

21-R-KIN-SS-55

A wire is bent to the shape shown in the figure with $L_{AB}=10\text{cm}$, $L_{BC}=5\text{cm}$ and $\theta=45^\circ$.

What angle does the line BC make with the vertical when the object is dangled by a rope from Point B?

Solution

Find the CG of each individual wire

$$CG_{AB,x} = \frac{L_{AB}}{2}$$

$$CG_{AB,y} = 0$$

$$CG_{BC,x} = \frac{L_{BC}}{2} \cos \theta$$

$$CG_{BC,y} = \frac{L_{BC}}{2} \sin \theta$$

Using the composite body equation, with the mass replaced by the length of wire (because mass is proportional to length for a constant density wire):

$$\begin{aligned} \sum m \cdot CG_x &= \sum_i (m_i \cdot CG_{x,i}) \\ (L_{AB} + L_{BC}) CG_x &= CG_{AB,x} \cdot L_{AB} + CG_{BC,x} \cdot L_{BC} \\ \Rightarrow CG_x &= 3.923 \quad [\text{cm}] \end{aligned}$$

Similarly, $CG_y = 0.589 \quad [\text{cm}]$

The angle the object makes is the angle between BC and the straight line from B to CG.

$$\begin{aligned} \phi &= \arctan \frac{CG_y}{CG_x} \\ &= 8.54^\circ \end{aligned}$$