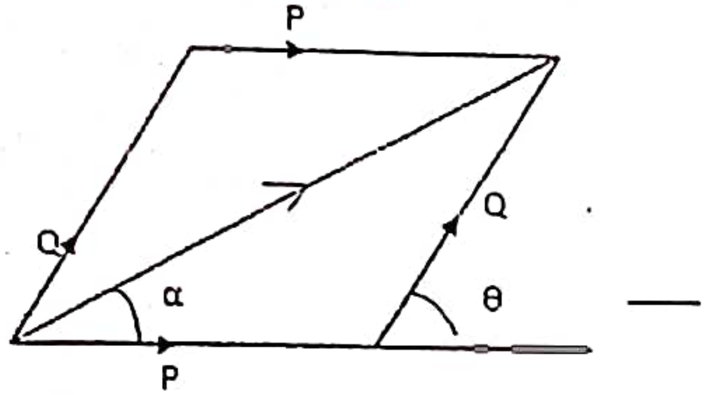
LIST OF FOEMULAE

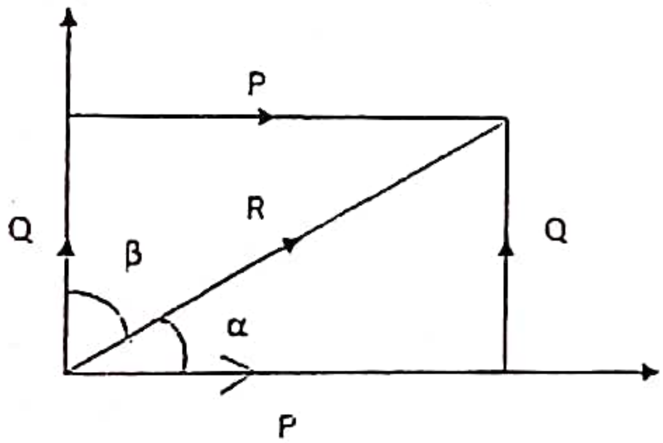
- Resultant of force acting in a straight line:
  a) same direction: $R = P + Q$
  b) Opposite direction : $R = P - Q$
- Resultant of two concurrent forces:

$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$$

$$\alpha = \tan^{-1}\frac{Q\sin\theta}{P + Q\cos\theta}$$



- Components of given force in two given directions:



- Resultant of number of co- planar concurrent forces:

$$R\cos\theta = \sum pi\cos\theta_i = \sum H = X$$

$$R\sin\theta = \sum pi\sin\theta_i = \sum V = Y$$

$$R\sqrt{X^2 + Y^2}$$

$$\theta = \tan^{-1}\frac{y}{x}$$

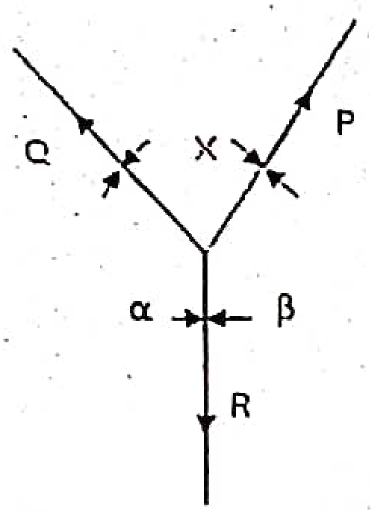
- Resultant of co-planar forces:

$$R = \sum P_i$$

$$\bar{x} = \frac{\sum P_i X_i}{\sum P_i}$$

Where X_i are distance of various forces from a reference axis $\bar{x}$ is the distance (perpendicular) of R from reference axis.

- Mechanical advantage of a lever $= \frac{Power\ arm}{Load\ arm}$
- Lami's theorem:



$$\frac{P}{\sin\alpha}\ \frac{Q}{\sin\beta}\ \frac{R}{\sin\chi}$$

- Friction force: $F=\mu N$; N=normal reaction
- Total reaction; $R=\sqrt{F^2+N^2}$

  $(F'=F_{max})$

  Angle of friction; $\theta = \tan^{-1}\frac{F}{N}$

  Also, $\mu = \tan\theta$
- Angle of response : $\alpha=\phi$
- Work done by a varying force:

  $$w = \int_0^s F.\delta S$$

  S= Total distance covered
- If a body freely falls from a height H, then velocity on reach the ground;

  $v=\sqrt{2gH}$
- If a body is projected vertically with initial velocity u, then the maximum height attained by it is:

  $H=\frac{U^2}{2g}$
- Distance covered in the nth second

  $$D_n = u+\frac{\alpha}{2}(2n-1)$$
- Motion of a particle in a place

$$u = \frac{dx}{dt}; v = \frac{dy}{dt}$$

$$v = \sqrt{u^2 + v^2}$$

$$\alpha_x = \frac{du}{dt} = \frac{d^2x}{dt^2}; \alpha_y = \frac{dv}{dt} = \frac{d^2y}{dt^2}$$

- Work done by a force field F(x,y,z) along path 1-2 is given by:

  $$w_{1-2} = \int_1^2 F dr = V_1(x, y, z) - v_2(x, y, z)$$

  Where, V(x,y,z) is the potential energy function (scalar function).
- For a conversation force field:

  $$\int F.dr = 0, \text{ and}$$

  $$F = -\Delta V$$
- Equation of trajectory

  $$Y = x \tan\alpha - \frac{1}{2g}, \frac{x^2}{u^2 \cos^2\alpha}$$

  (a) Motion of projectile up an inclined plane:

  Time of flight ,T= $\frac{2u \sin(\alpha - \beta)}{g \cos\beta}$

  [β: inclination of plane]
  Range up of the place:

  $$R = \frac{2u \cos\alpha \sin(\alpha - \beta)}{g \cos^2 \beta}$$

  $$R_{max} = \frac{u2}{g(1 + \sin\beta)} \text{ at } \alpha = \frac{\pi}{4} + \frac{\beta}{2}$$

  c) motion of a projectile projected horizontally at a height above the ground:
  x=ut

  $$y = \frac{1}{2} gt^2$$

  $$\frac{x^2}{y} = \frac{2u^2}{g} = \text{constant}$$
- Elastic collision: both momentum and (kinetic energy) are conversed

  $$m_1u_1 + m_2u_2 = \frac{1}{2} m_1v_1 + m_2v^2_2$$

  $$\frac{1}{2} m_1u_1^2 + m^2u^2_2 = \frac{1}{2} m_1v_1^2 + \frac{1}{2} m_2v^2_2$$
- Inelastic collision: only momentum is conversed

  $$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

- Coefficient of electricity or restitution:

$$e=\frac{v_2-v_1}{u_2-u_1}$$

e= 1 for perfectly elastic bodies, e = 0 for plastic impact

- Apparent weight in a lift:

Upward moving lift:

$$w_{eq}=mg\left(1+\frac{a}{g}\right)n$$

Downward moving Lift:

$$w_{eq}=mg\left(1-\frac{a}{g}\right)n$$

- Total kinetic energy of a body:

$$TE=\frac{1}{2}mv^2+\frac{1}{2}Iw^2$$

- Momentum of inertia of a thin circular ring:

(a) About an axis perpendicular to plane of ring:

$$I=\frac{1}{2}MR^2$$

(b) About any diameter:

$$I=\frac{1}{2}MR^2$$

(b) About a tangent in the plane of ring:

$$I=\frac{3}{2}MR^2$$

(d) About a tangent perpendicular to the plane of ring:

$$I=\frac{1}{2}MR^2$$

- Momentum of inertia of a uniform circular disc:

$$I=\frac{1}{2}MR^2$$

(About an axis perpendicular to plane of disc:)

- Momentum of inertia of a thin uniform rod;

(a) About an axis passing through the centre of length and perpendicular to the length:

$$I=\frac{1}{2}Ml^2$$

(b) About its axis:

$$I=\frac{1}{2}MR^2$$

(C) Hollow rod:

$$I = MR^2$$

- Moment of inertia of hollow sphere:

$$I = \frac{2}{3} MR^2$$

- Moment of inertia of solid sphere

$$I = \frac{2}{5} MR^2$$

- Motion of a cylinder rolling without slipping on an inclined plane;

$$\alpha = \frac{mg, \sin\theta}{m + \frac{1}{r^2}} = \frac{2}{3} g, \sin\theta [\alpha < g]$$

$$F = \frac{1}{3} mg, \sin\theta ; F < mg$$

$$\mu = \frac{1}{3} \tan\theta$$