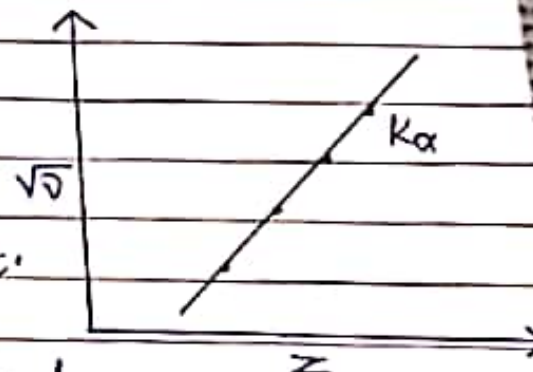


Mosley's law [D-2 (S)]

1.

Mosley found a striking regularity in the spectral lines of each series. The spectrum emitted by each element was found to be identical with that of the other except that the lines had different wavelengths. It was further found that the frequency of any particular line in a series varied regularly from one element to the next in the periodic table. On plotting a graph between the square root of the frequency of any particular line in a series and the atomic no. of the element emitting the line, Mosley obtained a straight line. He thus concluded that the square root of frequency of any particular spectral line is proportional to the atomic no. of the emitting element.



The relation is known as Mosley's law and in mathematical form it is expressed as

$$\sqrt{\nu} = a(z - b)^2$$

where $(z - b)$ is the effective atomic no. of the emitting element, a is the general constant and b is the characteristic constant of a particular series and is called screening constant.

According to Bohr's theory the energy of an electron moving in an orbit principal quantum no. n_1 is given by

$$E_1 = \frac{-2\pi^2 m e^4 z^2}{\eta_1^2 h^2}$$

Similarly,

$$E_2 = \frac{-2\pi^2 m e^4 z^2}{\eta_2^2 h^2}$$

Considering the effect of electrons which screen the positive charge of the nucleus.

$$E_1 = \frac{-2\pi^2 m e^4 (z-b_1)^2}{\eta_1^2 h^2}$$

$$E_2 = \frac{-2\pi^2 m e^4 (z-b_2)^2}{\eta_2^2 h^2}$$

$$\therefore E_1 - E_2 = \frac{2\pi^2 m e^4}{h^2} \left[\frac{(z-b_2)^2}{\eta_2^2} - \frac{(z-b_1)^2}{\eta_1^2} \right]$$

$$= \frac{2\pi^2 m e^4}{h^2} (z-b_2)^2 \left[\frac{1}{\eta_2^2} - \frac{(z-b_1)^2}{(z-b_2)^2 \eta_1^2} \right]$$

When z is high enough then,

$$b_1 \approx b_2 \approx b$$

and we have

$$h\nu = \frac{2\pi^2 m e^4 (z-b)^2}{h^2} \left(\frac{1}{\eta_2^2} - \frac{1}{\eta_1^2} \right)$$

For K_α line, $n_1 = 2$, $n_2 = 1$

$$\therefore \nu_{K_\alpha} = \frac{2\pi^2 m e^4 (z-b_{K_\alpha})^2}{h^2} \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$$

$$\text{or, } \lambda_{K\alpha} \propto (z-b)^2$$

This is ~~called~~ Mosley's law.

Mosley pointed out that the elements in the periodic table must be arranged in the order of increasing atomic no. instead of atomic weight. From this point of view he changed the position of ^{certain} elements in the Mendeleev's periodic table.
