

Name: \_\_\_\_\_

Date: \_\_\_\_\_

1. What is the molecular weight of  $\text{HC}_2\text{H}_3\text{O}_2$  1. 60.05 g/mol  
 $\text{H} = 4 \times 1.0079 = 4.0316$   
 $\text{C} = 2 \times 12.01 = 24.02$   
 $\text{O} = 2 \times 15.999 = 31.998$   
 $4.0316 + 24.02 + 31.998 = 60.0496 \therefore 60.05$
2. What is the molecular weight of  $\text{Al}(\text{C}_2\text{H}_3\text{O}_2)_3$  2. 204.081 g/mol  
 $\text{Al} = 1 (26.95)$   
 $\text{C} = 6 (12.011)$   
 $\text{O} = 6 (15.9954)$   
 $\text{H} = 9 (1.0079) \text{ MW} = 204.081 \text{ g/mol}$
3. What is the molecular weight of  $\text{Sc}_2(\text{C}_2\text{O}_4)_3$  3. 353.98 g/mol  
 $\text{Sc} = 2(44.96)$   
 $\text{C} = 6(12.011)$   
 $\text{O} = 12 (15.9954)$   
 $\text{MW} = 353.98 \text{ g/mol}$
4. What is the molarity of a solution made from 25.0 grams of  $\text{Mg}(\text{OH})_2$  dissolved in 175.0 mL of water? 4. 2.45 M  $\text{Mg}(\text{OH})_2$   

$$\frac{25.0 \text{ g}}{175.0 \text{ mL}} \times \frac{1 \text{ mol}}{58.33 \text{ g}} \times \frac{1 \text{ mL}}{0.001 \text{ L}}$$
5. How many grams of HCl are required to make 105.0 mL of 2.75 M HCl? 5. 10.5 g HCl  

$$\frac{105.0 \text{ mL}}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{2.75 \text{ mol}}{1 \text{ L}} \times \frac{36.46 \text{ g}}{1 \text{ mol}}$$
6. Given the reaction:  $2 \text{NaOH}(\text{aq}) + 1 \text{H}_2\text{SO}_4(\text{aq}) \longrightarrow 1 \text{Na}_2\text{SO}_4(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$   
 how many grams of  $\text{Na}_2\text{SO}_4$  can be produced from 25.0 grams of NaOH. 6. 44.4 g  $\text{Na}_2\text{SO}_4$   

$$\frac{25.0 \text{ g NaOH}}{40 \text{ g NaOH}} \times \frac{1 \text{ mol NaOH}}{40 \text{ g NaOH}} \times \frac{1 \text{ mol Na}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{142.05 \text{ g Na}_2\text{SO}_4}{1 \text{ mol Na}_2\text{SO}_4}$$
7. What is the molarity of a solution made from 25.0 grams of NaOH dissolved in 350.0 mL of water? 7. 1.79 M NaOH  

$$\frac{25.0 \text{ g NaOH}}{350.0 \text{ mL Sln}} \times \frac{1 \text{ mol NaOH}}{40.00 \text{ g NaOH}} \times \frac{1,000 \text{ mL}}{1 \text{ L}} = 1.79 \text{ M NaOH}$$
8. How many grams of NaOH are required to make 250.0 mL of 1.25 M NaOH? 8. 12.5 g NaOH  

$$\frac{250.0 \text{ mL sln}}{1,000 \text{ mL}} \times \frac{1 \text{ L}}{1,000 \text{ mL}} \times \frac{1.25 \text{ mol NaOH}}{1 \text{ L sln}} \times \frac{40.00 \text{ g NaOH}}{1 \text{ mol NaOH}} = 12.5 \text{ g NaOH}$$
9. 27.5 mL of 0.35M NaOH is how many grams of NaOH? 9. 0.39 g NaOH  

$$\frac{27.5 \text{ mL sln}}{1,000 \text{ mL}} \times \frac{1 \text{ L}}{1,000 \text{ mL}} \times \frac{0.35 \text{ mol NaOH}}{1 \text{ L sln}} \times \frac{40.00 \text{ g NaOH}}{1 \text{ mol NaOH}} = .39 \text{ g NaOH}$$
10. Jay performed a titration and noted that 225.0 mL of 0.85 M NaOH completely neutralized 175 mL of  $\text{H}_2\text{SO}_4$ . What is the Molarity of the  $\text{H}_2\text{SO}_4$  solution? (Hint:  $2\text{NaOH}(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \longrightarrow 2\text{HOH}(\text{l}) + \text{Na}_2\text{SO}_4(\text{aq}) + \text{heat}$ ) 10. .55 M  $\text{H}_2\text{SO}_4$   

$$\frac{225.0 \text{ mL NaOH}}{175.0 \text{ mL H}_2\text{SO}_4} \times \frac{1 \text{ L NaOH}}{1,000 \text{ mL NaOH}} \times \frac{.85 \text{ mol NaOH}}{1 \text{ L of Sln}} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{1,000 \text{ mL H}_2\text{SO}_4}{1 \text{ L of sln}} = .55 \text{ M H}_2\text{SO}_4$$

11. Jay performed a titration and noted that 15.0 mL of 8.0 M NaOH completely neutralized an unknown volume of 6.5 M H<sub>2</sub>SO<sub>4</sub>. What is the volume (in mL) of the H<sub>2</sub>SO<sub>4</sub> solution? (Hint: 2NaOH(aq) + H<sub>2</sub>SO<sub>4</sub>(aq) → 2HOH(l) + Na<sub>2</sub>SO<sub>4</sub>(aq) + heat.

11. **9.2 mL H<sub>2</sub>SO<sub>4</sub>**

$$\frac{150.0 \text{ mL NaOH}}{1,000 \text{ mL NaOH}} \times \frac{1 \text{ L NaOH}}{1,000 \text{ mL NaOH}} \times \frac{8.0 \text{ mol}}{1 \text{ L of Sln}} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{1 \text{ L of Sln}}{6.5 \text{ mol H}_2\text{SO}_4} \times \frac{1,000 \text{ mL}}{1 \text{ L of Sln}} = 9.2 \text{ mL H}_2\text{SO}_4$$

12. How many grams of HCl are required to make 750.0 mL of 3.000 M HCl?

12. **82.04 g HCl**

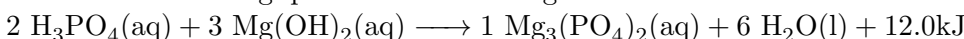
$$\frac{750.0 \text{ mL}}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{3.000 \text{ mol}}{1 \text{ L}} \times \frac{36.46 \text{ g}}{1 \text{ mol}}$$

13. What is the molarity of a solution made from 15.0 grams of AgNO<sub>3</sub> dissolved in 275.0 mL of water?

13. **0.321 M AgNO<sub>3</sub>**

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

14. Answer the following questions about the given the reaction:



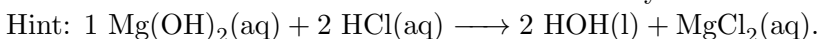
- (a) How many grams of Mg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub> can be produced from 125.0 grams of Mg(OH)<sub>2</sub>. 14(a) **187.8 g Mg(OH)<sub>2</sub>**

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

- (b) How many grams of H<sub>3</sub>PO<sub>4</sub> are required to react with 11.0 grams of Mg(OH)<sub>2</sub>. 14(b) **12.3 g H<sub>3</sub>PO<sub>4</sub>**

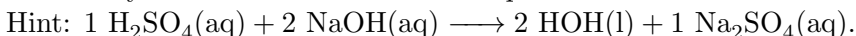
$$\frac{11.0 \text{ g Mg}(\text{OH})_2}{58.33 \text{ g Mg}(\text{OH})_2} \times \frac{1 \text{ mol Mg}(\text{OH})_2}{58.33 \text{ g Mg}(\text{OH})_2} \times \frac{2 \text{ mol H}_3\text{PO}_4}{3 \text{ mol Mg}(\text{OH})_2} \times \frac{97.99 \text{ g H}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4}$$

15. Bob performed a titration and noted that 75.0 mL of 0.65 M Mg(OH)<sub>2</sub> completely neutralized 250.0 mL of HCl. What is the Molarity of the HCl solution?

15. **0.39 M HCl**

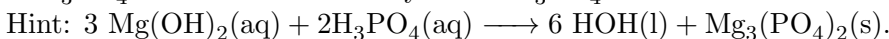
$$\frac{75 \text{ mL Mg}(\text{OH})_2}{250. \text{ mL HCl}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{0.65 \text{ mol Mg}(\text{OH})_2}{1 \text{ L}} \times \frac{2 \text{ mol HCl}}{1 \text{ mol Mg}(\text{OH})_2} \times \frac{1 \text{ mL}}{0.001 \text{ L}}$$

16. How many mL of 0.55 M NaOH are required to neutralize 195.0 mL of 1.87 M H<sub>2</sub>SO<sub>4</sub>?

16. **1300 mL NaOH**

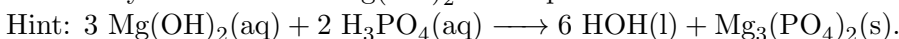
$$\frac{195.0 \text{ mL H}_2\text{SO}_4}{1 \text{ mL}} \times \frac{0.001 \text{ L}}{1 \text{ mL}} \times \frac{1.87 \text{ mol H}_2\text{SO}_4}{1 \text{ L}} \times \frac{2 \text{ mol NaOH}}{1 \text{ mol H}_2\text{SO}_4} \times \frac{1 \text{ L}}{0.55 \text{ mol NaOH}} \times \frac{1 \text{ mL}}{0.001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

17. Todd performed a titration and noted that 115.0 mL of 0.85 M Mg(OH)<sub>2</sub> completely neutralized 135.0 mL of H<sub>3</sub>PO<sub>4</sub>. What is the Molarity of the H<sub>3</sub>PO<sub>4</sub> solution?

17. **0.48 M H<sub>3</sub>PO<sub>4</sub>**

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

18. How many mL of 3.25 M Mg(OH)<sub>2</sub> are required to neutralize 240.0 mL of 1.25 M H<sub>3</sub>PO<sub>4</sub>?

18. **138 mL Mg(OH)<sub>2</sub>**

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

19. Jay is baking apple pies using the following recipe: 3 Apples + 2 cups sugar + 5 teaspoons Cinnamon + 4 cups Flour  $\longrightarrow$  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? 19(a) Sugar
- (b) Amount of Apples left: 19(b) 9 apples
- (c) Amount of Sugar left: 19(c) 0
- (d) Amount of Cinnamon left: 19(d) 5 teaspoons
- (e) Amount of Flour left: 19(e) 5 cups
- (f) Number of pies made: 19(f) 12.5 pies

Find the LR:

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

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

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

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

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

Calculating ER Left Over:

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

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

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

20. Given the reaction:  $3 \text{Mg(OH)}_2(\text{aq}) + 2 \text{H}_3\text{PO}_4(\text{aq}) \longrightarrow \text{Mg}_3(\text{PO}_4)_2(\text{aq}) + 6 \text{HOH} + 543 \text{kJ}$   
 25.0 g of  $\text{Mg(OH)}_2$  was reacted with 50.0 g of  $\text{H}_3\text{PO}_4$ . MW:  $\text{Mg(OH)}_2 = 58.3258 \text{ g/mol}$ ,  $\text{H}_3\text{PO}_4 = 97.9937 \text{ g/mol}$ ,  $\text{Mg}_3(\text{PO}_4)_2 = 262.87 \text{ g/mol}$ , and  $\text{HOH} = 18.0158 \text{ g/mol}$ .

- (a) What was the limiting reactant? 20(a)  $\text{Mg(OH)}_2$
- (b) Moles  $\text{Mg(OH)}_2$  left: 20(b) 0 mol
- (c) Moles  $\text{H}_3\text{PO}_4$  left: 20(c) 0.224 mol
- (d) Moles  $\text{Mg}_3(\text{PO}_4)_2$  left: 20(d) 0.143 mol
- (e) Moles HOH left: 20(e) 0.857 mol
- (f) Is the reaction Endothermic or Exothermic? 20(f) Exothermic

(g) How much heat is consumed/produced in the reaction?

20(g) **77.6 kJ produced**

$$\frac{25.0 \text{ g Mg(OH)}_2}{58.3258 \text{ g Mg(OH)}_2} \times \frac{1 \text{ mol Mg(OH)}_2}{1 \text{ mol Mg(OH)}_2} \times \frac{1 \text{ mol Mg}_3(\text{PO}_4)_2}{3 \text{ mol Mg(OH)}_2} = 0.143 \text{ mol Mg}_3(\text{PO}_4)_2$$

$$\frac{50.0 \text{ g H}_3\text{PO}_4}{97.9937 \text{ g H}_3\text{PO}_4} \times \frac{1 \text{ mol H}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4} \times \frac{1 \text{ mol Mg}_3(\text{PO}_4)_2}{2 \text{ mol H}_3\text{PO}_4} = 0.255 \text{ mol Mg}_3(\text{PO}_4)_2$$

$$\frac{25.0 \text{ g Mg(OH)}_2}{58.3258 \text{ g Mg(OH)}_2} \times \frac{1 \text{ mol Mg(OH)}_2}{1 \text{ mol Mg(OH)}_2} \times \frac{2 \text{ mol H}_3\text{PO}_4}{3 \text{ mol Mg(OH)}_2} = 0.286 \text{ mol H}_3\text{PO}_4$$

$$\frac{50.0 \text{ g H}_3\text{PO}_4}{97.9937 \text{ g H}_3\text{PO}_4} \times \frac{1 \text{ mol H}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4} = 0.510 \text{ mol H}_3\text{PO}_4$$

$$\text{initial} - \text{final} = 0.224 \text{ mol H}_3\text{PO}_4$$

$$\frac{25.0 \text{ g Mg(OH)}_2}{58.3258 \text{ g Mg(OH)}_2} \times \frac{1 \text{ mol Mg(OH)}_2}{1 \text{ mol Mg(OH)}_2} \times \frac{6 \text{ mol HOH}}{3 \text{ mol Mg(OH)}_2} = 0.857 \text{ mol HOH}$$

$$\frac{25.0 \text{ g Mg(OH)}_2}{58.3258 \text{ g Mg(OH)}_2} \times \frac{1 \text{ mol Mg(OH)}_2}{1 \text{ mol Mg(OH)}_2} \times \frac{543 \text{ kJ}}{3 \text{ mol Mg(OH)}_2} = 77.6 \text{ kJ released}$$

21. Given the reaction:  $2 \text{Al(OH)}_3(\text{s}) + 3 \text{H}_2\text{SO}_4(\text{aq}) \longrightarrow \text{Al}_2(\text{SO}_4)_3(\text{s}) + 6 \text{HOH} + 115 \text{kJ}$ 35.75 g of  $\text{Al(OH)}_3$  was reacted with 40.25 g of  $\text{H}_2\text{SO}_4$ .MW:  $\text{Al(OH)}_3 = 77.97 \text{ g/mol}$ ,  $\text{H}_2\text{SO}_4 = 98.09 \text{ g/mol}$ ,  $\text{Al}_2(\text{SO}_4)_3 = 342.11 \text{ g/mol}$ , and  $\text{H}_2\text{O} = 18.02 \text{ g/mol}$ .(a) What was the limiting reactant? 21(a)  **$\text{H}_2\text{SO}_4$** (b) Moles  $\text{H}_2\text{SO}_4$  left: 21(b) **0 mol**(c) Moles  $\text{Al(OH)}_3$  left: 21(c) **0.1849 mol**(d) Moles  $\text{Al}_2(\text{SO}_4)_3$  left: 21(d) **0.4103 mol**(e) Moles  $\text{H}_2\text{O}$  left: 21(e) **0.8207 mol**(f) Is the reaction Endothermic or Exothermic? 21(f) **Exothermic**(g) How much heat is consumed/produced in the reaction? 21(g) **15.73 kJ**

$$\frac{35.75 \text{ g Al(OH)}_3}{77.97 \text{ g Al(OH)}_3} \times \frac{1 \text{ mol Al(OH)}_3}{1 \text{ mol Al(OH)}_3} \times \frac{6 \text{ mol H}_2\text{O}}{2 \text{ mol Al(OH)}_3} = 1.376 \text{ mol H}_2\text{O}$$

$$\frac{40.25 \text{ g H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} \times \frac{6 \text{ mol H}_2\text{O}}{3 \text{ mol H}_2\text{SO}_4} = 0.8207 \text{ mol H}_2\text{O}$$

$$\frac{35.75 \text{ g Al(OH)}_3}{77.97 \text{ g Al(OH)}_3} \times \frac{1 \text{ mol Al(OH)}_3}{1 \text{ mol Al(OH)}_3} = 0.4585 \text{ mol Al(OH)}_3$$

$$\frac{40.25 \text{ g H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} \times \frac{2 \text{ mol Al(OH)}_3}{3 \text{ mol H}_2\text{SO}_4} = 0.2736 \text{ mol Al(OH)}_3$$

$$\text{initial} - \text{final} = 0.1849 \text{ mol Al(OH)}_3$$

$$\frac{40.25 \text{ g H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} \times \frac{1 \text{ mol Al}_2(\text{SO}_4)_3}{1 \text{ mol H}_2\text{SO}_4} = 0.4103 \text{ mol Al}_2(\text{SO}_4)_3$$

$$\frac{40.25 \text{ g H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} \times \frac{115 \text{ kJ}}{3 \text{ mol H}_2\text{SO}_4} = 15.73 \text{ kJ produced}$$

22. Given the reaction:  $2 \text{C}_2\text{H}_6 + 7 \text{O}_2 \longrightarrow 4 \text{CO}_2 + 6 \text{H}_2\text{O} + 75 \text{kJ}$ 22.25 g of  $\text{C}_2\text{H}_6$  was reacted with 22.05 g of  $\text{O}_2$ .MW:  $\text{C}_2\text{H}_6 = 30.07 \text{ g/mol}$ ,  $\text{O}_2 = 32.00 \text{ g/mol}$ ,  $\text{CO}_2 = 44.01 \text{ g/mol}$ , and  $\text{H}_2\text{O} = 18.02 \text{ g/mol}$ .

- (a) What was the limiting reactant? 22(a) O<sub>2</sub>
- (b) Moles O<sub>2</sub> left: 22(b) 0 mol
- (c) Moles C<sub>2</sub>H<sub>6</sub> left: 22(c) 0.543 mol
- (d) Moles CO<sub>2</sub> left: 22(d) 0.394 mol
- (e) Moles H<sub>2</sub>O left: 22(e) 0.591 mol
- (f) Is the reaction Endothermic or Exothermic? 22(f) Exothermic
- (g) How much heat is consumed/produced in the reaction? 22(g) 7.39 kJ

$$\frac{22.25 \text{ g C}_2\text{H}_6}{30.07 \text{ g C}_2\text{H}_6} \times \frac{1 \text{ mol C}_2\text{H}_6}{30.07 \text{ g C}_2\text{H}_6} \times \frac{4 \text{ mol CO}_2}{2 \text{ mol C}_2\text{H}_6} = 1.48 \text{ mol CO}_2$$

$$\frac{22.05 \text{ g O}_2}{32.00 \text{ g O}_2} \times \frac{1 \text{ mol O}_2}{32.00 \text{ g O}_2} \times \frac{4 \text{ mol CO}_2}{7 \text{ mol O}_2} = 0.394 \text{ mol CO}_2$$

$$\frac{22.25 \text{ g C}_2\text{H}_6}{30.07 \text{ g C}_2\text{H}_6} \times \frac{1 \text{ mol C}_2\text{H}_6}{30.07 \text{ g C}_2\text{H}_6} = 0.740 \text{ mol C}_2\text{H}_6$$

$$\frac{22.05 \text{ g O}_2}{32.00 \text{ g O}_2} \times \frac{1 \text{ mol O}_2}{32.00 \text{ g O}_2} = 0.690 \text{ mol O}_2$$

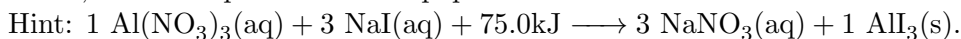
$$\frac{.690 \text{ mol O}_2}{7 \text{ mol O}_2} \times \frac{2 \text{ mol C}_2\text{H}_6}{7 \text{ mol O}_2} = 0.197 \text{ mol C}_2\text{H}_6$$

$$\text{initial} - \text{final} = 0.543 \text{ mol C}_2\text{H}_6$$

$$\frac{.690 \text{ mol O}_2}{7 \text{ mol O}_2} \times \frac{6 \text{ mol H}_2\text{O}}{7 \text{ mol O}_2} = 0.591 \text{ mol H}_2\text{O}$$

$$\frac{.690 \text{ mol O}_2}{7 \text{ mol O}_2} \times \frac{75 \text{ kJ}}{7 \text{ mol O}_2} = 7.39 \text{ kJ produced}$$

23. 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(NO<sub>3</sub>)<sub>3</sub>? 23(a) NaI
- (b) What is the theoretical yield of AlI<sub>3</sub> in grams? 23(b) 13.6 g AlI<sub>3</sub>
- (c) How many grams of the excess reagent will be left over? 23(c) 2.9 g
- (d) What is the percent yield if you performed the reaction in lab and produced 12.50 grams of AlI<sub>3</sub>? 23(d) 91.9%
- (e) Is the reaction exothermic or endothermic? 23(e) Endothermic
- (f) How much energy (in Joules) is consumed/produced in the reaction? 23(f) 2.50 × 10<sup>3</sup> or 2.50 kJ

Find the LR:

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

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

The LR is therefore Al(NO<sub>3</sub>)<sub>3</sub> and we produce 10.4 g AlI<sub>3</sub>

ER used:

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

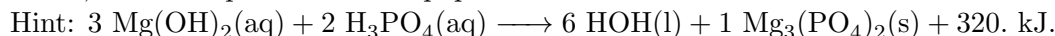
- Used (7.1) = 2.9 g Al(NO<sub>3</sub>)<sub>3</sub> Leftover

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

Finding the Energy produced:

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

24. 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)<sub>2</sub> and 25.0 grams of H<sub>3</sub>PO<sub>4</sub>?

24(a) H<sub>3</sub>PO<sub>4</sub>

(b) What is the theoretical yield in grams of Mg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub> in grams?

24(b) 33.5 g Mg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>

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

24(c) 2.7 g H<sub>3</sub>PO<sub>4</sub>

(d) What is the percent yield if you performed the reaction and produced 12.50 grams of Mg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>?

24(d) 37.3 %

(e) Is the reaction exothermic or endothermic?

24(e) Exothermic

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

24(f) 4.08 × 10<sup>4</sup> or 40,800 J

Find the LR:

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

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

The LR is therefore H<sub>3</sub>PO<sub>4</sub> and we produce 33.5 g Mg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>

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

therefore Start (25.0) - Used (22.3) = 2.7 g H<sub>3</sub>PO<sub>4</sub> Leftover

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

Finding the Energy produced:

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

25. Given the reaction:  $\text{H}_2\text{SO}_4(\text{aq}) + 2 \text{NaOH}(\text{aq}) \longrightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2 \text{H}_2\text{O} + 784 \text{ kJ}$   
 34.7 g of  $\text{H}_2\text{SO}_4$  was reacted with 75.0 g of NaOH. MW:  $\text{H}_2\text{SO}_4 = 98.09 \text{ g/mol}$ ,  $\text{NaOH} = 40.00 \text{ g/mol}$ ,  
 $\text{Na}_2\text{SO}_4 = 142.05 \text{ g/mol}$ , and  $\text{H}_2\text{O} = 18.02 \text{ g/mol}$ .

- (a) What was the limiting reactant? 25(a) **H<sub>2</sub>SO<sub>4</sub>**  
 (b) Grams  $\text{H}_2\text{SO}_4$  left: 25(b) **0 g**  
 (c) Grams NaOH left: 25(c) **46.7 g**  
 (d) Grams  $\text{Na}_2\text{SO}_4$  left: 25(d) **50.25 g**  
 (e) Grams  $\text{H}_2\text{O}$  left: 25(e) **12.75 g**  
 (f) Is the reaction Endothermic or Exothermic? 25(f) **Exothermic**  
 (g) How much heat is consumed/produced in the reaction? 25(g) **277.3 kJ produced**

$$\frac{34.7 \text{ g H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol H}_2\text{SO}_4} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 12.75 \text{ g H}_2\text{O}$$

$$\frac{75.0 \text{ g NaOH}}{40.00 \text{ g NaOH}} \times \frac{1 \text{ mol NaOH}}{40.00 \text{ g NaOH}} \times \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol NaOH}} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 33.79 \text{ g H}_2\text{O}$$

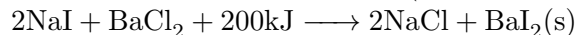
$$\frac{34.7 \text{ g H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{2 \text{ mol NaOH}}{1 \text{ mol H}_2\text{SO}_4} \times \frac{40.00 \text{ g NaOH}}{1 \text{ mol NaOH}} = 28.30 \text{ g NaOH}$$

$$\text{initial} - \text{final} = 46.7 \text{ g NaOH}$$

$$\frac{34.7 \text{ g H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol Na}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} \times \frac{142.05 \text{ g Na}_2\text{SO}_4}{1 \text{ mol Na}_2\text{SO}_4} = 50.25 \text{ g Na}_2\text{SO}_4$$

$$\frac{34.7 \text{ g H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{SO}_4}{98.09 \text{ g H}_2\text{SO}_4} \times \frac{784 \text{ kJ}}{1 \text{ mol H}_2\text{SO}_4} = 277.3 \text{ kJ released}$$

26. Answer the following questions about the reaction of Sodium Iodide with Barium Chloride to produce Sodium Chloride and Barium Chloride. (Clearly label and show work in the space provided below.)



- (a) What is the limiting reagent if you start with 50.0 grams of NaI and 35.0 grams of  $\text{BaCl}_2$ ? 26(a) **NaI**  
 (b) What is the theoretical yield in grams of  $\text{BaI}_2$  in grams? 26(b) **65.2 g BaI<sub>2</sub>**  
 (c) How many grams of the excess reagent will be left over? 26(c) **.30 g BaCl<sub>2</sub>**  
 (d) What is the percent yield if you performed the reaction and produced 15.0 grams of  $\text{BaI}_2$ ? 26(d) **23%**  
 (e) Is the reaction exothermic or endothermic? 26(e) **Endothermic**  
 (f) How much energy is consumed/produced in the reaction? 26(f) **33.4 kJ**

$$\frac{50.0 \text{ g NaI}}{149.9 \text{ g NaI}} \times \frac{1 \text{ mol NaI}}{149.9 \text{ g NaI}} \times \frac{1 \text{ mol BaI}_2}{2 \text{ mol NaI}} \times \frac{391.15 \text{ g BaI}_2}{1 \text{ mol BaI}_2} = 65.2 \text{ g BaI}_2$$

$$\frac{35.0 \text{ g BaCl}_2}{1} \times \frac{1 \text{ mol BaCl}_2}{208.2 \text{ g BaCl}_2} \times \frac{1 \text{ mol BaI}_2}{1 \text{ mol BaCl}_2} \times \frac{391.15 \text{ g BaI}_2}{1 \text{ mol BaI}_2} = 65.8 \text{ g BaI}_2$$

$$\frac{50.0 \text{ g NaI}}{1} \times \frac{1 \text{ mol NaI}}{149.9 \text{ g NaI}} \times \frac{1 \text{ mol BaCl}_2}{2 \text{ mol NaI}} \times \frac{208.2 \text{ g BaCl}_2}{1 \text{ mol BaCl}_2} = 34.7 \text{ g BaCl}_2$$

$$\text{initial} - \text{final} = .30 \text{ g BaCl}_2$$

$$\frac{15.0}{65.2} \times 100 = 23\%$$

$$\frac{50.0 \text{ g NaI}}{1} \times \frac{1 \text{ mol NaI}}{149.9 \text{ g NaI}} \times \frac{200 \text{ kJ}}{2 \text{ mol NaI}} = 33.4 \text{ kJ consumed}$$