Liquid and solid water; the growth of ice crystals

On a cold clear night the Earth loses heat by radiation. The temperature of the air above a pond is several degrees below zero as a skin of ice begins to form, while the temperature of the liquid water below the ice is slightly above freezing. As the ice thickens the latent heat is conducted through the ice layer and radiated away into the night sky. Under these conditions the interface between the ice and the water is very nearly smooth.

(i) Imagine that the layer of ice is about 10 mm thick. Estimate from your experience how quickly the ice is thickening. Give your answer as a rate in mm s^{-1}.
(ii) Design an experiment to measure the rate at which ice freezes (or melts).
(iii) Carry out your experiment after having it checked to see if it is feasible.
(iv) It is quite easy to explain why ice floats on water. Can you explain why the pond does not freeze solid?

Data

Latent heat of water = 333 kJ kg^{-1}

Thermal conductivity of ice = 2.1 J s^{-1} m^{-1} K^{-1}

Density of ice = 0.92 kg m^{-3}

Health & Safety

In planning this activity, you should consider health and safety. Check your plans with your teacher before implementing them.

Credits

Health & safety checked May 2018

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