Answer on Question #60843, Physics – Molecular Physics | Thermodynamics

A student wants to cool 0.25kg of Coke drink (mostly water), initially 25°C, by adding ice initially at -20°C. How much ice should be added so that the final temperature will be 0°C with all the ice melted if the heat capacity of the container may be neglected.

Solution:

Specific heat capacity, ice: c_{ice} = 2.108 kJ/kg-K

Specific heat capacity, water: c_{water} = 4.187 kJ/kg-K

The heat of fusion (or specific enthalpy of fusion) of ice is L = 334 kJ/kg.

After mixing, the hot liquid has cooled to a temperature Tc=0°C.

The quantity of heat from first liquid:

$$Q_1 = c_{water}\, m_{water}(T_1 - T_c)$$

The energy to heat up the ice is the sum of the following

$$Q = c_{ice} m_{ice}(T_C - T_2) + L m_{ice}$$

Since heat does not disappear, and transferred from one liquid to another:

$$Q_1 = Q_2$$

$$c_{water}\, m_{water}(T_1 - T_c) = c_{ice} m_{ice}(T_C - T_2) + L m_{ice}$$

Thus,

$$m_{ice} = \frac{c_{water}\, m_{water}(T_1 - T_c)}{c_{ice}(T_C - T_2) + L}$$

$$m_{ice} = \frac{4187 \cdot 0.25 \cdot (25 - 0)}{2108 \cdot (0 + 20) + 334000} = 0.0696 \text{ kg} \approx 0.07 \text{ kg}$$

Answer: