VIVA EXAM SAMPLE QUESTIONS

(EXPERIMENT WISE WITH POINTS TO REMEMBER)

EXPERIMENT 1

Coplanar Concurrent Force System

Resultant of a force system is the force or couple that will have the same effect to the body, both in translation and rotation if all the forces are removed and replaced by the resultant

Important Formulas

$$R_x = \Sigma F_x$$
$$R_y = \Sigma F_y$$
$$R = \sqrt{{R_x}^2 + {R_y}^2}$$
$$\tan\theta_x = \frac{R_y}{R_x}$$

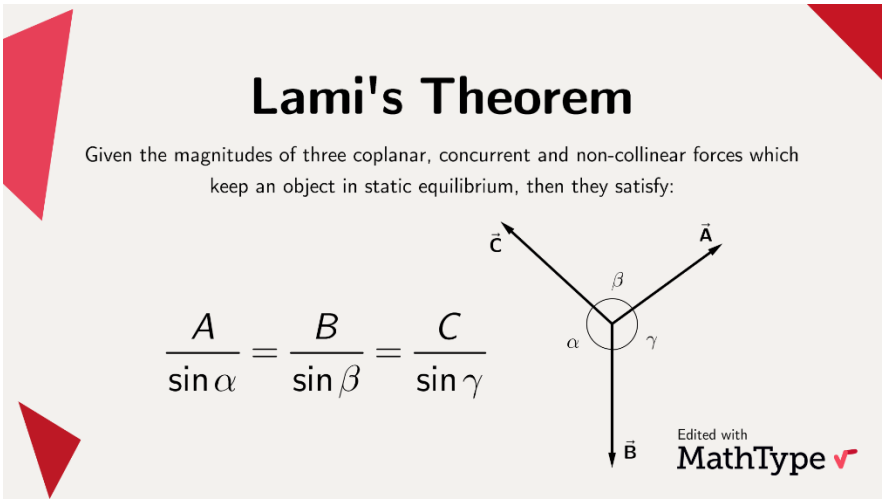
Questions and Answers

1. **Verification of polygon law of co planar forces**

   Ans. If any number of coplanar and concurrent forces are represented by the sides of a polygon in order, then the resultant of these forces is represented by the closing side of the polygon

2. **What is Lami's theorem? State its applications**

   Ans. Lami's theorem states that:



3. Define Equilibrium

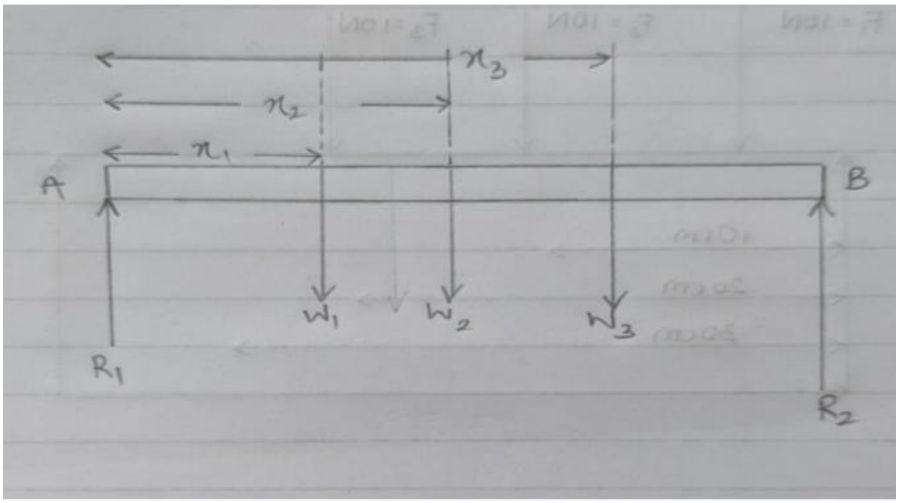
Ans. A state of a physical system *at rest* or in *unaccelerated motion*, and where the sum of all forces and torque acting on each particle of the system is zero.

EXPERIMENT 2

SUPPORT REACTION OF BEAM

Beams are structural members which are generally horizontal. They are subjected to lateral forces which act orthogonal to the length of the member. There are various types of mechanisms used for supporting the beams.

Important formulas



In equilibrium,

-w1*x1 + -w2*x2 + -w3*x3 + R2*L = 0

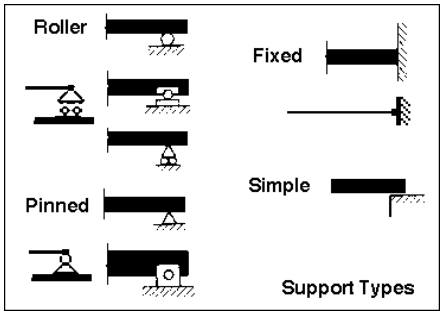
Thus,

R2 = (w1*x1 +w2*x2 +w3*x3)/L

Questions and Answers

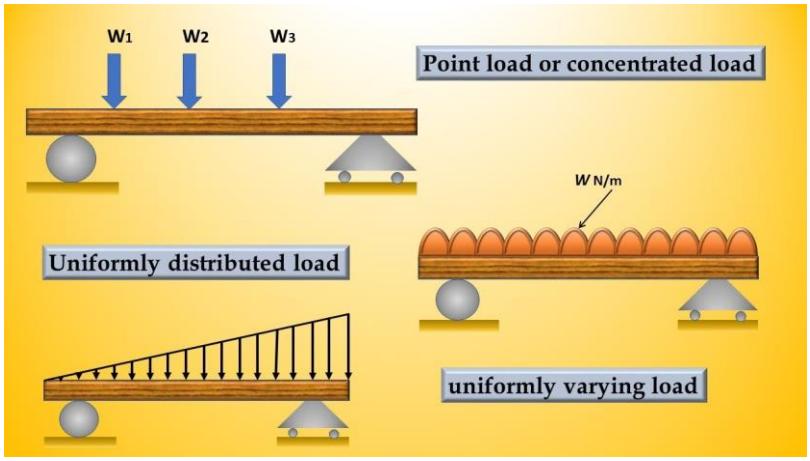
1. State the type of supports

Ans.



2. State the type of loads

Ans.



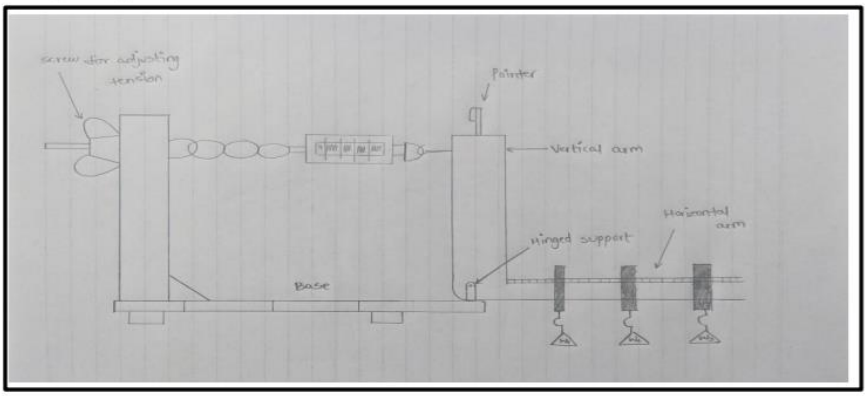
EXPERIMENT 3

Bell Crank Lever

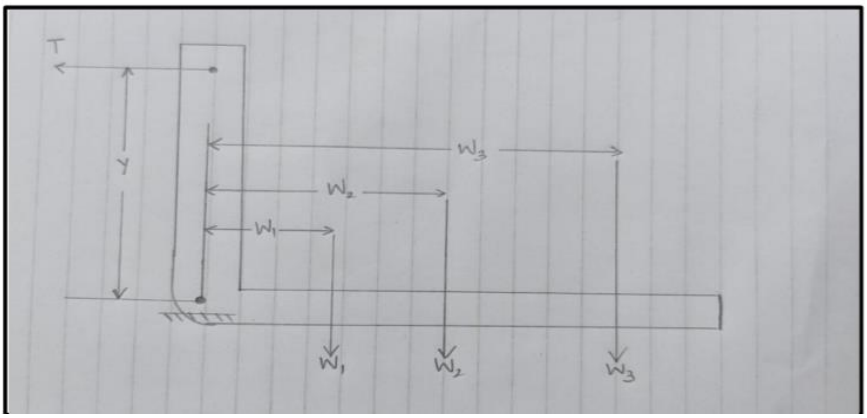
Principle of moments states that, 'the algebraic sum of moments of a system of coplanar forces about any point in the plane is equal to the moment of the resultant of a force of the system about the same point'.

This principle would be verified for a bell crank lever arrangement. *A lever whose two arms form a right angle and having its fulcrum at the apex of the angle is known as bell crank lever*

Setup Diagram:



Free body diagram:



EXPERIMENT 4

FRICTION

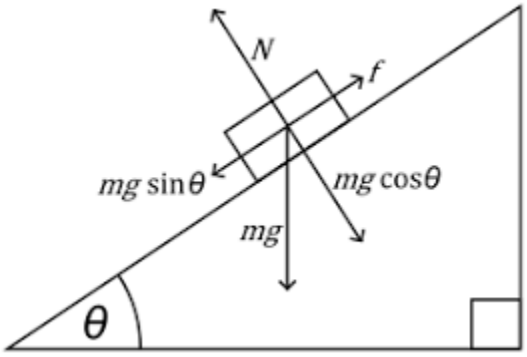
Friction is a force that is created whenever two surfaces move or try to move across each other.

• Friction always opposes the motion or attempted motion of one surface across another surface.

• Friction is dependent on the texture of both surfaces.

• Friction is also dependent on the amount of contact force pushing the two surfaces together Static friction is friction between two or more solid objects that are not moving relative to each other. For example, static friction can prevent an object from sliding down a sloped surface.

The coefficient of static friction, typically denoted as μs, is usually higher than the coefficient of kinetic friction



Free Body Diagram

Equations:

f = F + mg sin θ

N = mg cos θ

But $F = \mu N$

Thus, $P = \mu W \cos\theta + W \sin\theta$

Questions and Answers

1. **Define angle of repose**

Ans. The angle that the plane of contact between two bodies makes with the horizontal when the upper body is just on the point of sliding.

2. **Define angle of friction**

Ans. The angle of a plane to the horizontal when a body placed on the plane will just start to slide.

3. **Define coefficient of friction**

Ans. Ratio of the frictional force resisting the motion of two surfaces in contact to the normal force pressing the two surfaces together.

EXPERIMENT 5

Newton’s Second Law of Motion

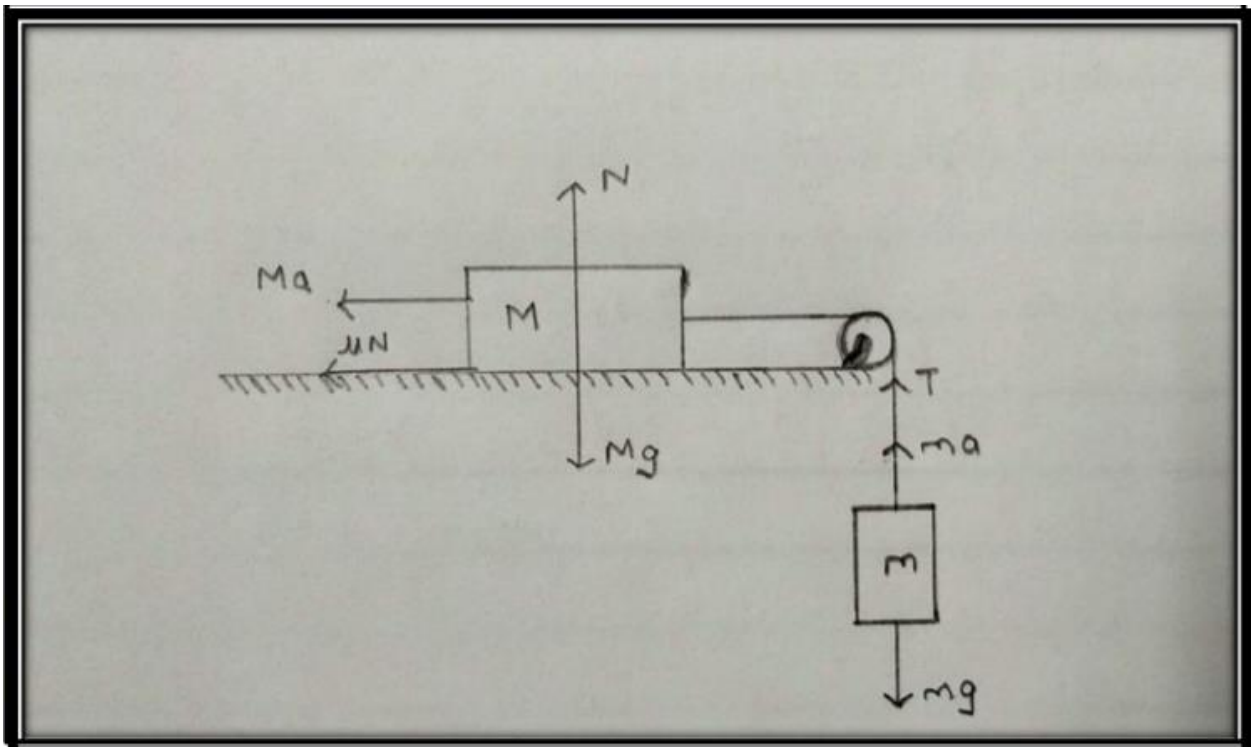
Newton's second law states that the force applied to a body produces a proportional acceleration

F = ma

It can also be used to derive,

F(net) = dP/dT

Netwon’s second law of motion FBD and formulas



For the above diagram,

The equation for T, the tension of the cable in the experiment are given by,

$$T = mg - ma$$
$$T = Ma + \mu Mg$$

The acceleration of an object can be found out using the below equation that is used in the experiment for the track slider setup

$$a = (mg - \mu Mg) / (M + m)$$

a = acceleration of the cart,
m = mass of the hanging weight,
g = gravitational acceleration(simulator used earth's 9.8m/s^2,
μ= coefficient of friction,
M = mass of the wagon.

The distance can be found out by

$$s = \frac{1}{2} a t^2$$

S = displacement of the cart,
a = acceleration of the cart,
t = time for the cart to travel distance S.

Questions and Answers

1. **State D' Lambert's principle**

Ans. The second law states that the force *F* acting on a body is equal to the product of the mass *m* and acceleration *a* of the body, or *F* = *ma;* in d'Alembert's form, the force *F* plus the negative of the mass *m* times acceleration *a* of the body is equal to zero: *F* - *ma* = 0.

2. **State impulse momentum equation**

Ans. The impulse experienced by a body is equal to its change in momentum

p = mv OR **F.t = m. dv**

EXPERIMENT 6

Moment of Inertia of Flywheel

The flywheel consists of a heavy circular disc/massive wheel fitted with a strong axle projecting on either side. The axle is mounted on ball bearings on two fixed supports. There is a small peg on the axle.

Let "m" be the mass of the weight hanger and hanging rings (weight assembly).When the mass "m" descends through a height "h", the loss in potential energy is

$$P_{loss} = mgh$$

The resulting gain of kinetic energy in the rotating flywheel assembly (flywheel and axle) is

$$K_{flywheel} = \frac{1}{2} I\omega^2$$

Where
I -moment of inertia of the flywheel assembly
ω-angular velocity at the instant the weight assembly touches the ground.

The gain of kinetic energy in the descending weight assembly is,

$$K_{weight} = \frac{1}{2} mv^2$$

Where v is the velocity at the instant the weight assembly touches the ground.

The work done in overcoming the friction of the bearings supporting the flywheel assembly is

$$W_{friction} = nW_f$$

Where
n - number of times the cord is wrapped around the axle

Wf - work done to overcome the frictional torque in rotating the flywheel assembly completely once

Therefore from the law of conservation of energy we get

$$P_{loss} = K_{flywheel} + K_{weight} + W_{friction} \quad (1)$$

On substituting the values we get

$$mgh = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2 + nW_f \quad (2)$$

Now the kinetic energy of the flywheel assembly is expended in rotating N times against the same frictional torque. Therefore

$$NW_f = \frac{1}{2}I\omega^2 \qquad W_f = \frac{1}{2N}I\omega^2$$

and

If r is the radius of the axle, then velocity v of the weight assembly is related to r by the equation

$$v = \omega r$$

Substituting the values of v and Wf we get:

$$mgh = \frac{1}{2}I\omega^2 + \frac{1}{2}mr^2\omega^2 + \frac{n}{N} \times \frac{1}{2}I\omega^2 \quad (3)$$

Now solving the above equation for I

$$I = \frac{Nm}{N+n}\left(\frac{2gh}{\omega^2} - r^2\right) \quad (4)$$

Where, I = Moment of inertia of the flywheel assembly
N = Number of rotation of the flywheel before it stopped
m = mass of the rings
n = Number of windings of the string on the axle
g = Acceleration due to gravity of the environment.
h = Height of the weight assembly from the ground.
r = Radius of the axle.

EXPERIMENT 7

Ballistic Pendulum

A ballistic pendulum is a device for measuring a bullet's momentum, from which it is possible to calculate the velocity and kinetic energy.

Ballistic pendulums have been largely rendered obsolete by modern chronographs, which allow direct measurement of the projectile velocity. It can be used to measure any transfer of momentum.

From the law of conservation of mechanical energy of the pendulum;

$$\frac{1}{2}(m+M)V^2 = (m+M)gh$$

where,

m- Mass of bullet
M- Mass of Pendulum
h- Maximum height reached by the pendulum
v- Velocity of the bullet

V- Velocity of pendulum
g-Gravity of earth

According to the law of conservation of momentum;

$$mv = (M+m)V$$

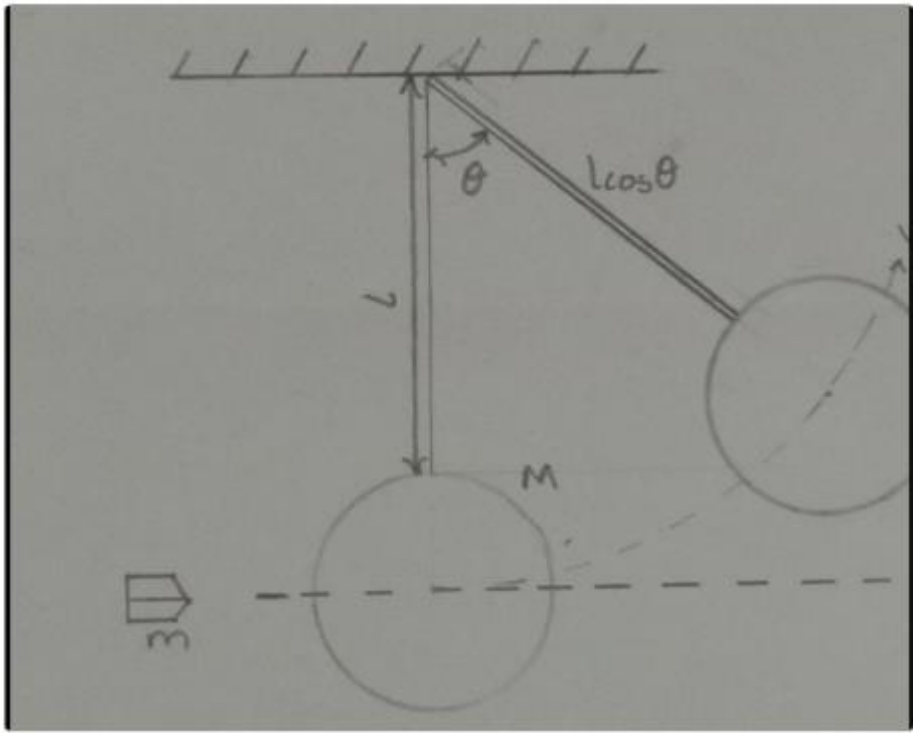
$$mv = (M+m)\sqrt{(2gh)}$$

Velocity of the bullet is given by;

$$v = \frac{1}{m}(M+m)\sqrt{(2gh)}$$

$$v = (\frac{M}{m}+1)\sqrt{(2gh)}$$

Free Body Diagram



Questions and answers

1. **Define conservation of momentum**

Ans. Law states that the total momentum of a system remains constant as indicated by the above Ballistic Pendulum experiment

EXPERIMENT 8

Compound Pendulum

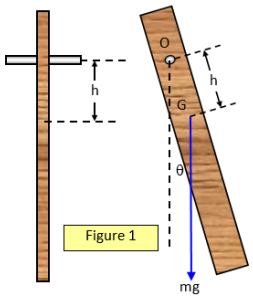


Figure 1

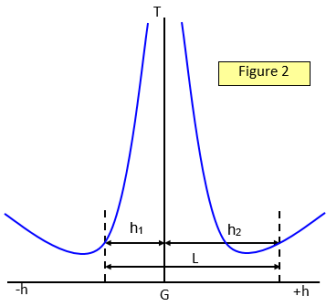


Figure 2

Any object mounted on horizontal axis so as to oscillate under the force of gravity is a compound pendulum

Time period of pendulum is given by:

$$T = 2\pi\left\{\frac{(h^2+k^2)}{gh}\right\}^{1/2}$$

Simplifying we get,

$$T^2.h = \left(\frac{4\pi^2}{g}\right)h^2 + \left(\frac{4\pi^2}{g}\right)k^2$$

The above equation is of the form y= mx+c which is equation of a straight line.
Thus plot of hT^2 vs h^2 will be a straight line.

From the slope, $m = \left(\frac{4\pi^2}{g}\right)$,

we can calculate g.

From the intercept $c = \left(\frac{4\pi^2}{g}\right)k^2$,

we can calculate k.

Where k = radius of gyration

EXPERIMENT 9

Projectile is defined as, any body thrown with some initial velocity, which is then allowed to move under the action of gravity alone, without being propelled by any engine or fuel. The path followed by a projectile is called its trajectory.

The equations used to find out various parameters are shown below;

Time of flight,

$$T = \frac{2u\sin\theta}{g}$$

Maximum height,

$$H = \frac{u^2\sin^2\theta}{2g}$$

Horizontal range,

$$R = \frac{u^2\sin 2\theta}{g}$$

If the body is projecting from a height "h" above the ground level, the additional height 'h' is to be considered and the equations modified accordingly.