VL-H3: DETERMINATION OF THE LATENT HEAT OF MELTING OF ICE USING ELECTRICAL METHOD

Objectives:

- To measure the latent heat of melting of ice when it undergoes a phase change.
- To measure the transfer of heat energy between the substance and its surrounding environment.

System requirements:

Computer (Desktop/Laptop), Operating systems: Windows, **Melting_vle (zipped) File**.

Advise:

Students are advised to follow the **procedures written in this manual very strictly,** while performing the experiment. **Do not try to explore anything else in the experiment.**

Theory:

When a substance is heated, the temperature of the substance increases gradually until it reaches its melting point where the substance starts to melt. As the substance start to melt, the temperature of the substance remains constant until the melting is completed. During the melting, thermometer reading will not be changed and at this time the heat is used to overcome the intermolecular force that binds the molecules of the substance together and make the substance change from solid state to liquid state.

The amount of heat required to accomplish a phase change is called the heat of transformation. More specifically, for a solid to liquid phase change, it is referred to as the heat of fusion (or melting). Therefore, the amount of heat required to convert unit mass of solid into liquid state without change its temperature is called the latent heat of fusion of that substance.

In this experiment, ice cube at 0°C of mass m is used and the energy supplied from the heater is only used to melt the ice into liquid at 0°C.

Therefore, Heat energy supplied + g = L × m .... (1)

where ‘L’ is the latent heat of melting, ‘m’ is the mass melted and ‘g’ is the heat gained from room

Now, the heat energy Q = (power× time required) = VI × t .... (2)

Equation (1) becomes VI × t + g = L × m .... (3)

Dividing the equation (3) by t and we get

$$\mathrm{VI} + \frac{g}{t} = L \times \frac{m}{t}$$

$$\text{or,}\ \ \mathrm{VI} + \mathrm{G} = L \times \frac{m}{t} \qquad \text{.................. (4)}$$

$$\text{or}\ \ \mathrm{VI} = L \times \frac{m}{t} - \mathrm{G} \qquad \text{................... (5)}$$

where G = $\frac{g}{t}$ is the rate of heat gained from room, which is constant. If we do the experiment for different power inputs, we can plot a graph of power (in Y-axis) against $\frac{dm}{dt}$ (in X-axis). The gradient will be a value for L, and the intercept will be the negative of G.

Procedures:

1. At first unzip **"Melting (zipped)"** File. Click on the executable file **"Melting_vle"**, then a window will open as shown in Fig. 1.

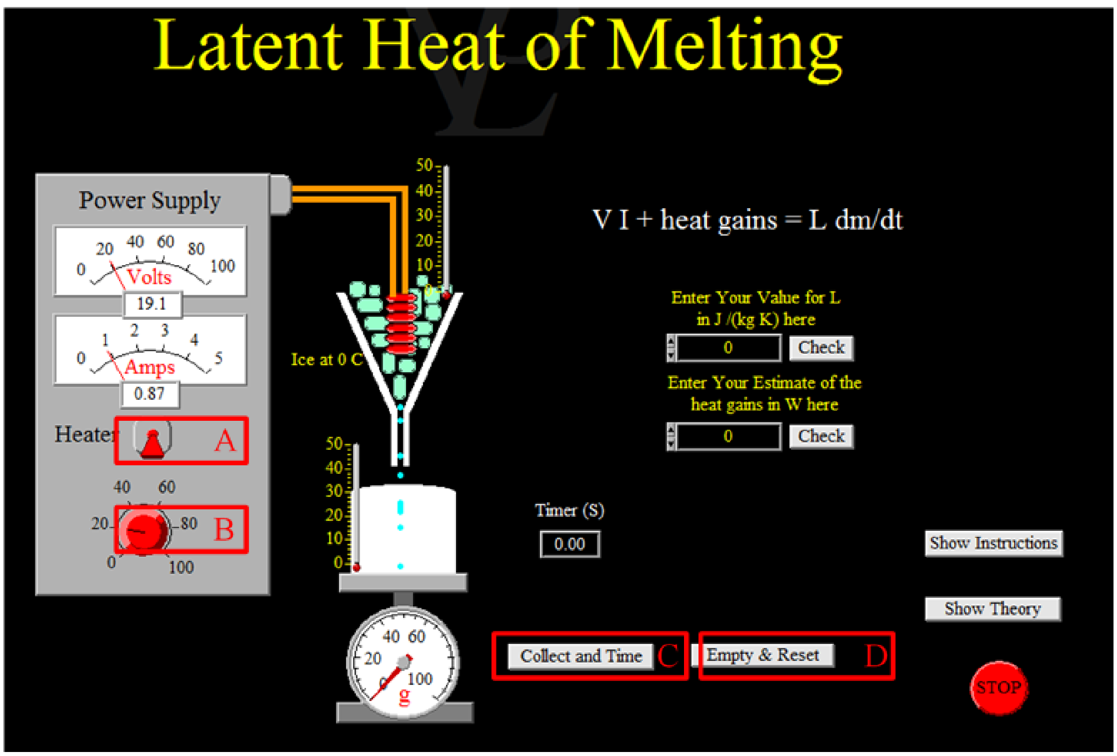

Fig. 1: Experimental set up for latent heat of melting.

2. Turn the heater on by toggling the red switch (marked by **A** in the Fig. 1).

3. Apply 20 volts (approx.) using the red colour knob (marked by B) and note the reading of the voltmeter and ammeter.
4. Record the time (t) for the collection of m g of water (say 50 g) by pressing the "time and collect" button (marked by C).
5. Now press the "Empty & Reset" button (marked by D) to remove the water from the container.
6. Repeat the steps 2 to 5 for different voltages (say 30, 40, 50….) to obtain at least 7 set of data. This enables you to obtain different melting rate and eliminate errors due to heat gain from the surroundings.
7. Calculate the power, $P(= VI)$ and $\frac{m}{t}$ for each observation.
8. Plot a graph of P versus $\frac{m}{t}$ (P as the ordinate and $\frac{m}{t}$ as the abscissa). The gradient will give you the value of the latent heat of melting and the intercept gives the rate of heat gained ($\text{G} = \frac{g}{t}$) from room as Figure 2.

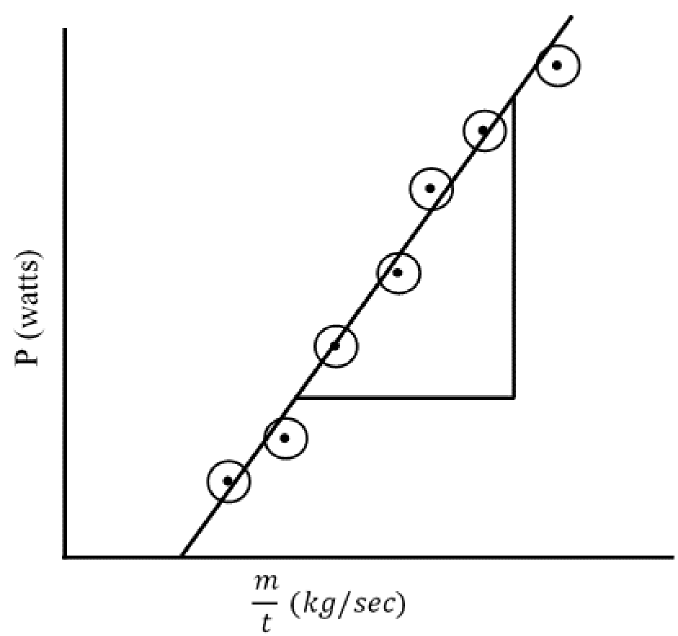

Fig. 2: A schematic plot of P versus $\frac{m}{t}$

Table-1: Data for the determination of latent heat of melting of ice

SL. No.	Voltage (volts)	Current (Amp)	Power $P = VI$ (Watt)	Time for 50 g water collection (sec)	$\frac{m}{t}$ (kg/sec)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

Calculations:

From graph,

Latent heat of melting = slope of the straight line

Rate of heat gained from room = the intercept of the straight line

Result:

Latent heat of melting of ice =……..

Error calculation:

$$\% \ of \ error = \frac{|Measured \ value - Standard \ value|}{Standard \ value} \times 100\% = \ldots . \%$$

Discussion:

Based on your understanding from this experiment, answer the following questions:

1. Is ice absorbing heat during its melting?
2. What happens to the heat when ice melts?
3. Explain the effect of heat gained from the room on your *L* value.
4. Why does the heater should be completely immersed in the ice?
5. If your experimental value is greater than the actual value, then explain why?
6. In the experiment ice cubes are considered as dry. If ice cubes are taken from a freezer and used immediately in the experiment, then will the value of the latent heat of fusion be less than or greater than the theoretical value? Explain.