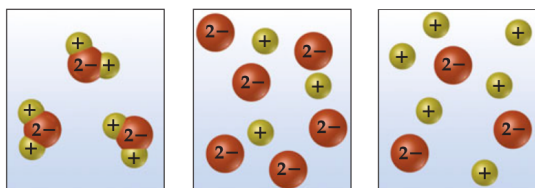


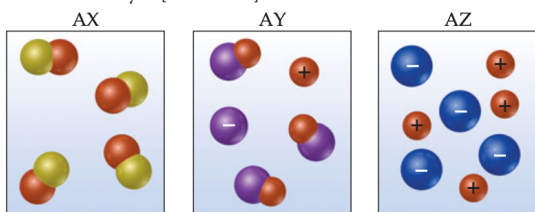
VISUALIZING CONCEPTS

4.1 Which of the following schematic drawings best describes a solution of Li_2SO_4 in water (water molecules not shown for simplicity)? [Section 4.1]



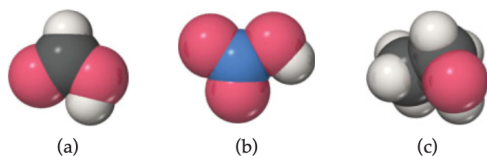
(a) (b) (c)

4.2 Aqueous solutions of three different substances, AX, AY, and AZ, are represented by the three accompanying diagrams. Identify each substance as a strong electrolyte, weak electrolyte, or nonelectrolyte. [Section 4.1]



(a) (b) (c)

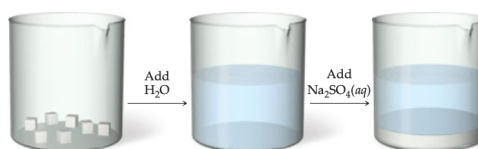
4.3 Use the molecular representations shown here to classify each compound as either a nonelectrolyte, a weak electrolyte, or a strong electrolyte (see inside back cover for element color scheme). [Sections 4.1 and 4.3]



(a) (b) (c)

4.4 A 0.1 M solution of acetic acid, CH_3COOH , causes the light-bulb in the apparatus of Figure 4.2 to glow about as brightly as a 0.001 M solution of HBr . How do you account for this fact? [Section 4.1]

4.5 You are presented with a white solid and told that due to careless labeling it is not clear if the substance is barium chloride, lead chloride, or zinc chloride. When you transfer the solid to a beaker and add water, the solid dissolves to give a clear solution. Next a $\text{Na}_2\text{SO}_4(aq)$ solution is added and a white precipitate forms. What is the identity of the unknown white solid? [Section 4.2]



4.6 We have seen that ions in aqueous solution are stabilized by the attractions between the ions and the water molecules. Why then do some pairs of ions in solution form precipitates? [Section 4.2]

4.7 Which of the following ions will *always* be a spectator ion in a precipitation reaction? (a) Cl^- , (b) NO_3^- , (c) NH_4^+ , (d) S^{2-} , (e) SO_4^{2-} . Explain briefly. [Section 4.2]

4.8 The labels have fallen off three bottles containing powdered samples of metals; one contains zinc, one lead, and the other platinum. You have three solutions at your disposal: 1 M sodium nitrate, 1 M nitric acid, and 1 M nickel nitrate. How could you use these solutions to determine the identities of each metal powder? [Section 4.4]

4.9 Explain how a redox reaction involves electrons in the same way that a neutralization reaction involves protons. [Sections 4.3 and 4.4]

4.10 If you want to double the concentration of a solution, how could you do it? [Section 4.5]

GENERAL PROPERTIES OF AQUEOUS SOLUTIONS (section 4.1)

4.11 When asked what causes electrolyte solutions to conduct electricity, a student responds that it is due to the movement of electrons through the solution. Is the student correct? If not, what is the correct response?

4.12 When methanol, CH_3OH , is dissolved in water, a nonconducting solution results. When acetic acid, CH_3COOH , dissolves in water, the solution is weakly conducting and acidic in nature. Describe what happens upon dissolution in the two cases, and account for the different results.

4.13 We have learned in this chapter that many ionic solids dissolve in water as strong electrolytes, that is, as separated ions in solution. What properties of water facilitate this process? Would you expect ionic compounds to be soluble in elemental liquids like bromine or mercury, just as they are in water? Explain.

4.14 What does it mean to say that ions are solvated when an ionic substance dissolves in water?

4.15 Specify what ions are present in solution upon dissolving each of the following substances in water: (a) ZnCl_2 , (b) HNO_3 , (c) $(\text{NH}_4)_2\text{SO}_4$, (d) $\text{Ca}(\text{OH})_2$.

4.16 Specify what ions are present upon dissolving each of the following substances in water: (a) MgI_2 , (b) $\text{Al}(\text{NO}_3)_3$, (c) HClO_4 , (d) NaCH_3COO .

4.17 Formic acid, HCOOH , is a weak electrolyte. What solute particles are present in an aqueous solution of this compound? Write the chemical equation for the ionization of HCOOH .

4.18 Acetone, CH_3COCH_3 , is a nonelectrolyte; hypochlorous acid, HClO , is a weak electrolyte; and ammonium chloride, NH_4Cl , is a strong electrolyte. (a) What are the solute particles present in aqueous solutions of each compound? (b) If 0.1 mol of each compound is dissolved in solution, which one contains 0.2 mol of solute particles, which contains 0.1 mol of solute particles, and which contains somewhere between 0.1 and 0.2 mol of solute particles?

PRECIPITATION REACTIONS (section 4.2)

- 4.19** Using solubility guidelines, predict whether each of the following compounds is soluble or insoluble in water: (a) MgBr_2 , (b) PbI_2 , (c) $(\text{NH}_4)_2\text{CO}_3$, (d) $\text{Sr}(\text{OH})_2$, (e) ZnSO_4 .
- 4.20** Predict whether each of the following compounds is soluble in water: (a) AgI , (b) Na_2CO_3 , (c) BaCl_2 , (d) $\text{Al}(\text{OH})_3$, (e) $\text{Zn}(\text{CH}_3\text{COO})_2$.
- 4.21** Will precipitation occur when the following solutions are mixed? If so, write a balanced chemical equation for the reaction. (a) Na_2CO_3 and AgNO_3 , (b) NaNO_3 and NiSO_4 , (c) FeSO_4 and $\text{Pb}(\text{NO}_3)_2$.
- 4.22** Identify the precipitate (if any) that forms when the following solutions are mixed, and write a balanced equation for each reaction. (a) NaCH_3COO and HCl , (b) KOH and $\text{Cu}(\text{NO}_3)_2$, (c) Na_2S and CdSO_4 .
- 4.23** Name the spectator ions in any reactions that may be involved when each of the following pairs of solutions are mixed.
(a) $\text{Na}_2\text{CO}_3(aq)$ and $\text{MgSO}_4(aq)$
(b) $\text{Pb}(\text{NO}_3)_2(aq)$ and $\text{Na}_2\text{S}(aq)$
(c) $(\text{NH}_4)_3\text{PO}_4(aq)$ and $\text{CaCl}_2(aq)$
- 4.24** Write balanced net ionic equations for the reactions that occur in each of the following cases. Identify the spectator ion or ions in each reaction.
- (a) $\text{Cr}_2(\text{SO}_4)_3(aq) + (\text{NH}_4)_2\text{CO}_3(aq) \longrightarrow$
(b) $\text{Ba}(\text{NO}_3)_2(aq) + \text{K}_2\text{SO}_4(aq) \longrightarrow$
(c) $\text{Fe}(\text{NO}_3)_2(aq) + \text{KOH}(aq) \longrightarrow$
- 4.25** Separate samples of a solution of an unknown salt are treated with dilute solutions of HBr , H_2SO_4 , and NaOH . A precipitate forms in all three cases. Which of the following cations could the solution contain: K^+ , Pb^{2+} , Ba^{2+} ?
- 4.26** Separate samples of a solution of an unknown ionic compound are treated with dilute AgNO_3 , $\text{Pb}(\text{NO}_3)_2$, and BaCl_2 . Precipitates form in all three cases. Which of the following could be the anion of the unknown salt: Br^- , CO_3^{2-} , NO_3^- ?
- 4.27** You know that an unlabeled bottle contains a solution of one of the following: AgNO_3 , CaCl_2 , or $\text{Al}_2(\text{SO}_4)_3$. A friend suggests that you test a portion of the solution with $\text{Ba}(\text{NO}_3)_2$ and then with NaCl solutions. Explain how these two tests together would be sufficient to determine which salt is present in the solution.
- 4.28** Three solutions are mixed together to form a single solution. One contains 0.2 mol $\text{Pb}(\text{CH}_3\text{COO})_2$, the second contains 0.1 mol Na_2S , and the third contains 0.1 mol CaCl_2 . (a) Write the net ionic equations for the precipitation reaction or reactions that occur. (b) What are the spectator ions in the solution?