1. A boat is pulled into a dock by a rope attached to the bow of the boat and passing through a pulley on the dock that is 1 meter higher than the bow of the boat. If the rope is pulled in at a rate of 1 m/s, how fast is the boat approaching the dock when it is 8 meters from the dock?

Solution: Let $y$ be the length of the rope from the dock to the bow of the boat. Let $x$ be the horizontal distance from the dock to the boat. We know:

$$\frac{dy}{dt} = -1$$

and we’re looking for the following:

$$\frac{dx}{dt} \bigg|_{x=8}$$

Finding an equation relating the variables $x$ and $y$, using the Pythagorean Theorem we have

$$1^2 + x^2 = y^2$$

Implicitly differentiating with respect to the variable $t$, we have

$$2x \frac{dx}{dt} = 2y \frac{dy}{dt}.$$  

This is where we use the $x = 8$. In that case, we see that $y = \sqrt{65}$. So,

$$2(8) \frac{dx}{dt} = 2\sqrt{65}(-1),$$

so

$$\frac{dx}{dt} = \frac{-\sqrt{65}}{8}$$

where the units are in meters per second.

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