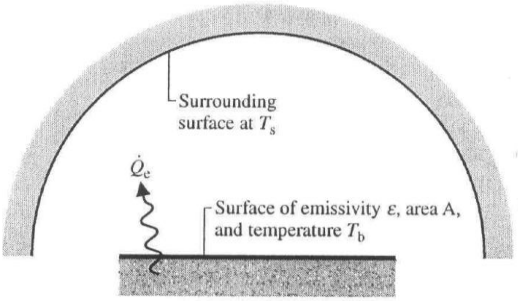
PROBLEM 2.54

KNOWN: Data are provided for a body placed in a large, evacuated chamber.

FIND: Determine the rate at which radiation is emitted from the surface and the *net* rate at which radiation is exchanged between the body and chamber.

SCHEMATIC & GIVEN DATA:



$A = 0.5\,m^2$, $\epsilon = 0.8$, $T_b = 423K$, $T_s = 298K$

ENGR. MODEL:

1. The area of the enclosed surface is much less than that of the chamber walls.
2. The chamber is evacuated.

ANALYSIS:

(a) The rate radiation is emitted from the surface is given by Eq. 2.32, where σ is the Stefan-Boltzmann constant. That is

$$\dot{Q}_e = \epsilon \sigma A T_b^4 = 0.8(0.5m^2)\left(5.67 \times 10^{-8} \frac{W}{m^2 \cdot K^4}\right)(423K)^4$$

$$= 726\,W \longleftarrow$$

(b) The net rate at which radiation is transferred from the surface to the chamber walls is given by Eq. 2.33. That is

$$(\dot{Q}_e)_{net} = \epsilon \sigma A \left[T_b^4 - T_s^4\right] = 0.8(0.5m^2)\left(5.67 \times 10^{-8} \frac{W}{m^2 \cdot K^4}\right)\left((423K)^4 - (298K)^4\right)$$

$$= 547\,W \longleftarrow$$