1.7.2021

Home Assignment

1. A motor car of mass 1200 kg is moving ~~at~~ along a straight line with a ~~at~~ uniform. velocity of 90 km/h. Its velocity i.e. is ~~slow~~ slowed down to 18 km/h in 4 s by an unbalanced external force. Calculate the acceleration and change in momentum. Also calculate the magnitude of the force required.

Ans:- acceleration $= \frac{v-u}{t}$

$= \dfrac{18-90}{\frac{4}{60\times60}}$

$\Rightarrow$ acceleration $= -\overset{18}{\cancel{72}} \times \dfrac{60\times60}{\cancel{4}}$

$= -64800 \text{ km/h}^2$

Ans: acceleration $= \frac{v-u}{t}$

$u = 90 \text{ km/h} = 90 \times \frac{5}{18} = 25 \text{ m/s}$

$v = 18 \text{ km/h} = 18 \times \frac{5}{18} = 5 \text{ m/s}$

$a = \frac{v-u}{t} = \frac{5-25}{4}$

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

Change in momentum $= m(v-u)$

$= 1200 \, (5-25)$

$= 1200 \times (-20) = -24000$ kgm/s

Magnitude of force required

$= ma$

$= 1200 \times (-5) = 6000$ N

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

(ii) acceleration produced by the force

(iii) the magnitude of the force.

Ans:- (i) $V = \frac{s}{t}$

$\Rightarrow V = \frac{100}{5} = 20 \, m/s$

(ii) $a = \frac{v-u}{t}$ $\Rightarrow a = \frac{20-0}{10} = \frac{20}{10} = 2 m/s^2$

(iii) $F = ma$

$\Rightarrow F = 100 \times 2 = 200N$

3. **Derive the relation between force and acceleration using Newton's second law of motion.**

Ans:- Newton's second law of motion:-

$$F \propto \frac{\text{Change in momentum}}{\text{Time taken}}$$

If a body is moving with initial velocity u and after applying a force F on it, its velocity becomes v in time t.

Initial momentum of the body

$P_i = mu$

Final momentum of the body

$P_f = mv$

Change in momentum in time t

$= mv - mu$

So, rate of change of momentum

$$= \frac{mv - mu}{t}$$

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

$$\Rightarrow F \propto m\left(\frac{v-u}{t}\right) \qquad \left[\frac{v-u}{t} = a\right]$$

$$\Rightarrow F \propto ma$$

$$F = kma$$

If 1N force is applied on a body of mass 1 kg and acceleration produced ~~by~~ in the body is $1 m/s^2$

then $k = 1$

Putting $k=1$ in ~~eq~~ eq. $F = kma$

$$\Rightarrow F = ma$$

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

Ans:- ~~The~~ Newton's first law of motion:-
Every body continuas to be in its state of rest or of uniform motion on a straight line unless compelled by an external force to act on it.

Newton's Second Law of motion:-

$F \propto$ ~~ma~~ change in momentum/time

~~$\Rightarrow F = m\left(\frac{v-u}{t}\right) \Rightarrow F =$~~

$\Rightarrow f = \frac{mv - mu}{t}$ $\Rightarrow Ft = mv - mu$

If $f = 0$, then
$mv = mu$
$\Rightarrow v = u$

This means initial velocity is ~~eq~~ equal to final velocity when no force acts on the body.

Thus, it represents Newton's first law of motion.

Q1. Name and state the action and reaction in the following cases:

(a) firing of a bullet from a gun.

Ans:- Action – Firing bullet
Reaction – Recoilling of gun

(b) hammering a nail

Ans:- Action – Hitting hammer on nail
Reaction – the nail exerts equal force on hammer.

(c) a book lying on a table

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

~~c~~) Reaction – the table exerts an equal force on the book.

(d) moving rocket

Ans:- Action – the fuel burns and releases large amount of force in opposite direction of the ~~a~~ movement of rocket.

Reaction – Force exerted by outgoing gases on the rocket in forward ~~directi~~ direction.

(e) a person moving on the floor

Ans:- Action – Force exerted by the feet on the floor in backward direction.

Reaction – force ~~extert~~ exerted by the floor on the feet in forward direction.

(f) a ~~A~~ moving train colliding with a stationary train

Ans:- ~~Acti~~ Action – Force exerted by moving train on the stationary train.

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Reaction — Force ~~exerted~~ exerted by the stationary train on the ~~not~~ moving train.

Q2 (a) Explain, why is it difficult to hold a hose, which ~~ef~~ ejects a large amount of water at a high velocity.

Ans:- ~~It~~ It is difficult to hold a ~~to~~ hose, which ejects a large amount of water at a high ~~veloct~~ velocity, because the ejecting water exerts a large reaction force ~~on~~ in the backward direction, on the person holding the hose. This ~~due~~ is due to Newton's third law of motion i.e. to every action, there is always an equal and opposite reaction.

(b) Why action and reaction do not cancel each other?

Ans:- Action and reaction exert equal and force but they don't ~~ca~~ cancel each other because they act on different bodies.

Q8. (a) If someone jumps to the shore from a boat the boat moves in the opposite direction. Explain.

Ans:- According to Newton's third law of motion i.e. to every action, there is an equal and opposite reaction.

When someone jumps to the shore from a boat, he /she is applying force on the boat in the opposite direction in ~~th~~ order to move forward. Hence, the boat moves in the opposite direction.

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

Ans:- When ~~it~~ a balloon's mouth is released with its mouth in the downward direction, the balloon ~~to~~ moves in the upward direction because air present in the balloon rushes out in the downward direction. According to Newton's third law, the equal and opposite reaction of downward going air pushes the balloon upwards.

Numerical

sol: (a) The direction of the rocket's acceleration is opposite to the direction along which the gas is expelled. The gas is expelled downwards, so the rocket's acceleration is upwards.

(b) Yes, the expelled gas exerts a force on the rocket.
The force is in the ~~upw~~ ~~forward~~ opposite direction to acceleration of expelled gas.

(c) ~~(a)~~ ~~Magn~~ Magnitude of rocket's acceleration ~~it~~ would be $2a_0$.

(d) Magnitude of rocket's acceleration would be $2a_0$.

(e) $F_{GR} = -F_{RG}$

$2m \times 2a_0 = -m \times 4a_0$ (As magnitude cannot be changed so acceleration becomes 4 times)

$\Rightarrow 4ma_0 = -4ma_0$

∴ Magnitude of rocket's acceleration would be $4a_0$.

Force exerted on the rocket by the gas in initial situation is

$F_i =$ ~~ma_0~~ ma_0

Force ~~ext~~ exerted on the rocket by the gas in final situation is

$F_f =$ ~~$4m$~~ $2m \times 2a_0$

$\Rightarrow F_f = 4ma_0$

The force would be 4 times larger.