Answer on Question #53366, Physics / Other

A man takes a brick out of the fire when it's at 275 °C, he drops it in a bucket of water, and then covers the bucket. The bucket and cover are made of an insulating material. The bucket contains 2,5 kg of ice originally at -5 °C. The 1.3 kg brick is made of iron, which has a specific heat of 448 J / (kg•°C). Let's find the temp of the brick and water once equilibrium is reached.

Solution:

When two or more objects at different temperatures are brought together in an isolated environment, they eventually reach the same temperature by the process of heat exchange. That is, warmer materials transfer heat to colder materials until their temperatures are the same.

The ice will warm up to 0 degrees Celsius, then melting and then warming to the final temperature.

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.

The energy to heat up the ice is

$$Q_1 = c_{ice} m \Delta T_1 = 2108 * 2.5 * \big(0 - (-5)\big) = 26350 \text{ J}$$

The energy to melt the ice is

$$Q_2 = Lm = 334 * 10^3 * 2.5 = 835000 \text{ J}$$

The heat released by the cooling iron brick to 0 degrees Celsius

$$Q_{iron} = c_{Fe} m_{Fe} (0 - 275) = 448 * 1.3 * (0 - 275) = -160160 \text{ J}$$

Hence,

$$Q_1 + Q_2 + Q_{iron} > 0$$

Not all of the ice melts. This means T_f = 0°C.

Answer: T_f = 0°C.