Home Assignment

(1). A motor car of mass 1200kg is moving in a straight line with a uniform velocity of 90km/h. Its velocity is slowed down to 18km/h in 4s by an unbalanced external force. (i) calculate the acceleration (ii) change in momentum (iii) magnitude of force.

Ans) Mass given, $m = 1200kg$.

u of the car $= 90km/h = 25 m/s$.

v " " " $= 18 km/h = 5 m/s$.

time taken $= t = 4s$.

$\Delta P = mv - mu$

$\Delta P = 1200 \times 5 - 1200 \times 25 = -24000 kg\ m/s$.

$v = u + at$

$5 = 25 + a \times 4$ $\Rightarrow a = -5 m/s^2$

<< retardation >>

$|f| = m|a| = 1200 \times 5 = 6000N$

(2) A force acts for 10s on a stationary body of mass 100kg after which the force ceases to act. The body moves through a distance of 100m in the next 5s. calculate the velocity acquired by the body and the acceleration produced by the force.

Ans) Mass (m) = 100 kg.
Time interval $\Delta t = 10$ s.

(i) The distance travelled in next 5 s =
$d = 100$ m.

Thus the velocity acquired =
$v = \frac{d}{t} = \frac{100}{5} = 20$ m/s

(ii) Acceleration produced by the force = $a = \frac{v}{\Delta t} = \frac{20}{10} = 2$ m/s^2

(iii) Magnitude of force $F = ma = 100$ kg $\times 2$ m/s^2
$= 200$ N

Q3) Using second law of motion, derive the relation between force and acceleration using Newton's 2nd law of motion.

Ans) Q. If a body is moving with initial velocity u and after applying a force F on it. Its velocity becomes v in time t.

$P_1 = mu$ = initial momentum of body.
$P_2 = mv$ = finial momentum of body

Change in momentum $= mv - mu$

rate of change of momentum = $\frac{mv - mu}{t}$.

according to Newton's 2nd law,

$$\frac{mv - mu}{t} \propto F.$$

$$F \propto \frac{mv}{t} - \frac{mu}{t}, \text{ here } \frac{v-u}{t} = a \text{ (acceleration)}$$

$$\Rightarrow F \propto ma \Rightarrow F = kma.$$

If 1 N force is applied in a body of mass 1 kg, acceleration produced = $1 m/s^2$

$$1 = k \times 1 \times 1 \text{ or } k = 1.$$

So if $k = 1$,

$$F = ma$$

Q4) How the first law of motion can be mathematically stated from the mathematical expression for the second law of motion?

- Newton's first law provides qualitative defination of 1st law.
- Newtons's second Law provides a quantitative measure of the force that will produce a given acceleration of the mass.
- If $F = 0$, we have $a = F/m$, and V = constant as the first law states.

Q-1) Name and state the action and reaction in the following cases

(a) firing a bullet from a gun.

Action - firing bullet

Reaction - Recoiling of gun.

(b) ~~Action and~~ Hammering a nail

Action - Hitting hammer on nail

Reaction - The nail exerts equal force on hammer

(c) A book lying on a table.

Action - book exerts force on the table due to gravity.

Reaction - the table exerts equal force on the book

(d) A moving rocket

Action - the fuel burns and releases large ~~number~~ amount of force in opposite direction of movement of rocket.

Reaction - The burnt fuel exerts equal pressure on the rocket and rocket move in upward direction.

(e) A person walking on the floor

Action - the person exerts force on the floor.

Reaction - the floor exerts equal force on the legs of person due to which he move forward.

(f) a moving train colliding with a stationary train

Action - the train collides to stationary train by applying large amount of force due to its large momentum.

Reaction - the stationary train also exerts equal force on the moving train which opposes the motion of the moving train.

(g) why is it difficult for a fireman to hold a hose, with ejects large amount of water at a high velocity?

Ans) when fireman directs a large amounts of water at a high velocity or fire from a hose pipe, they have to hold the horse pipe strongly because of its tendency to go backwards. the backward movement of the hose pipe is due to the backward reaction force of water rushing out through it in the forward direction at a high speed as per the Newton's third law of motion

(h) why action and reaction forces don't cancel out each other?

Ans) action and reaction forces do not cancel out each other as they act on different bodies.

Q3(a) If someone jumps to the shore from a boat the boat moves in the opposite direction. why?

Ans) According to Newton's third law, to every action, there is an equal and opposite reaction. when we jump on the shore from the boat, we are applying force on the boat in the opposite direction in order to move forward and hence the boat moves in the opposite direction.

(b) when air from an inflated balloon is allowed to be released, the balloon moves in a direction opposite to that of air. Explain.

Ans) if a balloon filled with compressed air and its mouth untied is released with its mouth in the downward direction, the balloon moves in the upward direction because of the air present in the balloon rushes out in the downward direction. The equal and opposite reaction of downward going air pushes the balloon upwards.