Chapter 3

Dynamics

What kind of changes in motion maybe produced by a force?

A force can produce the following changes in motion.

(i.) Change in speed
(ii.) Change in direction
(iii.) Change in shape

There changes depend on the magnitude, direction and point of application of the forc.

Give 5 examples of contact forces?

Example of contant forces are following:

(i.) Friction wit .
(ii.) Thrust
(iii.) Air resistance
(iv.) Electric force
(v.) Drag
(vi.) Tension force
(vii.) Normal force

An object moves with constant velocity in free space. How long will the object continue to move with this velocity?

The object will continue to move with constant velocity indefinitely, as long as no external force acts on it.

Define impulse of force.

Impulse of force: Impulse of force is the product of a force and time interval over which it acts. It equals to the change in momentum of an object.

Why has not Newton's first law been proved on Earth?

Newton's first law has not been fully proved on Earth because external force like friction and air resistance are always present. It is impossible to completely eliminate all external forces acting on an object on Earth.

When sitting in a car which suddenly accelerates from rest, you are pushed back into the seat, why?

You are pushed back into the seat due to inertia, as your body resists the change in motion and tends to remain at rest while the car accelerates forward.

The force expressed in Newton's second law is a net force. Why is it so?

The force in Newton's second law is a net force because it represents the vector sum of all forces acting on an objects, determining its acceleration according to

an objects, determining its acceleration according to

$$F_{net} = ma$$

How can you show that rolling friction is lesser than the sliding friction?

Rolling friction is less than sliding friction because less surface area is in contact during rolling, reducing resistance.

This can be shown by comparing the effort needed to slide an object verses rolling it.

Define terminal velocity of an object?

Terminal velocity is the constant maximum velocity of an object reaches, when the force of air resistance equals the gravitational force acting on it, resulting is zero net acceleration.

An astronaut walking in space wants to return to his spaceship by firing a hand rocket. In what direction does he fire the rocket?

The astronaut fires the rocket in the direction opposite to the spaceship to propel himself toward it, according to Newton's third law of motion.

Constructed Response Questions

3.1 Two ice skaters weighing 60kg and 80 kg push off against each other on a frictionless ice track. The 60 kg skater gains a velocity of 4ms-1. Considering all the relevant calculations involved, explain how Newton's third law applies to this situation.

Ans. Newton's third law states that for every action, there is an equal and opposite reaction. When the staker of mass 60kg applies a force on the skater of mass 80kg, the 80kg skater applies an equal and opposite force on the 60kg skater .

3.2 Inflatable air bags are installed in the vehicles as safety equipment. In terms of momentum, what is the advantage of air bags over seat belts?

Ans. Airbags, compared to seatbelts, offer a significant advantage by increasing the time over which the occupant's momentum changes during a collision. This result in a smaller force exerted on the occupant, reducing the risk of injury.

3.3 A horse refuses to pull a cart. The horse argues, "according to Newton's third law, whatever force I exert on the cart, the cart will exert an equal and opposite force on me. Since the net force will be zero, therefore I have no chance of accelerating (pulling) the cart." What is wrong with this reasoning?

Ans. The horse's reasoning is flawed because Newton's third law involved action-reaction acting on different objects, not cancelling each out. The horse exerts a force on the cart (action) is matched by the cart's force on the horse (reaction), but these forces act on separate objects.

To pull the cart, the horse applies a force on the ground. The ground exerts an equal and opposite reaction force on the horse, allowing it to accelerate forward.

Simultaneously, the horse pulls the cart, causing the cart to accelerate. The net force on the system depends on the interation between the horse, cart and ground.

3.4. When a cricket ball hits high, a fielder tries to catch it. While holding the ball he/she draws hands backward. Why?

Ans. By drawing their hands backward, the fielder increase the time over which the ball's momentum changes, reducing the force exerted on their hands and preventing injury.

3.5 When someone jumps from a small boat onto the river bank, why does the jumper often fall into the water? Explain.

Ans. When someone jumps from a small boat, they push the boat backward due to Newton's third law.

Since the boat is small and light, it moves in the opposite direction as the opposite direction as the person jumps. This backward motion of the boat can reduce the jumper's forward momentum, causing them to misjudge their landing and fall into the water instead of reaching the river bank.

3.6 Imagine that if friction vanishes suddenly from everything, then what could be the scenario of daily life activities.

Ans. If friction vanishes suddenly, most daily activities would become impossible. People would be unable to walk, as there would be no grip between their feet and the ground. Vehicles would lose friction and be unable to accelerate, steer, or brake. Objects would slide indefinitely on surfaces, making tasks like writing, holding items on operating machinery unfeasible. Buildings and structures relaying on friction for stability could collapse, leading to wide spread chaos.

Chapter # 3

3.1 A 10kg block ..... to the block.

a) the Acceleration ... block. (b) the velocity ..... 5 Sec.

Sol: Mass of the block $= m = 10\ kg$

Initial velocity $= V_i = 0$

Force Applied $= F = 5\ N$

time $= t = 5s$

Req: Acceleration $= a = ?$

Final Velocity $= V_f = ?$

Formula: $F = ma$, $V_f = V_i + at$

Sol: $F = ma$, $V_f = V_i + at$

$a = \frac{F}{m} = \frac{5\ N}{10\ kg}$, $V_f = 0 + (0.5\ ms^{-2})(5\ s)$

$\because N = kg\ ms^{-2}$, $\boxed{V_f = 2.5\ ms^{-1}}$

$\boxed{a = 0.5\ ms^{-2}}$

3.2 The mass of a ..... Moon is $1.6\ ms^{-2}$.

Sol Mass $= m = 80\ kg$

Acceleration due to gravity on Moon $= g_m = 1.6\ ms^{-2}$

Acceleration due to gravity on Earth $= g_e = 10\ ms^{-2}$

Req: Weight on Earth $= W_e = ?$

Weight on Moon $= W_m = ?$

Formula: Weight = Mass × Acceleration due to gravity

Sol On Earth

$W = mg_e$

$W = (80kg)(10ms^{-2})$

$\boxed{W = 800N}$

On Moon

$W = mg_m$

$W = (80kg)(1.6\ ms^{-2})$

$\boxed{W = 128N}$

3.3 What force is ..... $30\ ms^{-1}$ in 10 sec.

Sol Mass $= m = 800\ kg$

Initial velocity $= V_i = 10\ ms^{-1}$

Final velocity $= V_f = 30\ ms^{-1}$

Time $= t = 10\ s$

Req, Force $= F = ?$

Formula $F = ma$

Sol $a = \frac{V_f - V_i}{t} = \frac{30\ ms^{-1} - 10\ ms^{-1}}{10\ s} \Rightarrow \frac{20\ ms^{-1}}{10\ s}$

$a = 2\ ms^{-2}$

Now $F = ma \Rightarrow (800\ kg)(2\ ms^{-2})$

$\boxed{F = 1600\ N}$

3.4 A 5g bullet ..... Speed of the gun.

Sol Mass of bullet $= m_b = 5g = 0.005\ kg$

Mass of gun $= m_g = 10\ kg$

Velocity of bullet $= V_b = 300\ ms^{-1}$

Req, Velocity of gun $= V_g = ?$

Formula $m_b V_b + m_g V_g = 0$

Sol Initial momentum = Final momentum

$m_b V_b + m_g V_g = 0$

$V_g = -\frac{m_b V_b}{m_g} \Rightarrow -\frac{0.005 \times 300}{10}$

$V_g = -\frac{1.5\ kg\ ms^{-1}}{10\ kg}$

$\boxed{V_g = -0.15\ ms^{-1}}$

-ve sign indicate the gun moves in the oppsite direction to bullet.

3.5 An Astronaut ..... Speed of $3.5 ms^{-1}$.

(a) The speed ..... the wrench.

(b) The distance ..... in 30 minutes.

Sol Mass of wrench $= m_w = 300g = \frac{300}{1000} = 0.3 kg$

Mass of Astronaut $= m_a = 70 kg$

Velocity of Wrench $= V_w = 3.5 ms^{-1}$

Req Speed of Astronaut $= V_a = ?$

Distance covered Astronaut $= d = ?$

Formula $m_w V_w + m_a V_a = 0$, $d = V_a \times t$

Sol $m_w V_w + m_a V_a = 0$

$$V_a = -\frac{m_w V_w}{m_a} \Rightarrow -\frac{(0.3 kg)(3.5 ms^{-1})}{70 kg}$$

$$\boxed{V_a = -0.015 ms^{-1}}$$

(b) $d = V_a \times t \Rightarrow$

$t = 30 min \Rightarrow 30 \times 60 = 1800 sec$

$d = (0.015 ms^{-1})(1800 sec)$

$$\boxed{d = 27 m}$$

-ve Sign show Astronaut move opposite direction of wrench.

3.6 A $6.5 \times 10^3 kg$ bogie ..... they become Coupled.

Sol Mass of 1st bogie $= m_1 = 6.5 \times 10^3 kg$

Mass of Astronaut $= m_2 = 9.2 \times 10^3 kg$

Velocity of 1st bogie $= V_1 = 0.8 ms^{-1}$

Velocity of 2nd bogie $= V_2 = 1.2 ms^{-1}$

Req

Common velocity of both bogie After Collision $= V_f = ?$

Formula $m_1V_1 + m_2V_2 = (m_1 + m_2)V_f$

Sol $m_1V_1 + m_2V_2 = (m_1 + m_2)V_f$

$(6.5\times10^3 kg \times 0.8 ms^{-1}) + (9.2\times10^3 kg \times 1.2 ms^{-1}) = (6.5\times10^3 kg + 9.2\times10^3 kg)V_f$

$(5.2\times10^3 kgms^{-1}) + (11.04\times10^3 kgms^{-1}) = (15.7\times10^3 kg)V_f$

$16.24\times10^3 kgms^{-1} = (15.7\times10^3 kg)V_f$

$\frac{16.24\times10^3 kgms^{-1}}{15.7\times10^3 kg} = V_f$

$\boxed{V_f = 1.034 ms^{-1}}$

3.7 A cyclist weighing ..... by the cyclist.

Sol Cyclist mass $= m_1 = 55$ kg

Bicyle's mass $= m_2 = 5$ kg

Total mass $= m = m_1 + m_2 = 55 + 5 = 60$ kg

Initial Velocity $= V_i = 0\ ms^{-1}$

Force $= F = 90N$

Time $= t = 8s$

Req Total distance $= d = d_1 + d_2 = ?$

Formula $d_1 = V_it + \frac{1}{2}at^2$, $d_2 = V_f \times t$

Sol $F = ma$

$a = \frac{F}{m} = \frac{90N}{60kg} = \boxed{1.5 ms^{-2}}$

Now we Calculate distance $d_1 = ?$

$d_1 = V_it + \frac{1}{2}at^2$

$d_1 = 0 + \frac{1}{2}(1.5 ms^{-2})(8s)^2$

$= \frac{1}{2}(1.5 ms^{-2})(64s^2)$

$\boxed{d_1 = 48m}$

Now we Calculate $d_2 = ?$

$v_f = v_i + at \Rightarrow 0 + (1.5)(8)$

$v_f = 12\ ms^{-1}$

$d_2 = v \times t \Rightarrow (12 ms^{-1})(8s)$

$d_2 = 96m$

Total distance $= d = d_1 + d_2 \Rightarrow 48m + 96m$

$\boxed{d = 144m}$

3.8 A ball of mass ..... by the floor.

Sol Mass of the ball $= m = 0.4kg$

Initial height $= h_1 = 1.8m$

Final height $= h_2 = 0.8m$

Gravitational Accele $= g = 9.8\ ms^{-2}$

Req Impulse $= I = ?$

Formula $I = \Delta p = m\Delta v = m(v_2 - v_1)$

Sol $\frac{1}{2} m v_1^2 = mgh$

$v_1^2 = 2gh$

$v_1 = \sqrt{2gh}$

$v_1 = \sqrt{2 \times 9.8 \times 1.8}$

$v_1 = \sqrt{35.28}$

$\boxed{v_1 = 5.94\ ms^{-1}}$

Since ball is falling so velocity is -ve.

$v_1 = -5.94\ ms^{-1}$

After Impact

$\frac{1}{2} m v_2^2 = mgh$

$V_2' = \sqrt{2gh_2} \Rightarrow \sqrt{2\times 9.8\times 0.8} \Rightarrow \sqrt{15.68}$

$V_2 = 3.96 ms^{-1}$

Now we calculate Impulse

$I = \Delta p = m(v_2 - v_1)$

$I = 0.4(3.96 - (-5.94)) \Rightarrow 0.4(3.96 + 5.94)$

$I = 3.96 Ns \approx 4 Ns$

3.9 Two balls of ..... of 0.4 kg ball.

Sol Mass of 1st ball $= m_1 = 0.2$ kg

Velocity of 1st B.C ball $= V_1 = 20 ms^{-1}$

Mass of 2nd ball $= m_2 = 0.4$ kg ∵B.C = before collision

Velocity of 2nd B.C ball $= V_2 = -5 ms^{-1}$

(Since it is moving forward ball 1, we take the Velocity as -Ve.)

Velocity of 1st ball After Collision $= V_1' = 6 ms^{-1}$

Req Velocity of 2nd ball A.C $= V_2' = ?$

Formula $m_1V_1 + m_2V_2 = m_1V_1' + m_2V_2'$

Sol $m_1V_1 + m_2V_2 = m_1V_1' + m_2V_2'$

$(0.2kg \times 20ms^{-1}) + (0.4kg \times (-5ms^{-1})) = (0.2kg \times 6ms^{-1} + 0.4kg \times V_2')$

$4 Kg ms^{-1} - 2 Kg ms^{-1} = 1.2 Kg ms^{-1} + 0.4 Kg (V_2')$

$2 Kg ms^{-1} - 1.2 Kg ms^{-1} = (0.4 kg)\ V_2'$

$0.8 Kg ms^{-1} = (0.4 Kg)\ V_2'$

$\frac{0.8 Kg ms^{-1}}{0.4 Kg} = V_2'$

$V_2' = 2 ms^{-1}$

The Velocity of 0.4 kg ball after Collision is $2 ms^{-1}$.

Search Youtube

- **Step Academy**
- **@waqarhaider1**
- **Website:**
- **https://stepacademyofficial.com/**

ہوم اکیڈمی کی سہولت موجود ہیں۔(صرف گوجرانوالہ میں)

نوٹس میں کوئی غلطی ہو تو لازمی آگاہ کریں