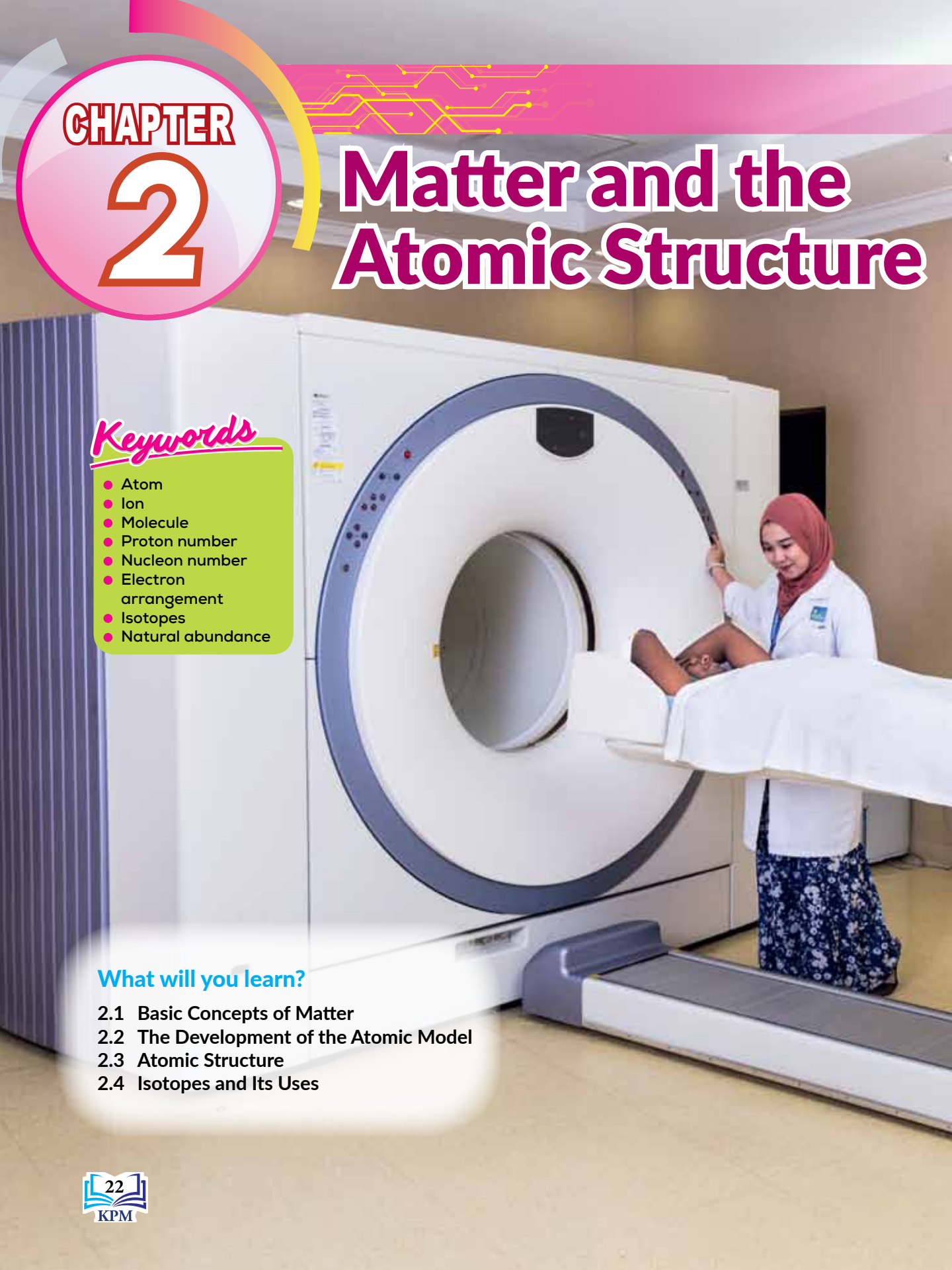
CHAPTER 2

Matter and the Atomic Structure



Keywords

- Atom
- Ion
- Molecule
- Proton number
- Nucleon number
- Electron arrangement
- Isotopes
- Natural abundance

What will you learn?

Bulletin

Have you heard of patients undergoing PET-CT scanning? PET-CT is the abbreviation for Positron Emission Tomography-Computed Tomography. PET-CT scanning can give accurate information on the position of a disease in the patient's body, especially to detect and treat diseases such as cancer, inflammation and infection. PET-CT is an imaging technique that combines CT scan and PET scan. CT is able to visualise the image of a tissue or organ through the anatomical cross section of organs. PET is able to show the metabolism level of cells and tissues in the body of a patient using radioisotopes as a tracer.

Did you know that radioisotopes are isotopes that exhibit radioactivity? What are isotopes? Do isotopes have the same subatomic particles like other atoms of their elements?

Who is the scientist that proved the existence of neutrons in the nucleus?

How many valence electrons are there in $^{12}_{6}C$?

What is the use of isotope cobalt-60?

2.1 Basic Concepts of Matter

Learning Standard

At the end of the lesson, pupils are able to:
2.1.1 Describe matter briefly
2.1.2 Explain the changes in the states of matter
2.1.3 Determine the melting point and freezing point of naphthalene through activity

Meaning of Matter

Try to recall what matter is based on the conversation in Figure 2.1.

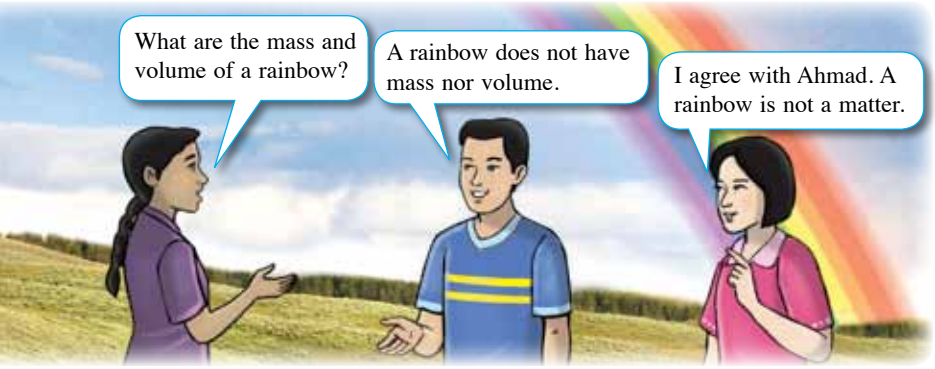


Figure 2.1 *Rainbow is not a matter*

Matter is something that has mass and occupies space. Matter consists of particles that are tiny and discrete. Matter can exist in three states, namely solid, liquid and gas. What are other examples of matter that you encounter in your daily life?

Chemistry Lens

Plasma is the fourth state of matter besides solid, liquid and gas. A plasma is an ionised gas. Although plasma in its natural state is rarely found on Earth, plasma is the state of matter most found in the universe. Most stars exist as plasma.

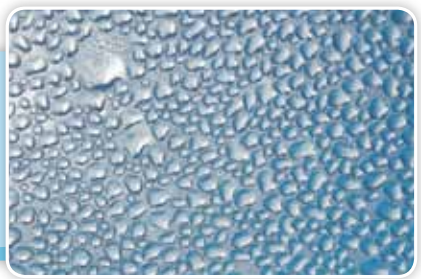
Changes in the State of Matter

The change in the state of matter is caused by **heating** or **cooling**.

Photograph 2.1 *Ice cream*

Ice cream that is left at room temperature absorbs heat energy and changes from solid to liquid state.

At night, glass windows release heat to the surroundings causing the surface of the glass window to become cold. Water vapour in the air that comes in contact with the cold surface loses heat and forms water droplets on the surface of the glass window.



Photograph 2.2 *Water droplets on the surface of a glass window*

Figure 2.2 shows the conversion among states of matter through the process of heat absorbed or heat released. When heat energy is absorbed or released, changes occur in kinetic energy, arrangement of particles and attraction force between particles, causing the state of matter to change.

The difference between deposition and sublimation process

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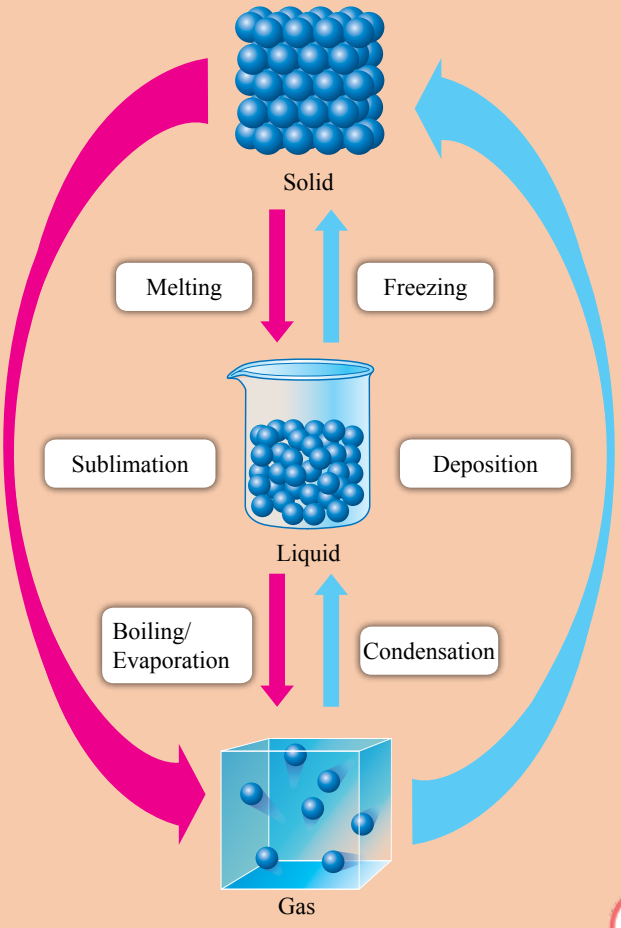


Solid

- Particles are closely packed in an orderly manner
- Kinetic energy of particles is low
- Attraction force between particles is strong

Liquid

- Particles are closely packed but not in an orderly manner
- Kinetic energy of particles is higher than solid state
- Attraction force between particles is strong, but less than solid state

Gas

- Particles are far apart
- Kinetic energy of particles is very high
- Attraction force between particles is weak

AR

Figure 2.2 *Conversion between states of matter*

Activity 2.1

Drawing the arrangement of particles in 2D form

1. Based on Figure 2.2, draw the arrangement of particles in solid, liquid and gas in 2D form.
2. Display your work on the notice board in your class.

Matter can exist in the form of elements or compounds. Elements consist of particles of atoms or molecules while compounds are made up of molecules or ions. Figure 2.3 shows the classification of matter.

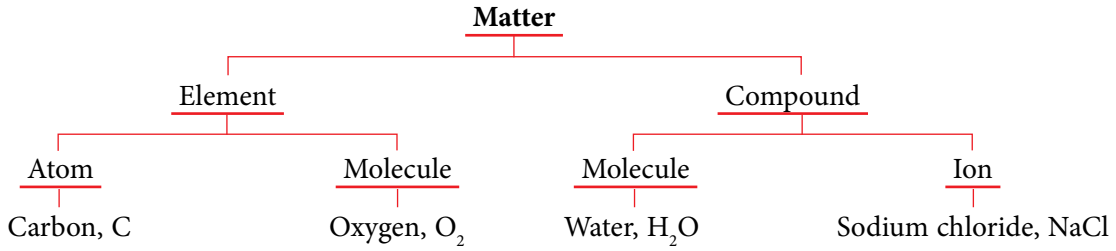
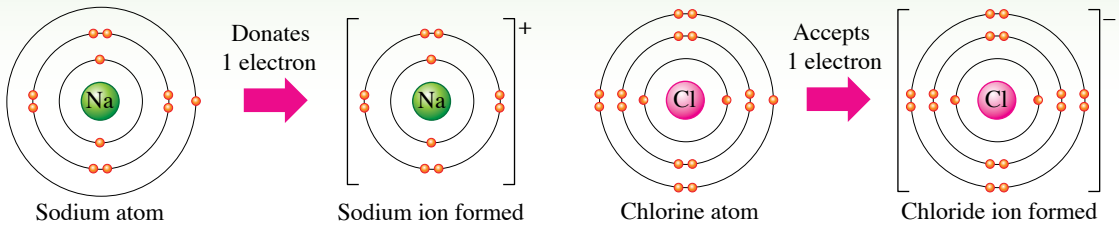


Figure 2.3 *Classification of matter*

Chemistry Lens

Ions are formed by transfer of electrons between atoms.



Melting Point and Freezing Point

How do scientists determine the melting point and freezing point of a substance? Carry out Activity 2.2 to determine the melting point and freezing point of naphthalene, $C_{10}H_8$.

Literacy Tips

- Melting point is the constant temperature when a substance changes from solid state to become liquid at a specific pressure.
- Freezing point is the constant temperature when a substance changes from liquid state to become solid at a specific pressure.

Activity 2.2

Aim: To determine the melting point and freezing point of naphthalene, $C_{10}H_8$.

Materials: Naphthalene, $C_{10}H_8$ and water

Apparatus: Boiling tube, 250 cm^3 beaker, thermometer, tripod stand, retort stand with clamp, Bunsen burner, stopwatch, conical flask, wire gauze and spatula

Procedure:

1. Fill up one third of a boiling tube with naphthalene, $C_{10}H_8$.
2. Place a thermometer in the boiling tube.
3. Pour water into a beaker until it is half filled.
4. Immerse the boiling tube into the beaker as shown in Figure 2.4. Ensure the level of naphthalene, $C_{10}H_8$ in the boiling tube is below the level of water in the beaker.

CAUTION

Avoid touching the naphthalene, $C_{10}H_8$ or inhaling the naphthalene gas.

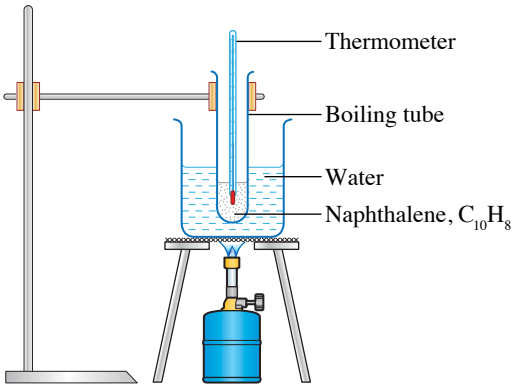


Figure 2.4 *Heating of naphthalene, $C_{10}H_8$*

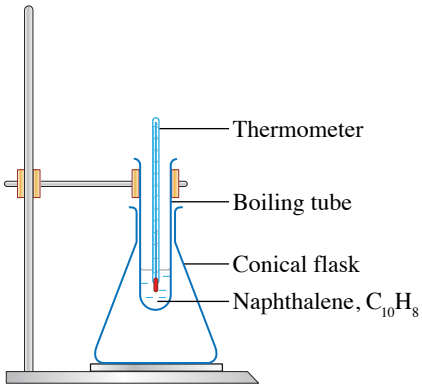


Figure 2.5 *Cooling of naphthalene, $C_{10}H_8$*

5. Heat water and stir the naphthalene, $C_{10}H_8$ slowly using the thermometer. When the temperature of the napthalene, $C_{10}H_8$ reaches 60 °C, start the stopwatch.
6. Record the temperature and state of matter of naphthalene, $C_{10}H_8$ at 30 seconds intervals until the temperature reaches 90 °C.
7. Remove the boiling tube from the water bath. Dry the outer surface of the boiling tube and put it into a conical flask as shown in Figure 2.5.
8. Stir the naphthalene, $C_{10}H_8$ continuously.
9. Record the temperature and state of matter of naphthalene, $C_{10}H_8$ at 30 seconds intervals until the temperature decreases to 60 °C.
10. Record your observations.

CAUTION

Deficiency of glucose-6-phosphate dehydrogenase (G6PD) is a genetic disease. Exposure to naphthalene, $C_{10}H_8$ to a patient with G6PD will cause haemolysis, that is destruction of red blood cells. This situation will cause the patient to feel tired and dizzy.

Interpreting data:

1. Plot a graph of temperature against time for the following:
   (a) Heating of naphthalene, $C_{10}H_8$
   (b) Cooling of naphthalene, $C_{10}H_8$
2. On the graphs, label the states of matter of naphthalene, $C_{10}H_8$ whether solid, liquid or both.
3. Determine the melting point and freezing point of naphthalene, $C_{10}H_8$ from the graphs plotted.

Discussion:

1. During the heating of naphthalene, $C_{10}H_8$:
   (a) Why is naphthalene, $C_{10}H_8$ not heated directly using the Bunsen burner?
   (b) Why is a water bath used?
2. During the cooling of naphthalene, $C_{10}H_8$:
   (a) Why is the boiling tube put into a conical flask?
   (b) Why is naphthalene, $C_{10}H_8$ stirred continuously?
   (c) Predict what would happen if naphthalene, $C_{10}H_8$ is not stirred continuously.
3. Explain why the temperature becomes constant when melting and freezing of naphthalene, $C_{10}H_8$ take place.

Prepare a complete report after carrying out this activity.

The graph of temperature against time for heating of naphthalene, $C_{10}H_8$ is shown in Figure 2.6 and the graph of temperature against time for cooling of naphthalene, $C_{10}H_8$ is shown in Figure 2.7.

Chemistry Lens

Lauric acid, $C_{12}H_{24}O_2$ is a type of fatty acid that can be obtained from coconuts. This acid is also suitable to be used as a substitute for naphthalene, $C_{10}H_8$ in Activity 2.2.

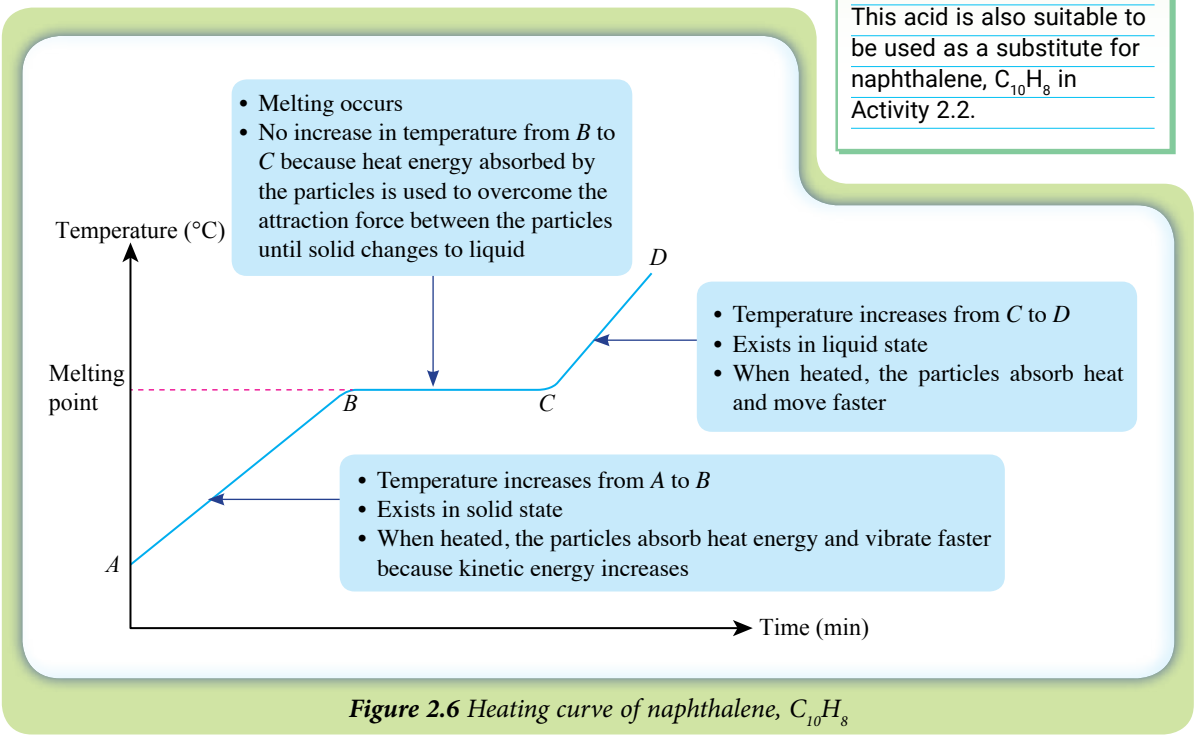


Figure 2.6 *Heating curve of naphthalene, $C_{10}H_8$*

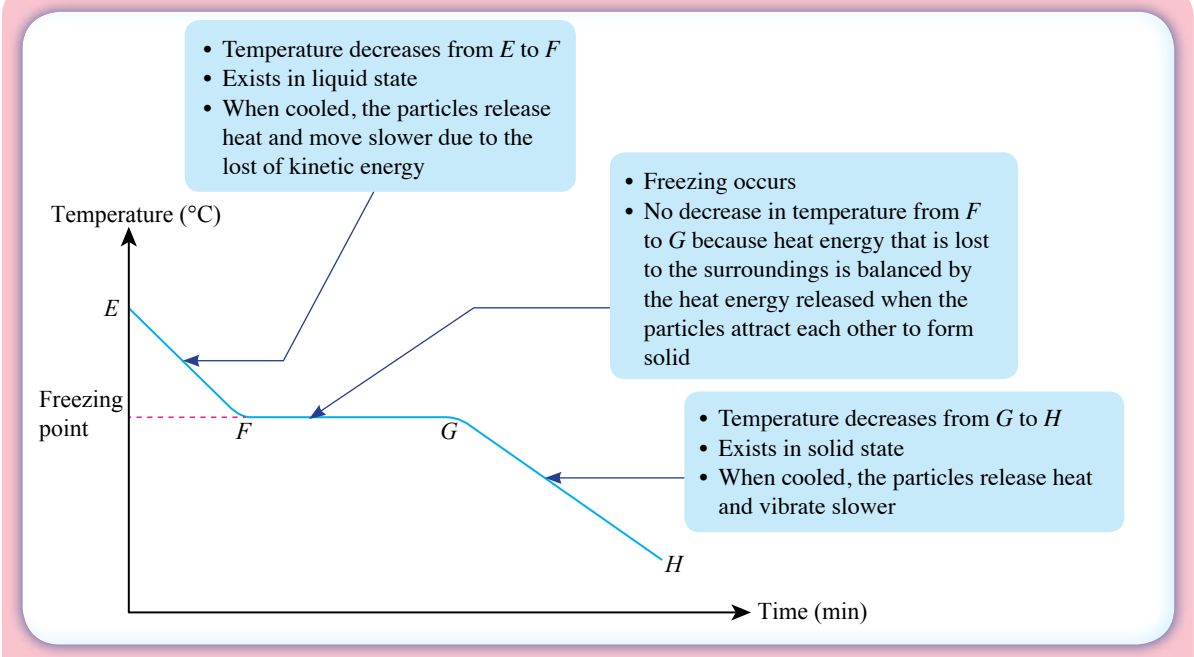


Figure 2.7 *Cooling curve of naphthalene, $C_{10}H_8$*

Test Yourself 2.1

1. State the types of particles that exist in a copper wire.
2. Lily dries her hair with a hair dryer.
   (a) Name the process involved during hair drying.
   (b) State the changes in the movement of water particles when hair is dried.
3. Lauric acid, $C_{12}H_{24}O_2$ is heated from room temperature to 50 °C. At 43 °C, lauric acid, $C_{12}H_{24}O_2$ starts to melt.
   (a) Draw a heating curve for lauric acid, $C_{12}H_{24}O_2$.
   (b) Why is the temperature constant at 43 °C?

2.2 The Development of the Atomic Model

Subatomic Particles

Figure 2.8 shows the subatomic particles found in an atom which is made up of protons, neutrons and electrons. What are the similarities and differences in these three types of subatomic particles?

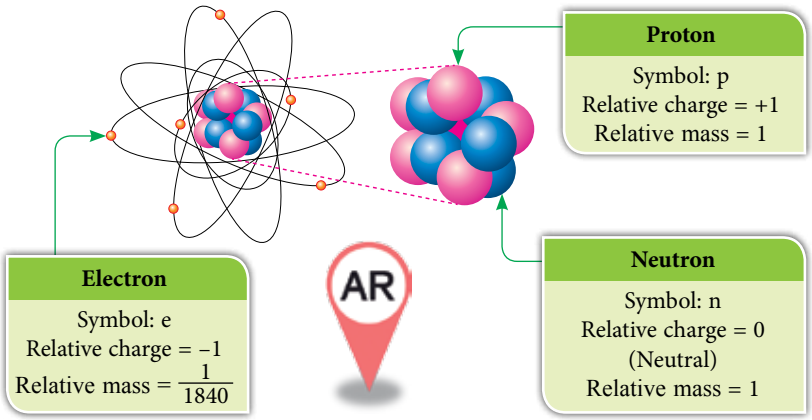


Figure 2.8 *Subatomic particles*

Learning Standard

At the end of the lesson, pupils are able to:
- 2.2.1 State the subatomic particles in atoms of various elements
- 2.2.2 Compare and contrast the relative mass and relative charge of proton, electron and neutron
- 2.2.3 Sequence the atomic structure models based on Atomic Models of Dalton, Thomson, Rutherford, Bohr and Chadwick

Brain Teaser

How are the relative charge and relative mass of subatomic particles determined?

Activity 2.3

Comparing and contrasting the subatomic particles

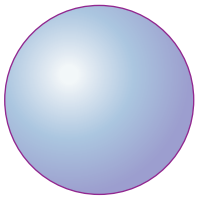
1. Watch a video clip on subatomic particles by searching the Internet.
2. Based on the video, compare and contrast the relative masses and charges of protons, electrons and neutrons.
3. Present your findings using a suitable graphic presentation software and upload your work to social media.

Development of the Atomic Structure Model

Atoms can neither be seen with the naked eye nor the microscope. Have you ever thought how the atomic structure model is produced? The atomic structure model that we know now is the product of many scientists' efforts. Studies on atoms started since the introduction of atomic theory by Democritus, a Greek philosopher, around 500 B.C. Figure 2.9 shows the historical development of the atomic structure model.

John Dalton
(1766 – 1844)

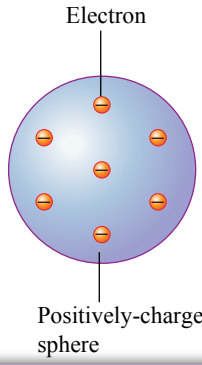
- Matter is made up of particles called **atoms**
- An atom is the smallest spherical body that cannot be created, destroyed nor divided further
- Same elements have the same atoms



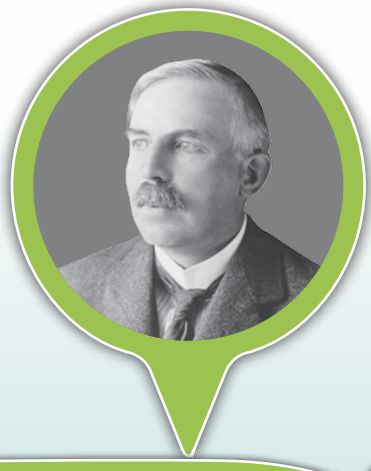
Dalton's Atomic Model

J.J. Thomson
(1856 – 1940)

- Discovered negatively-charged particles called **electrons**
- Atom is a positively-charged sphere with several electrons in it

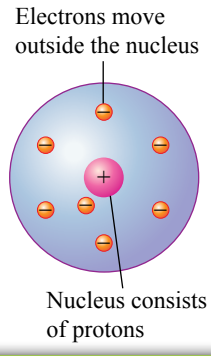


Thomson's Atomic Model



Ernest Rutherford
(1871 – 1937)

- Nucleus is the centre of the atom
- Discovered positively-charged particles called **protons** in the nucleus
- Almost the whole of atomic mass is concentrated in the nucleus
- Electrons move outside the nucleus



Rutherford's Atomic Model

Figure 2.9 *Historical development of the atomic model*

Activity 2.4

Role-playing on the development of the atomic structure model

21st Century Skills CT

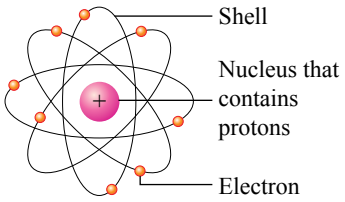
1. Carry out the Role-Play activity in groups.
2. In your group, find information on the atomic structure model explained by one of the following scientists:

John Dalton | Ernest Rutherford | James Chadwick | J.J. Thomson | Niels Bohr

3. Prepare the acting scripts and suitable props.
4. Present the group act in front of the class.

Niels Bohr
(1885 – 1962)

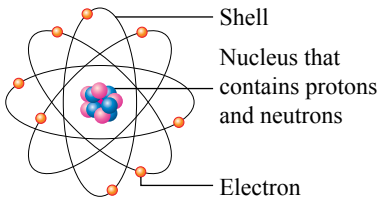
- Electrons in an atom move in **shells** around the nucleus



Bohr's Atomic Model

James Chadwick
(1891 – 1974)

- Discovered neutral particles, that are **neutrons** in the nucleus
- Neutrons contribute almost half of the mass of an atom



Chadwick's Atomic Model

Test Yourself 2.2

1. Figure 2.10 shows the atomic structure of nitrogen.

(a) Name *X*.

(b) State the subatomic particles found in the nucleus of nitrogen atom.

(c) Compare *X* and subatomic particles mentioned in (b) from the aspect of relative charge and relative mass.

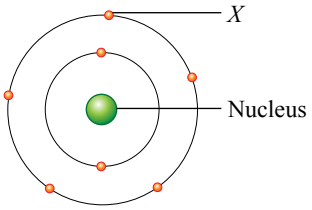


Figure 2.10

2.
- Electrons move around the nucleus in shells.
- Nucleus of an atom consists of protons and neutrons.

The statements above show the information on an atomic structure model.

(a) Which scientist identified it?

(b) Draw this atomic structure model.

2.3 Atomic Structure

Proton Number and Nucleon Number

Look at Table 2.1, what is the relationship between the number of protons and proton number, and the relationship between the nucleon number and the proton number?

Table 2.1 *Proton numbers and nucleon numbers of oxygen atom, sodium atom and chlorine atom*

Atom	Number of protons	Number of neutrons	Proton number	Nucleon number
Oxygen	8	8	8	16
Sodium	11	12	11	23
Chlorine	17	18	17	35

The number of protons in the nucleus of an atom is known as the **proton number**. The total number of protons and neutrons in the nucleus of an atom is known as the **nucleon number**.

Nucleon number = number of protons + number of neutrons
or
Nucleon number = proton number + number of neutrons

Atoms of different elements have different proton numbers. For example, sodium atom has a proton number of 11 and chlorine atom has a proton number of 17.

Learning Standard

At the end of the lesson, pupils are able to:

2.3.1 Define proton number and nucleon number

2.3.2 Determine the nucleon number, proton number and number of electrons in an atom

2.3.3 Write the standard representation of an atom

2.3.4 Construct an atomic structure diagram and electron arrangement

Brain Teaser

Are there any two elements with the same proton number? Explain.

An atom is neutral when the number of electrons is the same with the number of protons. For example, an oxygen atom has 8 protons and also 8 electrons. The examples and solutions are shown in Example 1 and 2.

Example 1

An aluminium atom has 13 protons and 14 neutrons. What are the proton number and nucleon number of an aluminium atom?

Solution

Proton number = number of protons
= 13

Nucleon number = proton number + number of neutrons
= 13 + 14
= 27

Example 2

The nucleon number of a potassium atom is 39. A potassium atom has 19 protons. How many neutrons and electrons are there in a potassium atom?

Solution

Number of electrons = number of protons
= 19

Number of neutrons = nucleon number – number of protons
= 39 – 19
= 20

Table 2.2 shows the comparison among the number of protons, neutrons and electrons when a chlorine atom accepts an electron to form a chloride ion. What are the changes in the number of protons, neutrons and electrons?

Table 2.2 *Number of subatomic particles of chlorine atom and chloride ion*

Type of particle	Chlorine atom, Cl	Chloride ion, Cl^-
Number of proton	17	17
Number of neutron	18	18
Number of electron	17	18

A chlorine atom accepts one electron to form a chloride ion, thus a chloride ion has one electron more than a chlorine atom. The number of protons and neutrons in a chlorine atom and chloride ion are the same. Therefore, during the formation of ion from an atom, the number of protons and neutrons in the nucleus remain the same.

Literacy Tips

When the number of electron increases, an anion is formed, which is a negatively-charged ion. However, when the number of electron decreases, a cation is formed, which is a positively-charged ion.

Standard Representation of an Atom

An atom can be represented using a standard representation as shown in Figure 2.11.

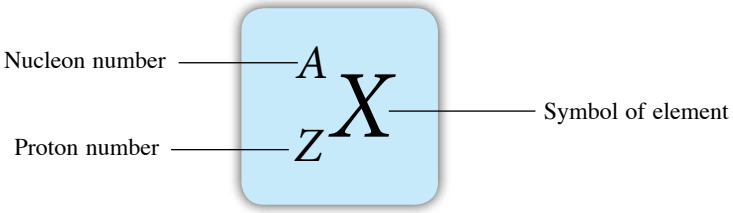
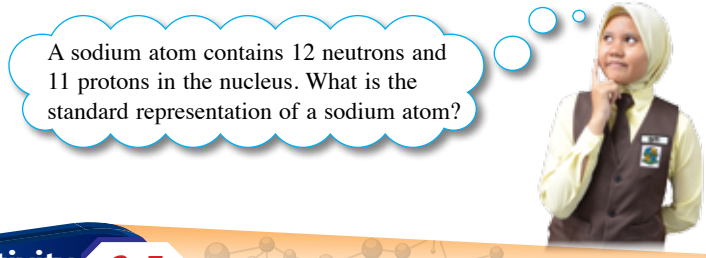


Figure 2.11 *Standard representation of an atom*

What information can you obtain from $^{12}_{6}C$? The symbol of carbon element is C, the nucleon number of a carbon atom is 12, while the proton number of a carbon atom is 6.



Activity 2.5

Finding the mystery code CT

1. In groups, answer the following questions:
   (a) The nucleon number and the proton number of fluorine element are 19 and 9 respectively. Is the following statement true or false?

   The atom of this element has 9 electrons and 9 neutrons in its nucleus.

   (b) Atom *X* has 11 protons and 12 neutrons. Find the nucleon number of this atom.
   (c) What is the proton number of an atom of nitrogen element that has 7 electrons?
   (d) The standard representation of an atom of oxygen element is $^{16}_{8}O$. This atom accepts electrons to form an oxide ion, O^{2-}. How many electrons are accepted by an oxygen atom to form an oxide ion, O^{2-}?
   (e) The nucleus of atom *Y* has the charge +4 and contains 5 neutrons. State the nucleon number of element *Y*.
   (f) A calcium atom has 20 protons and its nucleon number is 40. A calcium ion, Ca^{2+} is formed when a calcium atom donates 2 electrons. State the number of neutrons in a calcium ion, Ca^{2+}.
   (g) $^{7}_{\square}W$ An atom of element *W* has 3 electrons and 4 neutrons. What should the number in the box be, to represent the atom of element *W*?

2. Scan QR Code or visit the website provided to obtain the code guidance.
3. Get the mystery code.

Code guidance
http://bit.ly/2P8zNQV

Atomic Structure and Electron Arrangement

Electrons of an atom orbit around the nucleus in their respective shells. Electrons will fill the shell closest to the nucleus first. When the shell closest to the nucleus is full, electrons will fill the next shell. The maximum number of electrons in the first three shells for elements with proton numbers 1 to 20 are shown in Figure 2.12.

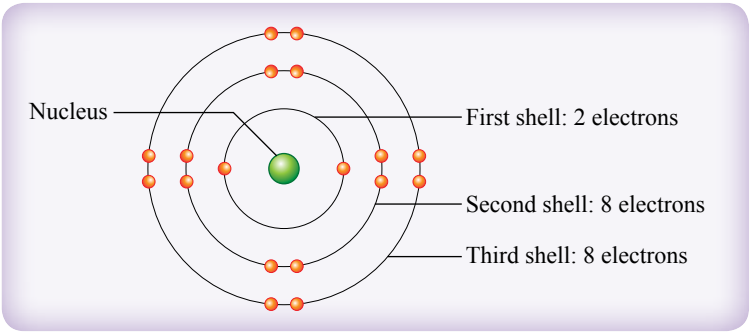


Figure 2.12 *Numbers of maximum electrons in the first three shells for elements with proton numbers 1 to 20*

Chemistry Lens

The third shell can be filled with a maximum of 18 electrons for elements with proton number exceeding 20.

For example, the proton number of aluminium is 13. This shows that an aluminium atom has 13 electrons. The electron arrangement of aluminium atom is, 2 electrons filled in the first shell, 8 electrons filled in the second shell and 3 electrons filled in the third shell. The electron arrangement of aluminium atom can be written as follows:

2.8.3 ← Number of valence electrons = 3

The outermost shell filled with electrons is the valence shell. Electrons in the valence shell are known as valence electrons. The chemical properties of an element depend on the number of valence electrons of the atom. Elements with the same number of valence electrons have similar chemical properties.

Chemistry Lens

The valence shell is the outermost shell of an atom.

The **electron arrangement** shows the nucleus and electron arrangement of an atom. For example, the electron arrangement of aluminium atom is shown in Figure 2.13.

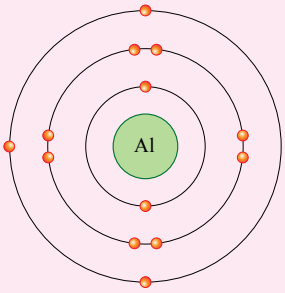


Figure 2.13 *Electron arrangement of aluminium atom*

The **atomic structure** shows the number of protons and neutrons in the nucleus and electron arrangement of an atom. For example, the atomic structure of aluminium is shown in Figure 2.14.

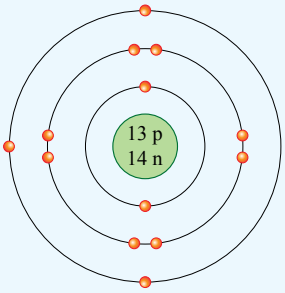


Figure 2.14 *Atomic structure of aluminium atom*

Activity 2.6

Writing the electron arrangement and drawing the atomic structure

CT

1. Get the standard representation of atoms of the first 20 elements in the Periodic Table of Elements from the QR code or the given website.
   Based on the information:
   (a) Write the electron arrangement of the 20 elements
   (b) Draw the atomic structure of the 20 elements
2. Display your work on the notice board in your class.

Standard representation of atoms

http://bit.ly/2qusDfC

Activity 2.7

Illustrating the atomic structure using a model

CT

1. Carry out this activity in groups.
2. Choose an element from the elements with proton numbers 1 to 20. Produce a model to illustrate the atomic structure using recycled materials.
3. The model that is produced must include the following:
   (a) Protons and neutrons in the nucleus
   (b) Electron arrangement in the shells
4. Present the model in front of the class.

Test Yourself 2.3

Table 2.3 shows the number of protons and the number of neutrons for elements *X*, *Y* and *Z*.

Table 2.3

Element	Number of protons	Number of neutrons
X	10	10
Y	11	12
Z	19	20

1. What is the nucleon number of atom *Y*?
2. Write the standard representation of element *Z*.
3. Atom *Y* donates one electron to form ion Y^+. State the number of protons, neutrons and electrons for ion Y^+.
4. (a) Write the electron arrangement of atom *X*.
   (b) Draw the electron arrangement for atom *X*.
   (c) Draw the atomic structure of atom *X*. Label all the subatomic particles in the diagram.

2.4 Isotopes and Its Uses

Learning Standard

At the end of this lesson, pupils are able to:
2.4.1 Deduce the meaning of isotopes
2.4.2 Calculate the relative atomic mass of isotopes
2.4.3 Justify the usage of isotopes in various fields

Meaning of Isotopes

Figure 2.15 shows three atoms of hydrogen element. All these three atoms of hydrogen have the same proton number but different nucleon numbers. These hydrogen atoms are known as **isotopes**.

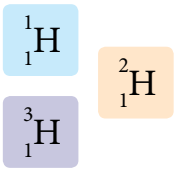


Figure 2.15

Activity 2.8

Generalising the meaning of isotopes

1. Carry out this activity in groups.
2. Compare and contrast the number of protons, electrons and neutrons in the isotopes of silicon, magnesium and phosphorus.

$^{28}_{14}Si$ $^{29}_{14}Si$ $^{30}_{14}Si$ $^{24}_{12}Mg$ $^{25}_{12}Mg$ $^{26}_{12}Mg$ $^{31}_{15}P$ $^{32}_{15}P$

3. Interpret the information obtained and generalise the meaning of isotopes.

Isotopes are atoms of the same element with the same number of protons but different number of neutrons. For example, chlorine has two isotopes, chlorine-35 and chlorine-37. Table 2.4 shows the number of subatomic particles for the isotopes of chlorine. Atoms of chlorine-35 and chlorine-37 have different masses because the number of neutrons in the nucleus are different.

Chemistry Lens

Chlorine atom with the nucleon number 35 can be represented by Cl-35, $^{35}_{17}Cl$ or ^{35}Cl.

Table 2.4 Number of subatomic particles for the isotopes of chlorine

Isotope	Atomic standard representation	Number of protons	Number of neutrons	Number of electrons
Chlorine-35	$^{35}_{17}Cl$	17	18	17
Chlorine-37	$^{37}_{17}Cl$	17	20	17

Relative Atomic Mass of Isotopes

Most elements exist naturally as a mixture of two or more isotopes. Relative atomic mass of these elements depend on the natural abundance of isotopes in a sample. **Natural abundance** is the percentage of isotopes present in a natural sample of element. The relative atomic mass can be calculated from the natural abundance of an element containing isotopes using the following formula:

$$\text{Relative atomic mass} = \frac{\Sigma(\%\ \text{isotope} \times \text{mass of isotope})}{100}$$

Example 3

Chlorine consists of two isotopes, $^{35}_{17}Cl$ and $^{37}_{17}Cl$. The natural abundance of $^{35}_{17}Cl$ is 75% and $^{37}_{17}Cl$ is 25%. Calculate the relative atomic mass of chlorine.

Solution

$$\text{Relative atomic mass of chlorine} = \frac{(\%\ \text{isotope}\ ^{35}_{17}Cl \times \text{mass}\ ^{35}_{17}Cl) + (\%\ \text{isotope}\ ^{37}_{17}Cl \times \text{mass}\ ^{37}_{17}Cl)}{100}$$

$$= \frac{(75 \times 35) + (25 \times 37)}{100}$$

$$= 35.5$$

Uses of Isotopes

Isotopes are used widely in various fields as listed in Table 2.5.

Table 2.5 *Uses of isotopes in various fields*

Field	Isotope	Uses
Medicine	Cobalt-60	• In radiotherapy to kill cancer cells without surgery • Sterilising surgical tools
	Iodine-131	• Treatment of thyroid disorders such as hyperthyroidism and thyroid cancer
Agriculture	Phosphorus-32	• Study of plant metabolism
Nuclear	Uranium-235	• Generating electricity through nuclear power generator
Archaeology	Carbon-14	• Estimation of artifacts or fossils' age
	Lead-210	• In determining the age of sand and earth layers up to 80 years
Industry	Hydrogen-3	• As a detector to study sewage and liquid wastes
Engineering	Sodium-24	• In detecting leakage in underground pipes

Development in the field of science, specifically chemistry has maximised the use of isotopes in various fields. Isotopes are used for sustainability of life. The use of isotopes causes both positive and negative effects on the environment and society.

Uses of isotopes

http://bit.ly/32zUJUP

Activity 2.9

Holding a forum on the issues of using isotopes

21st Century Skills

1. Carry out this activity in groups.
2. Each group is given a role as a chemist, medical representative, enforcer and others. Based on the role given, search for information concerning issues involving isotopes.
3. Hold a forum to discuss the positive and negative effects of using isotopes.
4. Record the forum proceedings and upload to social media.

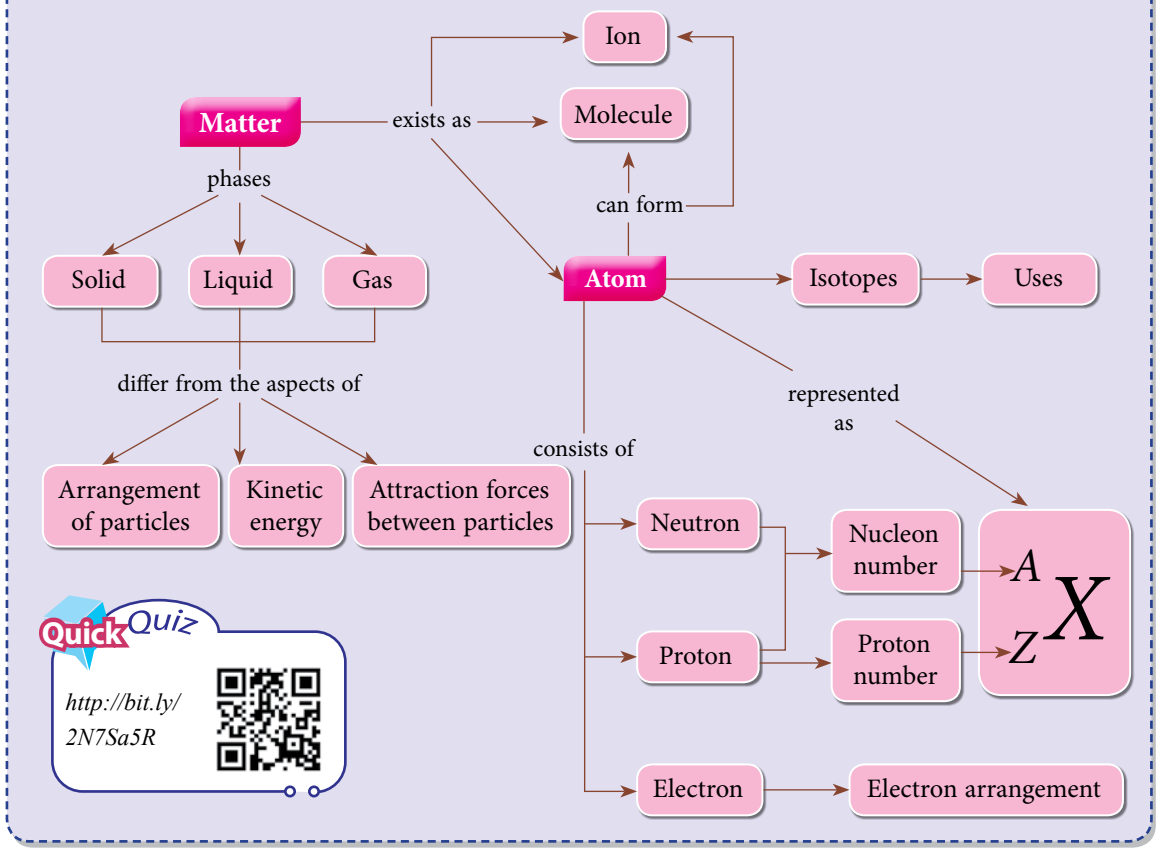
Test Yourself 2.4

1. Define isotopes.
2. Based on Table 2.6, which atoms are isotopes? Explain your answer.
3. Atoms of oxygen-16, oxygen-17 and oxygen-18 are isotopes. Compare and contrast these three isotopes.
4. Magnesium exists naturally as three isotopes, which are 79.0% of ^{24}Mg, 10.0% of ^{25}Mg and 11.0% of ^{26}Mg. Calculate the relative atomic mass of magnesium.
5. Madam Maimunah was diagnosed with bone cancer.
   (a) What isotope is used to treat Madam Maimunah?
   (b) Explain the positive and negative effects of using the isotope in (a).

Table 2.6

Element	Proton number	Nucleon number
W	6	12
X	6	13
Y	11	23
Z	12	24

Chain Concept



Quick Quiz

http://bit.ly/2N7Sa5R

SELF Reflection

1. What new knowledge have you learned in **Matter and Atomic Structure**?
2. Which is the most interesting subtopic in **Matter and Atomic Structure**? Why?
3. Give a few examples on the application of **Matter and Atomic Structure** in daily life.
4. Rate your performance in **Matter and Atomic Structure** 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 **Matter and Atomic Structure**?

http://bit.ly/2Mkz7Xa

Achievement Test 2

1. Table 1 shows the melting point and boiling point of substances *A*, *B*, *C*, *D* and *E*.

Table 1

Substance	Melting point (°C)	Boiling point (°C)
A	−101.0	−35.0
B	−94.0	65.0
C	17.8	290.0
D	97.8	883.0
E	801.0	1413.0

(a) Classify substances *A*, *B*, *C*, *D* and *E* according to states of matter at room temperature.

(b) State the substance that will change from liquid to solid when placed in the freezer at temperature 2 °C.

(c) Describe the changes that take place on the particles of substance *B* with relation to energy and attraction force between particles when cooled from 80 °C to −2 °C.

2. A group of students carried out an experiment to determine the melting point of lauric acid, $C_{12}H_{24}O_2$. Figure 1 shows the heating curve obtained.

(a) Copy Figure 1 and label the melting point of lauric acid, $C_{12}H_{24}O_2$ on the diagram.

(b) Draw the arrangement of particles in lauric acid, $C_{12}H_{24}O_2$ between *R* and *S*.

(c) The melting point of lauric acid, $C_{12}H_{24}O_2$ is 43 °C. Suggest a suitable method of heating lauric acid, $C_{12}H_{24}O_2$.

(d) Draw a labelled diagram to show the set-up of apparatus for the method suggested in (c).

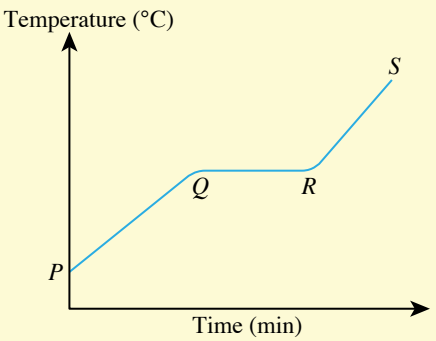


Figure 1

3. Chen Ling cleans her wound using alcohol as shown in Photograph 1. Chen Ling's skin feels cool when wiped with alcohol. Explain this situation.

Photograph 1

4. Figure 2 shows the nucleus charges of the atoms of elements *X*, *Y* and *Z*.

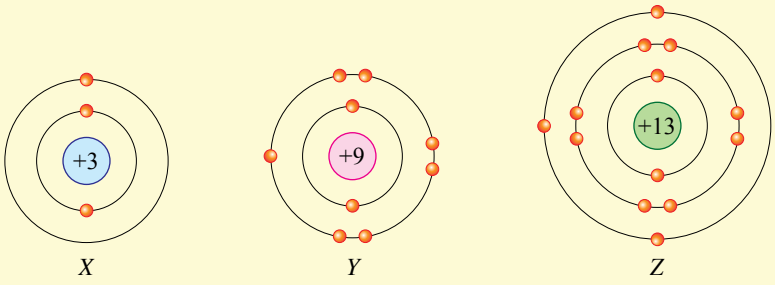


Figure 2

(a) State the subatomic particle that provides the charges in the atoms of the elements.
(b) State the other subatomic particle found in the nucleus of the atoms.
(c) Write the electron arrangement of the atoms for elements *X*, *Y* and *Z*.
(d) Atom *Z* contains 14 neutrons. Calculate the nucleon number of atom *Z*.

5. Figure 3 shows the information on boron. Boron has two isotopes, namely isotope ^{11}B and isotope ^{y}B. Based on the information given, calculate the nucleon number of isotope ^{y}B.

Relative atomic mass of boron = 10.81
80% ^{11}B
20% isotope Boron-Y

Figure 3

6. Figure 4 shows the standard representation of a platinum atom. A platinum ion contains 74 electrons and has a nucleon number of 195.
(a) What are the number of protons and neutrons in the platinum ion?
(b) What is the charge of the platinum ion?

$^{195}_{78}Pt$

Figure 4

7. Justify the use of iodine-131 in the treatment for hyperthyroidism.

Enrichment Corner

1. You lost your way while camping in a jungle. You felt thirsty but could not find a water source. In your bag, there were a transparent plastic bag and a string. Using the available things, describe how you could produce water through the condensation process. STEM

Check Answers
http://bit.ly/2odL87q