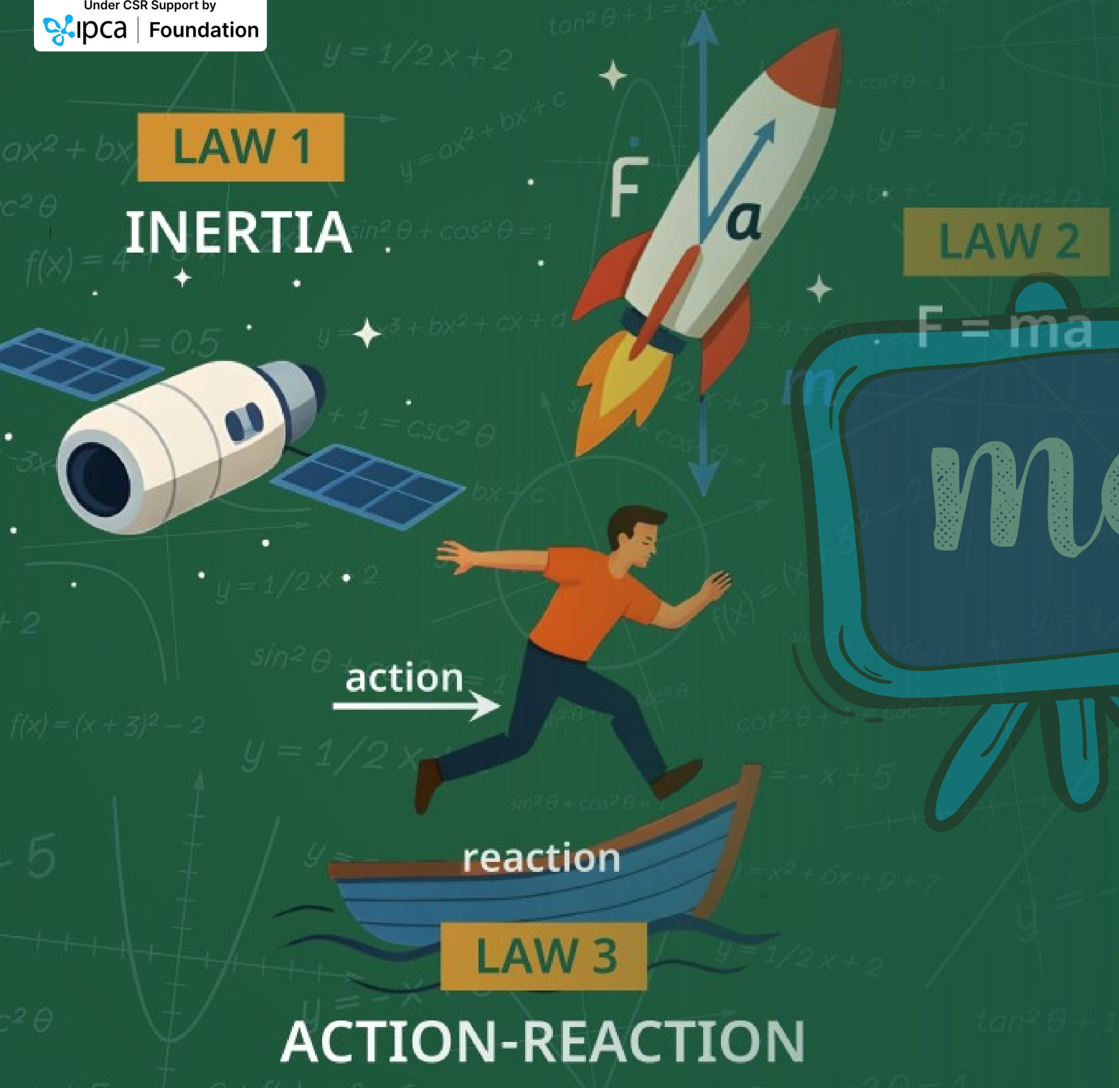


CLASS – 11

PHYSICS

Chapter – 4

Laws of Motion

Part – 7

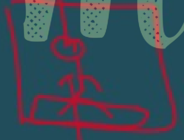
Exercise (Q. 13 - 23)

Alok Gaur

EXERCISE

13. A man of mass 70 kg stands on a weighing scale in a lift which is moving

(a) upwards with a uniform speed of 10 m s^{-1}



$a = 0$

$N = mg$

$W = mg$

$N = 70 \times 10$

$N = 700N$

EXERCISE

(b) downwards with a uniform acceleration of 5 m s^{-2}

$mg - N = ma$

$N = mg - ma = m(g-a)$

$N = 70(10-5)$

$N = 70 \times 5$

$N = 350\,N$

EXERCISE

(c) upwards with a uniform acceleration of 5 m s^{-2}. What would be the readings on the scale in each case?

$N = m(g+a)$

$N = 70(10+5)$

$N = 70 \times 15$

$N = 1050\ N$

EXERCISE

(d) What would be the reading if the lift mechanism failed and it hurtled down freely under gravity?

free fall $\quad a\downarrow = g$

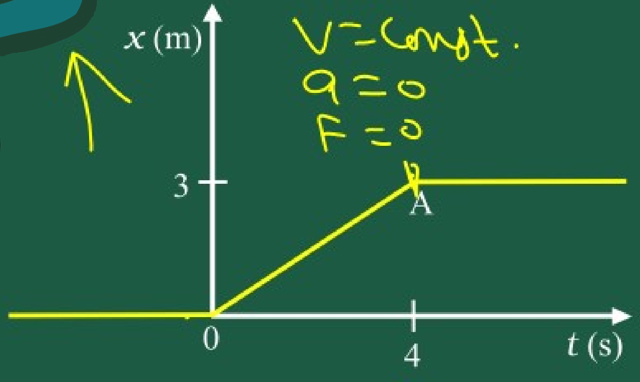
$N = m(g - a)$

$= m(g - g)$

$N = 0$

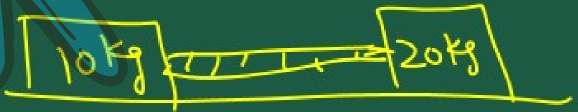
EXERCISE

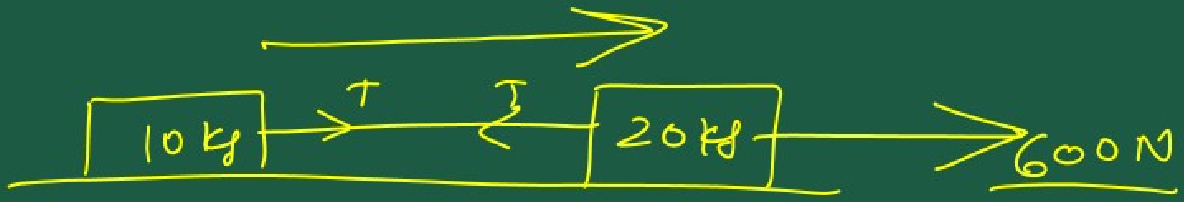
14. Figure shows the position-time graph of a particle of mass 4 kg. What is the (a) force on the particle for $t < 0$, $t > 4$ s, $0 < t < 4$ s? (b) impulse at $t = 0$ and $t = 4$ s? (Consider one-dimensional motion only).



EXERCISE

15. Two bodies of masses 10 kg and 20 kg respectively kept on a smooth, horizontal surface are tied to the ends of a light string. A horizontal force F = 600 N is applied to (i) A, (ii) B along the direction of string. What is the tension in the string in each case?



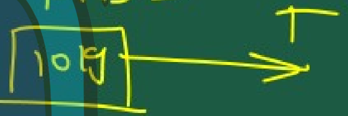


$$a = \frac{\text{Net force}}{\text{Net mass}}$$

$$= \frac{600}{30}$$

$$a = 20\ m/s^2$$

F.B.D

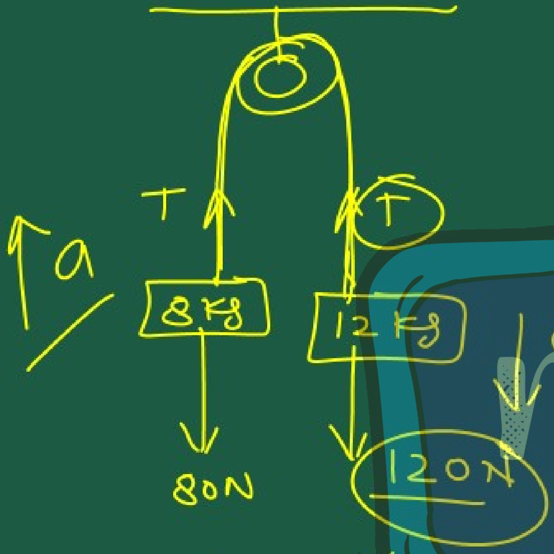


$$T = 10 \times 20$$

$$T = 200\ N$$

EXERCISE

16. Two masses 8 kg and 12 kg are connected at the two ends of a light inextensible string that goes over a frictionless pulley. Find the acceleration of the masses, and the tension in the string when the masses are released.



$a = ?$

$T = ?$

$120 - T = 12a \quad \text{---(1)}$

$T - 80 = 8a \quad \text{---(2)}$

$40 = 20a$

$a = 2\, m/s^2$

$T - 80 = 8 \times 2$

$T = 80 + 16$

$T = 96\, N$

EXERCISE

17. A nucleus is at rest in the laboratory frame of reference. Show that if it disintegrates into two smaller nuclei the products must move in opposite directions.

Conservation of linear Momentum

EXERCISE

17. A nucleus is at rest in the laboratory frame of reference. Show that if it disintegrates into two smaller nuclei the products must move in opposite directions.

Answer : Total initial momentum = Total final momentum

$$0 = m_1v_1 + m_2v_2$$

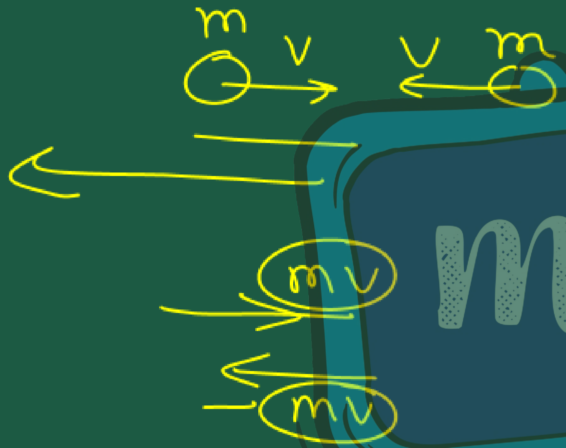
$$v_1 = \frac{-m_2v_2}{m_1}$$

(–) sign. shows opposite direction

EXERCISE

18. Two billiard balls each of mass 0.05 kg moving in opposite directions with speed 6 m s^{-1} collide and rebound with the same speed. What is the impulse imparted to each ball due to the other?

$m_1 = m_2 = 0.05$ kg



$$\Delta P = mv + mv$$

$$I = \Delta P = 2mv$$

$$= 0.05 \times 6 \times 2$$

$$= 0.6 \text{ N-s}$$

EXERCISE

19. A shell of mass 0.020 kg is fired by a gun of mass 100 kg. If the muzzle speed of the shell is 80 m s^{-1}, what is the recoil speed of the gun?

$M = 100\ kg$

$V = ?$

$m = 0.020\ kg$

$v = 80\ m/s$

$P_i = 0$

$P_f = 0$

$MV + mv = 0$

$MV = -mv$

$V = \frac{-mv}{M} = \frac{-0.020 \times 80}{100}$

$V = -0.016\ m/sec$

EXERCISE

20. A batsman deflects a ball by an angle of 45° without changing its initial speed which is equal to 54 km/h. What is the impulse imparted to the ball ? (Mass of the ball is 0.15 kg.)

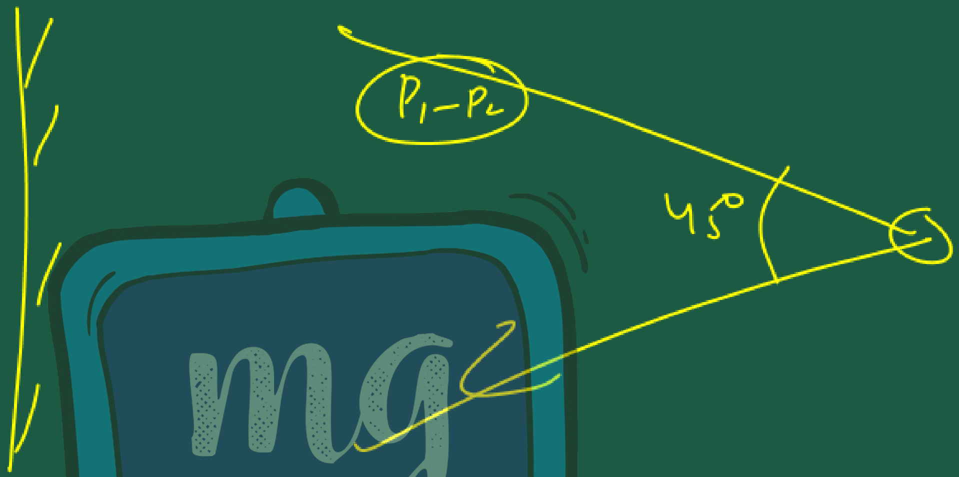
$54\ km/hr \times \frac{5}{18} = 15\ m/s$

$u = 15\ m/sec$ $\quad P_i = 0.15 \times 15 = 2.25$

$v = -15\ m/sec$ $\quad 2.25$

$54\ km/hr = 15\ m/sec$

$\sqrt{P_1^2 + P_2^2 + 2P_1P_2\cos\theta}$



$$\sqrt{P_1^2 + P_2^2 - 2P_1P_2\cos 45^\circ}$$

$$\sqrt{(2.25)^2 + (2.25)^2 - 2(2.25)^2 \frac{1}{\sqrt{2}}}$$

$$2.25\sqrt{1+1-1.41}$$

$$2.25 \times 0.59 = 2.25 \times 0.6$$

$$= 1.350 = 1.35 \text{ N-kg}$$

EXERCISE

21. A stone of mass 0.25 kg tied to the end of a string is whirled round in a circle of radius 1.5 m with a speed of 40 rev./min in a horizontal plane. What is the tension in the string? What is the maximum speed with which the stone can be whirled around if the string can withstand a maximum tension of 200 N?

$T = 200\ N$

$r = 1.5\ m$

$T = \frac{mv^2}{r}$

$v^2 = \frac{Tr}{m}$

$v = \sqrt{\frac{Tr}{m}}$

$= \sqrt{\frac{200 \times 1.5}{1/4}}$

$= \sqrt{\cancel{800}^{400} \times \frac{3}{\cancel{2}}}$

$v = \sqrt{1200}$

$= 10\sqrt{12}$

$v = 20\sqrt{3}\ m/s$

$m = 0.25\ kg$

$\nu = 40\ \frac{rev}{min}$

$= 40\ \frac{rev}{60\ sec}$

$= \frac{2}{3}\ \frac{rev}{sec}$

$T = \frac{mv^2}{r}$

$T = \frac{m r^2 \omega^2}{r}$

$T = m r \omega^2$

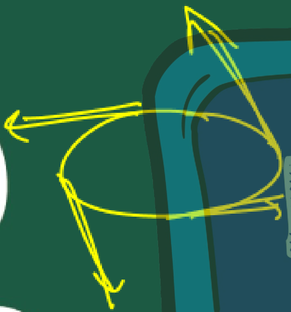
$T = 0.25 \times 1.5 \times 2\pi \times 2\pi \times \frac{4}{9}$

$T = \frac{1}{4} \times \frac{3}{2} \times 2\pi \times 2\pi \times \frac{4}{9}$

$T = \frac{2\pi^2}{9}\ N$

$T = \frac{20}{9}\ N = 2.1\ N$

EXERCISE



22. If, in Exercise 4.21, the speed of the stone is increased beyond the maximum permissible value, and the string breaks suddenly, which of the following correctly describes the trajectory of the stone after the string breaks :

(a) the stone moves radially outwards

EXERCISE

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(b) the stone flies off tangentially from the instant the string breaks

EXERCISE

(c) the stone flies off at an angle with the tangent whose magnitude depends on the speed of the particle?

EXERCISE

23. Explain why

(a) a horse cannot pull a cart and run in empty space.

EXERCISE

(a) a horse cannot pull a cart and run in empty space.

Answer : In order to pull a cart, a horse pushes the ground backward with some force. The ground in turn exerts an equal and opposite reaction force upon the feet of the horse.

This reaction force causes the horse to move forward. An empty space is devoid of any such reaction force.

EXERCISE

Hence, a horse cannot pull a cart and run in empty space.

EXERCISE

(b) a horse cannot pull a cart and run in empty space.

EXERCISE

(b) a horse cannot pull a cart and run in empty space.

Answer : If a speeding bus stops suddenly, the lower portion of a passenger's body, which is in contact with the seat, suddenly comes to rest. However, the upper portion tends to remain in motion (as per the first Law of Motion).

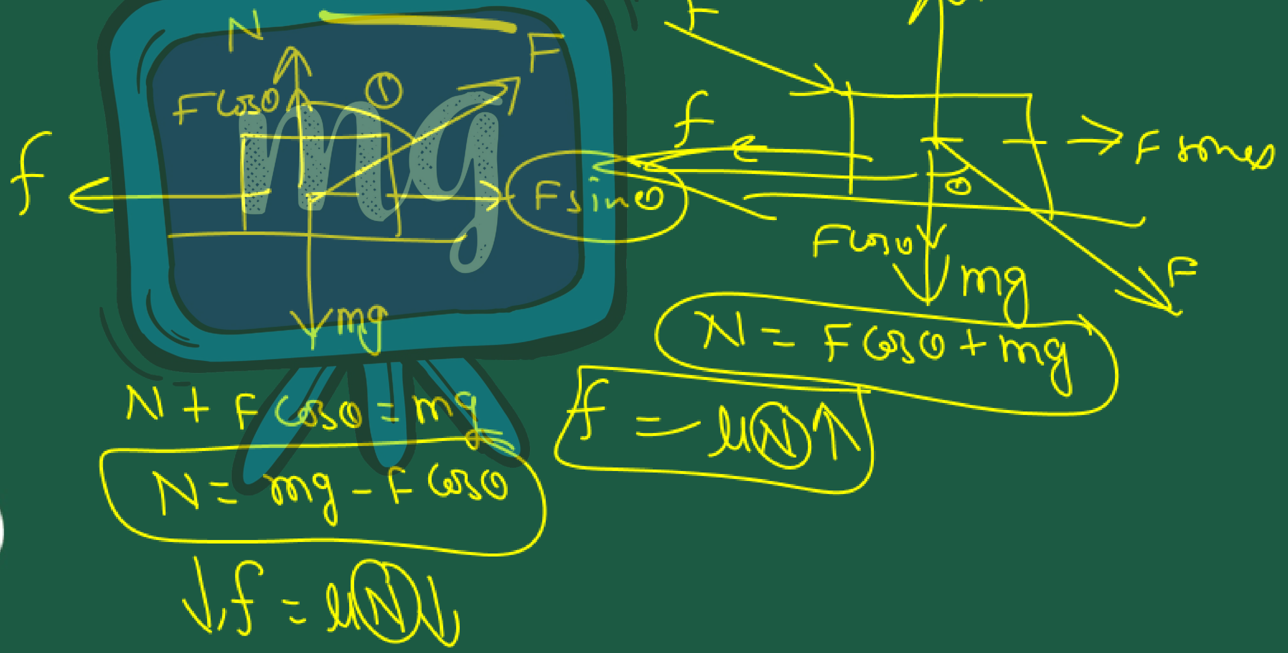
EXERCISE

So, the passenger's upper body is thrown forward in the direction in which the bus was moving.

EXERCISE

N = mg

(c) it is easier to pull a lawn mower than to push it



EXERCISE

(d) a cricketer moves his hands backwards while holding a catch.

$F = \frac{\Delta p}{\Delta t}$

EXERCISE

(d) a cricketer moves his hands backwards while holding a catch.

Answer : While taking a catch, a cricketer moves his hand backward to increase the time of impact Δt . This in turn results in a decrease in the stopping force, thereby preventing the hands of the cricketer from getting hurt.

Therefore, a cricketer moves his hands backwards while holding a catch.