

4.42 Quiz 1

An inventor proposes a refrigerator that makes ice which is then melted and used to cool a cold storage room. The refrigerator is put into a closed insulated room without any air flow into or out of the room. It is turned on when the water is liquid at 0C, the initial room temperature. It makes 10kg of ice which is then melted to liquid at 0C without any evaporation of the water.

- a) Will the room temperature increase or decrease for the entire process (from the time the refrigerator is turned on to the time the ice has melted)?
- b) If the refrigerator has a COP of 3 and it is only used to make the ice, how much electrical energy does the refrigerator require? Take the internal energy change from ice to liquid water at 0C as 334 kJ/kg. The COP is the rate of useful cooling to the rate of electrical energy consumed.
- c) If 0.25 kg of water evaporates after all of the ice has melted, does the room temperature increase or decrease over the entire process?

An MIT fraternity holds a party in their largest common room, which is 10m long x 10m wide x 3m high. The party lasts 4 hours and 300 students attend. Because everyone is dancing, each person gives off 300 Btu/hr of sensible heat. The home theatre system uses 1000W. Two 100W lights are also on.

The room has a 0.1m concrete slab floor. The air in the space and the slab are initially at 68 °F. Assume that the specific humidity remains constant for both problems.

a. If the room is perfectly insulated and there is no ventilation system, what is the temperature of the air in the space at the end of the party? Assume that the air and floor slab end up at the same temperature and that all electrical equipment is on the whole time. Is this a comfortable temperature?

b. For their second party, the frat brothers decide to naturally ventilate the space using two windows, each 1.5m x 2m. The temperature of the air outside is 60 °F and the wind velocity is 2 m/s. Let v_{in} be the velocity of air entering the open windows. Assume that $v_{in} = 0.35 v_{wind}$ and that all the rate of air leaving the space is the same as air entering the same. If all other conditions stay the same, what is the temperature of the air in the space at the end of the second party? Again assume that the air and floor slab end up at the same temperature and that all air is well-mixed. Is this a comfortable temperature?

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