

VL-H1: DETERMINATION OF THE SPECIFIC HEAT CAPACITY OF DIFFERENT MATERIALS

Objective:

- To explore the thermal properties of different materials.
- To determine the specific heat of various materials.

System Requirements:

Computer (Desktop/Laptop), Operating systems: Windows, Specific Heat Capacity_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 during the experiment.**

Theory:

The heat capacity C of a body is the amount of heat required to raise its temperature by 1 K. If Q amount of heat is applied to a block of a material for t sec and its temperature rises from $T_{initial}$ to T_{final} during this time then the heat capacity can be defined as

$$C = \frac{Q}{(T_{final} - T_{initial})} \quad (1)$$

The SI unit of heat capacity is therefore the joule per kelvin (J/K). The specific heat capacity c is an intrinsic property of an object and is defined as the amount of heat required to increase the temperature of an object of mass 1 Kg by 1 K. If m is the mass of the object then the specific heat capacity can be written as

$$c = \frac{Q}{m(T_{final} - T_{initial})} \quad (2)$$

The SI unit is the Joule per kilogram kelvin (J (kg. K)⁻¹). If the heat energy is supplied from an electrical source such that a voltage V and current I is applied to the object for t seconds then the amount of heat received is

$$Q = Vit \quad (3)$$

Then the specific heat capacity is

$$c = \frac{Vit}{m(T_{final} - T_{initial})} \quad (4)$$

If the temperature of a block is recorded at different time then the specific heat capacity can be determined from the gradient of the temperature versus time graph (e.g. Fig. 1).

$$c = \frac{Vi}{m} \frac{\Delta t}{\Delta T} \quad (5)$$

$$\text{or, } c = \frac{Vi}{m} (\text{gradient})^{-1} \quad (6)$$

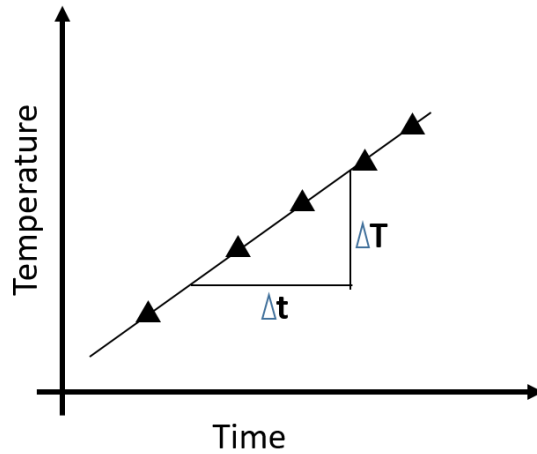


Fig. 1: Temperature vs time graph for a typical material

Procedure:

1. At first unzip “**Specific Heat Capacity_vle (zipped)**” File. Click on the executable file “**Specific Heat Capacity_vle**” then a window will open as shown in Fig. 2.

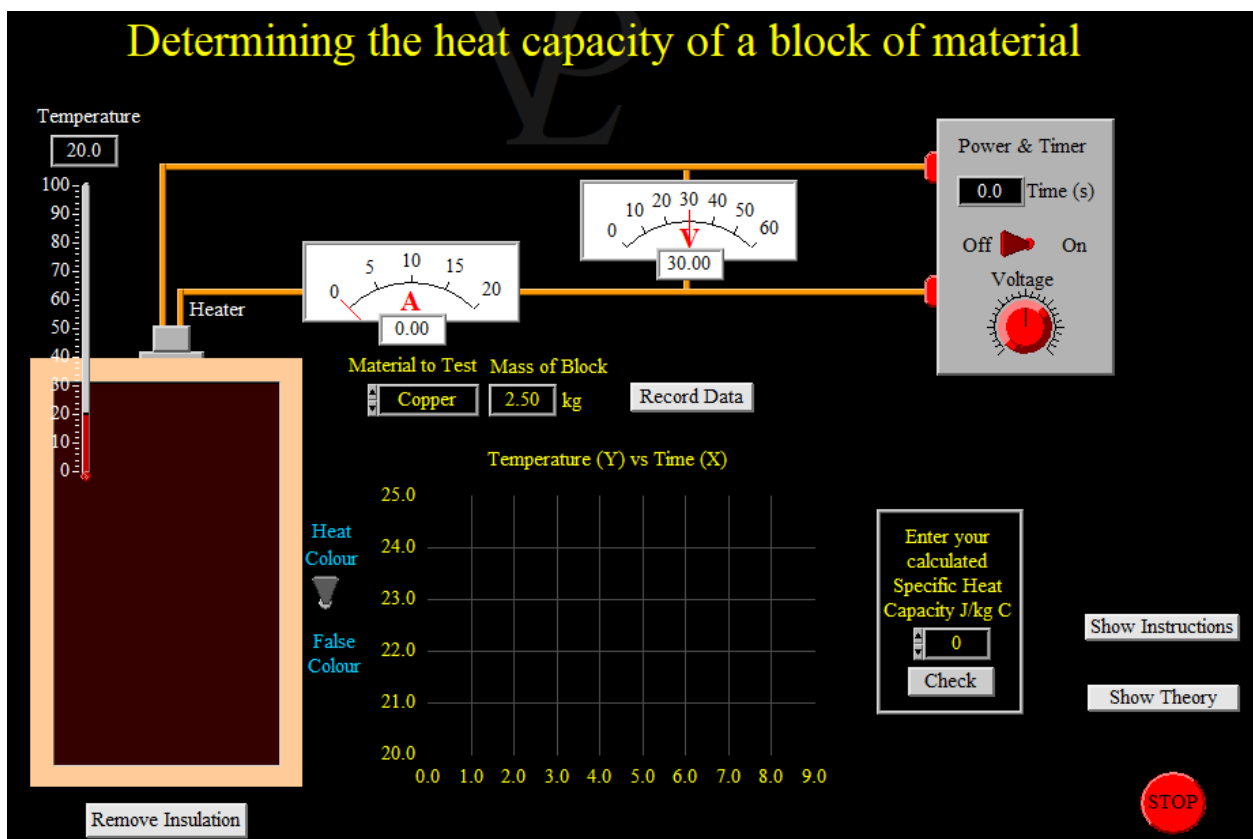


Fig. 2

2. Select the material you want to test. (Click the box named ‘**Material to Test**’ and select one of the five materials, say Copper).
3. Adjust the voltage around 30 V and switch the heater ON. The timer will start automatically. Wait until the temperature to rise by about 10 degrees. Record the voltage and current from the screen.
4. Now switch the heater **OFF**, the timer will stop automatically.
5. Allow the heat to be conducted through the block so that the temperature become uniform.

6. Record the steady temperature and corresponding time manually from the screen for which electrical power has been supplied. Also press the “record data” button to display the temperature versus time graph on the screen.
7. Repeat steps 3 to 6 until you obtain at least 6 set of data and draw temperature versus time graph.
8. From the gradient of the graph, and the mass of the block calculate the specific heat capacity using equation 6.
9. To measure the specific heat capacity of two other materials (Concrete, and Rubber) follow the procedure from step 3 to step 9.
10. Draw the temperature versus time graph and calculate the specific heat of the different materials.

Data Collections:

Table 1: Data for measuring the specific heat capacity of different materials with fixed mass.

Material	Mass of the block, m (kg)	Voltage, V (volt)	Current, I (Amp)	Time, t (sec)	Temperature, T (°C)	T (K)
Copper						
Concrete						
Rubber						

Plot the temperature versus time graph for all the three materials on the same graph paper (e.g. Fig. 2) and determine the respective gradient of the curves. Hence determine the specific heat capacity of these materials.

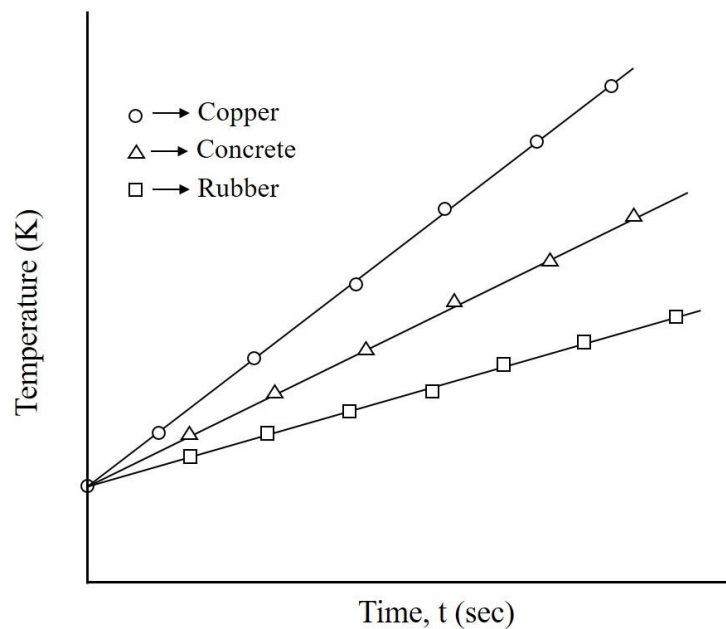


Fig. 2: Temperature vs time graphs of copper, concrete and rubber

Calculations:

Results:

The specific heat capacity of Copper: _____ J/kg K

The specific heat capacity of Concrete: _____ J/kg K

The specific heat capacity of Rubber: _____ J/kg K

Error analysis:

$$\% \text{ of error} = \frac{|\text{Experimental value} - \text{Standard value}|}{\text{Standard value}} \times 100\% = \dots\dots\%$$

Discussion:

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

- 1) What is the difference between heat capacity and specific heat capacity?
- 2) Does the result varies if you perform the experiment by removing the insulation?
- 3) In this experiment you determined the specific heat capacity of three different materials. Describe why does the specific heat capacity of these materials vary from each other?
- 4) In a real life experiment in order to measure specific heat capacity what could be the main source of error, briefly explain. How this error could be minimized?
- 5) Mention why does the temperature of the block reduces when the heater turns OFF.
- 6) Explain, whether this experimental technique is suitable for measuring the heat capacity of a solid non-metal or not.