**LATENT HEAT QUESTIONS**

1. Calculate the heat absorbed by an electric refrigerator in changing 2 kg of water at 15° C to ice at 0° C.
2. Determine the resulting temperature, **t**, when 0.150 kg of ice at 0° C are mixed with 0.300 kg of water at 50° C.
3. 0.5 kg of water and 0.100 kg of ice are in thermal equilibrium at 0° C. If 0.200 kg of steam at 100° C is introduced into the mixture, find the final temperature and composition of the mixture. (Extension Question)

**DATA**

Specific heat capacity of water is 4184 Jkg-1K-1.

Specific Latent Heat of Fusion of ice = 3.35 x 105 Jkg-1

Specific Latent Heat of Vaporization of water = 2.26 x 106Jkg-1

**Solutions commence over the page.**

**Solutions**

1. Heat absorbed in changing water at 15° C to water at 0° C:



Heat absorbed in changing water at 0° C to ice at 0° C:

 
2. So, the water is going to melt the ice. We need to calculate how much heat that takes. The liquid water produced by the melting ice will initially be at 0° C. So, we have to work out how much heat is required to raise the temperature of this water to the final temperature, **t**. The 0.300 kg of water at 50° C is going to lose heat in this process. We need to determine how much heat it loses.

Heat to melt ice:
 

Heat to raise temperature of 0.150 kg of water at 0° C to final temperature:
 

Heat lost by 0.300 kg of water at 50° C:
 

Heat lost by the warmer water = heat gained by the ice & ice water
 

Resulting temperature is 6.73° C.

1. Our plan of attack is to determine the expression for the heat required to melt the ice and raise the temperature of the water to the final temperature – let’s call it **t**; and the expression for the heat given up by the steam in condensing and cooling to the final temperature, **t**. That will enable us to find **t**, since the two expressions must be equal. So, let’s get that done first. Remember, the 0.5 kg of water and 0.1 kg of ice are in thermal equilibrium at 0° C initially. So, once the ice has melted, there will be 0.6 kg of water to raise from 0° C to **t**.

Heat to melt ice & raise temperature of water to final temperature, t:
 

Heat given up by steam in condensing & cooling to final temperature, t:
 

Then, heat absorbed by cold body = heat given up by hot body
 

Now, let’s think for a moment what this means. If **t** had been less than 100° C, it would mean that all of the steam had condensed, and the water had risen to whatever temperature **t** represented. A value of **t** > 100° C, means there was more steam than necessary to raise the temperature of the ice and water to 100° C. Thus, the final temperature of the mixture of steam and water is 100° C and some steam is not condensed. Let **M** be the mass of steam that has condensed.

Heat to melt ice and raise temperature of water to 100° C:
 

Heat given up by M kg of steam in condensing:
 

And heat absorbed by cold body = heat given up by hot body
 