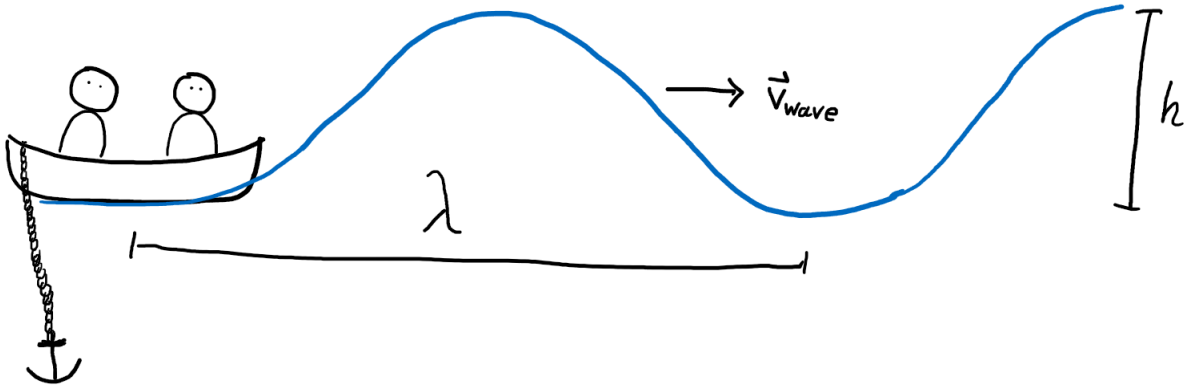
22-R-VIB-TW-44



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:

$$v_w = \lambda f$$
$$f = \frac{v_w}{\lambda}$$
$$\omega = 2\pi f = 2\pi \frac{v_w}{\lambda} = 2\pi \frac{1}{15} = 0.419 \text{ [Hz]}$$
$$A = \frac{h}{2} = 0.5 \text{ [m]}$$
$$y(t) = A\cos(\omega t + \phi)$$
$$y(0) = \frac{h}{2}\cos(\phi) = -\frac{h}{2} \Rightarrow \cos(\phi) = -1 \Rightarrow \phi = \pi$$
$$y(t) = 0.5\cos(0.419t + \pi)$$
$$y(t) = -0.5\cos(0.419t)$$