

CHAPTER 4 – SOLUTION CHEMISTRY

Solution Concentration and Molarity

1. A solution is made by dissolving 3.875 g of magnesium chloride in enough water to make 200.0 mL of solution. Calculate the molarity of magnesium chloride solution.

- A. 0.04070 M
- B. 2.035×10^{-4} M
- C. 0.2035 M
- D. 0.3242 M
- E. 8.140×10^{-3} M

2. How many grams of Na_2SO_4 (MM 142.04 g/mol) are in 250. mL of a solution that has a concentration of 0.115 M?

- A. 4.08 g
- B. 2.02 g
- C. 6.25 g
- D. 1.14 g
- E. 3.07 g

3. How many mL of 0.100 M Na_2SO_4 (MM 142.04 g/mol) are required to have a mass of 2.50 g of Na_2SO_4 ?

- A. 0.176 mL
- B. 3551 mL
- C. 176 mL
- D. 35.51 mL
- E. 17.6 mL

4. If a student wishes to make 250 mL of a 3.0 M solution of HCl using stock 12.0 M HCl, how much HCl stock solution do they need to use?

- A. 63 mL
- B. 6.9 mL
- C. 0.016 mL
- D. 1000 mL
- E. 0.144 mL

5. How many grams of CaCO_3 (MM 100.09 g/mol) will react with 142 mL of 0.750 M HCl (MM 36.46 g/mol)?



- A. 5.33 g
- B. 37.9 g
- C. 2.12 g
- D. 14.6 g
- E. 1.36 g

Electrolytes: Strong Electrolytes, Weak Electrolytes, and Nonelectrolytes

6. Classify the following compounds as **strong electrolytes**, **weak electrolytes**, or **nonelectrolytes**:

HCl, $\text{C}_2\text{H}_6\text{O}$, HNO_2 , CaCl_2

- A. Strong: HCl, CaCl_2 Weak: HNO_2 Nonelectrolyte: $\text{C}_2\text{H}_6\text{O}$
- B. Strong: HCl, CaCl_2 Weak: HNO_2 , $\text{C}_2\text{H}_6\text{O}$ Nonelectrolyte: none
- C. Strong: HCl, CaCl_2 , HNO_2 Weak: none Nonelectrolyte: $\text{C}_2\text{H}_6\text{O}$
- D. Strong: CaCl_2 Weak: HCl, HNO_2 , $\text{C}_2\text{H}_6\text{O}$ Nonelectrolyte: none
- E. Strong: HCl Weak: HNO_2 , $\text{C}_2\text{H}_6\text{O}$ Nonelectrolyte: CaCl_2

7. What are the differences between strong electrolytes, weak electrolytes and non-electrolytes?

- A. Strong electrolytes completely dissociate into ions in water, weak electrolytes partially ionize in water and nonelectrolytes do not dissociate into ions in when dissolved in water.
- B. Strong electrolytes partially ionize in water, weak electrolytes do not dissociate in water and nonelectrolytes partially ionize in water.
- C. Strong electrolytes do not dissociate in water, weak electrolytes partially ionize in water and nonelectrolytes do not dissociate in water.
- D. Strong electrolytes completely dissociate into ions in water, weak electrolytes do not dissociate in water and nonelectrolytes partially ionize in water.
- E. Strong electrolytes do not dissociate in water, weak electrolytes do not dissociate in water and nonelectrolytes partially ionize in water.

8. Which solution does NOT contain a total of 1.00 moles of ions, assuming complete dissociation of these strong electrolytes?

- A. 1.00 L of 0.500 M NaCl
- B. 0.500 L of 0.500 M K_3PO_4
- C. 0.250 L of 2.00 M NaNO_3
- D. 1.00 L of 0.250 M CaI_2
- E. 0.500 L of 1.00 M NaCl

9. Which ONE of the following species is NOT a strong electrolyte?

- A. $\text{HC}_2\text{H}_3\text{O}_2$
- B. HNO_3
- C. CaCl_2
- D. HCl
- E. Na_2SO_4

Precipitation Reactions

10. All of these solutions will form a precipitate with $\text{FeSO}_4(\text{aq})$ except one. Which of these solutions will **NOT** produce a precipitate?

- A. $\text{RbCl}(\text{aq})$
- B. $\text{KOH}(\text{aq})$
- C. $\text{Pb}(\text{NO}_3)_2(\text{aq})$
- D. $\text{Na}_2\text{S}(\text{aq})$
- E. $(\text{NH}_4)_2\text{CO}_3(\text{aq})$

11. Which of the following compounds are insoluble in water?

- A. $\text{Al}(\text{C}_2\text{H}_3\text{O}_2)_3$
- B. $\text{Ca}(\text{NO}_3)_2$
- C. FeS
- D. K_3PO_4
- E. All are soluble

12. What spectator ions are present in a solution in which a $\text{Ba}(\text{NO}_3)_2$ solution is mixed with a Na_2SO_4 solution?

- A. SO_4^{2-} and Na^+
- B. Ba^{2+} and Na^+
- C. Na^+
- D. NO_3^- and Na^+
- E. NO_3^-

13. Which of the following is the net ionic equation for the reaction between $\text{Pb}(\text{NO}_3)_2$ and K_2SO_4 ?

- A. $\text{Pb}^{2+}(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) \rightarrow 2\text{K}^+(\text{aq}) + \text{PbSO}_4(\text{s})$
- B. $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) \rightarrow 2\text{KNO}_3(\text{aq}) + \text{PbSO}_4(\text{s})$
- C. $\text{Pb}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + 2\text{K}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow 2\text{K}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + \text{PbSO}_4(\text{s})$
- D. $\text{Pb}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{PbSO}_4(\text{s})$
- E. $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2\text{K}^+(\text{aq}) \rightarrow \text{Pb}^{2+}(\text{aq}) + 2\text{KNO}_3(\text{aq})$

14. What precipitate is formed when $\text{Na}_3\text{PO}_4(\text{aq})$ reacts with $\text{MgSO}_4(\text{aq})$?

- A. $\text{MgPO}_4(\text{s})$
- B. $\text{Mg}_3(\text{PO}_4)_2(\text{s})$
- C. $\text{Na}_2\text{SO}_4(\text{s})$
- D. $\text{Na}_3\text{SO}_4(\text{s})$
- E. none of the above

15. What precipitate is formed when zinc chloride reacts with sodium carbonate?

- A. $\text{Zn}_2\text{CO}_3(\text{s})$
- B. $\text{Zn}_3(\text{CO}_3)_2(\text{s})$
- C. $\text{ZnCO}_3(\text{s})$
- D. $\text{Zn}_2\text{CO}_3(\text{s})$
- E. none of the above

16. A solution of 50.00 mL of 0.500 M sodium chloride solution is mixed with excess lead(II) nitrate solution.

How many grams of precipitate are produced?

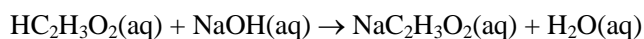
- A. 6.95 g
- B. 3.48 g
- C. 1.06 g
- D. 2.12 g
- E. 13.9 g

Acid-Base Neutralization Reactions

17. According to the Arrhenius definitions of acids and bases, an acid is a substance that:

- A. produces OH^- ions in aqueous solution
- B. produces H^+ ions in aqueous solution
- C. acts as an electron-pair acceptor
- D. acts as a proton donor
- E. acts as a proton acceptor

18. In a titration, 15.00 mL of a solution of vinegar containing acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$, is titrated to its end point with 10.00 mL of 0.5000 M NaOH .



What is the concentration (in M) of acetic acid in the vinegar solution?

- A. 1.333 M
- B. 3.000 M
- C. 0.7500 M
- D. 0.3333 M
- E. none of the above

19. What products are formed when calcium hydroxide reacts with nitric acid?

- A. $\text{CaNO}_3(\text{aq})$ and $\text{H}_2\text{O}(\text{l})$
- B. $\text{Ca}(\text{NO}_3)_2(\text{aq})$ and $\text{H}_2\text{O}(\text{l})$
- C. $\text{Ca}(\text{NO}_3)_2(\text{s})$ and $\text{H}_2\text{O}(\text{l})$
- D. $\text{Ca}(\text{NO}_3)(\text{aq})$ only
- E. none of the above

20. What products are formed when acetic acid reacts with sodium hydroxide?

- A. $\text{NaC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- B. $\text{NaC}_2\text{H}_3\text{O}_2(\text{s}) + \text{H}_2\text{O}(\text{g})$
- C. $\text{NaOH}(\text{s}) + \text{H}_2\text{O}(\text{l})$
- D. $\text{NaCl}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- E. none of the above

21. What products are formed when nitric acid reacts with sodium sulfide?

- A. $\text{NaNO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- B. $\text{Na}_2\text{SO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- C. $\text{NaNO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- D. $\text{NaNO}_3(\text{aq}) + \text{H}_2\text{S}(\text{g})$
- E. none of the above

22. What products are formed when hydrobromic acid reacts with sodium carbonate?

- A. $\text{NaBr}(\text{aq}) + \text{H}_2\text{CO}_3(\text{s})$
- B. $\text{NaBr}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
- C. $\text{NaBrO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- D. $\text{NaBr}(\text{s}) + \text{HC}_2\text{H}_3\text{O}_2(\text{aq})$
- E. none of the above

Oxidation-Reduction (Redox) Reactions

23. In a redox reaction:

- A. oxygen must be present.
- B. the oxidation number of the reducing agent decreases.
- C. an increase in oxidation state of a reactant must result in the decrease of the oxidation state of another reactant.
- D. oxidation can occur with no reduction reaction taking place.
- E. $\text{O}_2(\text{g})$ is produced.

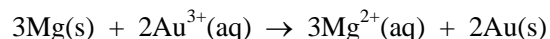
24. Pick the answer that correctly identifies the oxidation states of the indicated atoms in the following molecules and ions:

	O in O_2	Mn in KMnO_4	N in NO_3^-
A.	0	+4	+3
B.	-2	+8	+5
C.	-1	+6	+5
D.	-2	+2	+3
E.	0	+7	+5

25. What is the oxidation number of the indicated element in each of the following species?

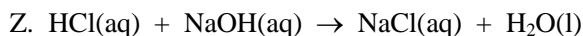
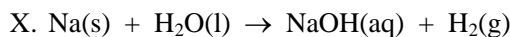
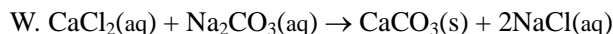
- A. Cl in Cl_2 is +2
Cr in $\text{K}_2\text{Cr}_2\text{O}_7$ is +2
N in NO_3^- is +3
- B. Cl in Cl_2 is 0
Cr in $\text{K}_2\text{Cr}_2\text{O}_7$ is +6
N in NO_3^- is +6
- C. Cl in Cl_2 is +7
Cr in $\text{K}_2\text{Cr}_2\text{O}_7$ is +3
N in NO_3^- is -2
- D. Cl in Cl_2 is 0
Cr in $\text{K}_2\text{Cr}_2\text{O}_7$ is +6
N in NO_3^- is +5
- E. Cl in Cl_2 is -1
Cr in $\text{K}_2\text{Cr}_2\text{O}_7$ is +2
N in NO_3^- is -3

26. Which of the following statements is correct about the reaction shown below:



- A. Mg is being reduced, and Au^{3+} is the oxidizing agent.
- B. Mg is being reduced, and Au^{3+} is the reducing agent.
- C. Au^{3+} is being reduced, and Mg is the oxidizing agent.
- D. Au^{3+} is being oxidized, and Mg is the reducing agent.
- E. Mg is being oxidized, and Au^{3+} is the oxidizing agent.

27. Which of the following are oxidation reduction reactions?



- A. W and Z
- B. W only
- C. X and Y
- D. W, X, and Z
- E. X only