FORCE AND LAWS OF MOTION

CHAPTER NO.9

SUB: PHYSICS
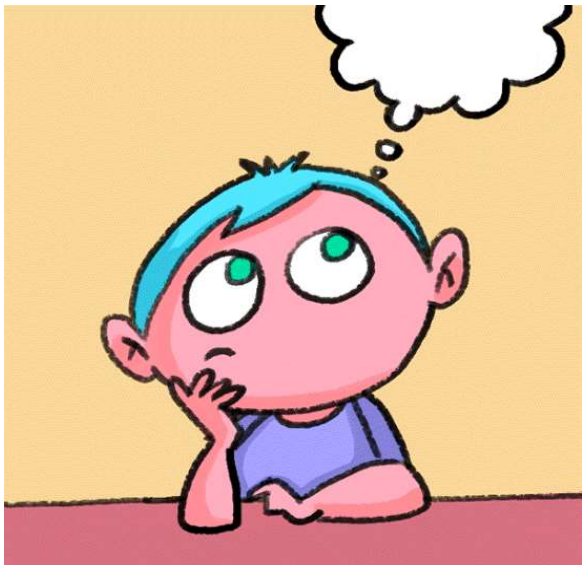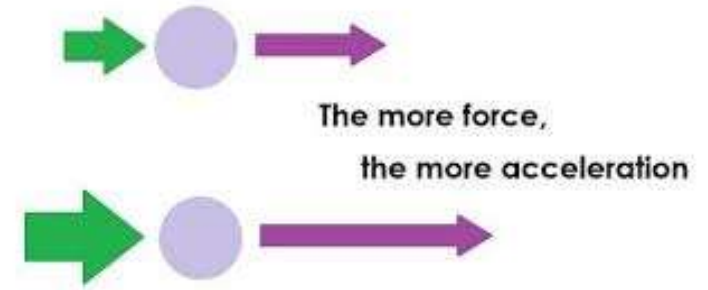
FORCE AND LAWS OF MOTION

LEARNING OBJECTIVE

Students will be able to

- State Newton's 2nd law of motion

- Derive 2nd law of motion

Momentum

- Momentum can be defined as "mass in motion". All objects have mass; so if an object is moving, then it has momentum - it has its mass in motion.

- The momentum, p of an object is defined as the product of its mass, m and velocity, v. That is, momentum p=mv

Newton's second law of motion

The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts.

Newton's Second Law of Motion

https://www.youtube.com/watch?v=8YhYqN9BwB4
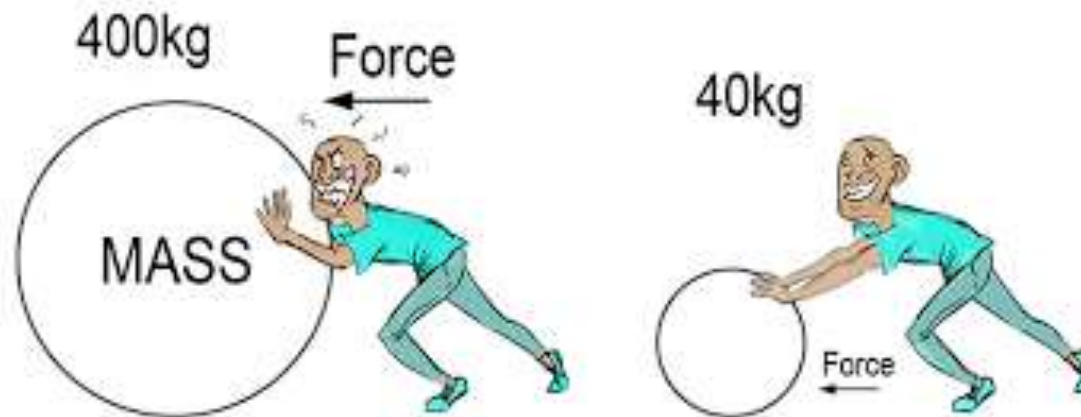
Newton's Second Law of Motion

It states that the rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts.

Mathematical formulation of Newton's Second Law of Motion:

Let mass of an moving object be m.

Let is initial velocity be u and final velocity be v.

We know that momentum (p) = Mass × velocity

Therefore,

Initial momentum of object = mu

And Final momentum of the object = mv

Therefore, change in momentum = mv − mu

$\Rightarrow$ Rate of change of momentum $= \dfrac{mv - mv}{t}$

Now, from the Newton's 2nd Law of Motion, we have:

Force $\propto$ Rate of change of momentum

$\Rightarrow \quad F \propto \dfrac{mv - mu}{t} \propto \dfrac{m(v-u)}{t} \quad ....(i)$

But we know that $\dfrac{(v-u)}{t} = a (\text{Acceleration})$

Using above relation in equation (i), we get:

$F \propto ma$

Or $\quad F = kma \quad ....(ii)$

Where k is the proportionality constant

Applications of Newton's 2nd Law of Motion

- *A fielder pulls his hand backward; while catching a cricket ball coming with a great speed*. Actually, while catching a cricket ball the momentum of ball is reduced to zero. If the ball is stopped suddenly, its momentum will be reduced to zero instantly causing the instant rate of change in momentum due to which ball will exert great force on the hands of player due to which the player's hand may get injured. Therefore, by pulling the hand backward a fielder gives more time to the change of momentum to become zero. This prevents the hands of fielder from getting hurt.

- *For athletes of long and high jump, sand bed or cushioned bed is provided at the place of landing*. This is because when an athlete falls on the ground after performing a high or long jump, the momentum of his body is reduced to zero. If the momentum of an athlete will be reduced to zero instantly, it will result in the production of a large force which may hurt the player. Whereas, by providing a cushioned bed, the momentum of player's body is reduced to zero in a delayed period due to which less force acts on his body hence, preventing the athlete from getting hurt.

Seat belts in a car are provided to prevent the passenger from getting thrown in the direction of motion. In case of sudden braking or any accident, passengers may get thrown in the direction of motion of vehicle and may get fatal injuries. Whereas, the stretchable seat belts prevent the passenger's body to fall suddenly and thus increase the time of the rate of momentum to be become zero. This will reduce the effective force hence preventing the passenger from getting any fatal injury.
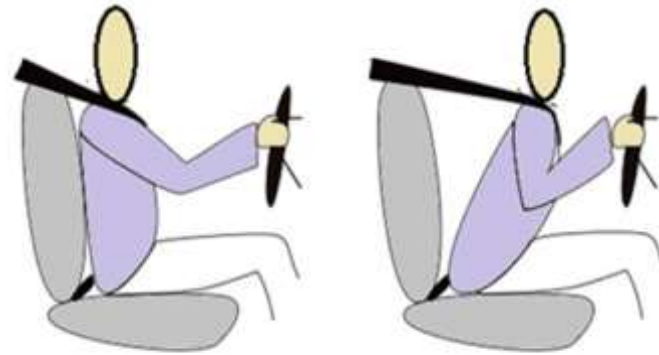
Because of inertia you feel jerk when brakes are applied

HOME ASSIGNMENT

1. State the 2nd law of motion.

2. A fielder pulls his hand backward; while catching a cricket ball coming with a great speed. Why?

THANKING YOU
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