G4 Latent Heat and Heat Capacity

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Data: Specific heat capacity of water = 4180 J kg^{-1} K^{-1}
Specific heat capacity of ice = 2030 J kg^{-1} K^{-1}
Specific latent heat of fusion of ice = 3.35×10^5 J kg^{-1}
Specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}
Assume that the given heat capacities remain constant with temperature.

G4.1 A frozen pipe contains 5.60 kg of ice.

a) How much energy is needed to melt it without changing its temperature?

b) If, in fact, the ice were initially at -3.5 °C, how much energy would be taken to warm it to melting point and then melt it?

G4.2 A certain quantity of ice requires 10.0 J to warm it to melting temperature. It then requires 100 J to melt it.

a) Calculate the initial temperature of the ice, assuming no heat loss to the surroundings.

b) The water, at freezing in (a), is then heated using a further 100 J. What is its final temperature?

G4.3 Calculate the ratio between the energy needed to vaporize a certain quantity of water, and the energy needed to heat that same quantity of water from the freezing to boiling point (without boiling it).

G4.4 2.25 kg of ice, initially at -40 °C, is heated using a 3.2 kW heater without loss to the surroundings. How much time elapses before

a) the ice reaches melting temperature?

b) the ice has all melted?

c) the water reaches boiling point?

d) the water has all vaporized?

G4.5 0.35 kg of ice at -15 °C is lowered into an insulated beaker of 0.61 kg of water at 59 °C.

a) What is the temperature after equilibrium has been reached?

b) What is the minimum mass of water at 59 °C which could be added to achieve a final temperature of 0.0 °C?

c) What is the maximum mass of water at 59 °C which could be added to achieve a final temperature of 0.0 °C?