Centripetal Force | Centripetal Acceleration

Centripetal force is the force that keeps the body moving in the circular path and directed towards the center of the circular path is called centripetal force.

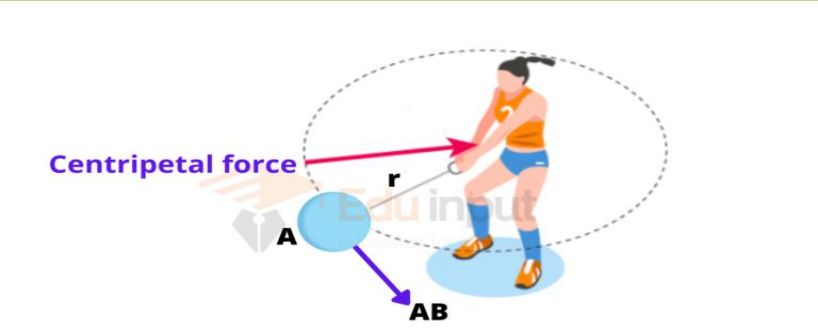
What is Centripetal Force?

The force that causes the body to follow a curved path is called centripetal force.

Its direction is always orthogonal to the movement of the body and the fixed point at the center of the momentary curvature of the path.

Examples:

- Force acting on an electron in fixed orbits around the nucleus
- Force acting on satellites around the earth
- Force acting on earth around the sun



spinning the ball on a string

Centripetal Force Formula

$F_c=ma_c= mv^2/r$

Where a_c is the centripetal acceleration

But according to the relation between angular and linear velocities

$v=r\omega$

So

$F_c=mr^2\omega^2/r$

What is the direction of centripetal force?

It is directed towards the center of the circle in the direction of centripetal acceleration.

What is centripetal acceleration?

The acceleration produced by centripetal force is called acceleration.

The instantaneous acceleration of an object traveling with uniform speed in a circle is directed towards the center of the circle and is called centripetal acceleration.

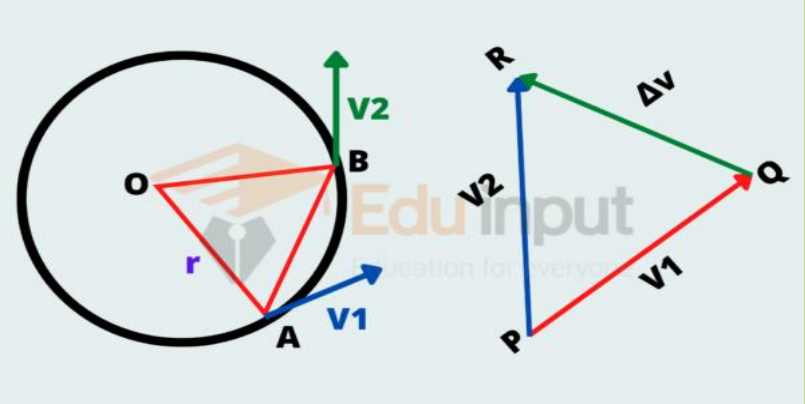
Centripetal acceleration formula

Consider a particle moving along a circle with a uniform speed V. If the particle moves from point A to B then the magnitude of its velocity remains the same but the direction of velocity changes.

Acceleration of the particle is given by

$$a= \Delta v/\Delta t$$

Where Δt is the time taken by the particle to travel from point A to B.



Let v_1 and v_2 be the velocities of particles at A and B respectively but

$$|v_1|=|v_2|=|v|=v$$

Then time taken by particle to cover distance 's' is given by;

$$\Delta t= S/V$$

$$a= \Delta v/s/v =V(\Delta v/s)$$

let us now draw a triangle PQR such that PQ is parallel and equal to v_1 and PR is parallel and equal to v_2.

As OA is perpendicular to v_1 and OB is perpendicular to v_2.

Therefore angle AOB and angle QPR are equal. Both triangles are isosceles. Because $V_1=V_2=V$ And OA=OB

And angles between their equal arms are equal. Hence triangle OAB and triangle PQR are similar.

$$\Delta v/v= AB/r$$

Now if Δ t→0 then point B approaches to point A and arc AB becomes nearly the same in length as the line AB.

AB=s

Δv/v= s/r

Δv=v(s/r)

As

a=v (Δv/s)

So

a= (v/s)v(s/r)

$a=v^2/r$

s this acceleration is caused by centripetal force so it is known as centripetal acceleration and is denoted by a_c

SO

$a_c=v^2/r$

What is the direction of Centripetal Acceleration?

As PQ is perpendicular to OA and PR is perpendicular to OB thus QR is perpendicular to AB.

Hence Δv is perpendicular to QR and is directed toward the center of the circle. Also when ABà0 the centripetal acceleration is direct along the radius in the direction of Δv. Hence a is also directed towards the center of the circle.