The forces

- force is a vector quantity and if more than one forces act on a particle we can find the resultant force using the laws of vector addition.

* Newton's third law of motion

If a body A exerts a force $\vec{F}$ on another body B, then B exerts a force $-F$ on A.

F & -F are called action-reaction pair.

* Types of forces:
  - Gravitational
  - Electromagnetic
  - Nuclear
  - Weak

① Gravitational forces:

$$F = \frac{G m_1 m_2}{r^2}$$

m_1, m_2 are masses of two body and r is the distance between them.

G = Gravitational constant

$= 6.67 \times 10^{-11}\ N\text{-}m^2/kg^2$

* Gravitational force on small bodies by the Earth

- The force of attraction exerted by the earth on other objects is called gravity.

Also, if the earth is a homogeneous sphere of radius R and mass M.

$R = 6400\ km$

$M = 6 \times 10^{24}\ kg$

Now, $F = \frac{GMm}{R^2}$ m is the mass of the particle near earth's surface.

The direction of this force is towards the centre of the earth which is called the vertically downward direction.

If the body m is very small compared to the earth, the quantity $\frac{GM}{R^2}$ is a constant and dimension of acceleration. It is called the acceleration

due to gravity (g).

$g = 9.8\ m/s^2$

Thus, the force exerted by the earth on a small body of mass m, kept near the earth's surface is mg in the vertically downward direction.

(iii) **Electromagnetic (EM) force**

$$F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}$$

$$\epsilon = 8.854 \times 10^{-12}\ C^2/Nm^2$$

$$\frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9\ \frac{Nm^2}{C^2}$$

q_1, q_2 Same nature – Repulsive

q_1, q_2 Opp. nature – Attractive.

Charge of Electron

1.6×10^{-19} Coulomb

(iii) Nuclear forces

- Nucleus volume $= 10^{-44}\ m^3$
- An Atom's volume $= 10^{-23}\ m^3$

i.e. the nucleus occupies a volume of about $1/10^{21}$ of the volume of the atom.

- If both the electrons are removed from a helium atom, we get the bare nucleus of helium which is called an alpha particle (He_4^{2+})
- Short ranged
- exerted only if the interacting particles are protons or neutrons or both.
- Radioactivity, nuclear energy (fission, fusion) etc. result from nuclear force.

(iv) Weak forces

- when reaction involving protons, electrons, and neutrons take place.

– A neutron can change itself into a proton and (simultaneously) emit an electron and a particle called antineutrino. This called β^- decay.

– A proton can also change into neutron and (simultaneously) emit a positron (and a neutrino). This is called β^+ decay.

– If, effect is experienced inside both particles only.

⊠ classical physics

Radius $> 10^{-6}$ m

Speed $< 10^8$ m/s ($\because 3 \times 10^8$ m/s)

– Newton's law of motion, law of gravitation, Maxwell's electromagnetism, laws of thermodynamics, inverse square rule

Radius $< 10^{-6}$ m

⟶ Quantum Physics.