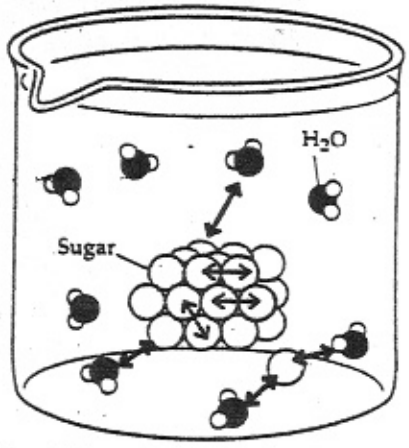
Properties of Solutions. Solutions share certain properties. These properties include the following:

- The particles of solvent and solute in solutions are spread evenly throughout the mixture.
- The particles of the solute are molecular or ionic in size.
- A solid solute can usually be separated from a liquid solvent by physical means, such as evaporation.
- The amounts of solute and solvent in a solution may vary within limits.

Fig. 30-1

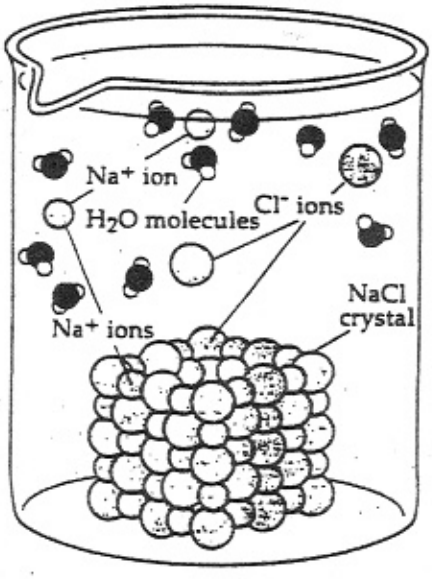


Molecules and Ions in Solutions. The action of a solvent on a solute forms a solution. Fig. 30-1 shows sugar dissolving in water. Water is the solvent and sugar is the solute. Molecules of water gather around the sugar crystal. There is a force of attraction between the solvent (water) and the solute (sugar). This force causes sugar molecules to leave the crystal and become dissolved in the water.

✓ 1. **In the solution shown in Fig. 30-1, sugar is the solute because** it is being dissolved in the water.

When an ionic compound is the solute and water is the solvent, the ions separate. Fig. 30-2 shows sodium chloride—NaCl—dissolving. Sodium chloride is ionically bonded. It consists of sodium ions—Na^+—and chloride ions—Cl^-. When sodium chloride dissolves, its Na^+ ions and Cl^- ions separate.

Fig. 30-2

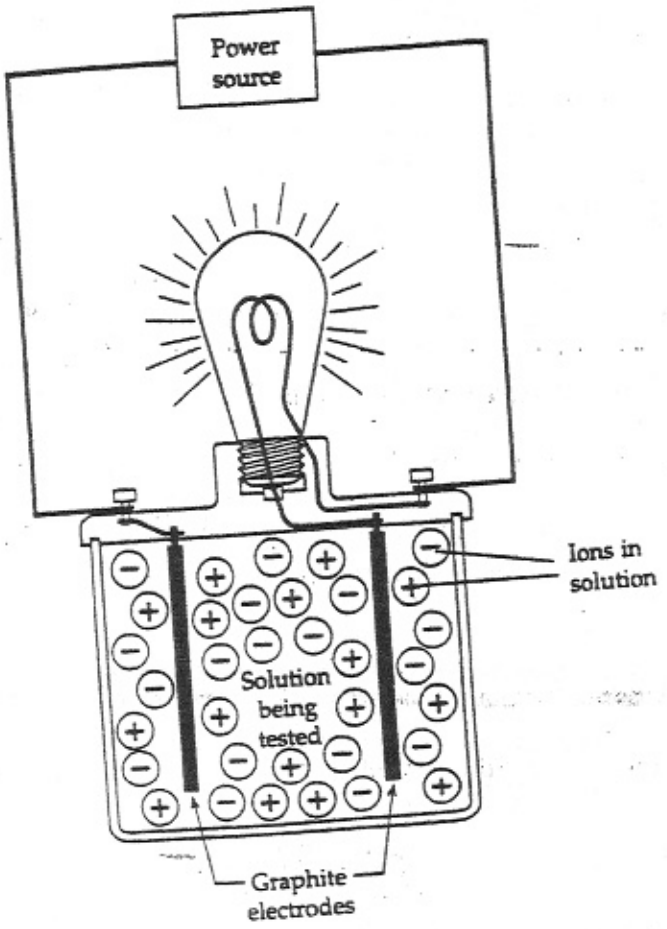


✓ 2. **In the solution shown in Fig. 30-2, is sodium chloride the solute or the solvent?** solute

Electrolytes. Substances whose water solutions contain ions will conduct electricity. Such substances are called **electrolytes** (ee-LEHK-troh-lyets). Sodium chloride is an electrolyte. Covalent compounds usually do not ionize when they dissolve in water. These solutions do not conduct electricity and are called nonelectrolytes. Sugar, for example, is a covalent compound that is a nonelectrolyte. Acids, however, are covalent compounds that do ionize when they dissolve in water. So an acid, such as hydrochloric acid, is an electrolyte.

Fig. 30-3 on page 146 shows a laboratory method used to test electrolytes. A light bulb is connected in a circuit with a low-voltage power source or battery. If the solution contains an electrolyte, the bulb will glow.

Fig. 30-3 Laboratory method to test electrolytes



✓ 3. Which substance, sugar or hydrochloric acid, is an electrolyte?

hydrochloric acid (HCl)

TAKE ANOTHER LOOK

Solutions can be classified as gas solutions, liquid solutions, and solid solutions. The table describes and gives examples of each type of solution.

Type	Description of solution	Examples
Gas	Both solvent and solute are gases or vapors.	Air, made up mostly of nitrogen and oxygen; other gases
Liquid	Liquid solvent in which the solute is (a) a gas, (b) a liquid, or (c) a solid	(a) Soda water, made of solvent: water solute: carbon dioxide (b) Antifreeze, made of solvent: water solute: ethylene glycol (c) Vinegar, made of solvent: water solute: acetic acid
Solid	Both solvent and solute are solids.	Alloys of metals, such as brass, made of copper and zinc

Use the terms *electrolyte, solute, solution, solvent* to fill in the blanks. A term may be used more than once.

4. A mixture in which the particles are the size of molecules is a(n) Solution.

5. The Solvent of a solution is present in the larger amount.

6. The solute of a solution is present in the smaller amount.

7. A substance whose water solution conducts electricity is a(n) electrolyte.

8. In soda water, carbon dioxide is the solute and water is the solvent.

If the statement is correct write the word *True*. If the statement is incorrect write the word *False*.

9. True — The smallest particle of a solute in a solution can be a molecule or an ion.

10. False — A solute must be separated from its solvent by chemical means.

11. False — A solution can only be made from the same amounts of solute and solvent.

12. True — Hydrochloric acid is an electrolyte.

Underline the term in parentheses that correctly completes each statement.

13. When salt dissolves in water, it breaks up into Na^+ and Cl^- (molecules, ions).

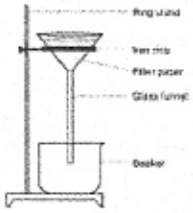
14. When sugar dissolves in water, the solute is the (water, sugar).

15. Antifreeze is a solution in which a (gas, liquid) is the solute.

16. Brass is a solution in which a (liquid, solid) is the solvent.

1. An example of a heterogeneous mixture is
   A) carbon monoxide B) soil
   C) sugar D) carbon dioxide

2. Which mixture can be separated by using the equipment shown below?



   A) $CO_2(aq)$ and $NaCl(aq)$
   B) $CO_2(aq)$ and $C_6H_{12}O_6(aq)$
   C) $NaCl(aq)$ and $SiO_2(s)$ sand
   D) $NaCl(aq)$ and $C_6H_{12}O_6(aq)$

3. Which formula represents a mixture?
   A) $C_6H_{12}O_6(s)$ B) $LiCl(aq)$ dissolved in water
   C) $C_6H_{12}O_6(\ell)$ D) $LiCl(s)$

4. Recovering the salt from a mixture of salt and water could best be accomplished by
   A) evaporation
   B) paper chromatography
   C) density determination
   D) filtration

5. Which statement is an identifying characteristic of a mixture?
   A) A mixture must be homogeneous.
   B) A mixture must have a definite composition by weight.
   C) A mixture can be separated by physical means.
   D) A mixture can consist of a single element.

6. When a mixture of water, sand, and salt is filtered, what passes through the filter paper?
   A) water and sand, only
   B) water, sand, and salt
   C) water and salt, only
   D) water, only

7. Petroleum can be separated by distillation because the hydrocarbons in petroleum are
   A) elements with identical boiling points
   B) compounds with identical boiling points
   C) elements with different boiling points
   D) compounds with different boiling point

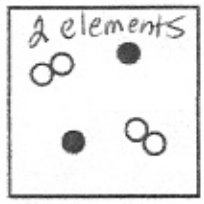
8. Which sample of matter can be separated into different substances by physical means?
   A) $NH_3(\ell)$ B) $LiCl(aq)$
   C) $NH_3(g)$ D) $LiCl(s)$

9. A mixture of sand and table salt can be separated by filtration because the substances in the mixture differ in
   A) density at STP
   B) freezing point
   C) boiling point
   D) solubility in water

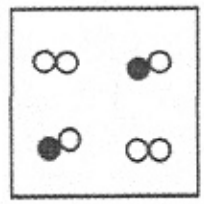
10. Which particle diagram represents a mixture of an element and a compound?

Key
○ = an atom of an element
● = an atom of a different element

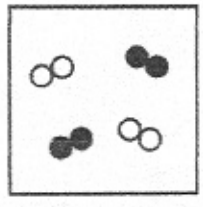
A) 2 elements



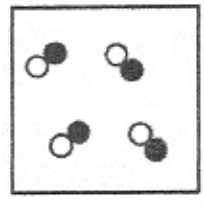
B)



C)



D)



11. One similarity between all mixtures and compounds is that both
   A) combine in a definite ratio
   B) are heterogeneous
   C) are homogeneous
   D) consist of two or more substances

12. A mixture of crystals of salt and sugar is added to water and stirred until all solids have dissolved. Which statement best describes the resulting mixture?

A) The mixture is heterogeneous and can be separated by filtration.
B) The mixture is homogeneous and cannot be separated by filtration.
C) The mixture is heterogeneous and cannot be separated by filtration.
D) The mixture is homogeneous and can be separated by filtration.

13. A bottle of rubbing alcohol contains both 2-propanol and water. These liquids can be separated by the process of distillation because the 2-propanol and water

A) have combined chemically and have the same boiling point
B) have combined physically and have the same boiling point
C) have combined physically and retain their different boiling points
D) have combined chemically and retain their different boiling points

14. Which property makes it possible to separate the oxygen and the nitrogen from a sample of liquefied air?

A) hardness B) electronegativity
C) boiling point D) conductivity

15. A dilute, aqueous potassium nitrate solution is best classified as a

A) homogeneous compound
B) homogeneous mixture
C) heterogeneous compound
D) heterogeneous mixture

16. Which must be a mixture of substances?

A) solution B) liquid
C) solid D) gas

17. Which of these contains only one substance?

A) distilled (pure) water B) rainwater
C) saltwater D) sugar water

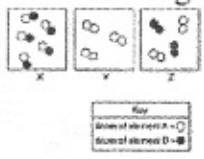
18. A dry mixture of KNO_3 and sand could be separated by

A) adding water to the mixture and evaporating
B) heating the mixture to a high temperature
C) adding water to the mixture and filtering
D) cooling the mixture to a low temperature

19. Which material is a mixture?

A) magnesium Mg B) water H_2O
C) methane CH_4 D) air

20. Given the diagrams *X*, *Y*, and *Z* below:



Which diagram or diagrams represent a mixture of elements *A* and *B*?

A) *X* and *Y* B) *X*, only
C) *Z*, only D) *X* and *Z*

21. At room temperature, a mixture of sand and water can be separated by

A) combustion B) filtration
C) sublimation D) ionization

22. Which formula represents a homogeneous mixture?

A) NaH(s) B) $H_2O(\ell)$
C) $H_2S(g)$ D) HCl(aq)

23. Which of these terms refers to matter that could be heterogeneous?

A) mixture B) solution
C) compound D) element

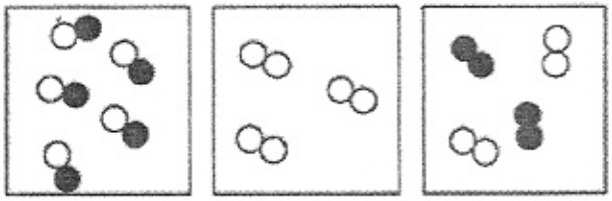
24. Which process would most effectively separate two liquids with different molecular polarities?

A) conductivity B) fermentation
C) filtration D) distillation

25. Describe diagrams *X, Y,* and *Z* using the following terms:

Pure substance
Compound
Element
Mixture of elements
Mixture of compounds

You may use more than one term for each diagram.



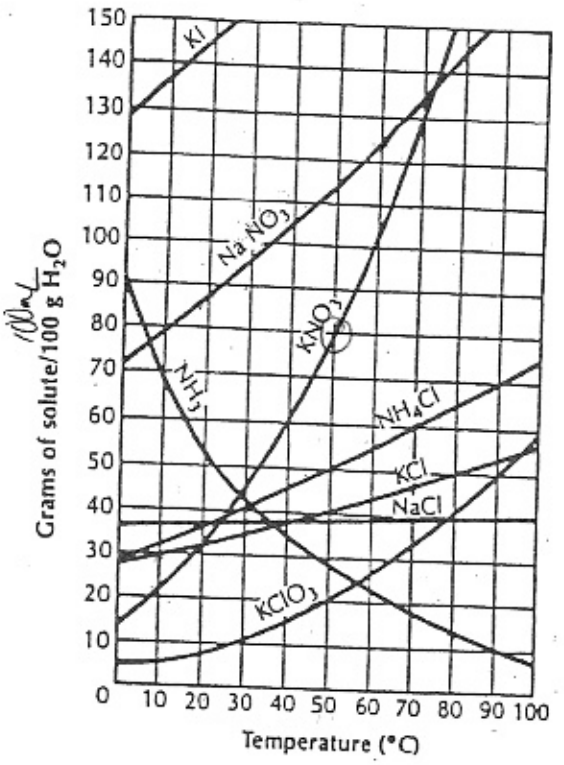
Key
Atom of element A = ○
Atom of element B = ●

x Compound / Pure substance
y Element / Pure substance
z Mixture of elements

Name _____ Class _____ Date _____

Solubility Curves

Study the solubility curves in the figure, and then answer the questions that follow.



1. What relationship exists between solubility and temperature for most of the substances shown?

2. a. What is the exception?

   b. What general principle accounts for this exception?

3. a. Approximately how many grams of $NaNO_3$ will dissolve in 100 g of water at 20°C?

   b. How many grams will dissolve at 60°C?

4. How many grams of NH_4Cl will dissolve in 1 liter of H_2O at 50°C? 1g = 1mL water 100 x 10 = 1000mL

5. Ninety grams of $NaNO_3$ is added to 100 g of H_2O at 0°C. With constant stirring, to what temperature must the solution be raised to produce a saturated solution with no solid $NaNO_3$ remaining?

6. A saturated solution of $KClO_3$ was made with 300 g of H_2O at 40°C. How much $KClO_3$ could be recovered by evaporating the solution to dryness?

7. Five hundred grams of water are used to make a saturated solution of KCl at 10°C. How many more grams of KCl could be dissolved if the temperature were raised to 100°C?

8. A saturated solution of KNO_3 in 200 g of H_2O at 50°C is cooled to 20°C. How much KNO_3 will precipitate out of solution?

55 3/4
275

1. As temperature increases, more grams of solute can be dissolved.
2a. NH_3
b. Gases decrease in solubility as temperature increases. Warm pop goes flat.
3a. 87g
b. 123g
4. 50 x 10 = 500g
5. 22°C
6. 15g x 3 = 45g
7. 30g x 5 = 150g 55 x 5 = 275g − 150 = 125g
8. 80 x 2 = 160g 32 x 2 = 64g 160 − 64 = 96g