H/W

24/7/21

1) A motor car of mass 1200 kg is moving along a st. line with a uniform velocity of 90 km/h. Its velocity is slowed down to 18 km/h in 4s by an unbalanced external force. Calculate the accln & change in momentum. Also calculate the magnitude of force required.

Sol) $m = 1200$ kg

$u = 90$ km/h $= 25$ m/s

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

$t = 4$ s.

$\Delta P = mv - mu$

$\Delta P = 1200 \times 5 - 1200 \times 25$

$= -24000$ kg m/s

$v = u + at$

$\Rightarrow 5 = 25 + a \times 4$

$\Rightarrow a = -5 m/s^2$

(-ve shows retardation)

$|F| = m|a| = 1200 \times 5 = 6000$ N.

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

i) the velocity acquired by the body.

Ans) Distance travelled in next 5 sec,

$d = 100m$.

Thus velocity acquired by body

$$\vec{v} = \frac{d}{t} = \frac{100}{5} = 20m/s.$$

ii) accl^n produced by the force.

Ans)
$$a = \frac{v}{\Delta t} = \frac{20}{10} = 2m/s^2.$$

iii) magnitude of the force.

Ans) $F = ma = 100kg \times 2m/s^2 = 200N.$

3) Derive the relation b/w force & accl^n using Newton's second law of motion,

Ans) $\rightarrow F_{net} \propto \frac{mv-u}{t}$

$\rightarrow F_{net} = K\left[\frac{m(v-u)}{t}\right]$ — (1)

- m → mass of the body.
- v - final velo.
- u - initial vel.
- t - time
- F_{net} - Net value

$$v = u + at$$

$$a = \frac{v-u}{t} \quad \text{—— (ii)},$$

from (i) & (ii), we have

$$F_{net} = m \times a.$$

4) How the first law of motion can be mathematically stated from the mathematical expression for the 2nd law of motion?

Ans) Let us consider an obj. of mass m, moving along st. line with an initial velocity u. Let us say, after a certain time t, with a const. acc^n, the finial velocity becomes v.

The change in momentum is

$$P_2 - P_1 = (m \times v) - (m \times u)$$

$$= m(v-u)$$

The rate of change of momentum with respect to time is proportional to the applied force.

Applied force

$$F = \frac{m(v-u)}{t}$$

(or)

$F = ma$

a = rate of change of velocity/time.

$F = K \times m \times a$

K = proportionality constant.

∴ We get =) $F = ma$.

5) a) Firing of a bullet from gun.

Ans) Action - force exerted on the bullet.
Reaction - Recoil experienced by the gun.

b) Hammering a nail.

Ans) Action - The force exerted by the hammer on the nail.
Reaction - The force applied by the nail on the hammer.

c) A book lying on a table.

Ans) Action - Weight of the book acting downwards.
Reaction - Force acted by the table upwards.

d) A moving rocket.

Action - Force exerted by the rocket on the gases backwards.

Reaction - Force exerted by the outgoing gases on the rocket in forward dir^{n}.

e) A person moving on the floor.

Action - Force exerted by the feet on the ground in backward dir^{n}.

Reaction - Force exerted by the ground on feet in forward dir^{n}.

f) A moving train colliding with a stationary train.

Action - force exerted by a moving train on a stationary train.

Reaction - force exerted by a stationary train on a moving train.

5) a) Explain why is it difficult to hold a hose, which ejects a large amount of water at high velocity.

Ans When a fireman holds a hose, which is ejecting large amounts of water at a high velocity, then a rea^{n} force is exerted on him by the ejecting water in the backward dir^{n}. This is because of Newtons Third Law Of Motion.

As a result of the backward force, the stability of the fireman decreases. Hence, it is difficult for him to remain stable while holding the hose.

b) Why action & reaction do not cancel each other?

Ans) Action & reaction force pair donot cancel because they act on different objects. Forces can cancel only if they act on the same object.

7) a) If someone jumps to the shore from a boat the boat moves in the opp. dirⁿ. Explain.

Ans) According to Newton's Third law, to every action, there is an equal & opp reaⁿ. When we jump on the shore from the boat, we are applying force on the boat in the opp. dirⁿ in order to move forward & hence the boat moves in the opp. dirⁿ.

b) When air from an inflated balloon is allowed to be released, the balloon moves in a dirⁿ opp. to that of air. Explain.

Ans) If a balloon filled with compressed air & its mouth untied is released with its mouth in the downward dirⁿ, the balloon moves in the upward dirⁿ because the air present in the balloon rushes out in the downward dirⁿ. The equal & opp. reaⁿ of downward going air pushes the balloon upwards.

8) a) How is the dirⁿ of the rocket's acclⁿ related to the dirⁿ along which the gas is expelled?

Ans) Opposite dirⁿ.

b) Does the expelled gas exert a force on the rocket? If so, in which dirⁿ is this force?

Ans) Yes. Opposite to acclⁿ of expelled gas.

c) Suppose that the same mass of gas is expelled with larger speed so that its accl^n is twice as large. What then would be the magnitude of the rocket's accl^n.

Ans) $2a_0$.

d) Suppose that more ~~fuel~~ fuel is burned per second so that twice as large a mass of gas is expelled with the original accl^n. What then would be the magnitude of the rocket's accl^n?

Ans) $2a_0$.

e) Suppose that twice as large a mass of gas is expelled with an accl^n twice as large as the original one. What then would be the magnitude of the rocket's accl^n? How much larger would be the force exerted on the rocket by the gas?

Ans) $4a_0$, 4 times larger.