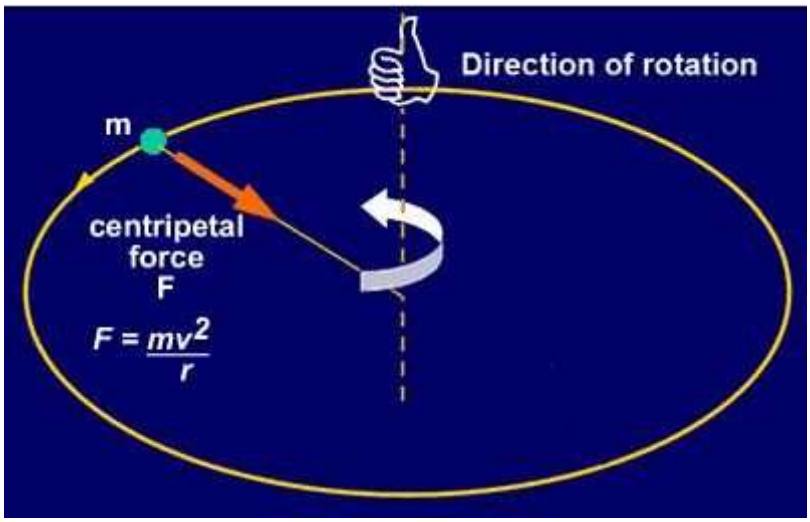
1. Circular Motion

Uniform Circular Motion:



- Speed = |Velocity| = v
- Time period, T = $\frac{2\pi r}{v}$
- Frequency, f = $\frac{v}{2\pi r}$
- Angular velocity, ω = $\frac{v}{r}$
- Centripetal force, F = $\frac{mv^2}{r}$mv2r
- Centripetal acceleration = $\frac{v^2}{r} = \omega^2 r$
- Angular velocity, ω = $\frac{v}{r}$
- Centripetal force is a real force that acts on a particle performing circular motion along the radius of a circle. The force is directed towards the centre of the circle.
- The magnitude of centripetal force is given by F = $\frac{mv^2}{r}$mv2r.

- Centrifugal force is a pseudo force in uniform circular motion. It acts along the radius and is directed away from the centre of the circle.

- Magnitude of centrifugal force = Mass × Acceleration of the reference frame
  $F_{CF} = mv\omega = \frac{mv^2}{r} = mr\omega^2$ FCF=mvω=mv2r=mrω2

- **Kinematics equations of motion**

$$\omega = \omega_0 + \alpha t$$
$$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$$
$$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$$
θ_0 = initial angular displacement
ω_0 = initial angular velocity

- **Friction force**, $F = \mu N$

  Where, N is the normal reaction of the body

  - Coefficient of friction

  ($\mu_{static} > \mu_{sliding} > \mu_{rolling}$)

- **Circular motion**

  For a level curved road

  - $F = \mu_s N \geq \frac{mv^2}{R}$ $F=\mu sN \geq mv2R$ (R = Radius of curvature of the road)
  - $v^2 \leq \leq \mu_s Rg$ (As, $N = mg$)

  Tha maximum speed of a car is,

  $$v_{max} = \sqrt{\mu_s Rg}$$

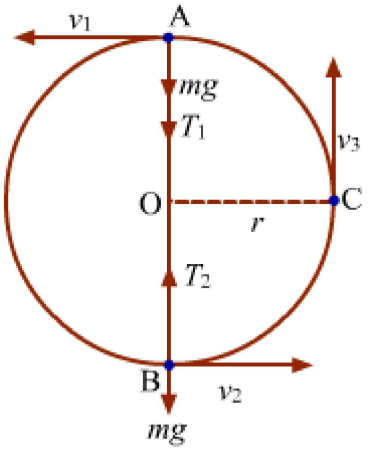
  For a banked curved road

  - Car can be parked, if $\tan\theta \leq \mu_s$

  The maximum speed of a car is,

  - $v_{max} = \left(\frac{Rg(\mu_s + \tan\theta)}{(1 - \mu_s \tan\theta)}\right)^{1/2}$ vmax=Rg(μs+tan θ)(1-μstan θ)12

Vertical Circular Motion



Vertical Circular Motion

- Motion of a particle in a vertical circle is non-uniform circular motion.
- Linear velocity of the particle at the highest point (A):

$v_1 = \sqrt{gr}$ v1=gr

- Linear velocity at the lowest point (B):

$v_2 = \sqrt{5gr}$ v2=5gr

- Linear velocity at the midway point (C):

$v_3 = \sqrt{3gr}$ v3=3gr

- Total energy of the particle at points A, B and C is same and is given by

$E = \frac{5}{2}mgr$ E=52mgr

- Difference in tensions at lowest and highest points:

$T_2 - T_1 = 6mg$ T2-T1=6mg