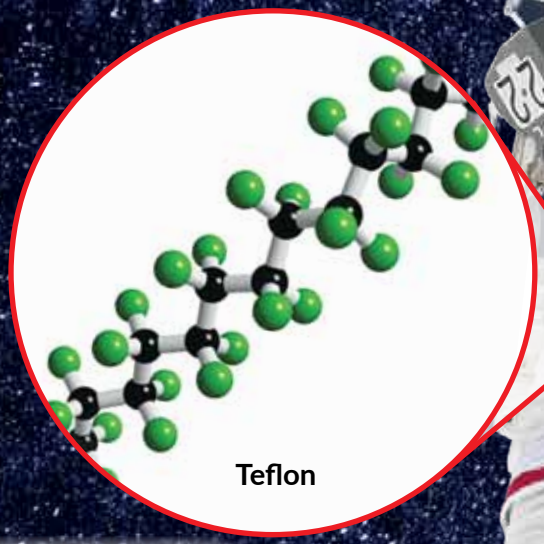
CHAPTER 5

Chemical Bond

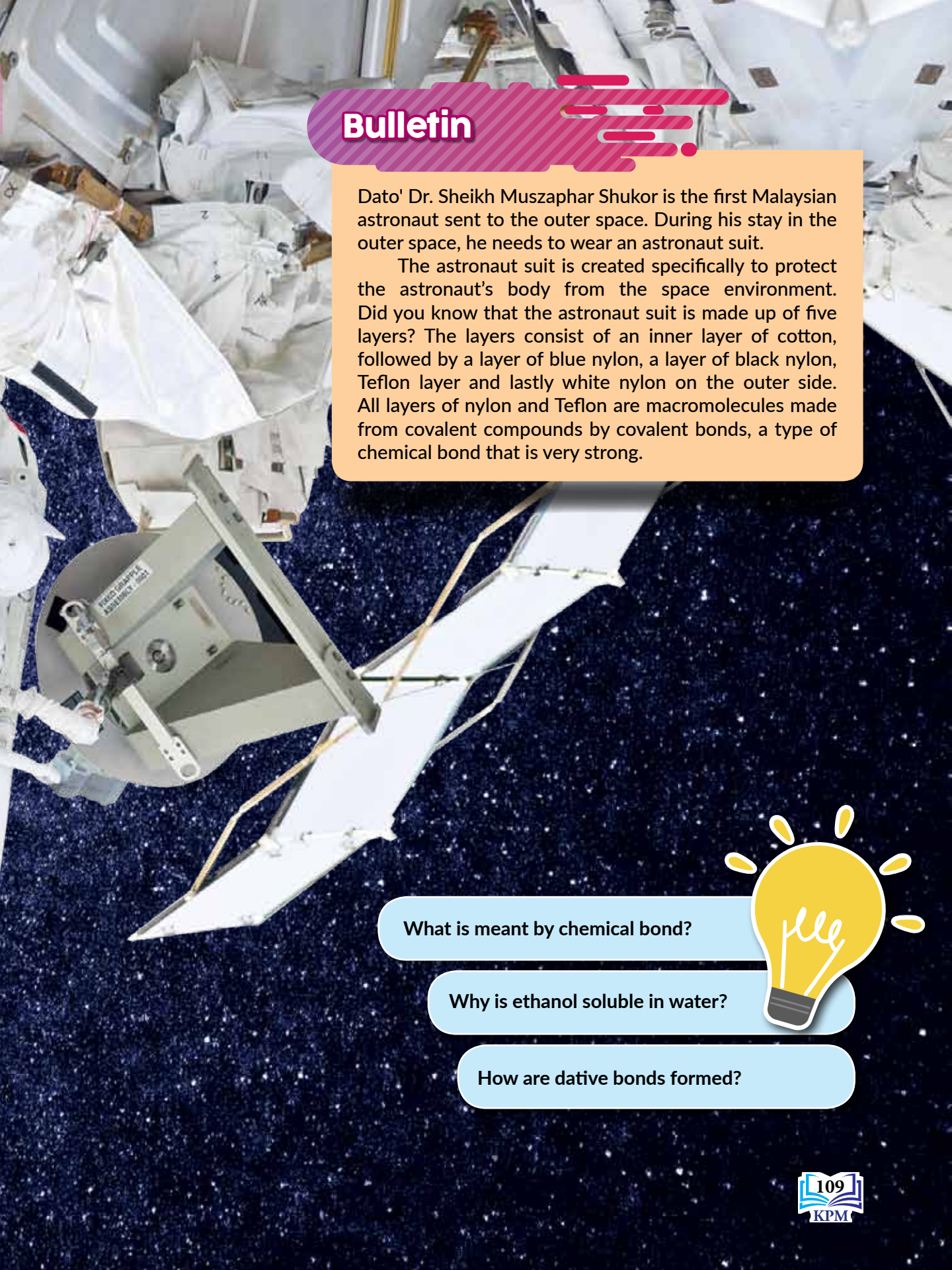
Keywords

- Chemical bonds
- Ionic bonds
- Electrostatic attraction force
- Covalent bonds
- Hydrogen bonds
- Dative bonds
- Van der Waals attraction force



Teflon

What will you learn?



Bulletin

Dato' Dr. Sheikh Muszaphar Shukor is the first Malaysian astronaut sent to the outer space. During his stay in the outer space, he needs to wear an astronaut suit.

The astronaut suit is created specifically to protect the astronaut's body from the space environment. Did you know that the astronaut suit is made up of five layers? The layers consist of an inner layer of cotton, followed by a layer of blue nylon, a layer of black nylon, Teflon layer and lastly white nylon on the outer side. All layers of nylon and Teflon are macromolecules made from covalent compounds by covalent bonds, a type of chemical bond that is very strong.

What is meant by chemical bond?

Why is ethanol soluble in water?

How are dative bonds formed?

5.1 Basics of Compound Formation

Learning Standard

At the end of the lesson, pupils are able to:
5.1.1 Explain the basics of compound formation

Sodium, Na is reactive towards chlorine gas, Cl_2 when heated and forms a white solid. Did you know that this white solid is the table salt that you use in your daily life? However, no compound is formed when sodium, Na is heated with neon gas, Ne. Why?

Compounds are formed when two or more elements are combined. Do you know how elements are combined to produce compounds?

Activity 5.1

Watching a video on the formation of compounds

1. Carry out the activity in groups.
2. Watch video clips on the formation of compounds by electron transfer (ionic bonds) and by sharing of electrons (covalent bonds) from your Internet search.
3. Based on those videos, discuss the following:
   (a) Formation of compounds by transfer of electrons to achieve a stable octet or duplet electron arrangement
   (b) Formation of compounds by sharing of electrons to achieve a stable octet or duplet electron arrangement
4. Present the findings of your discussion on a flip chart paper in front of the class.

Ionic bond
http://bit.ly/2MfCmit

Covalent bond
http://bit.ly/2BeDXi1

Noble gases exist as monoatomic gases and are not reactive chemically because they have achieved a stable duplet or octet electron arrangement. However, for atoms of other elements, stability of electron arrangement can be achieved by transferring or sharing of electrons. **Chemical bonds** are formed when electron transfer or electron sharing takes place. There are two types of chemical bonds; **ionic bond** and **covalent bond**. Chemical bonds only involve the **valence electrons**.

Brain Teaser

Why are electrons in the inner shells not involved in chemical bonds?

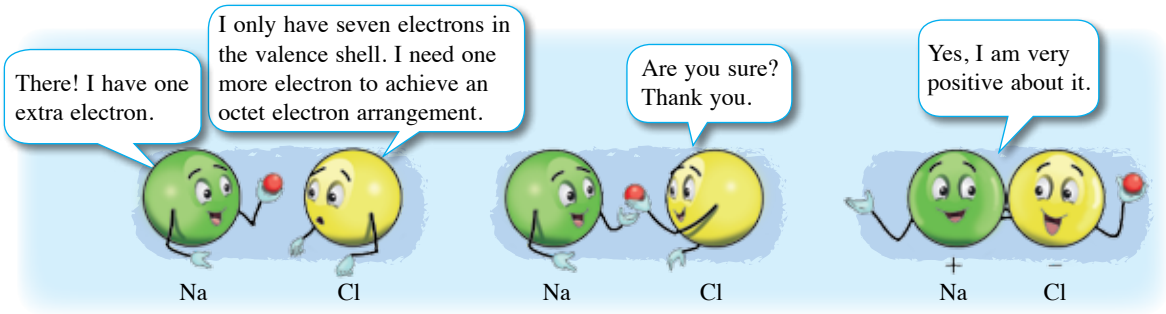


Figure 5.1 Formation of ionic bond

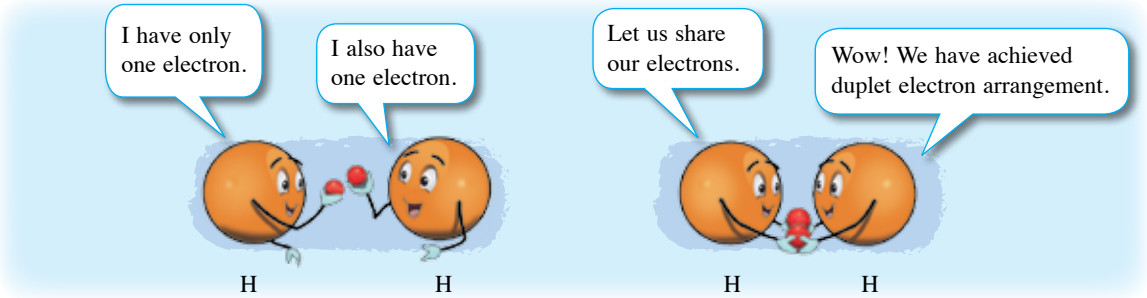


Figure 5.2 *Formation of covalent bond*

Test Yourself 5.1

1. What is chemical bond?
2. State two types of chemical bonds.
3. Why noble gases do not form compounds?
4. Is the electron arrangement of sodium atom, Na stable? If not, explain how the electron arrangement can become stable.

5.2 Ionic Bond

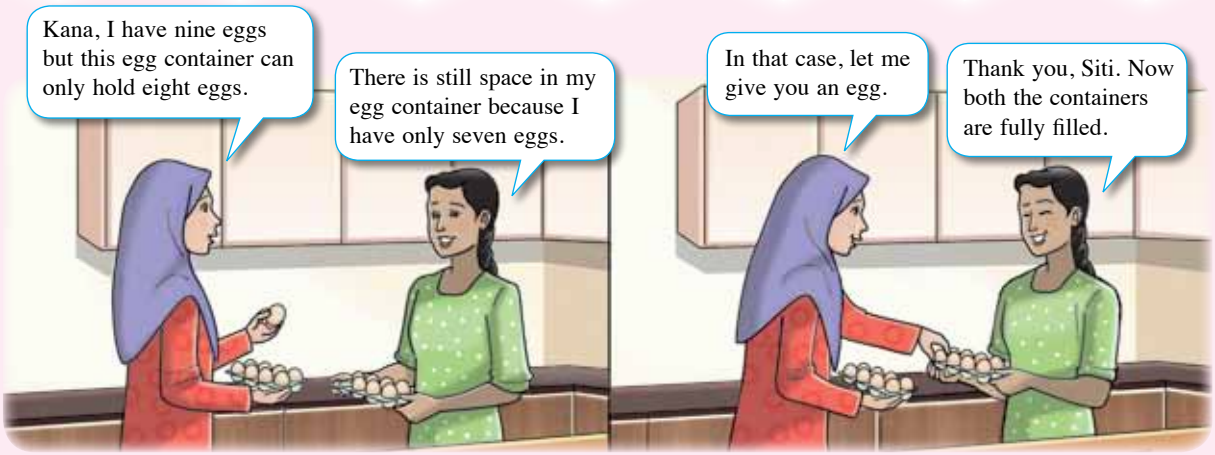


Figure 5.3 *Analogy for the formation of ionic bond*

Situation in Figure 5.3 gives the analogy for the formation of ionic bond. **Ionic bond** is formed by the **transfer** of electrons between a metal atom and a non-metal atom.

Learning Standard

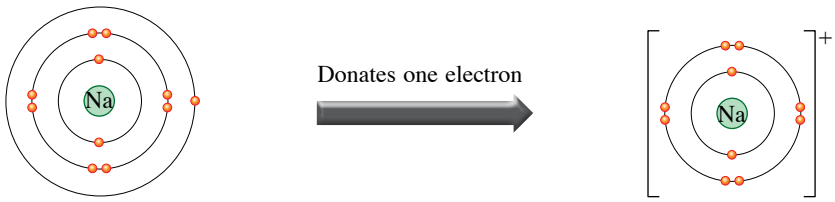
At the end of the lesson, pupils are able to:
5.2.1 Explain with examples the formation of ionic bond

Formation of Ions

Metal atom **donates** valence electron to form a positively-charged ion or cation. Figure 5.4 shows the formation of sodium ion, Na^+.

To achieve a stable electron arrangement, sodium atom, Na needs to donate an electron. The process of donating an electron from the valence shell of sodium atom, Na is much easier compared to accepting seven electrons from another atom.

After donating its valence electron, sodium ion, Na^+ achieves a stable octet electron arrangement. Sodium ion, Na^+ has 11 protons and 10 electrons, thus the charge for a sodium ion, Na^+ is +1.



2.8.1
Sodium atom, Na

2.8
Sodium ion, Na^+

Half-equation for the formation of sodium ion, Na^+:

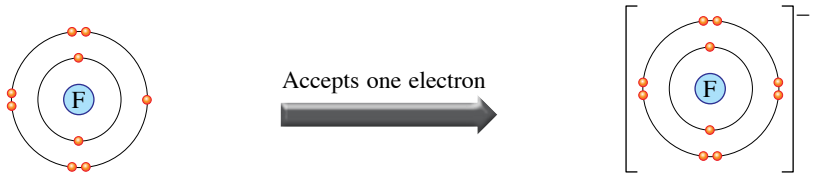
$$Na \longrightarrow Na^+ + e^-$$

Figure 5.4 *Formation of sodium ion, Na^+*

Non-metal atom **receives** electron from a metal atom to form a negatively-charged ion or anion. Figure 5.5 shows the formation of fluoride ion, F^-.

To achieve a stable electron arrangement, fluorine atom, F will accept an electron. The process of accepting one electron to the valence shell of fluorine atom, F is easier compared to donating its seven valence electrons to another atom.

After receiving one valence electron, fluoride ion, F^- achieves a stable octet electron arrangement. Fluoride ion, F^- has 9 protons and 10 electrons, so the charge of fluoride ion, F^- is –1.



2.7
Fluorine atom, F

2.8
Fluoride ion, F^-

Half-equation for the formation of fluoride ion, F^-:

$$F + e^- \longrightarrow F^-$$

Figure 5.5 *Formation of fluoride ion, F^-*

Formation of Ionic Bond

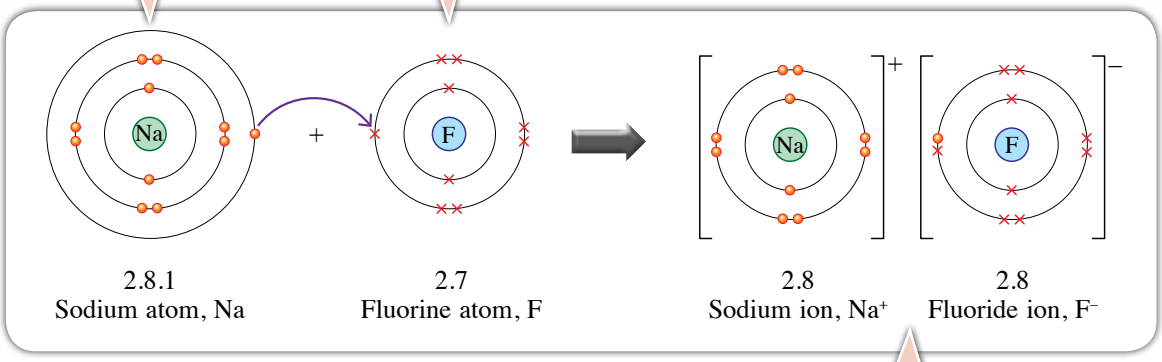
An ionic compound is formed when ions of opposite charges attract one another to form an ionic bond. How do ions of opposite charges attract one another?

Chemistry & Us

Besides calcium carbonate, $CaCO_3$, sodium fluoride, NaF is also added to toothpaste to strengthen the teeth.

Sodium atom, Na will donate one electron to achieve a stable octet electron arrangement. Sodium ion, Na^+ is formed.

Fluorine atom, F will accept one electron from sodium atom, Na to achieve a stable octet electron arrangement. Fluoride ion, F^- is formed.



Sodium ion, Na^+ and fluoride ion, F^- of opposite charges will attract one another by strong electrostatic attraction force. Electrostatic attraction forces are known as **ionic bonds**. A compound sodium fluoride, NaF is formed.

Figure 5.6 *Formation of sodium fluoride, NaF*

Activity 5.2

Discussing the formation of ionic bonds

21st Century Skills CT

1. Carry out the Gallery Walk activity.
2. Gather information from various reading resources and websites on the formation of ionic bonds for the following compounds:

   Magnesium oxide, MgO | Sodium chloride, NaCl | Sodium oxide, Na_2O

3. Scan the AR code to see the formation of ionic compound of sodium chloride, NaCl.
4. Discuss the formation of ionic bonds with your group members and prepare a presentation. You need to write half-equations for the formation of ions in each compound.
5. Display your group work in class. Move around to see the outcome of other groups' discussion.
6. Write comments on their work on sticky notes and paste them.

Test Yourself 5.2

1. Aluminium atom, Al has 13 protons while fluorine atom, F has 9 protons.
   (a) Write the formulae of ions formed from the two atoms respectively.
   (b) Write half-equations for the formation of ions in (a).
   (c) Draw the electron arrangement to show the transfer of electrons in the formation of ionic bonds in aluminium fluoride compound.
2. *Muriate of Potash* is a type of fertiliser that has a high content of potassium chloride compound. [Proton number: Cl = 17, K = 17, K = 19]
   (a) Write the chemical formula for potassium chloride.
   (b) Describe the formation of ionic bonds in potassium chloride compound.

5.3 Covalent Bond

Learning Standard

At the end of the lesson, pupils are able to:
5.3.1 Explain with examples the formation of covalent bond
5.3.2 Compare ionic bond and covalent bond

Did you know that diamond is one of the hardest substances in the world? The property of diamond is caused by the formation of **covalent bonds** between carbon atoms.

Covalent bonds are formed when non-metal atoms **share** their electrons to achieve a stable duplet or octet electron arrangement. There are three types of covalent bonds; single bond, double bond and triple bond.

Single Bond

A single bond is formed when two atoms share a **pair of electrons**.

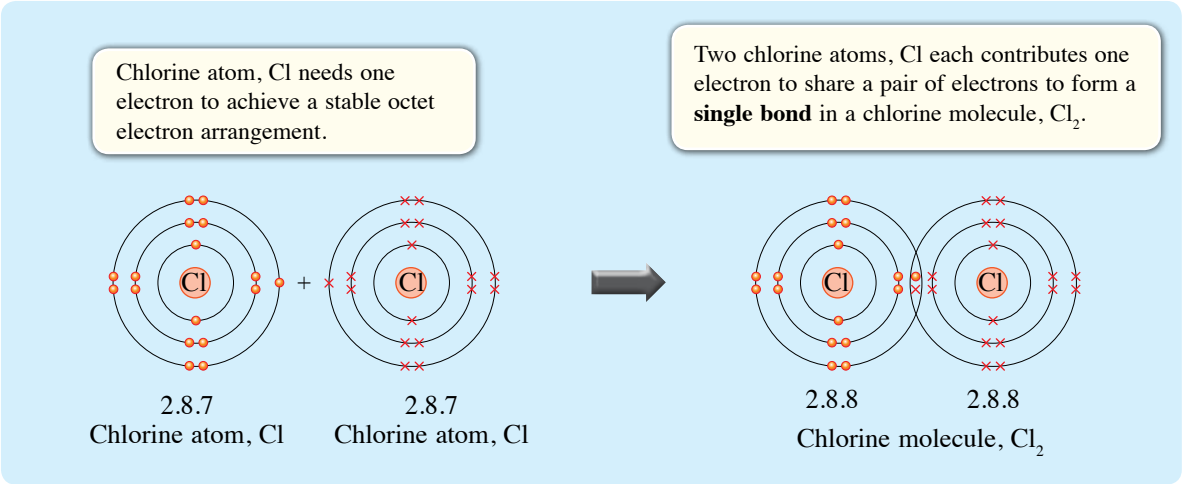
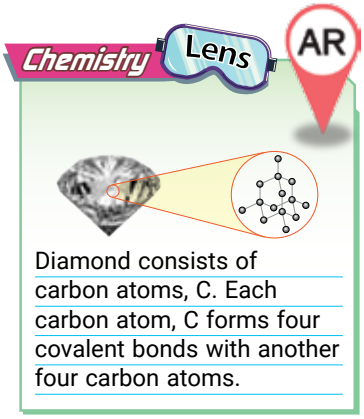


Figure 5.7 *Formation of single bond in chlorine molecule, Cl_2*

The formation of covalent bond can be visualised using the **Lewis structure**. Lewis structure only shows the valence electrons of the atoms involved. A pair of electrons shared, is represented with a line between the two atoms.

Figure 5.8 *Lewis structure for the formation of chlorine molecule, Cl_2*



Double Bond

A double bond is formed when two atoms share **two pairs of electrons.**

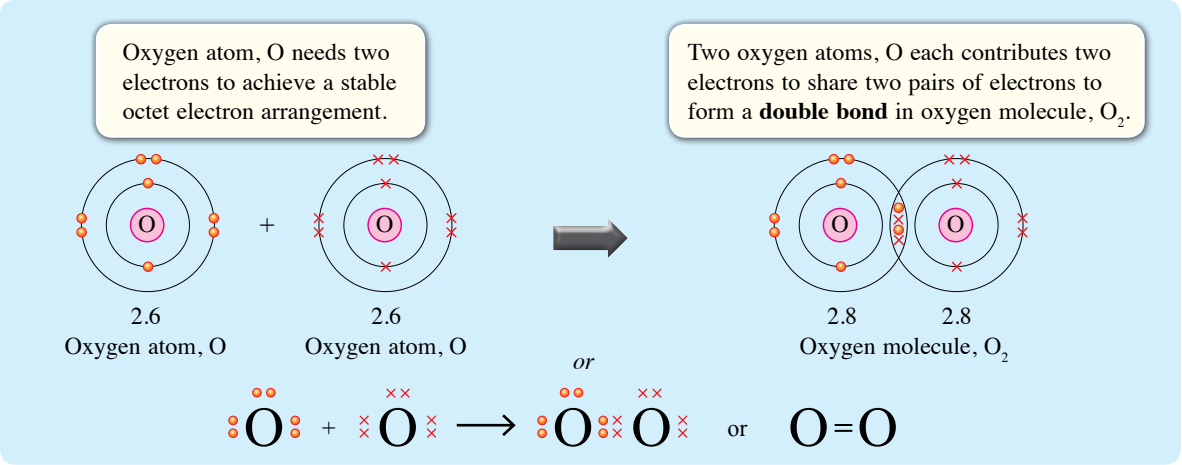


Figure 5.9 *Formation of double bond in oxygen molecule, O_2*

Triple Bond

A triple bond is formed when two atoms share **three pairs of electrons**.

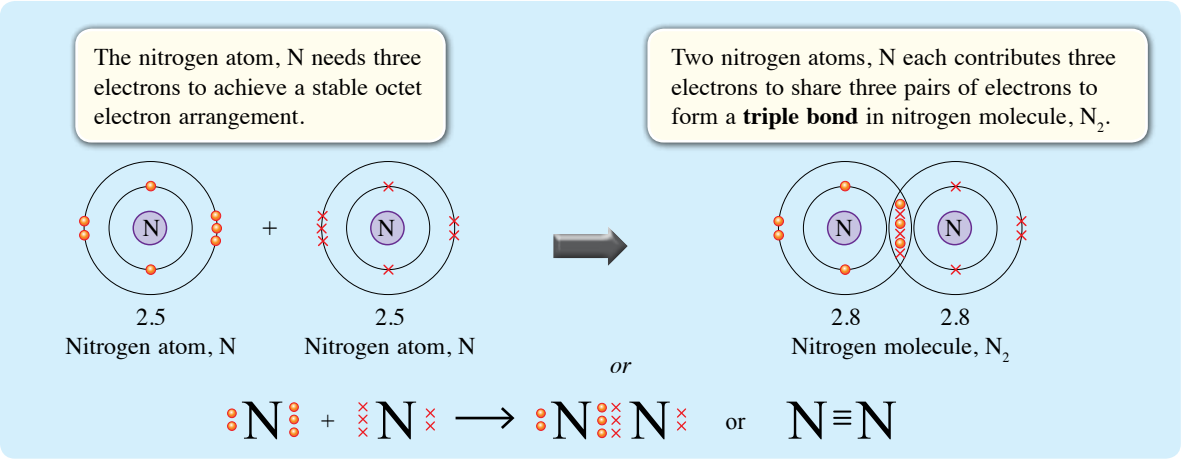


Figure 5.10 *Formation of triple bond in nitrogen molecule, N_2*

Activity 5.3

Visualising the formation of covalent bonds

21st Century Skills CT

1. Carry out the Three Stray One Stay activity.
2. Build a model to visualise the formation of covalent bonds in the following compounds.

   Hydrogen, H_2 | Hydrogen chloride, HCl | Oxygen, O_2 | Carbon dioxide, CO_2 | Nitrogen, N_2

3. Prepare an exhibition corner in the class and display the models from each group.
4. Choose a representative to give an explanation on the formation of covalent bond in a chosen compound. The rest of the members will move around to seek information from other groups.

Comparison between Ionic Bond and Covalent Bond

Similarities and differences between ionic bond and covalent bond are shown in Figure 5.11.

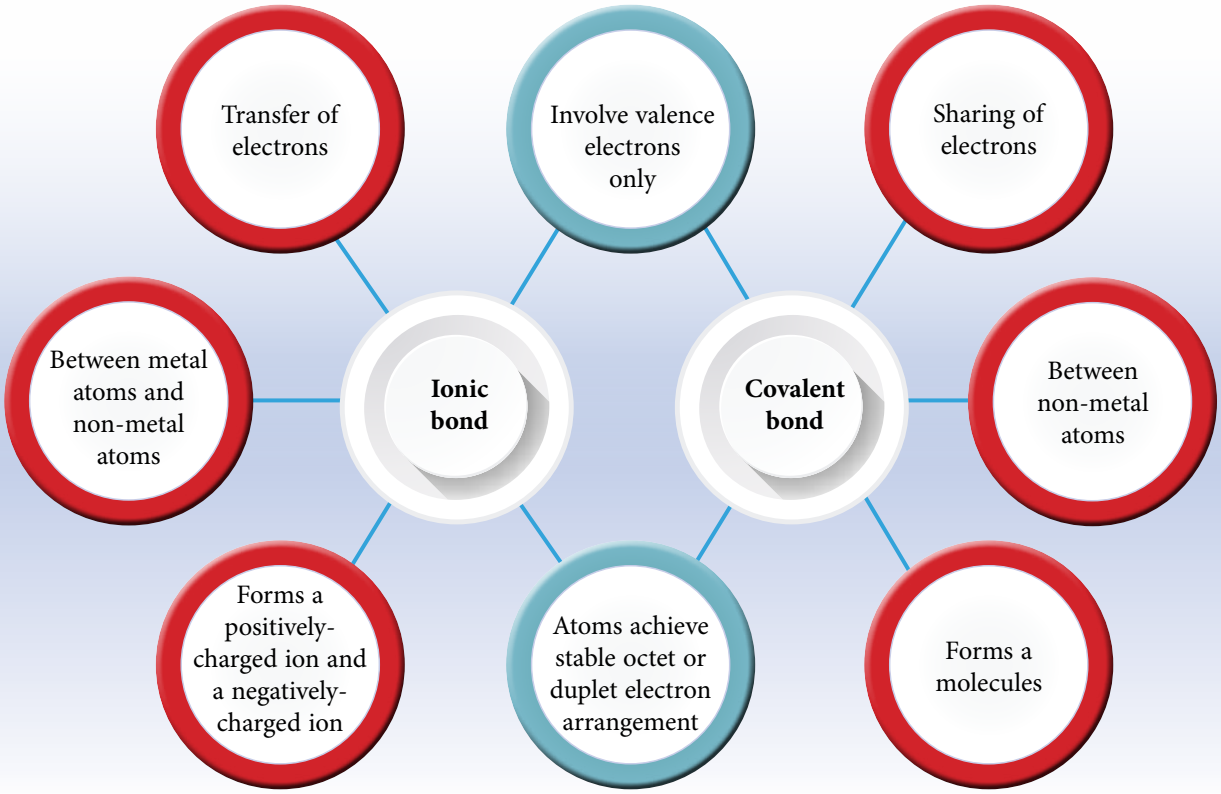


Figure 5.11 *Comparison between ionic bond and covalent bond*

Test Yourself 5.3

1. State three types of covalent bonds.
2. How are covalent bonds formed?
3. Draw the formation of covalent bonds in a water molecule, H_2O.
4. Can carbon atoms, C share electrons with four hydrogen atoms, H to form a methane molecule? Explain. [Proton number: H = 1, C = 6]
5. State one similarity and two differences between ionic bond and covalent bond.

5.4 Hydrogen Bond

Have you ever thought why an iceberg weighing thousands of tonnes is able to float on the surface of the sea? This is because the density of ice is lower compared with water. Why is water denser than ice? To answer this question, the concept of hydrogen bonds needs to be understood.

Hydrogen bonds are attraction forces between hydrogen atom, H that has bonded with an atom of high electronegativity, such as nitrogen, N, oxygen, O or fluorine, F with nitrogen, N, oxygen, O or fluorine, F in another molecule. For example, water molecule, H_2O can form hydrogen bonds among water molecules, H_2O.

Learning Standard

At the end of the lesson, pupils should be able to:
5.4.1 Explain with examples the formation of a hydrogen bond
5.4.2 Explain the effect of the hydrogen bond on physical properties of substances

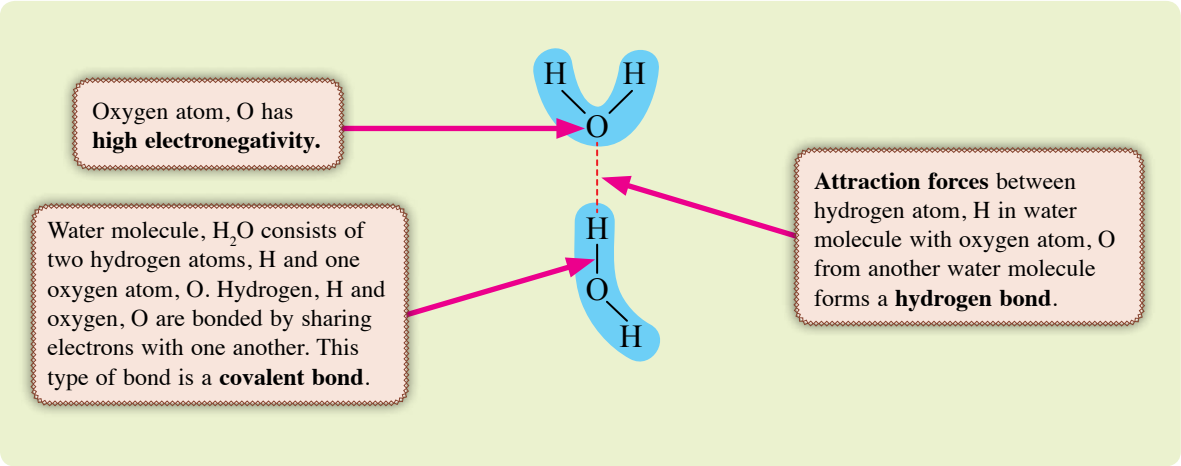


Figure 5.12 *Formation of hydrogen bonds between water molecules, H_2O*

Activity 5.4

21st Century Skills CT

Discussing the formation of hydrogen bonds in hydrogen fluoride, HF and ammonia, NH_3

1. Carry out the Think-Pair-Share activity.
2. Based on Figure 5.12, think about how hydrogen bonds are formed in hydrogen fluoride, HF and ammonia, NH_3.
3. Discuss with your partner.
4. Share your findings in front of the class.

Role of Hydrogen Bonds in Daily Life

Observe Figure 5.13. There are protein molecules that form hydrogen bonds among one another in the hair structure. Do you know why hair sticks together when wet?

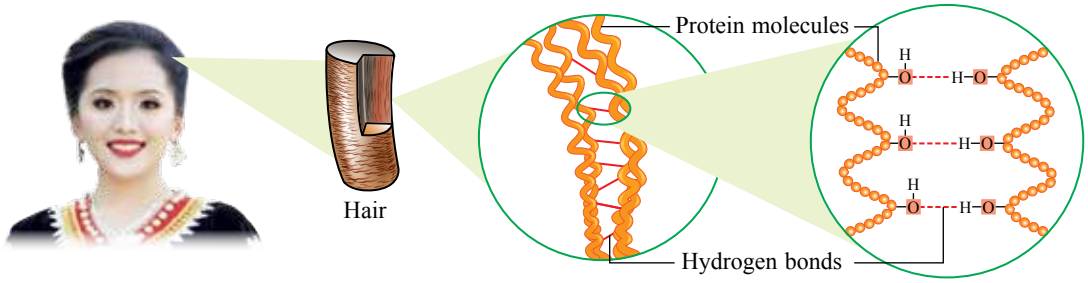


Figure 5.13 *Hydrogen bonds between protein molecules in the hair structure*

When hair is wet, protein molecules no longer form hydrogen bonds among themselves. Instead, protein molecules will form hydrogen bonds with water molecules, H_2O. Water molecules, H_2O will also form hydrogen bonds with other hair protein molecules. This causes hair to stick together.

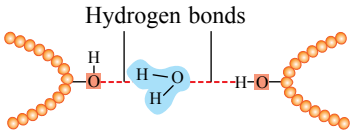


Figure 5.14 *Formation of hydrogen bond between protein molecule and water molecule*

Have you ever come across the problem of turning the pages of a book where the pages stick together? To overcome this problem, you lick your finger before turning the pages. Why does a wet finger help to turn the pages of a book? Explanation on this is given in Figure 5.15.

Brain Teaser

Why does wavy hair look straight when wet?

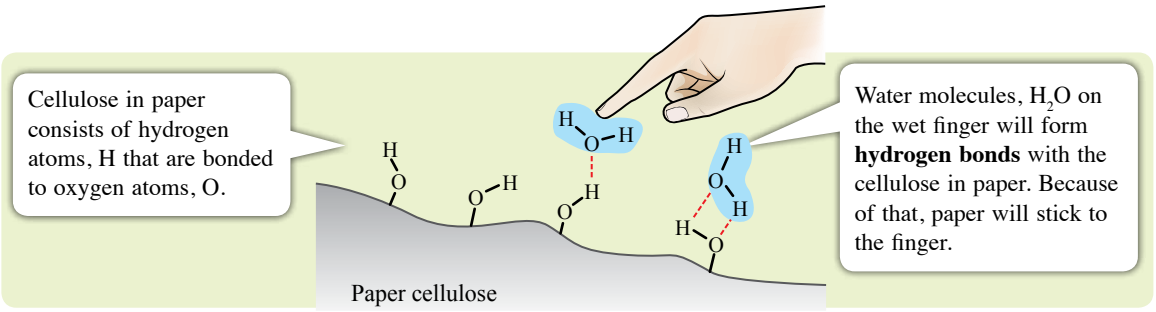


Figure 5.15 *Hydrogen bonds formed between cellulose in paper and water molecule, H_2O on the finger*

Effect of Hydrogen Bonds on The Physical Properties of Substances

Compounds in the form of liquids reach boiling point when the attraction forces between molecules are overcomed. In the covalent compound of ethanol, C_2H_5OH, there are hydrogen bonds formed between molecules, other than weak Van der Waals attraction forces. Strong hydrogen bonds are difficult to break. More heat energy is required to overcome the weak Van der Waals attraction forces, besides breaking the hydrogen bonds. As a result, the boiling point of ethanol, C_2H_5OH is high. On the other hand, molecules like chlorine, Cl_2 which do not form hydrogen bonds have lower boiling point compared to ethanol.

Ethanol, C_2H_5OH is also soluble in water. The solubility of ethanol, C_2H_5OH in water is due to the formation of hydrogen bonds between the ethanol molecule, C_2H_5OH and water molecule, H_2O.

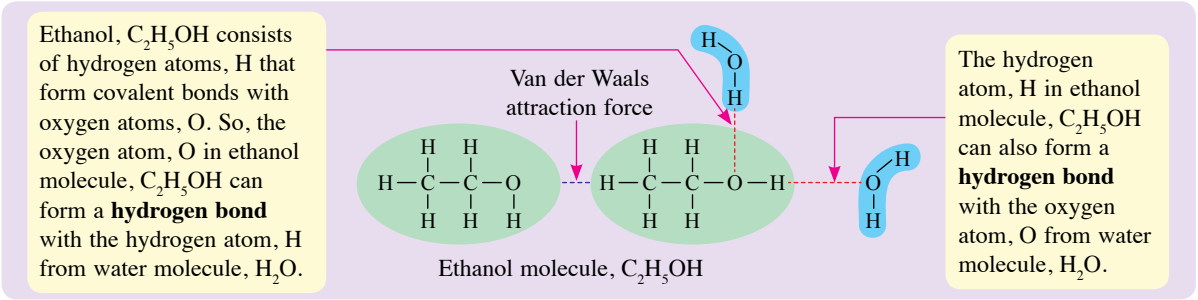


Figure 5.16 *Solubility of ethanol, C_2H_5OH in water, H_2O*

Activity 5.5

21st Century Skills CT

Discussing the solubility in water and boiling point of covalent compounds

1. Carry out the Round Table activity.
2. Gather information on the solubility in water and boiling point for hydrogen fluoride, HF and ammonia, NH_3 from various reading materials and websites.
3. Compare the solubility and boiling point for these compounds with molecules that do not form hydrogen bonds.
4. Take turns to record the related information on a piece of paper.
5. Pin up your group work on the classroom bulletin board to share the information and references with other groups.

Test Yourself 5.4

1. State the meaning of hydrogen bond.
2. Hydrogen fluoride, HF exists as liquid at room temperature. Explain this phenomenon based on the formation of hydrogen bonds.
3. Can hydrogen bonds form among hydrogen chloride molecules, HCl? Justify your answer.
4. Explain why paper sticks together when wet.

5.5 Dative Bond

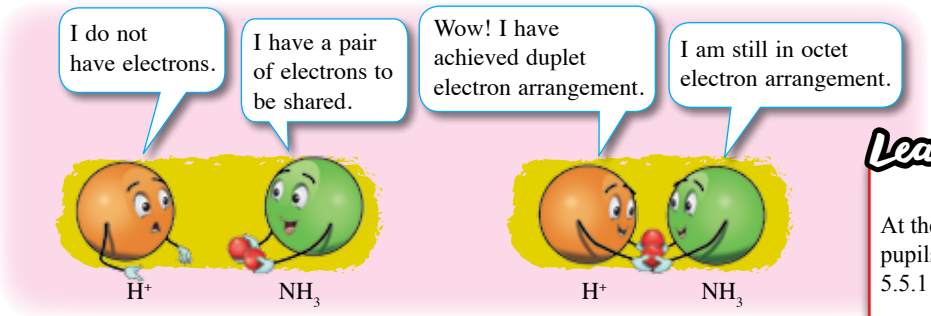


Figure 5.17 Formation of dative bond

Learning Standard

At the end of the lesson, pupils should be able to:
5.5.1 Explain with examples the formation of dative bond

Dative bond or coordinate bond is a type of covalent bond where the electron pair that is shared comes from one atom only. How does such sharing take place? Figure 5.18 shows the formation of dative bond in hydroxonium ion, H_3O^+.

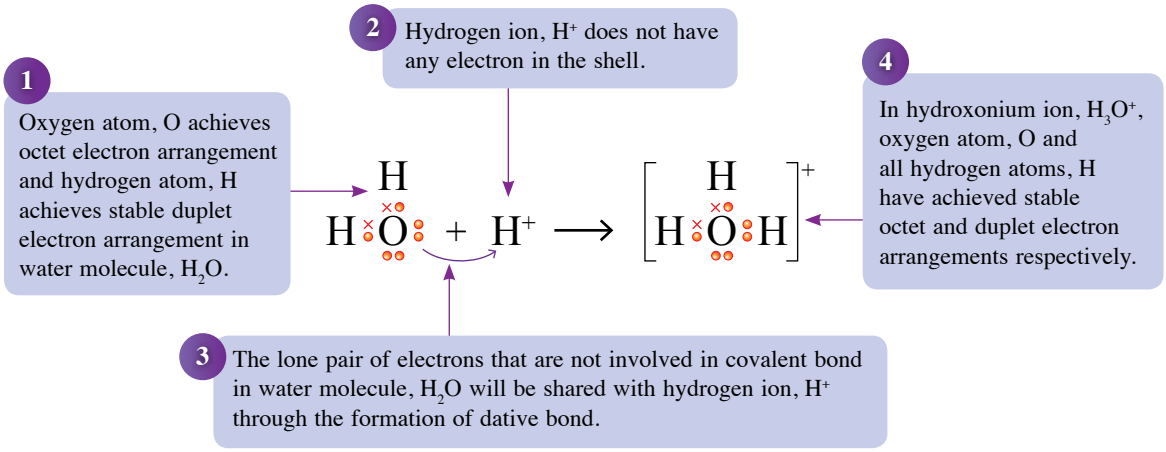


Figure 5.18 Formation of dative bond in hydroxonium ion, H_3O^+

Activity 5.6

Discussing the formation of dative bond in ammonium ion, NH_4^+

1. Carry out this activity in groups.
2. Based on the statement below, discuss the formation of dative bonds in ammonium ion, NH_4^+.

   When hydrogen chloride gas, HCl and ammonia gas, NH_3 are mixed, white fumes of ammonium chloride, NH_4Cl is formed as shown in Photograph 5.1.

3. Present your discussion results in an attractive presentation in front of the class.

Photograph 5.1 *Formation of white fumes of ammonium chloride, NH_4Cl*

Test Yourself 5.5

1. What is dative bond?
2. Explain the formation of ammonium ion through the formation of dative bond between hydrogen ion, H^+ and nitrogen atom, N in ammonia, NH_3.
3. Boron atom, B found in the compound boron trifluoride, BF_3 has not achieved octet electron arrangement because it has only six valence electrons. Can boron atoms, B form dative bonds with nitrogen atoms, N in the compound ammonia, NH_3? Explain your answer.

5.6 Metallic Bond

Learning Standard

At the end of the lesson, pupils should be able to:
5.6.1 Explain the formation of a metallic bond
5.6.2 Reason out the electrical conductivity of metal

Did you know that exposed electrical wires can cause electric shock? Electrical wires made from metal can conduct electricity. Why can metals conduct electricity?

Metal atoms are arranged closely packed and orderly in the solid state. Valence electrons of metal atoms can be donated easily and **delocalised** although in the solid state. Metal ions that are positively-charged are formed when valence electrons are delocalised. All delocalised valence electrons can move freely between the metal structure and form a **sea of electrons**. Electrostatic attraction force between the sea of electrons and the positively-charged metal ions form the **metallic bond**.

Chemistry Lens

Delocalised electron means electron that moves freely and is not owned by any atom nor ion. A sea of electron is formed when the valence shells of metal atoms overlap, resulting in electron delocalisation.

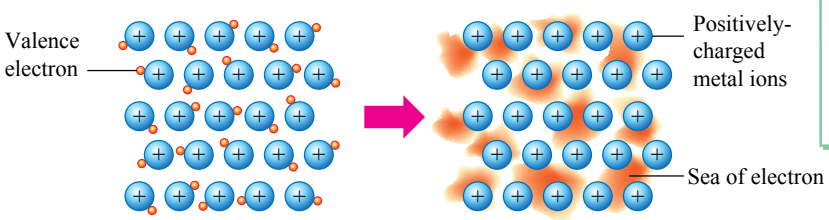


Figure 5.19 Formation of metallic bond

When electrons of metal atoms are delocalised in the sea of electrons, the metal can conduct electricity. Electrons that move freely in the metal structure carry the charges from the negative terminal to the positive terminal when electricity is supplied, as shown in Figure 5.20.

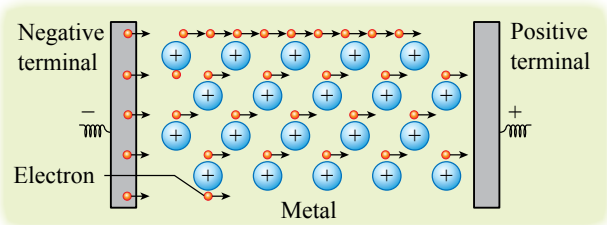


Figure 5.20 Electrical conductivity of metals

Activity 5.7

Comparing and contrasting the formation of bonds

21st Century Skills CT

1. Carry out the Think-Pair-Share activity.
2. Using suitable mind maps, compare and contrast the formation of all bonds studied from the following aspects:
   (a) Sharing or transfer of electrons
   (b) Attraction forces formed
   (c) Examples of compounds or elements
3. Pin up your mind maps produced on the classroom bulletin board.

Test Yourself 5.6

1. What is meant by a delocalised electron?
2. How a metallic bond is formed in metals?
3. Using aluminium, Al metal as an example, explain how metals can conduct electricity.

5.7 Properties of Ionic Compounds and Covalent Compounds

Learning Standard

At the end of the lesson, pupils should be able to:
5.7.1 Compare the properties of ionic compounds and covalent compounds through experiment
5.7.2 Explain with examples the uses of ionic compounds and covalent compounds in daily life

Observe salt (sodium chloride, NaCl) and ice in Photograph 5.2. Are both substances in the same physical state? Which substance will melt at room temperature?

Salt is an ionic compound

Ice is a covalent compound

Photograph 5.2 *Example of ionic compound and covalent compound*

Different compounds have different properties. The different properties of ionic compounds and covalent compounds can be studied through Experiment 5.1.

Experiment 5.1

Aim: To study the difference in properties between ionic compounds and covalent compounds.

Problem statement: What are the difference in properties between ionic compounds and covalent compounds?

Materials: Solid lead(II) bromide, $PbBr_2$, naphthalene, $C_{10}H_8$, magnesium chloride, $MgCl_2$, cyclohexane, C_6H_{12} and distilled water

Apparatus: Test tubes, spatula, evaporating dish, Bunsen burner, pipeclay triangle, wire gauze, beaker, 10 cm^3 measuring cylinder, tripod stand, battery, switch, light bulb and carbon electrodes

A Electrical conductivity of compounds

Hypothesis: Ionic compounds can conduct electricity in molten state but not in the solid state while covalent compounds cannot conduct electricity in both states.

Variables:

(a) Manipulated : Type of compound
(b) Responding : Electrical conductivity
(c) Fixed : Carbon electrode

Procedure:

1. Put lead(II) bromide, $PbBr_2$ powder into the crucible until half full.
2. Set up the apparatus as shown in Figure 5.21.
3. Switch on and observe whether the bulb lights up.
4. Switch off and heat the lead(II) bromide, $PbBr_2$ powder until all solids have melted.
5. Switch on once again and observe whether the bulb lights up.
6. Repeat steps 1 to 5 using naphthalene, $C_{10}H_8$ powder.
7. Record your observations on the condition of the bulb in Table 5.1

CAUTION

Carry out this experiment in the fume chamber.

Safety Precaution

- Naphthalene, $C_{10}H_8$ is a flammable substance.
- Bromine gas, Br_2 produced during the heating of lead(II) bromide, $PbBr_2$ is poisonous.

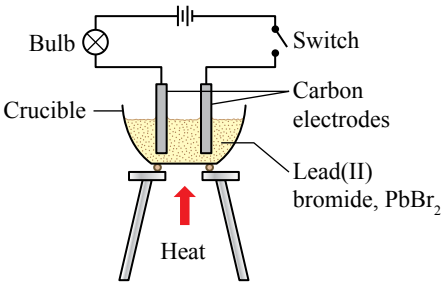


Figure 5.21

Results:

Table 5.1

Compound	Physical state	Condition of bulb
Lead(II) bromide, $PbBr_2$	Solid	
	Molten	
Naphthalene, $C_{10}H_8$	Solid	
	Molten	

Chemistry & Us.

Excessive exposure to naphthalene, $C_{10}H_8$ can cause haemolytic anaemia, liver and nervous system failure, cataract and bleeding of the retina.

B Solubility of compound in water and organic solvents

Make hypothesis and state all variables.

Procedure:

1. Put half spatula of magnesium chloride, $MgCl_2$ powder into the test tube.
2. Add 5 cm^3 of distilled water into the test tube and shake gently.
3. Observe the solubility of magnesium chloride, $MgCl_2$ in water.
4. Repeat steps 1 to 3 using cyclohexane, C_6H_{12} as the solvent.
5. Repeat steps 1 to 4 and substitute magnesium chloride, $MgCl_2$ with naphthalene, $C_{10}H_8$.
6. Record your observations on the solubility of compounds in Table 5.2.

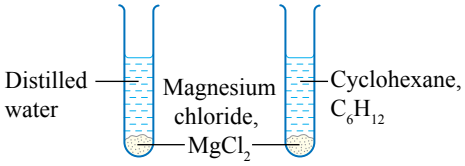


Figure 5.22

Results:

Table 5.2

Compounds	Solubility in distilled water	Solubility in cyclohexane, C_6H_{12}
Magnesium chloride, $MgCl_2$		
Naphthalene, $C_{10}H_8$		

C Melting point and boiling point of compound

Make hypothesis and state all variables.

Procedure:

1. Put half spatula of magnesium chloride, $MgCl_2$ powder and naphthalene, $C_{10}H_8$ into separate test tubes.
2. Heat both test tubes in the water bath as shown in Figure 5.23.
3. Observe and record the change in physical states and make inference of both substances in Table 5.3.

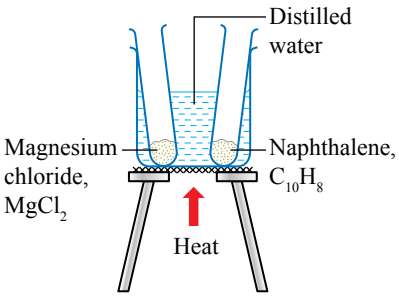


Figure 5.23

Results:

Table 5.3

Compound	Observation	Inference
Magnesium chloride, $MgCl_2$		
Naphthalene, $C_{10}H_8$		

Conclusion:

Is the hypothesis acceptable? What is the conclusion of this experiment?

Discussion:

1. What type of compound is lead(II) bromide, $PbBr_2$, magnesium chloride, $MgCl_2$ and naphthalene, $C_{10}H_8$?
2. Predict the electrical conductivity, solubility, melting point and boiling point of sodium chloride, NaCl.

Prepare a complete report after carrying out this experiment.

Electrical Conductivity

Based on Experiment 5.1, ionic compounds and covalent compounds have different electrical conductivity. Ionic compounds cannot conduct electricity in the solid state but can conduct electricity in the molten state and aqueous solution while covalent compounds cannot conduct electricity in all states.

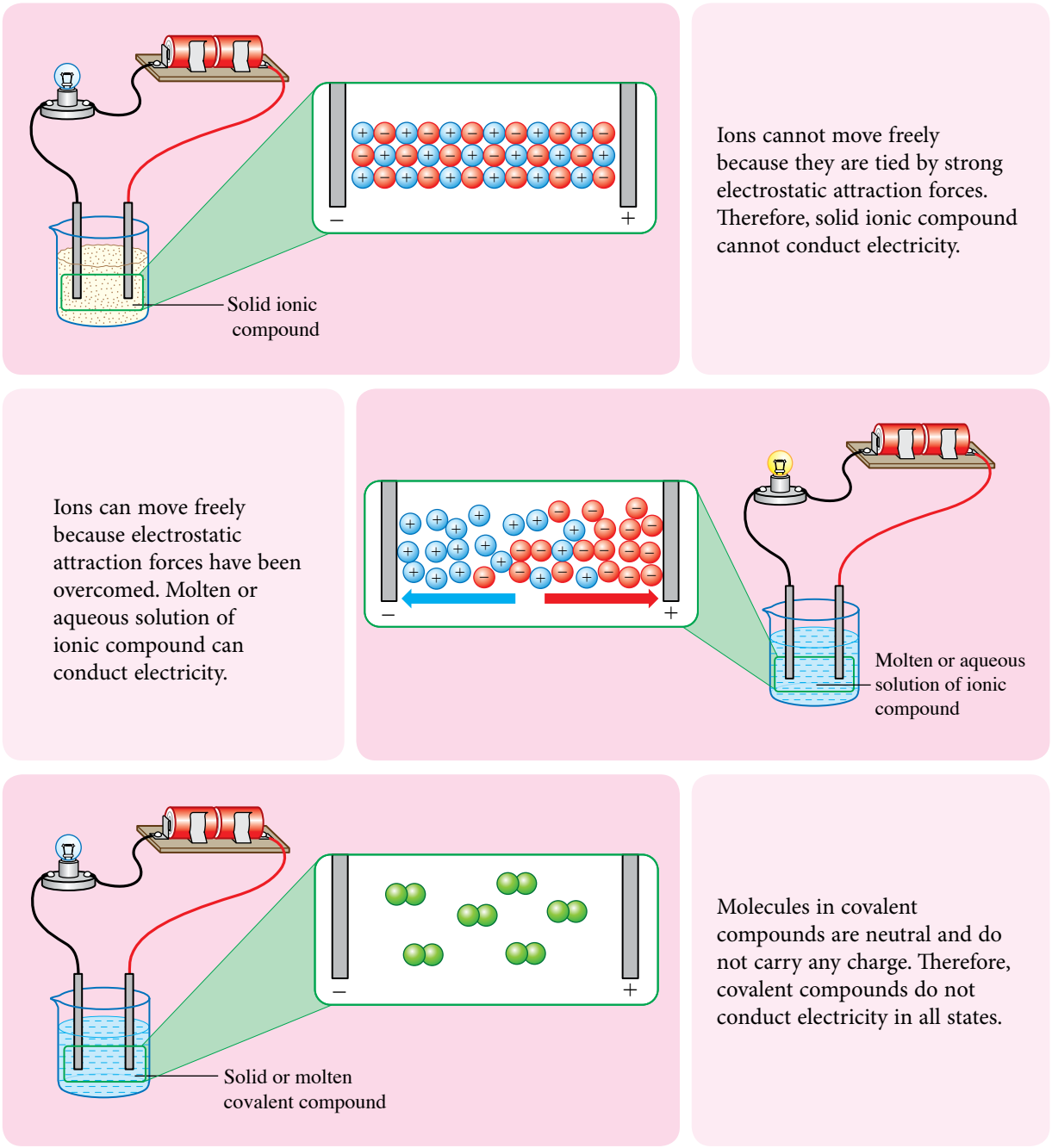


Figure 5.24 *Electrical conductivity of ionic compounds and covalent compounds*

Solubility in Water and Organic Solvents

Most ionic compounds are soluble in water but are not soluble in organic solvents. On the other hand, most covalent compounds are not soluble in water but are soluble in organic solvents.

When dissolved in water, water molecules help to overcome electrostatic attraction force between ions and break down the lattice structure of the solid compound. As a result, ions can move freely in water.

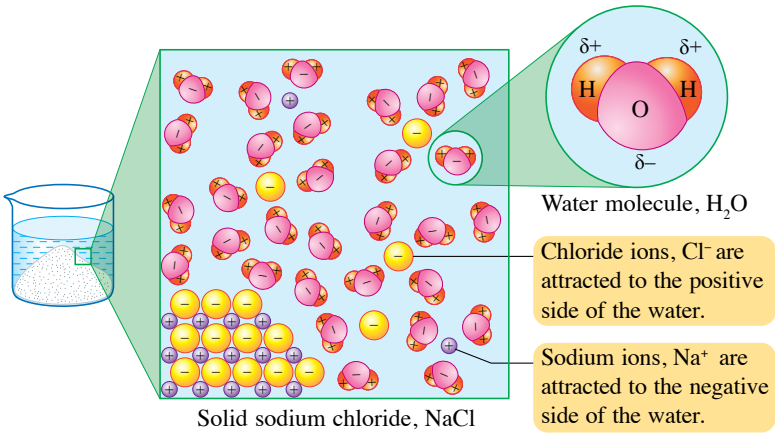
Chemistry Lens

Lattice structure is the orderly arrangement of atoms, ions or molecules of a compound in a solid crystal.

Chemistry Lens

The figure below shows the solubility of sodium chloride, NaCl in water. Water is a polar solvent that has partial negative charge at the oxygen atom and partial positive charge at the hydrogen atom. Positive ion, Na^+ will be attracted to the oxygen atom of water molecule which is negatively-charged while negative ion, Cl^- will be attracted to the hydrogen atom of water molecule which is positively-charged.

Attraction force between atom of water molecules with the ions of ionic compound are strong enough to overcome electrostatic attraction force between ions themselves. This enables most solid ionic compounds to be soluble in water.



Literacy Tips

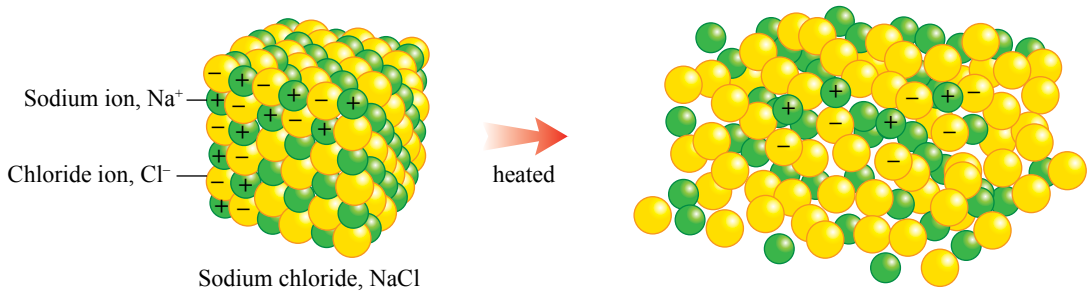
In a water molecule, oxygen atom has a higher electronegativity than hydrogen atom.This causes the electrons shared in the covalent bond to be pulled towards the oxygen atom. The unequal sharing of electrons creates partial negative charge, δ− at the oxygen atom and partial positive charge, δ+ at the hydrogen atom.

Organic solvents cannot overcome electrostatic forces between ions in a solid ionic compound. So, ionic compounds are not soluble in organic solvents. Molecules in a covalent compound are neutral and do not carry any charges. So, molecules in a covalent compound are soluble in an organic solvent but not soluble in water.

Melting Point and Boiling Point

You have learned that ionic compounds and covalent compounds are formed by ionic bonds and covalent bonds respectively. Do you know that both the chemical bonds influence the melting point and boiling point of a compound? Are these chemical bonds overcomed when compounds are melted or boiled?

Ionic compounds have **high melting point and boiling point**. Therefore, ionic compounds are not easily volatile.

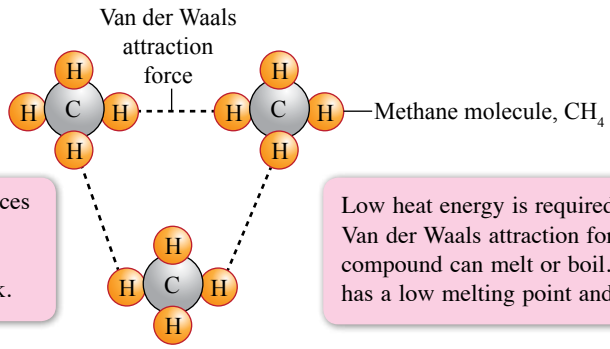


An ionic compound like sodium chloride, NaCl consists of positive ions, Na^+ and negative ions, Cl^- that attract one another by strong electrostatic attraction forces.

High heat energy is required to overcome the strong electrostatic attraction forces so that the ionic compound can melt or boil. Thus, sodium chloride, NaCl has a high melting point and boiling point.

Figure 5.25 *Ionic compounds have high melting point and boiling point*

Covalent compounds with simple molecules have **low melting point and boiling point**. Hence, covalent compounds with simple molecules are easily volatile.



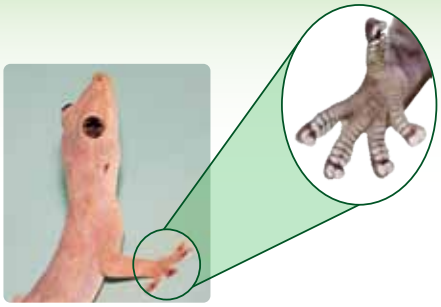
Van der Waals attraction forces between simple molecules in covalent compounds like methane, CH_4 are very weak.

Low heat energy is required to overcome the weak Van der Waals attraction forces so that the covalent compound can melt or boil. Thus, methane, CH_4 has a low melting point and boiling point.

Figure 5.26 *Covalent compounds with simple molecules have low melting point and boiling point*

Chemistry Lens

Lizards can stick to the surface of walls. This is due to the reaction between some electrons from the molecules of the hundreds of fine hairs found on the sole of the lizard's feet and some electrons from the molecules of the wall. This reaction forms the electromagnetic attraction known as Van der Waals attraction forces.



Structure of Covalent Compounds

There are two types of molecular structure for covalent compounds which are simple molecular structure and giant molecular structure. What is the difference between the simple molecular structure and giant molecular structure in covalent compounds?

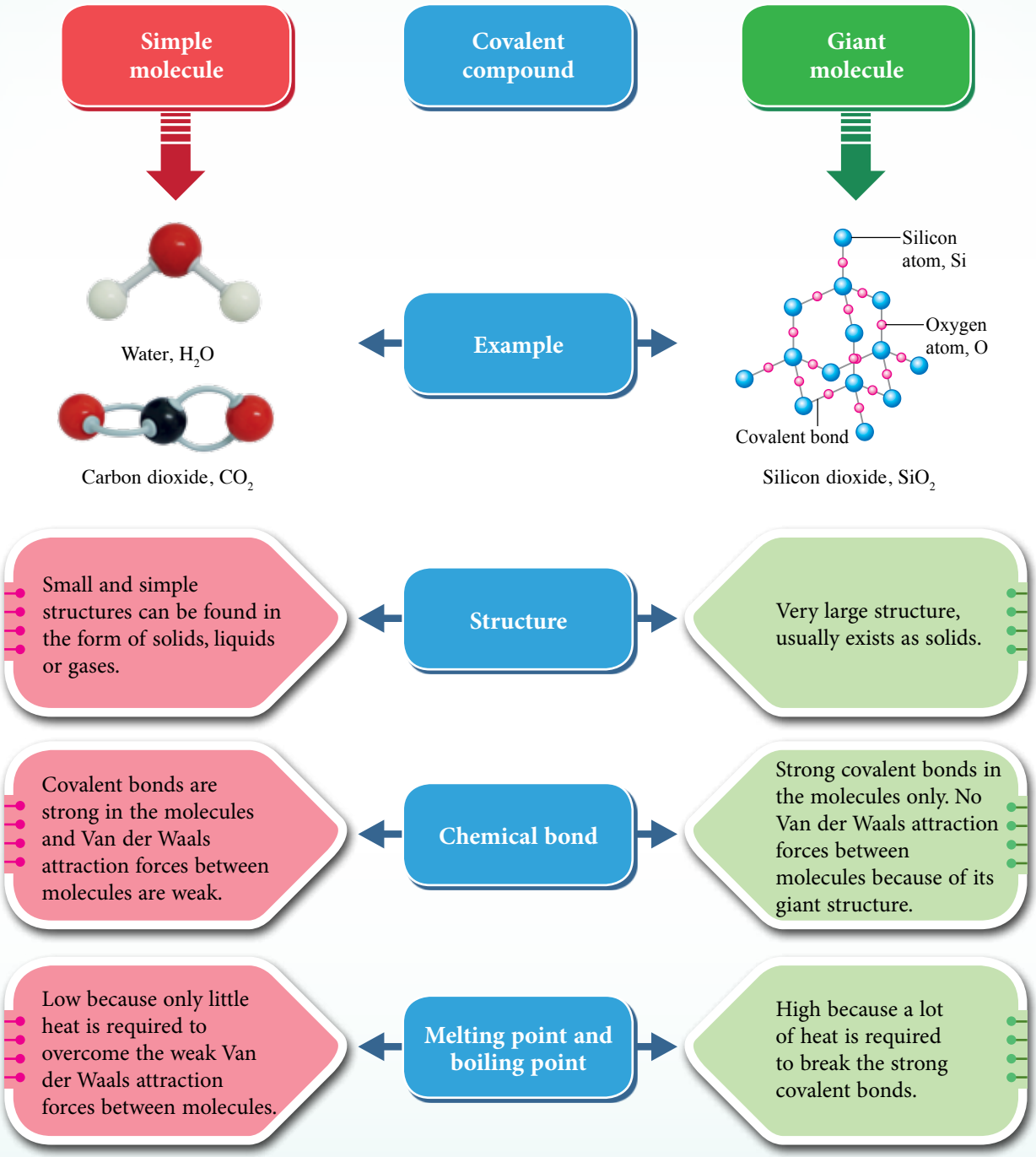


Figure 5.27 *Difference between simple molecule and giant molecule in covalent compounds*

Uses of Ionic Compounds and Covalent Compounds in Our Daily Lives

Most ionic compounds and covalent compounds used in our daily lives are in the industrial sector, agriculture, medicine and domestic use.

Industrial sector

The ionic compound of lithium iodide, LiI is used in batteries.

Paint contains covalent compounds such as pigment and turpentine solvent.

Agricultural sector

The ionic compounds of ammonium nitrate, NH_4NO_3 and potassium chloride, KCl are used in fertilisers.

Pesticides used to kill weeds and insects contain covalent compounds such as bromoethane, C_2H_5Br and chloropicrin, CCl_3NO_2.

The uses of ionic compounds and covalent compounds in daily life

Medical sector

The ionic compound of sodium bicarbonate, $NaHCO_3$ is used in antacids to relieve gastric pain.

Paracetamol, $C_8H_9NO_2$ is a covalent compound used to treat fevers and irritation.

Domestic use

Detergents contain the ionic compound, sodium chlorate(V), $NaClO_3$, which is used for domestic cleaning.

Glycerol, $C_3H_5(OH)_3$ is a covalent compound added to skincare products to moisturise skin and help to prevent dry skin.

Figure 5.28 *Uses of ionic compounds and covalent compounds in our daily lives*

Activity 5.8

Carry out a problem-solving project on the use of ionic compounds and covalent compounds in daily life

21st Century Skills CT

1. Carry out this activity in groups.
2. Read and understand the following passage:

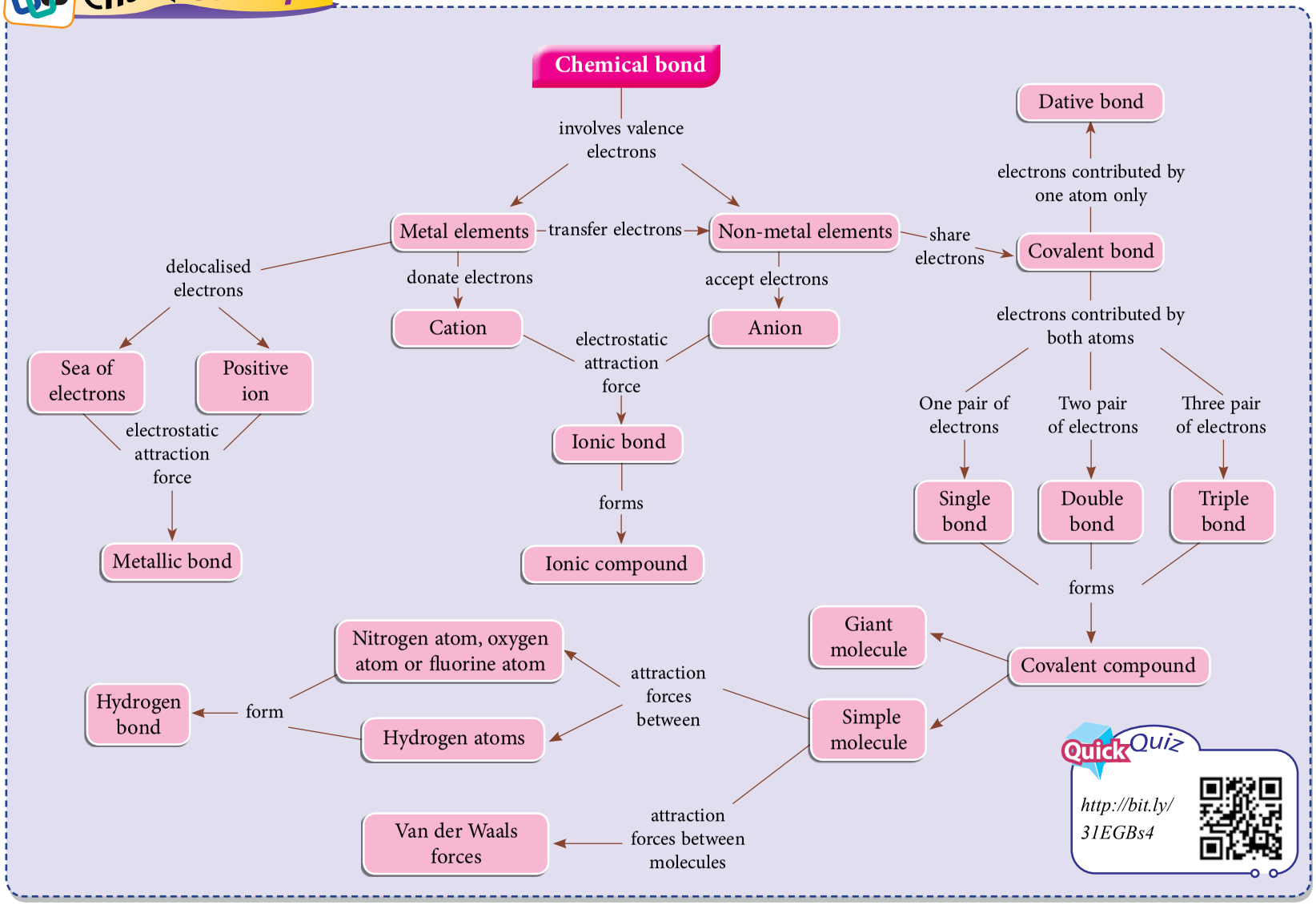
> Plastic particles in the sea can cause problems to aquatic life ranging from plankton, fish to big animals like turtles, dolphins and whales. The problem of aquatic life is not only the direct intake of plastics but also the chemicals in the plastics that can be absorbed into the tissues of these aquatic life.

3. Apart from the problem above, surf the Internet to find information about the problems of using ionic compounds and covalent compounds in one of the following fields:
   (a) Industry
   (b) Agriculture
   (c) Medicine
   (d) Domestic
4. Discuss the ways to solve the problems.
5. Present your findings in front of the class and carry out a question and answer session to improve the proposals of each group.

Test Yourself 5.7

1. Compare the melting point and boiling point of ionic compounds and covalent compounds.
2. Give one similarity between simple molecule and giant molecule of covalent compounds.
3. Magnesium hydroxide, $Mg(OH)_2$ known as milk of magnesia, is a type of ionic compound used to relieve gastric pain.
   (a) State the solubility of magnesium hydroxide, $Mg(OH)_2$ in water.
   (b) Can magnesium hydroxide, $Mg(OH)_2$ conduct electricity in the solid state?
   (c) Explain your answer in 3(b).
4. Diamond is a giant molecule of covalent compound while methane, CH_4 is a simple molecule of covalent compound.
   (a) Compare the melting point and boiling point of diamond and methane, CH_4. Explain.
   (b) Predict the electrical conductivity of diamond. Explain your prediction.

Chain Concept



SELF Reflection

1. What new knowledge have you learned in **Chemical Bond?**
2. Which is the most interesting subtopic in **Chemical Bond**? Why?
3. Give a few examples on the application of **Chemical Bond** in daily life.
4. Rate your performance in **Chemical Bond** on a scale of 1 to 10; 1 being the lowest and 10 the highest. Why would you rate yourself at that level?
5. What else would you like to know about **Chemical Bond**?

http://bit.ly/31le1ft

Achievement Test 5

1. What is the meaning of covalent bond?

2. Why does silicon dioxide, SiO_2 have a high melting point and boiling point?

3. Figure 1 shows several elements in the Periodic Table of Elements that are represented by letters *A*, *D*, *E*, *G* and *H*.

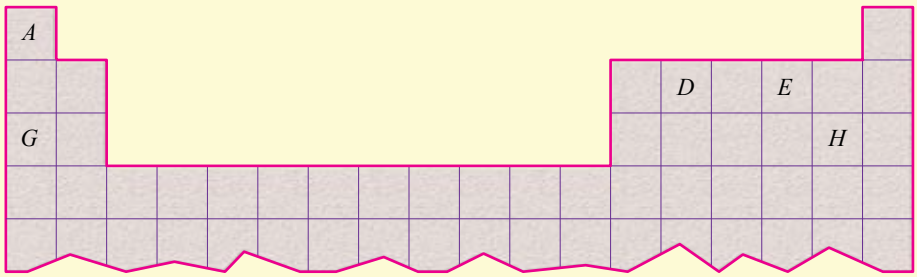


Figure 1

(a) State the elements that can combine to form ionic compounds.

(b) Element *D* reacts with element *E* to form a covalent compound. Write the chemical formula of the covalent compound formed.

(c) Atoms of element *H* combine to form diatomic molecules at room temperature. Explain the melting point and boiling point of molecule *H*.

4. Figure 2 shows the chemical symbols for elements *Q* and *R*.

(a) Write the electron arrangement for atom *Q* and atom *R*.

(b) Element *Q* and element *R* react to form compound *S*.

(i) State the type of chemical bond formed.

(ii) Explain the process of formation of compound *S*.

$^{24}_{12}Q$ $^{16}_{8}R$

Figure 2

5.
- Atom of element *J* has 12 neutrons and 23 nucleon number
- Atom of element *K* has 9 protons

(a) Which element is a metal?

(b) Explain how element *J* combines with element *K* to form white solid *T*.

6. Element *D* combines with element *E* to form a covalent compound with chemical formula ED_3. Element *D* has a proton number of 17. Predict the electron arrangement of the atom of element *E* with reasonable explanation.

7. Water, H_2O exists as liquid while hydrogen chloride, HCl exists as gas at room temperature. Explain this phenomenon based on the formation of hydrogen bonds.

8. Copper, Cu is a metal that is commonly used in the manufacturing of electric wires. Explain briefly how this metal can conduct electricity.

9. Kevin found a beaker filled with white solid left on top of the table in a laboratory. He would like to know what type of compound the white solid is. He carried out several tests to investigate the physical properties of the white solid and obtained the following results:

- Soluble in water
- Can conduct electricity in liquid state

Based on your observation and knowledge, predict the type of compound of this white solid. Explain your prediction.

Enrichment Corner

1. Deoxyribonucleic acid, DNA in organism is a complex macromolecule that stores genetic information. DNA consists of polynucleotides that coil around each other to form the double helix structure as shown in Figure 1(a). Based on the DNA structure as shown in Figure 1(b), explain how polynucleotides coil around each other using the concept of hydrogen bonds.

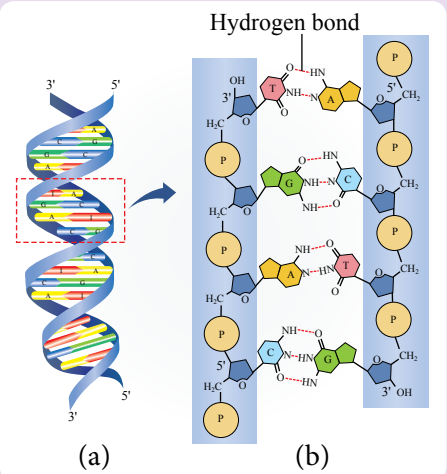


Figure 1

Check Answers

https://bit.ly/2PbIFFq