8.

Problem 11.59P(HRW)

Delivery trucks that operate by making use of energy stored in a rotating flywheel have been used in Europe. The trucks are charged by using an electric motor to get the flywheel up to its top speed of 200π rad s^{-1}. *One such flywheel is a solid, homogeneous cylinder with a mass of* 500 kg *and a radius of* 1.0 m.

(a) *What is the kinetic energy of the flywheel after charging?*

(b) *If the truck operates with an average power requirement of* 8.0 kW, *for how many minutes can it operate between chargings?*

Solution:

(a)

Flywheel is a rotating cylinder of mass *M* (500kg) and radius *R* (1.0 m). Its rotational inertia *I*,

$\frac{1}{2}MR^2 = \frac{1}{2}\times 500\times 1.0^2$ kg $m^2 = 250$ kg m^2.

When the flywheel is rotating at its top speed ω of 200π rad s^{-1} its kinetic energy will be

$$\tfrac{1}{2} I\omega^2 = \tfrac{1}{2} \times 250 \times (200\pi)^2 \text{ J} = 49 \times 10^6 \text{ J}.$$

(b)

By definition power is the energy delivered per second. Therefore, if the delivery truck operates with an average power of 8.0 kW, the charged flywheel will supply energy for time t,

$$t = \frac{49 \times 10^6 \text{ J}}{8 \times 10^3 \text{ J/s}} = 6125 \text{ s} ; \ 102 \text{ min}.$$