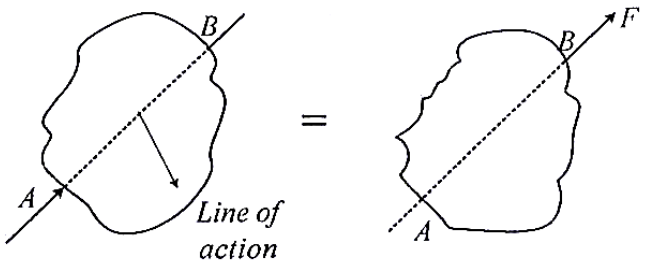
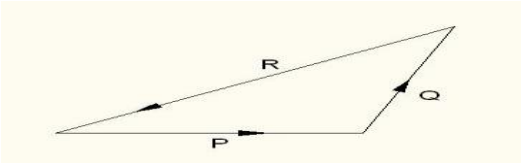
GE 8292 – ENGINEERING MECHANICS
TWO MARKS QUESTIONS WITH ANSWERS
Unit – I - STATICS OF PARTICLES

1. **State the polygon law of forces. (Nov/Dec 2017) (Nov/Dec 2015)**
   It states that "If a number of forces acting simultaneously on a particle be represented in magnitude and direction, by the sides of a polygon taken in order, then the resultant of all these forces may be represented in magnitude and direction, by the closing side of the polygon, taken in opposite order".

2. **State the principle of transmissibility. (Nov/Dec 2017) (April/May 2017) (Nov/Dec 2018)**
   It state that "any force at a point on a rigid body can be transmitted to act at any other point along its line of action without changing its effect on the rigid body"

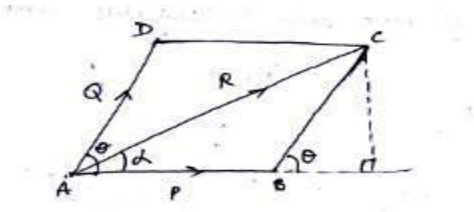


3. **State triangle law of forces. (Nov/Dec 2016)**
   It states that "If two forces acting simultaneously on a particle represented in magnitude and direction by the two sides triangle, taken in order, their resultant may be represented magnitude and direction by the third side of the triangle, taken opposite order".



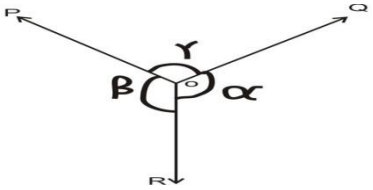
4. **Define scalar and vector quantities? (AUJUN'10,DEC'10,DEC'12)**
   Scalar: Quantities which have only magnitude and no direction. Eg. Mass, distance
   Vector: Quantities which have both direction and magnitude. Eg. Velocity, displacement.

5. **Define parallelogram law of forces. What is the use of this law? (JUN'12,DEC'11)**
   If two forces acting at a point be represented in magnitude and direction by the two sides of a parallelogram. Then the diagonal represents the resultant of the forces both in magnitude and direction. $R = \sqrt{(P^2 + Q^2 + 2PQcos\theta)}$



6. **State Lame's theorem. (May/June 2016) (Nov/Dec 2014)**

It states that, "If three forces acting at a point are in equilibrium then, each force will be proportional to the sine of the angle between the other two forces".



$$\frac{P}{Sin\alpha} = \frac{Q}{Sin\beta} = \frac{R}{Sin\gamma}$$

7. **State Newton's laws of motion.**

Newton's first law: Everybody preserves in its state of rest, or of uniform motion in a straight line, unless it is compelled to change that state by forces impressed there on.

Newton's second law : The acceleration of a particle will be proportional to the force and will be in the direction of the force (ie. F = ma)

Newton's third law: To every action there is an equal and opposite reaction.

8. **Define resultant force. (Nov/Dec 2016)**

Resultant force is a single equivalent force which can replace the given force system for an equivalence of effect.

9. **What are the three equations of equilibrium? (May/June 2016) (Nov/Dec 2015)**

Algebraic sum of horizontal and vertical forces is zero, algebraic sum of moments is zero.

$$\sum H = 0, \sum V = 0, \sum M = 0$$

10. **What is stable equilibrium?**

A body is said to be in stable equilibrium, if it returns back to its original position after it is slightly displaced from its position of rest.

11. **Distinguish between particle and Rigid body.**

A body of negligible dimension is called a particle. A large number of particles which occupy fixed positions with respect to each other both before and after applying a load is called Rigid body.

12. **Define equilibrium.**

A body is said to be in a state of equilibrium, if the body is either at rest or is moving at a constant velocity.

13. What is free body diagram? (May/June 2016)

Free-body diagrams are diagrams used to show the relative magnitude and direction of all forces acting upon an object in a given situation. The direction of the arrow shows the direction that the force is acting.

14. Define Coplanar and Non coplanar forces.

Coplanar: In coplanar force system, lines of action of all forces lie on a single plane.

Non coplanar forces: Forces have their line of action on different planes.

15. Define collinear and concurrent forces. (AU MAY'11)

Collinear forces: Forces which have the same line of action.

Concurrent forces: Forces whose line of action intersect at a common point.

16. Find the resultant and direction of Force $\bar{F}$ = 3i-4j. (April/May 2017)

$F = \sqrt{F_x^2 + F_y^2}$

$= \sqrt{3^2+4^2} = 5$ Units

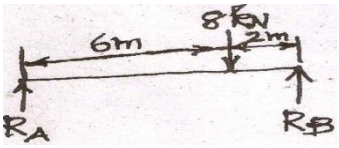
17. Find the resultant of Concurrent forces $\bar{F}_1$ = 2i+3j-2.5k, $\bar{F}_2$ = -i+5j-3k & $\bar{F}_3$ = 7i-7j+6k.

$\bar{F} = \bar{F}_1+\bar{F}_2+\bar{F}_3$

= 2i+3j-2.5k-i+5j-3k+7i-7j+6k.

$\bar{F}$ = 8i+j+0.5k

18. Find R_A and R_B of the beam shown in figure. (Dec/Jan 2016)



R_A x 8 = 8 x 2

R_A = 2 kN

$R_A + R_B$ = 8 kN

R_B = 6 kN

19. Distinguish particle and rigid body. (Nov/Dec 2018)

A body of negligible dimension is called a particle. A large number of particles which occupy fixed positions with respect to each other both before and after applying a load is called Rigid body

20. What is stable equilibrium and unstable equilibrium?

A body is said to be in stable equilibrium, if it returns back to its original position after it

is slightly displaced from its position of rest.

A body is said to be in unstable equilibrium, if it does not return back to its original position and heels farther away after slightly displaced from its position of rest.

Unit – II - EQUILIBRIUM OF RIGID BODIES

1. **State Varignon's theorem? (Nov/Dec 2017) (May/June 2016) (Nov/Dec 2014)**

   Varignon's theorem states that "if a number of coplanar forces are acting simultaneously on a body, the algebraic sum of the moments of all the forces about any point is equal to the moment of the resultant force about the same point".

2. **What is the difference between a moment and a couple? (April/May 2017)**

   The couple is a pure turning effect which may be moved anywhere in its own plane, or into a parallel plane without change of its effect on the body, but the moment of a force must include a description of the reference axis about which the moment is taken.

3. **Distinguish between the Resultant and Equilibrants. (Dec/Jan 2017)**

No.	Resultant	Equilibrant
1.	Definition: A resultant of number of forces acting on a body is a single. Force which can produce the same effect on the body as it is produced by all the forces acting together.	Definition: An equilibrant of number of forces acting on a body is a single force which cancels the effect of resultant of a system of forces or which brings the system and the body is equilibrium.
2.	Resultant (net) force causes the displacement of a body (i.e. body moves).	Equilibrant keeps the body at rest (i.e. in equilibrium).
3.	The set of forces which causes the displacement of a body are called as component of resultant or component forces.	The set of forces which keeps the body at restate known as equilibrium forces or components of equilibrant.

4. **Define moment of a force.**

   The moment of a force about a point is defined as the turning effect of the force about that point.

   Moment = Force X Perpendicular distance

5. **What are the characteristics of a couple?**

a. The algebraic sum of the forces is zero.
b. The algebraic sum of the moments of the forces about any point is the same and equal to the moment of the couple itself.

6. What are the common types of supports in beams? (Nov/Dec 2015) (April/May 2015) (April/May 2014)

1. Roller support
2. Hinged support 3. Fixed support

7. Define Couple. (Nov/Dec 2014)

A couple is that two forces are of equal magnitude opposite sensed parallel forces, which lie in the same plane.

8. What are the necessary and sufficient conditions for the equilibrium of a rigid body in three dimensions? (Nov/Dec 2018)

$\sum F_X = 0$ $\sum M_X = 0$

$\sum F_Y = 0$ $\sum M_Y = 0$

$\sum F_Z = 0$ $\sum M_Z = 0$

9. What are the common types of loads? (May/June 2016)

1. Point load 2. Uniformly distributed load 3.Uniformly varying load

10. Differentiate between force and moment. (May/June 2016)

Force	Momentum
The direction depends on acceleration	The direction depends upon the direction of velocity
The increase in time decreases the amount of force provided the momentum is constant	The increase in time results in increase in momentum
A force exists for a stationary object	The momentum is zero for a stationary object
Force can be result of actually touching between objects and without physical contact also	Momentum is the result of any unbalanced force acting on a body
Force= mass x acceleration	Momentum= mass x velocity

11. List the different types of beams.

Different types of beams can be classified based on the kind of support.

The four different types of beams are:

1. Simply Supported Beam
2. Fixed Beam

3. Cantilever Beam
4. Continuously Supported Beam

12. Differentiate between simply supported beam and cantilever and fixed beam.

1. Simply Supported Beam - If the ends of a beam are made to rest freely on supports beam, it is called a simple (freely) supported beam.
2. Fixed Beam - If a beam is fixed at both ends it is free called fixed beam. Its another name is a built-in beam.
3. Cantilever Beam - If a beam is fixed at one end while the other end is free, it is called cantilever beam.
4. Continuously Supported Beam - If more than two supports are provided to the beam, it is called continuously supported beam.

13. Define two force principle, three force principle and four force principle of equilibrium.

Two force principle: States that if two forces are in equilibrium they must be equal, opposite and collinear.

Three force principle: States that if three forces are in equilibrium then resultant of any two forces must be equal, opposite and collinear with the third force. Also if three forces are in equilibrium they are always concurrent.

Four force principle: States that if four forces are in equilibrium then resultant of any two forces is equal, opposite and collinear with the resultant of other two forces.

14. Define force couple system.

In mechanics, a **couple** refers to two parallel forces that are equal in magnitude, opposite in sense and do not share a line of action. A better term is **force couple** or **pure moment**. Its effect is to create rotation without translation, or more generally without any acceleration of the centre of mass.

15. Find the unit vector along the force $\vec{F}$ = 2i + 3j + 5k

Unit vector λ = 2i + 3j + 5k / $\sqrt{2^2 + 3^2 + 5^2}$

= 0.324i+0.489j+0.811k

16. What is statically determinate structure?

A structure which can be completely analyzed by static conditions of equilibrium ($\sum H = 0$; $\sum V = 0$ and $\sum M = 0$) alone is statically' determinate structure.

17. Define equilibrant.

The force which brings the system of forces into equilibrium is called equilibrant. It is equal to the resultant force in magnitude collinear but opposite in nature.

18. When is moment of a force zero about a line? (Nov/Dec 2018)

A force produces zero moment about an axis or reference point which intersects the line of action of the force**.**

19. Write the equations of equilibrium of a rigid body in two dimensions. (Nov/Dec 2018)

$\sum F_X = 0$
$\sum F_Y = 0$
$\sum M_Z = 0$

20. What is the difference between a fixed vector and a free vector?

A force which is applied at a particular location on a body is a fixed vector.

Example: A moment.

A force which can be moved anywhere in its own plane or in a parallel plane without change in its effect on the body is called free vector.

Example: A couple.

UNIT - III - PROPERTIES OF SURFACES AND SOLIDS

1. State Pappus and Guldinus theorems. (Nov/Dec 2017) (May/June 2016) (Nov/Dec 2018)

Theorem I: The area of the surface generated by revolving a plane curve about a non intersecting axis in the plane of the curve is equal to the product of length of the curve and the distance travelled by the centroid G of the curve during revolution**.**

Theorem II: The volume of the solid generated by revolving a plane area about a non intersecting axis in its plane is equal to the product of area and length of the path travelled by centroid G of the area during revolution**.**

2. State parallel axis theorem. (April/May 2018) (April/May 2017) (May/June 2016) (Nov/Dec 2015)

Parallel axis theorem states that " if the moment of inertia of a plane area about an axis through its centroid be denoted by IG, the moment of inertia of the area about an axis AB, parallel to the first and at a distance 'h' from the centroid is given by ,

$$I_{AB}=I_G+Ah^2$$

3. State perpendicular axis theorem. (Dec/Jan 2016) (April/May 2015)

It states that "if IXX and IYY be the moment of inertia of a plane section about two perpendicular axis meeting at 'O' the moment of inertia IZZ about the axis Z-Z perpendicular to the plane and passing through the intersection of X-X and Y-Y is given by the relation,

$$I_{ZZ} = I_{XX} + I_{YY}$$

4. Differentiate between area moment of inertia and mass moment of inertia. (Dec/Jan 2016)

Area moment of inertia about any axis is the product of area and square of the distance of its centroid from that axis. Mass moment of inertia about any axis is the product of mass and square of the distance of its centroid from that axis.

5. Define Radius of gyration. (Dec/Jan 2016)

Radius of gyration of any Lamina defined as the distance from the elemental parts of the lamina would about a given axis may be given axis at which all they have to be placed, so as not to alter the moment of inertia about the given axis.

Radius of gyration, $\mathbf{k} = \sqrt{I/A}$

Where, I = Moment of inertia A = Total area of the plane

6. Differentiate centroid and Centre of gravity. (April/May 2017) (May/June 2014) (Nov/Dec 2018)

Centroid is the geometric property of geometrical figures line, area and volume. Centre of gravity is the physical property of a body like wire, rod, disc and solids.

7. When will the product of inertia of an area become zero? (May/June 2016)

The product of inertia of lamina becomes zero when either one of the two axes or both the axes are axis of symmetry.

8. What do you understand by first moment of inertia? (May/June 2016) (April/May 2014)

The first moment of an area quantifies the distribution of an area about an axis. It is calculated as the summation of the product of each area and its distance from the axis.

9. Define principal axes and principal moment of inertia. (Nov/Dec 2014)

The maximum and minimum moment of inertia of a plane lamina are knows as Principal moment of inertia. The axes about which the moment of inertia is either maximum or minimum are knows as principal axes.

10. Define Polar moment of inertia. (May/June 2014) (Nov/Dec 2013)

The second moment of area about a pole '0' is called the polar moment of inertia (Ip).

Ip= Ixx+ Iyy

11. State the methods of determining the centre of gravity?

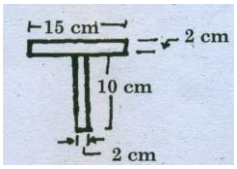
i. By Geometrical considerations
ii. Graphical method
iii. Integration method
iv. Method of moments

12. A right angle triangle of base 3m and height 4m is resolved about its 4m vertical edge. Compute the volume of the solid generated. (Dec/Jan 2016)

Volume = $1/3\ \pi\ r^2h$

$= 1/3 \times \pi \times 3^2 \times 4 = 37.69\ m^2$

13. For the 'T' section shown in figure. Find the centriod. (Nov/Dec 2015)



$\bar{x} = b/2 = 15/2 = 7.5$ cm

Since the section is symmetrical about y axis

$\bar{y} = (a_1y_1+a_2y_2) / (a_1+a_2)$

$= [(2x10x10/2) + (2x15x \{10+2/2\})] / [(2x10) + (2x15)] = 8.6$ cm

14. Define Centre of Gravity and Centre of mass.

Centre of Gravity is an imaginary point at which the entire weight of the body is assumed to act.

Centre of mass is the point where the entire mass of a body is assumed to be concentrated.

15. Differentiate centroid and Centre of gravity.

Centroid is the geometric property of geometrical figures line, area and volume. Centre of gravity is the physical property of a body like wire, rod, disc and solids.

16. What is Axis of revolution?

The fixed axis about which a plane curve (may be of an arc, straight line etc.,) or a plane area is rotated is known as axis of revolution.

17. Define Axis of Symmetry.

The axis about which similar configuration exist with respect to shape, size and weight on either side is known as axis of symmetry. It may be horizontal, vertical or inclined.

18. When centroid and centre of mass coincide?

Centroid and centre of mass coincide when the density of the material is uniform throughout the body.

19. Define Centre of mass.

Centre of mass is the point where the entire mass of a body is assumed to be concentrated.

20. What is Axis of revolution?

The fixed axis about which a plane curve (may be of an arc, straight line etc.,) or a plane area is rotated is known as axis of revolution.

UNIT – IV - DYNAMICS OF PARTICLES

1. **Write the equations of plane motion?**

   $v = u+at$

   $s = ut+1/2at^2$

   $v^2 = u^2+2gh$

   Where,

   v = Final velocity; u =Initial velocity; a = acceleration

   t = time taken for displacement; h (or) s = distance travelled.

2. **Define projectile.**

   A particle, moving under the combined effect of vertical and horizontal forces is called a projectile.

3. **Define Angle of projection.**

   The angle with the horizontal, at which a projectile is projected is known as the angle of projection.

4. **Define Instantaneous velocity. (Nov/Dec 2017)**

   Instantaneous velocity is defined as the rate of change of position for a time interval which is very small (almost zero). It is the limit of average velocity as the increment of time approaches zero. It can be either positive or negative.

5. **State the principle of work and energy. (April/May 2017) (Nov/Dec 2014)**

   It states that "when a particle moves from position, S1 to S2 under the action of a force F, the change in kinetic energy of the particle is equal to the force F".

6. **Define Impulse of a force. (Nov/Dec 2016)**

   When a large force acts over a short period of time, that force is called an impulsive force.

7. **What is dynamic equilibrium? (Dec/Jan 2016)**

   At dynamic equilibrium, the reaction rate of the forward reaction is equal to the reaction rate of the backward reaction.

8. **State D' Alembert's principle. (Dec/Jan 2016) (May/June 2016)**

   It states that "The system of forces acting on a body in motion is in dynamic equilibrium, with the inertia force of the body".

9. **Write the expression for relative velocity in plane motion. (May/June 2016)**

   Relative velocity = velocity of the body A – velocity of the body B

   The equation is:

$$v_{AB} = v_A - v_B$$

Where, v_{AB}: relative velocity of the body A respect body B

v_A: velocity of the body A

v_B: velocity of the body B

10. Define the term co-efficient of restitution. (May/June 2016) (Dec/Jan 2016)

The coefficient of restitution (COR) is the ratio of the final to initial relative velocity between two objects after they collide. It normally ranges from 0 to 1 where 1 would be a perfectly elastic collision.

$$\textbf{Coefficient of restitution (e)} = \frac{\textbf{Relative velocity after collision}}{\textbf{Relative velocity before collision}}$$

11. Define Angle of projection.

The angle with the horizontal, at which a projectile is projected, is known as the angle of projection.

12. What are the conditions under which the motion of a projectile is parabolic? (May/June 2015)

Projectile motion is parabolic because the vertical position of the object is influenced only by a constant acceleration, (if constant drag etc. is also assumed) and also because horizontal velocity is generally constant.

13. Distinguish between perfectly plastic impact and perfectly elastic body impact. (April/May 2015)

Descriptions	Plastic	Elastic
Definition	The property on account of which a body does not regain its original size and shape on removal of applied force is called as plastic body.	The property on account of which a body regains its original size and shape on removal of external deforming force is called as elastic body.
Process	It is irreversible.	It is reversible.
Ductility	They are highly ductile in nature.	It is less ductile in nature.
Shape and size	The shape and size changes permanently.	The shape and size does change permanently,

Example	Plastics	Rubber.

14. Define Newton's (Second law) of motion. (Nov/Dec 2014)

Newton's second law states that the acceleration of an object is directly proportional to the **net force** acting on it, and inversely proportional to its mass.

In algebraic form we write Newton's second law as **F** = m**a**.

15. Distinguish between uniform motion and uniformly accelerated motion. (Nov/Dec 2014)

Uniform motion: Where a body travels equal distance in equal interval of time or we can say motion where speed will be constant.

Uniform accelerated motion: Where a body travels with constant acceleration which means a body would have same change in velocity, so certainly it will not travel same distance.

16. The displacement of a particle is given by $S = 3t^2+2t$ meters. Where't' is in seconds? Find the velocity and acceleration when t = 10 seconds.

$S = 3t^2+2t$

$v = dS/dt$

$= 6t + 2 = (6x10) + 2 = 62$ m/s

$a = dv/dt = 6$ m/s^2

17. A body is moving with a velocity of 5 m/s. After 3 seconds the velocity is 8 m/s. Find the acceleration. (Nov/Dec 2015)

Acceleration, $a = dv/dt$

$= (v-u)/t$

$= (8-5)/3 = 3/3 = 1$ m/s^2

18. Equation of motion of a body is $s = 5t^3 + 4t^2 + 3t + 2$. Find velocity and acceleration. (Nov/Dec 2017)

$v = dS/dt$

$= 15t^2+8t+3$

$a = dv/dt$

$= 30t+8$

19. Define instant centre of rotation. (Nov/Dec 2018)

The **instant centre of rotation**, also called instantaneous velocity center or also instantaneous centre or instant centre, is the point fixed to a body undergoing planar movement that has zero velocity at a particular instant of time.

20. Define co-efficient of restitution. (Nov/Dec 2018)

The ratio of the magnitude of the impulses during the restitution period and deformation period is known co-efficient of restitution.

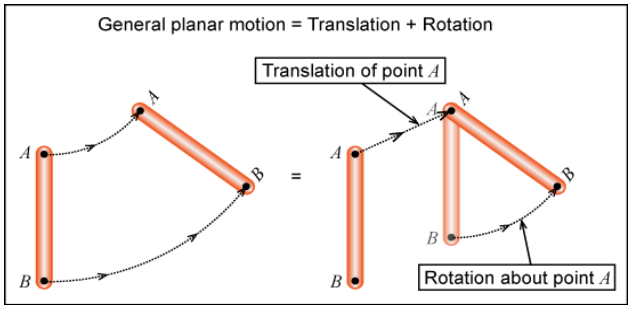
UNIT – V - FRICTION AND RIGID BODY DYNAMICS

1. **Define rolling resistance. (Nov/Dec 2017) (Nov/Dec 2014)**
   The rolling resistance of a wheel or ball is its resistance to movement caused by friction between it and the surface it is rolling on.

2. **Define coefficient of friction. (Nov/Dec 2017)**
   It's defined as the ratio of frictional force acting on between two surfaces to the normal reaction between two surfaces and also defined as the level of roughness or smoothness of a surface. Higher the coefficient of friction higher the roughness. The coefficient of friction value 0 indicates fully smooth surface.

3. **Define Solid Friction or Dry Friction. (April/May 2017)**
   If between two surfaces, no lubrication (oil or grease) used, the friction that exists between two surfaces is called solid friction (or) dry friction.

4. **What is general plan motion? Give on example. (April/May 2017) (May/June 2014)**
   General planar motion allows for simultaneous rotational and translational motion in a 2-D plane. The motion of the rigid body may be described as a simple superposition of the body's translation and rotation as illustrated in the following figure.



5. **What is impulsive force?**
   The force that two colliding bodies exert on one another acts only for a short time, giving a brief but strong push. This force is called an **impulsive force.**
   It is defined as the rate of change of momentum.
   Impulse =mv-mu (momentum change)
   Impulsive force=Impulse/time

6. **Define cone of friction. (Dec/Jan 2016) (Nov/Dec 2015)**

It is defined as the right circular cone with vertex at the point of contact of the two bodies (or surface) axis in the direction of normal reaction (R) and semi vertical angle equal to angle of friction.

7. State Coulomb's law of friction. (Dec/Jan 2016)

The law states that for two dry solid surfaces sliding against one another, the magnitude of the kinetic friction exerted through the surface is independent of the magnitude of the velocity (i.e., the speed) of the slipping of the surfaces against each other.

8. Define Angle of repose. (May/June 2016) (May/June 2015 - 3)

Angle of repose is the angle to which an inclined plane may be raised before an object resting on it will move under the action of the force of gravity.

9. Define instantaneous centre of rotation. (Nov/Dec 2015) (Nov/Dec 2014)

The **instant center of rotation**, also called instantaneous velocity center, or also instantaneous center or instant center, is the point fixed to a body undergoing planar movement that has zero velocity at a particular instant of time.

10. Define Limiting Friction. (Nov/Dec 2014)

Limiting friction 'F' is the maximum value of static friction that occurs when motion is impending.

11. Define Angle of Friction. (May/June 2014)

Angle of friction is the angle between the line of action of the total reaction of one body on another and the normal to the common tangent between the' bodies when motion is impending.

12. Define Co-efficient of static friction and coefficient of Dynamic friction. (April/May 2014)

Coefficient of static friction is the ratio of the Static friction to the normal reaction.

Coefficient of Dynamic friction is the ratio of the Dynamic friction to the normal reaction

13. What is the sliding friction and Rolling Friction?

Sliding friction: It is the friction, experienced by a body when it slides over another body.

Rolling Friction: It is the friction, experienced by a body when it rolls over the other.

14. State the Laws of static friction.

a. The force of friction always acts in a direction opposite to that in which the body tends to move.
b. The Magnitude of the force of friction is equal to the force, which tends to move the body.

c. Limiting friction bears a constant ratio to the normal reaction between the two surfaces
d. The force of friction is independent of the area of contact between the two surfaces
e. The force of friction depends upon the roughness of the surfaces.

15. What is meant by the term 'translation'?

The type of motion of a body is said to be translation if the linear displacement of every point in the rigid body is the same.

16. What is impending motion?

The motion is said to be impending if the applied forces are such that the body is just about to slide.

17. A small ball is drooped from a height of 19.62 m, what velocity the ball will strike the ground. (Nov/Dec 2015)

$v^2 = u^2 + 2gh$

$v^2 = 0 + (2 \times 9.81 \times 19.62)$

$= 19.62$ m/s

18. A motor bike wheel of radius 80 cm is moving along a straight road with a speed of 60 km/hr. Find the angular speed of the wheel.

$v = 60$ km/hr $= (60 \times 10^3) / 3600 = 16.67$ m/s^2

$\omega = v/r = 16.67 / 0.8$

$= 20.83$ rad/s.

19. When a screw is said to be self locking?

If the friction angle is larger than the lead angle of screw, the load will remain in plane even after the removal of effort. This Condition is said to be self locking.

20. State the Laws of Dynamic friction.

a)The force of friction always acts in a direction, opposite to that in which the body is moving.

b)The magnitude of the kinetic friction bears a constant ratio to the normal reaction between the two surfaces.