3. The dissolving of both salt and sugar involves the solid separating into particles too small to see. The salt solution contains ions of sodium and chlorine and will conduct a current, while the sugar dissolves to release sugar molecules, so its solution will not conduct electricity.

Try This Activity: Substances in Water

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(a) The potassium permanganate, sugar, and ethanol dissolve.
(b) Sugar and ethanol are certainly soluble, as they disappear completely. The solubility of potassium permanganate is less certain, as some of it remains undissolved.
Note: Students may be uncertain about any substance that does not "disappear" completely upon dissolving, because they rarely encounter this. Expect discussion about potassum permanganate, if they had some remain in solid state. Students may be uncertain if they speculate about whether some calcium carbonate or vegetable oil dissolves, even though there is no visible reduction of the original phase. They have only visible evidence of sample "shrinking" to go on, where no colour change is involved.
(c) The calcium carbonate and vegetable oil do not dissolve.
(d) We cannot be entirely certain, as a small amount may have dissolved.
(e) Properties are different: solutions are visibly homogeneous. Some other properties that might differ include electrical conductivity, acidity, melting/freezing points, viscosity, and so forth.
(f) Acidity could be tested with pH paper or conductivity with a multimeter.
Note: Tests listed by students should be consistent with their answers to (e).

6.1 DEFINING A SOLUTION

PRACTICE

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Understanding Concepts

1. (a) Heterogeneous: different substances are visible.
   (b) Homogeneous: only one phase is visible.
   (c) Homogeneous if it has been decanted; if not, there may be sediment in the bottle and the red wine would then be considered heterogeneous.
   (d) Heterogeneous if corroded; if clean, bronze appears homogeneous.
   (e) Homogeneous: the metal looks all the same throughout.
   (f) Heterogeneous if corroded; otherwise it is homogeneous.
   (g) Humid air is usually homogeneous; however, when cloud, fog, or rain forms, the solution is heterogeneous.
   (h) Heterogeneous: the suspended droplets of water make it opaque.
   (i) Heterogeneous: the water is not clear.
2. The solutions are (b), (d), (h) and (i).
   (a), (c), (e), (f) and (g) are not solutions.
3. Solutions may be classified by type of solvent, by electrical conductivity, by acidity, by colour, or by physical state at room conditions. Even categories such as viscosity, volatility, etc., can be used to classify substances.
4. (a) An aqueous solution is one in which the solvent is water.
   (b) Aqueous solutions found around the home will be substances such as shampoo, vinegar, syrup, clear fruit juices, tea, bleach, drain cleaners.
5. Methanol is a nonelectrolyte (it is a nonacidic molecular substance); sodium chloride is an electrolyte (it dissolves to release ions); hydrochloric acid is an electrolyte (acids are the only molecular substances to conduct electricity); and potassium hydroxide is an electrolyte (it is ionic).
6. (a) Electrolyte solutes include soluble ionic compounds (including ionic hydroxides) and acids.
   (b) electrolyte: a substance that dissolves in water to form a conducting solution
7. (a) Acidic solutions have acid solutes.
   (b) Basic soutions have ionic hydroxide solutes.
   (c) Neutral solutions have molecular solutes (other than acids) or ionic solutes (other than ionic hydroxides).
8. (a) Electrolytes: citric acid, salt (assume sodium chloride), sodium citrate, and monosodium phosphate (4 of the 11 substances listed).

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Nonelectrolytes: water, liquid sugar, glucose-fructose, and brominated vetgetable oil (4 of the 11 substances listed).
The remaining ingredients (natural flavour, colour, and ester gum) cannot be classified at this stage.
Although there are the same number of ingredients that are electrolytes and nonelectrolytes, there is a greater quantity of nonelectrolytes than electrolytes.

(b) In this product salt (sodium chloride) and sodium citrate contain sodium ions; only the monopotassium phosphate contains potassium ions. The drink therefore contains more sodium ions than potassium ions.

(c) All of the food energy in the drink comes from carbohydrates—essentially from sugars.

(d) The drink attempts to replace water, energy, and alkali metal ions that are lost from the body during physical activity.

SECTION 6.1 QUESTIONS

(Page 271)

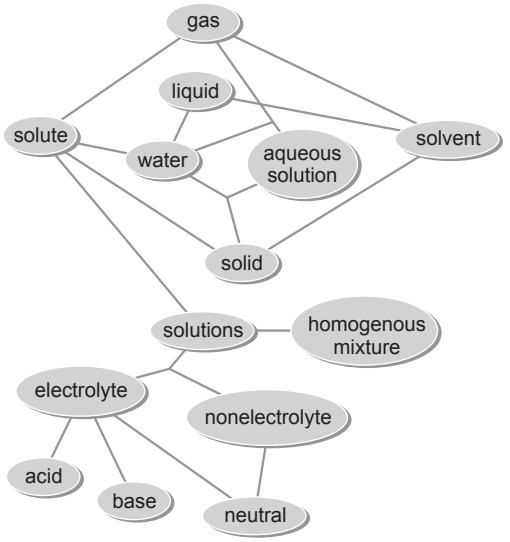
Understanding Concepts

1. (a) An appropriate table might be:

	Solute		
Solvent	**Solid**	**Liquid**	**Gas**
Solid	brass or solder	Hg amalgams	lead in air
Liquid	sugar syrup	vinegar	soda pop
Gas	oxygen in ice	humid air	air

(b) Solutions of gaseous, liquid, and solid solutes in liquid solvents
Note: Some students might correctly suggest gas in gas as being a very common solution.

2.



3. Examples include gasoline, lubricating oils, Varsol, mineral spirits, and turpentine.
4. The solvent in alkyd paints is a mixture of oils. Any thinner/cleaner for alkyd paints must be an oil, such as mineral oil or Varsol. Nonpolar alkyd paint components dissolve in nonpolar solvents. Water is used as a thinner/cleaner (solvent) or diluent for latex paints because water is a component of the paint mixture. Polar latex paint components dissolve in polar water molecules. Since water and oil will not dissolve in each other (polar does not dissolve in nonpolar), it is critical not to mix the two types of solvent.
5. (a) electrolyte
   (b) nonelectrolyte
   (c) electrolyte
   (d) nonelectrolyte
6. (a) $HCl_{(aq)}$: acidic solution; blue litmus turns pink.
   (b) $NaOH_{(aq)}$: basic solution; pink litmus turns blue.

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(c) Methanol: neutral solution; neither colour of litmus changes from its original colour.
(d) Sodium hydrogen carbonate: neutral solution; neither colour of litmus changes from its original colour.

Applying Inquiry Skills

7. (a)

Predicting Properties of Compounds

Substance	Acidic/Basic/Neutral	Electrolyte/Nonelectrolyte
$C_3H_7OH_{(l)}$ (a rubbing alcohol)	neutral	nonelectrolyte
calcium hydroxide (slaked lime)	basic	electrolyte
$H_3PO_{4(aq)}$ (for manufacturing fertilizer)	acidic	electrolyte
glucose (a product of photosynthesis)	neutral	nonelectrolyte
sodium fluoride (in toothpaste)	neutral	electrolyte

(b) Each compound is dissolved in pure water, and the resulting solutions are tested with litmus. They are also tested for electrical conductivity.

Making Connections

8. Using gasoline as a cleaner in a basement is unsafe because the liquid is very volatile (evaporates very readily), and the vapours are very flammable. Gasoline should only be used in a very well-ventilated area, with no sources of ignition anywhere nearby — preferably outdoors.

Reflecting

9. If water really were a universal solvent, everything (and everyone) on Earth would be part of a huge unchanging sphere of homogeneous solution.

6.2 EXPLAINING SOLUTIONS

PRACTICE

(Page 273)

Understanding Concepts

1. Most molecules are polar. The four categories of polar molecules are:
   AB (e.g., $HCl_{(g)}$, $CO_{(g)}$)
   N_xA_y (e.g., $NH_{3(g)}$, $NF_{3(g)}$)
   O_xA_y (e.g., $H_2O_{(l)}$, $OCl_{2(g)}$)
   $C_xA_yB_z$ (e.g., $CHCl_{3(l)}$, $C_2H_5OH_{(l)}$)
2. Nonpolar molecules are those in which no part of the molecule is significantly more (or less) electronegative than any other part. The two categories of nonpolar molecules are
   molecular elements (e.g., $N_{2(g)}$ or $P_{4(s)}$);
   compounds consisting only of carbon and one other type of atom, with a general formula C_xA_y (e.g., $CH_{4(g)}$, $CO_{2(g)}$, and $C_8H_{18(l)}$).

PRACTICE

(Page 277)

Understanding Concepts

3. Intramolecular forces act between atoms within a molecule; intermolecular forces act between molecules.
4. (a) No, gasoline will not dissolve in water. The film floating on puddles of water at gas stations is evidence that supports this statement.
   (b) the "like dissolves like" rule
   (c) Since gasoline is nonpolar and water is highly polar, the two liquids would not be miscible.

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