OCR A Physics A-Level

PAG 11.2

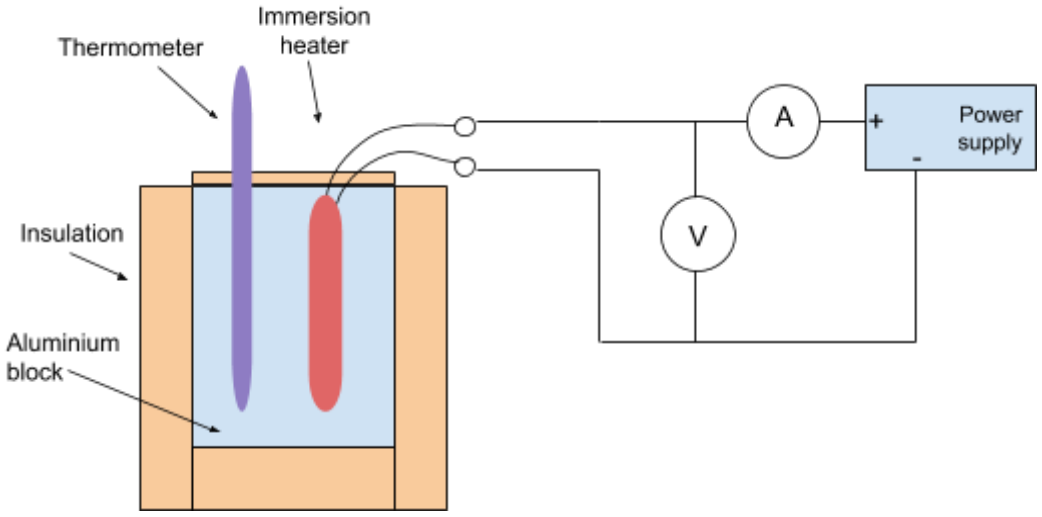
Determining the specific heat capacity of a material

Equipment

- Thermometer
- Immersion heater
- Aluminium block with two holes (one for the heater and one for the thermometer)
- Stopwatch
- DC power supply
- Top pan balance
- Insulation for the aluminium block
- Leads
- Ammeter
- Voltmeter

Method

1. Calibrate the top pan balance and measure the mass of the aluminium block.
2. Set up the equipment as in the diagram below:



3. Before switching on the power supply, record the temperature of the aluminium block.
4. Switch on the power supply and simultaneously start the stopwatch.
5. Record the voltage on the voltmeter, current on the ammeter and temperature of the aluminium block every 30 s for 5 minutes.
6. After 5 minutes, turn off the power supply and measure the highest temperature reached by the block. This may be a little while after switching off the power supply so keep checking the temperature every 20 s for the next few minutes until it is clear the temperature is only decreasing.

Calculations

- Organise your data in a table with the following columns, calculating power (P) using the following equation:

$$P = V I$$

Where V is the voltage and I is the current.

Time (s)	Current (A)	Voltage (V)	Power (W)

- Using the following equation, calculate the work done (W) by the heater at each 30 second interval:

$$W = P t$$

Where P is the power and t is the time interval (in this case this would be 30 s).

- Find the cumulative value of energy transferred at each 30 second interval by calculating the sum of the work done up to and including that interval.
- Draw a table of cumulative energy transferred (at each time interval) against the recorded temperature of the aluminum block at that time interval.
- Use your table to plot a graph of cumulative energy transferred against temperature and draw a line of best fit.
- Your line of best fit should be a straight line through the origin showing that energy transferred (Q) and change in temperature (Δθ) are directly proportional.
- Your line of best fit will follow the equation y = mx where y is Q and x is Δθ. You can use the equation for energy required to change temperature to find what your gradient represents:

$$Q = mc\Delta\theta$$

$$y = m\ x$$

Therefore, the gradient of your graph is equal to mc, where m is the mass of the block and c is the specific heat capacity of aluminium. This means you can find the specific heat capacity by dividing your value of gradient by the measured mass of the aluminium block.

Safety

- The immersion heater can get extremely hot, therefore it must be fully submerged in the aluminum block. The aluminum block should also be insulated to prevent any burns.

Notes

- The aluminium block can be swapped out for a similar block made of another material to measure its specific heat capacity.
- The calculated specific heat capacity will be larger than the actual value due to energy losses to the environment through resistance in the wires in the circuit, and heat being radiated away from the aluminum block.
- The immersion heater should be touching the aluminum block so that heat can be transferred easily.