

1) Simmons Hall, the new MIT student dorm on campus will be operated to minimize energy use. One proposed strategy to reduce air conditioning energy in the summer is night cooling. At 8 p.m. the windows are opened and cool night air is circulated through the room. By 8 a.m. the room air and the concrete floor slab have a temperature close to that of the outside air, 18 degrees Centigrade. The slab is four inches thick. At 8 a.m. the windows are closed and heat transfer to the cooled floor slab helps to maintain a comfortable interior temperature. Neglect any heat transfer through the closed windows. Assume that the average rate of electrical and solar energy into the room totals 500 watts over the 12 hours. Sketch the room temperature vs. time for the 12 hour period between 8 a.m. and 8 p.m. What is the maximum room temperature? Assume as a limiting case that the slab and the air temperature are always equal.

2) To supplement the night cooling strategy described above, it is proposed to spray liquid water droplets into the air. If the room air at 8 a.m. is completely dry what is the maximum amount of liquid water that can be evaporated into the room air at 18 degrees Centigrade? Assume that the room is closed up and there is no air circulation from the outside into the room.

3) Using both night cooling and the maximum amount of liquid water evaporation in the room, estimate the room temperature at 8 p.m. From 8 a.m. to 8 p.m. the windows are closed and the average electrical and solar energy into the room totals 500 watts. To solve, write an energy balance for a system including the floor slab, the water and the air. Take state 1 as liquid water, floor slab and air at 18 degrees Centigrade, the conditions and 8 a.m. Take state 2 as the slab and saturated air at 8 p.m.

4) What do you think about the feasibility of the proposed solutions?