15-Phys-203

S 2002

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Quiz 2 Name _____

1. A cube of ice whose mass is $m_{ice} = 10$ g and whose temperature is 0°C - the freezing temperature of water - is placed in an insulated thermos containing $m_w = 100$ g of water at the temperature $T_i = 2$°C.

   (a) Calculate the heat required to completely melt the ice cube. The heat of fusion of water is $L_F = 333$ kJ/kg.

   $$Q_{ice} = L_F m_{ice} = (333 \text{ J/g})\,(10 \text{ g}) = 3330J$$

   (b) Calculate the heat that the water would loose if cooled to 0°C. The specific heat of water is $c_w = 4190$ J/kg·K.

   $$Q_w = c_w m_w\,(T_i - 0°C) = (4190 \text{ J/kg}\cdot\text{K})\,(0.1 \text{ kg})\,(2°\text{C} - 0°\text{C}) = 838J$$

   (c) Based on the above calculations, will all the ice melt? If not, how much of the ice will melt? What is the final temperature in the thermos?

   The final temperature in the thermos is 0°C.

   The amount of ice that will melt is

   $$\Delta m_{ice} = Q_w/L_F = 838J/\,(333 \text{ J/g}) = 2.5 \text{ g}$$

   (d) Suppose now that the mass of water in the thermos is $M_w = 5m_w = 500$ g. What is the final temperature T_f in the thermos?

   $$Q_{ice} + c_w m_{ice}\,(T_f - 0°C) + c_w M_w\,(T_f - T_i) = 0$$
   $$Q_{ice} - c_w M_w T_i + c_w m_{ice} T_f + c_w M_w T_f = 0$$
   $$T_f = \frac{c_w\,(5m_w)\,T_i - Q_{ice}}{c_w\,(m_{ice} + M_w)} = \frac{5Q_w - Q_{ice}}{c_w\,(m_{ice} + M_w)} = \frac{4190J - 3330J}{(4190 \text{ J/kg}\cdot\text{C°})\,(0.51 \text{ kg})} = 0.4°\text{C}$$