al}} \times \frac{1 \text{ mol Al}}{26.982 \text{ g Al}} \times \frac{2 \text{ mol Fe}}{2 \text{ mol Al}} \times \frac{55.845 \text{ g Fe}}{1 \text{ mol Fe}} = 103.5$$

Smaller amount of product is made (

- (b) How many grams of the excess reagent will be left over?

68(b) 29.7 g Al

$$\frac{60.0 \text{ g Fe}_2\text{O}_3}{159.7 \text{ g Fe}_2\text{O}_3} \times \frac{1 \text{ mol Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{2 \text{ mol Al}}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{26.982 \text{ g Al}}{1 \text{ mol Al}} = 20.3$$

Start - End = Left Over
 $50.0 - 20.3 = 29.7$

- (c) What is the theoretical yield in grams of Fe in grams?

68(c) 42.0 g Fe_2O_3

See part (a)

- (d) What is the percent yield if you performed the reaction and produced 23.0 68(d) 54.8 % grams of Fe?

$$\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

$$\frac{23.0}{42.0} \times 100 = 54.8\%$$

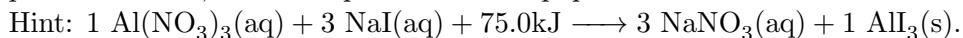
- (e) How many Joules of heat will be released?

68(e) 50,700 J

$$\frac{60.0 \text{ g Fe}_2\text{O}_3}{159.7 \text{ g Fe}_2\text{O}_3} \times \frac{1 \text{ mol Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{135 \text{ kJ}}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{1000 \text{ J}}{1 \text{ kJ}} = 50720.1$$

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[12 pt] 69. Answer the following questions about the reaction below. Clearly label and show work in the space provided below, or on a separate sheet of paper.



(a) What is the limiting reagent if you start with 15.0 grams of NaI and 10.0 grams of Al(NO₃)₃?

69(a) NaI

(b) What is the theoretical yield of AlI₃ in grams?

69(b) 13.6 g AlI₃

(c) How many grams of the excess reagent will be left over?

69(c) 2.9 g

(d) What is the percent yield if you performed the reaction in lab and produced 12.50 grams of AlI₃?

69(d) 91.9%

(e) Is the reaction exothermic or endothermic?

69(e) Endothermic

(f) How much energy (in Joules) is consumed/produced in the reaction?

69(f) 2.50×10^3 or 2.50 kJ

Find the LR:

$$\frac{15.0 \text{ g NaI}}{149.9 \text{ g}} \times \frac{1 \text{ mol NaI}}{1 \text{ mol NaI}} \times \frac{1 \text{ mol AlI}_3}{3 \text{ mol NaI}} \times \frac{407.68 \text{ g AlI}_3}{1 \text{ mol AlI}_3} = 13.6 \text{ g AlI}_3$$

$$\frac{10.0 \text{ g Al}(\text{NO}_3)_3}{212.98 \text{ g Al}(\text{NO}_3)_3} \times \frac{1 \text{ mol Al}(\text{NO}_3)_3}{1 \text{ mol Al}(\text{NO}_3)_3} \times \frac{1 \text{ mol AlI}_3}{1 \text{ mol Al}(\text{NO}_3)_3} \times \frac{407.86 \text{ g AlI}_3}{1 \text{ mol AlI}_3} = 19.15 \text{ g AlI}_3$$

The LR is therefore Al(NO₃)₃ and we produce 10.4 g AlI₃

ER used:

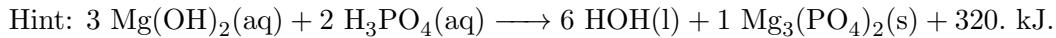
$$\frac{15.0 \text{ g NaI}}{149.9 \text{ g NaI}} \times \frac{1 \text{ mol NaI}}{1 \text{ mol NaI}} \times \frac{1 \text{ mol Al}(\text{NO}_3)_3}{3 \text{ mol NaI}} \times \frac{212.98 \text{ g Al}(\text{NO}_3)_3}{1 \text{ mol Al}(\text{NO}_3)_3} = 10.4 \text{ g Al}(\text{NO}_3)_3 \text{ used, therefore Start } (10.0) - \text{Used } (7.1) = 2.9 \text{ g Al}(\text{NO}_3)_3 \text{ Leftover}$$

The Percent Yield is: $\frac{12.5}{13.6} \times 100 = 91.9\%$

Finding the Energy produced:

$$\frac{15.0 \text{ g NaI}}{149.9 \text{ g NaI}} \times \frac{1 \text{ mol NaI}}{1 \text{ mol NaI}} \times \frac{75.0 \text{ kJ}}{3 \text{ mol NaI}} \times \frac{1000 \text{ J}}{1 \text{ kJ}} = 2.50 \times 10^3 \text{ J or } 2.50 \text{ kJ}$$

[10 pt] 70. Answer the following questions about the reaction below. Clearly label and show work in the space provided below, or on a separate sheet of paper.



(a) What is the limiting reagent if you start with 25.0 grams of Mg(OH)₂ and 25.0 grams of H₃PO₄?

70(a) H₃PO₄

(b) What is the theoretical yield in grams of Mg₃(PO₄)₂ in grams?

70(b) 33.5 g Mg₃(PO₄)₂

(c) How many grams of the excess reagent will be left over?

70(c) 2.7 g H₃PO₄

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(d) What is the percent yield if you performed the reaction and produced 12.50 grams of $\text{Mg}_3(\text{PO}_4)_2$?

70(d) **37.3 %**

(e) Is the reaction exothermic or endothermic?

70(e) **Exothermic**

(f) How much energy (in Joules) is consumed/produced in the reaction?

70(f) **4.08×10^4 or 40,800J**

Find the LR:

$$\frac{25.0 \text{ g Mg(OH)}_2}{58.33 \text{ g}} \times \frac{1 \text{ mol Mg(OH)}_2}{1 \text{ mol}} \times \frac{1 \text{ mol Mg}_3(\text{PO}_4)_2}{3 \text{ mol Mg(OH)}_2} \times \frac{262.87 \text{ g}}{1 \text{ mol}} = 37.6 \text{ g Mg}_3(\text{PO}_4)_2$$

$$\frac{25.0 \text{ g H}_3\text{PO}_4}{97.99 \text{ g H}_3\text{PO}_4} \times \frac{1 \text{ mol H}_3\text{PO}_4}{1 \text{ mol}} \times \frac{1 \text{ mol Mg}_3(\text{PO}_4)_2}{2 \text{ mol H}_3\text{PO}_4} \times \frac{262.87 \text{ g}}{1 \text{ mol}} = 33.5 \text{ g Mg}_3(\text{PO}_4)_2$$

The LR is therefore H_3PO_4 and we produce 33.5 g $\text{Mg}_3(\text{PO}_4)_2$

ER used: $\frac{25.0 \text{ g H}_3\text{PO}_4}{97.99 \text{ g H}_3\text{PO}_4} \times \frac{1 \text{ mol H}_3\text{PO}_4}{1 \text{ mol}} \times \frac{3 \text{ mol Mg(OH)}_2}{2 \text{ mol H}_3\text{PO}_4} \times \frac{58.33 \text{ g Mg(OH)}_2}{1 \text{ mol}} = 22.3 \text{ g Mg(OH)}_2$ used,
therefore Start (25.0) - Used (22.3) = 2.7 g H_3PO_4 Leftover

The Percent Yield is: $\frac{12.5}{33.5} \times 100 = 37.3 \%$

Finding the Energy produced:

$$\frac{25.0 \text{ g H}_3\text{PO}_4}{97.99 \text{ g H}_3\text{PO}_4} \times \frac{1 \text{ mol H}_3\text{PO}_4}{1 \text{ mol}} \times \frac{320 \text{ kJ}}{2 \text{ mol H}_3\text{PO}_4} \times \frac{1000 \text{ J}}{1 \text{ kJ}} = 40820 = 4.08 \times 10^4 \text{ or } 40,800 \text{ J} =$$

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- [5 pt] 71. Given the reaction: 2 NaOH(aq) + 1 H₂SO₄(aq) \longrightarrow 1 Na₂SO₄(aq) + 2 H₂O(l) 71. **44.4 g Na₂SO₄**
how many grams of Na₂SO₄ can be produced from 25.0 grams of NaOH. Some useful MW: NaOH = 40.0 g/mol, H₂SO₄ = 98.0 g/mol, Na₂SO₄ = 142.1 g/mol and H₂O = 18.0 g/mol.

$$\frac{25.0 \text{ g NaOH}}{40 \text{ g NaOH}} \times \frac{1 \text{ mol NaOH}}{1 \text{ mol NaOH}} \times \frac{1 \text{ mol Na}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{142.05 \text{ g Na}_2\text{SO}_4}{1 \text{ mol Na}_2\text{SO}_4}$$

- [5 pt] 72. How many grams of H₂O can be produced by burning 38.75 grams of C₂H₆? 72. **69.66 g H₂O**
2 C₂H₆(g) + 7 O₂(g) \longrightarrow 4 CO₂(g) + 6 H₂O(g)

$$\frac{38.75 \text{ g C}_2\text{H}_6}{30.07 \text{ g C}_2\text{H}_6} \times \frac{1 \text{ mol C}_2\text{H}_6}{1 \text{ mol C}_2\text{H}_6} \times \frac{6 \text{ mol H}_2\text{O}}{2 \text{ mol C}_2\text{H}_6} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 69.6649$$

- [4 pt] 73. How many grams of NaOH are required to make 375 mL of 0.550 M NaOH? 73. **8.25 g NaOH**

$$\frac{375 \text{ mL NaOH}}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{0.5 \text{ mol NaOH}}{1 \text{ L NaOH}} \times \frac{40.00 \text{ g NaOH}}{1 \text{ mol NaOH}} = 8.250$$

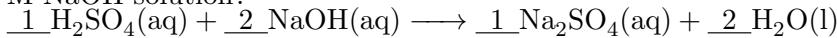
- [5 pt] 74. What is the Molarity of a solution made from 35.0 g of Ca(OH)₂ added to 450.0 mL of 74. **1.05 M Ca(OH)₂** water?

$$\frac{35.0 \text{ g Ca(OH)}_2}{450 \text{ mL}} \times \frac{1 \text{ mol Ca(OH)}_2}{74.10 \text{ g Ca(OH)}_2} \times \frac{1 \text{ mL}}{0.001 \text{ L}} = 1.0496326$$

- [5 pt] 75. In a titration, it took 125.0 mL of 0.38 M H₃PO₄ to neutralize 55.0 mL of an unknown concentration of Ca(OH)₂. What is the concentration of the Ca(OH)₂ solution?
2 H₃PO₄(aq) + 3 Ca(OH)₂(aq) \longrightarrow 1 Ca₃(PO₄)₂(aq) + 6 H₂O

$$\frac{125.0 \text{ mL H}_3\text{PO}_4}{55.0 \text{ mL Ca(OH)}_2} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{0.38 \text{ mol H}_3\text{PO}_4}{1 \text{ L H}_3\text{PO}_4} \times \frac{3 \text{ mol Ca(OH)}_2}{2 \text{ mol H}_3\text{PO}_4} \times \frac{1 \text{ mL}}{0.001 \text{ L}} = 1.29545$$

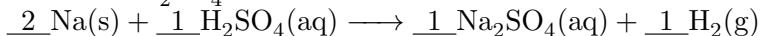
- [5 pt] 76. How many mL of 0.350 M H₂SO₄ solution are required to neutralize 138.5 mL of 0.825 M NaOH solution?



$$\frac{138.5 \text{ mL NaOH}}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{0.825 \text{ mol NaOH}}{1 \text{ L NaOH}} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{1 \text{ L H}_2\text{SO}_4}{0.350 \text{ mol NaOH}} \times \frac{1 \text{ mL}}{0.001 \text{ L}} = 163.232$$

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- [5 pt] 77. How many grams of H₂ gas can be produced if 75.0 g of Na are reacted with 600.0 mL 77. **3.29 g H₂** of 3.25 M H₂SO₄?



$$\frac{75.0 \text{ g Na}}{22.990 \text{ g Na}} \times \frac{1 \text{ mol Na}}{1 \text{ mol Na}} \times \frac{1 \text{ mol H}_2}{2 \text{ mol H}_2} \times \frac{2.016 \text{ g H}_2}{1 \text{ mol H}_2} = 3.2883$$

$$\frac{600.0 \text{ mL H}_2\text{SO}_4}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{3.25 \text{ mol H}_2\text{SO}_4}{1 \text{ L H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2}{1 \text{ mol H}_2\text{SO}_4} \times \frac{2.016 \text{ g H}_2}{1 \text{ mol H}_2} = 3.9312$$

The smaller amount is produced since you run out of your Limiting Reactant and the reaction can no longer proceed.

- [4 pt] 78. How many grams of HCl are required to make 750.0 mL of 3.000 M HCl? 78. **82.04 g HCl**

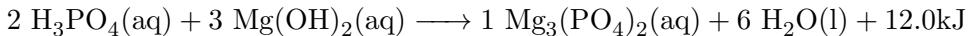
$$\frac{750.0 \text{ mL}}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{3.000 \text{ mol}}{1 \text{ L}} \times \frac{36.46 \text{ g}}{1 \text{ mol}}$$

- [4 pt] 79. What is the molarity of a solution made from 15.0 grams of AgNO₃ dissolved in 275.0 mL of water?

$$79. \underline{\text{0.321 M AgNO}_3}$$

$$\frac{15.0 \text{ g}}{275.0 \text{ mL}} \times \frac{1 \text{ mol}}{169.88 \text{ g}} \times \frac{1 \text{ mL}}{0.001 \text{ L}}$$

- [8 pt] 80. Answer the following questions about the given reaction:



- (a) How many grams of Mg₃(PO₄)₂ can be produced from 125.0 grams of Mg(OH)₂. 80(a) **187.8 g Mg(OH)₂**

$$\frac{125.0 \text{ g Mg(OH)}_2}{58.33 \text{ g Mg(OH)}_2} \times \frac{1 \text{ mol Mg(OH)}_2}{1 \text{ mol Mg(OH)}_2} \times \frac{1 \text{ mol Mg}_3(\text{PO}_4)_2}{3 \text{ mol Mg(OH)}_2} \times \frac{262.87 \text{ g Mg}_3(\text{PO}_4)_2}{1 \text{ mol Mg}_3(\text{PO}_4)_2}$$

- (b) How many grams of H₃PO₄ are required to react with 11.0 grams of Mg(OH)₂. 80(b) **12.3 g H₃PO₄**

$$\frac{11.0 \text{ g Mg(OH)}_2}{58.33 \text{ g Mg(OH)}_2} \times \frac{1 \text{ mol Mg(OH)}_2}{1 \text{ mol Mg(OH)}_2} \times \frac{2 \text{ mol H}_3\text{PO}_4}{3 \text{ mol Mg(OH)}_2} \times \frac{97.99 \text{ g H}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4}$$

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- [5 pt] 81. Bob performed a titration and noted that 75.0 mL of 0.65 M Mg(OH)₂ completely neutralized 250.0 mL of HCl. What is the Molarity of the HCl solution?

Hint: 1 Mg(OH)₂(aq) + 2 HCl(aq) → 2 HOH(l) + MgCl₂(aq).

81. 0.39 M HCl

$$\frac{75 \text{ mL Mg(OH)}_2}{250.0 \text{ mL HCl}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{0.65 \text{ mol Mg(OH)}_2}{1 \text{ L}} \times \frac{2 \text{ mol HCl}}{1 \text{ mol Mg(OH)}_2} \times \frac{1 \text{ mL}}{0.001 \text{ L}}$$

- [5 pt] 82. How many mL of 0.55 M NaOH are required to neutralize 195.0 mL of 1.87 M H₂SO₄?

Hint: 1 H₂SO₄(aq) + 2 NaOH(aq) → 2 HOH(l) + 1 Na₂SO₄(aq).

82. 1300 mL NaOH

$$\frac{195.0 \text{ mL H}_2\text{SO}_4}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{1.87 \text{ mol H}_2\text{SO}_4}{1 \text{ L}} \times \frac{2 \text{ mol NaOH}}{1 \text{ mol H}_2\text{SO}_4} \times \frac{1 \text{ L}}{0.55 \text{ mol NaOH}} \times \frac{1 \text{ mL}}{0.001 \text{ L}}$$

- [4 pt] 83. What is the molarity of a solution made from 25.0 grams of Mg(OH)₂ dissolved in 175.0 mL of water?

83. 2.45 M Mg(OH)₂

$$\frac{25.0 \text{ g}}{175.0 \text{ mL}} \times \frac{1 \text{ mol}}{58.33 \text{ g}} \times \frac{1 \text{ mL}}{0.001 \text{ L}}$$

- [4 pt] 84. How many grams of HCl are required to make 105.0 mL of 2.75 M HCl?

84. 10.5 g HCl

$$\frac{105.0 \text{ mL}}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{2.75 \text{ mol}}{1 \text{ L}} \times \frac{36.46 \text{ g}}{1 \text{ mol}}$$

- [4 pt] 85. Given the reaction: 2 NaOH(aq) + 1 H₂SO₄(aq) → 1 Na₂SO₄(aq) + 2 H₂O(l)
how many grams of Na₂SO₄ can be produced from 25.0 grams of NaOH.

85. 44.4 g Na₂SO₄

$$\frac{25.0 \text{ g NaOH}}{40 \text{ g NaOH}} \times \frac{1 \text{ mol NaOH}}{1 \text{ mol NaOH}} \times \frac{1 \text{ mol Na}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{142.05 \text{ g Na}_2\text{SO}_4}{1 \text{ mol Na}_2\text{SO}_4}$$

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- [5 pt] 86. Todd performed a titration and noted that 115.0 mL of 0.85 M $\text{Mg}(\text{OH})_2$ completely neutralized 135.0 mL of H_3PO_4 . What is the Molarity of the H_3PO_4 solution?

Hint: $3 \text{ Mg}(\text{OH})_2(\text{aq}) + 2\text{H}_3\text{PO}_4(\text{aq}) \longrightarrow 6 \text{ HOH(l)} + \text{Mg}_3(\text{PO}_4)_2(\text{s})$.

86. **0.48 M H_3PO_4**

$$\frac{1150 \text{ mL } \text{Mg}(\text{OH})_2}{135 \text{ mL } \text{H}_3\text{PO}_4} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{0.85 \text{ mol } \text{Mg}(\text{OH})_2}{1 \text{ L}} \times \frac{2 \text{ mol } \text{H}_3\text{PO}_4}{3 \text{ mol } \text{Mg}(\text{OH})_2} \times \frac{1 \text{ mL}}{0.001 \text{ L}}$$

- [5 pt] 87. How many mL of 3.25 M $\text{Mg}(\text{OH})_2$ are required to neutralize 240.0 mL of 1.25 M H_3PO_4 ?

Hint: $3 \text{ Mg}(\text{OH})_2(\text{aq}) + 2 \text{ H}_3\text{PO}_4(\text{aq}) \longrightarrow 6 \text{ HOH(l)} + \text{Mg}_3(\text{PO}_4)_2(\text{s})$.

87. **138 mL $\text{Mg}(\text{OH})_2$**

$$\frac{240.0 \text{ mL } \text{H}_3\text{PO}_4}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{1.25 \text{ mol } \text{H}_3\text{PO}_4}{1 \text{ L}} \times \frac{3 \text{ mol } \text{Mg}(\text{OH})_2}{2 \text{ mol } \text{H}_3\text{PO}_4} \times \frac{1 \text{ L}}{3.25 \text{ mol } \text{Mg}(\text{OH})_2} \times \frac{1 \text{ mL}}{0.001 \text{ L}}$$