Chapter 2: Chemical Compounds and Bonding

Mini Investigation: Fun with Teflon Tape, page 55
A. MSDS warnings include statements such as “Above 250 °C, some decomposition of polytetrafluoroethylene products can be expected with evolution of gaseous and particulate products, which are toxic if inhaled. This can give rise to a characteristic syndrome with influenza-type symptoms known as ‘polymer fume fever’.”
B. The tape did not undergo any changes in water but it dissolved slightly in oil. This indicates that PTFE and oil have some type of similar property.
C. Answers may vary. Sample answer: PTFE is so useful because it is waxy, flexible, and extremely slippery.
D. Answers may vary. Sample answer: PTFE is a useful material for the lining of containers (beverage containers, industrial vessels, laboratory equipment). It is an excellent electrical insulator, so it can be used to wrap cables and wires. Due to its flexibility, it can be moulded into complex shapes.
E. PTFE does not degrade naturally (or it degrades very slowly). It can thus be placed safely in landfills; however, it will add to the landfill burden indefinitely.

Section 2.1: Ionic Compounds

Tutorial 1 Practice, page 58
1. (a) Potassium chloride:
\[ \text{K} \text{ and } \text{Cl} \rightarrow \text{K}^+ \text{ and } \text{Cl}^- \]
One K atom is needed for every Cl atom.

(b) Calcium chloride:
\[ \text{Ca} \text{ and } \text{Cl} \rightarrow \text{Ca}^{2+} \text{ and } 2\text{Cl}^- \]
Two Cl atoms are needed for every Ca atom.

(c) Calcium oxide:
\[ \text{Ca} \text{ and } \text{O} \rightarrow \text{Ca}^{2+} \text{ and } \text{O}^{2-} \]
One Ca atom is needed for every O atom.
(d) Potassium oxide:

\[ \text{K} \cdot \text{O} : \]

Two K atoms are needed for every O atom.

\[ 2 \text{K} + \cdot \text{O} : \rightarrow [ \text{K} ]^+ [ \text{O} ]^{2-} [ \text{K} ]^+ \]

The chemical formula for potassium oxide is K₂O.

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1. Three distinctive physical properties of ionic compounds are a high melting and boiling point, brittleness, and conductivity when dissolved in water.

2. An electrolyte is a compound that dissolves in water, producing a solution that conducts electricity.

An ionic bond is the electrostatic force of attraction between a positive ion and a negative ion – a type of chemical bond.

A formula unit is the smallest repeating unit in an ionic crystal.

3.

\[ \text{Mg} \cdot \cdot \text{O} : \]

One Mg atom is needed for every O atom.

\[ \text{Mg} \cdot + \cdot \text{O} : \rightarrow [ \text{Mg} ]^{2+} [ \text{O} ]^{2-} \]

The chemical formula for magnesium oxide is MgO.

4. Pure water is a poor conductor of electricity because H₂O is a molecular compound. There are no charged particles to help with the flow of electricity. Tap water is a fair conductor of electricity because tap water contains many dissolved ions, which allow for the passage of electricity.

5. The magnitude of the charge of the ions within an ionic compound has an effect on the strength of the ionic bond. Magnesium oxide, which has ionic bonds between Mg²⁺ and O²⁻ ions, has a greater force of attraction than the other ionic compounds listed because the charge of the ions involved is greater. For example, sodium chloride has ionic bonds between the Na⁺ and Cl⁻ ions. As well, the size of the ions can influence the strength of the ionic bond. In general, the smaller the ionic radius, the greater the force of attraction between the ions.

6. The strong ionic bonds will keep ionic compounds in the solid state at ambient temperatures. When the ionic crystal structure is offset, this may result in ions with like charges being side by side, and consequently the repelling forces of like charges will shatter the compound.

7. (a) Lithium chloride:

\[ \text{Li} \cdot \cdot \text{Cl} : \]

One Li atom is needed for every Cl atom.

\[ \text{Li} + \cdot \text{Cl} : \rightarrow [ \text{Li} ]^+ [ \cdot \text{Cl} : ]^- \]

The chemical formula for lithium chloride is LiCl.
(b) Magnesium chloride:
\[ \text{Mg} \cdot \cdot \cdot \text{Cl} : \]
One Mg atom is needed for every two Cl atoms.
\[ \text{Mg} \cdot + 2 \cdot \text{Cl} : \rightarrow [\cdot \text{Cl} : ]^{-} \, [\text{Mg}]^{2+} \, [\cdot \text{Cl} : ]^{-} \]
The chemical formula for magnesium chloride is MgCl₂.
(c) Sodium sulfide:
\[ \text{Na} \cdot \cdot \cdot \text{S} : \]
Two Na atoms are needed for every S atom.
\[ 2 \, \text{Na} \cdot + \cdot \text{S} : \rightarrow [\text{Na}]^{+} \, [\cdot \text{S} : ]^{2-} \, [\text{Na}]^{+} \]
The chemical formula for sodium sulfide is Na₂S.
(d) Aluminum oxide:
\[ \text{Al} \cdot \cdot \cdot \text{O} : \]
Two Al atoms are needed for every 3 O atoms.
\[ 2 \, \text{Al} \cdot + 3 \cdot \text{O} : \rightarrow [\cdot \text{O} : ]^{2-} \, [\text{Al}]^{3+} \, [\cdot \text{O} : ]^{2-} \, [\text{Al}]^{3+} \, [\cdot \text{O} : ]^{2-} \]
The chemical formula for aluminum oxide is Al₂O₃.
8. (a) Element A with 2 valence electrons is most likely a metal. Element B with 7 valence electrons is a non-metal.
(b) Elements A and B would form a compound as follows:
\[ \text{A} \cdot \cdot \cdot \cdot \text{B} : \]
Two B atoms are needed for every A atom.
\[ \text{A} \cdot + 2 \cdot \text{B} : \rightarrow [\cdot \text{B} : ]^{-} \, [\text{A}]^{2+} \, [\cdot \text{B} : ]^{-} \]
(c) An ionic compound is formed.
(d) The chemical formula for this compound is AB₂.
9. Ionic compounds, houndstooth check fabrics, and the work of M.C. Escher all have repeating units or formula units.
10. Answers may vary based on research. Sample answer: Sodium chloride, NaCl, is the most common road salt. Sodium chloride is inexpensive but it is not an effective de-icer at low temperatures. It also damages cars and concrete, poisons the soil, and can kill plants and harm pets. Sodium contamination of drinking water supplies can have negative impacts on humans. Calcium chloride works at very low temperatures and isn’t as damaging to soil and plants as sodium chloride, but it costs a bit more and is corrosive to metal and concrete. Calcium magnesium acetate does not cause corrosion, is safe for concrete and plants, but is only good down to the same temperature as sodium chloride. It is better at preventing water from re-freezing than at melting snow and ice. Potassium acetate is a less-toxic, biodegradable alternative that works at colder temperatures than either calcium magnesium acetate or sodium chloride.