The structure of Atom IV

Symbol of elements

1. A symbol of element is the chemical symbol written in short form to represent a particular element.
2. Each element is represented by a symbol, consisting of either one letter or two letters of the alphabet.
3. Some elements are represented by the first letter of its name.
   Examples:

Element	Symbol
Fluorine	F
Hydrogen	H
Iodine	I
Nitrogen	N
Oxygen	O
Phosphorus	P
Sulphur	S

4. If there are two or more elements that have mane start with the same alphabet letter, a second letter is added to differentiate between these elements.
5. The second letter used is always lowercased.
   Examples

Elements	Symbol
Bromine	Br
Calcium	Ca
Chlorine	Cl
Chromium	Cr
Magnesium	Mg
Manganese	Mn
Neon	Ne
Nickel	Ni
Silicon	Si

6. Some elements are represented by their Latin names. For example,

Elements	Latin Name	Symbol
Copper	Cuprum	Cu
Iron	Ferrum	Fe
Lead	Plumbum	Pb
Mercury	Hydrargyrum	Hg
Potassium	Kalium	K
Silver	Argentum	Ag
Sodium	Natrium	Na
Tin	Stannum	Sn

Isotopes and their Importance

Isotope

1. Isotopes are atoms of certain elements which have the same number of protons but different number of neutrons in the nucleus of the atoms.
2. It can also can be defined as atoms of certain elements with the same proton numbers but with different nucleon numbers.

Three important points to define isotopes.
• Isotopes are different atoms of the same element. • Isotopes have the same number of protons or same proton numbers. • Isotopes have different numbers of neutrons or nucleon numbers.

Properties of Isotope	
Number of proton	equal
Number of neutron	difference
Chemical properties	same
Physical properties	difference

Element	Name	Symbol	Proton Number	Nucleon Number	Number of proton	Number of neutron
Hydrogen	Hydrogen	${}_{1}^{1}H$	1	1	1	0
	Deuterium	${}_{1}^{2}H$	1	12	1	1
	Tritium	${}_{1}^{3}H$	1	23	1	2
Oxygen	Oxygen-16	${}_{8}^{16}O$	8	16	8	8
	Oxygen-17	${}_{8}^{17}O$	8	17	8	9
	Oxygen-18	${}_{8}^{18}O$	8	18	8	10
Carbon	Carbon-12	${}_{6}^{12}C$	6	12	6	6
	Carbon-13	${}_{6}^{13}C$	6	13	6	7
	Carbon-14	${}_{6}^{14}C$	6	14	6	8
Chlorine	Chlorine-35	${}_{17}^{35}Cl$	17	35	17	18
	Chlorine-37	${}_{17}^{37}Cl$	17	37	17	20
Sodium	Sodium-23	${}_{11}^{23}Na$	11	23	11	12
	Sodium-24	${}_{11}^{24}Na$	11	24	11	13

Uses of isotopes in our daily lives

1. There are two types of isotopes, namely
   a. the stable isotopes (non-radioactive)
   b. the non-stable isotopes (radioactive).
2. Unstable isotopes go through radioactive decay and emit radiation and they are known as radioisotopes.
3. Radioisotopes have many applications in daily life.
4. Several uses of radioisotopes in daily life are shown in Table below.

Medical	Gamma rays of cobalt-60 are used to kill cancer cells without surgery in patients. This treatment is known as radiotherapy.
	Patients with skin cancer can be treated using beta rays from the isotopes phosphorus-32 and strontium-90
	Medical instruments such as surgical equipment, syringes and bandages can sterilize by using gamma rays.
	Radioisotopes are also used as tracers. A small amount of sodium-24 is injected into the patient's body. A radioactive detector is then used to detect accumulation of sodium-24 and therefore detect tumours and blood clots before they become dangerous.
	This tracing method is also used to investigate the thyroid glands by measuring the uptake of iodine-131.
	Plutonium-238 in a nuclear battery is used to produce small electric shocks in the **heart pacemaker**. People with irregular heartbeats need to have a **heart pacemaker** implanted inside their chest. The nuclear battery of the pacemaker provides a tiny electrical shock to ensure a steady heartbeat.

Agricultural	Radio isotopes are used to cause mutation in insects so as to make them sterile or to cause death. These serve as pest control in agriculture.
	The metabolism of phosphorus by plants can be studied using phosphate fertilisers that contain phosphorus-32. A small amount of phosphorus-32 is used in fertilisers. The radiation produced by phosphorus-32decaying is detected by a Geiger-Miller counter. This method can trace the passage of phosphate ions in plants..
	Carbon-14 is used to study the passage of carbon during photosynthesis in plants.
Industrial	Isotope sodium-24 is used to detect leakage of underground pipes.
	Beta rays are used to control the thickness of plastic, paper and metal sheets in factory.
	Gamma rays are used to detect whether cans or bottles are filled up to the required amount.
	Sodium-24 is used to measure the wear out rate of engine in a vehicle.
Food Preservation	The gamma rays from cobalt-60 are used to kill bacteria in food to make fresh vegetables and fruits last longer without any change in quality, flavour and texture of food.
	Gamma rays are used to inhibit budding in potatoes.
Archeology	Radioisotope carbon-14 is used to study and estimate the age of ancient artifacts. This method is named as the **radiocarbon dating**.
Production of Energy	Plutonium is used in nuclear reactors to produce electrical energy.

5. Radioactive isotopes are very dangerous if it is misused.
6. Short-term exposure to radioactive rays may
   a) kill or destroy the cells in our body and cause organ damage
   b) cause rashes and burns on the exposed skin
7. Long-term exposure to radioactive rays may
   1. cause mutation in our genes and abnormalities in newborn babies
   2. disturb the growth and division of cells and consequently cause cancer

Electron Configuration in Atom

1. We have learnt that electrons occupy orbits with definite energy level of an atom, as suggested by Neils Bohr.
2. These orbits with definite energy level are known as the shell.
3. Every single shell is capable of holding up to certain amount of electrons.
4. The first shell can hold up to two electrons. This is called a duplet.
5. The second shell can hold up to eight electrons. This is called an octet.
6. The third shell can hold up to eighteen electrons.
7. However, with the third shell, when eight electrons are present, extra stability is gained. The additional electrons go into the fourth shell before the third shell is completely filled.
8. The way in which the electrons are distributed in the shells of an atom is called the electron arrangement or electron configuration of the atom.
9. The examples below show the electron arrangement of some elements:

Atom	Notes	Electrons Arrangement
$^{6}_{3}Li$	1. Lithium has 3 protons and 3 neutrons and three electrons as well. 2. All the three electrons are arrange as follows: • Two electrons are filled in the first shell. • One electron is filled in the second shell. • The electron arrangement of carbon is 2.1	
$^{35}_{17}Cl$	1. Chlorine has 17 protons and 18 neutrons and 17 electrons. 2. All the three electrons are arrange as follows: • Two electrons are filled in the first shell. • Eight electrons are filled in the second shell. • Seven electrons are filled in the third shell. • The electron arrangement of chlorine is 2.8.7.	
$^{40}_{20}Ca$	1. Calcium has 20 protons and 20 neutrons and 20 electrons. 2. All the three electrons are arrange as follows: • Two electrons are filled in the first shell. • Eight electrons are filled in the second shell. • Eight electrons are filled in the third shell. • Two electrons are filled in the forth shell. • The electron arrangement of carbon is 2.8.8.2.	

Element	Proton Number	Number of Electron	Number of electron in				Electron Arrangement
			1st shell	2nd shell	3rd shell	4th shell	
Hydrogen	1	1	1	0	0	0	1
Helium	2	2	2	0	0	0	2
Lithium	3	3	2	1	0	0	2.1
Beryllium	4	4	2	2	0	0	2.2
Boron	5	5	2	3	0	0	2.3
Carbon	6	6	2	4	0	0	2.4
Nitrogen	7	7	2	5	0	0	2.5
Oxygen	8	8	2	6	0	0	2.6
Fluorine	9	9	2	7	0	0	2.7
Neon	10	10	2	8	0	0	2.8
Sodium	11	11	2	8	1	0	2.8.1
Magnesium	12	12	2	8	2	0	2.8.2
Aluminium	13	13	2	8	3	0	2.8.3
Silicon	14	14	2	8	4	0	2.8.4
Phosphorus	15	15	2	8	5	0	2.8.5
Sulphur	16	16	2	8	6	0	2.8.6
Chlorine	17	17	2	8	7	0	2.8.7
Argon	18	18	2	8	8	0	2.8.8
Potassium	19	19	2	8	8	1	2.8.8.1
Calcium	20	20	2	8	8	2	2.8.8.2

Valence electrons

1. The electrons in the outermost shell of an atom are called valence electrons.
2. The valence electrons have great significance in determining the chemical properties of an atom.
3. Elements with the same number of valence electron have the same chemical properties.

Structured Question

Particle	Proton Number	Nucleon Number	Electronic Configuration	Number of Valence Electrons
P	6	12		
Q	6	14		
R	8	16		
S	11	23		
T	17	35		

1. Table above shows the proton number and nucleon number of particle P, Q, R, S and T.
   a. Define proton number and nucleon number.

   b. What is the number of electrons in one particle R?

   c. Find the number of nucleons in one particle Q.

   d. Write the electronic configuration and number of valence electron for all theparticles in the table.

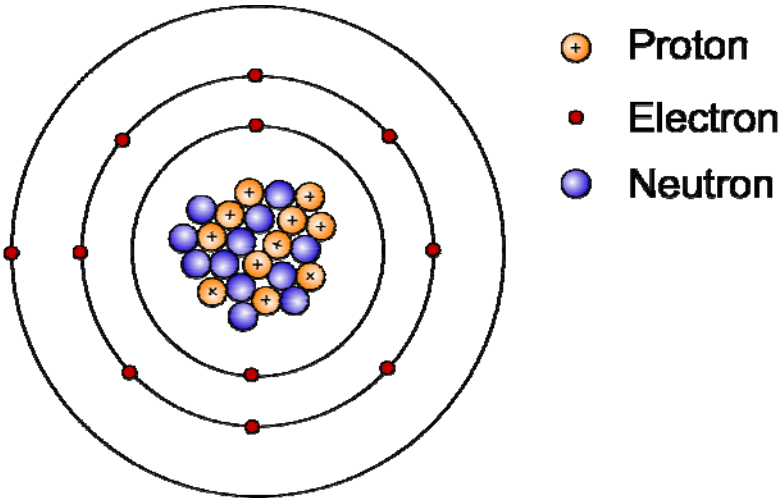
   e. Draw the atomic structure of particle P and T.

   f. How many shells are fill with electron in an atom of particle S.

   g. What is mean by isotope.

h. Which of the two particles are isotopes?

i. Write down two similarities and two differences of isotopes.



2. The structure of a sodium particle is shown in the figure above. Answer the following question base on the figure above.
   a. What is the proton number and nucleon number of sodium?

   b. What is the charge of the particle? Give a reason to your answer.

   c. What is the electronic configuration of the sodium particle?

   d. The sodium particle has how many valence electrons?