Topic 2.5
In what ways do scientists communicate about elements and compounds?

Specific Expectations

- **C1.2** assess the social and environmental impact of the production or use of a common element or simple compound
- **C2.6** construct and draw models of simple molecules
- **C3.6** use symbols and chemical formulae to represent common elements and simple compounds
- **C3.7** identify the elements and compounds in common household products

Skills

- make predictions or hypotheses based on research
- select, organize, and record relevant information from various sources
- analyze data for reliability and bias
- communicate using appropriate language and a variety of formats

Materials

Please see the teaching notes for each activity for a list of the materials required. Please see page TR-40 for a summary of the materials required in this topic.

Overview

In this topic, students will learn to represent elements and compounds by writing chemical symbols and formulas, drawing diagrams, and building models.

Common Misconceptions

- **Students assume that the number in front of a chemical formula applies only to the first symbol (for example, $2H_2O$ has four hydrogen atoms and one oxygen atom).** Explain that the number applies to the entire molecule and that students need to multiply the number by each subscript number to find the total number of atoms for each element. To clarify this concept, write several simple chemical formulas, such as $3CO_2$, 2NaCl, and $4SiH_4$ on the chalkboard. Draw pictures to represent the molecules or pass around models, and then have students count the total number of each element. Students might want to add brackets around the molecule, for example, $2(H_2O)$, to help them remember.
- **Students think the subscript number in a chemical formula applies to the symbol after it rather than before it (for example, H_2O means one hydrogen atom and two oxygen atoms).** Explain that the number after a symbol shows how many atoms of that element are present, not the number of atoms of the next element. Clarify this by deconstructing the chemical formula out loud. For example: "What does H_2O mean? There is hydrogen because I see the symbol H. Then there is a two, so that means there are two hydrogen atoms. Then there in an O, which represents oxygen. There is no number after the O, so there is only one atom of oxygen. So H_2O means two hydrogen atoms bonded with one oxygen atom."

Background Knowledge

Each element in the periodic table is represented by a chemical symbol. The elements that were known since ancient times have symbols based on Latin or Greek words (Cu for copper or *cuprium* in Latin). As more elements were discovered, scientists developed several naming rules to ensure each chemical symbol was unique. The first element discovered that started with a specific letter was assigned the first letter of the element name (C for carbon). The next element discovered which started with the same letter was assigned the first two letters of the element name (Ca for calcium). Subsequent discoveries were assigned the first letter and the next letter that had not already been used in the element name (Cl for chlorine, Cf for californium). The chemical symbols form the basis of an international system for communication in chemistry.

Elements are pure substances made of one particle called an atom, and some elements are also molecular. The non-metallic elements hydrogen, nitrogen, oxygen, chlorine, bromine, and iodine are all able to form bonds with another atom of the same type to form diatomic molecules like O_2. Phosphorous and sulfur are also able to bond to themselves but they can form larger structures of four to six atoms. These bonds are very strong covalent bonds.

Molecules form because atoms are more stable with a full outer shell of electrons. A stable outer shell is two electrons for period 1 and eight electrons for periods 2 and 3. If an element has one outer shell electron, it will lose its electron to another atom that needs more electrons to fill its outer shell. The number of bonds an atom can make with other atoms is called combining capacity. The combining capacities important in this topic are: carbon (4), oxygen (2), hydrogen (1), and nitrogen (3). When building molecular models, it is important to give all of the atoms the correct number of bonds.

Salt is an interesting compound. Composed of two dangerous chemicals, the compound sodium chloride is harmless. It is an excellent example of how the properties of elements change when they combine. Sodium reacts with water to form hydrogen gas, which can be explosive. It will react with the water in your skin and will burn you if you pick it up. Chlorine gas is highly toxic. In liquid form, it is used to kill bacteria in pools and drinking water. Combined, sodium chloride does not react with water, is not toxic, and is a solid. Sodium (Na) ions are essential in the functioning of the cells in our bodies, especially in the transmission of nerve impulses. The best thing to do when severely dehydrated is to eat some salt. This prepares your body to receive any water that you drink, meaning you absorb more of the water. This is why sodium is one of the electrolytes found in sports drinks.

Literacy Strategies

Before Reading

- Point out all the day-to-day things we use symbols for and how the use of symbols helps us. Consider showing a symbol slide show, including addition and multiplication symbols, road signs that include symbols, and computer icons. Write a simple math equation with symbols and with words, and ask students which is easier to solve.
- Review with students the difference between elements and compounds.

During Reading

- Use a think-aloud strategy to model the use of text features such as tables, titles, and definitions, to aid comprehension as you read to students.
- Have students discuss the use of each item in Figure 2.14.
- ELL Encourage English language learners to use sticky notes to mark words and phrases that they do not understand as they read, and to consult a dictionary or glossary, a classmate, or you afterward for clarification. Students can name the elements in their first language as well.

After Reading:

- Challenge students to make a set of rules for determining symbols.
- Students can share their answers to **BLM 2-28 Counting Atoms**.
- Play Element Bingo to help students learn the element names and symbols.
- Students can add new words to the word wall and to their pictorial glossaries.

Assessment FOR Learning

Tool	Evidence of Student Understanding	Supporting Learners
Learning Check, page 133 Learning Check, page 134	Students represent elements and compounds using chemical symbols and formulas.	• Have students make rhymes or other mnemonic devices to help them remember the names and symbols of the more common elements and share these with the class. • Play Element Bingo again, but have students write the symbols on their board, and call out the element names.
Activity 2.10, page 135	Students apply their knowledge of chemical symbols to construct models of compounds using the chemical formulas.	• DI Pair spatial and bodily-kinesthetic learners and have each pair hand in one copy of the activity for assessment.
Case Study Investigation, page 136 Activity 2.11, page 138	Students research and describe a common element and a common compound.	• Have students use a concept map to record the results of their research. They can use **BLM G-33 Concept Map**. • Direct students to a particular book or website for their research.

Topic 2.5 (Student textbook pages 130–139)

Using the Topic Opener

- Have students list as many substances as they can, for example, water, glass, copper, and wood. You could have students classify the items in their list as an element, a compound, or a mixture.
- Explain to students that carbon and hydrogen are essential elements in living things.
- Use the topic opener as a diagnostic assessment. Students should be able to name some chemical and physical properties of carbon and hydrogen and their compounds by using the information in the pictures. Discuss the properties of each element before having students complete the Starting Point Activity.
- If students are unable to describe the properties, review the concepts of physical and chemical properties. See student textbook pages 106–109.

Starting Point Activity (Student textbook page 131)

Pedagogical Purpose

The purpose of this activity is to have students compare the physical and chemical properties of elements and their compounds.

Planning		
Materials	Samples of each substance in the photographs (optional) **BLM 2-26 Topic 2.5 Starting Point Activity** (optional)	For demonstration (optional): water calcium carbide (size of a grain of rice) 0.1 M hydrochloric acid charcoal calcium splint lighter test tubes
Time	15 min	
Safety	Wear safety goggles. Perform the experiments behind a splash screen or in a fume hood. Do not leave experiments unattended. Reactions will produce flammable and explosive gases.	

Activity Notes and Troubleshooting

- Students can use Think-Pair-Share to complete the activity in pairs and discuss their answers as a class. As you discuss their answers, ask students why they chose each physical or chemical property.
- Have the class respond to this activity using an exit card. On the card, have them list at least three ways hydrogen and carbon are important in their lives.
- A good demonstration of the chemical properties of hydrocarbons is to mix calcium carbide and water in a test tube to produce acetylene gas, which is flammable. Place the calcium carbide into 10 mL of the hydrochloric acid and place your thumb on top of the test tube. Allow the chemicals to bubble until you feel pressure on your thumb and then introduce a flame on a splint and it should burn. The products of the reaction are acetylene and calcium hydroxide (limewater). Remember that the more bubbles you see, the more gas is being produced. Compare this reaction to the flammability of a piece of pure carbon (charcoal) and to hydrogen gas produced through the reaction of calcium and the hydrochloric acid (the gas will explode).

Additional Support

- ELL English language learners and students who require support organizing and recording a response can use **BLM 2-26 Topic 2.5 Starting Point Activity** to record their observations.
- DI For spatial learners, there are excellent videos on the Internet that show the combustion of hydrocarbons.
- DI Have interpersonal learners describe to their partners how they would use the substances and then record some of their feelings or experiences on the exit card.
- DI Have spatial learners draw a picture that incorporates at least three of the substances showing the use of their properties in some practical way.

Answers

1. The physical properties of hydrogen and carbon are different from the physical properties of hydrocarbons. Hydrogen is a non-conductive gas. Carbon is a heavy solid that is non-conductive. It can be soft and powdery or very hard and dense. It is usually dull but can have a high lustre when polished. Hydrocarbons can be solid, liquid, or gas. The solids have lustre and are lighter than carbon.
2. Three chemical properties most of the hydrocarbons have in common are combustibility, reactivity to oxygen, and decomposition.

Instructional Strategies for Topic 2.5

Chemical symbols are used to represent elements.

(Student textbook pages 132–133)

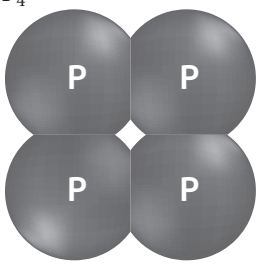
- Read page 132 to students using a think-aloud strategy. Read the text to students and verbalize the process they can use to decode the text and pictures. Pause after key terms and ask students to define the term in their own words. Pause after the tables are mentioned and look for them on the page. Connect the tables to the text and describe what you are thinking as you look at the table. For example, while looking at Table 2.6, you could say: "Many elements have Latin names. I wonder if the name is based on properties of the element?"
- Before reading about elements as molecules, tell students a story about Hofbrincl the clown. Use **BLM 2-27 Hofbrincl the Clown** to support the story. Hofbrincl loved chemistry because he could see the atoms that made up all matter. He found all the different shapes fascinating. One day, he noticed that some atoms were joined together in pairs. He started to make a list of the elements that came in pairs and was very surprised that they spelled out his name. What elements did he find as molecules? (H_2, O_2, F_2, Br_2, I_2, N_2, Cl_2)
- ELL Have students read page 133 on their own, but ask them to use the strategies they saw you using. Before having English language learners read, work through one example from Table 2.7 using the language and sequence of the key ideas from the textbook.
- After reading, have students work in pairs to infer a set of rules to determine how the symbols were chosen for the elements. See Background Information for details about chemical symbol rules.
- Have students add new words to the word wall and to their pictorial glossaries.
- To help students practise using the names and symbols of the first 20 elements, have them play a variation of the game from Topic 2.4. Give students **BLM 2-24 Element Bingo** and have them write the symbols for the first 20 elements randomly in the blank spaces. Call out the element name and have students find the matching symbol without using the periodic table. Students call out "elemento" when they have completed a column, a row, or the right diagonal.

Chemical formulas are used to represent the types and numbers of atoms in compounds. (Student textbook pages 134–135)

- Before reading, use **BLM 2-28 Counting Atoms** to help students decode the method of reading chemical formulas.
- While reading, have students copy Figure 2.13 into their notes. Discuss with them the use of each item in Figure 2.14. (Hydrogen peroxide is an antiseptic, lye is an oven cleaner, and sodium chloride is a seasoning.)
- Use **BLM 2-28 Counting Atoms** to help students understand how to read chemical formulas.
- ELL Syntactically complex sentences are difficult for English language learners to understand. Provide unfinished sentences for them to complete, such as "A molecule is formed when ...," or "A substance is a compound if ... ."
- After reading, have students share their answers to **BLM 2-28 Counting Atoms** in pairs and explain each row to their partner.

Learning Check Answers (Student textbook page 133)

1. helium (He) , aluminium (Al) , tungsten (T), cadmium (Cd), krypton (K), francium (Fr), iodine (I), cobalt (Co), and barium (Ba)
2. Silver has the symbol Ag from *argentum*. which is Latin for silver. Silicon was discovered later and given the symbol Si, for the first two letters of its name.
3. P_4



4. Some elements use the first one or two letters of the Latin word as the chemical symbol: potassium is K from *kalium*, iron is Fe from *ferrum*, sodium is Na from *natrium*, and copper is Cu from *cuprum*. Other elements have a chemical symbol that uses the first letter and some other letter in the Latin word: silver is Ag from *argentum*, mercury is Hg from *hydrargyrm*, tin is Sn from *stannum*, and lead is Pb from *plumbum*.
5. Answers may vary. Asherium (Ah), Phoenixium (Ph), Wymium (Wy), Searlium (Sa), Edwardium (Ed), Weberum (Wb), Canadium (Cn), and Ontarium (On)

Learning Check Answers (Student textbook page 134)

1. If the atoms are different, then it must be a compound. Elements have only one type of atom.
2. H_2O_2 has two hydrogen atoms and two oxygen atoms.
3. $NaHCO_3$

Activity 2.10 Building Molecules (Student textbook page 135)

Pedagogical Purpose

In this activity, students apply their knowledge of chemical symbols to construct models of compounds using the chemical formulas.

Planning	
Materials	**BLM 2-29 Colouring Molecules** molecular model kits modelling clay and toothpicks (optional)
Time	30 min

Skills Focus

- interpret chemical formulas
- construct models

Activity Notes and Troubleshooting

- Use **BLM 2-29 Colouring Molecules** to introduce this activity and reinforce the method used to decode formulas.
- Students should work in pairs. If there are not enough model kits, they could work in groups up to four.
- If using modelling clay, ask students not to mix the colours so the clay can be reused.
- Encourage students to complete each row in the table before moving on to the next molecule.
- Remind students that they are making models when they draw or build molecules and that models are an important communication tool that requires care and precision.

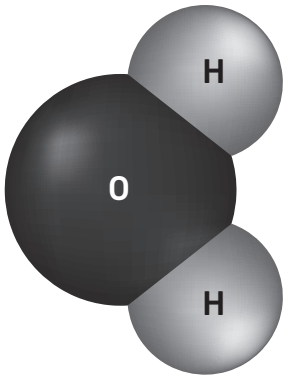
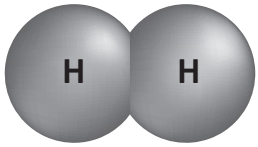
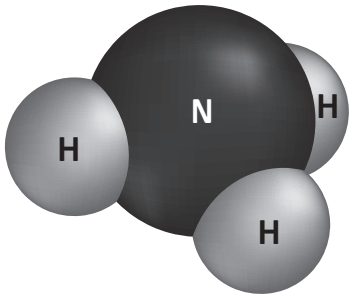
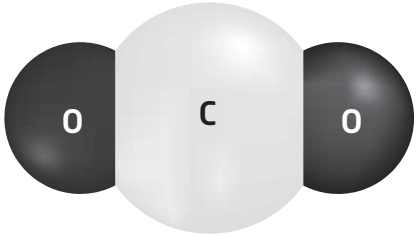
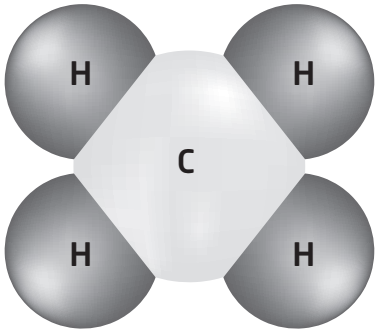
Additional Support

- DI Bodily-kinesthetic learners may want to build other molecules. C_2H_6 and $NaHCO_3$ would be good challenges for them.
- DI Consider having spatial and bodily-kinesthetic learners work together. Have each pair hand in one copy of the activity for assessment. Make sure bodily-kinesthetic learners check with you after building each molecule to get feedback.
- Students can practise these skills by making up their own formula and then building the molecule, or building a molecule, then drawing it and determining its formula.
- Enrichment—Discuss the concept of combining capacities with students (see Background Knowledge) and have students make up their own molecules using this information.

Activity 2.10 Answers

What To Do

2., 4.

Chemical Formula	Number and Type of Atom Present	Drawing of Molecule
H_2O	2 atoms hydrogen (H) 1 atom oxygen (O)	
H_2	2 atoms hydrogen (H)	
NH_3	1 atom nitrogen (N) 3 atoms hydrogen (H)	
CO_2	1 atom carbon (C) 2 atoms oxygen (O)	
CH_4	1 atom carbon (C) 4 atoms hydrogen (H)	

Using the Case Study Investigation
Salt of the Earth (Student textbook pages 136–137)

Pedagogical Purpose

This case study introduces students to the historical and economic importance of a common compound—salt.

Literacy Support

Before Reading

- ELL Have students complete rapid writing for two minutes in response to the question: "What do I know about salt?" This should activate their prior knowledge and prepare them for reading the case study. English language learners may find it easier to write in their first language.
- Students can work in pairs or small groups.
- ELL Preview the vocabulary with English language learners to ensure they understand the text. Students could also skim the text and identify any words they need explained.
- Set the context for the reading. Have students tell you what they notice about the newspaper article at the top of the page. (1930, Bombay, India) Read the article together and ask why there would be a tax on salt. Ask, "Why was salt so important?"

During Reading

- DI Spatial learners would benefit from visualizing the meaning of the text.
- ELL English language learners should look for contextual cues to determine overall meaning of a paragraph. They might benefit from reading the paragraph with a strong reader who could explain connections. To help them stay focussed, have them list what they are learning about salt as they read.
- Students could work with a classmate. They should paraphrase the text for their partner and agree on the meaning by discussing each paragraph before moving on.
- Students should pause after each section to answer the Pause and Reflect questions and discuss their solutions with their partner. Once they come to a consensus, they should record the answer in their notebooks.

After Reading

- ELL Have students summarize what this case study says about salt. They should reduce the passage to no more than 20 words. Students can use **BLM G-30 Summarizing** to help them develop their summary. Have English language learners work with their partner to identify the key ideas from the ideas they listed as they read.
- Enrichment—Small groups could investigate one of the four Inquire Further topics and report back to the class.

Activity Notes

- The Inquire Further section of this case study could be set up as a carousel activity with stations that each explore a different aspect of salt.

  Station 1: Students build a molecule of salt using a model kit and a diagram of a salt molecule.
  Station 2: Students watch and respond to a video of Gandhi's salt march.
  Station 3: Students read and respond to health information about the dangers of eating too much salt.
  Station 4: Students read and respond to information about the Sifto salt mines.
  Station 5: Students compare and contrast salt mining methods using photographs of historic and modern salt mines. Students could visit the stations that interested them and use the information to complete the Inquire Further section of the case study. This activity will appeal to all types of learners.

- DI Interpersonal learners will find videos of Gandhi's salt march and salt production engaging.
- Resources for the case study and the carousel activity can be found at **www.scienceontario.ca**.
- An excellent resource for this topic is "Salt: A World History" by Mark Kurlansky (Knopf, 2002). The book provides an accessible and engaging examination of the historic and modern uses of salt around the world and includes many anecdotes and photographs

Case Study Investigation Answers

Pause and Reflect

1. Sodium chloride, NaCl

2. Salt supply was limited before the development of modern mining methods and it is essential for life.

3. Salt is used to preserve food and is necessary for chemical reactions in our bodies.

Inquire Further

4. Graphic novels may vary. Students should show that salt was discovered while drilling for oil.

5. Gandhi was arrested in 1930 for picking up a piece of salt from the ground. Several non-violent protests occurred and eventually India gained independence from Britain.

6. *Salam* means peace in Arabic.

7. a) Increased blood pressure is a common effect of eating too much salt. (If your kidneys cannot eliminate enough sodium, the sodium starts to accumulate in your blood. Because sodium attracts and holds water, your blood volume increases. Increased blood volume, in turn, makes your heart work harder to move more blood through your blood vessels, increasing pressure in your arteries.)

b) Reduce salt consumption by eating fewer packaged foods, cooking meals instead of eating in restaurants, and not adding salt to your food.

Activity 2.11 Learning More About The Elements and Their Compounds (Student textbook page 138)

Pedagogical Purpose

In this activity, students investigate the economic and social consequences of obtaining and using some common elements and their compounds.

Planning	
Materials	Research materials and Internet access **BLM G-32 Cause and Effect Map** to **BLM G-39 Double Bubble Organizer** (optional)
Time	60 min

Skills Focus

- gather and analyze data
- communicate using a variety of formats
- justify conclusions

Activity Notes and Troubleshooting

- Students should work in pairs on this activity.
- Before they start their research, ask students to divide a piece of paper into four parts, and label them as shown.

How?	Consequences?
Found	Found
Used	Used

Students can use this as their research organizer when writing their notes.

- Students can use Science Skills Toolkit 8: How to Do a Research-Based Project and **BLM G-12 Scientific Research Planner** to help them choose good sources of information.
- Either assign half the information to be researched to each partner or have all students complete all the research. This will increase accountability and allow students to practise their research skills.
- For question 3, have students read Literacy Skills Toolkit 5: Organizing Your Learning: Using Graphic Organizers, on pages 390 to 395, to choose a format for presenting their information. Students can copy the graphic organizer(s) of their choice from the book or use the Study Toolkit Masters (**BLM G-32 Cause and Effect Map** to **BLM G-39 Double Bubble Organizer**).
- Ask students to complete their own independent research and then give pairs time to meet and share their answers. If they do not agree on an answer, each student must find an additional supporting resource for their answer.

Additional Support

- Some students might need help finding good resources. See **www.scienceontario.ca** for websites that students could use.
- Enrichment—Ask students to pose two more questions that they are curious about and to include their findings in their report.
- ELL Allow students to present in a format of their choice, if they do not want to use a graphic organizer. Students could create a role-play, a cartoon, a poster, a Web page, a computer slide show presentation, or write a short essay or a story. Give English language learners time to rehearse before presenting in front of their peers. Some English language learners may have had limited access to a computer. A peer partner might be required, or you may need to limit the amount of research to be completed.
- Enrichment—You could use a RAFT activity to make the activity into a larger project. Provide several Roles for students to choose from (such as advertiser, political activist, and consumer), several Audiences they will address (such as the local government, consumers, and a company which uses the element in their products), and several Formats (such as a letter, an advertisement, and a poster). The Topics are the list of elements.
- Enrichment—You could use this activity to teach students about making a positive contribution to their communities. Have students work together to write a constructive letter to their local MP or MPP about the environmental issues they identified in this activity. Send the letters to the representative and have a class discussion about the representative's responses.

Activity 2.11 Answers

What Did You Find Out?

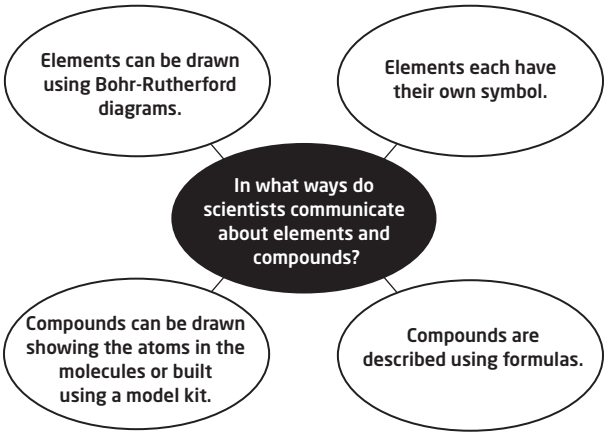
1. Answers will vary. Students should list at least one benefit and one risk and should give at least two reasons to justify their position.

Topic 2.5 Review (Student textbook page 139)

Please also see **BLM 2-30 Topic 2.5 Review (Alternative Format)**.

Answers

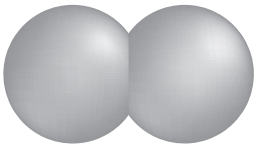
1.



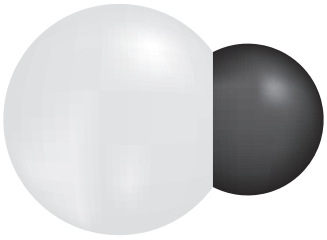
2. C (carbon), O (oxygen), N (nitrogen), Si (silicon)

3. Fe comes from *ferrum*, the Latin word for iron.

4. Two atoms of the same type combine to form an element.



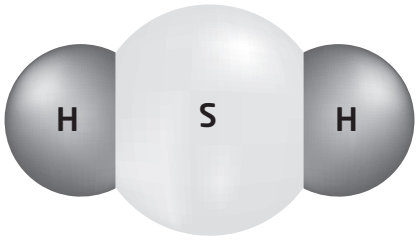
Two atoms that are different combine to form a compound.



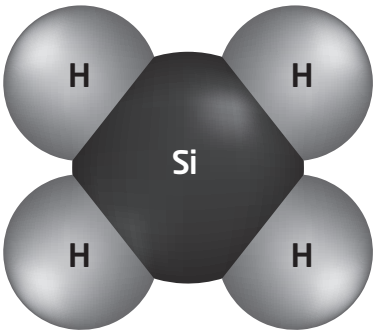
5. hydrogen H_2, oxygen O_2, fluorine F_2, bromine Br_2, iodine I_2, nitrogen N_2, chlorine Cl_2, phosphorus P_4, sulfur S_8

6. $C_6H_{12}O_6$ means that there are 6 carbon (C) atoms, 12 hydrogen (H) atoms, and 6 oxygen (O) atoms in each glucose molecule.

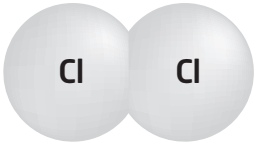
7. a) H_2S



b) SiH_4



c) Cl_2



8. C_3H_8

9. water H_2O, oxygen O_2, hydrogen H_2