Freezing a Community Skating Rink

Base your answers on the information provided and your knowledge of chemistry. Use the 2025 Chemistry Reference Tables as needed.

A community rink uses coolant circulating through tubing under its floor. Heat moves from the water into the colder coolant. In a small model of the rink, the crew spreads 2.00 kg of water initially at 8.0 °C. The crew first cools the water to 0.0 °C and then freezes it at that temperature. Ignore heat exchange with the air during this test.

Property	**Value for the water model**
Specific heat of liquid water	4.18 J/(g·°C)
Heat of fusion	334 J/g
Freezing temperature	0.0 °C

1 Which statement describes the direction of heat flow while the model water cools toward 0.0 °C?

(1) From the coolant into the warmer water

(2) From the water into the colder coolant

(3) From the floor into the water because the water loses mass

(4) No net transfer occurs until freezing begins

2 Calculate q for the water during cooling before freezing begins. Include the sign and show a setup. [1]

Answer and work

3 The crew continues to remove heat while the water and ice remain at 0.0 °C. Explain how this can happen. [1]

Answer and work

Keeping the ice frozen

Once the ice has formed, a section of the rink gains heat through its floor. The crew tests panels of the same area. The proposed panel must add at most 3.0 kg of mass to the section and must reduce the heat entering through the floor to at most 84 kJ in one hour.

Panel	Added mass (kg)	Heat entering in one hour (kJ)
No panel	0.0	134
Fiber	2.2	88
Foam	2.8	67
Laminate	3.4	53

4 Which panel meets both limits?

(1) Fiber

(2) Foam

(3) Laminate

(4) Fiber and foam

5 If all the heat entering with the foam panel melts ice at 0.0 °C, estimate the mass of ice that melts in one hour. Show a setup. [1]

Answer and work

6 Evaluate the claim that the foam panel cuts the heat entering through the floor by more than half in one hour. Cite numerical evidence. [1]

Answer and work