(e) The liquids were affected by both positive and negative charges because the polar molecules of the liquids are positively charged at one end and negatively charged at the other end. A positively charged object attracts the negatively charged end of the polar molecule, while a negatively charged object attracts the positively charged end of the polar molecule.

1.13 INVESTIGATION: CLASSIFYING SOLIDS USING PHYSICAL PROPERTIES

(Pages 46–47)

Prediction

(a) Potassium iodide and sodium chloride are ionic compounds, whereas sucrose and camphor are molecules.

Hypothesis

(b) Potassium iodide and sodium chloride are ionic compounds because they each consist of a cation and an anion, and are therefore held together by ionic bonds. Sucrose and camphor are both molecular solids because they consist of nonmetal atoms that are held together by covalent bonds.

Observations

Table 1 Physical Properties of Different Compounds

Compound	Part 1: Solubility (dissolves/ does not dissolve)	Part 2: Conductivity (conducts electricity/ does not conduct electricity)	Part 3: Hardness (descriptive)	Hardness (ranking)	Part 4: Melting point (°C)
potassium iodide, $KI_{(s)}$	dissolves	solution conducts electricity	brittle, fair amount of pressure placed on crystal	2	686
sodium chloride, $NaCl_{(s)}$	dissolves	solution conducts electricity	brittle, large amount of pressure placed on crystal	1	801
sucrose, $C_{12}H_{22}O_{11(s)}$	dissolves	solution does not conduct electricity	not too hard to break	3	185
camphor, $C_{10}H_{16}O_{(s)}$	dissolves slightly	solution does not conduct electricity	soft	4	177
Part 5: Unidentified solid	[Answer will vary depending on sample]	[Answer will vary depending on sample]	[Answer will vary depending on sample]	Not applicable	[Answer will vary depending on sample]

Analysis

(c) According to the results, sodium chloride and potassium iodide belong to one category while sucrose and camphor belong in the second category.

(d) Sodium chloride and potassium iodide both dissolve in water, have high melting points, a high level of hardness, and their solutions conduct electricity. Camphor and sucrose are relatively soft, have low melting points, and do not conduct electricity when dissolved in water.

(e) Sodium chloride and potassium iodide are ionic compounds. Ionic compounds are soluble in water, exhibit a high level of hardness, have a high melting point, and their solutions conduct electricity. Molecular solids, such as sucrose and camphor, have low melting points, are softer than ionic compounds, and their solutions do not conduct electricity.

(f) Student answers will vary depending on whether their unidentified sample is ionic or molecular. Students should compare the properties of the unidentified solid with those of the category to which the solid belongs.

Evaluation

(g) The physical properties studied in this investigation are sufficient for classifying the solids into two categories. Other properties that may be investigated to further distinguish between molecular and ionic compounds include boiling point, solubility in solvents other than water, and volatility (odour).

(h) A possible source of error in this Procedure is the ranking of the hardness of samples. It may be difficult to tell how hard the samples are relative to each other using this test. Another possible source of error in this Procedure is the amount of solid placed in solution for dissolving and testing for conductivity. If not enough solid is placed in solution, the solution may not register a current even though the compound is an electrolyte. Stirring is important when testing for solubility. A substance may be soluble, but if it is not stirred to help it dissolve, it may appear insoluble. The Procedure could be improved by measuring identical masses of each solid and stirring each sample the same number of times and with the same vigour.

(i) The Prediction is correct, based on the Analysis.

1.14 CHEMICAL REACTIONS

SECTION 1.14 QUESTIONS

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Understanding Concepts

1. (a) decomposition reaction—a compound is broken down into two elements
   (b) synthesis reaction—two elements combine to form a compound
   (c) decomposition reaction—a complex compound is broken down into two simpler compounds
2. $2\ H_2O_{(l)} \rightarrow 2\ H_{2(g)} + O_{2(g)}$
3. A synthesis reaction is the combination of two or more simple substances to form a more complex substance. A combustion reaction is the rapid combination of oxygen and another element or compound to form new substances. Thus, a combustion reaction is a type of synthesis reaction where one of the reactants is oxygen. For example, $4\ Na_{(s)} + O_{2(g)} \rightarrow 2\ Na_2O_{(s)}$ is a combustion reaction as well as a synthesis reaction.
4. (a) $Zn_{(s)} + CuCl_{2(aq)} \rightarrow ZnCl_{2(aq)} + Cu_{(s)}$
   (b) $Ca_{(s)} + 2\ HCl_{(aq)} \rightarrow CaCl_{2(s)} + H_{2(g)}$
   (c) $2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ NaOH_{(aq)} + H_{2(g)}$
5. In general, a synthesis reaction involves the reaction of two elements to form a new compound. A decomposition reaction involves the breaking down of a compound into elements or simpler compounds. A single displacement reaction is a reaction between an element and a compound. A double displacement reaction occurs between two compounds.
6. The general equation for a synthesis reaction is $A + B \rightarrow AB$, whereas the general equation for a decomposition reaction is $AB \rightarrow A + B$. The decomposition reaction is the reverse of the synthesis reaction and vice versa. They are therefore opposite reactions.
7. (a) $Al_{(s)} + 3\ AgNO_{3(aq)} \rightarrow Al(NO_3)_{3(aq)} + 3\ Ag_{(s)}$ single displacement reaction
   (b) zinc + sulfuric acid → zinc sulfate + hydrogen gas
   $Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$ single displacement reaction
   (c) aqueous magnesium chloride + aqueous silver nitrate → solid silver chloride + aqueous magnesium nitrate
   $MgCl_{2(aq)} + 2\ AgNO_{3(aq)} \rightarrow 2\ AgCl_{(s)} + Mg(NO_3)_{2(aq)}$ double displacement reaction
   (d) sodium + water → sodium hydroxide + hydrogen gas
   $2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ NaOH_{(aq)} + H_{2(g)}$ single displacement reaction
   (e) $3\ KOH_{(aq)} + FeCl_{3(aq)} \rightarrow Fe(OH)_{3(s)} + 3\ KCl_{(aq)}$ double displacement reaction