

HEAT TRANSFER

FREE CONVECTION – TUTORIAL

1. A household oven door of 0.5 m height and 0.7 m width reaches an average surface temperature of 32 °C during operation. Estimate the heat loss to the room with ambient air at 22 °C. If the door has an emissivity of 1.0 and the surrounding are also at 22 °C, comment of the heat loss by free convection relative to that by radiation. (**Ans: $q_{\text{conv}} = 11.7 \text{ W}$; $q_{\text{rad}} = 21.4 \text{ W}$**)
2. Coca cola in cans 150 mm long and 60 mm in diameter is initially at 27 °C and is to be cooled by placement in a refrigerator compartment at 4 °C. In the interest of maximizing the cooling rate, should the cans be laid horizontally or vertically in the compartment? As a first approximation, neglect heat transfer from the ends. (**Ans: $q_v = 3.28 \text{ W}$; $q_h = 3.38 \text{ W}$**)
3. An 8 m long section of a 9 cm diameter horizontal hot water pipe passes through a large room whose temperature is 25 °C. If the outer surface temperature of the pipe is 95 °C, determine the rate of heat loss form the pipe by natural convection. Assume steady state condition, air is ideal gas and atmospheric pressure is 1 atm. (**Ans: 990 W**)
4. Consider a 0.6 m x 0.6 m thin square plate in a room at 30 °C. One side of the plate is maintained at 90 °C, while the other side is insulated. Determine the rate of heat transfer form the plate by natural convection if the plate is:
 - (a) vertical, (**Ans: 107 W**)
 - (b) horizontal with hot surface facing up, (**Ans: 130 W**)
 - (c) horizontal with hot surface facing down. (**Ans: 64.8 W**)
5. A horizontal, high pressure steam pipe of 0.1 m outside diameter passed through a large room whose wall and sir temperatures are 23 °C. The pipe has an outside surface temperature of 165 °C and an emissivity of 0.85. Estimate the heat loss from the pipe per unit length. (**Ans: 764 W/m**)