

State Examination Commission – Physics Higher Level, 2005

Question 2

In an experiment to measure the specific latent heat of vaporisation of water, cool water was placed in an insulated copper calorimeter. Dry steam was added to the calorimeter.

The following data was recorded.

Mass of calorimeter = 50.5 g

Mass of calorimeter + water = 91.2 g

Initial temperature of water = 10 °C

Temperature of steam = 100 °C

Mass of calorimeter + water + steam = 92.3 g

Final temperature of water = 25 °C

Calculate a value for the specific latent heat of vaporisation of water. The specific heat capacity of copper is $390 \text{ J kg}^{-1} \text{ K}^{-1}$ and the specific heat capacity of water is $4200 \text{ J kg}^{-1} \text{ K}^{-1}$. (24)

Why was dry steam used? How was the steam dried? (10)

A thermometer with a low heat capacity was used to ensure accuracy. Explain why. (6)

Calculate a value for the specific latent heat of vaporisation of water. (24)

Heat lost by steam condensing at 100 °C + Heat lost by resulting water cooling from 100 °C to final temperature, 25 °C = Heat gained by water in calorimeter rising from 10 °C to final temperature 25 °C + Heat gained by copper calorimeter rising from 10 °C to final temperature 25 °C

$$\begin{aligned} m_s l_w + m_s c_w \Delta \theta_s &= m_w c_w \Delta \theta_w + M_c c_c \Delta \theta_c \\ (0.0011) l_w + (0.0011)(4200)(75) &= (0.0407)(4200)(15) + (0.0505)(390)(15) \\ l_w &= 2.28 \times 10^6 \text{ J kg}^{-1} \end{aligned}$$

Why was dry steam used? (6) How was the steam dried? (4)

In the above calculation we assume that the steam loses all of its latent heat of vaporization to the calorimeter and the water within it. However, condensed steam entering the calorimeter would already have lost its latent heat to its surroundings and would therefore produce error in our result. The steam is dried by passing it through a steam trap immediately prior to passing it into the calorimeter.

A thermometer with a low heat capacity was used to ensure accuracy. Explain why. (6)

If the thermometer has a low heat capacity, then it will absorb very little heat in order to record a temperature change. Our calculation does not allow for heat being absorbed by the thermometer, so the low heat capacity improves the accuracy of our result.