CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering

ECHE 225: Fall 2024

Homework #1: Thermodynamic concepts, work and heat

Due: September 5

1. [Chapter 3] Consider a room that is held at a constant temperature of $20°C$. The room contains six 14.5-W lightbulbs, a 2-kW electric oven, and a 200-W refrigerator. Assuming no heat transfer through the walls, determine the rate at which an air conditioning unit must remove heat from the room when all of these devices are on.

2. [Chapter 3] A fan is to accelerate quiescent air to a velocity of 8 m/s at a rate of 10.62 kg/s. If 30 W of the supplied power is turned into heat, determine the minimum power that must be supplied to the fan.

3. [Chapter 3] A homeowner is considering these heating systems for heating their house:

   - Electric resistance heating at $0.12/kWh (1 kWh = 3600 kJ)
   - Natural gas heating at $1.22/therm (1 therm = 105,500 kJ)
   - Oil heating at $2.35/gal (1 gal of oil = 138,500 kJ)

   Assuming efficiencies of 100% for the electric furnace and 87% for oil and gas furnaces, determine the heating system with the lowest cost.

4. [Chapter 5] A rigid container equipped with a stirring device contains 1.5 kg of motor oil. Determine the rate of specific energy increase when heat is transferred to the oil at a rate of 1 W and 1.5 W of power is applied to the stirring device.

1. 2287 W

2. 370 W

3. Gas

4. 1.67 W/kg