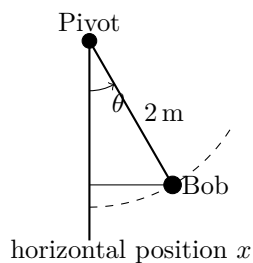


## Question 6

**Problem:**

A pendulum of length 2 meters swings back and forth in a vertical plane. At a certain instant, the angle  $\theta$  between the pendulum and the vertical is  $\frac{\pi}{6}$ , and the angle is increasing at a rate of  $0.4 \text{ rad/s}$ . How fast is the pendulum bob moving horizontally at that instant?



**Question 6 - Solution**

Let:

- $\theta$  be the angle between the pendulum and vertical
- $x$  be the horizontal displacement of the bob from the vertical

Using trigonometry:

$$x = L \sin(\theta) = 2 \sin(\theta)$$

Differentiate both sides with respect to time  $t$ :

$$\frac{dx}{dt} = 2 \cos(\theta) \cdot \frac{d\theta}{dt}$$

Substitute:

$$\theta = \frac{\pi}{6}, \quad \frac{d\theta}{dt} = 0.4 \text{ rad/s}, \quad \cos\left(\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$$

$$\frac{dx}{dt} = 2 \cdot \frac{\sqrt{3}}{2} \cdot 0.4 = \sqrt{3} \cdot 0.4 \approx 0.6928 \text{ m/s}$$

**Answer:**

|                                           |
|-------------------------------------------|
| $\frac{dx}{dt} \approx 0.693 \text{ m/s}$ |
|-------------------------------------------|