

Heat Transfer (Conduction)

30. (a) Calculate the rate of heat conduction through house walls that are 13.0 cm thick and that have an average thermal conductivity twice that of glass wool. Assume there are no windows or doors. The surface area of the walls is 120 m² and their inside surface is at 18.0°C , while their outside surface is at 5.00°C . (b) How many 1-kW room heaters would be needed to balance the heat transfer due to conduction? $Q/t = KA(T_1 - T_2)/L = (\text{Constant}) \times 120 \text{ m}^2 (18 - 5)/0.13$

31. The rate of heat conduction out of a window on a winter day is rapid enough to chill the air next to it. To see just how rapidly the windows transfer heat by conduction, calculate the rate of conduction in watts through a 3.00-m² window that is 0.635 cm thick (1/4 in) if the temperatures of the inner and outer surfaces are 5.00°C and −10.0°C , respectively.

This rapid rate will not be maintained—the inner surface will cool, and even result in frost formation.

32. Calculate the rate of heat conduction out of the human body, assuming that the core internal temperature is 37.0°C , the skin temperature is 34.0°C , the thickness of the tissues between averages 1.00 cm , and the surface area is

1.40 m² .

33. Suppose you stand with one foot on ceramic flooring and one foot on a wool carpet, making contact over an area of 80.0 cm² with each foot. Both the ceramic and the carpet are 2.00 cm thick and are 10.0°C on their bottom sides. At what rate must heat transfer occur from each foot to keep the top of the ceramic and carpet at 33.0°C ?

34. A man consumes 3000 kcal of food in one day, converting most of it to maintain body temperature. If he loses half this energy by evaporating water (through breathing and sweating), how many kilograms of water evaporate?

35. (a) A firewalker runs across a bed of hot coals without sustaining burns. Calculate the heat transferred by conduction into the sole of one foot of a firewalker given that the bottom of the foot is a 3.00-mm-thick callus with a conductivity at the low end of the range for wood and its density is 300 kg/m³ . The area of contact is 25.0 cm² , the temperature of the coals is 700°C , and the time in contact is 1.00 s.

(b) What temperature increase is produced in the 25.0 cm³ of tissue affected?

(c) What effect do you think this will have on the tissue,

keeping in mind that a callus is made of dead cells?

36. (a) What is the rate of heat conduction through the 3.00-cm-thick fur of a large animal having a 1.40-m² surface area? Assume that the animal's skin temperature is 32.0°C , that the air temperature is −5.00°C , and that fur has the same thermal conductivity as air. (b) What food intake will the animal need in one day to replace this heat transfer?