Additional Problem X for Physics 6 (from an old exam)

Dr. Wacko enjoys making ice sculptures in her free time. One winter day, she gets a block of ice, of mass 0.40 kg, out of her freezer, and sets it on a table in her studio. The temperature of the ice as it leaves the freezer is $-20°$C. The lab is maintained at a constant temperature of 25°C.

Just as Dr. Wacko is about to begin carving the ice, she hears a strange noise from the lab next door. Worried that something has happened to Bernice, or to their latest invention, she rushes to the lab, leaving the ice sitting out. She returns some time later, having taken care of the situation, and is dismayed to see that the piece of ice has entirely melted.

Some numbers that may be useful: the specific heat of ice is 2090 J/kg°C. The specific heat of water is 4186 J/kg°C. The latent heat of fusion of water is 3.33×10^5 J/kg.

a) How much heat was transferred from the surroundings to the ice in order to warm the ice to its melting point?

b) Once the ice reached the melting temperature, how much heat needed to be transferred from the surroundings in order to melt it completely?

c) From just before the ice began to melt until just after it had completely melted, what was its change in entropy? (Note that the temperature of the ice does not change during this time.)

d) What was the change in entropy of the surroundings (the air, the table, etc.) during this same time period?

e) (4 points) What was the *total* change in entropy of the system (ice + lab) during this time period? Explain how your answer is consistent with the second law of thermodynamics.