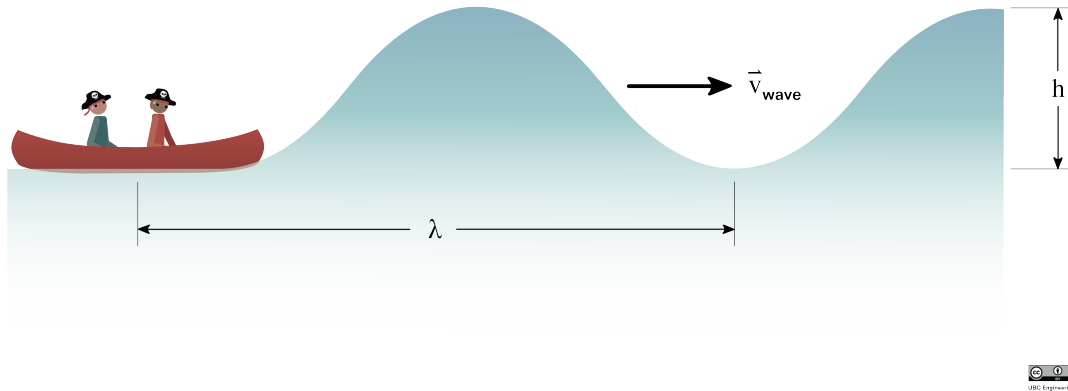


## 22-R-VIB-TW-44



A small boat sits anchored in the ocean. If the waves are measured to have a wavelength  $\lambda = 15$  m, height  $h = 1$  m, and a horizontal velocity of  $\vec{v}_{\text{wave}} = 1\hat{i}$  m/s with respect to the boat, what is the vertical displacement of the boat as a function of time? Take the starting displacement of the boat to be  $y(0) = -\frac{h}{2}$  m.

**Solution:**

$$v_w = \lambda f$$

$$f = \frac{v_w}{\lambda}$$

$$\omega_0 = 2\pi f = 2\pi \frac{v_w}{\lambda} = 2\pi \frac{1}{15} = 0.419 \text{ [rad/s]}$$

$$A = \frac{h}{2} = 0.5 \text{ [m]}$$

$$y(t) = A \cos(\omega_0 t + \phi)$$

$$y(0) = \frac{h}{2} \cos(\phi) = -\frac{h}{2} \Rightarrow \cos(\phi) = -1 \Rightarrow \phi = \pi$$

$$y(t) = 0.5 \cos(0.419t + \pi)$$

$$y(t) = -0.5 \cos(0.419t)$$