CHAPTER 8 Review

Reflecting on Chapter 8

Summarize this chapter in the format of your choice. Here are a few ideas to use as guidelines:

- Describe the difference between a saturated and an unsaturated solution.
- Explain how you can predict whether a solute will dissolve in a solvent.
- What factors affect the rate of dissolving?
- What factors affect solubility?
- How does temperature affect the solubility of a solid, a liquid, and a gas?
- Describe how particle attractions affect solubility.
- Explain how to plot a solubility curve.
- Write the formulas for (m/v) percent, (m/m) percent, (v/v) percent, ppm, ppb, and molar concentration.
- Explain how you would prepare a standard solution using a volumetric flask.

Reviewing Key Terms

For each of the following terms, write a sentence that shows your understanding of its meaning.

solution	hydrogen bonding
solvent	ion-dipole attractions
solutes	hydrated
variable composition	electrolyte
aqueous solution	non-electrolytes
miscible	concentration
immiscible	mass/volume percent
alloys	mass/mass percent
solubility	volume/volume percent
saturated solution	parts per million
unsaturated solution	parts per billion
rate of dissolving	molar concentration
dipole	standard solution
dipole-dipole attraction	volumetric flask

Knowledge/Understanding

1. Identify at least two solutions in your home that are
   (a) beverages
   (b) found in the bathroom or medicine cabinet
   (c) solids
2. How is a solution different from a pure compound? Give specific examples.
3. Mixing 2 mL of linseed oil and 4 mL of turpentine makes a binder for oil paint. What term is used to describe liquids that dissolve in each other? Which liquid is the solvent?
4. How does the bonding in water molecules account for the fact that water is an exellent solvent?
5. Why does an aqueous solution of an electrolyte conduct electricity, but an aqueous solution of a non-electrolyte does not?
6. Use the concept of forces between particles to explain why oil and water are immiscible.
7. Explain the expression "like dissolves like" in terms of intermolecular forces.
8. What factors affect the rate of dissolving of a solid in a liquid?
9. Which of the following substances would you expect to be soluble in water? Briefly explain each answer.
   (a) potassium chloride, KCl
   (b) carbon tetrachloride, CCl_4
   (c) sodium sulfate, Na_2SO_4
   (d) butane, C_4H_{10}
10. Benzene, C_6H_6, is a liquid at room temperature. It is sometimes used as a solvent. Which of the following compounds is more soluble in benzene: naphthalene, $C_{10}H_8$, or sodium fluoride, NaF? Would you expect ethanol, CH_3CH_2OH, to be soluble in benzene? Explain your answers.

Inquiry

11. Boric acid solution is used as an eyewash. What mass of boric acid is present in 250 g of solution that is 2.25% (m/m) acid in water?
12. 10% (m/m) sodium hydroxide solution, $NaOH_{(aq)}$, is used to break down wood fibre to make paper.
    (a) What mass of solute is needed to make 250 mL of 10% (m/m) solution?
    (b) What mass of solvent is needed?
    (c) What is the molar concentration of the solution?
13. What volume of pure ethanol is needed to make 800 mL of a solution of ethanol in water that is 12% (v/v)?

14. Some municipalities add sodium fluoride, NaF, to drinking water to help protect the teeth of children. The concentration of sodium fluoride is maintained at 2.9×10^{-5} mol/L. What mass (in mg) of sodium fluoride is dissolved in 1 L of water? Express this concentration in ppm.

15. A saturated solution of sodium acetate, $NaCH_3COO$, can be prepared by dissolving 4.65 g in 10.0 mL of water at 20°C. What is the molar concentration of the solution?

16. What is the molar concentration of each of the following solutions?

(a) 7.25 g of silver nitrate, $AgNO_3$, dissolved in 100 mL of solution

(b) 80 g of glucose, $C_6H_{12}O_6$, dissolved in 70 mL of solution

17. Calculate the mass of solute that is needed to prepare each solution below.

(a) 250 mL of 0.250 mol/L calcium acetate, $Ca(CH_3COO)_2$

(b) 1.8 L of 0.35 mol/L ammonium sulfate, $(NH_4)_2SO_4$

18. Calculate the molar concentration of each solution formed after dilution.

(a) 20 mL of 6.0 mol/L hydrochloric acid, $HCl_{(aq)}$, diluted to 70 mL

(b) 300 mL of 12.0 mol/L ammonia, $NH_{3(aq)}$, diluted to 2.50 L

19. Calculate the molar concentration of each solution. Assume that the volumes can be added.

(a) 85.0 mL of 1.50 mol/L ammonium chloride, $NH_4Cl_{(aq)}$, added to 250 mL of water

(b) a 1:3 dilution of 1.0 mol/L calcium phosphate (that is, one part stock solution mixed with three parts water)

20. A standard solution of 0.250 mol/L calcium ion is prepared by dissolving solid calcium carbonate in an acid. What mass of calcium carbonate is needed to prepare 1.00 L of the solution?

21. Suppose that your teacher gives you three test tubes. Each test tube contains a clear, colourless liquid. One liquid is an aqueous solution of an electrolyte. Another liquid is an aqueous solution of a non-electrolyte. The third liquid is distilled water. Outline the procedure for an experiment to identify which liquid is which.

22. Fertilizers for home gardeners may be sold as aqueous solutions. Suppose that you want to begin a company that sells an aqueous solution of potassium nitrate, KNO_3, fertilizer. You need a solubility curve (a graph of solubility versus temperature) to help you decide what concentration to use for your solution. Describe an experiment that you might perform to develop a solubility curve for potassium nitrate. State which variables are controlled, which are varied, and which must be measured.

23. Potassium alum, $KAl(SO_4)_2 \cdot 12H_2O$, is used to stop bleeding from small cuts. The solubility of potassium alum, at various temperatures, is given in the following table.

Solubility of Potassium Alum

Solubility (g/100 g water)	Temperature (°C)
4	0
10	10
15	20
23	30
31	40
49	50
67	60
101	70
135	80

(a) Plot a graph of solubility against temperature.

(b) From your graph, interpolate the solubility of potassium alum at 67°C.

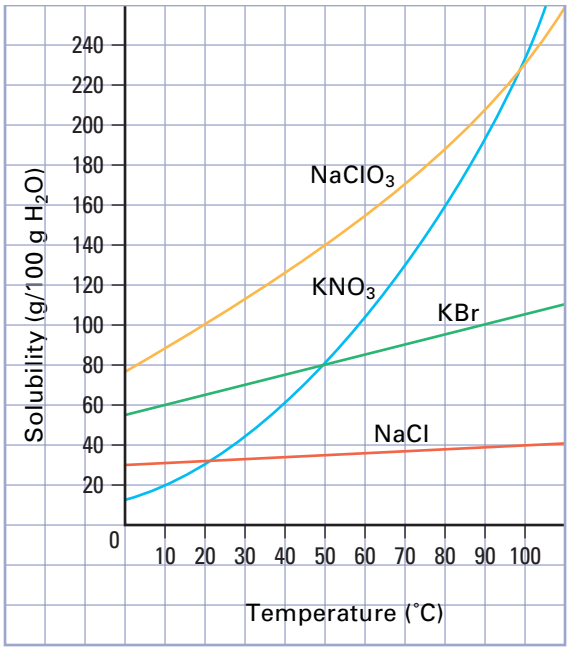
(c) By extrapolation, estimate the solubility of potassium alum at 82°C.

(d) Look at your graph. At what temperature will 120 g of potassium alum form a saturated solution in 100 g of water?

24. Use the graph on the next page to answer questions 24 and 25. At 80°C, what mass of sodium chloride dissolves in 1.0 L of water?

25. What minimum temperature is required to dissolve 24 g of potassium nitrate in 40 g of water?

26. A teacher wants to dilute 200 mL of 12 mol/L hydrochloric acid to make a 1 mol/L solution. What safety precautions should the teacher take?



This graph shows the solubility of four salts at various temperatures. Use it to answer questions 24 and 25.

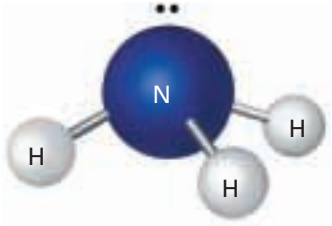
Communication

27. Suppose that you make a pot of hot tea. Later, you put a glass of the tea in the refrigerator to save it for a cool drink. When you take it out of the refrigerator some hours later, you notice that it is cloudy. How could you explain this to a younger brother or sister?

28. Define each concentration term.
- **(a)** percent (m/v)
- **(b)** percent (m/m)
- **(c)** percent (v/v)
- **(d)** parts per million, ppm
- **(e)** parts per billion, ppb

29. The concentration of iron in the water that is supplied to a town is 0.25 mg/L. Express this in ppm and ppb.

30. Ammonia is a gas at room temperature and pressure, but it can be liquefied easily. Liquid ammonia is probably present on some planets. Scientists speculate that it might be a good solvent. Explain why, based on the structure of the ammonia molecule shown above.



31. At 20°C, the solubility of oxygen in water is more than twice that of nitrogen. A student analyzed the concentration of dissolved gases in an unpolluted pond. She found that the concentration of nitrogen gas was greater than the concentration of oxygen. Prepare an explanation for the student to give to her class.

32. What is the concentration of pure water?

Making Connections

33. A bright red mineral called cinnabar has the chemical formula HgS. It can be used to make an artist's pigment, but it is a very insoluble compound. A saturated solution at 25°C has a concentration of 2×10^{-27} mol/L. In the past, why was heavy metal poisoning common in painters? Why did painters invariably waste more cinnabar than they used?

34. Vitamin A is a compound that is soluble in fats but not in water. It is found in certain foods, including yellow fruit and green vegetables. In parts of central Africa, children frequently show signs of vitamin A deficiency, although their diet contains a good supply of the necessary fruits and vegetables. Why?

Answers to Practice Problems and Short Answers to Section Review Questions:

Practice Problems: **1.(a)** 3.16% **(b)** 1.75% **(c)** 2.9% **2.** 6.31% **3.** 0.362 g **4.** 3.0 g, 0.1 g, 0.12 g **5.(a)** 26% **(b)** 16.6% **(c)** 15.1% **6.** 35% **7.** 85 g **8.** 6.35 g **9.** 15 g **10.** 15% **11.** 12 mL **12.** 38% **13.** 18 mL **14.** 285 mL **15.(a)** 0.33 ppm **(b)** 3.3×10^2 ppb **(c)** 0.000033% **16.** 0.040 g **17.** 3.0 ppm **18.** 500 ppm **19.(a)** 1.7 mol/L **(b)** 2.41 mol/L **(c)** 1.2 mol/L **(d)** 0.805 mol/L **(e)** 0.18 mol/L **20.(a)** 3.3 g **(b)** 8.49 g **(c)** 4.9×10^2 g **(d)** 24 g **(e)** 263 g **21.** 0.359 mol/L **22.** 1.4 L **23.** 7.45 g **24.** 4.5×10^2 g **25.(a)** 40 mL **(b)** 128 mL **(c)** 60.0 mL **26.(a)** 0.300 mol/L **(b)** 9.00×10^{-2} mol/L **(c)** 7.20×10^{-3} mol/L **27.** 2.1×10^{-2} mol/L

Section Review: 8.1: **1.** solute, solvent **8.** polar, ionic **13.** non-polar **8.2:** **3.(a)** increases **(b)** decreases **6.(a)** $Ce_2(SO_4)_3$ **(b)** $Ce_2(SO_4)_3$, $NaNO_3$ **(c)** NaCl **(d)** 84°C **(e)** 10 g **8.3:** **1.** 33.3 **2.** 23.8% **3.** 8.67 mol/L **8.4:** **1.** 3.73 g **2.** 0.25 mol/L **4.** 601 mL **5.** 175 mL, 525 mL