

## The Atom : Notes/W.S. - 30

By about 1920, the basic structure of the atom was known.

All atoms consist of a nucleus containing positively charged protons and uncharged neutrons. Negatively charged electrons move in orbits about the nucleus. The charge on a proton ( $+1.6 \times 10^{-19}$  coulombs) is equal but opposite to the charge on the electron. The mass of the proton is about 1837 times the mass of the electron and the mass of the neutron is the same as that of the proton.

Since most atoms are neutral, the number of electrons is equal to the number of protons. The number of protons determines the element. This number is the **atomic number**. But atoms of a particular element can have differing numbers of neutrons. These are called **isotopes**. The sum of the number of protons and neutrons in the nucleus is called the **mass number**.

Example : The isotope potassium-39, which is also written as;  $^{39}\text{K}_{19}$ , has a mass number of 39. The atomic number is 19. The number of neutrons for this isotope is  $39 - 19 = 20$ . The number of electrons is 19 for a neutral potassium atom.

Note : The weighted average of all mass numbers for an atom is called the **atomic mass** or **atomic weight**.

Example : Find the atomic weight of copper. The two main isotopes are: copper-63, (69.1%) and copper-65, (30.9%). The weighted average of these two isotopes is  $63 \times 0.691 + 65 \times 0.309 = 63.6$ .

Problems :

- 1) Write down four things Dalton said about the atom.
- 2) Crookes and others studied cathode rays. Give three properties of these rays.

3) Thomson experimented with cathode rays. State briefly what he found out about the atom.

4) What did Rutherford's experiment with gold foil show about the atom?

5) What is the atomic number?

6) What is the mass number?

7) What are isotopes?

8)a) The proton has a mass that is equal to the mass of \_\_\_\_\_ electrons.

b) The charge on the proton is \_\_\_\_\_ coulombs.

9)a) Find the atomic number, mass number and number of neutrons in the isotope Beryllium-10.

b) Magnesium has three isotopes, Mg-24 (79.0 %), Mg-25 (10.0 %), and Mg-26 (11.0 %). Find the average mass number or atomic weight of Magnesium in a.m.u.'s (to three sig figs).

10) What happens to the ratio of neutrons to protons as the atomic number gets larger? Explain.

11) Fill in the blanks for the elements below. Use the most common isotope.

Element	Isotope symbol	Number of protons	Number of neutrons	Number of electrons	Mass Number
Nitrogen	_____	_____	_____	_____	_____

		11		
			83	
			5	
	$^{181}\text{Ta}_{73}$			
				45

Answers : 1) Atoms are the smallest component of matter., They are indivisible., Different elements have atoms which have different masses and properties., Atoms combine in simple ratios to form compounds., 2) The rays are composed of small, negatively charged particles. They have a low penetrating power., They are deflected by a magnetic field., They travel in straight lines., 3) He found that all atoms are composed small negatively charged particles called electrons. He suggested that atoms consisted of a positively charged sphere with embedded electrons., He found the charge to mass ratio of the electron., 4) He found that the atom had a small, massive, positively charged nucleus., He also found that the atom was mostly empty space., 5) This is the number of protons (or electrons) in the nucleus of an atom., 6) It is the number of protons plus neutrons in the nucleus., 7) These are atoms of an element that have differing numbers of neutrons., 8)a) 1837, b)  $1.6 \times 10^{-19}$ , 9)a) 4, 10, 6, b) 24.3., 10) The ratio of neutrons to protons increases with atomic mass. This is necessary to help overcome the repulsion of the protons so as to make the nucleus stable., 11)

Element	Isotope symbol	Number of protons	Number of neutrons	Number of electrons	Mass Number
Nitrogen	$^{14}\text{N}_7$	7	7	7	14
Sodium	$^{23}\text{Na}_{11}$	11	12	11	23
Bismuth	$^{209}\text{Bi}_{83}$	83	126	83	209
Beryllium	$^9\text{Be}_4$	4	5	4	9
Tantalum	$^{181}\text{Ta}_{73}$	73	108	73	181

Scandium  $^{45}\text{Sc}_{21}$  21 24 21 45