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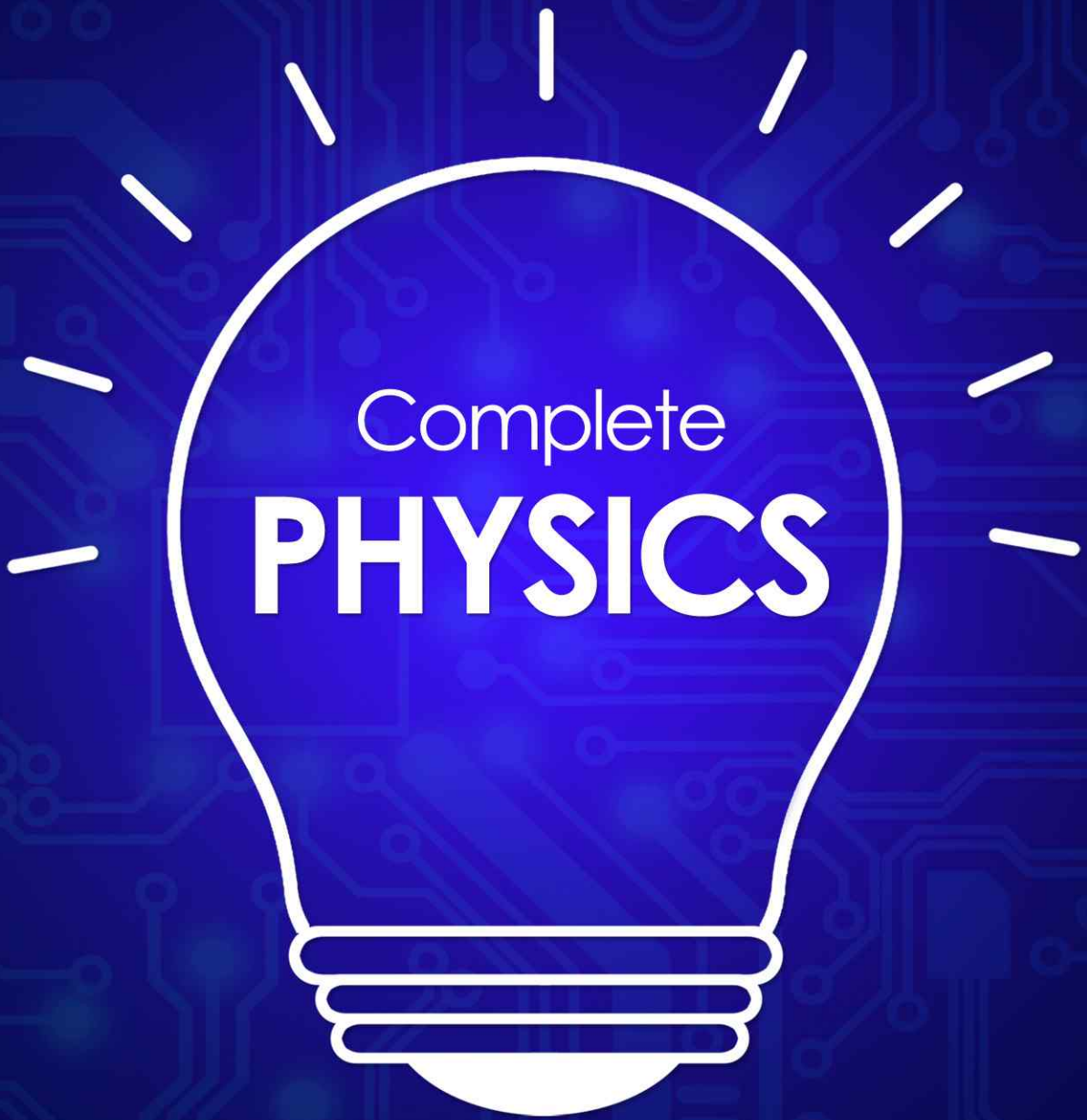

Complete PHYSICS

IIT-JEE · NEET · CBSE eBOOKS

CLASS 11&12th

CLASS 11th

Laws of Motion

01. First Law of Motion

If the (vector) sum of all the farces acting on a particle is zero then and only then the particle remains unaccelerated (i.e., remains at rest or moves with constant velocity).

If the sum of all the forces on a given particle is $\vec{F}$ and its acceleration is $\vec{a}$, the above statement may also be written as

" $\vec{a}=0$ if and *only* if $\vec{F}=0$".

Thus, if the sum of the forces acting on a particle is known to be zero, we can be sure that the particle is unaccelerated, or if we know that a particle is unaccelerated, we can be sure that the sum of the forces acting on the particle is zero.

02. Inertial Frames other than Earth

Suppose S is an inertial frame and S' a frame moving uniformly with respect to S. Consider a particle P having acceleration $\vec{a}_{p,s}$ with respect to S and $\vec{a}_{p,s'}$ with respect to S'.

We know that,

$$\vec{a}_{p,s} = \vec{a}_{p,s} + \vec{a}_{s',s}.$$

As S' moves uniformly with respect to S,

$$\vec{a}_{s',s} = 0.$$

Thus, $$\vec{a}_{p,s} = \vec{a}_{p,s'} \quad \text{...(i)}$$

Now S is an inertial frame. So from definition, $\vec{a}_{p,s} = 0$, if F=0 and hence, from (i), $\vec{a}_{p,s'} = 0$ if and only if $\vec{F}=0$.

Thus, S' is also an inertial frame. We arrive at an important result : *All frames moving uniformly with respect to an inertial frame are themselves inertial.*

03. Free Body Diagram

No system, natural or man made, consists of a single body alone or is complete in itself. A single body or a part of the system can, however be isolated from the rest by appropriately accounting for its effect on the remaining system.

A free body diagram (FBD) consists of a diagrammatic representation of a single body or a sub-system of bodies isolated from its surroundings showing all the forces acting on it.

Consider, for example, a book lying on a horizontal surface.

A free body diagram of the book alone would consist of its weight ($W=mg$), acting through the centre of gravity and the reaction (N) exerted on the book by the surface.