Recitation Worksheet Four

Name: key

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Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname that is not reflected in eLC).
- Your UGA myID is a combination of letters and numbers (example: mine is jmj81738). Do *not* enter your 81x number.
- Download this worksheet and print it if you have a printer. Write the answers in the answer boxes and show your work when appropriate. Using the instructions in the Welcome module on eLC, convert your worksheet to a PDF and then upload it to Gradescope. If you have an iPhone or Android device, you can scan and upload directly through the Gradescope app. The pages must be in the correct order or Gradescope will not be able to read it.
- If you do not have a printer, download the worksheet and type your answers in the answer boxes and upload it to Gradescope. Write your work on separate sheets of paper, convert these pages to a PDF using the instructions in the Welcome module on eLC, then upload them to the dropbox on eLC for this worksheet.
- If you are using an app to annotate the worksheet, make sure the pages are in the correct order and have the same layout as the original or Gradescope will not be able to read it.
- Answers must be written in the corresponding answer box or no credit will be awarded.
- This worksheet is due no later than **11:59 PM on the Friday of the recitation week.**
- The instructions for uploading worksheets to Gradescope can be found in the Content area of eLC in the Welcome Module.
- **You must show your work to receive credit.**

1. First, balance the equation below, then determine the limiting reactant in each of the following scenarios. Write the corresponding letter ("A" or "B") in the boxes below.

$$\underline{1}\ P_4\ (s) + \underline{6}\ Cl_2\ (g) \rightarrow \underline{4}\ PCl_3\ (l)$$

B — (A) 6 mol P_4 reacting with (B) 6 mol Cl_2

$$6 \text{ mol } P_4 \times \frac{4 \text{ mol } PCl_3}{1 \text{ mol } P_4} = 24 \text{ mol } PCl_3$$

$$6 \text{ mol } Cl_2 \times \frac{4 \text{ mol } PCl_3}{6 \text{ mol } Cl_2} = \boxed{4 \text{ mol } PCl_3}$$

B — (A) 297 mol P_4 reacting with (B) 54 mol Cl_2

$$297 \text{ mol } P_4 \times \frac{4 \text{ mol } PCl_3}{\text{mol } P_4} = 1188 \text{ mol } PCl_3$$

$$54 \text{ mol } Cl_2 \times \frac{4 \text{ mol } PCl_3}{6 \text{ mol } Cl_2} = \boxed{36 \text{ mol } PCl_3}$$

2. First, balance the equation below, then answer the following questions in which 20.00 grams of explosive sodium metal and 20.00 grams of poisonous chlorine gas produces sodium chloride.

$\underline{\ 2\ }$ Na (s) + $\underline{\ 1\ }$ Cl_2 (g) → $\underline{\ 2\ }$ NaCl (s)

(a) What is the limiting reactant?

B

A. Na
B. Cl_2
C. Both Na and Cl_2 because equal amounts of reactants were used

$$20.00\,g\ Na \times \frac{mol\ Na}{22.99\,g\ Na} \times \frac{2\,mol\ NaCl}{2\,mol\ Na} \times \frac{58.44\,g\ NaCl}{mol\ NaCl} = \underline{\underline{50.839}}\ g\ NaCl$$

$$20.00\,g\ Cl_2 \times \frac{mol\ Cl_2}{70.90\,g\ Cl_2} \times \frac{2\,mol\ NaCl}{1\,mol\ Cl_2} \times \frac{58.44\,g\ NaCl}{mol\ NaCl} = \boxed{\underline{\underline{32.9704}}\ g\ NaCl}$$

(b) What mass (in grams) of NaCl forms if the percent yield is 100%?

32.97

grams

limiting theoretical yield from part "a"

(c) What mass (in grams) of NaCl forms if the percent yield is 74.1%?

24.4

grams

$$\% = \frac{actual}{theoretical} \times 100$$

$$actual = \frac{74.1}{100}(32.97\,g) = 24.\underline{\underline{4}}310\,g$$

(d) What is the percent yield of the reaction if 23.51 grams of NaCl is collected?

71.31

%

$$\% = \frac{23.51\,g}{32.9704\,g} \times 100 = 71.31$$

$d = \frac{m}{V}$ $m = Vd = 6.67\,mL \times 0.804\,\frac{g}{mL} = 5.36268\,g\ C_3H_7OH$

$1\,mL = 1\,cm^3$ $2.45\,mL \times 1.00\,\frac{g}{mL} = 2.45\,g\ H_2O$

3. Consider the balanced combustion reaction below in which 6.67 mL C_3H_7OH (d = 0.804 g/cm^3) reacts in the presence of 9.04 g O_2 gas yielding 2.45 mL of H_2O (density = 1.00 g/cm^3).

$$2\ C_3H_7OH\ (l) + 9\ O_2\ (g) \rightarrow 6\ CO_2 + 8\ H_2O$$

(a) What is the limiting reactant? $5.36268\,g\ C_3H_7OH \times \frac{mol}{60.11\,g} \times \frac{8\,mol\ H_2O}{2\,mol\ C_3H_7OH} \times \frac{18.02\,g\ H_2O}{mol\ H_2O} = 6.4306\,g\ H_2O$

$\boxed{B}$

A. C_3H_7OH
B. O_2

$9.04\,g\ O_2 \times \frac{mol}{32.00\,g} \times \frac{8\,mol\ H_2O}{9\,mol\ O_2} \times \frac{18.02\,g\ H_2O}{mol\ H_2O} = \boxed{4.5250\,g\ H_2O}$

(b) What is the theoretical yield of H_2O (in grams)?

$\boxed{4.52}$ grams the limiting theoretical yield from part a

(c) What is the percent yield of H_2O?

$\boxed{54.1}$ % $\% = \frac{2.45\,g}{4.5250\,g} \times 100$

4. A scientist goes to lab to synthesize Na_3AlF_6 via the balanced chemical reaction below. If they need 780. grams of Na_3AlF_6, and the overall percent yield is 45.4 %, how much Al_2O_3 (in grams) is needed? You may assume NaOH and HF is in excess here.

$$6\ NaOH + Al_2O_3 + 12\ HF \rightarrow 2\ Na_3AlF_6 + 9\ H_2O$$

$\boxed{417}$ grams $\% = \frac{actual}{theoretical} \times 100 = 0.454 = \frac{780.\,g}{x}$

$x = \frac{780\,g}{0.454} = 1718.06\,g$

$1718.06\,g\ Na_3AlF_6 \times \frac{mol}{209.95\,g} \times \frac{1\,mol\ Al_2O_3}{2\,mol\ Na_3AlF_6} \times \frac{101.96\,g\ Al_2O_3}{mol\ Al_2O_3} = 417.179\,g\ Al_2O_3$

5. Consider the balanced equation below in which 10.86 grams of PCl_5 reacts with 13.58 grams of AsF_3.

$$3\ PCl_5 + 5\ AsF_3 \rightarrow 3\ PF_5 + 5\ AsCl_3$$

What is the **excess** reactant?

$10.86\ g\ PCl_5 \times \frac{mol}{208.22\ g} \times \frac{3\ mol\ PF_5}{3\ mol\ PCl_5} \times \frac{125.97\ g\ PF_5}{mol\ PF_5} = 6.57014\ g$

B

A. PCl_5
B. AsF_3

$13.58\ g\ AsF_3 \times \frac{mol}{131.52\ g} \times \frac{3\ mol\ PF_5}{5\ mol\ AsF_3} \times \frac{125.97\ g\ PF_5}{mol\ PF_5} = \boxed{7.7805\ g}$

How many grams of **excess** reactant are left over after the reaction is complete?

2.113

grams

7.7805-6.57014=1.21036 g PF_5 theoretical excess

sig figs can vary here

$1.21036\ g\ PF_5 \times \frac{mol}{125.97\ g} \times \frac{5\ mol\ AsF_3}{3\ mol\ PF_5} \times \frac{131.92\ g\ AsF_3}{mol\ AsF_3} = 2.11255\ g$

6. How many moles of particles are present upon dissolving one mole of each of the compounds below? Answer by using an integer (e.g. 0, 1, etc.).

all species aqueous once dissolved

Answer	Compound	
4	Na_3PO_4	$3Na^+ + PO_4^{3-} = 4$
1	$C_{17}H_{18}F_3NO$	molecule = 1
3	$Mg(NO_3)_2$	$Mg^{2+} + 2NO_3^- = 3$
2	NH_4Cl	$NH_4^+ + Cl^- = 2$

7. Label the following compounds as a (A) strong electrolyte, (B) weak electrolyte, or (C) nonelectrolyte. Answer by placing the appropriate letter in the boxes below.

B	HCH_3COO	organic weak acid	C	CH_3CH_2OH	alcohol/molecule
~~X~~	$BaSO_4$	skip; insoluble ionic compound	B	NH_3	weak organic base

8. Consider a hypothetical set of experiments completed by a student in lab:

(a) The student starts by dissolving 7.24 × 10^3 milligrams of NaCl in 150.00 mL deionized water inside a volumetric flask. What is the concentration of NaCl in the flask?

[NaCl] : $\boxed{0.826}$ M $= \frac{\text{mol NaCl}}{\text{L } H_2O} = \dfrac{7{,}240 \cancel{\text{mg}} \times \frac{\cancel{g}}{1000 \cancel{\text{mg}}} \times \frac{\text{mol NaCl}}{58.44 \cancel{g}}}{150.00 \cancel{\text{mL}} \times \frac{L}{1000 \cancel{\text{mL}}}}$

(b) In a separate flask, the student dissolves 3.79 × 10^{-2} kilograms of LiBr in 200.00 mL deionized water. What is the concentration of LiBr in the flask?

[LiBr] : $\boxed{2.18}$ M $\dfrac{0.0379 \text{ kg LiBr} \times \frac{1000 g}{kg} \times \frac{mol}{86.84 g}}{200.00 \text{ mL} \times \frac{L}{1000 mL}}$

(c) After making both solutions, the student places 100.00 mL of the NaCl solution and 100.00 mL of the LiBr solution in a separate volumetric flask together. What are the final concentrations of both solutions after mixing them together?

[NaCl]: $\boxed{0.413}$ M $(0.826 \text{ M})(100.00 \text{ mL}) = M_2(200 \text{ mL})$

[LiBr] : $\boxed{1.09}$ M $(2.18 \text{ M})(100.00 \text{ mL}) = M_2(200 \text{ mL})$

$M_1V_1 = M_2V_2$

9. A researcher mixes 50. mL of water with 1.0 L of ethanol. Which is the solvent?

$\boxed{B}$

greater volume is solvent

A. Water
B. Ethanol
C. Both
D. Cannot be determined

10. Concentrated hydrochloric acid is approximately 12.2 M. If a student needs to prepare 300. mL of 1.500 M hydrochloric acid, what volume (mL) of concentrated acid is needed?

$\boxed{36.9}$ mL

$$M_1V_1 = M_2V_2$$

$$(12.2\,M)\,V_1 = (1.500\,M)(300.\,mL)$$

$$V_1 = \frac{(1.500\,\cancel{M})(300.\,mL)}{12.2\,\cancel{M}}$$

Extra Practice Questions: these questions will not be graded.

$K_3PO_4 \rightarrow 3K^+_{(aq)} + PO_4^{3-}{}_{(aq)}$

1. If 31.5 g of potassium phosphate is dissolved in 750. mL of water, what is the molarity of the **potassium ions** in the resulting solution?

0.594	M

$$\frac{31.5\,g\ K_3PO_4 \times \frac{mol}{212.27\,g} \times \frac{3\,mol\ K^+}{mol\ K_3PO_4}}{750.\,mL \times \frac{1\,L}{1000\,mL}}$$

2. A student leaves 750. mL of a 50.0 mM salt solution in an uncorked flask, and it evaporates down to a volume of 699 mL before someone else finds it. What is the concentration (mM) of the resulting solution?

$M_1V_1 = M_2V_2$

53.6	mM

$(50.0\,mM)(750.\,mL) = M_2(699\,mL)$

3. If 70. mL of a 0.29 M $Mg(OH)_2$ solution is diluted to a total volume of 250. mL, what is the final concentration (M) of the **hydroxide ions** in solution?

$Mg(OH)_2 \rightarrow Mg^{2+}{}_{(aq)} + 2OH^-{}_{(aq)}$ $(70.\,mL)(0.29\,M) = M_2(250.\,mL)$

0.16	M

$M_2 = 0.0812\ M\ Mg(OH)_2$

$$0.0812\ \frac{mol\ \cancel{Mg(OH)_2}}{L} \times \frac{2\,mol\ OH^-}{mol\ \cancel{Mg(OH)_2}}$$

4. Luria Broth (LB) is a widely used bacterial culture medium. Most recipes for LB are 40.% tryptone, 40.% sodium chloride, and 20.% yeast extract. 2.00 L of LB is made by dissolving 50. g of this mixture in 2.00 L of water. What is the molarity of the sodium chloride in the resulting solution?

0.17	M

$50.\,g \times 0.40\ NaCl = 20.\,g\ NaCl$

$$M_{NaCl} = \frac{20.\,g\ NaCl \times \frac{mol}{58.44\,g}}{2.00\,L}$$