

## Chapter 15

### SOLUTIONS

A **solution** is a homogeneous mixture of two or more substances in a single physical state. Solutions can be solid, liquid or gaseous. Liquid solutions in which water is the solvent are called **aqueous solutions**.

A solution consists of a **solute** (the substance being dissolved) and the **solvent** (the substance that is the acceptor).

A **soluble** substance can be dissolved into another substance. A **miscible** liquid is soluble because it can be mixed in. An **insoluble** substance cannot be dissolved. An **immiscible** liquid cannot be mixed.

#### Types of solutions:

1. **Aqueous solutions** are solutions in which water is the solvent.
2. **Electrolytes** are aqueous solutions in which the solute dissolves to form ions. That is why electrolytes are able to conduct electricity.
3. **Tinctures** are solutions in which alcohol is the solvent.
4. **Alloys** are solid solutions of two or more metals.
5. **Amalgams** are specific alloys in which one of the metals is mercury.

### SOLUBILITY

A measurement of the amount of a solute can be dissolved into the solvent is referred to as its **solubility** in the solvent. Temperature and pressure both can have an affect on solubility. When temperature increases solubility in solids and liquids increases and decreases in gases.

Temperature changes can be best expressed in graph form. (Practice reading graphs!) Pressure changes do not generally affect solid and liquid solutions. However, pressure has a great affect on gases mixing with a liquid. The solubility of any gas in a solvent increases as the pressure increases. When the pressure is released from a solution of gas in a liquid, the escaping gas is referred to as **effervescence**. **Stability** or **equilibrium** is the point at which the rate of solute going into solution is equal to the amount of solute coming out of solution.

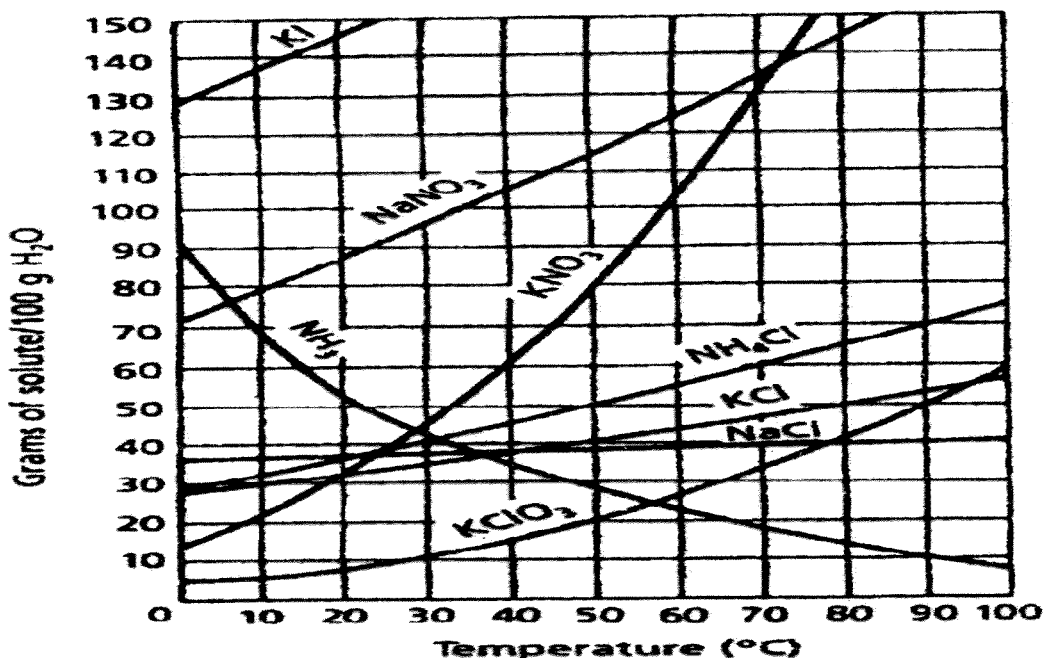
#### Rate of Dissolving can be affected by:

1. **Surface area**: increased surface area generally results in a faster rate of dissolving.

- Stirring:** stirring mixes areas of high concentration with areas of low concentration to optimize dissolving. Stirring also acts as a grinder to increase surface area.
- Temperature:** increasing temperature generally increases the rate of dissolving.

The solubility of a solute into a solvent is often graphed as a function of temperature.

**Practice:** Answer the following questions based on the graph below.



- In general, what relationship exists between solubility and temperature?
- Which substance is an exception to this relationship?
- Approximately how many grams of  $\text{NH}_4\text{Cl}$  can be dissolved in 100 g of water at  $70^\circ\text{C}$ ?
- If 105 g of  $\text{NaNO}_3$  is added to 100 g of water at  $20^\circ\text{C}$ , with constant stirring, to what temperature must this solution be raised for all of the substance to dissolve?
- A saturated solution of  $\text{KClO}_3$  was made with 300 g of water at  $40^\circ\text{C}$ . How much  $\text{KClO}_3$  could be recovered by evaporating the water from the solution?

Name: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_

## Homework: Solutions

Fill in the blank.

1. A \_\_\_\_\_ solution contains as much solute as can be dissolved under existing pressure and temperature.
2. The amount of solute in a given amount of solvent or solution is the \_\_\_\_\_ of a solution.
3. A solution that contains more solute particles than are normally in a saturated solution is referred to as \_\_\_\_\_.
4. A solution that is composed of two or more metals is called a(n) \_\_\_\_\_.
5. The rapid release of gas from a solution is referred to as \_\_\_\_\_.

Complete the following multiple choice questions.

- \_\_\_ 6. Which two substances are miscible in all proportions?
- a) Sugar and water
  - b) Water and gasoline
  - c) water and mineral oil
  - d) ethanol and water
- \_\_\_ 7. All of the following are solutions except:
- a) Ocean water
  - b) antifreeze
  - c) a silver bracelet
  - d) apple (just the meat)
- \_\_\_ 8. A solution that contains as much solute as can possibly be dissolved under the existing conditions is said to be:
- a) Saturated
  - b) Supersaturated
  - c) Soluble
  - d) Concentrated
- \_\_\_ 9. All solutions have the following properties except that:
- a) Dissolved particles are very small
  - b) Particles in a solution are evenly distributed
  - c) Solution particles do not separate or settle out
  - d) Final physical state of solution is always a liquid.
- \_\_\_ 10. Solutions with water as the solvent are called
- a) liquids
  - b) aqueous solutions
  - c) miscible solutions
  - d) electrolytic
- \_\_\_ 11. Supersaturated solutions are characterized by:
- a) Being super hot
  - b) Having great stability
  - c) Having a larger amount of solute that can be dissolved
  - e) Being able to exist at super-low temperature
- \_\_\_ 12. The process of dissolving

- a) occurs at the surface of the solid solute.
- b) Occurs only under heated conditions.
- c) Increases with stirring.
- d) Both a and c are correct.

- \_\_\_ 13. An electrolyte
- a) is not a solution.
  - b) Can transmit an electric current in solution.
  - c) Is a solution made of two or more metals.
  - d) Is electrically neutral in solution.

- \_\_\_ 14. Which of the following solutions is an alloy?
- a) oxygen gas in nitrogen gas
  - b) silver in copper
  - c) table salt in water
  - d) none of these

- \_\_\_ 15. In general, when the temperature of a solute increases the amount of solvent that can be dissolved:
- a) increases
  - b) decreases
  - c) remains the same

Based on the solubility below, decide whether each of the following is **A**: unsaturated, **B**: saturated, **C**: supersaturated, or whether **D**: not enough information is given. \* **assume it's dissolved** \*

- 1) 50 g KCl in 100 g of water at 90°C. \_\_\_\_\_
- 2) 50 g KCl in 100 g of water at 60°C. \_\_\_\_\_
- 3) 50 g KNO<sub>3</sub> in 100 g of water at 60°C. \_\_\_\_\_
- 4) 50 g KNO<sub>3</sub> in 25 g of water at 60°C. \_\_\_\_\_
- 5) 65 g KNO<sub>3</sub> in 50 g of water at 70°C. \_\_\_\_\_
- 6) 25 g KNO<sub>3</sub> in 100 g of water. \_\_\_\_\_
- 7) 25 g NaCl in 100 g of water. \_\_\_\_\_
- 8) 40 g of KCl in 100 g of water at 20°C. \_\_\_\_\_

- 9) How many grams of KCl can dissolve in 100.0 g of water at 65°C? \_\_\_\_\_
- 10) What temperature would be required to get 85 g of KNO<sub>3</sub> to dissolve in 100.0 g of water? \_\_\_\_\_

**SHOW ALL WORK FOR THE FOLLOWING**

- 11) How many grams of KNO<sub>3</sub> can be dissolved in 50.0 g of water at 50.0°C? \_\_\_\_\_
- 12) What mass of KCl can be dissolved in 200.0 g of water at 15.0°C? \_\_\_\_\_
- 13) How much KNO<sub>3</sub> can be dissolved in 14.3 g of water at 69.0°C? \_\_\_\_\_
- 14) How many grams of water will it take to dissolve 28.0 g NaCl at 60.0°C? \_\_\_\_\_
- 15) How much water is needed to dissolve 46.6 g of KNO<sub>3</sub> at 52°C? \_\_\_\_\_

- 16) What temperature would be required to get 51.0 g of KCl to dissolve in 156 g of water? \_\_\_\_\_

