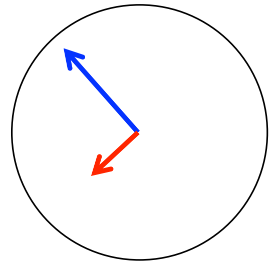
Problem 10.45

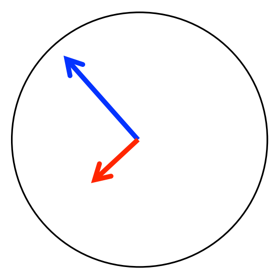


London's Parliamentary clock has a 60.0 kg hour-hand of length 2.70 meters and a 100. kg minute hand that is 4.5 meters long. Determine the total rotational kinetic energy of the clock's hands?

The two hands have different *angular speeds*, so we need to determine both:

$$\omega_{hr} = \left(\frac{2\pi \text{ rad}}{12 \cancel{\text{hr}}}\right)\left(\frac{1 \cancel{\text{hr}}}{3600 \text{ s}}\right)$$
$$= 1.45\text{x}10^{-4} \text{ rad/hr}$$

$$\omega_{min} = \left(\frac{2\pi \text{ rad}}{1 \cancel{\text{hr}}}\right)\left(\frac{1 \cancel{\text{hr}}}{3600 \text{ s}}\right)$$
$$= 1.75\text{x}10^{-3} \text{ rad/hr}$$



With the angular speeds, and assuming the hands are rods that rotate around their ends (this allows us a model for the *moment of inertia*) and we can write:

$$\begin{aligned} KE_{tot} &= KE_{min} + KE_{hr} \\ &= \frac{1}{2} I_{min}\,\omega_{min}{}^2 + \frac{1}{2} I_{hr}\,\omega_{hr}{}^2 \\ &= \frac{1}{2}\left(\frac{1}{3} m_{min}\left(R_{min}\right)^2\right)\omega_{min}{}^2 + \frac{1}{2}\left(\frac{1}{3} m_{hr}\left(R_{hr}\right)^2\right)\omega_{hr}{}^2 \\ &= \frac{1}{2}\left[\frac{1}{3}(100.\text{ kg})(4.50\text{ m})^2\right](1.75\text{x}10^{-3}\text{ rad/s})^2 \\ &\qquad + \frac{1}{2}\left[\frac{1}{3}(60.0.\text{ kg})(2.70\text{ m})^2\right](1.45\text{x}10^{-4}\text{ rad/s})^2 \\ &= 1.04\text{x}10^{-3}\text{ J} \end{aligned}$$