

## Recitation Worksheet Four

Name:

UGA ID:

### Textbook:

Chemistry & Chemical Reactivity

by John C. Kotz, Paul M. Treichel, John R. Townsend, David Treichel

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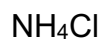
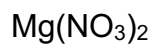
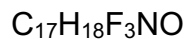
### Instructions:

- This recitation worksheet covers Ch. 3.4-3.9, 4.1.
- 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: Dr. Seivert's MyID is mds73312). **Do not use your 81x number.**
- Your completed worksheet has to be submitted to **Gradescope**. You have multiple options for submission:
  - You may use an app to annotate the worksheet by placing your answers in the answer boxes and showing your work when appropriate. Afterward, submit the worksheet to Gradescope. You will not need to upload anything to eLC.
  - You may print out the worksheet, write your answers in the answer boxes, and show your work on it when appropriate. Afterward, convert the worksheet to a PDF and submit to Gradescope. You will not need to upload anything to eLC.
  - If you do not have access to a printer, you may type your answers directly into the worksheet PDF and then submit it to Gradescope. Write your work on separate sheets of paper, convert them to a PDF, and upload to the appropriate dropbox on eLC.
  - There is a Gradescope app available for both iOS and Android devices that allows you to scan and submit your printed work, or you can submit your fillable PDF directly.
- The following criteria **must** be met to be eligible for full credit:
  - You must make sure the pages are in the correct order and have the same layout as the original worksheet when submitting to Gradescope regardless of your submission type.
  - Answers must be written in the corresponding answer boxes.
  - You must show your work when appropriate.
- This worksheet is due no later than **9:00 AM on the Saturday of the recitation week.**
- A periodic table and formula sheet are attached to the end of this worksheet. Please keep these attached to your worksheet in the correct order when submitting to Gradescope.

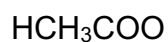
1. A solution was made by combining 1 g of sodium chloride, 100 mL of water ( $d = 1$  g/mL), and 5 mL of ethanol ( $d = 0.78$  g/mL). What is/are considered the solute(s) in this solution?

- A. Sodium chloride
- B. Water
- C. Ethanol
- D. Sodium chloride and ethanol
- E. Sodium chloride and water
- F. Ethanol and water

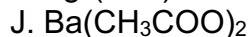
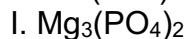
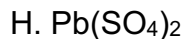
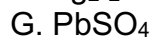
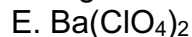
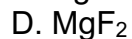
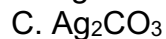
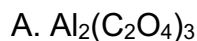
2. How many moles of particles are present upon dissolving one mole of each of the compounds below? Answer by using an integer (e.g. 0, 1, etc.).



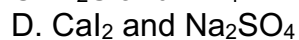
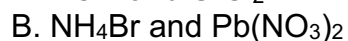
3. Label the following compounds as a (A) strong electrolyte, (B) weak electrolyte, or (C) nonelectrolyte. Answer by placing the appropriate letter in the boxes below.



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



5. Which of the following mixtures result in a precipitate? Select any that apply and answer with capital letters and no spaces (e.g. ABCDE).



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

- A.  $\text{NaSO}_4 (\text{aq}) + \text{BaCl}_2 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{aq}) + \text{NaCl} (\text{aq})$
- B.  $\text{NaSO}_4 (\text{aq}) + \text{BaCl}_2 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{s}) + \text{NaCl} (\text{aq})$
- C.  $\text{NaSO}_4 (\text{aq}) + \text{BaCl}_2 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{aq}) + \text{NaCl} (\text{s})$
- D.  $\text{Na}_2\text{SO}_4 (\text{aq}) + \text{BaCl}_2 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{aq}) + 2 \text{NaCl} (\text{s})$
- E.  $\text{Na}_2\text{SO}_4 (\text{aq}) + \text{BaCl}_2 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{s}) + 2 \text{NaCl} (\text{aq})$
- F.  $\text{Na}_2\text{SO}_4 (\text{aq}) + \text{BaCl}_2 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{aq}) + 2 \text{NaCl} (\text{aq})$

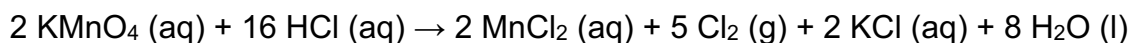
7. Consider the reaction between aqueous hydroiodic acid and aqueous barium hydroxide. What is/are the spectator ion(s) in this reaction? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

- 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

8. 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.  $\text{Hg}_2^{2+} (\text{aq}) + 2 \text{NO}_3^- (\text{aq}) + 2 \text{K}^+ (\text{aq}) + 2 \text{I}^- (\text{aq}) \rightarrow \text{Hg}_2\text{I}_2 (\text{s}) + 2 \text{K}^+ (\text{aq}) + 2 \text{NO}_3^- (\text{aq})$

9. 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.  $2 \text{K}^+ (\text{aq}) + 2 \text{MnO}_4^- (\text{aq}) + 16 \text{H}^+ (\text{aq}) + 16 \text{Cl}^- (\text{aq}) \rightarrow 2 \text{Mn}^{2+} (\text{aq}) + 5 \text{Cl}_2 (\text{g}) + 8 \text{H}_2\text{O} (\text{l}) + 2 \text{K}^+ (\text{aq})$
- 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

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



- A.  $6 \text{ O}^{2-} \text{ (aq)} + 6 \text{ H}^+ \text{ (aq)} + 3 \text{ Cl}_2 \text{ (g)} \rightarrow 3 \text{ H}_2\text{O (l)} + 3 \text{ O}^{2-} \text{ (g)} + 6 \text{ Cl}^- \text{ (aq)}$
- B.  $6 \text{ Na}^+ \text{ (aq)} + 6 \text{ Cl}^- \text{ (g)} \rightarrow 6 \text{ Cl}^- \text{ (aq)} + 6 \text{ Na (s)}$
- C.  $6 \text{ OH}^- \text{ (aq)} + 6 \text{ Cl}^- \text{ (g)} \rightarrow 6 \text{ Cl}^- \text{ (aq)} + 3 \text{ O}^{2-} \text{ (aq)} + 6 \text{ H}^+ \text{ (aq)}$
- D.  $6 \text{ Na}^+ \text{ (aq)} + 6 \text{ OH}^- \text{ (aq)} \rightarrow \text{Na}^+ \text{ (aq)} + 5 \text{ Na}^+ \text{ (aq)} + 6 \text{ O}^{2-} \text{ (aq)} + 3 \text{ H}_2\text{O (l)}$
- E.  $6 \text{ OH}^- \text{ (aq)} + 3 \text{ Cl}_2 \text{ (g)} \rightarrow 5 \text{ Cl}^- \text{ (aq)} + 3 \text{ H}_2\text{O (l)} + \text{ClO}_3^- \text{ (aq)}$

11. What is the net ionic equation for the acid-base reaction between solid aluminum hydroxide and aqueous nitric acid?

- A.  $3 \text{ OH}^- \text{ (aq)} + 3 \text{ H}^+ \text{ (aq)} \rightarrow 3 \text{ H}_2\text{O (l)}$
- B.  $\text{OH}^- \text{ (aq)} + \text{H}^+ \text{ (aq)} \rightarrow \text{H}_2\text{O (l)}$
- C.  $\text{Al (s)} + 3 \text{ NO}_3^- \text{ (aq)} \rightarrow \text{Al(NO}_3)_3 \text{ (s)}$
- D.  $\text{Al(OH)}_3 \text{ (s)} + 3 \text{ H}^+ \text{ (aq)} \rightarrow \text{Al}^{3+} \text{ (aq)} + 3 \text{ H}_2\text{O (l)}$
- E. No net ionic equation exists

12. 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 the sign and a whole number or a decimal to two decimal places (e.g. +2, -0.75, +1.33).

(a) hypochlorite

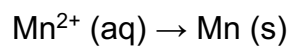
(b) chlorite

(c) chlorate

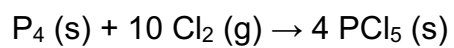
(d) perchlorate

13. What is the oxidation state of carbon in  $\text{C}_2\text{H}_4\text{OH}$ ? Answer with the sign and a whole number or a decimal to two decimal places (e.g. +2, -0.75, +1.33).

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



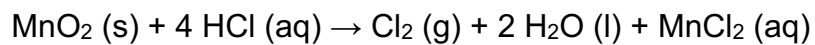
15. Consider the oxidation-reduction reaction below and answer the following questions. Write the **chemical formula** in the boxes below.



(a) What species is oxidized?

(b) What species is reduced?

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



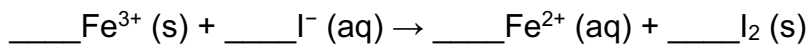
(a) What species is oxidized?

(b) What species is reduced?

(c) What species is the oxidizing agent?

(d) What species is the reducing agent?

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



(a) What species is oxidized?

(b) What species is reduced?

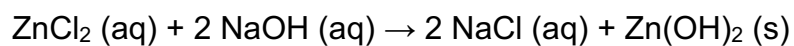
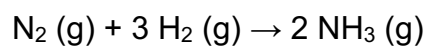
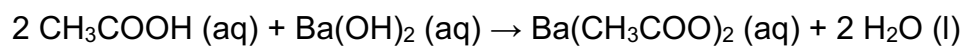
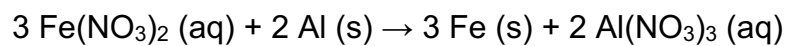
(c) Fully balance the equation and list the coefficients as whole numbers with no commas or spaces (e.g. 1234).

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

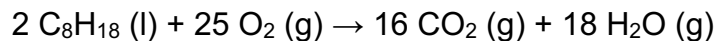
18. An acid is a...

- A. Proton acceptor
- B. Proton donor
- C. Binary compound
- D. Ionic compound
- E. More than one of the above

19. 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.



20. Consider the balanced equation below. How many mL of C<sub>8</sub>H<sub>18</sub> is required to completely react with 50.00 g of O<sub>2</sub>? The density of C<sub>8</sub>H<sub>18</sub> is 0.692 g/mL.



- A. 20.6 mL
- B.  $1.54 \times 10^3$  mL
- C. 9.88 mL
- D.  $3.22 \times 10^3$  mL
- E.  $1.01 \times 10^4$  mL

21. A student goes to the lab and decomposes a sample of solid potassium chlorate. As a result, they collect solid potassium chloride and emit oxygen gas from their decomposition reaction. If they collected 9.25 grams of potassium chloride, what mass of potassium chlorate did they start with? Report your answer in **standard notation**.

Hint: potassium chloride and oxygen gas are your products in this problem.

g

22. Consider a reaction in which gaseous dinitrogen pentoxide is decomposed into gaseous nitrogen dioxide and gaseous oxygen. If 31.00 g of dinitrogen pentoxide is decomposed, how many **total molecules** of the products will form?

Hint: nitrogen dioxide gas and oxygen gas are your products in this problem. Find the number of molecules for **both** products that form. Report your answer in **scientific notation**.

$\times 10^{\text{$  molecules

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

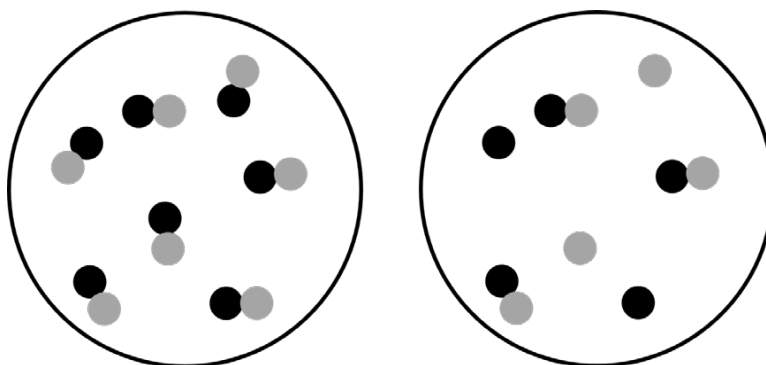
1. Which of the following compounds below would you expect to **fully** dissociate when dissolved in water?

- A. HClO
- B. HNO<sub>3</sub>
- C. NH<sub>3</sub>
- D. NO<sub>2</sub>
- E. CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH
- F. More than one of the options above

2. Which of the following equations best represents the dissolution of copper(II) nitrate in water?

- A.  $\text{Cu}(\text{NO}_3)_2 (\text{s}) \rightarrow \text{Cu}(\text{NO}_3)_2 (\text{l})$
- B.  $\text{Cu}(\text{NO}_3)_2 (\text{s}) \rightarrow \text{Cu}^{2+} (\text{aq}) + 2 \text{NO}_3^- (\text{aq})$
- C.  $\text{Cu}(\text{NO}_3)_2 (\text{s}) \rightarrow \text{Cu}^{2+} (\text{aq}) + 2 \text{N}^{3-} (\text{aq}) + 6 \text{O}^{2-} (\text{aq})$
- D.  $\text{Cu}(\text{NO}_3)_2 (\text{s}) \rightarrow \text{Cu}^{2+} (\text{l}) + 2 \text{NO}_3^- (\text{l})$

3. The following image shows a compound before & after it is dissolved in solution (water not pictured). The compound is a...



- A. Strong electrolyte
- B. Weak electrolyte
- C. Nonelectrolyte

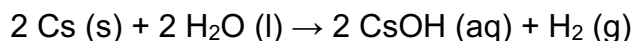
4. When aqueous solutions of the following combinations are mixed, which combination will produce a precipitate? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

- A.  $\text{NiBr}_2$  (aq) and  $\text{Pb}(\text{NO}_3)_2$  (aq)
- B.  $\text{Hg}_2(\text{NO}_3)_2$  (aq) and  $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$  (aq)
- C.  $\text{NaOH}$  (aq) and  $\text{FeSO}_4$  (aq)
- D.  $\text{Li}_2\text{CO}_3$  (aq) and  $\text{NH}_4\text{Cl}$  (aq)
- E.  $\text{K}_2\text{S}$  (aq) and  $\text{CaCl}_2$  (aq)

5. Consider the double displacement reaction between aqueous sodium chloride and aqueous silver nitrate. What is/are the spectator ion(s) in this reaction? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

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

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



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

7. 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

8. Consider the balanced equation given below:



In the net ionic equation for this reaction, how many nitrate ions are present?

- A. 0
- B. 1
- C. 4
- D. 7
- E. -1

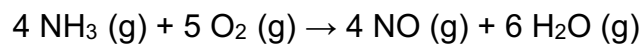
9. What is the net ionic equation for the mixture of sodium carbonate and barium nitrate?

- A.  $2 \text{Na}^+ (\text{aq}) + 2 \text{NO}_3^- (\text{aq}) \rightarrow 2 \text{NaNO}_3 (\text{s})$
- B.  $\text{Ba}^{2+} (\text{aq}) + \text{CO}_3^{2-} (\text{aq}) + 2 \text{Na}^+ (\text{aq}) + 2 \text{NO}_3^- (\text{aq}) \rightarrow \text{BaCO}_3 (\text{aq}) + 2 \text{NaNO}_3 (\text{aq})$
- C.  $2 \text{Na}^+ (\text{aq}) + \text{CO}_3^{2-} (\text{aq}) + \text{Ba}^{2+} (\text{aq}) + 2 \text{NO}_3^- (\text{aq}) \rightarrow 2 \text{Na}^+ (\text{aq}) + 2 \text{NO}_3^- (\text{aq}) + \text{BaCO}_3 (\text{s})$
- D.  $2 \text{Na}^+ (\text{aq}) + \text{CO}_3^{2-} (\text{aq}) + \text{Ba}^{2+} (\text{aq}) + 2 \text{NO}_3^- (\text{aq}) \rightarrow 2 \text{NaNO}_3 (\text{s}) + \text{Ba}^{2+} (\text{aq}) + \text{CO}_3^{2-} (\text{aq})$
- E.  $\text{Ba}^{2+} (\text{aq}) + \text{CO}_3^{2-} (\text{aq}) \rightarrow \text{BaCO}_3 (\text{s})$

10. Which of the following options below **incorrectly** assigns the oxidation state of the indicated element in the respective species?

- A. In perchloric acid, the oxidation state of Cl is +7
- B. In barium nitrate, the oxidation state of Ba is +2
- C. In carbon dioxide, the oxidation state of C is +4
- D. More than one of the assigned oxidation states are incorrect
- E. All of the assigned oxidation states are correct

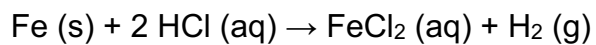
11. Consider the following chemical reaction.



Which substance is the oxidizing agent?

- A.  $\text{NH}_3$
- B.  $\text{O}_2$
- C.  $\text{NO}$
- D.  $\text{H}_2\text{O}$

12. Consider the following oxidation-reduction reaction.



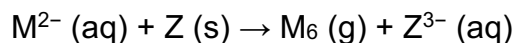
Which substance is the oxidizing agent?

- A.  $\text{Fe}$
- B.  $\text{HCl}$
- C.  $\text{FeCl}_2$
- D.  $\text{H}_2$

13. What is the **balanced** reduction half reaction for  $\text{Li (s)} + \text{F}_2\text{(g)} \rightarrow \text{Li}^+\text{(aq)} + \text{F}^-\text{(aq)}$ ?

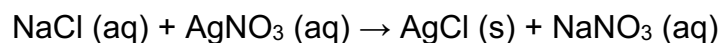
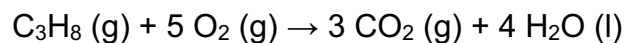
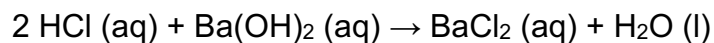
- A.  $\text{Li (s)} \rightarrow \text{Li}^+\text{(aq)} + \text{e}^-$
- B.  $\text{F}_2\text{(g)} + \text{e}^- \rightarrow \text{F}^-\text{(aq)}$
- C.  $\text{F}_2\text{(g)} + \text{e}^- \rightarrow 2 \text{F}^-\text{(aq)}$
- D.  $\text{Li (s)} + \text{e}^- \rightarrow \text{Li}^+\text{(aq)}$
- E.  $\text{F}_2\text{(g)} \rightarrow 2 \text{F}^-\text{(aq)} + 2 \text{e}^-$
- F.  $\text{F}_2\text{(g)} + 2 \text{e}^- \rightarrow 2 \text{F}^-\text{(aq)}$

14. What are the coefficients of the hypothetical oxidation-reduction below when it is fully balanced?

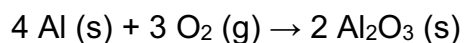


- A. 3, 2, 3, 2
- B. 6, 1, 1, 1
- C. 3, 2, 1, 2
- D. 6, 4, 1, 4
- E. 3, 3, 1, 2

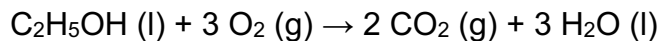
15. Label the following reactions below as an (A) acid-base, (B) precipitation, or (C) oxidation-reduction reaction. Write the corresponding letter in the boxes below.



16. Using the equation below, how many atoms of aluminum must fully react in order to produce a 12 formula unit sample of aluminum oxide? Report your answer in **standard notation**.



17. If the density of ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , is 0.789 g/mL, how many milliliters of ethanol are needed to produce 20.0 g of  $\text{CO}_2$  according to the following chemical equation? You may assume oxygen is in excess here. Report your answer in **standard notation**. (MW  $\text{C}_2\text{H}_5\text{OH}$  = 46.08 g/mol, MW  $\text{CO}_2$  = 44.01 g/mol)



mL

18.  $\text{C}_2\text{H}_4$  (g) can be combusted in the presence of excess oxygen gas to form gaseous water and gaseous carbon dioxide. If 205.0 g of  $\text{C}_2\text{H}_4$  (g) is reacted, how many grams of water will be formed? Report your answer in **standard notation**.

g

1

1 <b>H</b> 1.01
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3 <b>Li</b> 6.94	4 <b>Be</b> 9.01
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11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31
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19 <b>K</b> 39.10	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96
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37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91
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37 <b>Cs</b> 132.91	56 <b>Ba</b> 137.33
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87 <b>Fr</b> [223]	88 <b>Ra</b> [226]
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18

2 <b>He</b> 4.00
------------------------

5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18
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13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.06	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
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31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.63	33 <b>As</b> 74.92	34 <b>Se</b> 78.97	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80
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49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.60	53 <b>I</b> 126.90	54 <b>Xe</b> 131.29
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81 <b>Tl</b> 204.38	82 <b>Pb</b> 207.2	83 <b>Bi</b> 208.98	84 <b>Po</b> [209]	85 <b>At</b> [210]	86 <b>Rn</b> [222]
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113 <b>Nh</b> [286]	114 <b>Fl</b> [290]	115 <b>Mc</b> [290]	116 <b>Lv</b> [293]	117 <b>Ts</b> [294]	118 <b>Og</b> [294]
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# Periodic Table of the Elements

57 <b>La</b> 138.91	58 <b>Ce</b> 140.12	59 <b>Pr</b> 140.91	60 <b>Nd</b> 144.24	61 <b>Pm</b> [145]	62 <b>Sm</b> 150.36	63 <b>Eu</b> 151.96	64 <b>Gd</b> 157.25	65 <b>Tb</b> 158.93	66 <b>Dy</b> 162.50	67 <b>Ho</b> 164.93	68 <b>Er</b> 167.26	69 <b>Tm</b> 168.93	70 <b>Yb</b> 173.05	71 <b>Lu</b> 174.97
89 <b>Ac</b> [227]	90 <b>Th</b> 232.04	91 <b>Pa</b> 231.04	92 <b>U</b> 238.03	93 <b>Np</b> [237]	94 <b>Pu</b> [244]	95 <b>Am</b> [243]	96 <b>Cm</b> [247]	97 <b>Bk</b> [247]	98 <b>Cf</b> [251]	99 <b>Es</b> [252]	100 <b>Fm</b> [257]	101 <b>Md</b> [258]	102 <b>No</b> [259]	103 <b>Lr</b> [262]

## **Formula Sheet**

### **Length**

1 kilometer = 0.62137 mile

1 inch = 2.54 centimeters (exactly)

1 Ångstrom =  $1 \times 10^{-10}$  meter

### **Energy**

1 joule =  $1 \text{ kg} \cdot \text{m}^2/\text{s}^2$

1 calorie = 4.184 joules

1 Calorie = 1 kilocalorie = 1000 calories

1 L·atm = 101.325 joules

### **Pressure**

1 pascal =  $1 \text{ N}/\text{m}^2 = 1 \text{ kg}/\text{m} \cdot \text{s}^2$

1 atmosphere = 101.325 kilopascals = 760 mm Hg = 760 torr = 14.70 lb/in<sup>2</sup>

1 bar =  $1 \times 10^5$  Pa (exactly)

### **Temperature**

0 K = -273.15°C

K = °C + 273.15

°C = (5/9)(°F - 32)

### **Mass**

1 kg = 2.205 lbs

### **Volume**

1 mL =  $1 \text{ cm}^3$  = 1 cc

### **Constants**

c =  $2.998 \times 10^8$  m/sec

h =  $6.626 \times 10^{-34}$  J·sec

R = 0.08206 L·atm/mol·K = 8.314 J/mol·K

Specific heat of water = 4.184 J/g·K

Mass of an electron:  $9.109 \times 10^{-31}$  kg

Mass of a proton:  $1.673 \times 10^{-27}$  kg

RH =  $2.18 \times 10^{-18}$  J

Specific heat of water = 4.184 J/g·K

Avogadro's number:  $6.022 \times 10^{23}$

F = 96485 J/(V·mol e<sup>-</sup>)

K<sub>w</sub> =  $1.0 \times 10^{-14}$  at 25 °C

k<sub>b</sub> =  $1.381 \times 10^{-23}$  J/K

### **Equations**

$(P + a(n^2/V^2)) \cdot (V - nb) = nRT$

molar mass (M) =  $nRT/PV$

density (d) =  $MP/RT$

$$KE = \frac{3}{2}RT$$

$$\mu_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{\text{Rate of effusion A}}{\text{Rate of effusion B}} = \sqrt{\frac{MW_B}{MW_A}}$$

$$\Delta E = -2.18 \times 10^{-18} J \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$\ln \left( \frac{P_2}{P_1} \right) = \frac{\Delta H_{vap}}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$$

$$C_g = kP_g$$

$$P_{\text{solution}} = P_{\text{solvent}} X_{\text{solvent}}$$

$$P_{\text{solution}} = \sum P_j = \sum P_j X_j$$

$$\pi = MRTi$$

### **Thermodynamic and Electrochemistry**

$$S = k_b \times \ln(W)$$

$$\Delta S = q_{\text{rev}}/T$$

$$\Delta G = \Delta G^\circ + RT \cdot \ln Q$$

$$R = 8.314 \text{ J/mol.K}$$

$$\Delta G^\circ = -RT \cdot \ln K$$

$$\Delta G = -nFE_{\text{cell}}$$

$$E^\circ_{\text{cell}} = RT/nF \ln K$$

$$E^\circ_{\text{cell}} = (0.0257/n) \ln K = (0.0592/n) \log K$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - (RT/nF) \ln Q$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - (0.0257/n) \ln Q$$

$$\text{Electrolysis: } Q (\text{total charge}) = I \times t = n \times F$$

### **Integrated Rate Laws & half-life**

$$\ln \frac{[A]}{[A]_0} = -kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$[A] = -kt + [A]_0$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$\ln \frac{k_2}{k_1} = -\frac{E_a}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$$

### **Equilibrium and Acid / Base**

$$K_p = K_c \times (RT)^{\Delta n}$$

$$\ln \frac{K_2}{K_1} = \frac{\Delta H_{rxn}^\circ}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$$