

Answer on Question # 37026

Physics – Thermodynamics

Question:

A slab of stone of area 0.36 m square and thickness 0.1 m is exposed on the lower surface to steam at 100 degree c. a block of ice at 0 degree c rests on the upper surface of the slab. In one hour 4.8 kg of ice is melted. The thermal conductivity of slab is latent heat of fusion of ice = 3.36 into 10 raise to power 5 J/kg.

Solution:

$$S = 0.36 \text{ m}^2$$

$$d = 0.1 \text{ m}$$

$$T_1 = 100^\circ\text{C}$$

$$T_2 = 0^\circ\text{C}$$

$$m = 4.8 \text{ kg}$$

$$L = 33600 \frac{\text{J}}{\text{kg}}$$

$$t = 1 \text{ hour} = 3600 \text{ s}$$

Fourier's law:

$$q = -k\nabla T \equiv k \frac{T_1 - T_2}{d}.$$

Power of a heater:

$$P = qS = \frac{kS(T_1 - T_2)}{d} = \frac{Lm}{t}$$

Thus,

$$k = \frac{Lmd}{S(T_1 - T_2)} = 448 \frac{\text{W}}{\text{m} \cdot \text{K}}$$

Answer:

$$k = 448 \frac{\text{W}}{\text{m} \cdot \text{K}}$$