Answers to Review Questions 5.3:

1. A good insulator has a higher Specific Heat Capacity because it takes time to absorb more heat before it actually heats up (temperature rising) to transfer the heat.
2. Concrete absorbs more heat than soil in the day time. Similarly, the concrete releases more heat during the night than the day time, by then making cities warmer than country sides during the night other factors kept the same.
3. Given: m =100g = 0.1 kg, T_0= 20°C, T = 100°C, c = 129 J/kg.°C

The heat supplied is

$$Q = mc\Delta T = 0.1\ \text{kg} \times 129\ \text{J/kg.°C} \times (100°C - 20°C) = 1032J$$

4. Water has a higher heat capacity than soil and rock, so the ocean takes much longer to heat and to cool than the land. Coastal areas will generally have more moderate temperatures than inland areas because of the heat capacity of the ocean.
5. Given: T_0 = 10 °C, C = 2580 J/K, T_{Au} = 50°C , c_{Cu} = 385 J/kg.K, c_{Au} = 129 J/kg.K

The heat absorbed by gold or copper is

$$Q = C\Delta T = 2580\ \text{J/K} \times (50\ °C - 10\ °C) = 103200\ \text{J}$$

The mass, m, of gold/copper is

$$m = \frac{C_{Au}}{c_{Au}} = \frac{2580\ J/K}{129J/kg.K} = 20kg$$

$$Q = mc_{Cu}\left(T_{Cu} - T_0\right)$$

Solving this for T_{Au} and T_{Cu} from $Q = mc\left(T - T_0\right)$, for gold and copper, respectively, yield

$$T_{Au} = \frac{Q}{mc_{Au}} + T_0 = \frac{103200J}{20kg \times 129J/kg.°C} + 10°C = 50°C$$

$$T_{Cu} = \frac{Q}{mc_{Cu}} + T_0 = \frac{103200J}{20kg \times 385J/kg.°C} + 10°C = 23.4°C$$

6. Given: m_{Al} = 0.80 kg, m_w = 0.20 kg, T_0 = 25.0 °C, T = 85.0 °C

a) Heat required to bring about this temperature,

$$Q = m_{Al}c_{Al}\Delta T + m_w c_w \Delta T$$

$$Q = (0.80kg \times 900J/kg.K + 0.20\ kg \times 4200J/kg.K) \times (85.0\ °C - 25.0\ °C)$$

$$Q = 93600J$$

b) Heat absorbed by the pan is

$$Q_{pan} = (0.80kg \times 900J/kg.K) \times (85.0\ °C - 25.0\ °C) = 43200J$$

$$Q_{pan}\% = \frac{Q_{pan}}{Q} \times 100\% = \frac{43200J}{93600J} \times 100\% = 46.15\%$$

7. Half of the gravitational energy of the steel (U = mgh) is converted to heat.

Q = ½ U, implies mcΔT =½mgh.

Simplifying this, yields

$$\Delta T = \frac{gh}{2c} = \frac{10m/s^2 \times 50m}{2 \times 448J/kg.°C} = \frac{1000J/kg}{896J/kg.°C} = 0.56°C$$