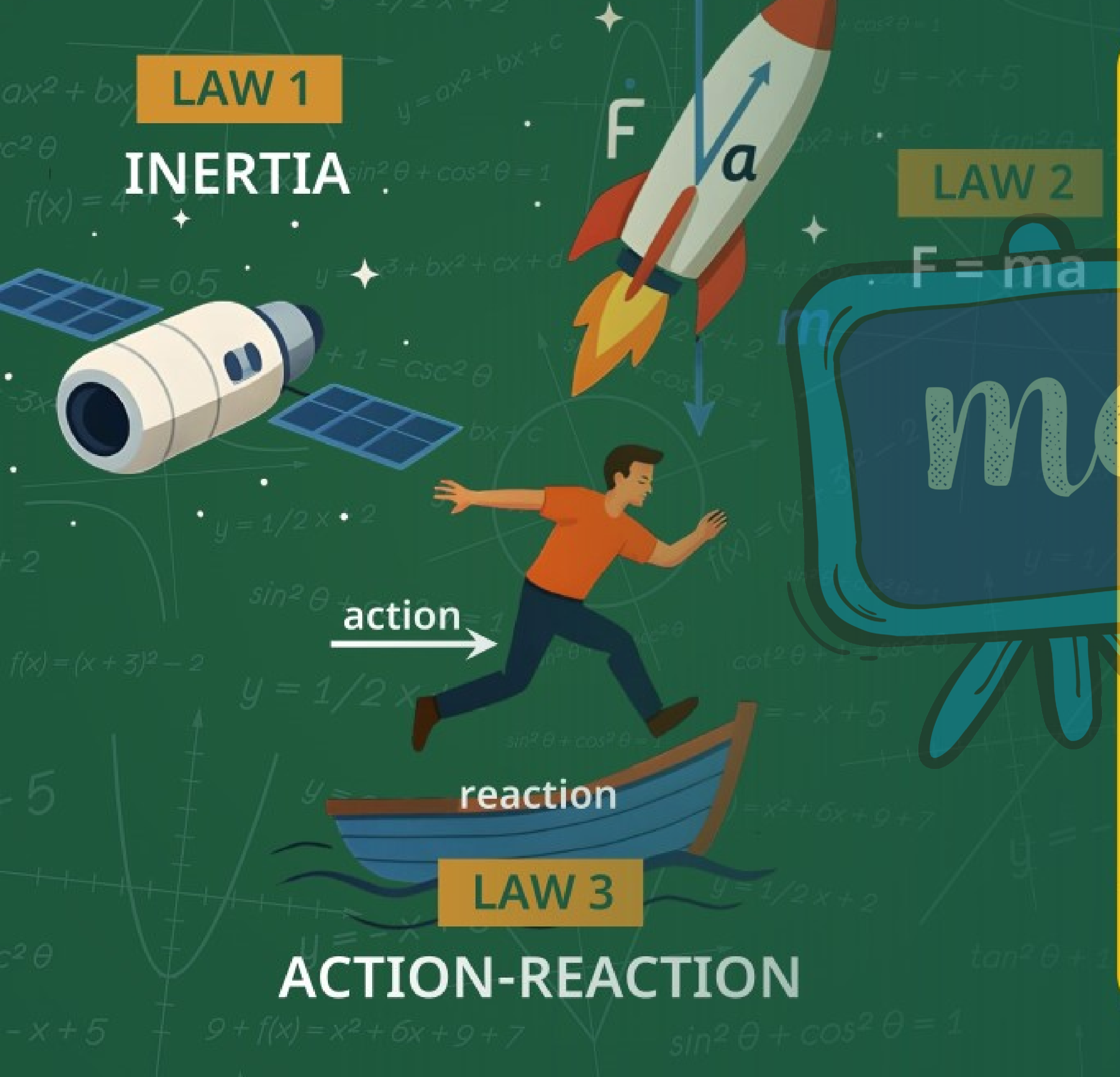
Under CSR Support by Ipca Foundation

missiongyan LET'S LEARN TOGETHER



CLASS – 11

PHYSICS

Chapter – 4

Laws of Motion

Part – 6

Exercise (Q. 1 - 12)

Alok Gaur

EXERCISE

(For simplicity in numerical calculations, take $g = 10\ m\ s^{-2}$)

1. Give the magnitude and direction of the net force acting on.

(a) a drop of rain falling down with a constant speed

EXERCISE

(a) a drop of rain falling down with a constant speed

Answer : The net force is zero.

As the speed of the rain drop falling down is constant, its acceleration is zero.

Therefore, from Newton's second Law of Motion, the net force acting on the raindrop is zero.

Constant speed

$a = 0$

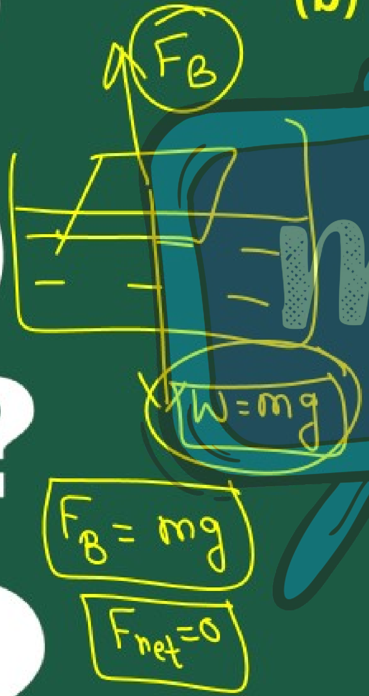
$F = ma$

$F_{net} = 0$

EXERCISE

(b) a cork of mass 10 g floating on water

EXERCISE



(b) a cork of mass 10 g floating on water

Answer : The net force is zero.

It is known that the weight of a cork floating on water acts downward.

The weight of the cork is balanced by buoyant force exerted by the water in the upward direction.

Therefore, no net force acts on the floating cork.

EXERCISE

(c) a kite skillfully held stationary in the sky

EXERCISE

(c) a kite skillfully held stationary in the sky

Answer : The net force is zero.

The kite is stationary in the sky indicates that it is not moving.

Therefore, from Newton's first Law of Motion, the net force acting on the kite is zero.

EXERCISE

(d) a car moving with a constant velocity of 30 km/h on a rough road

EXERCISE

Constant vel.

a = 0

F = 0

(d) a car moving with a constant velocity of 30 km/h on a rough road

Answer : The net force is zero.

As the car is moving at constant velocity, its acceleration is zero.

Therefore, from Newton's second Law of Motion, net force acting on the car is equal to zero.

EXERCISE

(e) a high-speed electron in space far from all material objects, and free of electric and magnetic fields.

EXERCISE

(e) a high-speed electron in space far from all material objects, and free of electric and magnetic fields.

$F_{net} = 0$

Answer : The net force is zero.

As the high-speed electron is free from the influence of all the fields, no net force acts on the electron.

EXERCISE

2. A pebble of mass 0.05 kg is thrown vertically upwards. Give the direction and magnitude of the net force on the pebble.

Ignore air resistance

(a) during its upward motion

m = 0.05 kg

$mg = 0.05 \times 10$

$= 0.5\ N$

EXERCISE

(a) during its upward motion

Answer : $m = 0.05$ kg

$a = g = 10\ m/s^2$

$F = ma = mg$

$F = 0.05 \times 10$

$F = 0.5$ N (downward)

EXERCISE

(b) during its downward motion

EXERCISE

(b) during its downward motion

Answer : The only force that acts on the pebble during its downward motion is the gravitational force.

Therefore, the net force on the pebble in its downward direction is same as in upward direction i.e., 0.5N and this force acts in the downward direction.

EXERCISE

(c) at the highest point where it is momentarily at rest. Do your answers change if the pebble was thrown at an angle of 45° with the horizontal direction?

Answer : When the pebble is thrown at an angle of 45° with the horizontal, it will have both the horizontal and vertical components of velocity.

At the highest point, only the vertical component of velocity becomes zero.

EXERCISE

However, the pebble will have the horizontal component of velocity throughout its motion. This component of velocity produces no effect on the net force acting on the pebble.

Therefore, the net force on the pebble is 0.5N.

EXERCISE

3. Give the magnitude and direction of the net force acting on a stone of mass 0.1 kg.

Neglect air resistance throughout

(a) just after it is dropped from the window of a stationary train

mg ↓

$0.1 \times 10 = 1\,N \downarrow$

EXERCISE

(a) just after it is dropped from the window of a stationary train

Answer : $m = 0.1$ kg

$a = g = 10\ m/s^2$

$F = ma = mg = 0.1 \times 10 = 1N$ (downward)

EXERCISE

Under CSR Support by Ipca Foundation

missiongyan LET'S LEARN TOGETHER

(b) just after it is dropped from the window of a train running at a constant velocity of 36 km/h

$a = 0$

$F = 0$

$36 \frac{km}{hr}$

mg

$0.1 \times 10 = 1N$

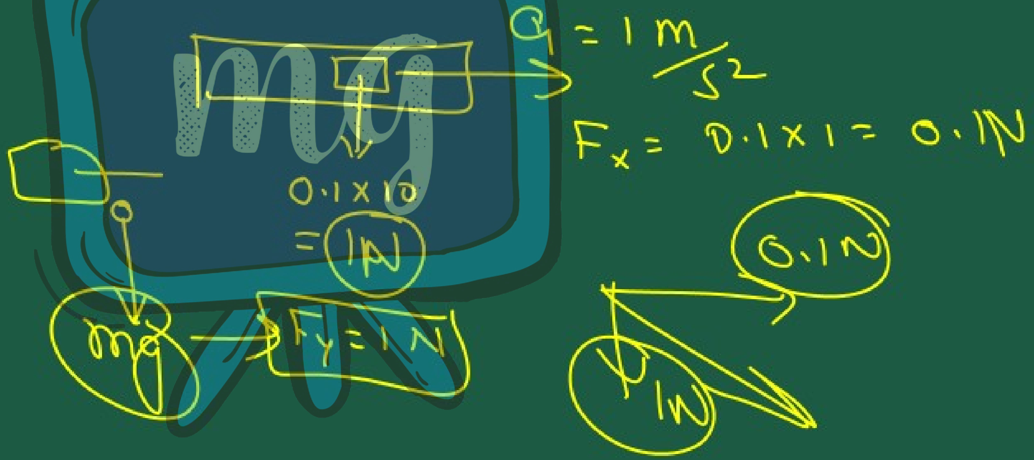
EXERCISE

(b) just after it is dropped from the window of a train running at a constant velocity of 36 km/h

Answer : F = 1N (vertically downward)

EXERCISE

(c) just after it is dropped from the window of a train accelerating with 1 m s^{-2}



EXERCISE

(c) just after it is dropped from the window of a train accelerating with $1\ m\ s^{-2}$

Answer : $F = 1N$ (vertically downward)

EXERCISE

(d) lying on the floor of a train which is accelerating with 1 m s–2, the stone being at rest relative to the train.

EXERCISE

(d) lying on the floor of a train which is accelerating with 1 m s–2, the stone being at rest relative to the train.

Answer : F = 1N (direction of motion of the train)

EXERCISE

4. One end of a string of length l is connected to a particle of mass m and the other to a small peg on a smooth horizontal table. If the particle moves in a circle with speed v the net force on the particle (directed towards the center) is :

(i) T

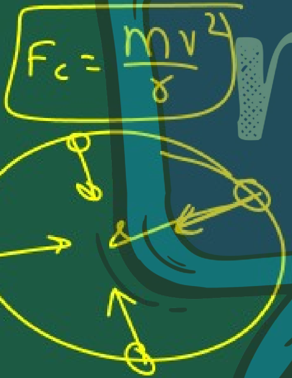
(ii) $T - \frac{mv^2}{\ell}$,

(iii) $T + \frac{mv^2}{\ell}$,

(iv) 0

T is the tension in the string. [Choose the correct alternative].

EXERCISE



Answer : (i) T

The centripetal force of a particle connected to a string revolving in a circular path around a center is provided by the tension produced in the string.

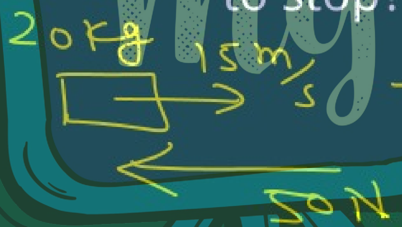
Therefore, the net force on the particle is the tension T, i.e.,

$$F = T = \frac{mv^2}{\ell}$$

Where F is the net force acting on the particle.

EXERCISE

5. A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m s^{-1}. How does the body take to stop?



$u = 15\ m/sec$

$a = \frac{F}{m}$

$a = -\frac{50}{20} = -2.5\ m/s^2$

$V = 0,\ t = ?$

$V = u + at$

$t = \frac{v-u}{a} = \frac{0-15}{-5/2}$

$= \frac{+15}{+5/2} = 3 \times 2$

$= 6\ sec$

EXERCISE

5. A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m s^{-1}. How does the body take to stop?

Answer : 6 sec

EXERCISE

6. A constant force acting on a body of mass 3.0 kg changes its speed from 2.0 ms^{-1} to 3.5 ms^{-1} in 25 s. The direction of the motion of the body remains unchanged. What is the magnitude and direction of the force?

Answer : 0.18 N

$m = 3\,kg$, $u = 2\,m/s$, $v = 3.5\,m/s$

$t = 25\,s$, $F = ?$, $a = ?$

$a = \frac{v-u}{t} = \frac{3.5-2}{25} = \frac{1.5}{25}$

$F = ma$

$= 3 \times \frac{1.5}{25}$

$= \frac{4.5}{25}$

$= \frac{0.9}{5}$

$F = 0.18\,N$

EXERCISE

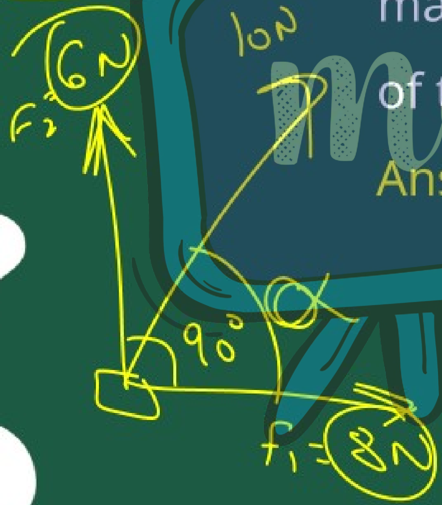
7. A body of mass 5 kg is acted upon by two perpendicular forces 8 N and 6 N. Give the magnitude and direction of the acceleration of the body.

Answer : $\theta = \tan^{-1}\left(\frac{-6}{8}\right) = -37°$

(–) sign → it shows opposite direction

$\tan\alpha = \frac{B}{A} = \frac{6}{8} = \frac{3}{4}$

$\alpha = 37°$



$F_{net} = \sqrt{F_1^2 + F_2^2}$

$F_{net} = \sqrt{64+36}$

$F_{net} = 10N$

$a = F/m = \frac{10}{5}$

$a = 2 m/s^2$

EXERCISE

8. The driver of a three-wheeler moving with a speed of 36 km/h sees a child standing in the middle of the road and brings his vehicle to rest in 4.0 s just in time to save the child. What is the average retarding force on the vehicle?

The mass of the three-wheeler is 400 kg and the mass of the driver is 65 kg.

Answer : –1162.5 N

$m = 400 + 65 = 465\ kg$

$u = 36\ \frac{km}{hr} \times \frac{5}{18} = 10\ \frac{m}{s}$

$t = 4\ sec$

$v = 0$

$a = ?$

$a = \frac{v - u}{t} = \frac{0 - 10}{4}$

$a = -\frac{10}{4} = -2.5\ \frac{m}{s^2}$

$F = ma$

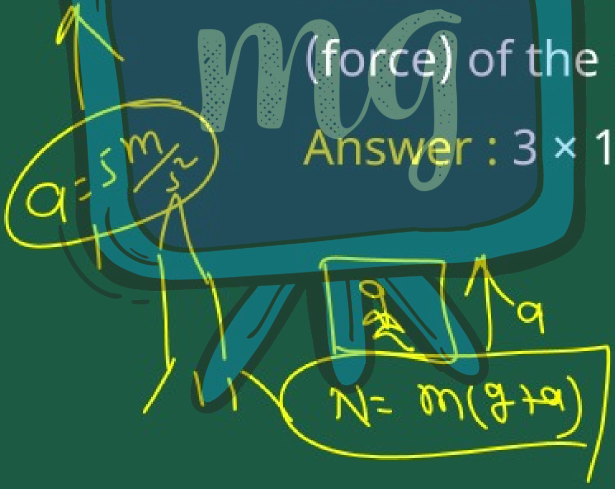
$F = 465 \times -2.5$

$F = -1162.5\ N$

EXERCISE

9. A rocket with a lift-off mass 20,000 kg is blasted upwards with an initial acceleration of 5.0 m s^{-2}. Calculate the initial thrust (force) of the blast.

Answer : 3×10^5 N



Thrust = m(g+a)
= 20000(10+5)
= 20000 × 15
= 300000 N
= 3×10^5 N

EXERCISE

10. A body of mass 0.40 kg moving initially with a constant speed of 10 m s^{-1} to the north is subject to a constant force of 8.0 N directed towards the south for 30 s. Take the instant the force is applied to be t = 0, the position of the body at that time to be x = 0, and predict its position at t = –5 s, 25 s, 100 s.

Answer : –50 m, –6000 m, –50000m

~~starting~~ 30 sec → accel ✓

next 70 sec → accel. ✗

first 30 sec

$x_3 = ut + \frac{1}{2}at^2$

$x_3 = 10(30) + \frac{1}{2}(-20)(30)^2$

$= 300 - 9000$

$x_3 = -8700\ m$

$v = u + at$

$v = 10 - 20(30)$

$v = -590\ m/s$

next 70 sec

a = 0, const speed

$x_4 = -590 \times 70$

$= -41300\ m$

0 to 100

$x = x_3 + x_4 = -8700 - 41300$

$-50000\ m$

$-50\ km$

m = 0.4 kg

10 m/sec

t = 0

F = 8 N

x = ?, at t = -5 sec, 25 sec, 100 sec

~~t = -5 sec~~

a = 0

$x = 10 \times -5$

$x_1 = -50\ m$

t = 25 sec

$a = \frac{F}{m} = -\frac{8}{0.4} = -20\ m/s^2$

$x_2 = ut + \frac{1}{2}at^2$

$= 10 \times 25 + \frac{1}{2}(-20)(625)$

$= 250 - 6250$

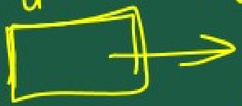
$x_2 = -6000\ m$

EXERCISE

11. A truck starts from rest and accelerates uniformly at 2.0 m s^{-2}. At t = 10 s, a stone is dropped by a person standing on the top of the truck (6 m high from the ground). What are the (a) velocity, and (b) acceleration of the stone at t = 11s ? (Neglect air resistance.)

Answer : (a) 22.36 m/s, (b) 10 m/sec^2

$u = 0$ $\quad a = 2\ m/s^2$ $\quad t = 10\ sec$



at $t = 10\ sec$

Speed of truck

$V = u + at$

$V = 2 \times 10 = 20\ m/sec$

$\rightarrow 20\ m/sec$

$a_x = 0$

at $t = 11\ sec$

$\rightarrow 20\ m/s$

$u_y = 0$

$t = 10 \rightarrow 11\ sec$

$1\ sec$

$V_y = 0 + 10(1)$

$V_y = 10\ m/sec$

$t = 11\ sec$

20, 10

$a = 10\ m/s^2$

$V = \sqrt{V_x^2 + V_y^2}$

$= \sqrt{(20)^2 + (10)^2}$

$= 10\sqrt{4+1}$

$= 10\sqrt{5}\ m/sec$

$= 10 \times 2.2$

$= 22\ m/s$

EXERCISE

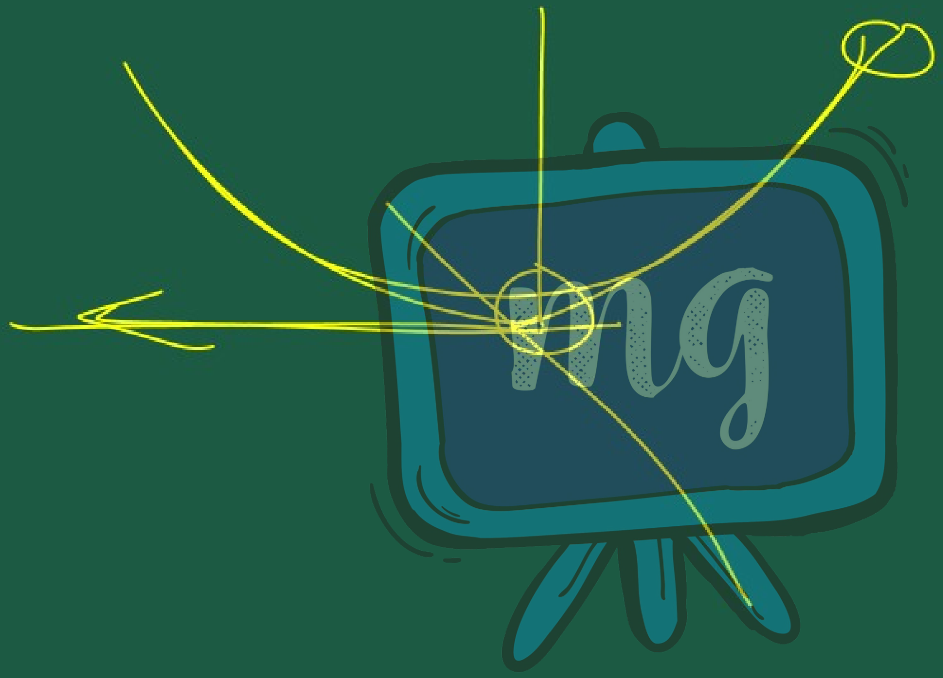
Under CSR Support by Ipca Foundation

missiongyan LET'S LEARN TOGETHER

12. A bob of mass 0.1 kg hung from the ceiling of a room by a string 2 m long is set into oscillation. The speed of the bob at its mean position is 1 m s^{-1}. What is the trajectory of the bob if the string is cut when the bob is (a) at one of its extreme positions, (b) at its mean position.

12. A bob of mass 0.1 kg hung from the ceiling of a room by a string 2 m long is set into oscillation. The speed of the bob at its mean position is 1 m s^{-1}. What is the trajectory of the bob if the string is cut when the bob is (a) at one of its extreme positions, (b) at its mean position.

Answer : (a) at one of its extreme positions, If the string is cut when the bob is at one of its extremes then the bob will fall vertically



EXERCISE

on the ground.

Therefore, at the extreme position, the velocity of the bob becomes zero.

(b) at its mean position,

If the string is cut when the bob is at its mean position then the bob will trace a projectile path having the horizontal components of velocity only.

The direction of this velocity is tangential to the arc formed by the oscillating bob.

EXERCISE

At the mean position, the velocity of the bob is 1m/s.

Therefore, it will follow a parabolic path.