From the above two figures it is observed that the direction of ω is through the centre of circular path but remains normal to plane of the circle.

Consider a body completes one revolution in time 'T', with angular velocity ω for which it has to go through $2\pi^c$

But $\quad$ Angular velocity = $\dfrac{\text{Angular displacement}}{\text{Time}}$

$$\boxed{\omega = \frac{2\pi}{T}} \quad \text{.......(3)}$$

$$\therefore \quad \omega = 2\pi \times \frac{1}{T}$$

$$\therefore \quad \boxed{\omega = 2\pi n} \quad \text{.......(4)}$$

Angular Acceleration :

It is the rate of change of angular velocity with respect to time.

It is denoted by 'α'

Angular Acceleration = $\dfrac{\text{Change in angular velocity}}{\text{Time}}$

Consider a body starts its circular motion from point 'A' with angular velocity 'ω' along circular path of radius 'R'. Let 'O' be the centre of the circle so that in short time 'dt' the body covers small angular displacement '$d\theta$' and comes to new position 'B' where its angular velocity becomes $\omega + d\omega$.

Imp :- (For MCQ's)

→ Use VCM

$v_1 \neq v_2 \neq v_3 \neq v_4$

$\vec{v_1} + \vec{v_2} + \vec{v_3} + \vec{v_4}$

But, $\quad$ Angular Acceleration = $\dfrac{\text{Change in angular velocity}}{\text{Time}}$

$$\therefore \quad \alpha = d\omega/dt$$

$$\frac{d\omega}{dt} = \frac{d(\omega)}{dt} = \frac{d}{dt}\left(\frac{d\theta}{dt}\right) = \frac{d^2\theta}{dt^2}$$

$$\boxed{\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}} \quad \text{.......(1)}$$

$$\boxed{\vec{\alpha} = \frac{d\vec{\omega}}{dt} = \frac{d^2\vec{\theta}}{dt^2}} \quad \text{.......(2)}$$

1) Linear accl^n

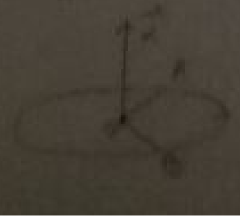
∴ a.s. $d\omega \neq 0$ $\frac{d\omega}{dt}$

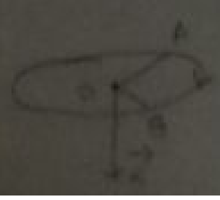
2) Angular accl^n

∴ $\alpha = \frac{d\omega}{dt}$

The unit of angular acceleration (α) is radian/Sec^2 while its dimension are $[M^0 L^0 T^{-2}]$.

From equation (2) it is observed that the direction of $\vec{\alpha}$ is in the direction of $\vec{\omega}$ and $d\vec{\theta}$. It means direction of $\vec{\alpha}$ can also be decided by Screw Rule or Right Hand Rule.



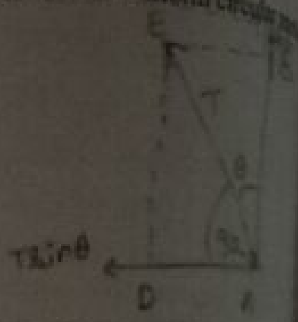


In any position of the bob, there are two forces acting upon it. These forces are (i) its weight acting vertically downwards and (ii) the tension T in the string. The tension can be resolved into a vertical component $T\cos\theta$ and a horizontal component $T\sin\theta$ (Fig. The component $T\cos\theta$ balances the weight of the bob).

$$\therefore \quad T\cos\theta = mg \rightarrow (1)$$

The component $T\sin\theta$ acts as the centripetal force necessary for the uniform circular motion of the bob. T sin θ = C.P.F

$$\therefore \quad T\sin\theta = \frac{mv^2}{r} \rightarrow (2)$$



where v is the magnitude of the velocity of the bob.

Dividing Eq. (2) by Eq. (1) we get

$$\frac{T\sin\theta}{T\cos\theta} = \frac{mv^2/r}{mg}$$

$$\tan\theta = \frac{v^2}{rg} \rightarrow (3)$$

$$v^2 = rg\tan\theta$$

$$\therefore \quad v = \sqrt{rg\tan\theta} \rightarrow (4)$$

In Rt. Δ AOE,

$\cos\theta = \frac{AB}{AE}$

This expression gives the magnitude of the velocity of the bob.

AB = AE cos θ

AB = T cos θ

From Fig. In Rt. Δ OCA,

$$\tan\theta = \frac{AC}{OC} = \frac{r}{h} \rightarrow (5)$$

where h is the axial or vertical height of the conical pendulum. From Eq. and Eq. we get

From (3) and (5)

$$\frac{v^2}{rg} = \frac{r}{h}$$

In Rt. Δ ADE

$\cos(90-\theta) = \frac{AD}{AE}$

$$\therefore \quad \frac{v^2}{r^2} = \frac{g}{h}$$

$\sin\theta = \frac{AD}{AE}$

$$\therefore \quad \frac{v}{r} = \sqrt{\frac{g}{h}} \rightarrow (6) \quad \frac{r}{v} = \sqrt{\frac{h}{g}}$$

AD = AE sin θ

AD = T sin θ

The period of revolution (t) of the bob is given by

velocity = $\frac{\text{displacement}}{\text{time}}$, $v = \frac{2\pi r}{t}$, $t = \frac{2\pi r}{v}$

$$t = \frac{2\pi r}{v} \text{ or}$$

$$\therefore \quad t = 2\pi\sqrt{\frac{h}{g}} \rightarrow (7)$$

The period of the bob is also called the period of the conical pendulum. From Fig.

In Rt. Δ OCA, $\cos\theta = \frac{OC}{OA}$, $\cos\theta = \frac{h}{l}$

$$\therefore \quad h = l\cos\theta \rightarrow (8)$$

Substituting this value of h in Eq. the period of the conical pendulum can be written as

Put (8) in (7),

$$t = 2\pi\sqrt{\frac{l\cos\theta}{g}} \rightarrow (9)$$