Q: Explain law of conservation of momentum? Also drive its formula.

(OR)

State and explain law of conservation of momentum.

Law of conservation of momentum:

Statement:

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

Momentum of a system depends upon its mass and velocity. "An isolated system is a group of interacting bodies on which no external force is acting".

If no unbalanced or net force acts on a system, its momentum remains constant. Thus the momentum of an isolated system is always conserved. This is the law of conservation of momentum.

Explanation:

Consider an isolated system of two spheres of masses m_1 and m_2 as shown in figure. They are moving in a straight line with initial velocities u_1 and u_2 respectively, such that u_1 is greater than

This equation shows that the momentum of an isolated system before and after collisions remains the same which is the law of conservation of momentum.

law of conservation of momentum is an important law and has vast applications.

Application of law of conservation of momentum:

Consider a system of a gun and bullet. Before firing the gun, both the gun and bullet are at rest, so the total momentum of the system is zero. As the gun is fired, bullet shoots out of the gun and acquires momentum. To conserve momentum of the system, the gun recoils. According to law of conservation of momentum, the total momentum of the gun and the bullet will also be zero after the gun is fired. Let m be the mass of the bullet and v be its velocity on firing the gun; M be the mass of the gun and V be the velocity with which it recoils. Thus the total momentum of the gun and the bullet after the gun is fired will be;

[Total momentum of the gun and the bullet after the gun is fired] = MV + mv.

Q no.7 Explain Newton's third law of motion.

Ans:

Statement:

"To every action there is always an equal but opposite reaction."

Explanation:

Newton's third law of motion deals with the reaction of a body. When a force F acts on it. Let a body A exerts a force on another body B, the body B reacts against this force and exerts a force on body A. The force exerted by the body A on B is called action. When as the force exerted by the body B on A is called the reaction force.

Note:

According to this law, action is always accompained by a reaction.

E.g. Consider a book on the table. The weight of the book is acting on table acts on the book in downward direction. This is called action. The reaction of the table acts on the book in the upward direction. This called reaction.

Q: Define limiting friction?

Ans: "The maximum value of friction is known as the force of limiting friction. (F_s)"

It depends on the normal reaction (pressing force) between the two surfaces in contact.

Q: What is meant by coefficient of friction? Write its mathematical form?

Ans: The ratio between the force of limiting friction F_s and the normal reaction R is constant. This constant is called the coefficient of friction and is represented by μ.

Thus $\mu = \frac{F_s}{R}$

$F_s = \mu R$

If m be the mass of them block, then for

horizontal surface:

$R = W$

$R = mg$

Hence $F_s = \mu mg$

:-

Co-efficient of friction has no unit.

e.g. The motion of the moon around the Earth is circular motion.

Q:- Define and explain centripetal force and write down its mathematical form.

Ans:- Definition:-

"Centripetal force is a force that keeps a body moving in a circle."

Example 1:-

The moon revolves around the Earth. The gravitational force of the Earth provides the necessary centripetal force.

Example 2:

Electrons revolve around the nucleus. The electromagnetic force between electrons and nucleus provides the centripetal force.

Example 3:-

A stone tied to one end of a string rotating in a circle. The tension in the string provides the necessary centripetal force. It keeps the stone remain in a circle.

Q. No. 9 Find the tension and acceleration during vertical motion of two bodies attached to the ends of a string that passes over a frictionless pulley.

Ans: Consider two bodies "A" and "B" of masses m_1 and m_2 respectively. Let m_1 is greater than m_2. The bodies are attached to the opposite ends of an inuntinsible string. The string passes over a frictionless pulley. The body "A" being heavier must be moving downwards with some acclenation. Let this acclenation be "a". At the same time, the body B attached to the other end of the string moves up with the same acclenation "a". As the pulley is frictionless, hence tension will be the same throughout the string. Let the tension in the string be "T".

Since the body "A" moves downward, hence its weight $m_1 g$ is greater than the tension T in the string.

Net force acting on body A = Weight − T

$$F_1 = W_1 - T \Rightarrow F_1 = m_1 g - T$$

From second law of motion.

$$F_1 = m_1 a$$

Putting the values in above equation.

$$\Rightarrow m_1 a = m_1 g - T \quad \ldots\ldots (1)$$

As body B moves upward, hence its Weight is less than the tension T in the string.

Net force acting on body B = T − Weight

Factors:-

Centripetal force depends on the following factors:

(i) Mass of a body (m)
(ii) Square of velocity of a body (v^2)
(iii) Radius of a circle (r)

Explanation:-

Let a body of mass m move with uniform speed v in a circle of radius r. The acceleration a_c produced by the centripetal force F_c is given by:

Centripetal acceleration $a_c = \frac{v^2}{r}$ ..... (i)

According to Newton's second law of motion, the centripetal force F_c is given by

$$F_c = ma_c$$

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

Equation (3.26) shows that the centripetal force needed by a body moving in a circle depends on the mass (m) of the body, square of its velocity v and reciprocal to the

Q:- Write down four methods of reducing friction?

Ans:- The friction can be reduced by:

Making the sliding surfaces smooth.

Making the fast moving objects a streamline shape (fish shape) such as cars, aeroplanes, etc. This causes the smooth flow of air and thus minimizes air resistance at high speeds.

Lubricating the sliding surfaces.

Use ball bearings or roller bearings. Because the rolling friction is less than the sliding friction.

Q:- Define circular motion. Also write its example.

Ans:- "The motion of an object in a circular path is known as circular motion."

Example:- Take a small stone. Tie it at one end of a string and keep the other end of the string in your hand. Now rotate the stone holding the string. The motion of stone will be called as the circular motion.

Q.5 [illegible] and write the name of its unit?

Ans Definition: "One newton is that force which produces an acceleration of one metre per second square in a body of mass one kilogram."

i.e. $1N = 1kg \times 1ms^{-2}$

$1N = kgms^{-2}$

Q.6 What is difference between Mass & Weight.

Ans: Mass	Weight
Mass of a body is the quantity of matter possessed by the body	Weight of a body is equal to the force with which Earth attracts the body towards its centre.
It is a scalar quantity	It is a vector quantity
It is represented by m	It is represented by W
It doesn't change with change of place	It varies from point to point depending upon the value of g
It is measured by physical balance	It is measured by spring balance
Its unit is kg	Its unit is Newton
Formula of mass is $m = \frac{F}{a}$	Formula of weight is $W = mg$

Similarly, a moving object doesn't stop moving by itself. A ball rolled on rough ground stops earlier than rolled on a smooth ground. It is because rough surfaces offer greater friction. If there would be no force to oppose the motion of a body then the moving body would never stop.

Newton's first law as law of inertia:

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

Q-4 State and Derive Newton's Second law of motion.

Ans "When a net force acts on a body an acceleration is produced in the direction of net force, the magnitude of acceleration is directly proportional to the applied force and is inversly proportional to mass of a body."

Explanation:

If F produces an acceleration a in a body of mass m, then the body will be accelerated in the direction of mass (force). If we double the applied force, the acceleration will be doubled. The magnitude of acceleration is directly proportional to applied force. i.e.

According to Newton's second law of motion

$F_2 = m_2 a$

$m_2 a = T$ ..... (2)

Adding Eqv. 1 and Eq. 2

$m_1 a + m_2 a = m_1 g - T + T$

$m_1 a + m_2 a = m_1 g$

$a(m_1 + m_2) = m_1 g$

$$\boxed{a = \frac{m_1 g}{m_1 + m_2}} \quad \text{..... (A)}$$

Putting this value of "a" in Eqv. (2)

$$\boxed{T = \frac{m_1 m_2}{m_1 + m_2} g} \quad \text{..... (B)}$$

ws of motion

$F_2 = T - w_2 \Rightarrow F_2 = T - m_2 g$

From second law

$F_2 = m_2 a$

Putting the values in above equation

$m_2 a = T - m_2 g$ ..... (2)

Adding Eq. 1 and Eq. 2 we get acceleration a.

$m_1 a + m_2 a = m_1 g - T + T - m_2 g$

$a(m_1 + m_2) = m_1 g - m_2 g$

$a(m_1 + m_2) = g(m_1 - m_2)$

$$\boxed{a = \frac{m_1 - m_2}{m_1 + m_2} g} \quad \text{..... (A)}$$

By using this formula we can find acceleration

By dividing Eq. (1) and 2, we get Tension

$$\frac{m_1 a}{m_2 a} = \frac{m_1 g - T}{T - m_2 g}$$

$$\frac{m_1}{m_2} = \frac{m_1 g - T}{T - m_2 g}$$

$\Rightarrow m_1(T - m_2 g) = m_2(m_1 g - T)$

$m_1 T - m_1 m_2 g = m_1 m_2 g - m_2 T$

$m_1 T + m_2 T = m_1 m_2 g + m_1 m_2 g$

$T(m_1 + m_2) = 2(m_1 m_2 g)$

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

According to the law of conservation of momentum

[Total momentum of the gun and the bullet after the gun is fired] = [Total momentum of the gun and the bullet before the gun is fired]

$$MV + mv = 0$$

or $MV = -mv$

Hence,

$$V = -\frac{m}{M}v$$

Equation of the gun gives velocity

Negative sign indicates the velocity of the gun is opposite to the velocity of the bullet i.e. the gun recoils. Since mass of the gun is much larger than the bullet, therefore, the recoil is much smaller than the velocity of bullet.

Example:

Rockets and jet engines also work on the same principle. In these machines, hot gases produced by burning of fuel rush out with large momentum. The machines gain an equal and opposite momentum. This enables them to move with very high velocities.

Q. Define fri... produce?

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A magn... in conta... between ... the two ... welds. ... sliding ... over. ... pressing ... increas... is the ... frictio...

According to Newton's second law of motion

$F_2 = m_2 a$

$m_2 a = T$ ..... (2)

Adding Eq-1 and Eq-2

$m_1 a + m_2 a = m_1 g - T + T$

$m_1 a + m_2 a = m_1 g$

$a(m_1 + m_2) = m_1 g$

$$\boxed{a = \frac{m_1 g}{m_1 + m_2}} \quad \ldots\ldots\ldots (A)$$

Putting this value of "a" in Eq-(2)

$$\boxed{T = \frac{m_1 m_2 g}{m_1 + m_2}} \quad \ldots\ldots\ldots (B)$$

$a \propto F$ ..... (1)

It is easy to produce acceleration in a lighter body than that of heavier body. It means that acceleration produced by the force is inversely proportional to the mass of a body.

$$a \propto \frac{1}{m} \quad \ldots\ldots (2)$$

Combining (1) and (2)

$$\Rightarrow a \propto \frac{F}{m}$$

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

putting k as proportionality constant, we get.

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

Let $F = 1N$ which produce acceleration $1 ms^{-2}$ in a body of mass 1kg.
In SI units, the value of k comes out to be 1.
Thus above equations becomes.

$$a = \frac{F}{m} \Rightarrow \boxed{F = ma.}$$

u_2 Sphere of mass m_1 approaches the sphere of mass m_2 as they move.

Initial momentum of mass $m_1 = m_1 u_1$

" " " " $m_2 = m_2 u_2$

Total initial momentum of the system before collision $= m_1 u_1 + m_2 u_2$

After sometime mass m_1 hits m_2 with some force. According to Newton's third law of motion, m_2 exerts an equal and opposite reaction force on m_1. Let their velocities become v_1 and v_2 respectively after collision. Then

Final momentum of mass $m_1 = m_1 v_1$

" " " " $m_2 = m_2 v_2$

Total final momentum of the system after collision $= m_1 v_1 + m_2 v_2$

According to the law of conservation of momentum

[Total initial momentum of the system before collision] = [Total Rf of the system after collision]

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

Q: Show that rate of change of momentum is equal to applied force?
(OR)
How can you relate a force with the change of momentum of a body?

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

Explanation:

Consider a body of mass m moving with initial velocity v_i.

When a force acts upon a body an acceleration is produced in it, this change the velocity v_i of the body to final velocity v_f.

If P_i and P_f be the initial momentum and final momentum of the body related to initial and final velocities respectively then

$$P = mv_i$$

and $P = mv_f$

Change in momentum = final momentum − initial momentum

$$P_f - P_i = mv_f - mv_i$$

Q:- Why is rolling friction less than sliding friction?

Ans:- When the axle of a wheel is pushed, the force of friction between the wheel and the ground at the point of contact provides the reaction force. The reaction force acts at the contacts points of the wheel in a direction opposite to applied force. The wheel rolls without rupting the cold welds. That is why the rolling friction is extremely small than sliding friction.

Q:- Write a few applications of rolling friction?

Ans:- (i) The fact that rolling friction is less than sliding friction is applied in ball bearings or roll bearings to reduce losses due to friction.

(ii) The wheel would not roll on pushing it if there would be no friction between the wheel and the ground. Thus, friction between the wheel and the ground is desirable for wheels to roll over a surface. It is dangerous to drive on a wet road because the friction between the road and tyres is very small. This increases the chance of slipping the tyres from the road. The threading on tyres is designed to increase friction.

Q: Define friction and how does it produce?

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

Explanation:

Friction is a force that comes into action as soon as a body is pushed or pulled over a surface. In case of solids, the force of friction between two bodies depends upon many factors force between them.

Production:

No surface is perfectly smooth. A surface that appears smooth has pits and bumps that can be seen under a microscope. Two wooden blocks with their polished surfaces in contact. A magnified view of two smooth surfaces in contact shows the gaps and contacts between them. The contact points between the two surfaces form a sort of cold welds. These cold welds resist the surfaces sliding over each other. Adding weight over the upper block increases the force pressing the surfaces together and hence, increases the resistance. Thus, greater is the pressing force greater will be the friction between the sliding surfaces.

Q.no 8 Define tension. Also write its condition during the vertical motion of block.

Ans:

Definition:

"The force exerted by a string when it is subjected to pull." Tension and weight are in opposite direction.

(OR)

The force acting along the string is called tension.

i.e. $\bar{T} = W = mg$

It is a vector quantity. And its SI unit is Newton.

It is represented by $\bar{T}$.

Conditions:

If $\bar{T} > W$ when the body moves upward.

If $\bar{T} = W$ then the body doesn't move.

If $\bar{T} < W$ then body moves downward.

Define the following terms:

Force:

A force moves or tends to move, stops or tends to stop the motion of a body. It force can also change the direction of motion of a body. It can also change the size or shape of the object.

(ii) It is a vector quantity. (iii) It is represented by F. Its unit is newton represented by N. (iv) Its formula is $F = ma$.

Inertia:

Inertia is that characteristics of a body due to which it resists any change in its state of rest or of uniform motion.

Inertia of a body depends upon mass of body. Greater is mass greater is inertia.

Examples to understand inertia:

Take a glass and cover it with a piece of cardboard. Place a coin on the cardboard. Now kick the card horizontally with a jerk of your finger. The coin doesnot move with the cardboard due to inertia and fall down into the glass because it continue its state of rest.

Consider another example of inertia. Cut a strip of paper. Place it on the table. Stack a few coins

at its one end. Pull out the paper strip under the coins with a jerk. The coin will remain at its position due to inertia.

(iii) **Momentum:**

The quantity of motion of a body it possesses due to its mass and velocity is called momentum.

(i) It is a vector quantity. (ii) It is represented by P. (iii) Its SI unit is $kg\text{-}ms^{-1}$ or (N.S).
(iv) It's formula is as $P = mv$.

Momentum of system depends upon mass and velocity of P.

Q no. 2 State Newton's first law of motion?

Ans:

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

According to the Newton's first law of motion, a body at rest remains at rest provided no net force acts on it. This part of the law is true as we observe that objects do not move by themselves unless someone moves them.

E.g. A book lying on table at rest as long as no net force acts on it.

Body "B" also moves the horizontal surface with some acceleration "a". As the pulley is frictionless, hence tension T will be the same throughout the string.

Since body A moves downwards, therefore its weight $m_1 g$ is greater than the tension T in the string.

Net force acting on body A

Net force acting on body A:

$F_1 = m_1 g - T$

And from second law: $F_1 = m_1 a$

$m_1 a = m_1 g - T$ ..... (1)

The forces acting on body B:

The forces acting on body B are:

i) Weight $m_2 g$ of the body B acting downward.
ii) Reaction R of the horizontal surface acting on body B in the upwards direction.
iii) Tension T in the string pulling the body B horizontally over the smooth surface.

As body B has no vertical motion, hence resultant of vertical forces ($m_2 g$ and R) must be zero. Thus, the net force acting on body B is T.

$F_2 = T$

Q.5 Define Newton (unit of force) or Define force and write the name of its unit?

Ans: Definition:

"One newton is that force which produces an acceleration of one metre per second square in a body of mass one kilogram"

i.e. $1N = 1kg \times 1ms^{-2}$

$1N = kg \cdot ms^{-2}$

Q.6 What is difference between Mass & Weight.

Ans:

Mass	Weight
Mass of a body is the quantity of matter possessed by the body.	Weight of a body is equal to the force with which Earth attracts the body towards its centre.
It is a scalar quantity.	It is a vector quantity.
It is represented by m.	It is represented by W.
It doesnot change with change of place.	It varies from point to point depending upon the value of g.
It is measured by physical balance.	It is measured by spring balance.
Its unit is kg.	Its unit is Newton.
Formula of mass is $m = \frac{F}{a}$	Formula of weight is $W = mg$.

The rate of change of momentum is given by

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

$$\frac{P_f - P_i}{t} = m \frac{v_f - v_i}{t} \quad \ldots\ldots\ldots (1)$$

Since $\frac{v_f - v_i}{t} = a$

$$\therefore \frac{P_f - P_i}{t} = ma \quad \ldots\ldots\ldots (2)$$

According to Newton's second law of motion,

$F = ma$ put in Eq. no (2)

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

OR

$F = \frac{\Delta P}{t}$ This equation shows that rate of change of momentum is equal to applied force.

Physics

Unit no. 3

"DYNAMICS"

Introduction:

In this unit we learn about momentum, Newton's law of friction, uniform circular motion.

Q.no.1 Diff b/w dynamics and kinematics

Ans:

Dynamics:

The branch of mechanics that deals with the study of motion of an object and the causes of its motion is called dynamics.

Kinematics:

The branch of mechanics that deals with the study of motion of a body without discussing the cause of its motion is called kinematics.

(Fig. threading) improves road grip and make it safer to drive even on wet road.

(iii) A cyclist applies brakes to stop bicycle. The same as brakes are applied, the wheels stop rolling and begin to slide over the road. Since sliding friction is much greater than rolling friction, therefore, the cycle stops very quickly.

Q:- How does braking and skidding happen?

Ans:- The wheels of a moving vehicle have two velocity components:
Motion of wheels along the road.
Rotation of wheels about their axis.

Braking :-

"The force of friction (gripping force) between the tyres and the road must be enough that prevents them for slipping."

To move a vehicle on the road as well as to stop a moving vehicle requires friction between its tyres and the road. For example, if the road is slippery or the tyres are worn out then the tyres instead of rolling, slip over the road. The vehicle will not move.

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if the wheels start slipping at the same point on the slippery road. Thus for the wheels to roll, the force of friction between the tyres and the road must be enough that prevent them slipping.

Skidding :- "In order to reduce the chance of skidding, it is advisable not to apply brakes too hard that lockup their rolling motion especially at high speeds. Moreover it is unsafe to drive a vhicle with worn out tyres."

To stop a car quickly, large force of friction between the tyres and the road is needed. But there is a limit to this force of friction that tyres can provide. If the brakes are applied too strongly, the wheels of the car will lockup (stop turning) and the car will skid due to its large momentum. It will lose its directional control that may result in an accident.

Body "B" also moves the horizontal surface over with same acceleration "a". As the pulley is frictionless, hence tension T will be the same throughout the string.

Since body A moves downwards, therefore its weight $m_1 g$ is greater than the tension T in the string.

Net force acting on body A

Net force acting on body A:

$F_1 = m_1 g - T$

And from second law: $F_1 = m_1 a$

$m_1 a = m_1 g - T$ ..... (1)

The forces acting on body B:

The forces acting on body B are:

i) Weight $m_2 g$ of the body B acting downward.
ii) Reaction R of the horizontal surface acting on body B in the upwards direction.
iii) Tension T in the string pulling the body B horizontally over the smooth surface.

As body B has no vertical motion, hence resultant of vertical forces ($m_2 g$ and R) must be zero. Thus, the net force acting on body B is T.

$F_2 = T$

The above arrangement is also known as Atwood machine. It is used to find the acceleration due to gravity by using relation given below:

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

Q: What is Atwood machine?

A: **Definition:** "It is a machine which is used to find the acceleration due to gravity"

Construction: Atwood machine is an arrangement of two objects of unequal masses. Both the objects are attached to the ends of a string. The string passes over a frictionless pully.

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

: Find out a relation for acceleration and tension for motion of two bodies attached to the ends of string that passes over a frictionless pully such that one body moves vertically and the other moves on a smooth horizontal surface.

ns: Consider two bodies A and B of masses m_1 and m_2 respectively attached to the ends of inextensible string. Let the body "A" moves downward with an acceleration "a"

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Centrifugal force :-

"A force which pulls the body outward during the circular motion is called centrifugal force."

Explanation :-

Consider a stone tied to a string moving in a circle. The necessary centripetal force acts on the stone through the string that keeps it to move in a circle. According to Newton's third law of motion, there exists a reaction to this centripetal force. Centripetal reaction that pulls the string outward is sometimes called the centrifugal force.

Q:- From which does centrifugal force F come during motion of circular track?

Ans:- When a car takes a turn, centripetal force is needed to keep in its curved track.

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Q:- Write note on the banking of the roads.

Ans:- When a car takes a turn, centripital force is needed to keep it in its curved track. The friction between the tyres and the road provides the necessary centripetal force. The car would skid if the force of friction between the tyres and the road is not sufficient enough particularly when the roads are wet. This problem is solved by banking of curved roads. Banking of a road means that the outer edge of a road is raised. Imagine a wheel on a curved road.

Q:- Explain the working of washing machine dyer.

Ans:- The dyer of a washing machine is a basket spinner. They have a perforated wall having large number of pine holes in the cylindrical rotor.

The lid of the cylindrical container is closed after putting wet clothes in it. When it spins at high speed, the water from wet clothes is forced out through these holes due to lack of centripetal force.

Q:- Write advantages and disadvantages of friction.

Ans:- Disadvantages:-

(i) Friction is undesirable when moving at high speeds because it opposes the motion and thus limits the speed of moving object.

(ii) Most of energy is lost as heat and sound due to the friction between various moving parts of machines.

(iii) In machines, friction also causes wear and tear of their moving parts.

Advantages:-

Friction is needed to walk on the ground.

We cannot write with pencil if there is no friction between pencil and paper.

Athletes use special shoes that have extraordinary ground grip. Such shoes prevent them from slipping while running fast.

Q:- Write down reducing fr

Ans:- The friction

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Q:- Define Write it

Ans:- "The mot circular motion"

Example it at en the oth hand. the str called.

Q:- Explain cream separator.

Ans:- Most modern plants use a separator to control the fat contents of various products. A separator is a high-speed spinner. It acts on the same principle of centrifuge machine.

The bowl spins at very high speed causing the heavier contents of milk to move outward in the bowl, pushing the lighter contents inward toward the spinning axis. Cream or butterfat is lighter than other components in milk. Therefore, skimmed milk, which is denser than cream is collected at the other wall of the bowl. The lighter part (cream) is pushed toward the centre from where it is collected through a pipe.