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 $Al(C_2H_3O_2)_3$ 1. **204.081 g/mol**

Al = 1 (26.950)
C = 6 (12.011)
O = 6 (15.9954)
H = 9 (1.0079) MW = 204.081 g/mol

[3 pt] 2. What is the molecular weight of $Sc_2(C_2O_4)_3$ 2. **353.98 g/mol**

Sc = 2(44.96)
C = 6(12.011)
O = 12 (15.9954)
MW = 353.98 g/mol

[5 pt] 3. What is the molecular weight of $(NH_4)_2CO_3$

3. **96.086 g/mol**

[3 pt] 4. What is the Molecular Weight of $Ca_3(PO_4)_2$?

4. **310.174 g/mol**

3 Ca = 3 (40.078) g/mol
2 P = 2 (30.974) g/mol
8 O = 8 (15.999) g/mol
310.174 g/mol

[4 pt] 5. How many mols of $Ca_3(PO_4)_2$ are in 100.0 grams of $Ca_3(PO_4)_2$? 5. **0.3224 mol**

[5 pt] 6. How much (in milligrams) does 25.5 mols of $Ca_3(PO_4)_2$ weigh? 6. **791,000 mg**

[5 pt] 7. How many grams does 3.7×10^{24} molecules of $Ca_3(PO_4)_2$ weigh? 7. **1900 g**

[5 pt] 8. How many atoms of Oxygen are in 130.5 grams of $Ca_3(PO_4)_2$ 8. 2.026×10^{24} **atoms**

[4 pt] 9. How many mols of $Ca_3(PO_4)_2$ are in 125.0 grams of $Ca_3(PO_4)_2$?

9. **0.4030 mol $Ca_3(PO_4)_2$**

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

[4 pt] 10. How much (in milligrams) does 12.5 mols of $Ca_3(PO_4)_2$ weigh?

10. **388,000 mg$Ca_3(PO_4)_2$**

$$\frac{12.5\,\text{mol}}{} \times \frac{310.174\,\text{g}}{\text{mol}} \times \frac{1\,\text{mg}}{0.001\,\text{g}} =$$

[4 pt] 11. How many grams does 2.4×10^{25} molecules of $Ca_3(PO_4)_2$ weigh?

11. **12,000 g $Ca_3(PO_4)_2$**

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

[5 pt] 12. How many atoms of Oxygen are in 240.5 grams of $Ca_3(PO_4)_2$

12. 3.734×10^{24} **O atoms**

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

[5 pt] 13. What is the Molecular Weight of $Al_2(SO_4)_3$? 13. **342.11 g/mol**

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

[5 pt] 14. How many mols of $Al_2(SO_4)_3$ are in 195.0 grams of $Al_2(SO_4)_3$? 14. **0.5700 mol**

$$\frac{195.0\,\text{g}\,Al_2(SO_4)_3}{} \times \frac{1\,\text{mol}}{342.11\,\text{g}\,Al_2(SO_4)_3}$$

[5 pt] 15. How much (in kilograms) does 125 mols of $Al_2(SO_4)_3$ weigh? 15. **42.8 kg**

$$\frac{125\,\text{mol}\,Al_2(SO_4)_3}{} \times \frac{342.11\,\text{g}\,Al_2(SO_4)_3}{1\,\text{mol}\,Al_2(SO_4)_3} \times \frac{1\,\text{kg}}{1000\,\text{g}}$$

[5 pt] 16. How many grams does 2.87×10^{25} molecules of $Al_2(SO_4)_3$ weigh? 16. **16300 g**

$$\frac{2.87 \times 10^{25}\,\text{molec.}\,Al_2(SO_4)_3}{} \times \frac{1\,\text{mol}\,Al_2(SO_4)_3}{6.02 \times 10^{23}\,\text{molec.}\,Al_2(SO_4)_3} \times \frac{342.11\,\text{g}\,Al_2(SO_4)_3}{1\,\text{mol}\,Al_2(SO_4)_3}$$

[5 pt] 17. How many mols of Sulfur are in 15.0 mL of Sulfur? 17. **0.968 mol S**

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

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

$H_2\,N_2\,O_2\,F_2\,Cl_2\,Br_2\,I_2$

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

Gasses: $H_2\,N_2\,O_2\,F_2\,Cl_2$ and Liquids: $Hg\,Br_2$

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

$CO\,CO_2\,NO\,NO_2\,N_2O_4\,NH_3\,SO_2\,SO_3$

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

$H_2CO_3(aq) \longrightarrow H_{20}(l) + CO_2(g)$
$NH_4OH(aq) \longrightarrow H_2O(l) + NH_3(g)$
$H_2SO_3(aq) \longrightarrow H_2O(l) + SO_2(g)$

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

1. Formation of PPT (aq) $\longrightarrow$ (s)
2. Formation of Gas (aq) $\longrightarrow$ (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.

Reaction 1: $\underline{\ 2\ }\,J_7(s) + \underline{\ 1\ }\,J_8(NO_3)_2(aq) \longrightarrow \underline{\ 2\ }\,J_7NO_3(aq) + \underline{\ 1\ }\,J_8(s)$

Reaction 2: $\underline{\quad}\,J_9(NO_3)_3(aq) + \underline{\quad}\,J_7(s) \longrightarrow NR$

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 CO2ready in compound)

Therefore: J9 > J7 > J8.

[4 pt] 24. 1 $Al(OH)_3$ (s) + 1 $(NH_4)_3AsO_4$ (aq) $\longrightarrow$ 1 Al2AsO_4 (s) + 3 H_2O (l) + 3 NH_3 (g)
24. _____

[4 pt] 25. 2 Na (s) + 1 Ag_2CO_3 (s) $\longrightarrow$ 2 Ag (s) + 1 Na_2CO_3 (aq) 25. _____

[4 pt] 26. 1 C_3H_8 + 5 O_2 (g) $\longrightarrow$ 3 CO_2 (g) + 4 H_2O (g) + heat 26. _____

[4 pt] 27. 1 H_2SO_4 (aq) + 1 $Mg(OH)_2$ (aq) $\longrightarrow$ 1 $MgSO_4$ (aq) + 2 H_2O (l) + heat 27. _____

[4 pt] 28. __Ag (s) +__ MgI_2 (aq) $\longrightarrow$ NR 28. **NR**

[4 pt] 29. __Na_3AsO_4(aq) + 3 $AgNO_3$(aq) $\longrightarrow$ __Ag_3AsO_4(s) + 3 $NaNO_3$(aq) 29. _____

[4 pt] 30. 3 $Ba(NO_3)_2$(aq) + 2 K_3PO_4(aq) $\longrightarrow$ __$Ba_3(PO_4)_2$(s) + 6 KNO_3(aq) 30. _____

[4 pt] 31. __NaCl(aq) + __$Mg(NO_3)_2$(aq) $\longrightarrow$ No Reaction 31. **NR**

[4 pt] 32. __F_2(g) + 2 KI(aq) $\longrightarrow$ 2 KF(aq) + __I_2(s) 32. _____

[4 pt] 33. 3 KOH(aq) + __H_3PO_4(aq) $\longrightarrow$ __K_3PO_4(aq) + 3 H_2O(l) + Heat 33. _____

[3 pt] 34. 1 $MgBr_2(aq)$ + 1 $Cl_2(g)$ $\longrightarrow$ 1 $MgCl_2(aq)$ + 1 $Br_2(l)$ 34. _____

[3 pt] 35. 3 $Na(s)$ + 1 $Al(NO_3)_3(aq)$ $\longrightarrow$ 3 $NaNO_3(aq)$ + 1 $Al(s)$ 35. _____

[3 pt] 36. 1 $CH_4(g)$ + 2 $O_2(g)$ $\longrightarrow$ 1 $CO_2(g)$ + 2 $H_2O(g)$ + heat 36. _____

[3 pt] 37. 1 $Na_2CO_3(aq)$+ 2 $HCl(aq)$ $\longrightarrow$ 2 $NaCl(aq)$ + 1 $H_2O(l)$ + 1 $CO_2(g)$ 37. _____

[3 pt] 38. ___$KCl(aq)$ + ___$Ni(s)$ $\longrightarrow$ NR 38. **NR**

[3 pt] 39. 1 $Ba(C_2H_3O_2)_2(aq)$+ 1 $MgCrO_4(aq)$ $\longrightarrow$ 1 $BaCrO_4(s)$ + 1 $Mg(C_2H_3O_2)_2(aq)$ 39. _____

[3 pt] 40. 1 $F_2(g)$ + 2 $HCl(aq)$ $\longrightarrow$ 2 $HF(aq)$ + 1 $Cl_2(g)$ 40. _____

[3 pt] 41. 2 $NH_4OH(aq)$+ 1 $H_2SO_4(aq)$ $\longrightarrow$ 1 $(NH_4)SO_4(aq)$ + 2 $H_2O(l)$ + heat 41. _____

[3 pt] 42. 1 $H_3PO_4(aq)$ + 3 $NaOH(aq)$ $\longrightarrow$ 1 $Na_3PO_4(aq)$ + 3 $H_2O(l)$ + heat 42. _____

[3 pt] 43. 1 $ZnSO_4(aq)$ + 1 $Mg(s)$ $\longrightarrow$ 1 $MgSO_4(aq)$ + 1 $Zn(s)$ 43. _____

[3 pt] 44. ___$CoCl_3(aq)$ + ___$NaC_2H_3O_2(aq)$ $\longrightarrow$ NR 44. **NR**

[3 pt] 45. 2 $AgNO_3(aq)$ + 1 $PbCl_2(aq)$ $\longrightarrow$ 2 $AgCl_2(s)$ + 1 $Pb(NO_3)_2(aq)$ 45. _____

[3 pt] 46. 2 $C_4H_{10}(l)$ + 13 $O_2(g)$ $\longrightarrow$ 8 $CO_2(g)$ + 10 $H_2O(g)$ + heat 46. _____

[3 pt] 47. 1 $Na_2CO_3(aq)$ + 1 $ZnBr_2(aq)$ $\longrightarrow$ 1 $ZnCO_3(s)$ + 2 $NaBr(aq)$ 47. _____

[3 pt] 48. ___$NaOH(aq)$ + ___$NH_4Cl()$ $\longrightarrow$ ___$NaCl(aq)$ + 1 $H_2O(l)$ + 1 $NH_3(g)$ 48. _____

[3 pt] 49. 2 $C_4H_{10}(l)$ + 13 $O_2(g)$ $\longrightarrow$ 8 $CO_2(g)$ + 10 $H_2O(g)$ + heat 49. _____

[3 pt] 50. 2 $KOH()$+ 1 $(NH_4)_2C_2O_4(aq)$ $\longrightarrow$ 1 $K_2C_2O_4(aq)$ 2 $H_2O(l)$ + 2 $NH_3(g)$ 50. _____

[3 pt] 51. 1 $HF(aq)$ + 1 $KOH(aq)$ $\longrightarrow$ 1 $KF(aq)$ + 1 $H_2O(l)$ + heat 51. _____

[3 pt] 52. 1 $I_2(s)$ + 1 $CaBr_2(aq)$ $\longrightarrow$ NR 52. _____

[3 pt] 53. 1 $K_2SO_3(aq)$ + 2 $HBr(aq)$ $\longrightarrow$ 2 $KBr(aq)$ + 1 $H_2O(l)$ + 1 $SO_2(g)$ 53. _____

[3 pt] 54. 3 $NaOH(aq)$ + 1 $H_3PO_4(aq)$ $\longrightarrow$ 1 $Na_3PO_4(aq)$ + 3 $H_2O(l)$ + heat 54. _____

[3 pt] 55. 1 $CaCl_2(aq)$ + 1 $F_2(g)$ $\longrightarrow$ 1 $CaF_2(s)$ + 1 $Cl_2(g)$ 55. _____

[3 pt] 56. 2 $K(s)$ + 1 $Ag_2CO_3(aq)$ $\longrightarrow$ 1 $K_2CO_3(aq)$ + 2 $Ag(s)$ 56. _____

[3 pt] 57. 1 $NaCl(aq)$ + 1 $HNO_3(aq)$ $\longrightarrow$ NR 57. _____

[3 pt] 58. 1 $C_2H_5OH(l)$ + 3 $O_2(g)$ $\longrightarrow$ 2 $CO_2(g)$ + 3 $H_2O(l)$ + heat 58. _____

[3 pt] 59. 1 $ZnSO_4(aq)$+ 1 $Ca(C_2H_3O_2)_2(aq)$ $\longrightarrow$ 1 $Zn(C_2H_3O_2)(aq)$ + 1 $CaSO_4(s)$ 59. _____

[3 pt] 60. 2 $Al(s)$ + 6 $HNO_3(aq)$ $\longrightarrow$ 2 $Al(NO_3)_3(aq)$ + 3 $H_2(g)$ 60. _____

[3 pt] 61. 1 $MgCl_2(aq)$ + 1 $H_2CO_3(aq)$ $\longrightarrow$ 1 $MgCO_3(s)$ + 2 $HCl(aq)$ 61. _____

[3 pt] 62. 1 $H_2SO_4(aq)$ + 2 $NaOH(aq)$ $\longrightarrow$ 1 $Na_2SO_4(aq)$ + $H_2O(l)$ + heat 62. _____

[48 pt] 63. (a) ___$Mg(NO_3)_2(aq)$ + 2 $Na(s) \longrightarrow$ ___$Mg(s)$ + 2 $NaNO_3(aq)$ 63(a) _____

(b) ___$NaCl(aq)$ + ___$Mg(NO_3)_2(aq) \longrightarrow$ No Reaction 63(b) **NR**

(c) ___$F_2(g)$ + 2 $KI(aq) \longrightarrow$ 2 $KF(aq)$ + ___$I_2(s)$ 63(c) _____

(d) 2 $Al(s)$ + 6 $HC_2H_3O_2(aq) \longrightarrow$ 2 $Al(C_2H_3O_2)_3(aq)$ + 3 $H_2(g)$ 63(d) _____

(e) 3 $Ba(NO_3)_2(aq)$+ 2 $K_3PO_4(aq) \longrightarrow$ ___$Ba_3(PO_4)_2(s)$ + 6 $KNO_3(aq)$ 63(e) _____

(f) 3 $KOH(aq)$ + ___$H_3PO_4(aq) \longrightarrow$ ___$K_3PO_4(aq)$ + 3 $H_2O(l)$ + Heat 63(f) _____

(g) ___$Na_3AsO_4(aq)$ + 3 $AgNO_3(aq) \longrightarrow$ ___$Ag_3AsO_4(s)$ + 3 $NaNO_3(aq)$ 63(g) _____

(h) ___$H_2SO_4(aq)$+ 2 $NH_4OH(aq) \longrightarrow$ ___$(NH_4)_2SO_4(aq)$ + 2 $H_2O(l)$ + Heat 63(h) _____

(i) 2 $C_2H_6(l)$ + 7 $O_2(g) \longrightarrow$ 4 $CO_2(g)$ + 6 $H_2O(l)$ + Heat 63(i) _____

(j) 3 $Ba(C_2H_3O_2)_2(aq)$+___$Al_2(CO_3)_3(aq) \longrightarrow$ 3 $BaCO_3(s)$ + 2 $Al(C_2H_3O_2)_3(aq)$ 63(j) _____

(k) ___$K_2CO_3(aq)$ + 2 $HCl(aq) \longrightarrow$ 2 $KCl(aq)$ + ___$CO_2(g)$ + ___$H_2O(l)$ 63(k) _____

(l) ___$Sn(s)$ + ___$Fe(NO_3)_3(aq) \longrightarrow$ No Reaction 63(l) **NR**

[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 $\longrightarrow$ _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 $\longrightarrow$ amount Product (least amount made determines the Limiting Reactant. When you are done baking you are out of the Limiting Reactant (0 left)

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

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

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

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

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

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

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

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

[6 pt] 65. 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? 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**

Find the LR:

$$\frac{24 \text{ apples}}{} \times \frac{2.5 \text{ pies}}{3 \text{ apples}} = 20 \text{ pies}$$
$$\frac{10 \text{ cups Sugar}}{} \times \frac{2.5 \text{ pies}}{2\text{cups Sugar}} = 12.5 \text{ pies}$$
$$\frac{30 \text{ teaspoons Cinnamon}}{} \times \frac{2.5 \text{ pies}}{5 \text{ teaspoons Cinnamon}} = 15 \text{ pies}$$
$$\frac{25 \text{ cups Flour}}{} \times \frac{2.5 \text{ pies}}{4 \text{ cups Flour}} = 15.6 \text{ pies}$$

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

Calculating ER Left Over:

$$\frac{10 \text{ cups Sugar}}{} \times \frac{3 \text{ apples}}{2 \text{ cups Sugar}} = 15 \text{ apples used (24-15=9 left)}$$
$$\frac{10 \text{ cups Sugar}}{} \times \frac{5 \text{ teaspoons Cinnamon}}{2 \text{ cups Sugar}} = 25 \text{ teaspoons Cinnamon used (30-25=5 left)}$$
$$\frac{10 \text{ cups Sugar}}{} \times \frac{4 \text{ cups Flour}}{2 \text{ cups Sugar}} = 20 \text{ cups Flour used (25-20=5 left)}$$

[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)

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

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

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

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

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

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

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

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

[30 pt] 67. You perform a reaction in lab starting with 25.0 g of C_3H_8 and 50.0 g O_2. Some useful MW: C_3H_8 = 44.1 g/mol, O_2 = 32.0 g/mol, CO_2 = 44.0 g/mol and H_2O = 18.0 g/mol. Show CO2l calculations in the space provided.

$$\underline{1}\ C_3H_8(s) + \underline{5}\ O_2(g) \longrightarrow \underline{3}\ CO_2(g) + \underline{4}\ H_2O(g) + 150\ \text{kJ}$$

(a) What is the limiting reactant? 67(a) **O_2**

$$\frac{25.0\,\text{g}\,C_3H_8}{} \times \frac{1\,\text{mol}\,C_3H_8}{44.1\,\text{g}\,C_3H_8} \times \frac{3\,\text{mol}\,CO_2}{1\,\text{mol}\,C_3H_8} \times \frac{44.0\,\text{g}\,CO_2}{1\,\text{mol}\,CO_2} = 74.8$$

$$\frac{50.0\,\text{g}\,O_2}{} \times \frac{1\,\text{mol}\,O_2}{32.0\,\text{g}\,O_2} \times \frac{3\,\text{mol}\,CO_2}{5\,\text{mol}\,O_2} \times \frac{44.0\,\text{g}\,CO_2}{1\,\text{mol Fe}} = 41.3$$

Smaller amount of product is made therefore O_2 is the LR and 41.3 grams of CO_2 are made

(b) How many grams of the excess reagent will be left over? 67(b) **11.2 g C_3H_8**

$$\frac{50.0\,\text{g}\,O_2}{} \times \frac{1\,\text{mol}\,O_2}{32.0\,\text{g}\,O_2} \times \frac{1\,\text{mol}\,C_3H_8}{5\,\text{mol}\,O_2} \times \frac{44.1\,\text{g}\,CO_2}{1\,\text{mol}\,CO_2} = 13.8$$

Start - End = Left Over

25.0 - 13.8 = 11.2

(c) What is the theoretical yield in grams of CO_2 in grams? 67(c) **41.3 g CO_2**

See part (a)

(d) What is the percent yield if you performed the reaction and produced 23.0 grams of CO_2? 67(d) **55.7 %**

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

$$\frac{23.0}{41.3} \times 100 = 55.7$$

(e) How many Joules of heat will be released? 67(e) **46,900 J**

$$\frac{50.0\,\text{g}\,O_2}{} \times \frac{1\,\text{mol}\,O_2}{32\,\text{g}\,CO_2} \times \frac{150\,\text{kJ}}{5\,\text{mol}\,O_2} \times \frac{1000J}{1\,\text{kJ}} = 46,875$$

(f) How much H_2O will be produced? 67(f) **22.5 g H_2O**

$$\frac{50.0\,\text{g}\,O_2}{} \times \frac{1\,\text{mol}\,O_2}{32.0\,\text{g}\,O_2} \times \frac{4\,\text{mol}\,H_2O}{5\,\text{mol}\,O_2} \times \frac{18.0\,\text{g}\,H_2O}{1\,\text{mol}\,H_2O} = 22.5$$

(g) Does the reaction obey the Law of Conservation of Mass. Explain/prove your answer. 67(g) **Yes**

Start = End

25 + 50 = 11.2 + 41.3 + 22.5

75 = 75

[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.

$$\underline{1}\ Fe_2O_3(s) + \underline{2}\ Al(s) \longrightarrow \underline{2}\ Fe(l) + \underline{1}\ Al_2O_3(l) + 135kJ$$

(a) What is the limiting reactant? 68(a) **Fe_2O_3**

$$\frac{60.0\,g\,Fe_2O_3}{} \times \frac{1\,mol\,Fe_2O_3}{159.7\,g\,Fe_2O_3} \times \frac{2\,mol\,Fe}{1\,mol\,Fe_2O_3} \times \frac{55.845\,g\,Fe}{1\,mol\,Fe} = 42.0$$

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

Smaller amount of product is made (

(b) How many grams of the excess reagent will be left over? 68(b) **29.7 g Al**

$$\frac{60.0\,g\,Fe_2O_3}{} \times \frac{1\,mol\,Fe_2O_3}{159.7\,g\,Fe_2O_3} \times \frac{2\,mol\,Al}{1\,mol\,Fe_2O_3} \times \frac{26.982\,g\,Al}{1\,mol\,Al} = 20.3$$

Start - End = Left Over

50.0 - 20.3 = 58.1

(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 grams of Fe? 68(d) **54.8 %**

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

$$\frac{23.0}{42.0} \times 100 = 51.76$$

(e) How many Joules of heat will be released? 68(e) **50,700 J**

$$\frac{60.0\,g\,Fe_2O_3}{} \times \frac{1\,mol\,Fe_2O_3}{159.7\,g\,Fe_2O_3} \times \frac{135\,kJ}{1\,mol\,Fe_2O_3} \times \frac{1000J}{1\,kJ} = 50720.1$$

[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.
Hint: 1 $Al(NO_3)_3(aq) + 3\ NaI(aq) + 75.0kJ \longrightarrow 3\ NaNO_3(aq) + 1\ AlI_3(s)$.

(a) What is the limiting reagent if you start with 15.0 grams of NaI and 10.0 grams of $Al(NO_3)_3$? 69(a) **NaI**

(b) What is the theoretical yield of AlI_3 in grams? 69(b) **13.6 g AlI_3**

(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 AlI_3? 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:

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

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

The LR is therefore $Al(NO_3)_3$ and we produce 10.4 g AlI_3

ER used:

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

used, therefore Start (10.0) - Used (7.1) = 2.9 g $Al(NO_3)_3$ Leftover

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

Finding the Energy produced:

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

[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.
Hint: 3 $Mg(OH)_2(aq) + 2\ H_3PO_4(aq) \longrightarrow 6\ HOH(l) + 1\ Mg_3(PO_4)_2(s) + 320.\ kJ$.

(a) What is the limiting reagent if you start with 25.0 grams of $Mg(OH)_2$ and 25.0 grams of H_3PO_4? 70(a) **H_3PO_4**

(b) What is the theoretical yield in grams of $Mg_3(PO_4)_2$ in grams? 70(b) **33.5 g $Mg_3(PO_4)_2$**

(c) How many grams of the excess reagent will be left over? 70(c) **2.7 g H_3PO_4**

(d) What is the percent yield if you performed the reaction and produced 12.50 grams of $Mg_3(PO_4)_2$? 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** $40,800 J$

Find the LR:

$$\frac{25.0\,\text{g}\,Mg(OH)_2}{} \times \frac{1\,\text{mol}\,Mg(OH)_2}{58.33\,\text{g}} \times \frac{1\,\text{mol}\,Mg_3(PO_4)_2}{3\,\text{mol}\,Mg(OH)_2} \times \frac{262.87\,\text{g}}{1\,\text{mol}} = 37.6\,\text{g}\,Mg_3(PO_4)_2$$

$$\frac{25.0\,\text{g}\,H_3PO_4}{} \times \frac{1\,\text{mol}\,H_3PO_4}{97.99\,\text{g}\,H_3PO_4} \times \frac{1\,\text{mol}\,Mg_3(PO_4)_2}{2\,\text{mol}\,H_3PO_4} \times \frac{262.87\,\text{g}}{1\,\text{mol}} = 33.5\,\text{g}\,Mg_3(PO_4)_2$$

The LR is therefore H_3PO_4 and we produce 33.5 g $Mg_3(PO_4)_2$

ER used: $\frac{25.0\,\text{g}\,H_3PO_4}{} \times \frac{1\,\text{mol}\,H_3PO_4}{97.99\,\text{g}\,H_3PO_4} \times \frac{3\,\text{mol}\,Mg(OH)_2}{2\,\text{mol}\,H_3PO_4} \times \frac{58.33\,\text{g}\,Mg(OH)_2}{1\,\text{mol}} = 22.3\,\text{g}\,Mg(OH)_2$ 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:

$$\frac{25.0\,\text{g}\,H_3PO_4}{} \times \frac{1\,\text{mol}\,H_3PO_4}{97.99\,\text{g}\,H_3PO_4} \times \frac{320\,\text{kJ}}{2\,\text{mol}\,H_3PO_4} \times \frac{1000\,\text{J}}{1\,\text{kJ}} == 40820 = 4.08 \times 10^4 \text{ or } 40,800\,\text{J} =$$

[5 pt] 71. Given the reaction: _2_ $NaOH(aq)$ + _1_ $H_2SO_4(aq)$ $\longrightarrow$ _1_ $Na_2SO_4(aq)$ + _2_ $H_2O(l)$ how many grams of Na_2SO_4 can be produced from 25.0 grams of NaOH. Some useful MW: NaOH = 40.0 g/mol, H_2SO_4 = 98.0 g/mol, Na_2SO_4 = 142.1 g/mol and H_2O = 18.0 g/mol. 71. **44.4 g Na_2SO_4**

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

[5 pt] 72. How many grams of H_2O can be produced by burning 38.75 grams of C_2H_6? 72. **69.66 g H_2O**

_2_ $C_2H_6(g)$ + _7_ $O_2(g)$ $\longrightarrow$ _4_ $CO_2(g)$ + _6_ $H_2O(g)$

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

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

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

[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 water? 74. **1.05 M $Ca(OH)_2$**

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

[5 pt] 75. In a titration, it took 125.0 mL of 0.38 M H_3PO_4 to neutralize 55.0 mL of an unknown concentration of $Ca(OH)_2$. What is the concentration of the $Ca(OH)_2$ solution? 75. **1.3 M $Ca(OH)_2$**

_2_ $H_3PO_4(aq)$ + _3_ $Ca(OH)_2(aq)$ $\longrightarrow$ _1_ $Ca_3(PO_4)_2(aq)$ + _6_ H_2O

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

[5 pt] 76. How many mL of 0.350 M H_2SO_4 solution are required to neutralize 138.5 mL of 0.825 M NaOH solution? 76. **163 mL H_2SO_4**

_1_ $H_2SO_4(aq)$ + _2_ $NaOH(aq)$ $\longrightarrow$ _1_ $Na_2SO_4(aq)$ + _2_ $H_2O(l)$

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

[5 pt] 77. How many grams of H_2 gas can be produced if 75.0 g of Na are reacted with 600.0 mL of 3.25 M H_2SO_4? 77. **3.29 g H_2**

_2_ Na(s) + _1_ H_2SO_4(aq) $\longrightarrow$ _1_ Na_2SO_4(aq) + _1_ H_2(g)

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

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

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**

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

[4 pt] 79. What is the molarity of a solution made from 15.0 grams of $AgNO_3$ dissolved in 275.0 mL of water? 79. **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 the reaction:

$2\ H_3PO_4(aq) + 3\ Mg(OH)_2(aq) \longrightarrow 1\ Mg_3(PO_4)_2(aq) + 6\ H_2O(l) + 12.0\text{kJ}$

(a) How many grams of $Mg_3(PO_4)_2$ can be produced from 125.0 grams of $Mg(OH)_2$. 80(a) **187.8 g $Mg(OH)_2$**

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

(b) How many grams of H_3PO_4 are required to react with 11.0 grams of $Mg(OH)_2$. 80(b) **12.3 g H_3PO_4**

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

[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 $Mg(OH)_2(aq) + 2\ HCl(aq) \longrightarrow 2\ HOH(l) + MgCl_2(aq)$. 81. **0.39 M HCl**

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

[5 pt] 82. How many mL of 0.55 M NaOH are required to neutralize 195.0 mL of 1.87 M H_2SO_4?
Hint: 1 $H_2SO_4(aq) + 2\ NaOH(aq) \longrightarrow 2\ HOH(l) + 1\ Na_2SO_4(aq)$. 82. **1300 mL NaOH**

$$\frac{195.0\,\text{mL}\,H_2SO_4}{} \times \frac{0.001\,\text{L}}{1\,\text{mL}} \times \frac{1.87\,\text{mol}\,H_2SO_4}{1\,\text{L}} \times \frac{2\,\text{mol}\,NaOH}{1\,\text{mol}\,H_2SO_4} \times \frac{1\,\text{L}}{0.55\,\text{mol}\,NaOH} \times \frac{1\,\text{mL}}{0.001\,\text{L}}$$

[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**

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

[4 pt] 85. Given the reaction: 2 $NaOH(aq) + 1\ H_2SO_4(aq) \longrightarrow 1\ Na_2SO_4(aq) + 2\ H_2O(l)$ how many grams of Na_2SO_4 can be produced from 25.0 grams of NaOH. 85. **44.4 g Na_2SO_4**

$$\frac{25.0\,\text{g}\,NaOH}{} \times \frac{1\,\text{mol}\,NaOH}{40\,\text{g}\,NaOH} \times \frac{1\,\text{mol}\,Na_2SO_4}{2\,\text{mol}\,NaOH} \times \frac{142.05\,\text{g}\,Na_2SO_4}{1\,\text{mol}\,Na_2SO_4}$$

[5 pt] 86. Todd performed a titration and noted that 115.0 mL of 0.85 M $Mg(OH)_2$ completely neutralized 135.0 mL of H_3PO_4. What is the Molarity of the H_3PO_4 solution?
Hint: 3 $Mg(OH)_2(aq) + 2H_3PO_4(aq) \longrightarrow 6\ HOH(l) + Mg_3(PO_4)_2(s)$. 86. **<u>0.48 M H_3PO_4</u>**

$$\frac{1150\,\text{mL}\,Mg(OH)_2}{135\,\text{mL}\,H_3PO_4} \times \frac{0.001\,\text{L}}{1\,\text{mL}} \times \frac{0.85\,\text{mol}\,Mg(OH)_2}{1\,\text{L}} \times \frac{2\,\text{mol}\,H_3PO_4}{3\,\text{mol}\,Mg(OH)_2} \times \frac{1\,\text{mL}}{0.001\,\text{L}}$$

[5 pt] 87. How many mL of 3.25 M $Mg(OH)_2$ are required to neutralize 240.0 mL of 1.25 M H_3PO_4?
Hint: 3 $Mg(OH)_2(aq) + 2\ H_3PO_4(aq) \longrightarrow 6\ HOH(l) + Mg_3(PO_4)_2(s)$. 87. **<u>138 mL $Mg(OH)_2$</u>**

$$\frac{240.0\,\text{mL}\,H_3PO_4}{} \times \frac{0.001\,\text{L}}{1\,\text{mL}} \times \frac{1.25\,\text{mol}\,H_3PO_4}{1\,\text{L}} \times \frac{3\,\text{mol}\,Mg(OH)_2}{2\,\text{mol}\,H_3PO_4} \times \frac{1\,\text{L}}{3.25\,\text{mol}\,Mg(OH)_2} \times \frac{1\,\text{mL}}{0.001\,\text{L}}$$