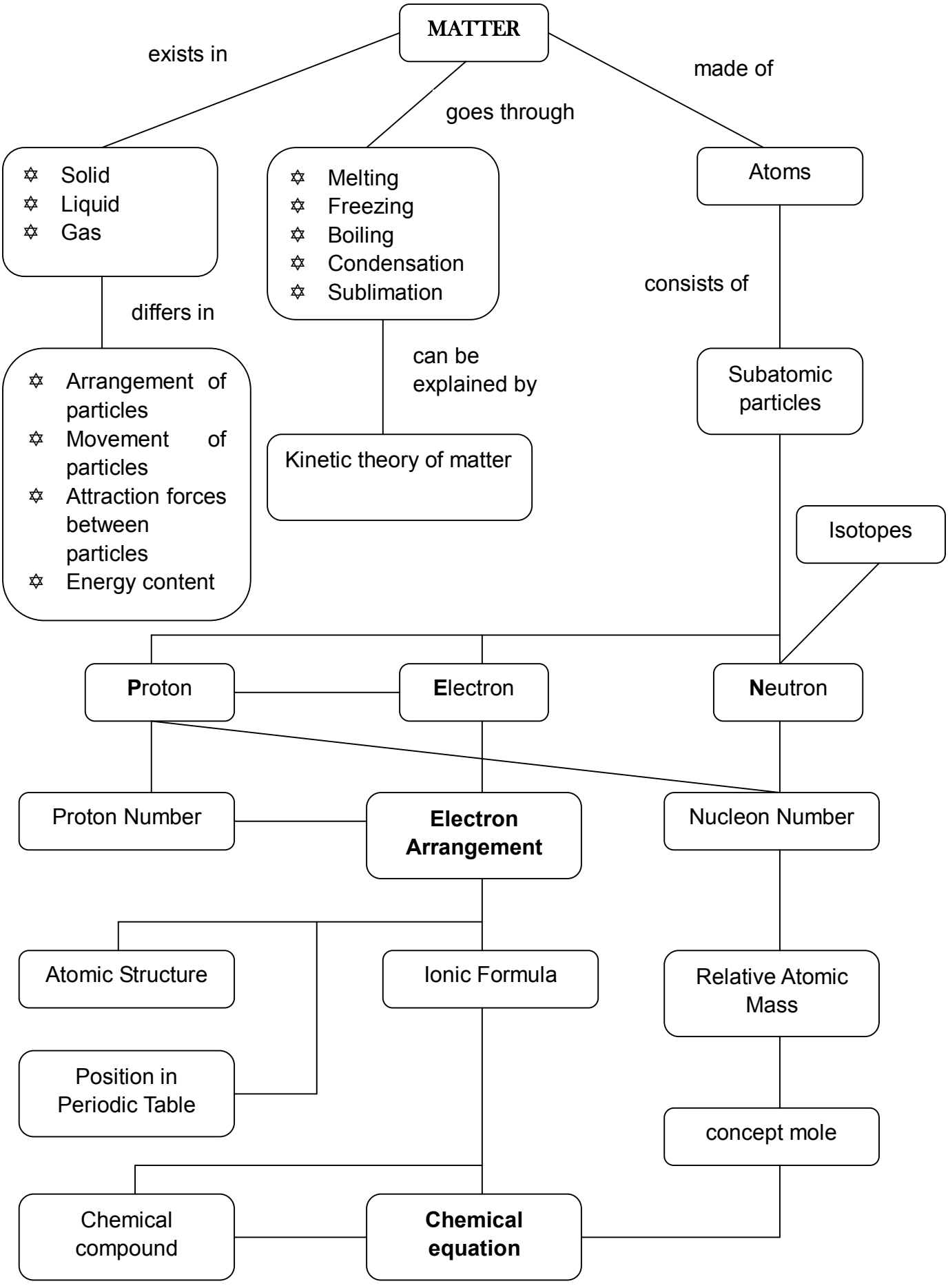
Chapter 2: the Structure of the Atom



A) Matter

1.	**Matter**	- Is anything that occupies space and has mass. - Is made up of tiny and discrete particles. - There are spaces between these particles. - These particles may be atoms, molecules or ions. - Matter exists in three states → solid, liquid and gas
2	**Element**	- Is a substance that consists of only one type of atom
3	**Compound**	- Is a substance that contains two or more elements that are chemically bonded together - Molecule, Ion
4.	**Atom**	- An atom is the smallest particle of an element that can participate in a chemical reaction. - Metals and some non metals such as carbon and helium exist as atoms. - Fe, Al, Mg, Au
5.	**Molecule**	- Is a group of two or more atoms which are chemically bonded together - O_2, H_2 , H_2O, CO_2
6.	**Ion**	- Is a positively-charged or negatively-charged particle. - Sodium Chloride, NaCl: Na^+, Cl^-
7.	**Diffusion**	- Occur when particles of a substance, move in between the particles of another substance. - Occur most rapidly in gases, slower in liquids and slowest in solids.
8.	**The Kinetic Theory of Matter**	

i. Solid

- a solid has a fixed volume and shape
- a solid cannot be compressed
- the particles are packed closely together in an orderly manner
- there are strong forces between the particles
- the particles can only vibrate and rotate about their fixed positions

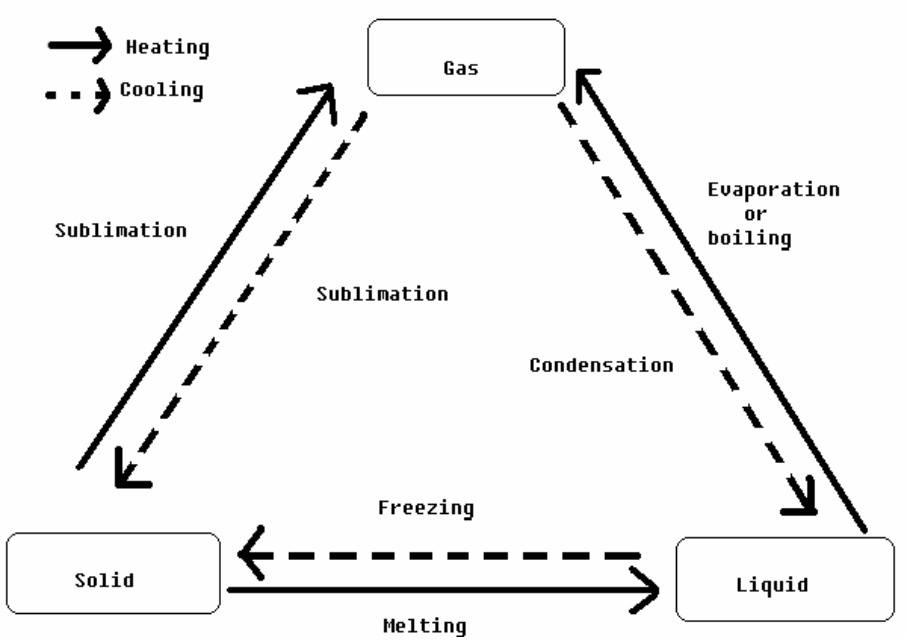
ii. Liquid

- a liquid has fixed volume. It does not have a fixed shape but takes the shape of the container
- a liquid cannot be compressed easily
- The particles are packed closely together but not in orderly arrangement
- The particles are held together by strong forces but weaker that the forces in a solid
- The particles can vibrate, rotate and move through the liquid. They collide against each other

iii. Gas

- a gas does not gave a fixed shape or volume
- a gas can be compressed easily
- the particles are very far apart from each other and in a random motion
- there are weak forces between the particles ， the particles can vibrate, rotate and move freely. The rate of collision is greater that the rate of collision in a liquid

9 **The change in the state of matter**

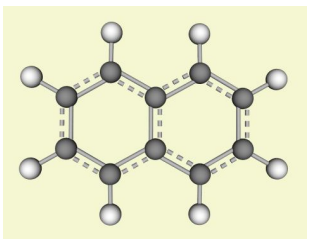


Sublimation	Solid → Gas	Heat energy is absorbed
Melting	Solid → Liquid	Heat energy is absorbed
Evaporation or Boiling	Liquid → Gas	Heat energy is absorbed
Freezing	Liquid → Solid	Heat energy is released
Sublimation	Gas → Solid	Heat energy is released
Condensation	Gas → Liquid	Heat energy is released

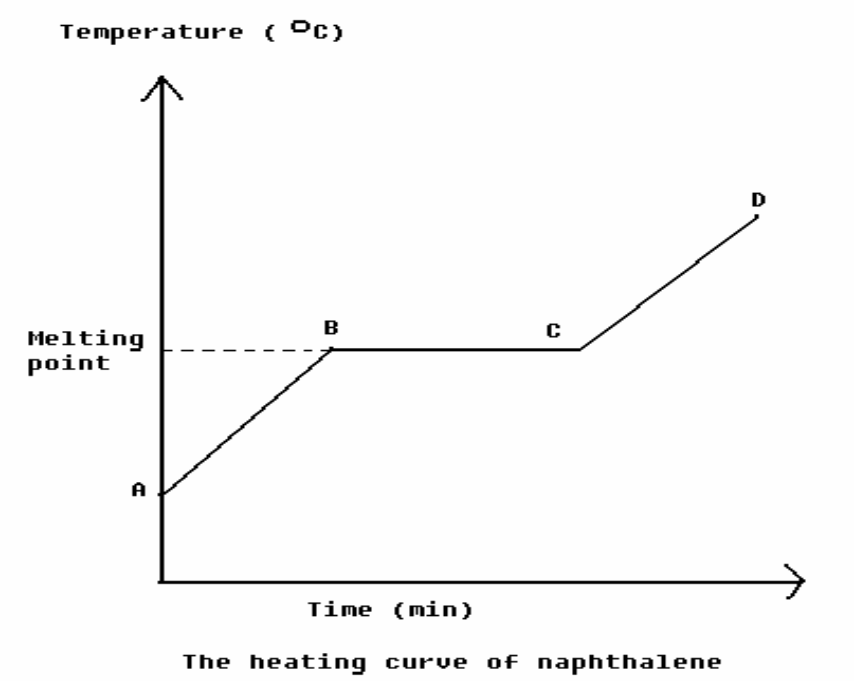
10 **The kinetic theory of matter**

i. ***when a solid is heated***,

- the particles in the solid gain kinetic energy and vibrate more vigorously
- the particles vibrate faster as the temperature increases until the energy they gained is able to overcome the forces that hold them at their fixed positions
- At this point, the solid becomes a liquid. This process is called melting.
- ***Melting point is the temperature at which a solid changes into a liquid at a particular pressure***



- Example: Naphthalene $C_{10}H_8$



The heating curve of naphthalene

- The curve shows the changes in temperature when solid naphthalene melts

At point A

- naphthalene exists as solid
- When the solid is heated, heat energy is absorbed. This cause the particles to gain kinetic energy and vibrate faster
- This is why the temperature increases from point A to point B

At point B

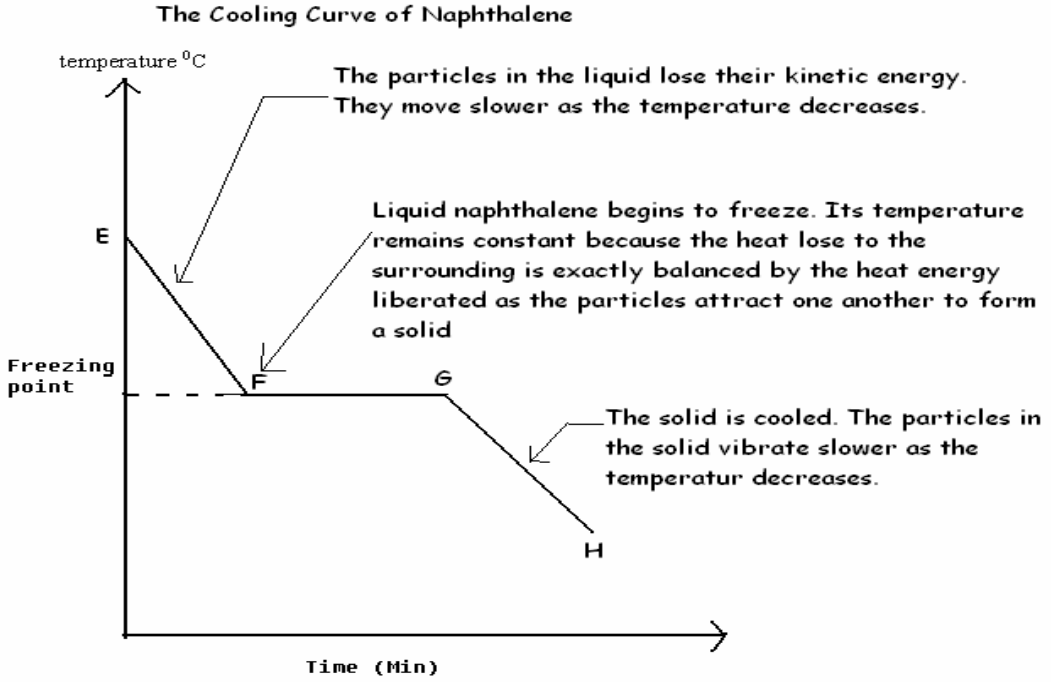
- solid naphthalene begins to melt
- during the melting process, the temperature ^{0}Cof naphthalene does not rise, even though heating continues
- ***the temperature remains constant because the heat energy absorbed by the particles is used to overcome the forces between particles***
- the solid can turn into liquid
- this constant temperature is the melting point of naphthalene
- at this temperature, both solid and liquid are present

At point C

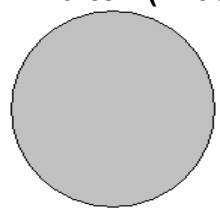
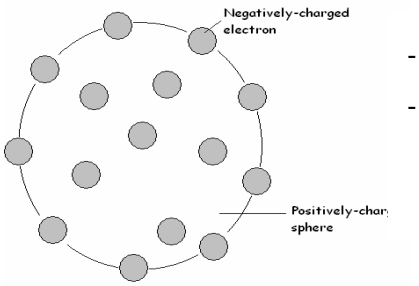
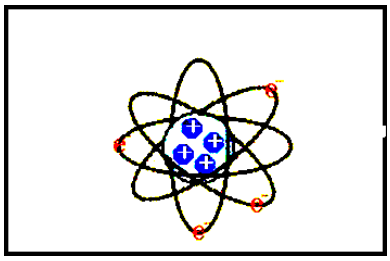
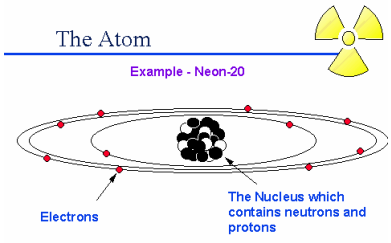
- all the solid naphthalene has melted
- from point C to D, the particles in liquid naphthalene absorb heat energy and move faster
- the temperature increases from point C to point D

ii. *When a liquid is cooled / freezing*

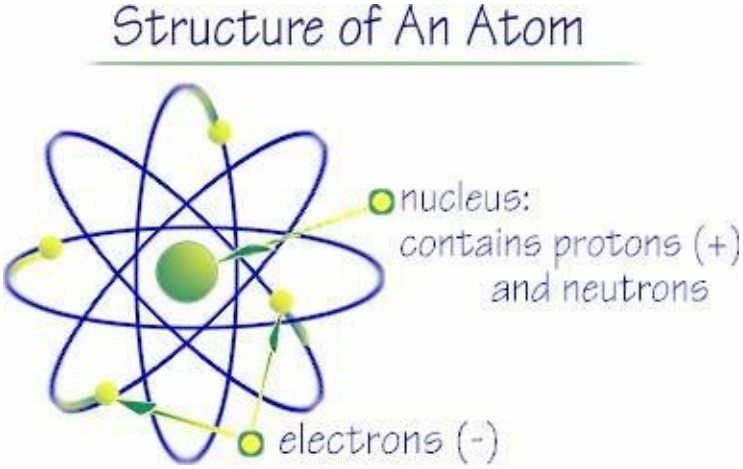
- the particles in the liquid lose energy and move slower
- As the temperature continues to drop, the particles continue to lose more energy until they do not have enough energy to move freely
- At this point, the ***liquid changes into solid***. This process is called ***freezing***
- **<u>Freezing point</u>** is the temperature at which a liquid changes into a solid at a particular pressure.
- Example: Naphthalene, acetamide



B) The Atomic Structure

1.	**John Dalton (1766 – 1844)**  - Atom as a small, invisible ball similar to a very tiny ball
2.	**J.J. Thomson (1856 – 1940)**  - He discovered electron - He described the atom as sphere of positive charge which contains a few negatively charged particles called electron
3.	**Ernest Rutherford (1871 – 1937)**  - He discovered proton, a positive charge in an atom - The positive charge and most of the mass of the atom are concentrated in a small, central region called nucleus - The electrons move in a space that is lager than the space occupied by the nucleus -
4.	**Neils Bohr (18856 – 1962)**  - he proposed that the electrons in an atom move in shells around the nucleus
5.	**James Chadwick (1891 – 1974)** - He proved the existence of neutrons, the neutral particles in the nucleus. - Neutrons contribute approximately to half the mass of an atom

Subatomic particles of an atom



1.	**Proton**	- Symbol: P Relative electric charge: +1 Relative mass: 1
2.	**Neutron**	- Symbol: N Relative electric charge: 0 Relative mass: 1
3.	**Electron**	- Symbol: e Relative electric charge: -1 Relative mass: Approximately $\frac{1}{1840}$ ~ 0.0005
4.	**Nucleus**	- Contain proton and neutron. - Most of the mass of an atom is concentrated in the nucleus - The nucleus has an overall positive charge due to the positively-charged protons in it
5.	**Proton number**	- The number of proton in its atom
6.	**Nucleon number**	- The total number of protons and neutrons in its atom - Nucleon number = number of proton + number of neutrons - ***Number of neutron*** = Nucleon number – Proton number

7. **Symbols of elements**

Element	Symbol	Element	Symbol	Element	Symbol	Element	Symbol
Hydrogen		Carbon		Sodium		Sulphur	
Helium		Nitrogen		Magnesium		Chlorine	
Lithium		Oxygen		Aluminium		Argon	
Beryllium		Fluorine		Silicon		Potassium	
Boron		Neon		Phosphorus		Calcium	

8 **Standard representation for an atom**

- Nucleon Number → A; Proton number → Z; X ← Symbol of element
  Nucleon Number → 23; Proton number → 11; Na ← Symbol of element
- $^{19}_{9}F$ → number of proton = 9, number of neutron = 19 – 9 = 10, number of electron = 9

	$^{12}_{6}C$	$^{20}_{10}Ne$	$^{39}_{19}K$	$^{80}_{35}Br$
Number of proton				
Number of neuron				
Number of electron				

9. **Isotopes**

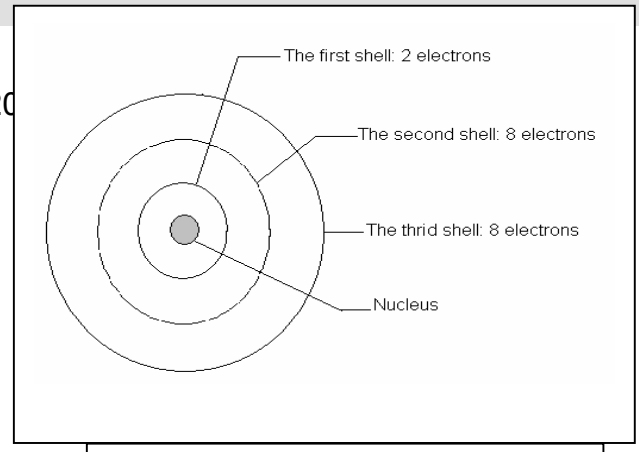
- Isotopes are atoms of the same element (same number of proton) with different number of neutrons.
- Examples: Hrogren-1, Hydrogen-2, Hydrogen-3, Chlorine-35, Chlorine-37

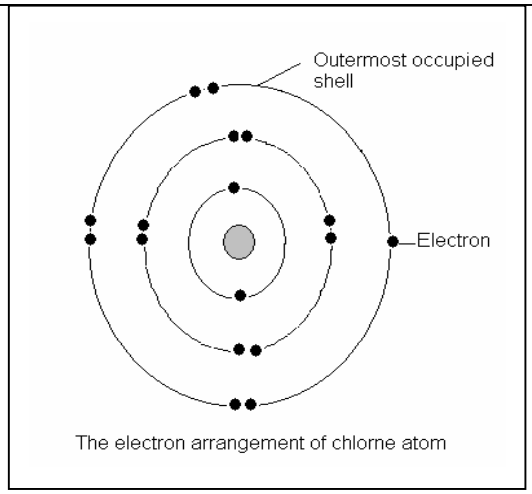
Uses of Isotopes

Isotopes	Uses
Cobalt-60	✡ used in radiotherapy for the treatment of cancer
Gamma rays of cobalt-60	✡ used to destroy bacteria in food without changing the quality of food
Carbon-14	✡ estimate the age of fossils and artefacts
Phosphorous-32	✡ study the metabolism of phosphorus in plants
Sodium-24	✡ Used to detect leaks in pipes carrying gas

10 **Electron arrangement**

- Also know as electronic configuration
- For atoms with the proton numbers of 1 to 20
- First shell: 2 electrons
- Second shell: 8 electrons
- Third shell: 8 electrons
- Example: Cl → 2.8.7





The electron arrangement of chlorne atom

- For atoms with more than 20 electrons, the third shell can accommodate up to 18 electrons
- Example: Rubidium, Rb → 2.8.18.8.1

11 **Valence electrons**

- Valence electrons are electrons found in the outermost occupied shell of an atom
- Example, Cl, 2.8.7. The valence electrons of a chlorine atom are 7.

Important information based on the electron arrangement

Element	**Mg**	**Cl**	**K**	**O**	**Ca**	**Si**
Proton number	12	17	19	8		
Electron arrangement	2.8.2	2.8.7	2.8.8.1	2.6		
Number of valence electron	2	7	1	6		
Number of shells	3	3	4	2		
Position in periodic table	Group 2, Period 3	Group 12, Period 3	Group 1 Period 4	Group 16 Period 2		