Q- A 240 g mass suspended by a 0.8 m long string is pulled 8.4° to one side and released. How long does it take for the pendulum to reach 6.0° on the opposite side?

For small angles the motion of a pendulum bob is simple harmonic with time period T given by

$$T = 2\pi\sqrt{\frac{L}{g}}$$

Where L is the length of the pendulum

The angular frequency for this motion is given by

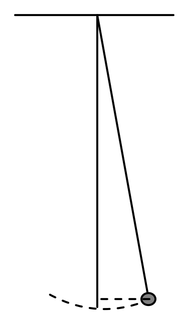
$$\omega = \frac{2\pi}{T} = \sqrt{\frac{g}{L}} = 3.5 \text{ rad/sec.} = 200.6^0 \text{ /s}$$

The displacement from equilibrium position as a function of time is given by

$X = \theta L = A \sin(\omega t + \phi)$

Initially at t =0 the bob is released from extreme position $\theta = \theta_{max}$, the initial phase ϕ is 90^0 and hence the equation can be written as

$\theta L = \theta_{max} L \sin(\omega t + 90^0)$ (For small angles $\sin\theta = \theta$ in radians)



Or $\theta = \theta_{max} \cos(\omega t)$ ------------------------ (1)

Now here $\theta_{max} = 8.4^0$

And $\theta = -6.0^0$

Substituting in equation 1 we get

$-6.0^0 = 8.4^0 \cos[(200.6)*t]$

Or $\cos[(200.6^0)*t] = -6.0^0/8.4^0 = -0.714$

Gives $(200.6^0)*t = \cos^{-1}(-0.714) = [135.58^0]$

Gives $t = 135.58/200.6 = 0.676$ s