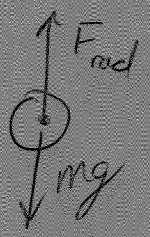
Ch.16 Prob. 68

$r = 2\,mm$

$m = 20\,\mu g = 20\times10^{-6}\,g = 20\times10^{-9}\,kg$

Find the intensity of the light needed to suspend the ball in a vacuum.

By Newton's 2nd Law



$$\Sigma F = ma \rightarrow F_{rad} - mg = 0$$

$$F_{rad} = mg$$

Since Pressure is force per area, then

$$A \cdot P_{rad} = mg$$

If the light is absorbed then $P_{rad} = \frac{I}{c}$

and $\frac{A \cdot I}{c} = mg$

The intensity of the light is then

$$I = \frac{mgc}{A}$$

Area of the styrofoam ball is the area exposed to the radiation. This would be the area of a circle

$$A = \pi r^2$$

so $$I = \frac{mgc}{\pi r^2} = \frac{(20\times10^{-9}\,kg)(9.8\,m/s^2)(3.0\times10^{8}\,m/s)}{\pi(2.0\times10^{-3}\,m)^2}$$

$$\boxed{I = 4.68\times10^{6}\,W/m^2}$$