

### Heat and Other Forms of Energy

**14.81** The rate of heat transfer per unit surface area is called heat flux  $q$ . It is related to the rate of heat transfer by  $Q = \int q dA$ .

**14.82** Energy can be transferred by heat, work, and mass. An energy transfer is heat transfer when the driving force is temperature difference.

**14.83** Thermal energy is the sensible and latent forms of internal energy, and it is related to air heat by Eq. 14.6.

**14.84** For the constant pressure case, this is because the heat transfer to an ideal gas is  $m_c u_2 - m_c u_1$  at constant pressure and  $m_c u_2 - m_c u_1$  at constant volume, and  $u_2$  is always greater than  $u_1$ .

**14.85** A cylindrical resistor on a circuit board dissipates 0.6 W of power. The amount of heat dissipated is 24 J, the heat flux, and the fraction of heat dissipated from the top and bottom surfaces are to be determined.

**Assumptions** Heat is transferred uniformly from all surfaces.

**Analysis** (a) The amount of heat the resistor dissipates during a 24-hour period is

$$Q = \dot{Q} \Delta t = (0.6 \text{ W})(24 \text{ h}) = 0.62 \text{ kWh} = 0.62 \text{ kWh} \times 3600 \text{ s/h} = 2232 \text{ Wh} = 2.232 \text{ kWh}$$

(b) The heat flux on the surface of the resistor is

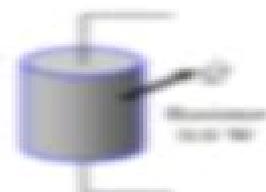
$$q_s = \frac{\dot{Q}}{A_s} = 0.6 \text{ W} = 0.6 \frac{\text{W}}{0.0006 \text{ m}^2} = 1000 \text{ W/m}^2 \quad \text{on the top and bottom surfaces} = 0.2(1000) = 200 \text{ W/m}^2$$

$$q_c = \frac{\dot{Q}}{A_c} = \frac{0.6 \text{ W}}{2(0.0006 \text{ m}^2)} = 500 \text{ W/m}^2$$

(c) Assuming the heat transfer coefficient to be uniform, heat transfer is proportional to the surface area. Then the fraction of heat dissipated from the top and bottom surfaces of the resistor becomes

$$\frac{\dot{Q}_{\text{top}}}{\dot{Q}_{\text{total}}} = \frac{\dot{Q}_{\text{bottom}}}{\dot{Q}_{\text{total}}} = \frac{0.2(1000)}{1000} = 0.200 \quad \text{on each side}$$

**Discussion** Heat transfer from the top and bottom surfaces is small relative to that transferred from the side surface.



# Heat Transfer Cengel 3rd Edition Solution Manual

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