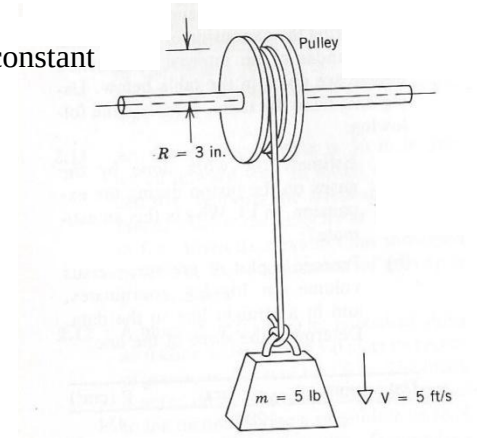
PROBLEM 2.42

Figure P2.42 shows an object whose mass is 5 lb attached to a rope wound around a pulley. The radius of the pulley is 3 in. If the mass falls at a constant velocity of 5 ft/s, determine the power transmitted to the pulley, in hp, and the rotational speed of the shaft, in revolutions per minute (RPM). The acceleration of gravity is 32.2 ft/ s^2.

KNOWN: An object attached to a rope wound around a pulley falls at a constant velocity.

FIND: Find the power transmitted to the pulley and the rotational speed.

SCHEMATIC AND GIVEN DATA:



ENGINEERING MODEL: (1) the object falls at a constant speed. (2) The acceleration of gravity is constant.

ANALYSIS: The power is obtained using Eq. 2.13

$$\dot{W} = \mathbf{F} \cdot \mathbf{V} = (mg)\mathrm{V}$$

$$= (5\ \text{lb})\left(32.2\ \frac{\text{ft}}{\text{s}^2}\right)\left(5\ \frac{\text{ft}}{\text{s}}\right)\left|\frac{1\ \text{lbf}}{32.2\ \text{lb}\cdot\text{ft}/s^2}\right|$$

$$= 25\ \text{ft}\cdot\text{lb/s}$$

Converting to horsepower

$$\dot{W} = \left(25\ \text{ft}\cdot\frac{\text{lbf}}{\text{s}}\right)\left|\frac{1\ \text{hp}}{550\ \text{ft}\cdot\text{lbf/s}}\right| = 0.0455\ \text{hp}$$

The rotational speed of the pulley is related to the velocity of the object and the radius by $V = R\omega$. Thus

$$\omega = \frac{\mathrm{V}}{\mathrm{R}} = \left(\frac{5\ \text{ft/s}}{3/12\ \text{ft}}\right)\left|\frac{1\ \text{rev}}{2\pi}\right|\left|\frac{60\ \text{s}}{1\ \text{min}}\right| = 191\ \text{rev/min}$$