

GEOL 455. Fall, 2006.

Heat flow exercise

Assigned: October 26, 2006

Due: November 2, 2006.

Be careful on this exercise to use the correct units. The given units are a mix of SI and other common units.

1. Given that $k=0.8 \text{ W m}^{-1} \text{ K}^{-1}$ for glass, and that $k=0.025 \text{ W m}^{-1} \text{ K}^{-1}$ for air, find the effective thermal conductivity of two alternative window systems: a) 1.5 cm of glass, and b) two layers of glass, each 0.3 cm thick, separated by 0.9 cm of air. Discuss the relative advantages of these two alternative systems.
2. The temperature of the inside surface of a sliding glass door with the characteristics of system (b) above is 50.5 F. On the outside the temperature is 31.5 F. The door has two layers of glass with air between, and the thickness is 1.5 cm. With this information, what is the heat flow through this door? Express the results in both W m^{-2} and hfu. Compare this to a typical heat flow in the Earth, as discussed in class.
3. Suppose that this door is the only surface in a building where heat is lost to the environment. The room is 5 m by 6 m in floor area, and 2.5 m high, and filled with air. The door is 2 m high and 3 m wide. The specific heat capacity of the air in the room is $c= 1.0 \text{ J g}^{-1} \text{ K}^{-1}$, and the density of the air is $\rho= 1.2 \text{ kg m}^{-3}$. The outside air temperature is 20 F. If the air inside the room is not heated from the walls, floor or ceiling, and is well mixed by convection currents, how long will it take the room to cool down from an initial temperature of 70 F to 50 F? To simplify the problem, approximate the heat flow as a constant over time equal to the rate when the temperature inside is 60 F.