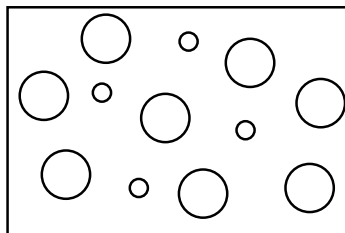


MULTIPLE CHOICE (NO CALCULATOR ALLOWED)

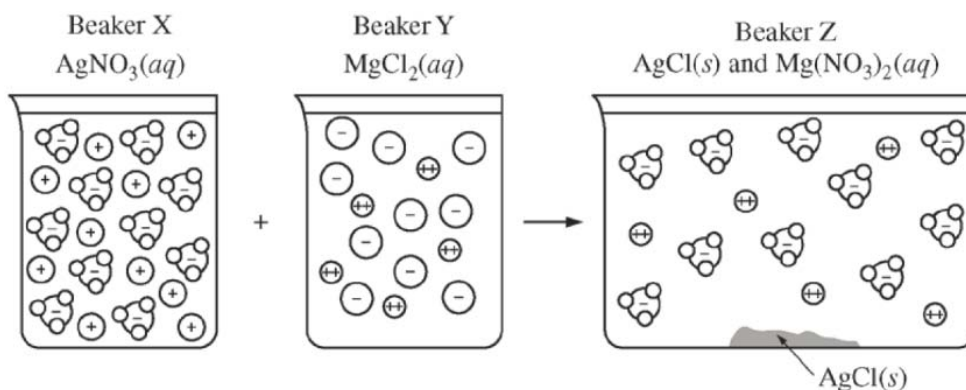


1. The particle diagram above represents an aqueous solution of an ionic compound. The smaller circles represent cations and the larger circles represent anions. Water molecules are omitted for clarity. Which of the following solutes does the diagram best represent?
- (A) calcium chloride
 (B) magnesium oxide
 (C) potassium bromide
 (D) sodium sulfide
2. Which of the following choices best represents what happens when solid NH_4NO_3 is dissolved into water?
- (A) $\text{NH}_4\text{NO}_3(s) \longrightarrow \text{NH}_4\text{NO}_3(aq)$
 (B) $\text{NH}_4\text{NO}_3(s) \longrightarrow \text{NH}_4^+(aq) + \text{NO}_3^-(aq)$
 (C) $\text{NH}_4\text{NO}_3(s) \longrightarrow \text{NH}_3(aq) + \text{H}^+(aq) + \text{NO}_3^-(aq)$
 (D) $\text{NH}_4\text{NO}_3(s) \longrightarrow \text{NH}_3(aq) + \text{OH}^-(aq) + \text{NO}_2^-(aq)$

Reaction between a solution of Compound X and a solution of K_2SO_4	Reaction between a solution of Compound X and a solution of AgNO_3
white precipitate	white precipitate

3. Compound X is an ionic compound that is soluble in water. An aqueous solution of Compound X is prepared, and a few drops of this solution are tested with two separate solutions. The results of this experiment are shown in the table above. Based on this information, which of the following substances is most likely to represent the identity of Compound X?
- (A) barium chloride
 (B) sodium bromide
 (C) lead carbonate
 (D) strontium nitrate

4. Which of the following would result in the formation of a precipitate when aqueous solutions of each substance are mixed together?
- (A) mercury(I) nitrate and silver acetate
 (B) zinc chloride and aluminum sulfate
 (C) potassium sulfide and lithium phosphate
 (D) sodium iodide and lead(II) nitrate

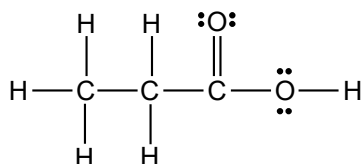


5. Beaker X and beaker Y each contain 1.0 L of solution, as shown above. A student combines the solutions by pouring them into a larger, previously empty beaker Z and observes the formation of a white precipitate. Assuming that volumes are additive, which of the following sets of solutions could be represented by the diagram above?

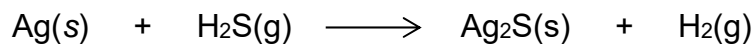
	Beaker X	Beaker Y	Beaker Z
(A)	2.0 M AgNO ₃	2.0 M MgCl ₂	4.0 M Mg(NO ₃) ₂ and AgCl(s)
(B)	2.0 M AgNO ₃	2.0 M MgCl ₂	2.0 M Mg(NO ₃) ₂ and AgCl(s)
(C)	2.0 M AgNO ₃	1.0 M MgCl ₂	1.0 M Mg(NO ₃) ₂ and AgCl(s)
(D)	2.0 M AgNO ₃	1.0 M MgCl ₂	0.50 M Mg(NO ₃) ₂ and AgCl(s)

6. Which of the following best describes the substance whose structural formula is shown below?

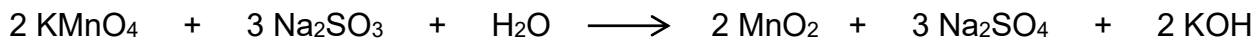
- (A) nonelectrolyte
 (B) weak acid
 (C) weak base
 (D) strong base



7. Which of the following statements concerning HF is true?
- (A) It is classified as a strong acid because it is very soluble in water.
 (B) It is classified as a weak acid because it is not very soluble in water.
 (C) It is classified as a strong acid because it is completely ionized in water.
 (D) It is classified as a weak acid because it is only partially ionized in water.
8. Solid calcium carbonate is insoluble in water, but will dissolve completely in a solution of hydrochloric acid. Which of the following represents the net-ionic equation for the reaction between solid calcium carbonate and aqueous hydrochloric acid?
- (A) $\text{CaCO}_3(s) + 2 \text{H}^+(aq) \longrightarrow \text{Ca}^{2+}(aq) + \text{H}_2\text{O}(l) + \text{CO}_2(g)$
 (B) $\text{CaCO}_3(s) + 2 \text{Cl}^-(aq) \longrightarrow \text{CaCl}_2(aq) + \text{CO}_2(g)$
 (C) $\text{CO}_3^{2-}(aq) + 2 \text{H}^+(aq) \longrightarrow \text{H}_2\text{O}(l) + \text{CO}_2(g)$
 (D) $\text{CaCO}_3(s) + 2 \text{H}^+(aq) \longrightarrow \text{Ca}^{2+}(aq) + \text{H}_2(g) + \text{CO}_2(g)$
9. Which of the following represents the net-ionic equation for the reaction that occurs when solutions of acetic acid and potassium hydroxide are mixed?
- (A) $\text{H}^+(aq) + \text{OH}^-(aq) \longrightarrow \text{H}_2\text{O}(l)$
 (B) $\text{H}^+(aq) + \text{KOH}(aq) \longrightarrow \text{H}_2\text{O}(l) + \text{K}^+(aq)$
 (C) $\text{CH}_3\text{COOH}(aq) + \text{OH}^-(aq) \longrightarrow \text{H}_2\text{O}(l) + \text{CH}_3\text{COO}^-(aq)$
 (D) $\text{CH}_3\text{COOH}(aq) + \text{KOH}(aq) \longrightarrow \text{H}_2\text{O}(l) + \text{CH}_3\text{COOK}(aq)$

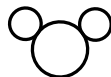
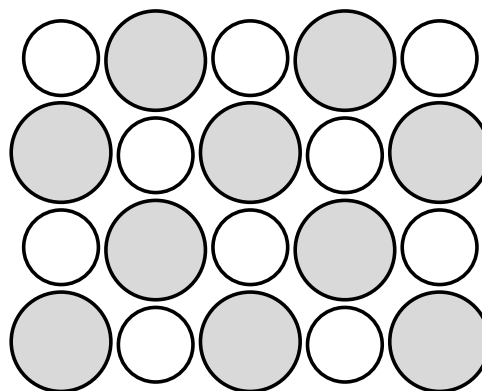


10. Which of the following statements is true regarding the reaction above?
- (A) Sulfur is being oxidized because its oxidation state changes from -2 to $+2$.
 (B) Hydrogen is being oxidized because its oxidation state changes from $+1$ to 0 .
 (C) Silver is being oxidized because its oxidation state changes from 0 to $+1$.
 (D) This is not an oxidation-reduction reaction.



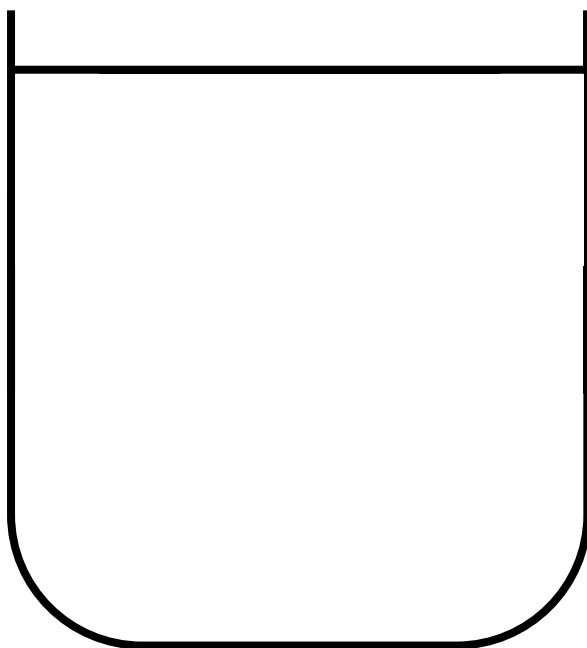
11. Which of the following statements is true regarding the reaction above?
- (A) Manganese is oxidized; sulfur is reduced.
 - (B) Sulfur is oxidized; manganese is reduced.
 - (C) Potassium is oxidized; hydrogen is reduced.
 - (D) Hydrogen is oxidized; potassium is reduced.
12. Which of the following choices represents a pair of substance in which carbon has the same oxidation state in each substance?
- (A) CH_4 and CH_3OH
 - (B) CH_2O and CO
 - (C) C_2H_4 and C_6H_6
 - (D) CO_2 and H_2CO_3
13. A certain metal is added to a solution of cobalt(II) nitrate, and no visible sign of reaction occurs. When this metal is added to a solution of hydrochloric acid, bubbles appear on the surface of the metal. The identity of metal is most likely to be
- (A) calcium
 - (B) zinc
 - (C) tin
 - (D) silver

FREE RESPONSE (CALCULATOR IS ALLOWED)

H₂O molecule

LiCl crystal

1. The structures of a water molecule and a crystal of LiCl(s) are represented above. A student prepares a solution by dissolving 1 g LiCl into 100 mL of water.
- (a) In the space provided below, show the interactions of the components of LiCl(aq) by making a drawing that represents the different particles present in the solution. You should base the particles in your drawing on the particles in the representations above. Include only one formula unit of LiCl and no more than ten molecules of water. Your drawing must include the following details.
- identity of the ions (symbol and charge)
 - the arrangement and proper orientation of the particles in solution



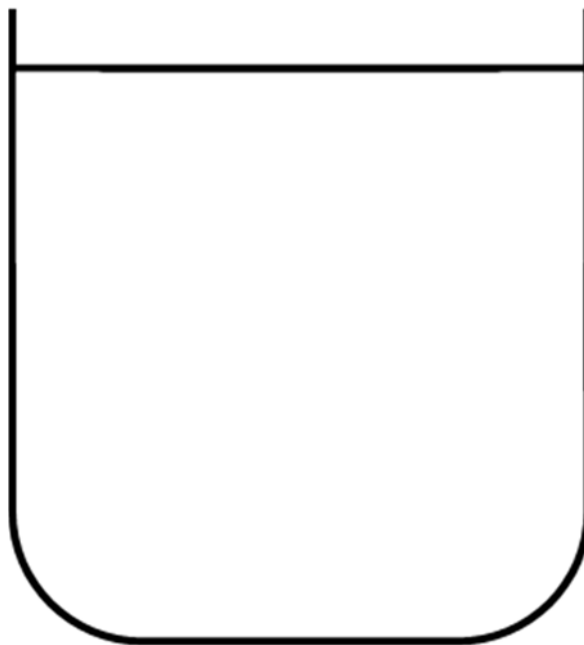
LiCl(aq)

1. (b) Is $\text{LiCl}(aq)$ classified as a strong electrolyte, a weak electrolyte, or a nonelectrolyte? Justify your prediction with an explanation that includes information about the drawing that you made in part (a).

2. Atoms of hydrogen, carbon, and oxygen are shown as follows.



- (a) In the space provided below, show what happens when two molecules of methanol (CH_3OH) are dissolved completely into water. You should use the particles in the representations above to help you draw the particle diagram for $\text{CH}_3\text{OH}(aq)$. You do not have to draw any water molecules in your diagram.



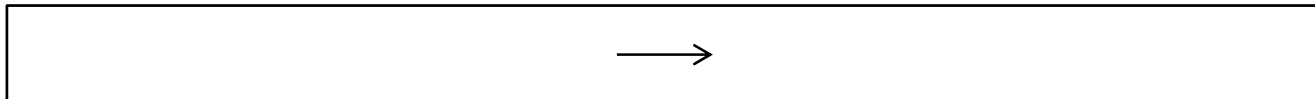
$\text{CH}_3\text{OH}(aq)$

- (b) Is $\text{CH}_3\text{OH}(aq)$ classified as a strong electrolyte, a weak electrolyte, or a nonelectrolyte? Justify your prediction with an explanation that includes information about the drawing that you made in part (a).

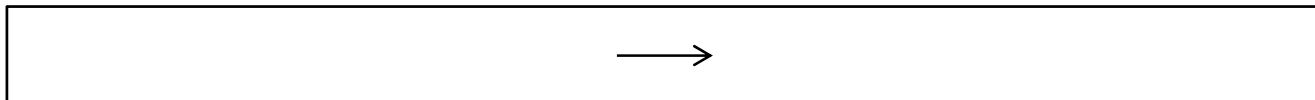
3. For each of the following, write the balanced molecular equation and the balanced net ionic equation. You do not have to write (s), (l), (g) or (aq). If no reaction occurs, write NO REACTION.

(a) Solutions of nickel(II) bromide and barium hydroxide are mixed.

molecular equation:

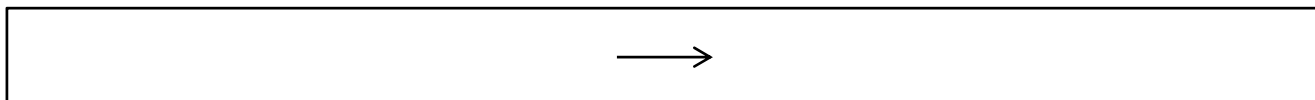


net ionic equation:

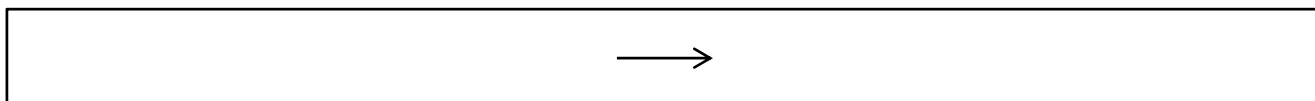


(b) Solutions of copper(II) chloride and ammonium sulfate are mixed.

molecular equation:

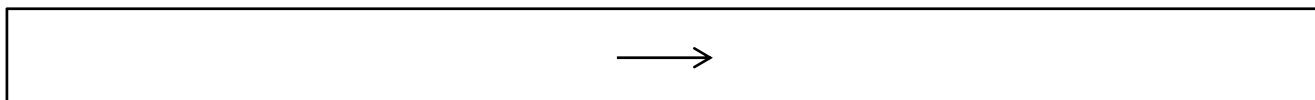


net ionic equation:

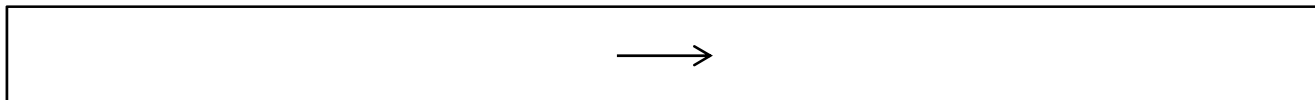


(c) Solutions of propanoic acid ($\text{CH}_3\text{CH}_2\text{COOH}$) and sodium hydroxide are mixed.

molecular equation:

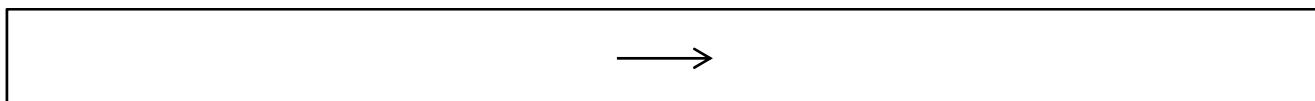


net ionic equation:

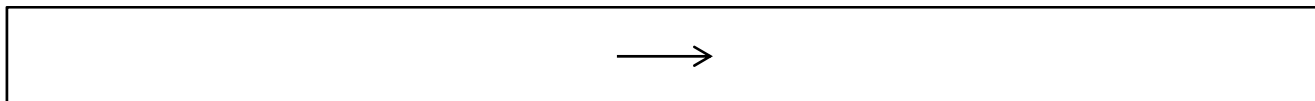


(d) Solutions of nitric acid and methylamine (CH_3NH_2) are mixed.

molecular equation:

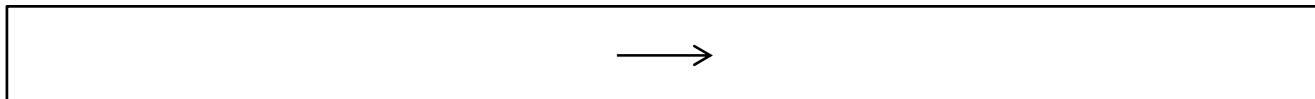


net ionic equation:

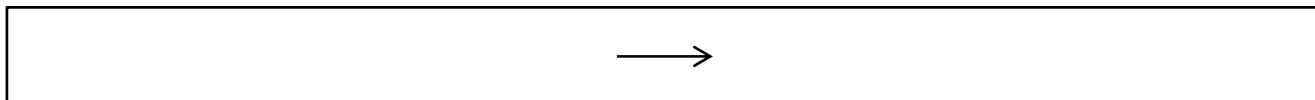


(e) Aluminum metal is added to a solution of zinc sulfate.

molecular equation:

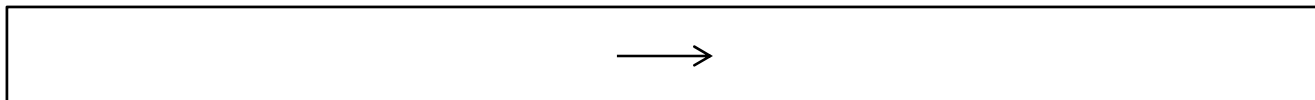


net ionic equation:

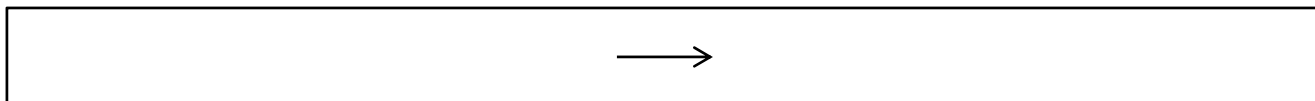


(f) Chromium metal is added to a solution of magnesium nitrate.

molecular equation:



net ionic equation:



4. For each of the following reactions, identify which elements, if any, are being oxidized and which elements are being reduced. Fill in the blanks with the correct oxidation numbers for the appropriate elements before and after the reaction.

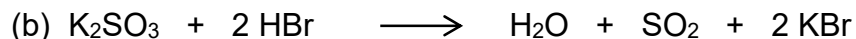
If there are no changes in oxidation number for any of the elements in the reaction, check the box to indicate that it is not an oxidation–reduction reaction.



_____ is being oxidized from _____ to _____ and

_____ is being reduced from _____ to _____

_____ This is not an oxidation–reduction reaction.



_____ is being oxidized from _____ to _____ and

_____ is being reduced from _____ to _____

_____ This is not an oxidation–reduction reaction.

Soluble Ionic Compounds		Important Exceptions
Compounds containing	NO_3^- and CH_3CO_2^-	none
	Cl^- , Br^- , and I^-	compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	SO_4^{2-}	compounds of Sr^{2+} , Ba^{2+} , Hg_2^{2+} , and Pb^{2+}

Insoluble Ionic Compounds		Important Exceptions
Compounds containing	S^{2-} and OH^-	compounds of NH_4^+ , alkali metal cations, Ca^{2+} , Sr^{2+} , and Ba^{2+}
	CO_3^{2-} and PO_4^{3-}	compounds of NH_4^+ and alkali metal cations

Most reactive	$\text{Li}(s) \rightarrow \text{Li}^+(aq) + e^-$
	$\text{K}(s) \rightarrow \text{K}^+(aq) + e^-$
	$\text{Ba}(s) \rightarrow \text{Ba}^{2+}(aq) + 2e^-$
	$\text{Ca}(s) \rightarrow \text{Ca}^{2+}(aq) + 2e^-$
	$\text{Na}(s) \rightarrow \text{Na}^+(aq) + e^-$
	$\text{Mg}(s) \rightarrow \text{Mg}^{2+}(aq) + 2e^-$
	$\text{Al}(s) \rightarrow \text{Al}^{3+}(aq) + 3e^-$
	$\text{Mn}(s) \rightarrow \text{Mn}^{2+}(aq) + 2e^-$
	$\text{Zn}(s) \rightarrow \text{Zn}^{2+}(aq) + 2e^-$
	$\text{Cr}(s) \rightarrow \text{Cr}^{3+}(aq) + 3e^-$
	$\text{Fe}(s) \rightarrow \text{Fe}^{2+}(aq) + 2e^-$
	$\text{Co}(s) \rightarrow \text{Co}^{2+}(aq) + 2e^-$
	$\text{Ni}(s) \rightarrow \text{Ni}^{2+}(aq) + 2e^-$
	$\text{Sn}(s) \rightarrow \text{Sn}^{2+}(aq) + 2e^-$
	$\text{Pb}(s) \rightarrow \text{Pb}^{2+}(aq) + 2e^-$
	$\text{H}_2(g) \rightarrow 2 \text{H}^+(aq) + 2e^-$
	$\text{Cu}(s) \rightarrow \text{Cu}^{2+}(aq) + 2e^-$
	$\text{Ag}(s) \rightarrow \text{Ag}^+(aq) + e^-$
	$\text{Hg}(l) \rightarrow \text{Hg}^{2+}(aq) + 2e^-$
	$\text{Pt}(s) \rightarrow \text{Pt}^{2+}(aq) + 2e^-$
Least reactive	$\text{Au}(s) \rightarrow \text{Au}^{3+}(aq) + 3e^-$

