

Latent Heats

This activity considers the latent heats of vaporization and fusion of water.

1. An amount of water of mass $m_w = 150\text{g}$ is initially at temperature $T_I = 10^\circ\text{C}$ inside a calorimeter of heat capacity C_c . The temperature of the water is raised to $T_F = 30^\circ\text{C}$ by passing steam through it and it is found that the mass of the water increases by Δm .

a) Write down an equation that represents the conservation of energy for the process.

b) From your result to part (a) determine the latent heat of vaporization in terms of T_I , T_F , m_w , Δm , c_w , C_c .

c) The above result can be used to determine the water latent heat once the heat capacity of the calorimeter is known. Suppose the calorimeter is partially filled with a known mass of warm water and the temperature of the system is recorded. Now cold water of known mass and temperature is added to the warm water-calorimeter system and the final equilibrium temperature recorded. Explain how this procedure can be used to estimate the heat capacity of the calorimeter.

d) Carry out the steps outlined in (c) and from your results determine the calorimeter heat capacity.

e) Now that you have an estimate for C_c you can proceed to experimentally determine the latent heat of vaporization of water. Carry out the process outlined at the beginning of this problem and use your results to determine L_v .

f) How do your results compare with the accepted value of the heat of vaporization of water? How do they compare with your estimation of the latent heat you performed last week? Which method do you trust more?

g) What advantage, if any, is there with starting the liquid out at a temperature below that of room temperature?

h) Roughly what fraction of the total heat capacity of the system does the calorimeter contribute?

2. Consider 150g of water initially at $T_I = 30^\circ\text{C}$ inside the calorimeter. Now an amount Δm of ice is added to the water that lowers its temperature to $T_F = 10^\circ\text{C}$.

a) Write down an equation that expresses energy conservation for the process.

b) Using the result of part (a) determine the water latent heat of fusion in terms of T_I , T_F , m_w , Δm , c_w , C_c .

c) Experimentally carry out the process outlined in this problem. Use your results and your previous value for C_c to determine the latent heat of fusion for water.

d) Compare your results with the accepted value of L_f and comment on any factors you believe lead to the discrepancy. Is there any advantage using shaved ice over cube ice? What effect, if any, would using wet ice have on your results?