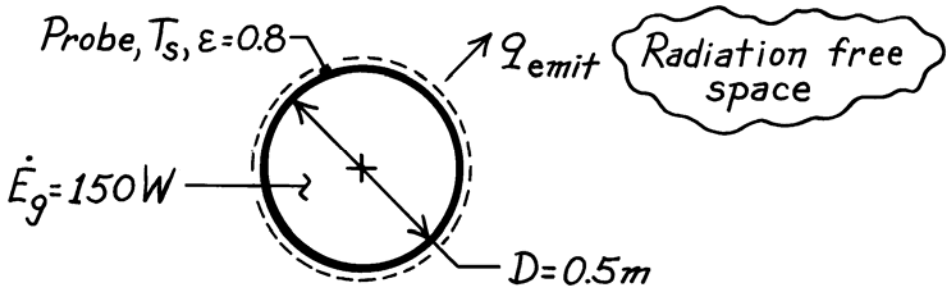
PROBLEM 1.25

KNOWN: Diameter and emissivity of spherical interplanetary probe. Power dissipation within probe.

FIND: Probe surface temperature.

SCHEMATIC:



ASSUMPTIONS: (1) Steady-state conditions, (2) Negligible radiation incident on the probe.

ANALYSIS: Conservation of energy dictates a balance between energy generation within the probe and radiation emission from the probe surface. Hence, at any instant

$$-\dot{E}_{out} + \dot{E}_g = 0$$

$$\varepsilon A_s \sigma T_s^4 = \dot{E}_g$$

$$T_S = \left(\frac{\dot{E}_g}{\varepsilon \pi D^2 \sigma} \right)^{1/4}$$

$$T_S = \left(\frac{150\text{W}}{0.8\pi (0.5\ \text{m})^2\, 5.67\times10^{-8}\ \text{W/m}^2\cdot\text{K}^4} \right)^{1/4}$$

$$T_s = 254.7\ \text{K}. \qquad <$$

COMMENTS: Incident radiation, as, for example, from the sun, would increase the surface temperature.