A. An object (m = 0.175 kg) is fired horizontally (velocity v₀) at a block (M = 2.20 kg) sitting at rest on a horizontal surface. The object embeds itself perfectly inelastically in the block, and the block with the embedded object, slides off to the right covering a distance of 0.780 m before stopping. The work done by the kinetic frictional force in stopping the block is -11.8 J. See drawing.

1. \[9 \text{ pts.}\] What is the velocity of the block/embedded object immediately after the perfectly inelastic collision? \[W_{\text{NCR}} = -11.8 \text{ J} = F_2 - F_0 = \frac{1}{2} (m + M) v^2\]

\[v = \sqrt{\frac{-2W_{\text{NCR}}}{m + M}} = \sqrt{\frac{-2(-11.8 \text{ J})}{2.35 \text{ kg}}}\]

\[v = 3.15 \text{ m/s}\]

2. \[9 \text{ pts.}\] What is the velocity of the object, v₀, just before the collision?

\[P_{\text{tot}} (\text{BE}) = P_{\text{tot}} (\text{ABE})\]

\[m v_0 = (m + M) v\]

\[v_0 = \frac{(m + M) v}{m} = \frac{(2.35 \text{ kg})(3.15 \text{ m/s})}{0.175 \text{ kg}}\]

\[v_0 = 43.8 \text{ m/s}\]

B. A 450 kg speedboat is negotiating a circular turn (radius r = 40.0 m) around a buoy. During the turn the boat’s motor gives rise to a constant in magnitude net tangential force of 675 N applied to the boat. The initial tangential speed of the boat going into the turn is 5.60 m/s.

1. \[6 \text{ pts.}\] Find the tangential acceleration of the boat.

\[a_T = \frac{F_{\text{net}}}{m} = \frac{675 \text{ N}}{450 \text{ kg}} = 1.50 \text{ m/s}^2\]

2. \[6 \text{ pts.}\] Find the angular acceleration of the boat.

\[a = \frac{a_T}{r} = \frac{1.50 \text{ m/s}^2}{40 \text{ m}} = 3.75 \times 10^{-2} \text{ rad/s}^2\]

3. \[6 \text{ pts.}\] Find the angular speed of the boat after the boat is 2.75 s into the circular turn.

\[\omega = \omega_0 + at = \frac{\omega_0}{r} + at = \frac{5.6 \text{ m/s}}{40 \text{ m}} + (3.75 \times 10^{-2} \text{ rad/s}^2)(2.75 \text{ s})\]

\[\omega = 4.2 \text{ rad/s}\]