

State Examination Commission – Physics Higher Level, 2010

Question 2

In an experiment to measure the specific latent heat of vaporisation of water, a student used a copper calorimeter containing water and a sensitive thermometer.

The water was cooled below room temperature before adding dry steam to it.

The following measurements were recorded.

Mass of copper calorimeter	= 34.6 g
Initial mass of calorimeter and water	= 96.4 g
Mass of dry steam added	= 1.2 g
Initial temperature of calorimeter and cooled water	= 8.2 °C
Final temperature of calorimeter and water	= 20.0 °C

How was the water cooled below room temperature? (6)

How was the steam dried? (6)

Describe how the mass of the steam was determined. (6)

Why was a sensitive thermometer used? (6)

Using the data, calculate the specific latent heat of vaporisation of water. (16)

(specific heat capacity of water = 4180 J kg⁻¹ K⁻¹; specific heat capacity of copper = 390 J kg⁻¹ K⁻¹)

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Final temperature of calorimeter and water	= 20.0 °C

How was the water cooled below room temperature? (6)

Cold water from the fridge was added to get it to the desired temperature

How was the steam dried? (6)

By passing it through a steam trap, which collected any steam that had condensed into water, just before passing it into the cold water.

Describe how the mass of the steam was determined. (6)

by subtracting the mass of the calorimeter + cold water from the mass of the calorimeter + cold water + steam.

Why was a sensitive thermometer used? (6)

To increase the accuracy of the temperature measurements, thereby reducing the possible percentage error.

Using the data, calculate the specific latent heat of vaporisation of water.

(16)

Heat lost by steam condensing at 100 °C + Heat lost by resulting water cooling from 100 °C to final temperature, 20 °C = Heat gained by water in calorimeter rising from 8.2 °C to final temperature 20 °C + Heat gained by copper calorimeter rising from 8.2 °C to final temperature 20 °C

$$m_s l_v + m_s c_w \Delta\theta_s = m_w c_w \Delta\theta_w + m_c c_c \Delta\theta_c$$

$$(0.0012) l_v + (0.0012)(4180)(80) = (0.0618)(4180)(11.8) + (0.0346)(390)(11.8)$$

$$l_v = 2.33 \times 10^6 \text{ J kg}^{-1}$$