STRUCTURED QUESTIONS

MOMENTUM

1. a) Define momentum with SI unit?
   b) Find the moment of body of mass 6 kg moving with a velocity of 25 ms^{-1}.
   c) What will be the velocity if the momentum becomes 200Ns?

Ans:

(a) MOMENTUM

The linear momentum of an object of mass **m** moving with a velocity **v** is defined as **the product of mass of a body and its velocity is called momentum.** It is a vector quantity.

FORMULA

Let m = mass of a body
v = linear velocity
and P = linear momentum
Now by definition, we can write

P = mv

UNIT

The unit of momentum is **Kg m/s**
(**N s**) Newton sec is the unit of momentum in the SI system

b) Find the moment of body of mass 6 kg moving with a velocity of 25 ms^{-1}.

DATA	**SOLUTION**
Mass m = 6 Kg Velocity **V** = 25 m/s TO DETERMINE Momentum p = ? Given formula **P = mv**	P = mv P = (6) (25) P = 150 kg m/s

c) What will be the velocity of same body if the momentum becomes 200Ns?

DATA	**SOLUTION**
Mass m = 6 Kg momentum **P** = 200 Ns TO DETERMINE Velocity **V** = ? Given formula **P = mv**	P = mv $v = \frac{P}{m}$ $v = \frac{200}{6} = 33.33\, m/s$

2. a) When a free-falling object moves towards the earth due to the pull of the earth on it. Does the earth also move towards that object due to reaction? Explain.

b) A body of mass 10 kg is moving with a velocity of 10 ms^{-1}. A force acts for 5 seconds to reduce its velocity to 2 ms^{-1} . Find the momentum of the body before and after the application of the force on it.

ANS: (a)

Yes, there is the action-reaction principle, the object pulls the Earth with the same force as the Earth pulls the object. If the object is 10 kg, the pulling force is 98 newtons. The acceleration is proportional to the mass. The mass of the earth is around M =6 x 10^{24} kg (it's 24 zeros). Then the acceleration of the earth due to this pulling force of 98 newtons is

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

$$a = \frac{98}{6 \times 10^{24}} = 1.63 \times 10^{-23}\ m/s^2$$

So, in order to move the earth toward free falling body by 1 mm with this acceleration it will take 109 years.

(b) A body of mass 10 kg is moving with a velocity of 10 ms^{-1}. A force acts for 5 seconds to reduce its velocity to 2 ms^{-1} . Find the momentum of the body before and after the application of the force on it

DATA

Before the application of force

Mass m = 10 Kg

Velocity **V** = 10 m/s

After the application of force

Mass m = 10 Kg

Velocity **V** = 2 m/s

TO DETERMINE

Before the application of force

Momentum p = ?

After the application of force

Given formula

P = mv

SOLUTION

Before the application of force

P = mv

P = (10) (10)

P = 100 kg m/s

After the application of force

P = mv

P = (10) (2)

P = 20 kg m/s

3. a) Why a wire fence is designed in the helmet of a batsman?
b) How does it prevent from injuries?

ANS

(a)

A wire fence is designed in the helmet of a batsman to provide protection to the face and head from the impact of the fast-moving cricket ball. The wire fence helps in absorbing and distributing the force of the ball over a larger area, reducing the chances of injury.

(b)

A helmet aims to reduce the risk of serious head and brain injuries by reducing the impact of a force or collision on the head. A helmet works in a three-way, it reduces the deceleration of the skull, and hence the brain movement, by managing impact

LAWS OF MOTION

4. a) State the Newton's first law of motion. Give some common examples.
b) Enlist some common observations that are caused by the property of inertia.

Ans

(a)

The Newton's first law of motion states that,

If the body is at rest, it will remain at rest. If the body is moving, it will continue to move forever at the same velocity (same speed and direction) unless it is acted upon by an external force

1- Car Air Bags

The function of the airbag is to inflate in an accident and prevent the driver's head from hitting the windshield. When a car with an airbag is exposed to an accident, the sudden slowdown in its speed leads to the operation of an electrical switch, and this starts a chemical reaction that produces a gaseous substance that works to fill the airbag and protect the driver's head.

2- Baseball Is at Rest

It needs an external force to move, gets thrown, or is hit. The distance the ball travels depends on the amount of force that acts on it.

3 A Kite Flying through the Air

The forces acting on a kite in flight include the weight, the aerodynamic lift and drag, and the tension in the control line. In stable flight, these forces are all balanced and the kite holds a fixed altitude.

(b) some common observations that are caused by the property of inertia

1 You tend to move forward when a sudden break is applied
2. You feel a backward force when the bus moves quickly from rest.
3. Dusting the bed with a broom removes dust due to the inertia of rest
4. when you shake a branch the leaves get detached.
5. Athlete taking a short run before a jump
6. Cricketer moving backward before catching a ball
7. Tightening of seat belts in a car when it stops quickly.
8. Objects that establish orbit around the earth, like satellites, continue on their trajectory due to inertia

5. a) Define Newton's second law of motion.
b) A force of 3400 N is applied on a body of mass is 850 kg, find the acceleration produced by the force.
c) How much force should be applied on a body of mass 425kg to produce acceleration same as calculated in part b.

Ans

(a) **NEWTON'S SECOND LAW**

When a net force acts on an object, it will cause the object to accelerate in the direction of the force. The amount of acceleration of an object is directly proportional to the net force and inversely proportional to its mass

(b) A force of 3400 N is applied on a body of mass 850 kg, find the acceleration produced by the force.

DATA

Force F = 3400 N

mass **m** = 850 kg

TO DETERMINE

Velocity **a** = ?

Given formula

F = ma

SOLUTION

F = ma

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

$$v = \frac{3400}{850} = 4.0\ N$$

6. a) Show the relationship between applied force and the acceleration produced in the body.
b) Find the mass of a body that is accelerated by applying a force of 200 N, that speeds up it to 36 ms^{-1}.
c) What should be the acceleration of the same body if the applied force changes to 280N

Ans

(a) As per Newton's second law of motion, acceleration is directly proportional to the force applied provided the mass remains constant(F=ma). The larger the force greater the acceleration

b) Find the mass of a body that is accelerated by applying a force of 200 N, that speeds up it to 36 ms^{-1}.

c) What should be the acceleration of the same body if the applied force changes to 280N

(b) DATA

fore **F** = 200 N

$acceleration\ a = 36\ m/s^2$

TO DETERMINE

Mass m = ?

Given formula

F = ma

SOLUTION

$$F = ma$$

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

$$m = \frac{200}{36} = 5.5\ kg$$

7. An empty car has a 1200 kg mass. Its engine can produce an acceleration of 4 ms^{-2}. If a 300 kg load is added to the mass by passengers and luggage. What acceleration the same engine will produce?

DATA

Empty car mass $\mathbf{m_1}$ = 1200 N

Load mass $\mathbf{m_2}$ = 300 kg

Total mass m = $\mathbf{m_1 + m_2}$

Total mass m = 1200 +300 =1500kg

$a = 4\ m/s^2$

TO DETERMINE

acceleration passenger and load a_1 =?

Given formula

F = ma

SOLUTION

$F = m_1 a$

F = 1200 x 4

F = 4800 N

Now, the acceleration of the same car produced acceleration with load

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

$$a = \frac{4800}{1500} = 3.2\ m/s^2$$

8. a) Enumerate at least three clear differences between mass and weight.
b) The mass of an object is 60 kg, find its weight on
(i) Earth (ii) Moon (iii) Mars assume the acceleration due to gravity on Earth = 9.8 ms^{-2} on Moon=1.6 ms^{-2} and on Mars= 3.7 ms^{-2}

a) Enumerate at least three clear differences between mass and weight.

	MASS		WEIGHT
1	**The quantity of matter in a body is called Mass.**	1	**Weight is the force with which Earth attracts a body towards its centre.**
2	**The mass of a body remains constant everywhere.**	5	**The weight of a body does not remain constant. It is different at different attitudes of earth.**
3	**Mass is a scalar quantity**	8	**Weight is a vector quantity.**

b) The mass of an object is 60 kg, find its weight on
(i) Earth (ii) Moon (iii) Mars assume the acceleration due to gravity on Earth = 9.8 ms^{-2} on Moon=1.6 ms^{-2} and on Mars= 3.7 ms^{-2}

(b) DATA
mass **m** = 60 kg
TO DETERMINE
weght W = ?
Given formula
W = mg
SOLUTION
The weight of an object on the Earth
W = (60) (9.8)
W = 588 N

The weight of an object on the Moon

W = (60) (1.6)
W = 96 N

The weight of an object on Mars
W = (60) (3.7)
W = 222 N

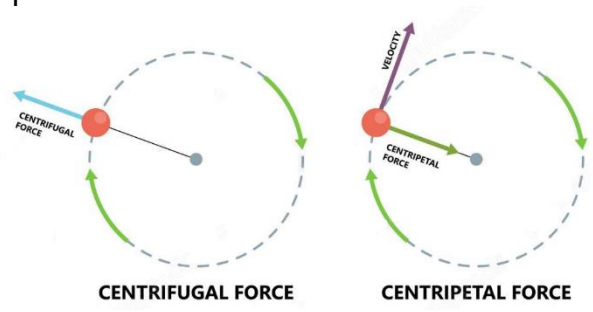
CIRCULAR MOTION

9. a) Define the forces acting on an object in circular motion.
b) Draw a figure showing the direction of centripetal force, centrifugal force, and velocity of an object along a circular path.
c) A car is running on a circular part of the highway having about a 1000m radius. The mass of car is 600kg and its velocity is 72 kmh. Find
(i) Centripetal force exerted by the car.
(ii) Centripetal acceleration of car.
d) List down some purposeful uses of centrifuge that humans are benefitting every day.

Ans:
a) Define the forces acting on an object in circular motion.

Centripetal force is the force acting on an object in a circular motion directed towards the axis of rotation or centre of the circle.

b) Draw a figure showing the direction of centripetal force, centrifugal force, and velocity of an object along a circular path.



c) A car is running on a circular part of the highway having about a 1000m radius. The mass of car is 600kg and its velocity is 72 kmh. Find
(i) Centripetal force exerted by the car.
(ii) Centripetal acceleration of car.

(c) DATA

Radius **r** = 1000 m

mass **m** = 600 kg

velocity **v** = 72 km/h

$$v = \frac{72 \times 1000}{3600}$$

$$v = 20\ m/s$$

TO DETERMINE

Centripetal force F = ?

Centripetal acceleration a = ?

Centripetal force

$$F = \frac{m\,v^2}{r}$$

$$F = \frac{(600)\,(20)^2}{1000}$$

$$F = \frac{240000}{1000} = 240\ N$$

Centripetal acceleration

$$a = \frac{v^2}{r}$$

$$a = \frac{(20)^2}{1000} = \frac{400}{1000} = 0.4\ m/s^2$$

FRICTION

10. a) What is force of friction? Explain with two examples from daily life.
b) A block is placed on a wet slippery floor. The mass of block is 15 kg. When it is pulled through a string and spring balance, it shows force equal to 3 N. Find the coefficient of friction. (Fs = μ mg)

Ans

(a) Friction force is the resistance that one surface or object encounters when moving over another. It acts in the opposite direction to the motion and arises from the interactions between the surfaces in contact.

Examples of Friction Force

1 Walking: When you walk, static friction between your shoes and the ground allows you to push off without slipping.

2 Braking a Car: When brakes are applied, kinetic friction between the brake pads and the wheels slows down the vehicle.

A block is placed on a wet slippery floor. The mass of the block is 15 kg. When it is pulled through a string and spring balance, it shows force equal to 3 N. Find the coefficient of friction. (Fs = μ mg)

(c) DATA

mass **m** = 15 kg

force **F** = 3 N

TO DETERMINE

coefficient of friction μ = ?

Fs = μ mg

$$\mu = \frac{F_s}{m\,g}$$

$$\mu = \frac{3}{(15)\,(9.8)}$$

$$\mu = \frac{3}{147} = 0.20\ N$$

11. a) How anti-lock braking system prevent the risk of sliding?
b) Enlist any four uses of rolling friction in everyday life.

Ans

(a)

Anti-lock braking system (ABS) prevents the risk of sliding by preventing the wheels from locking up. When the brakes are applied, ABS monitors the wheel speed and applies the brakes in a pulsating manner. This prevents the wheels from locking up and allows the driver to maintain steering control.

(b).

Rolling friction is the force that opposes the motion of a rolling object.

1 Using roller skates or skateboards: The wheels of roller skates and skateboards reduce friction, making it easier to move.
2 Using ball bearings in machines: Ball bearings are used in many machines to reduce friction and improve efficiency.
3 Using tires on vehicles: Tires are designed to minimize rolling friction, allowing vehicles to move more efficiently.
4 Using wheels on luggage: Wheels on luggage reduce friction, making it easier to transport luggage.

12. Explore the following phenomenon to dynamics
a) When an air-filled balloon is released.
b) Riding a bicycle needs continuous paddling.
c) The biker riding in the death well.
d) You always feel a pullback whenever you pull on your school bag or some heavier object.

Ans:

a) As the balloon rises, the air inside it expands due to the decreasing air pressure. This expansion reduces the buoyant force, eventually becoming equal to the force of gravity. At this point, the balloon stops accelerating and reaches a constant upward velocity.

b) Riding a bicycle requires continuous pedaling to maintain speed and overcome frictional forces and air resistance. When a cyclist pedals, they apply a force to the pedals, which translates into motion. If the rider stops paddling, the bicycle will slow down and eventually come to a stop due to the opposing forces.

c) In a death well, the biker experiences centripetal force as they ride along the vertical wall. The biker must maintain a sufficient speed to counteract gravitational pull and stay against the wall. The dynamics involve balancing gravitational force and the required centripetal force to keep the biker in circular motion, illustrating the principles of circular dynamics

d) When pulling on a heavy object, you feel a pullback due to Newton's third law of motion. As you exert a force on the object, it exerts an equal and opposite force back on you. This reaction force is what you feel as resistance or pullback, demonstrating the interaction between forces in dynamics