5. Modern Physics

(a) Force from a Light Beam

Force is the rate of change of momentum. For a perfectly absorbing (blackened) plate, the momentum transferred per second is the total momentum of the photons arriving per second. Photon momentum $p = E/c$. The total energy per second is the power, P_{power}.

$$F = \frac{\Delta p}{\Delta t} = \frac{P_{\text{power}}}{c}$$

The power is $P_{\text{power}} = I \times A = (24\,\text{W/m}^2)(200 \times 10^{-4}\,\text{m}^2) = 0.48\,\text{W}$.

$$F = \frac{0.48\,\text{W}}{3.00 \times 10^8\,\text{m/s}} = \mathbf{1.6 \times 10^{-9}}\,\text{N}$$

Assumption: The plate is a perfect absorber (blackbody).