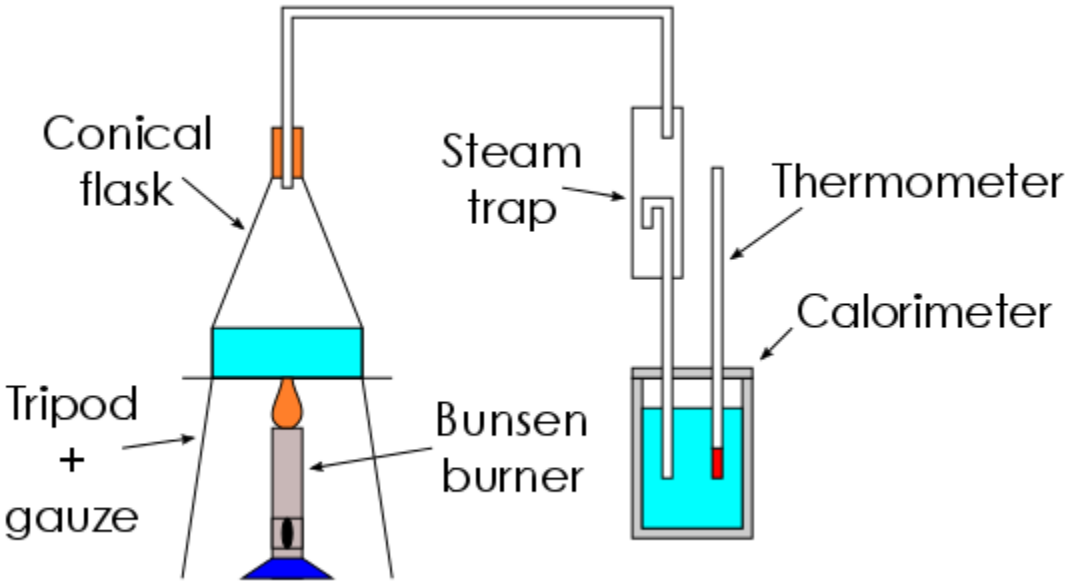
To Measure the Specific Latent Heat of Vaporisation of Steam

Diagram



Apparatus

- Bunsen burner, tripod, and gauze
- Flask, stopper, and tubing
- Retort stands
- Steam trap
- Calorimeter and insulation
- Thermometer
- Mass balance

Procedure

1. Measure the mass of the calorimeter using the mass balance.
2. Half-fill the calorimeter with water and find the mass of the combination.
3. Cool the calorimeter and water to around 5 degrees below room temperature by immersing it in ice and measuring the temperature with a thermometer.
4. Add the insulation to the calorimeter.
5. Add some water to the conical flask, then connect it to the steam trap.
6. Heat the water with the Bunsen burner and wait until a lot of dry steam is emerging from the steam trap.
7. Insert the tubing from the output of the steam trap into the water in the calorimeter.
8. Allow the water in the calorimeter to reach around 5 degrees above room temperature.
9. Measure the mass of the calorimeter and the water.

Results

Controlled Variables

- Mass of empty calorimeter = 0.0346 kg
- Mass of calorimeter + water = 0.0946 kg
- $\Delta\theta_{water} = \Delta\theta_{copper} = 10\ K$
- $c_{copper} = 390\ J\ kg^{-1}\ K^{-1}$
- $c_{water} = 4180\ J\ kg^{-1}\ K^{-1}$

Results Table

None

Graph

None

Calculations

- Mass of water = 0.0964 – 0.0346 = 0.0500 kg
- Mass of calorimeter + water + steam = 0.0954 kg
- ⇒ Mass of steam = 0.0954 – 0.0946 = 0.0008 kg
- $\Delta\theta_{steam} = 100 - 23 = 77\ K$

- Heat lost by steam = heat gained by water and calorimeter
- $m_s l + m_s c_s \Delta\theta_s = m_w c_w \Delta\theta_w + m_c c_c \Delta\theta_c$
- $\Rightarrow 0.0008(l) + (0.0008)(4180)(77) = (0.0500)(4180)(10) + (0.0346)(390)(10)$
- $\Rightarrow 0.0008l + 257.488 = 2090 + 134.94$
- $\Rightarrow 0.0008l = 1967.452$
- $\Rightarrow l = 2459315 \approx 2.46\times10^6\ J\ kg^{-1}$

Conclusions

- The specific latent heat of vaporisation of steam is $2.46\times10^6\ J\ kg^{-1}$.

Comments

Precautions

- Stir the water in the calorimeter lightly to allow the water and copper to come to the same temperature.
- Start the water below room temperature and end the measurements above room temperature to ensure that heat lost to the environment is the same as the heat gained from it.

Sources of Error

- The small mass of steam added means a large percentage error in the measurement of its mass due to the limited accuracy of the mass balance.
- Room temperature may vary over the course of the experiment, meaning that the water may lose more or less heat to the environment than it gains.

Improvements

- Repeat the experiment for a wider temperature range to require more added steam.
- Repeat the experiment for larger masses of water to require more added steam.