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QUANTITATIVE STUDIES FROM IMPULSE

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Abstract:

From very long time the Impulse is always in consideration which is arose from the derivation of Newton's second law of motion. However,Impulse is very important topic of consideration in classical as well as modern physics. We can also say that wherever is momentum there definitely be impulse. If a particle of mass 'm' is moving with velocity 'v' then their momentum is P=mv and the impulse associated with this motion is always the product of force exerted by that particle and the time acquired for the motion. Here, we are going to discuss some of important aspects of impulse under the title of 'Quantitative studies from impulse'.

Keywords **—**Impulse, electron, momentum, radioactivity, temperature**.**

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I. RELATIVISTIC MOMENTUM

In this chapter we are going to find an important derivation with Lorentz force and Newton's second law.

We have a stationary particle with charge q having an electric field (E). Suppose we let this charge to move with velocity (v) then the magnetic field associated with this charged particle is given by Lorentz and known as Lorentz force.

$$F=q(E+v\times B)$$

And Newton's second law of motion is given by

$$P = \frac{dp}{dt}$$

On equating both the equations we get

$$\frac{dp}{dp} = q(E + v \times B)$$

The above equation gives the relation between Lorentz force and the momentum. Rewriting above equation as

$$dp = q(E + v \times B)\, dt$$

On integrating we get,

$$\int dp = \int qE.dt + \int q(v \times B).dt$$

Here, qE = force due to electric field

$q(v \times B)$ = force due to motion of charged particle

$$=> \int dp = \int F(E).dt + \int F(B).dt$$

Both the integrals on right hand side is integral function of time since both the fields are time varying fields.

Therefore,

$$P = Impulse\ of\ Electric\ field + Impulse\ of\ Magnetic\ field.$$

II. IMPULSE ON THE ELECTRON

In this chapter we are going to discuss the emission of radiation (photon) during the change in energy levels of electrons.

According to Maxwell's theory changing electric field produces magnetic field and vice versa.

Mathematically,

$$\nabla \times B = \mu_0 \varepsilon_0 \frac{\partial E}{\partial t}$$

$$\nabla \times E = \frac{\partial B}{\partial t}$$

And continuous changeof electric and magnetic field produces electromagnetic field (or waves) which is also known as **Light**. Now, as we all learnt in high school that when an electron changeits energy level or fall down to lower energy state from high energy state a photon or energy is liberated. Let's think of it as per our study we can conclude that when an electron in high energy state emits a photon or radiation it poses some momentum due to which electron experience an impulse so that the electron is shifted towardlower energy state.

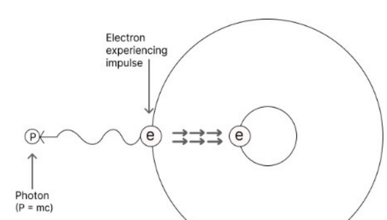

Image explaining the impulse which is experienced by electron
Image credit: Sneha Kakde
(Sir J.J. institute of Applied Art, Mumbai)

III. RADIOACTIVITY: (THE STRUGGLE OF PARTICLES)

Every atom radiates some energy as per Prevost's theory.
In case of unstable atom due to changing of orbits or energy level in the atom it leads to radiate energy from electron as well as nucleus. Due to the compactness of nucleus, the nucleons struggle to get a stable position this struggle between the nucleons causes the collision or a friction which leads to liberation of energy in the form of alpha rays, beta rays and gamma rays.

Table:1

Particles	*Constituent*
α particle	${}^{4}_{2}He$ or ${}_{2}\alpha^{4}$
β particle	${}_{-1}e^{0}$ or ${}_{-1}\beta^{0}$
γ particle	${}_{0}\gamma^{0}$
Neutron	${}_{0}n^{1}$
Proton	${}_{1}H^{1}$ or ${}_{1}P^{1}$
Positron	${}_{1}e^{0}$ or ${}_{1}\beta^{0}$

α particlesare highly active and energetic Helium atom that contains two neutrons and protons minimum penetration power and highest ionization power.
β particles are extremely energetic electrons that liberated from the inner nucleus. Bears the negligible mass and negative charge. A neutron in the nucleus split into a Proton and an electron on the emission of Beta particle. Hence, it is the electron that is emitted by the nucleus at rapid pace.
γ particles are weightless packets of energy called photons. Unlike alpha and beta particles, which have both energy and mass, gamma rays are pure energy. Gamma rays are similar to visible light, but have much higher energy. Gamma rays are often emitted along with alpha or beta particles during radioactive decay.

Half- life: Let's talk about half-life of atom, the time required to decay or disintegrate to half of its initial value is called half-life.
We have several examples of radioactive elements with their half-life:

Table:2

Elements	**Half-life**
Potassium ^{40}	~ 10^{9} years
Uranium ^{238}	~ 10^{9} years
Thorium ^{232}	~ 10^{9} years
Polonium ^{214}	0.16 milliseconds

From above table we might thought that half-life of Polonium ^{21}□ is very small as compared to Uranium ^{23}□. This is just because of nucleons per nuclear diameter ratio is very small for polonium ^{21}□ due to which the struggle between the particles is maximum which leads to disintegrate faster, very faster than uranium ^{23}□.

CONCLUSIONS:

i. Momentum and impulse are just like Newton's third law.If there is Momentum, then there will be impulse.The impact of momentum is impulse.

ii. Momentum the impulse is quite similar to reflection that is friction causes collisioneffect which is nothing else but momentum wish you had seen in radioactive elements.

iii. Most of the radioactive elements are found inside the crust of the Earth. Coming from this radioactive leads to increase the temperature of Earth surface.

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