Chapter: 03

Dynamics

Exercise MCQs

1. Newton's first law of motion is valid only in the absence of:

Ⓐ Force Ⓑ Net force Ⓒ Friction Ⓓ Momentum

2. Inertia depends upon:

Ⓐ Force Ⓑ Net force Ⓒ Mass Ⓓ Velocity

3. A boy jumps out of a moving bus. There is a danger for him to fall:

Ⓐ Towards the moving bus Ⓑ Away from the bus
Ⓒ in the direction of motion Ⓓ opposite to the direction of motion

4. A string is stretched by two equal and opposite forces 10N each. The tension in the string is:

Ⓐ Zero Ⓑ 5N Ⓒ 10N Ⓓ 20N

5. The mass of a body:

Ⓐ decrease when accelerated Ⓑ increases when accelerated
Ⓒ decreases when moving with high velocity Ⓓ none of the above

6. Two bodies of masses m_1 and m_2 attached to the ends of an inextensible string passing over a frictionless pulling such that both move vertically. The acceleration of the bodies is:

Ⓐ $\frac{m_1 \times m_2}{m_1 \times m_2} g$ Ⓑ $\frac{m_1 - m_2}{m_1 + m_2} g$ Ⓒ $\frac{m_1 + m_2}{m_1 - m_2} g$ Ⓓ $\frac{2m_1 m_2}{m_1 + m_2} g$

7. Which of the following is the unit of momentum?

Ⓐ Nm Ⓑ $kgms^{-2}$ Ⓒ Ns Ⓓ Ns^{-1}

8. When a horse pulls a cart, the action is on her:

Ⓐ Cart Ⓑ Earth Ⓒ Horse Ⓓ Earth and cart

9. Which of the following materials lowers friction when pushed between metal plates?

Ⓐ water Ⓑ fine marble powder Ⓒ Air Ⓓ Oil

Answer Key:

1	Ⓑ	**6**	Ⓑ
2	Ⓒ	**7**	Ⓒ
3	Ⓒ	**8**	Ⓓ
4	Ⓒ	**9**	Ⓓ
5	Ⓓ		

Short Questions

1. Define the following terms:

(a) Inertia (b) Momentum (c) Force (d) Force of friction

(e) Centripetal force

Ans:

(a) Inertia:

The inertia of a body is its property due to which is resists any change in its state of rest or motion.

(b) Momentum:

The momentum of a body is the quantity of motion possessed by the body. The momentum of a body is equal to the product of its mass and velocity.

Formula:

$$P = mv$$

Unit:

Ns or $kgms^{-1}$

(c) Force:

A force is a push or pull. It moves or tends to move, stops or tends to stop the motion of a body. The force can also change the direction of motion of a body.

Unit:

Its SI unit is $kgms^{-2}$.

(d) Force of friction:

The force that opposes the motion of moving objects is called friction.

(e) Centripetal force:

The force which keeps the body to move in a circular path is called the centripetal force.

Formula:

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

2. What is the law of inertia?

Ans: Law of inertia:

Newton's first law of motion deals with the inertial property of matter, so Newton's first law of motion is also known as law of inertia.

Statement:

"A body continues its state of rest or of uniform motion in a straight line provided no net force acts on it".

3. What is the difference between?

(a) Mass and weight.

(b) Action and reaction.

(c) Sliding friction and rolling friction.

Ans: Difference between Mass and weigh is:

Mass (m)	Weight (w)
➢ The mass of a body is the quantity of matter that it possesses. ➢ Mass is a scalar quantity.	➢ The weight of the body is equal to the force with which Earth attracts it. ➢ Weight is a vector quantity.

Difference Action and reaction is:

Action	Reaction

It is a force that is exerted by the body on other body. **Examples:** Let the force of **A** on the other body **B** is called action force.	It is also a force which is exerted by the other body on the first one. **Examples:** Let the force of B on the first body A is called reaction force.

Difference sliding friction and Rolling friction is:

Sliding Friction	Rolling Friction
A force between the sliding objects which opposes the relative motion between them is called sliding friction.	Rolling friction is the force of friction between a rolling body and the surface over which it rolls.

4. Why is it dangerous to travel on the roof of a bus?

Ans: If a person travels on the roof of a bus, it would be dangerous because when a bus takes a sharp turn, passengers fall in the outward direction. It is due to inertia that they want to continue their motion in a straight line and thus fall outwards.

5. How can you relate a force with the change of momentum of a body?

Ans: When a force acts on a body, it produces acceleration in the body and will be equal to the rate of change of momentum of the body.

Suppose a force 'F' acts on a body of mass 'm' moving with initial velocity 'v_i' which produces an acceleration a in it. This changes the velocity of the body to 'v_f' after time t. If P_i, and P_f be the initial momentum and final momentum of the body's final velocities, then,

Momentum of the body having velocity $v_i = P_i = mv_i$

Momentum of the body having velocity $v_f = P_f = mv_f$

Change in momentum = final momentum − initial momentum

Change in momentum $= P_f - P_i = mv_f - mv_i = m(v_f - v_i)$

$$\text{Rate of change in momentum} = \frac{P_f - P_i}{t} = \frac{mv_f - mv_i}{t}$$

$$\text{Rate of change in momentum} = m\frac{v_f - v_i}{t}$$

Since $\frac{v_f - v_i}{t}$ is the rate of change of velocity equal to acceleration produced by the force F.

So,

$$\frac{P_f - P_i}{t} = ma$$

According to Newton's second law of motion,

$$F = ma$$

So,

$$\frac{P_f - P_i}{t} = \frac{mv_f - mv_i}{t}$$

So, equation (I) can be written as,

Rate of change in momentum = ma

According to second law of motion,

$$F = ma$$

So,

$$\frac{P_f - P_i}{t} = F$$

Rate of change of momentum of a body is equal to the applied force on it and the direction of change of in momentum is in the direction of the force.

6. Why does a passenger move outward when a bus takes a turn?

Ans: When a bus takes a sharp turn, passengers fall in the outward direction. It is due to inertia that they want to continue their motion in a straight line and thus fall outwards.

7. What will be the tension in a rope that is pulled from its ends by two opposite forces 100N each?

Ans: When two forces of 100N, each are applied on a string, then the resultant tension is 100N.

8. A horse pulls that cart. If the action and reaction are equal and opposite then how does the cart move?

Ans: The horse applies action by feet on the road; the reaction is given by the road on the horse, due to which the horse moves. The cart, which is tied to the horse, also moves. Since, action and reaction never act on the same body, so the cart moves.

9. Action and reaction are always equal and opposite. Then how does a body move?

Ans: According to Newton's third law of motion, action and reaction are always equal and opposite in direction. But action and reaction forces always act on different bodies, so they do not cancel the effect of each other, and under the condition of forces the body moves irrespective of this, that action and reaction are equal but opposite in direction.

10. What is the law of conservation of momentum?

Ans: **Law of conservation of momentum:**

"The momentum of an isolated system of two or more than two interacting bodies remains constant."

Examples:

Firing a bullet, release of air from a balloon.

11. When a gun is fired, it recoils. Why?

Ans: As the gun is fired, the bullet shoots out of the gun and acquires some momentum. To conserve the momentum of the system, the gun recoils.

12. Why is the law of conservation of momentum important?

Ans: By using the law of conservation of momentum, it is possible to calculate the force, velocity, and acceleration of a body. Most elementary particles are discovered by the use of this law.

13. Describe two situations in which force of friction is needed?

Ans: There are many conditions in which friction is desirable; two of them are given below:

- Friction is needed when we write.
- Friction enables us to walk on the ground.

14. Describe ways to reduce friction.

Ans: Method of reducing friction:

- Using grease or any other lubricant.
- Using smoother surfaces.
- Using rollers, wheels, or ball bearings.
- Objects like cars and planes are modeled with streamlined shapes.

15. How does oiling the moving parts of a machine lower friction?

Ans: Oiling the moving parts of a machine lowers friction because the oil fills up all the rough spot (cold welds) and make the surface smooth.

16. Why roiling friction is less than sliding friction?

Ans: "Rolling friction is much less than sliding friction because in the case of rolling friction contact area (cold welds points) of the two surfaces is very small as compared to sliding friction."

17. What you know about the following.

(a) Tension in a string **(b) Limiting force of friction**

(c) Braking force **(d) Skidding of vehicles**

(e) Seatbelts **(f) Banking of roads**

(g) Cream separator

Ans:

(a) Tension in a string:

The force acting along a string causes tension in the string.

(b) Limiting force of friction:

The frictional force that exists between the surfaces of two stationary bodies in contact with each other.

(c) Braking force:

It is a measure of the braking power of a vehicle.

(d) Skidding of vehicles:

The act of sliding or slipping of a vehicle over a surface, often sideways without revolving.

(e) Seatbelts:

A belt or strap in an automobile, or airplanes to hold you in your seat in case of an accident or sudden stop.

(f) Banking of roads:

The phenomenon of raising the outer edge of the curved road above the inner edge to provide the necessary centripetal force to the vehicle to take a safer turn on the curve road is called banking of roads.

(g) Cream separator:

A device which is used to separate cream from milk.

18. What would happen if all friction suddenly disappears?

Ans: If there was no friction then we could not walk, we would keep slipping. Nothing would steady on the ground and nothing would exist in the way they do now.

19. What would happen if all friction suddenly disappears?

Ans: The spinner of a washing machine is made to spin at a very high speed. Because when it spins at high speed, the water from wet clothes is forced out through these holes due to lack of centripetal force.

Important Formulas

- $F = ma$
- $F = \frac{\Delta P}{t}$
- $F_c = \frac{mv^2}{r}$

If both masses are suspended vertically

- $T = \left(\frac{2m_1 m_2}{m_1 + m_2}\right) g$
- $a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$
- Unit of tension = Newton
- Unit of acceleration $= ms^{-2}$

- $W = mg$
- $F_s = \mu_s R = \mu_s mg$

If one mass is horizontal and other is suspended vertically.

- $T = \left(\frac{m_1 m_2}{m_1 + m_2}\right) g$
- $a = \left(\frac{m_1 g}{m_1 + m_2}\right)$

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Numerical

1. A force of 20N moves a body with an acceleration of $2ms^{-2}$, what is its mass?

Ans: Given data:

$F = 20N$

$a = 2ms^{-2}$

To Find:

$m = ?$

Solution:

By using Newton's second law of motion,

$F = ma$

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

$$m = \frac{20}{2}$$

m = 10kg

2. The weight of a body is 147. What is its mass? (Take the value of g as $10ms^{-2}$).

Ans: Given data:

$$w = 147N$$

$$g = 10ms^{-2}$$

To Find:

$$m = ?$$

Solution:

We know that,

$$w = mg$$

$$m = \frac{w}{g}$$

$$m = \frac{147}{10}$$

m = 14.7kg

3. How much force is needed to prevent a body of mass 10kg from falling?

Ans: Given data:

$$m = 10kg$$

$$g = 10ms^{-2}$$

To Find:

$$F = ?$$

Solution:

We know that,

$$F = ma$$

$$F = (10)(10)$$

F = 100N

4. Find the acceleration produced by a force of 100N in a mass of 50kg.

Ans: Given data:

$$F = 100N$$

$$m = 50kg$$

To Find:

$a = ?$

Solution:

Using Newton's second law of motion,

$$F = ma$$

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

$$a = \frac{100}{50}$$

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

5. A body has a weight 20N. How much force is required to move it vertically upwards with an acceleration of $2ms^{-2}$?

Ans: Given data:

$w = 20N$

$a = 2ms^{-2}$

To Find:

$F = ?$

Solution:

As we know that,

$$w = mg$$

$$m = \frac{w}{g}$$

$$m = \frac{20}{2}$$

$$m = 2kg$$

Using Newton's 2nd law of motion,

$$F = ma$$

$$F = (2)(2)$$

$$\mathbf{F = 4N}$$

6. Two masses 52kg and 48 kg are attached to the ends of a string that passes over a frictionless pulley. Find the tension in the string and acceleration in the bodies, when both masses are moving vertically.

Ans: Given data:

$m_1 = 52kg$

$m_2 = 48kg$

$g = 10ms^{-2}$

To Find:

$T = ?$

$a = ?$

Solution:

As we know that,

$$T = \left(\frac{2m_1 m_2}{m_1 + m_2}\right) g$$

$$T = \left(\frac{2 \times 52 \times 48}{52 + 48}\right) 10$$

$$T = 499.2N$$

$T = 500N$ (approximately)

Now for acceleration,

$$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$$

$$a = \left(\frac{52 - 48}{52 + 48}\right) \times 10$$

$$a = \frac{4 \times 10}{100}$$

$$a = \frac{40}{100}$$

$a = 0.4ms^{-2}$

7. Two masses 26kg and 24kg are attached to the ends of the string which passes over a frictionless pulley. 26kg is lying over a smooth horizontal table. 24N mass is moving vertically downward. Find the tension in the string and the acceleration in the bodies.

Ans: Given data:

$m_1 = 24kg$

$m_2 = 26kg$

$g = 10ms^{-2}$

To Find:

$T = ?$

$a = ?$

Solution:

As we know that,

$$T = \left(\frac{m_1 m_2}{m_1 + m_2}\right) g$$

$$T = \left(\frac{24 \times 26}{24 + 26}\right) \times 10$$

$$T = \frac{6240}{50}$$

$$\mathbf{T = 125N}$$

Now for acceleration,

$$a = \left(\frac{24 \times 10}{24 + 26}\right)$$

$$a = \frac{240}{50}$$

$$a = \frac{240}{50}$$

$$\mathbf{a = 4.8ms^{-2}}$$

8. How much time is required to change 22Ns momentum by a force of 20N?

Ans: Given data:

Change in momentum = $\Delta P = 22Ns$

$F = 20N$

To Find:

$t = ?$

Solution:

As we know that rate of change of momentum is equal to force acting on it,

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

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

$$t = \frac{22}{20}$$

$$\mathbf{t = 1.1s}$$

9. How much is the force of friction between a wooden block of mass 5kg and the horizontal marble floor? The coefficient of friction between wood and marble is 0.6.

Ans: Given data:

$m = 5kg$

$\mu_s = 0.6$

$g = 10ms^{-2}$

To Find:

Force of friction = F = ?

Solution:

By using formula,

$$F = \mu_s R$$

$$F = \mu_s mg \qquad (\therefore F = mg)$$

$$F = (0.6)(5)(10)$$

$$\mathbf{F = 30N}$$

10. How much centripetal force is needed to make a body of mass 0.5kg to move in a circle of radius 50cm with a speed $3ms^{-1}$?

Ans: Given data:

$m = 0.5kg$

$r = 50cm = \frac{50}{100} m = 0.5m$

$v = 3ms^{-1}$

To Find:

$F_c = ?$

Solution:

By using formula,

$$F_c = \frac{m v^2}{r}$$

$$F_c = \frac{(0.5)(3)^2}{(0.5)}$$

$$F_c = \frac{(0.5)(9)}{(0.5)}$$

$$\mathbf{F_c = 9N}$$