

## Understanding Concepts

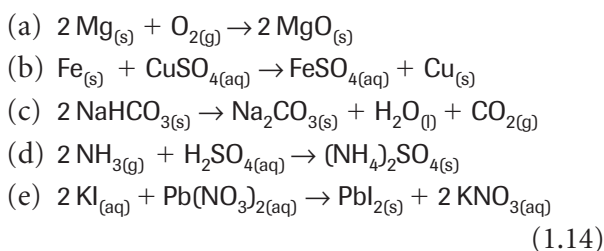
- Using examples, explain the difference between
  - inference and observation
  - empirical knowledge and theoretical knowledge
  - theory and model (1.2)
- The six terms in question 1 are interrelated. Create a concept map that illustrates the relationships among the six terms. (1.2)
- Many scientists have contributed to the development of the current model of the atom. Copy and complete **Table 1**, indicating the main contribution of each scientist. (1.3)

**Table 1** History of Atomic Theory

Scientist	Contribution to atomic theory
John Dalton	
J.J. Thomson	
Ernest Rutherford	
James Chadwick	
Niels Bohr	

- Red light has a longer wavelength than blue light.
  - Which colour of light has a higher frequency?
  - Which colour of light has more energy? (1.4)
- Explain why a rainbow is considered to be an example of a continuous spectrum. (1.4)
- Electrons can be found in either the ground state or the excited state.
  - Explain how an electron is promoted from the ground state to the excited state.
  - In which state does the electron possess more energy?
  - What happens when an electron returns to the ground state? (1.6)
- In your own words, explain what Bohr meant when he stated that the energy of an electron in an atom is quantized. (1.6)
- Describe how spectroscopy can be used to identify a gas. (1.6)
- “Matter emits light when it is subjected to a flame test.” Explain this statement using Bohr’s model of the atom. (1.6)
- Why may solutions that contain an ionic solute conduct electricity? (1.11)
- Draw a Lewis symbol for each of the following atoms and ions:
  - sodium ion
  - calcium ion
  - oxygen atom
  - phosphorus atom
  - neon atom
  - chloride ion (1.11)
- Identify which ions in question 11 are negatively charged and which ions are positively charged. Indicate how many electrons each atom has gained or lost when forming the ion. (1.11)
- Which of the following pairs of atoms would you expect to form ionic compounds? Give reasons for your answer.
  - sodium and fluorine
  - carbon and hydrogen
  - magnesium and chlorine (1.11, 1.12)
- Describe one similarity and one difference between a covalent bond and an ionic bond. (1.11, 1.12)
- Draw a Lewis structure for the compound that consists of each of the following pairs of atoms:
  - hydrogen and nitrogen
  - oxygen and oxygen
  - hydrogen and oxygen
  - nitrogen and nitrogen (1.12)
- Why is water a polar molecule? (1.12)
- Why is carbon tetrachloride,  $\text{CCl}_4$ , a nonpolar molecule even though the C–Cl bond is polar? (1.12)
- Why do nonpolar molecules composed of many atoms have higher melting points than nonpolar molecules composed of fewer atoms? (1.12)

19. Classify each of the following reactions as a synthesis, decomposition, single displacement, or double displacement reaction:



20. Which reaction in question 19 could also be classified as a combustion reaction? (1.14)

21. Determine the products and write a balanced chemical equation to show the reaction (if any) that occurs when each pair of solutions is mixed. Use the solubility rules to help you predict precipitates.  
 (a) sodium chloride and silver nitrate  
 (b) copper(II) chloride and sodium nitrate  
 (c) sodium sulfide and lead(II) nitrate  
 (d) potassium hydroxide and ammonium chloride (1.15)

22. For any chemical reactions in question 21, write the total ionic equation and net ionic equation. (1.15)

23. Describe how each of the following procedures may be used in qualitative chemical analysis:  
 (a) flame tests  
 (b) spectroscopy  
 (c) precipitation (1.15)

## Applying Inquiry Skills

24. An unidentified substance appears on the surface of a city's water reservoir (**Figure 1**). What are some experimental techniques that could be used to help classify and identify the substance? (1.15)

25. Household cleaning products contain different chemicals. Obtain a cleaning product from your home, and list the ingredients. Using your knowledge of qualitative analysis techniques and the solubility rules, determine which ions could be used to test for the ions in the cleaning product. (1.16)

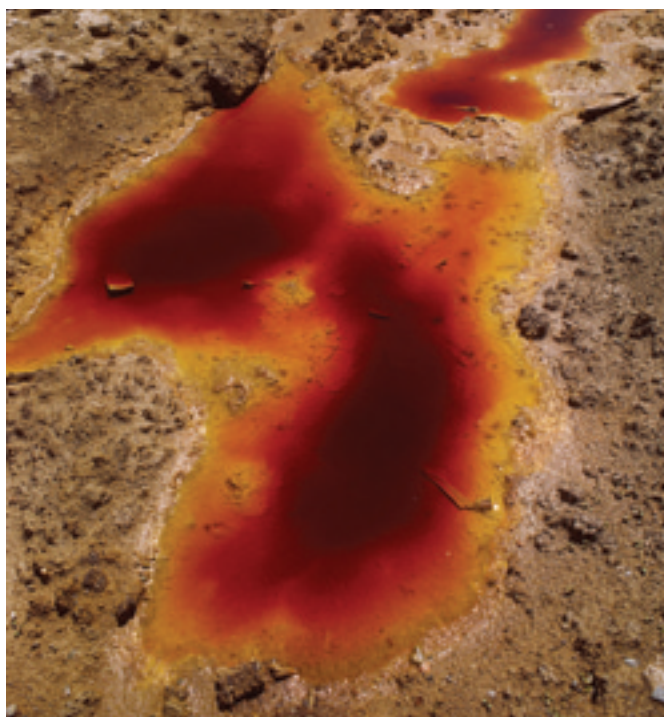
26. Molecular solids and ionic solids differ in many ways.

- (a) Given the information in **Table 2**, determine whether each solid is ionic or molecular.  
 (b) What other tests could you conduct on solid A and solid B in order to support your classifications? Describe the expected results of these tests. (1.13)

**Table 2** Molecular and Ionic Solids

Solid	Melting point (°C)	Boiling point (°C)	Conductivity in aqueous solution
A	776	1500	good
B	76	196	none

27. A forensic chemist is given samples of four unidentified solutions. The identities of these solutions could affect the outcome of a court case involving an electrocution. The chemist has reason to believe that the four solutions are sodium chloride,  $\text{NaCl}_{(aq)}$ , ethanol,  $\text{C}_2\text{H}_5\text{OH}_{(aq)}$ , hydrochloric acid,  $\text{HCl}_{(aq)}$ , and barium hydroxide (a base),  $\text{Ba}(\text{OH})_{2(aq)}$ . The chemist designs an experiment to identify the chemicals. The chemist dissolves each sample in water and tests the solution with a conductivity apparatus and



**Figure 1**

litmus paper. (Acidic solutions turn blue litmus paper red. Basic solutions turn red litmus paper blue.) Complete the Analysis and Synthesis for the following lab report:

### Question

What are the identities of the four substances, labelled 1 to 4 in **Table 3**?

### Observations

**Table 3** Evidence for Identifying Solutions

Solution	Electrical conductivity	Litmus
water	none	no change
1	high	no change
2	high	blue to red
3	none	no change
4	high	red to blue

### Analysis

(a) Answer the Question.

### Synthesis

- (b) Why was the water that was used to prepare the solutions also tested?
- (c) Which of the solutions (1, 2, 3, and/or 4) could have been involved in an electrocution? (1.11, 1.12)


## Making Connections

28. Some natural waters contain iron ions that affect the taste of the water and cause rust stains. Aeration converts any iron(II) ions into iron(III) ions. A basic solution (containing hydroxide ions) can then be added to produce a precipitate.
- (a) Write the net ionic equation for the reaction of aqueous iron(III) ions and aqueous hydroxide ions.
- (b) What separation method is most likely to be used during this water treatment process? (1.15)
29. A heterogeneous mixture (a wet sample) of barium sulfate,  $\text{BaSO}_{4(s)}$ , is given to patients before an X-ray scan of the gastrointestinal tract. Barium sulfate is a white ionic compound with low solubility. Why is barium sulfate “sludge” safe to drink, even though barium ions are toxic? (1.15)

30. Forensic scientists use many qualitative analysis techniques in order to identify a substance conclusively. Why would the use of just one qualitative analysis technique be open for questioning in a court of law? (1.11)
31. The production and circulation of counterfeit money has increased dramatically over the last decade. Many governments, including the governments of Canada and the United States, have redesigned their currency to make it more difficult to counterfeit. Detection devices in stores now allow merchants to test for counterfeit money. Research the measures that are used to prevent the production of American counterfeit currency, and the measures that are used to detect it. Compare these measures with the measures that are used to prevent the counterfeiting of Canadian currency. Summarize your findings in paragraph form. (1.9)



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32. Currently, in Ontario, there is a shortage of medical MRI technologists. The increasing demand for MRI by patients and doctors, together with the low number of qualified individuals who can perform MRI procedures, points to a healthy job market for medical MRI technologists. Research where MRI technologist programs are offered in Canada. Find out the courses taken in the program, and the duration of the program. Present your findings in paragraph form.  (1.10)



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## Extension

33. Laundry detergents give better results when they are used with soft water rather than hard water. Today, many laundry detergents contain chemicals called zeolites, which soften the water. Research the difference between soft water and hard water. Also research how zeolites work to soften water. Write a paragraph to summarize your findings.



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