

Unit 1

Matter and Qualitative Analysis

Prerequisites

Concepts

- balanced chemical equations
- the states of matter
- physical and chemical changes and properties
- the symbols for common elements and the formulas for common compounds
- the formulas of common ionic and molecular compounds, based on the periodic table and an IUPAC table of ions
- Bohr–Rutherford diagrams

Skills

- design and conduct controlled experiments
- select and use laboratory materials accurately and safely
- organize and display experimental observations and data in suitable tabular and graphical formats



Figure 1
Calcium chloride is used to melt ice on walkways and roads in the winter.

ARE YOU READY?

Knowledge and Understanding

1. Calcium chloride (**Figure 1**) is a salt that is added to roads and sidewalks in the winter to melt ice and snow. State whether each of the following properties of calcium chloride is physical or chemical, and whether each physical property is qualitative or quantitative.
 - (a) Calcium chloride has a melting point of 782°C .
 - (b) Calcium chloride has a density of 2150 kg/m^3 .
 - (c) Calcium chloride is soluble in water.
 - (d) In the presence of sulfuric acid, calcium chloride reacts to form hydrogen chloride.
 - (e) When heated to decomposition, calcium chloride produces chlorine gas.
2. Classify each of the following changes as physical or chemical. Explain your classification.
 - (a) Water boils in a kettle.
 - (b) Propane burns in a barbecue.
 - (c) Acid rain corrodes iron.
 - (d) An apple rots.
 - (e) Sugar dissolves in hot tea.
 - (f) An egg is boiled.
 - (g) Butter melts on hot toast.
 - (h) Wood burns.
 - (i) Copper wire bends.
 - (j) A candle burns.
 - (k) Snow melts.
3. What physical property is described by each of the following statements?
 - (a) Aluminum can be hammered into thin sheets.
 - (b) Copper wire is used for electrical circuitry in homes.
 - (c) One millilitre of water has a mass of one gram.
 - (d) Ice melts at 0°C .
 - (e) Diamond can scratch glass.
4. Distinguish between the two terms in each of the following pairs of terms. Provide examples where possible.
 - (a) element and compound
 - (b) solute and solvent
 - (c) mechanical mixture and solution
 - (d) homogeneous mixture and heterogeneous mixture
 - (e) proton and neutron
 - (f) metal and nonmetal
 - (g) atom and molecule
 - (h) atomic number and mass number
 - (i) pure substance and mixture

5. Look carefully at the following diagrams (**Figure 2**). Decide whether each diagram represents an element, a compound, or a mixture. If the diagram represents a mixture, state how many elements and how many compounds are present in the mixture. Note that each different circle represents a different atom.

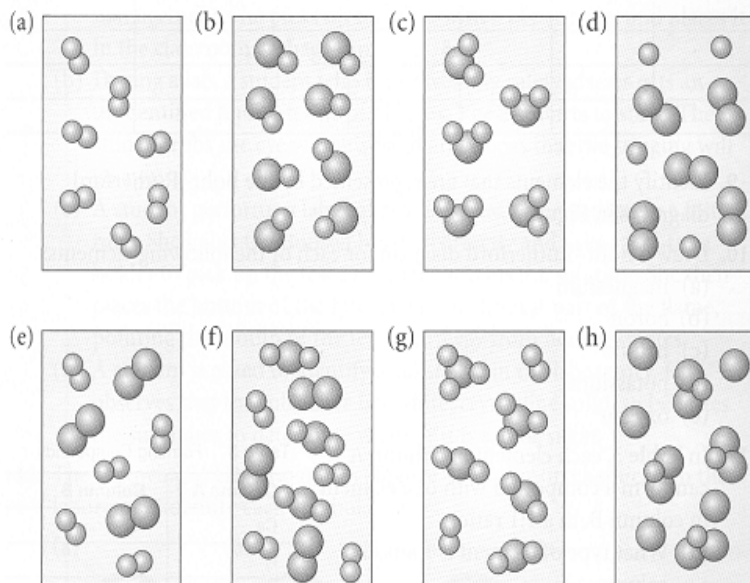


Figure 2
Elements, compounds, and mixtures

6. Copy and complete **Table 1**.

Table 1 Subatomic Particles


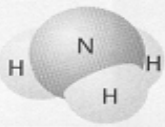
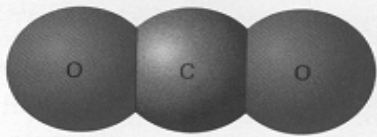
| Particle | Relative mass | Relative charge | Location within atom |
|----------|---------------|-----------------|----------------------|
| proton | | | |
| electron | | | |
| neutron | | | |

7. List the elements that belong to each of the following groups in the periodic table:
- halogens
 - alkali metals
 - noble gases
 - alkaline earth metals

Knowledge and Understanding

1. Copy and complete Table 1.

Table 1 Chemical Elements and Compounds

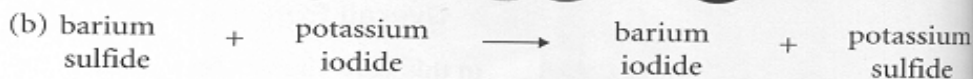
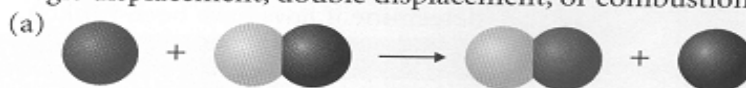
| IUPAC name | Chemical formula | Space-filling models | Element or compound |
|------------|------------------|--|---------------------|
| | O_2 |  | |
| ammonia | |  | |
| | |  | compound |

2. Copy and complete Table 2.

Table 2 Ionic Compounds

| Positive ion | Negative ion | Compound formula | IUPAC name |
|--------------|--------------|------------------|------------|
| Na^+ | Cl^- | | |
| Ca^{2+} | Br^- | | |
| Al^{3+} | S^{2-} | | |
| Na^+ | SO_4^{2-} | | |
| NH_4^+ | CO_3^{2-} | | |
| K^+ | ClO_3^- | | |
| Cu^{2+} | PO_4^{3-} | | |

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



4. A piece of magnesium is placed in a beaker that contains hydrochloric acid. Aqueous magnesium chloride and bubbles of hydrogen gas are produced. Write a word equation that represents this chemical change.

5. Balance each of the following chemical equations:

- (a) $\text{Na}_{(s)} + \text{F}_{2(g)} \rightarrow \text{NaF}_{(s)}$
 (b) $\text{Al}_{(s)} + \text{S}_{8(s)} \rightarrow \text{Al}_2\text{S}_{3(s)}$
 (c) $\text{CO}_{(g)} + \text{H}_{2(g)} \rightarrow \text{C}_7\text{H}_{14(l)} + \text{H}_2\text{O}_{(l)}$





6. Write a balanced symbol equation for each of the following word equations:

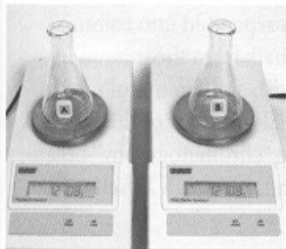
- (a) solid calcium + liquid water \rightarrow solid calcium hydroxide + hydrogen gas
 (b) aqueous lead(II) nitrate + aqueous potassium iodide \rightarrow solid lead(II) iodide + aqueous potassium nitrate

Inquiry and Communication

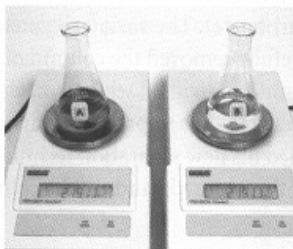
7. Match each WHMIS symbol in the first column of **Table 3** with the correct class and type of compound in the second column.
 8. A student performs the following experiment:

Table 3 Matching HMIS Symbols

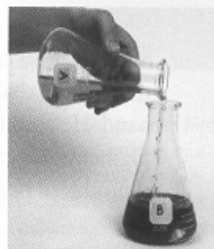
| Symbol | Class and type of compound |
|---|---|
|  | Class B: Flammable and Combustible Materials |
|  | Class C: Oxidizing Materials |
|  | Class D: Toxic Materials Immediate and Severe |
|  | Class F: Dangerously Reactive Materials |



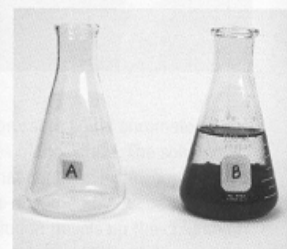
Part 1: Empty flasks (121.08 g)



Part 2: Reactants A and B (219.17 g)



Part 3: Reaction



Part 4: Products in flask B

- (a) What evidence indicates that a chemical reaction occurs in Part 3?
 (b) Predict the final mass of flask B and its contents (Part 4).
 (c) Which law of chemistry is the student trying to test?
 (d) Suggest reasons why the total mass of the products (Part 4, flask B) could appear to be less than the total mass of the reactants (Part 2, flasks A and B).

Math Skills

9. Copy and complete **Table 4**.

10. Complete each of the following calculations:

- (a) Given $\frac{x}{y} = \frac{3}{2}$, find y when $x = 9$.
 (b) There are 436 boys and 657 girls in a school. Calculate the percentage of girls in the school.
 (c) $\frac{5.42 \times 10^8 \text{ g}}{7.34 \text{ mL}} = ?$

11. Graph the data in **Table 5** by plotting volume on the x -axis and mass on the y -axis. Draw a line of best fit. Remember to label the axes and include a title for your graph.

Table 4 Converting Measurements

| Decimal notation | Scientific notation |
|------------------|-------------------------------|
| 0.010 m | |
| | $4.01 \times 10^2 \text{ mL}$ |
| 385.5 g | |

Table 5 Data for Graph

| Mass (g) | Volume (mL) |
|----------|-------------|
| 1.0 | 1.9 |
| 2.0 | 3.4 |
| 4.0 | 5.6 |
| 5.0 | 7.8 |
| 7.0 | 10.0 |
| 9.0 | 12.3 |