

### Recitation Worksheet Five

Name:

Key

UGA ID:

#### 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. How many of the following compounds below are soluble in water? Answer by using an integer (e.g. 0, 1, etc.).

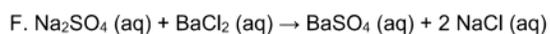
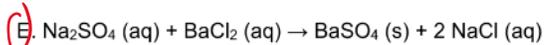
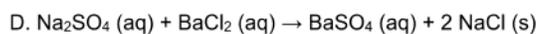
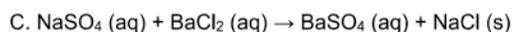
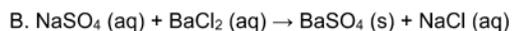
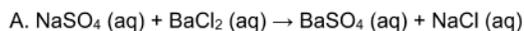
5

- A.  $\text{Rb}_2\text{SO}_4$
- B.  $\text{AgI}$
- C.  $\text{Ag}_2\text{CO}_3$
- D.  $\text{BaS}$
- E.  $\text{Na}_2\text{CO}_3$

- F.  $\text{SrSO}_4$
- G.  $\text{Hg}_2\text{I}_2$
- H.  $\text{Ba}_3(\text{PO}_4)_2$
- I.  $\text{NH}_4\text{NO}_3$
- J.  $\text{Ba}(\text{CH}_3\text{COO})_2$

2. What is the correct balanced formula equation for the reaction between aqueous solutions of sodium sulfate and barium chloride?

E



3. Consider the reaction between aqueous hydroiodic acid and aqueous barium hydroxide. What is/are the spectator ion(s) in this reaction? Select all that apply.

BC

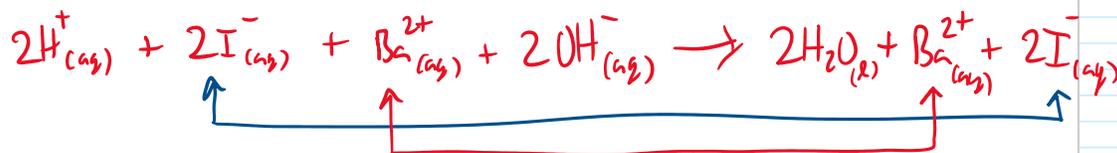
A. The hydrogen ion

B. The iodide ion

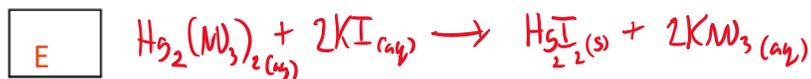
C. The barium ion

D. The hydroxide ion

E. There are no spectator ions in this reaction

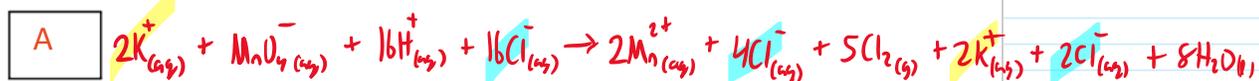
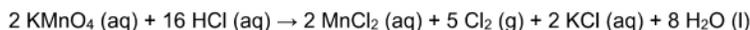


4. What is the total ionic equation for the double displacement reaction between aqueous mercury(I) nitrate and aqueous potassium iodide?



- A.  $\text{Hg}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{HgI}(\text{s}) + \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$   
 B.  $\text{Hg}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{Hg}^+(\text{aq}) + \text{I}^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$   
 C.  $\text{Hg}^+(\text{aq}) + \text{N}^{5+}(\text{aq}) + \text{O}_3^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{HgI}(\text{s}) + \text{K}^+(\text{aq}) + \text{N}^{5+}(\text{aq}) + \text{O}_3^-(\text{aq})$   
 D.  $\text{Hg}_2^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + 2\text{K}^+(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow \text{Hg}_2^{2+}(\text{aq}) + 2\text{I}^-(\text{aq}) + 2\text{K}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq})$   
 E.  $\text{Hg}_2^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + 2\text{K}^+(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow \text{Hg}_2\text{I}_2(\text{s}) + 2\text{K}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq})$

5. What is the net ionic equation for the balanced equation given below?



- A.  $2\text{MnO}_4^-(\text{aq}) + 16\text{H}^+(\text{aq}) + 10\text{Cl}^-(\text{aq}) \rightarrow 2\text{Mn}^{2+}(\text{aq}) + 5\text{Cl}_2(\text{g}) + 8\text{H}_2\text{O}(\text{l})$   
 B.  $2\text{K}^+(\text{aq}) + 2\text{MnO}_4^-(\text{aq}) + 16\text{H}^+(\text{aq}) + 16\text{Cl}^-(\text{aq}) \rightarrow 2\text{Mn}^{2+}(\text{aq}) + 5\text{Cl}_2(\text{g}) + 8\text{H}_2\text{O}(\text{l}) + \text{K}_2(\text{aq})$   
 C.  $2\text{Mn}^{7+}(\text{aq}) + 4\text{O}^{2-}(\text{aq}) + 16\text{H}^+(\text{aq}) + 16\text{Cl}^-(\text{aq}) \rightarrow 2\text{Mn}^{2+}(\text{aq}) + 10\text{Cl}^-(\text{g}) + 8\text{H}_2\text{O}(\text{l})$   
 D.  $2\text{K}^+(\text{aq}) + 2\text{Mn}^{7+}(\text{aq}) + 4\text{O}^{2-}(\text{aq}) + 16\text{H}^+(\text{aq}) + 16\text{Cl}^-(\text{aq}) \rightarrow 2\text{Mn}^{2+}(\text{aq}) + 10\text{Cl}^-(\text{g}) + 8\text{H}_2\text{O}(\text{l})$   
 E. No net ionic equation exists

all potassium ions are spectators but only 6 chloride ions

6. Write the net ionic equation for the balanced equation below. Afterwards, determine the sum of the coefficients and report your answer in the box below. Remember to include a coefficient of 1 in your calculations even if it is usually left out.



18



$$6+3+1+5+3=18$$

7. Write the net ionic equation for the acid-base reaction between solid aluminum hydroxide and aqueous nitric acid. Afterwards, determine the sum of the coefficients and report your answer in the box below. Remember to include a coefficient of 1 in your calculations even if it is usually left out.

8



$$1+3+3+1=8$$

8. If 60.00 mL of 0.810 M BaCl<sub>2</sub> is added to 54.20 mL of 0.170 M AgNO<sub>3</sub>, and 1.12 grams of solid is collected, what is the percent yield of the reaction?

84.8



$$0.810 \frac{\text{mol BaCl}_2}{\text{L}} \times 0.06000 \text{ L} \times \frac{2 \text{ mol AgCl}}{1 \text{ mol BaCl}_2} \times \frac{143.32 \text{ g AgCl}}{\text{mol AgCl}} = 13.93070 \text{ g AgCl}$$

$$0.170 \frac{\text{mol AgNO}_3}{\text{L}} \times 0.05420 \text{ L} \times \frac{2 \text{ mol AgCl}}{2 \text{ mol AgNO}_3} \times \frac{143.32 \text{ g AgCl}}{\text{mol AgCl}} = 1.320550 \text{ g AgCl}$$

$$\% = \frac{\text{Actual}}{\text{Theoretical}} \times 100 = \frac{1.12 \text{ g}}{1.320550 \text{ g}} \times 100 = 84.8131 \%$$

Excess Reagent

Limiting Reagent

9. Consider a hypothetical scenario in which you need 100.0 grams of  $\text{PbCl}_2$ . You go to the lab and find a limited volume of 0.600 M  $\text{NaCl}$  and an excessive amount of 0.700 M  $\text{Pb}(\text{NO}_3)_2$ , both of which can be combined to form  $\text{PbCl}_2$ . If the percent yield of the reaction is 44.25 %, what volume (in mL) of 0.600 M  $\text{NaCl}$  do you need? Hint:  $\text{Pb}(\text{NO}_3)_2$  will be your excess reactant.

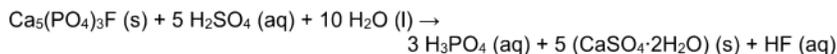
2.71E3



$$\frac{100.0 \text{ g}}{\text{theoretical}} = 0.4425 \quad \text{theoretical} = 225.988701 \text{ g PbCl}_2$$

$$225.988701 \text{ g PbCl}_2 \times \frac{\text{mol}}{278.1 \text{ g}} \times \frac{2 \text{ mol NaCl}}{1 \text{ mol PbCl}_2} \times \frac{\text{L NaCl}}{0.600 \text{ mol NaCl}} \times \frac{1000 \text{ mL}}{\text{L}} = 2.71 \times 10^3 \text{ mL}$$

10. What volume (in mL) of 6.74 M  $\text{H}_3\text{PO}_4$  is produced when 2.50 metric tons of  $\text{Ca}_5(\text{PO}_4)_3\text{F}$  reacts with excess  $\text{H}_2\text{SO}_4$  and excess  $\text{H}_2\text{O}$  if the percent yield is 74.1%? Note: 1 metric ton = 1000 kg



1.64E6

mL

$$2.50 \text{ metric tons} \times \frac{1000 \text{ kg}}{1 \text{ metric ton}} \times \frac{1000 \text{ g}}{\text{kg}} \times \text{Ca}_5(\text{PO}_4)_3\text{F} \times \frac{\text{mol}}{504.31 \text{ g}} \times \frac{3 \text{ mol H}_3\text{PO}_4}{1 \text{ mol Ca}_5(\text{PO}_4)_3\text{F}} \times \frac{\text{L H}_3\text{PO}_4}{6.74 \text{ mol H}_3\text{PO}_4} \times \frac{1000 \text{ mL}}{\text{L}} \times \frac{74.1}{100}$$

11. A 225.00 mL sample of 0.500 M  $\text{CsCl}$  and a 155.00 mL sample of 1.560 M  $\text{CsCl}$  is added to a beaker. Afterwards,  $\text{AgNO}_3$  is added to the beaker to react with the  $\text{CsCl}$  solution. Start by writing the balanced equation, and then determine the mass of  $\text{AgNO}_3$  required to completely react with  $\text{CsCl}$ .

60.2

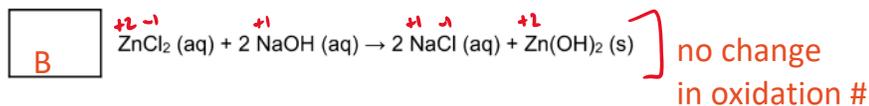
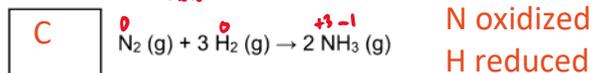
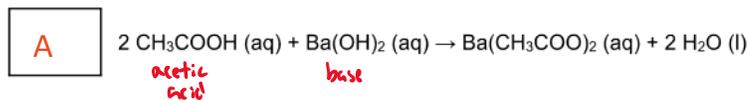
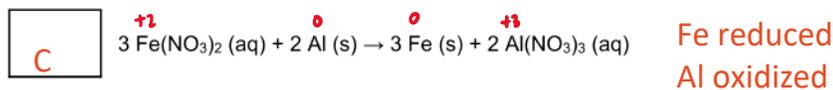


$$\left( \frac{0.500 \text{ mol CsCl}}{\text{L}} \times 0.22500 \text{ L} \right) + \left( \frac{1.560 \text{ mol CsCl}}{\text{L}} \times 0.15500 \text{ L} \right) = \text{mol CsCl}$$

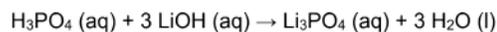
$$0.1125 \text{ mol} + 0.2418 \text{ mol} = 0.3543 \text{ mol CsCl}$$

$$0.3543 \text{ mol CsCl} \times \frac{\text{mol AgNO}_3}{\text{mol CsCl}} \times \frac{169.88 \text{ g AgNO}_3}{\text{mol AgNO}_3} = 60.2 \text{ g AgNO}_3$$

12. Label the following reactions below as an (A) acid-base, (B) precipitation, or (C) oxidation-reduction reaction. Write the corresponding letter in the boxes below.



13. A scientist goes to the lab and finds a solution of  $\text{H}_3\text{PO}_4$  that has an unknown concentration. Upon experimentation, they find that they can neutralize 45.00 mL of the  $\text{H}_3\text{PO}_4$  solution by using 32.50 mL of a 1.500 M LiOH solution. Based on this information, what is the concentration of the unknown  $\text{H}_3\text{PO}_4$  solution?



M  $0.03250 \text{ L LiOH} \times \frac{1.500 \text{ mol}}{\text{L}} \times \frac{1 \text{ mol H}_3\text{PO}_4}{3 \text{ mol LiOH}} = 0.01625 \text{ mol H}_3\text{PO}_4$

$$\frac{0.01625 \text{ mol H}_3\text{PO}_4}{0.04500 \text{ L}} = 0.3611$$

14. Recently, you learned the names of numerous polyatomic ions including those listed below. Record the oxidation state of chlorine in each of the compounds below with an integer and if applicable its charge (e.g. 0, +/- 1, +/- 2, etc.).

(a)

hypochlorite  $\text{ClO}^-$   
 $\text{Cl} + 0 = -1$   
 $\text{Cl} + (-2) = -1$   
 $\text{Cl} = +1$

(c)

chlorate  $\text{ClO}_3^-$   
 $\text{Cl} + 3(0) = -1$   
 $\text{Cl} - 6 = -1$   
 $\text{Cl} = +5$

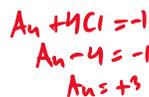
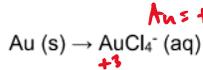
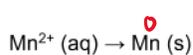
(b)

chlorite  $\text{ClO}_2^-$   
 $\text{Cl} + 2(0) = -1$   
 $\text{Cl} - 4 = -1$   
 $\text{Cl} = +3$

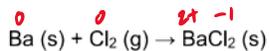
(d)

perchlorate  $\text{ClO}_4^-$   
 $\text{Cl} + 4(0) = -1$   
 $\text{Cl} - 8 = -1$   
 $\text{Cl} = +7$

15. How many electrons are transferred in the following half reactions below? Answer by using an integer (e.g. 0, 1, etc.).



16. Consider the oxidation-reduction reaction below and answer the following questions. Write the **chemical formula** in the boxes below.



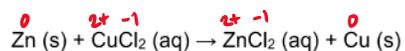
What species is oxidized?



What species is reduced?

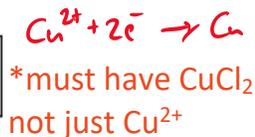


17. Consider the oxidation-reduction reaction below and answer the following questions. Write the **chemical formula** in the boxes below.



What species is the oxidizing agent?

CuCl<sub>2</sub>

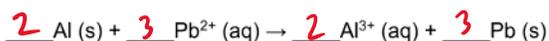


What species is the reducing agent?

Zn



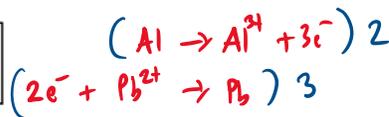
18. Consider the oxidation-reduction reaction below and answer the following questions. Write the **chemical formula** in the boxes below.



must balance atoms AND electrons

What species is oxidized?

Al



What species is reduced?

Pb<sup>2+</sup>



Fully balance the equation and list the coefficients as whole numbers with no commas or spaces (e.g. 1234).

2323

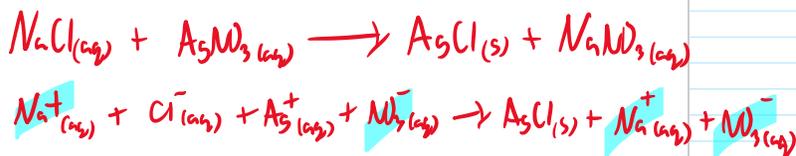
How many electrons were transferred after balancing the equation? Answer by using an integer (e.g. 0, 1, etc.).

6

**Extra Practice Questions: these questions will not be graded.**

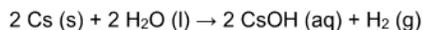
1. Consider the double displacement reaction between aqueous sodium chloride and aqueous silver nitrate. What is/are the spectator ion(s) in this reaction? Select all that apply.

AD

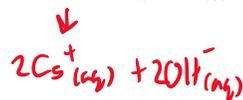


- A.  $\text{Na}^+$
- B.  $\text{Cl}^-$
- C.  $\text{Ag}^+$
- D.  $\text{NO}_3^-$
- E. There are no spectator ions in this reaction

2. What is the total ionic equation for the balanced equation given below?



D



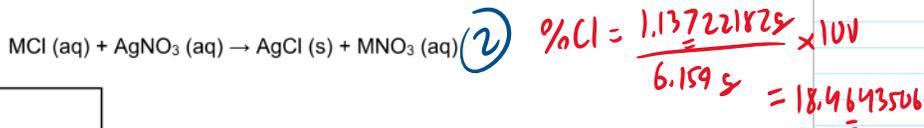
- A.  $2 \text{Cs} (s) + 2 \text{H}_2\text{O} (l) \rightarrow 2 \text{CsOH} (aq) + \text{H}_2 (g)$
- B.  $2 \text{Cs} (s) + 4 \text{H}^+ (aq) + 2 \text{O}^{2-} (aq) \rightarrow 2 \text{Cs}^+ (aq) + 2 \text{OH}^- (aq) + \text{H}_2 (g)$
- C.  $2 \text{Cs} (s) + 4 \text{H}^+ (aq) + 2 \text{O}^{2-} (aq) \rightarrow 2 \text{Cs}^+ (aq) + 2 \text{OH}^- (aq) + 2 \text{H}^+ (aq)$
- D.  $2 \text{Cs} (s) + 2 \text{H}_2\text{O} (l) \rightarrow 2 \text{Cs}^+ (aq) + 2 \text{OH}^- (aq) + \text{H}_2 (g)$
- E. No total ionic equation exists

3. What is the net ionic equation for the double displacement reaction between ammonium sulfate and lithium chloride?



- A.  $2\text{Li}^+ (\text{aq}) + \text{SO}_4^{2-} (\text{aq}) \rightarrow \text{Li}_2\text{SO}_4 (\text{s})$   
 B.  $2\text{Li}^+ (\text{aq}) + \text{SO}_4^{2-} (\text{aq}) + 2\text{Cl}^- (\text{aq}) \rightarrow \text{Li}_2\text{SO}_4 (\text{s}) + \text{Cl}_2 (\text{aq})$   
 C.  $\text{NH}_4^+ (\text{aq}) + \text{Cl}^- (\text{aq}) \rightarrow \text{NH}_4\text{Cl} (\text{s})$   
 D.  $\text{NH}_4^+ (\text{aq}) + \text{Cl}^- (\text{aq}) + \text{SO}_4^{2-} (\text{aq}) \rightarrow \text{NH}_4\text{Cl} (\text{s}) + \text{S}^{6+} (\text{aq}) + 4\text{O}^{2-} (\text{aq})$   
 E. No net ionic equation exists
- all aqueous

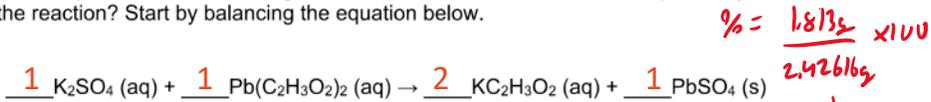
4. Approximately 6.159 grams of an unknown metal chloride compound (MCl) is dissolved in water, and then precipitated out with 106.4 mL of 0.3015 M  $\text{AgNO}_3$  solution. Assuming the equation provided below is balanced, determine the mass percent of chlorine.



18.46

(1)  $0.1064 \text{ L} \times \frac{0.3015 \text{ mol AgNO}_3}{\text{L}} \times \frac{1 \text{ mol MCl}}{1 \text{ mol AgNO}_3} \times \frac{1 \text{ mol Cl}}{1 \text{ mol MCl}} \times \frac{35.45 \text{ g Cl}}{\text{mol Cl}} = 1.13722182 \text{ g Cl}$

5. If 30.00 mL of a 0.500 M  $\text{K}_2\text{SO}_4$  solution is mixed with 20.00 mL of a 0.400 M  $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$  solution, and 1.813 grams of solid are collected, what is the percent yield of the reaction? Start by balancing the equation below.



74.7

$0.03000 \text{ L K}_2\text{SO}_4 \times \frac{0.500 \text{ mol}}{\text{L}} \times \frac{1 \text{ mol PbSO}_4}{1 \text{ mol K}_2\text{SO}_4} \times \frac{303.27 \text{ g}}{\text{mol}} = 4.54565 \text{ g PbSO}_4$

$0.02000 \text{ L} \times \frac{0.400 \text{ mol}}{\text{L}} \times \frac{1 \text{ mol PbSO}_4}{1 \text{ mol Pb}(\text{C}_2\text{H}_3\text{O}_2)_2} \times \frac{303.27 \text{ g}}{\text{mol}} = 2.42616 \text{ g PbSO}_4$

Limiting Reagent  
 $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$

6. The scientist from question 13 finishes up their reaction and is putting away their reagents. In the process, they accidentally knock over a bottle of 5.50 M  $\text{H}_2\text{SO}_4$ . To clean up the mess, they neutralize the acid using  $\text{NaHCO}_3$ , which is a common practice in the laboratory. If they spilled 135.51 mL of  $\text{H}_2\text{SO}_4$ , what mass (in grams) of  $\text{NaHCO}_3$  will they need to completely neutralize the acid?



Disclaimer: it is also common practice in the laboratory to use an excessive amount of  $\text{NaHCO}_3$  as quickly as possible to neutralize an acid spill due to safety concerns.

125 g

$$0.13551 \text{ L} \times \frac{5.50 \text{ mol H}_2\text{SO}_4}{\text{L}} \times \frac{2 \text{ mol NaHCO}_3}{1 \text{ mol H}_2\text{SO}_4} \times \frac{84.01 \text{ g}}{\text{mol}}$$