# Structure of Atom

## Main characteristics of cathode rays

**Cathode rays cast shadows of opaque objects placed in its path indicating that cathode rays travel in straight lines.**
**When an electric field is applied on both sides of the rays, they are found to be attracted towards the positive side From this we can infer that cathode rays have negative charge .**

**Eugen Goldstein, the German scientist conducted discharge tube experiments with perforated cathode and he discovered rays known as canal rays.**
**According to this model, negatively charged electrons are embedded in a positively charged sphere. The total number of positive charges and negative charges in the sphere will be equal. So, an atom is electrically neutral.**

### Rutherford's Gold Foil Experiment

**Most of the alpha particles passed through the gold foil undeflected.**
**Some of the alpha particles deflected by a small angle from the straight line when they hit the gold foil.**

### Limitations of Rutherford's atom model

**a charged body in motion should continuously emit energy. Hence, negatively charged electrons revolving around the nucleus should continuously lose energy and collapse into the nucleus. But this does not happen. Therefore Rutherford atom model failed to explain the stability of an atom.**

**James Chadwick discovered neutron.**

**Atomic number is the number of protons or electrons in an atom.**

Rutherford atom model can be briefed as follows:

- Atom has a centre called nucleus.
- The size of the nucleus is extremely small when compared to the size of the atom.
- The entire positive charge and most of the mass of the atom are concentrated in the nucleus.
- Electrons revolve very fast around the nucleus in circular paths or orbits.

**The main concepts of Bohr Atom model:**

- Electrons revolve around the nucleus of an atom in fixed orbits.
- Electrons in each orbit have a definite energy. So orbits are also known as energy levels.
- As long as the electrons revolve in a particular orbit their energy does not change. So, the orbits are known as stationary energy levels.
- The energy of the orbit increases as the distance from the nucleus increases.
- Energy is emitted when the electrons shift from orbits of higher energy to orbits of lower energy. Energy is absorbed when the electrons shift from orbits of lower energy to orbits of higher energy.
- Orbits can be represented by giving numbers 1, 2, 3, 4, 5.... etc.

**Mass number is the number of protons and neutrons.**

**Number of neutrons is the mass number ---atomic number.**

| Symbol | Atomic number | Mass number | Number of protons | Number of electrons | Number of neutrons |
|---|---|---|---|---|---|
| $^{1}_{1}H$ | 1 | 1 | 1 | 1 | 0 |
| $^{7}_{3}Li$ | 3 | 7 | 3 | 3 | 4 |
| $^{16}_{8}O$ | 8 | 16 | 8 | 8 | 8 |
| $^{23}_{11}Na$ | 11 | 23 | 11 | 11 | 12 |
| $^{20}_{10}Ne$ | 10 | 20 | 10 | 10 | 10 |
| $^{48}_{22}Ti$ | 22 | 48 | 22 | 22 | 26 |
| $^{235}_{92}U$ | 92 | 235 | 92 | 92 | 143 |
| $^{232}_{90}Th$ | 90 | 232 | 90 | 90 | 142 |
| $^{65}_{30}Zn$ | 30 | 65 | 30 | 30 | 35 |

According to the Bohr atom model, where is the electron situated in an atom?

nucleus

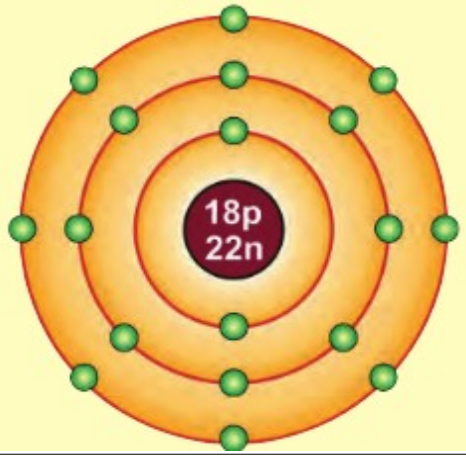
What are the symbols given to the energy levels 1, 2, 3 and 4?

K,L,M,N

.. The maximum number of electrons that can be accommodated in any orbit is $2n^2$ (n=orbit number).

| Orbit number (n) | Name | Maximum number of electrons that can be accommodated ($2n^2$) |
|---|---|---|
| 1 | K | $2\times 1^2 = 2$ |
| 2 | L | $2\times 2^2 = 8$ |
| 3 | M | .....2x3x3=18..... |
| 4 | N | ..2x4x4=32..... |

The orbit electron configuration of an atom is given.




Analyse the figure and find the following.

Atomic number.....18.....Mass number.....40.....

Number of protons.....18.....Number of neutrons.....22.....

Electron configuration.....2,8,18,12.....

**Isotopes are different atoms of the same element having the same atomic number but different mass numbers.**

**Isotopes exhibit the same chemical properties. But they show slight variations in physical properties.**

**C-14 is a radioactive isotope. This is used to determine the age of fossils.**

| Isotope | Uses |
|---|---|
| Iodine-131 | To study the functioning of Thyroid gland and in its treatment |
| Uranium-235 | Fuel in nuclear reactors |
| Cobalt-60 | Cancer treatment |
| Sodium -24 | To detect the leakage in industrial pipelines |
| Iron-59 | To diagnose Anaemia |

**Isobars are atoms having the same mass number and different atomic numbers.**

Some observations related to experiments on cathode rays are given. Write the inference based on each observation.

a. A paddle wheel placed in the path of cathode rays rotates.

b. A shadow is formed if an object is placed in the path of cathode rays.

c. When an electric field is applied perpendicular to the path of cathode rays, the rays deflect towards the positive plate.

**a)we can understand that particles in the cathode rays have mass.**
**b)indicating that cathode rays travel in straight lines.**
**c)we can infer that cathode rays have negative charge.**

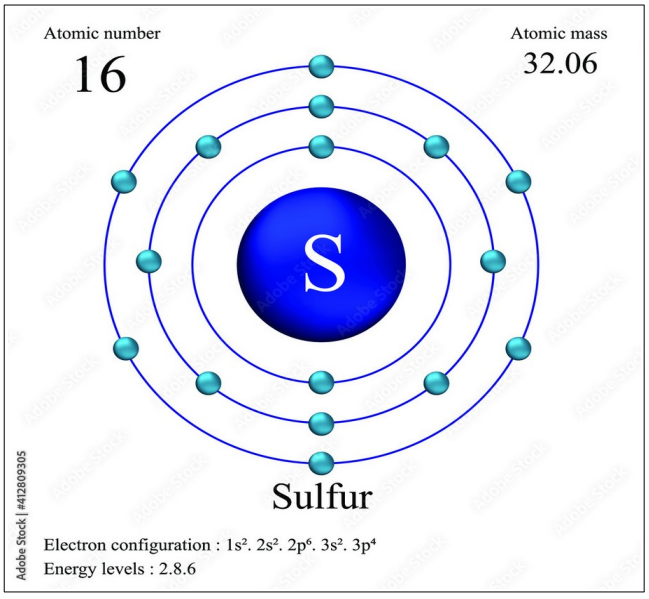
The atomic number of an atom is 16 and mass number is 32.

a. How many electrons, protons and neutrons are present in this atom?

b. Write the electron configuration of this atom.

c. Draw the orbit electron configuration of this atom.

**a)electrons=16,proton=16,neutron=16**
**b)2,8,6**
**c)**



Electrons are present in the K, L and M shells of an atom.

a. Which of these shells has the highest energy?

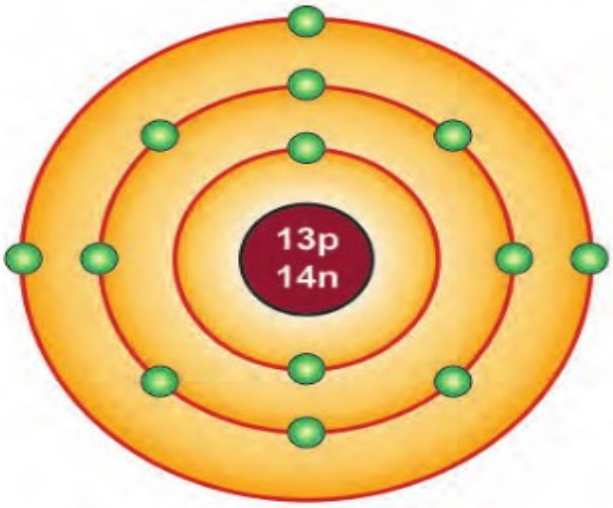
b. If M shell contains only 3 electrons, write the atomic number of this atom.

c. What is the number of electrons in this atom?

d. If the nucleus of this atom contains 16 neutrons, what is its mass number?

**a)M**
**b)13**
**c)13**
**d)29**

The orbit electron configuration of an atom is given below.




a. What is the mass number of this atom?

b. Write its electron configuration.

**a)27**
**b)2,8,3**

The symbols of some elements are given.

$^{24}_{12}Mg$, $^{12}_{6}C$, $^{15}_{7}N$, $^{14}_{6}C$, $^{24}_{11}Na$

a. Select a pair of isotopes from the given elements. Write the reason for selecting it.

b. Select a pair of isobars from the given elements.

**a)$_{6}C^{12}$ and $_{6}C^{14}$ ,same atomic number ,different mass numbers.**

**b)$_{12}Mg^{24}$ and $_{11}Na^{24}$ ,different atomic number same mass number.**

Match the items in column A & B suitably.

| A | B |
|---|---|
| Plum pudding model | James Chadwick |
| Planetary model of atom | Goldstein |
| Canal rays | J. J. Thomson |
| Neutron | Rutherford |

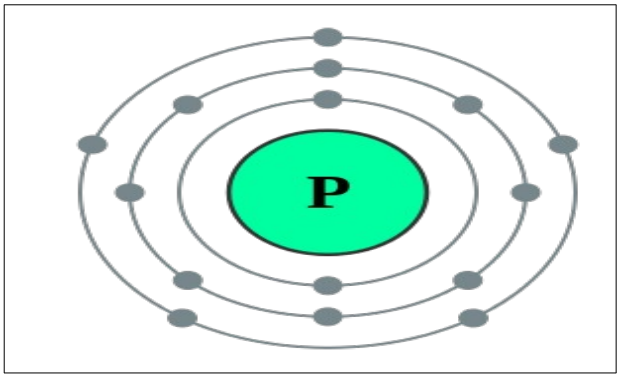
The atomic number and mass number of an element are 15 and 31 respectively.

a. What is the number of valence electrons in this atom?

b. How many neutrons are present in this atom?

c. Draw the orbit electron configuration of this atom.

**a)5 b)16 c)**



Isotope of an element is used to determine the age of fossils.

a. Which is this isotope?

b. Which are the other two main isotopes of this element?

c. Write the number of neutrons in each isotope.

**a)c-14**
**b)c-13,c-12**
**c)c-12=6**
**c-13= 7**
**c-14 =8**

| Element | Proton | Electron | Neutron | Atomic number | Mass number |
|---|---|---|---|---|---|
| Ar | 18 | 18 | 18 | 18 | 39 |
| K | 19 | 19 | 19 | 19 | 39 |
| Ca | 20 | 20 | 20 | 20 | 40 |