Answer on Question #80115, Physics / Molecular Physics | Thermodynamics

A room in a house has a floor made entirely of concrete which is 200 mm thick. The lower surface of the concrete in contact with the ground has a temperature of 10°C and the upper surface, in contact with the living area has a temperature of 15°C. The floor is square and has sides 10m x 10m

a) Calculate the rate at which thermal energy ia conducted through the concrete. Assume the thermal conductivity of concrete is 0.750W/mK.
b) The temperature of thr carpet/concrete interface. The rate of conduction for both conductors are the same and the thermal conductivity of the carpet is 0.06W/mk.
c) The rate at which thermal energy is conducted through the two layers.

Answer:

a)

$$\frac{\Delta Q}{\Delta t} = \frac{kA}{l}(\theta_1 - \theta_2)$$

$$\frac{\Delta Q}{\Delta t} = \frac{0.75 \times 100}{0.2}(15 - 10) = 1875\ W = 1.875\ kW$$

b)

$$\frac{\Delta Q}{\Delta t} = \frac{k_1 A}{l_1}(\theta_1 - \theta_3)$$

$$\frac{\Delta Q}{\Delta t} = \frac{0.06 \times 100}{0.015}(15 - \theta_3) = 400\ (15 - \theta_3)$$

$$\frac{\Delta Q}{\Delta t} = \frac{k_2 A}{l_2}(\theta_3 - \theta_2)$$

$$\frac{\Delta Q}{\Delta t} = \frac{0.75 \times 100}{0.2}(\theta_3 - 10) = 375\ (\theta_3 - 10)$$

$$400\ (15 - \theta_3) = 375\ (\theta_3 - 10)$$

$$\theta_3 = 12.58\ ℃$$

c)

$$\frac{\Delta Q}{\Delta t} = 400(15 - 12.58) = 968\ W = 0.968\ kw$$

Answer: a) $1.875\ kW$; b) 12.58 ℃; c) $0.968\ kw$