Scope and Sequence Subject Physics Class 9th

Sr	Week No.	No. of Periods	Topics/Chapter Unit
1	1	08-06-20	Ch.3 Dynamics, force, inertia, momentum
2	1	09-06-20	Newton's law of motion. 1st law of motion, 2nd law of motion, related problems.
3	1	10-06-20	Mass and weight, 3rd law of motion
4	1	11-06-20	Tension in a string, vertical motion of bodies attached to the ends of a string + problems
5	1	12-06-20	Motion of two bodies attached to the ends of a string g that passes over a friction less pulley such that.
			One body moves horizontally and other vertically + problem
6	2	13-06-20	Force and momentum + related problem
7	2	15-06-20	Law of conservation of momentum
8	2	16-06-20	Friction, rolling friction, problem
9	2	17-06-20	Braking and skidding, advantages and disadvantages of friction methods of reducing friction.
10	2	18-06-20	Uniform circular motion, centripetal force centrifugal force + related problem
11	2	19-06-20	Applications of centripetal force.
12	2	20-06-20	Test ch.3

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PHYSICS **CLASS :9TH**

Unit 3 Dynamics

LECTURE NO.1

08 -06- 2020

DYNAMICS:
The branch of **mechanics** that deals with the study of motion of an object and the cause of its motion (**FORCE**) is called dynamics.

FORCE:
A force 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.
For Example

1. We can open a door either by pushing or pulling it.
2. The push on a cart may move the cart or change the direction of its motion or may stop the moving cart.
3. A batsman can change the direction of a moving ball by pushing it with his bat.
4. we can cut an apple with a knife by pushing its sharp edge into the apple. Thus a force can also change the shape or size of a body on which it acts.

INERTIA:
Inertia of a body is its property due to which it resists any change in its state of rest or motion.

Galileo observed that it is easy to move or to stop light objects than heavier ones. Heavier bjects are difficult to move or if moving then difficult to stop.
Newton concluded that everybody resists to the change in its state of rest or of uniform motion in a straight line. He called this property of matter as inertia. He related the inertia of a body with its mass; **greater is the mass of a body greater is its inertia.**
EXPERIMENT 3.1
Take a glass and cover it with a piece of cardboard. Place a coin on the cardboard Now flick the card horizontally with a jerk of your finger. The coin does not move with the cardboard due to inertia.
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 coins does not move with the strip of paper due to inertia.
MOMENTUM
Momentum of a body is the quantity of motion it possesses due to its mass and velocity.
The momentum P of a body is given by the product of its mass m and velocity v.
Thus $$\boldsymbol{P} = m\boldsymbol{v} \quad \ldots\ldots\ldots\ldots\ldots (3.1)$$
Momentum is a vector quantity. Its direction is along the direction of velocity .
Its SI unit is $kgms^{-1}$ or Ns.
For Example
A bullet has a very small inertia due to its small mass. But its impact is so strong when it is fired from the gun due to its high velocity.Thus a fired bullet has a greater momentum than a bullet thrown with a hand.
On the other hand, the impact of a loaded truck on a body coming its way is very large even if the truck is moving slowly. Thus the slow moving truck has large momentum due to its large mass.So **momentum of a body depends upon its mass as well as its velocity.**

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PHYSICS **CLASS :9TH**

Unit 3 Dynamics

LECTURE NO.2

09-06- 2020

NEWTON'S LAWS OF MOTION

Newton was the first to formulate the laws of motion known as Newton's laws of motion.

NEWTON'S FIRST LAW OF MOTION

A body continues its state of rest or of uniform motion in a straight line provided no net force(external force /unbalanced force) acts on it.

Explanation:

First law of motion deals with bodies which are either at rest or moving with uniform speed in a straight line. According to 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. For example, a book lying on a table remains at rest as long as no **net force** (external force/unbalanced force) acts on it. Similarly, a moving object does not stop moving by itself.

A ball rolled on a rough ground stops earlier than that rolled on a smooth ground. It is because rough surfaces offer greater friction. If there would be no force (**friction**)to oppose the motion of a body then the moving body would never stop.

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**. We have observed that the passengers standing in a bus fall forward when its driver applies brakes suddenly. It is because the upper parts of their bodies tend to continue their motion, while lower parts of their bodies in contact with the bus stop with it. Hence, they fall forward.

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.

NET FORCE:

Net force is the resultant of all the forces acting on a body.

NEWTON'S SECOND LAW OF MOTION

Newton's second law of motion deals with situations when a net force is acting on a body.

It states that:

When a net force acts on a body, it produces acceleration in the body in the direction of the net force. The magnitude of this acceleration is directly proportional to the net force acting on the body and inversely proportional to its mass.

Explanation:

If a force produces an acceleration a in a body of mass m, then we can state mathematically that

$$a \propto F$$

and $$a \propto 1/m$$

or $$a \propto F/m$$

or $$F \propto ma$$

Putting k as proportionality constant, we get

$$F=kma \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.2$$

In SI units, the value of k comes out to be 1.

Thus Eq. 3.2 becomes $F=ma$

SI unit of force is newton (N). According to Newton's second law of motion:

One newton (1 N) is the force that produces an acceleration of 1 ms^{-2} in a body of mass of 1 kg.

Thus, a force of one newton can be expressed as

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

(continue to page -3)

Problems on Newton's second Law of motion (lecture-2)

3.1

A force of 20 N moves a body with an acceleration of 2 ms^{-2}. What is its mass? (10 kg)

Solution:

F=20N

a=2 ms^{-2}

m=?

F=ma

m=F/a

m=20N/2 ms^{-2}

m=10kg (Ans)

3.4

Find the acceleration produced by a force of 100 N in a mass of 50 kg. (2 ms^{-2}

Solution:

F=100N

m=50kg

a=?

F=ma

a=F/m

a=100N/50kg

a=2 ms^{-2} (Ans)

3.5

A body has weight 20 N. How much force is required to move it vertically upward with an acceleration of 2 $ms^{□2}$? (24 N)

Solution:

W=20N

a=2 $ms^{□2}$

w=mg

m=w/g

g=10 $ms^{□2}$

m=20/10

m=2kg

Force needed to move the body vertically upward =F=?

F=w+ma

F=20N+2x2 N

F=24N (Ans)

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PHYSICS **CLASS :9TH**

Unit 3 Dynamics

LECTURE NO.3

10 -06- 2020

MASS AND WEIGHT

Generally, mass and weight are considered similar quantities, but it is not correct. They are two different quantities.

Mass:

1. Mass of a body is the quantity of matter possessed by the body.
2. It is a scalar quantity.
3. It does not change with change of place.
4. It is measured by comparison with standard masses using a beam balance.
5. Its SI unit is kg.
6. It is a base quantity.
7. It can be calculated by using formulas F=ma and w=mg

Weight:

1. weight of a body is the force equal to the force with which Earth attracts it.
2. It varies from place to place depending upon the value of ***g,*** acceleration due to gravity.
3. Weight w of a body of mass m is related by the equation.w = mg .... (3.5)
4. Weight is a force and thus it is a vector quantity.
5. Its SI unit is newton (N); the same as force.
6. Weight is measured by a spring balance.
7. It is a derived quantity.

NEWTON'S THIRD LAW OF MOTION

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

Explanation:

According to this law, action is always accompanied by a reaction force and the two forces must always be equal and opposite. Note that action and reaction forces act on different bodies.

1. Consider a book lying on a table . The weight of the book is acting on the table in the downward direction. This is the action of book on the table . The reaction of the table acts on the book in the upward direction.
2. Consider another example. Take an air-filled balloon . When the balloon is set free, the air inside it rushes out and the balloon moves forward. In this example, the action is by the balloon that pushes the air out of it when set free. The reaction of the air which escapes out from the balloon acts on the balloon. It is due to this reaction of the escaping air that moves the balloon forward.
3. A rocket moves on the same principle. When its fuel burns, hot gases escape out from its tail with a very high speed. The reaction of these gases on the rocket causes it to move opposite to the gases rushing out of its tail.

<u>Quick Quiz</u>

Stretch out your palm and hold a book on it.

1. How much force you need to prevent the book from falling?
   We need force equal to the weight of the book to prevent it from falling.
2. Which is action?
   The weight of the book acting downward on the hand is action.

3. Is there any reaction? If yes, then what is its direction?
   Yes, there is a reaction applied by the hand whose direction is upward.

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PHYSICS **CLASS :9TH**

Unit 3 Dynamics

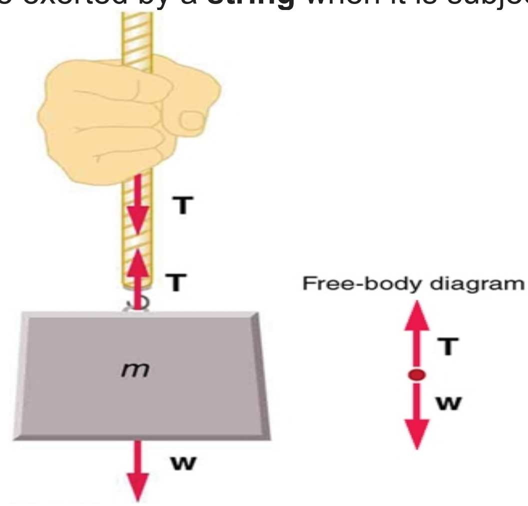
LECTURE NO.4

11 -06- 2020

TENSION AND ACCELERATION IN A STRING

Tension

The **tension** is defined as: "The force exerted by a **string** when it is subjected to pull"



Consider a block supported by a string.

The upper end of the string is fixed on a stand ' Let *w* be the weight of the block. The block pulls the string downwards by its weight. This causes a tension *T* in the string. The tension *T* in the string is acting upwards at the block. As the block is at rest, therefore, the weight of the block acting downwards must be balanced by the upwards tension *T* in the string Thus the tension *T* in the string must be equal and opposite to the weight w of the block.

VERTICAL MOTION OF TWO BODIES ATTACHED TOTHE ENDS OF A STRING THAT PASSES OVER A FRICTIONLESS PULLEY

Consider two bodies A and B of masses *m1* and *m2* respectively. Let *m1* is greater than *m2* . The bodies are 1 attached to the opposite ends of an inextensible string.The string passes over a frictionless pulley as shown in

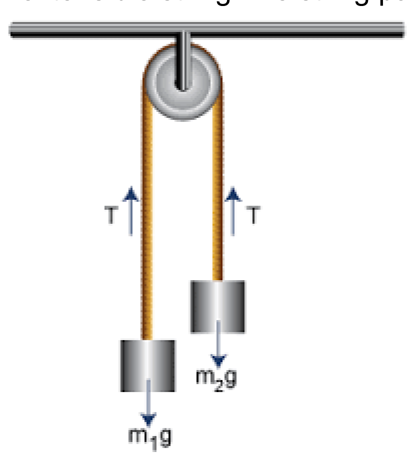


figure . The body *A* being heavier must be moving downwards with some acceleration. Let this acceleration be *a*. At the same time, the body *B* attached to the other end of the string moves up with the same acceleration *a*. As the pulley is frictionless, hence tension will be the same throughout the string. Let the tension in the string be *T*.

Since the body *A* moves downwards, hence its weight *m1g* is greater than the tension *T* in the string.

Net force acting on body *A* = *F1=m1g-T*

According to Newton s second law of motion; F1=m1a

So, m1a=m1g-T…………………………(1)

As body B moves upwards, hence its weight *m2 g* is less than the tension *T* in the string.

Net force acting on body B =F2= *T- m 2g*

According to Newton's second law of motion; F2=m2a

So, m2a=T-m2g…………………………(2)

Adding Eq. (1) and Eq.(2), we get acceleration *a*.

m1a+m2a=m1g-T+T-m2g

a(m1+m2)=g(m1-m2)

a=(m1-m2)g/(m1+m2)…………..(A)

Divide Eq. 2 by Eq. 1, to find tension *T* in the string.

T=2m1m2g/(m1+m2)…………….(B)

The above arrangement is also known as ***Atwood machine.*** It can be used to find the acceleration ***g*** *due* to gravity using Eq. **A**,

g=(m1+m2)a/(m1-m2)

An ***Atwood machine*** is an arrangement of two objects of unequal masses such as shown in figure .Both the objects are attached to the ends of a string. The s t r i n g p a s s e s o v e r a frictionless pulley. This arrangement is sometime used to find the acceleration due to gravity.

problem 3.6:

Two masses 52 kg 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 the masses are moving vertically. (500 N,0.4 ms)

Solution:

m1=52kg

m2=48kg

g =10ms^{-2}

T=?

a=?

T=2m1m2g/(m1+m2)

T=2x52x48/(52+48)

T=4992/100

T=500N

a=(m1-m2)g/(m1+m2)

a=(52-48)x10/(52+48)

a=40/100 **a=0.4 ms^{-2}**

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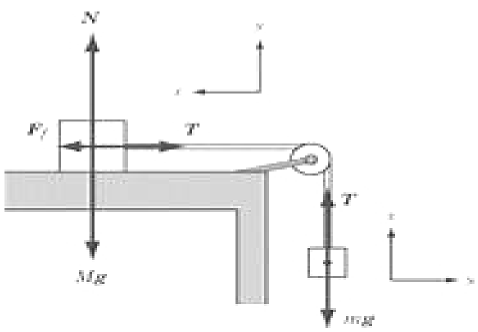
Unit 3 Dynamics

LECTURE NO.5

12 -06- 2020

MOTION OF TWO BODIES ATTACHED TO THE ENDS OF A STRING THAT PASSES OVER A FRICTIONLESS PULLEY SUCH THAT ONE BODY MOVES VERTICALLY AND THE OTHER MOVES ON A SMOOTH HORIZONTAL SURFACE

Consider two bodies *A* and *B* of masses *m1* and *m2* respectively attached to the ends of an inextensible string as shown in figure . Let the body *A* moves downwards with an acceleration **a**. Since the string is inextensible, therefore, body B also moves over the horizontal surface with the 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 *m1g* is greater than the tension *T* in the string.

Net force acting on body *A* = F1=*m1 g*- *T*

According to Newton's second law of motion;

F1=m1a

So m1a=m1g-T………………………(1)

The forces acting on body *B* are:

i. Weight *m2g* 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(*m2 g* and *R*) must be zero.

Thus, the net force acting on body *B* is *F2=T*

According to Newton's second law of motion;

F2=m2a

m2a=T…………………………(2)

Adding Eqs. 3.10 and 3.11, we get acceleration a as

m1a+m2a=m1g-T+T

a(m1+m2)=m1g

a=m1g/(m1+m2)………………..(A)

Putting the value of a in equation (2) to get tension *T* as

T=m1m2g/(m1+m2)……………(B)

Problem:3.8
Two masses 26 kg and 24 kg are attached to the ends of a string which passes over a frictionless pulley. 26 kg is lying over a smooth horizontal table. 24 kg mass is moving vertically downward. Find the tension in the string and the acceleration in the bodies. (125 N, 4.8 ms□2)
Solution:

$m_1 = 24kg$

$m_2 = 26kg$

$g = 10ms^{-2}$

$T = ?$

$a = ?$

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

$T = 24 \times 26 \times 10/(24+26)$

$T = 6240/50$

$T = 125N$

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

$a = (24) \times 10/(24+26)$

$a = 240/50$

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

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PHYSICS **CLASS :9TH**

Unit 3 Dynamics

LECTURE NO.6 13 -06- 2020

FORCE AND THE MOMENTUM

Consider a body of mass m moving with initial velocity *vi* . Let a force *F* acts on the body which produces an acceleration a in it. This changes the velocity of the body. Let its final velocity after time becomes *vf* . If *Pi* and f*P* be the initial momentum and final momentum of the body related to initial and final velocities respectively, then

$$Pi=mvi$$

$$Pf=mvf$$

change of momentum $Pf-Pi=mvf-mvi$

Thus the rate of change in momentum is given by:

$$(Pf-Pi)/t(=mvf-mvi)/t$$

$$=m(vf-vi)/t$$

since $a=(vf-vi)/t$

so $(Pf-Pi)/t=ma$

$$(Pf-Pi)/t=F$$

since the rate of change of velocity equal to the acceleration a produced by the force *F*.

According to Newton's second law of motion, above equation also defines force and states

Newton's second law of motion as

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.

SI unit of momentum is newton-second (Ns) which is the same as kgms□1.

problem 3.8:

How much time is required to change 22 Ns momentum by a force of 20 N? (1.1s)

Solution:

change of momentum Pf-Pi =22Ns

Applied force F =20N

Time Required t =?

Rate of change of momentum =F

$(Pf-Pi)/t=F$

$22/t =20$

$t =22/20$ **t =1.1s**

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PHYSICS **CLASS :9TH**

Unit 3 Dynamics

LECTURE NO.7

15 -06- 2020

LAW OF CONSERVATION OF MOMENTUM:

Momentum of a system depends on its mass and velocity. A system is a group of bodies within certain boundaries. 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, then its momentum remains constant. Thus the momentum of an isolated system is always conserved. This is the Law of Conservation of Momentum. It states that:

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

Consider an isolated system of two spheres of masses *m1* and *m2* as shown in figure.

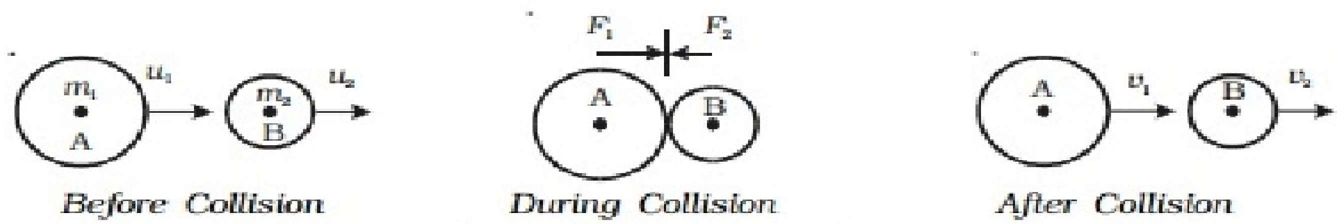

Fig.. Law of conservation of momentum

They are moving in a straight line with initial velocities *u1* and *u2* respectively, such that u1 is greater than u2 . Sphere of mass m1 approaches the sphere of mass m2 as they move.

Initial momentum of mass m1 = m1 u1

Initial momentum of mass m2= m2 u2

Total initial momentum of the system before collision = *m1 u1 +m2u2* ... (1)

After sometime mass $m1$ hits $m2$ with some force. According to Newton's third law of motion, $m2$ exerts an equal and opposite reaction force on $m1$. Let their velocities become $v1$ and $v2$ respectively after collision.

Then Final momentum of mass $m1 = m1\ v1$

Final momentum of mass $m2 = m2\ v2$

Total final momentum of the system after collision = $m1v1 + m2\ v2$... (2)

According to the law of conservation of momentum

Total initial momentum of the system before collision=Total final momentum the system after collision.

$$m1u1+m2u2=m1v1+m2v2.....(3)$$

Equation 3.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.

Consider a system of gun and a 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 the 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

Total initial momentum of the system before the gun is fired =0

Total final momentum of the system after the gun is fired = m v +MV .... (4)

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

$$MV=-mv$$

$$V=-mv/M..................(5)$$

Hence

Equation (5) gives the velocity V of the gun. Negative sign indicates that 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 the bullet.

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.

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PHYSICS **CLASS :9TH**

Unit 3 Dynamics

LECTURE NO.8

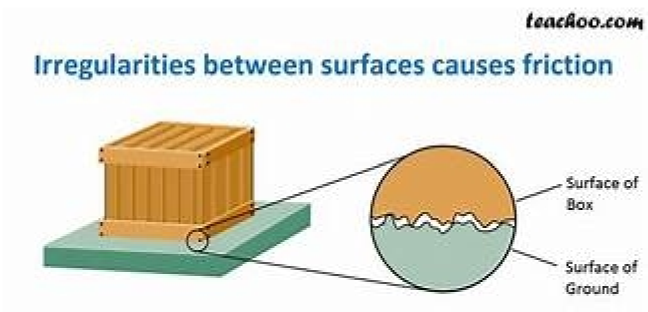
16 -06- 2020

FRICTION :

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

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 such as **nature of the two surfaces** in contact and the **pressing force** between them. Rub your palm over different surfaces such as table, carpet, polished marble surface, brick, etc. You will find smoother is the surface, easier it is to move over the surface. Moreover, harder you press your palm over the surface, more difficult would it be to move.

Cause of Friction: No surface is perfectly smooth. A surface that appears smooth has pits and bumps that can be seen under a microscope. Figure shows 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 from 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.

Friction is equal to the applied force that tends to move a body at rest. It increases with the applied force.

Friction can be increased to certain maximum value. It does not increase beyond this. The maximum value of friction is known as the **force of limiting friction (Fs).** It depends on the normal reaction (pressing force) between the two surfaces in contact. The ratio between the force of limiting friction Fs and the normal reaction *R* is constant. This constant is called the **coefficient of friction** and is represented by μ.

Thus $\mu = Fs/R$

$Fs = \mu R$

If m is the mass of the block, then for horizontal surface; $R = mg$

Hence $Fs = \mu mg$

Friction is needed to walk on the ground. It is risky to run on wet floor with shoes that have smooth soles. Athletes use special shoes that have extraordinary ground grip. Such shoes prevent them from slipping while running fast. To stop our bicycle We will apply brakes. The rubber pads pressed against the rims provide friction. It is the friction that stops the bicycle.

problem:3.9

How much is the force of friction between a wooden block of mass 5 kg and the horizontalmarblefloor? The coefficient of friction between wood and the marble is 0.6. (30 N).

Solution:

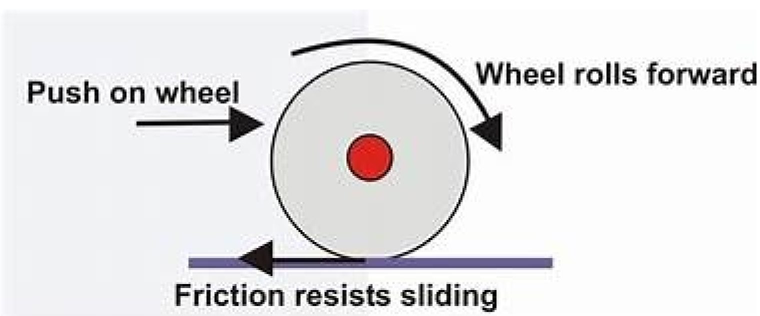
m=5kg
$\mu = 0.6$
g=10ms^{-2}
Fs= μmg
Fs=0.6x5x10N
Fs=30N

Rolling friction:

Rolling friction is the force of friction between a rolling body and a surface over which it rolls. Rolling friction is lesser than the sliding friction.

Wheel is one of the most important inventions in the history of mankind. The first thing about a wheel is that

it rolls as it moves rather than to slide. This greatly reduces friction. 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 contact points of the wheel in a direction opposite to the applied force. The wheel rolls without rupturing the cold welds. That is why the rolling friction is extremely small than sliding friction. The fact that **rolling friction is less than sliding friction** is applied in ball bearings or roller bearings to reduce losses due to friction. The wheel would not roll on pushing it if there would be no friction between the wheel and the ground. Thus, friction 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 the tyres is very small. This increases the chance of slipping the tyres from the road. The threading on tyres is designed to increase friction. Thus, threading improves road grip and make it safer to drive even on wet road. A cyclist applies brakes to stop his/her bicycle. As soon as brakes are applied, the wheels stop rolling and begin to slide over the road. Since sliding friction much greater than rolling friction. Therefore, the cycle stops very quickly.



[1]BALL BEARING

[2]THREADED TYRES

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PHYSICS CLASS :9TH

Unit 3 Dynamics

LECTURE NO.9

17 -06- 2020

BRAKING AND SKIDDING:

The wheels of a moving vehicle have two velocity components:

(i) motion of wheels along the road. (ii) rotation of wheels about their axis.

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 if the wheels start slipping at the same point on the slippery road. Thus for the wheels to roll, the force of friction (gripping force) between the tyres and the road must be enough that prevents them from slipping. Similarly, to stop a car quickly, a 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 lock up (stop turning) and the car will skid due to its large momentum. It will lose its directional control that may result in an accident. In order to reduce the chance of skidding, it is advisable not to apply brakes too hard that lock up their rolling motion especially at high speeds. Moreover, it is unsafe to drive a vehicle with worn out tyres.

ADVANTAGES AND DISADVANTAGES OF FRICTION:

ADVANTAGES:

1. We cannot write if there would be no friction between paper and the pencil.
2. Friction enables us to walk on the ground.
3. We cannot run on a slippery ground. A slippery ground offers very little friction. Hence, anybody who tries to run on a slippery ground may meet an accident.
4. It is dangerous to apply brakes with full force to stop a fast moving vehicle on a slippery road
5. . Birds could not fly, if there is no air resistance. The reaction of pushed air enables the birds to fly.
6. Friction is required to erase a pencil work.
7. friction is needed to stop a moving vehicle.
8. friction is highly desirable when climbing up a hill.

DISADVANTAGES:

1. Friction is undesirable when moving at high speeds because it opposes the motion and thus limits the speed of moving objects.
2. Most of our useful energy is lost as heat and sound due to the friction between various moving parts of machines.
3. In machines, friction also causes wear and tear of their moving parts..

METHODS OF REDUCING FRICTION: The friction can be reduced by:

(i) making the sliding surfaces smooth.

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

(iii) Lubricating the sliding surfaces.

(iv) Using ball bearings or roller bearings .Because the rolling friction is lesser than the sliding friction.

SARDAR KAUREY KHAN PUBLIC HIGHER SECONDARY SCHOOL MUZAFFARGARH

PHYSICS **CLASS :9TH**

Unit 3 Dynamics

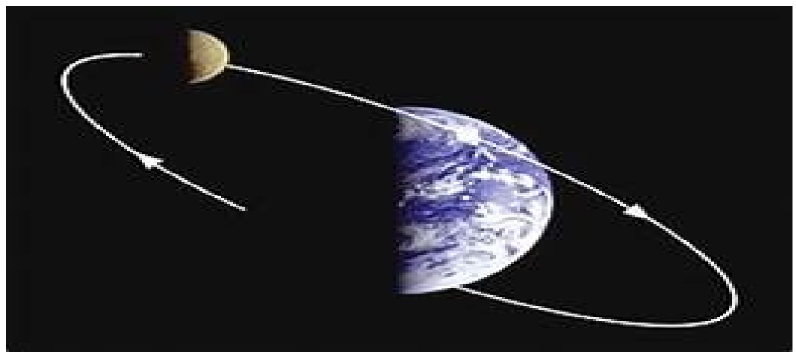
LECTURE NO.10

18 -06- 2020

<u>UNIFORM CIRCULAR MOTION:</u>

The motion of an object in a circular path with uniform speed is known as circular motion.

We come across many things in our daily life that are moving along circular path. Take a small stone. Tie it at one end of a string and keep the other end of the string in your hand as shown in figure.

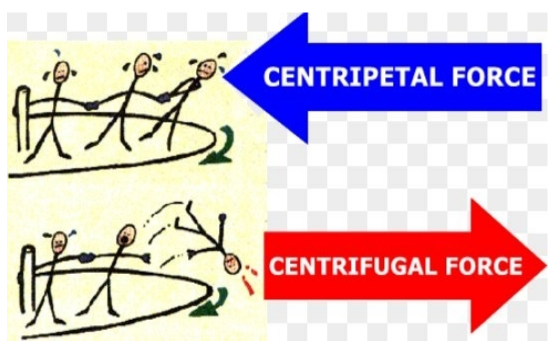


Now rotate the stone holding the string. The stone will move in a circular path. The motion of stone will be called as circular motion. Similarly, motion of the moon around the Earth is circular motion.

<u>CENTRIPETAL FORCE :</u>

Centripetal force is a force that keeps a body to move in a circle.

Consider a body tied at the end of a string moving with uniform speed in a circular path. A body has the tendency to move in a straight line due to inertia. The string to which the body is tied keeps it to move in a circle by pulling the body towards the centre of the circle. The string pulls the body perpendicular to its motion as shown in figure .



This pulling force continuously changes the direction of motion and remains towards the centre of the circle. This centre seeking force is called the centripetal force. It keeps the body to move in a circle. Centripetal force always acts perpendicular to the motion of the body.

Let us study the centripetal forces in the following examples:

(i) Figure (1) shows 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 to remain in the circle. If the string is not strong enough to Provide the necessary tension, it breaks and the stone moves away along a tangent to the circle .

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

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

centripetal acceleration $a_c=mv^2/r$

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

$$F_c=ma_c$$

$$F_c= mv^2/r$$

Equation 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 radius *r* of the circle.

CENTRIFUGAL FORCE:

According to Newton's third law of motion, there exists a reaction to the centripetal force. Centripetal reaction that pulls the bodies moving along a circular path outward is sometimes called the centrifugal force.

Consider a stone shown in above figure 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 that pulls the string outward is sometimes called the centrifugal force.

Problem3.10

How much centripetal force is needed to make a body of mass 0.5 kg to move in a circle of radius 50 cm with a speed 3 ms□1?

Solution:

m=0.5kg

v=3ms-1

r=50cm=0.5m

F_c= ?

$F_c= mv^2/r$

$F_c= 0.5x(3)^2/0.5$ **F_c= 9N**

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PHYSICS **CLASS :9TH**

Unit 3 Dynamics

LECTURE NO.11

19 -06- 2020

APPLICATIONS OF CENTRIPITAL FORCE:

1.BANKING OF THE ROADS

When a car takes a turn, centripetal 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 vehicle on a curved road. Banking causes a component of vehicle's weight to provide the necessary centripetal force while taking a turn. Thus banking of roads prevents skidding of vehicle and thus makes the driving safe.

2.WASHING MACHINE DRYER

The dryer of a washing machine is basket spinners. They have a perforated wall having large numbers of fine 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.

3.CREAM SEPARATOR

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 machines. The bowl spins at very high speed causing the heavier contents of milk to move outward in the bowl pushing the lighter contents inward

towards 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 outer wall of the bowl. The lighter part (cream) is pushed towards the centre from where it is collected through a pipe