State Examination Commission – Physics Higher Level, 2008

Question 2

In an experiment to measure the specific latent heat of fusion of ice, warm water was placed in a copper calorimeter. Dried, melting ice was added to the warm water and the following data was recorded.

mass of calorimeter	60.5 g
mass of calorimeter + water	118.8 g
temperature of warm water	30.5 °C
mass of ice	15.1 g
temperature of water after adding ice	10.2 °C

Explain why warm water was used.
Why was dried, melting ice used?
Describe how the mass of the ice was found.
What should be the approximate room temperature to minimise experimental error? (22)
Calculate:
(i) the energy lost by the calorimeter and the warm water;
(ii) the specific latent heat of fusion of ice. (18)

(specific heat capacity of copper = 390 J kg^{-1} K^{-1}; specific heat capacity of water = 4200 J kg^{-1} K^{-1})

Explain why warm water was used.

Warm water was used to speed the melting of the ice and so that the heat exchange between the calorimeter and its contents with the environment, during the whole experiment, would be balanced.

Why was dried, melting ice used?

Ice that is melting is at zero degrees. Ice that has melted has already acquired it latent heat of fusion, which during this experiment it should be taking from the calorimeter and warm water and not the air outside. Hence, the ice is dried.

Describe how the mass of the ice was found.

The mass of the calorimeter with warm water in it, is, subtracted from the mass of the calorimeter, warm water and ice.

What should be the approximate room temperature to minimise experimental error? (22)

Midway between initial temperature of the calorimeter and warm water and the final temperature after all the ice has been added. In this case about 20.4 ^{0}C.

Calculate:
(i) the energy lost by the calorimeter and the warm water;

Heat lost by calorimeter and warm water	=	Heat lost by water in calorimeter falling from 30.5 ^{0}C to final temperature 10.2 ^{0}C	+	Heat lost by copper calorimeter falling from 30.5 ^{0}C to final temperature 10.2 ^{0}C
E	=	$m_w c_w \Delta\theta_w$	+	$m_c c_c \Delta\theta_c$
E	=	(0.0583)(4200)(20.3)	+	(0.0605)(390)(20.3)
E	=	5450 J		

(ii) the specific latent heat of fusion of ice.

Heat lost by calorimeter and warm water	=	Heat gained by 15.1 g of ice melting at 0 ^{0}C	+	Heat gained by 15.1 g of water rising from 0.0 ^{0}C to final temperature 10.2 ^{0}C
5450	=	$m\, l_m$	+	$m_w c_w \Delta\theta_w$
5450	=	$(0.0151) l_m$	+	(0.0151)(4200)(10.2)
l_m	=	3.18×10^5 J kg^{-1}		