## 3.3 Specific heat capacity

When an object is heated, the mean kinetic energy of its particles increases. We record this as a rise in temperature. For some materials, the temperature rise is large for the amount of heat energy added. For other materials, the temperature rise is small. The specific heat capacity ($c$) of a material is a measure of how the temperature of a material responds to heating:

$$c = \frac{\Delta E}{m \times \Delta T}$$

*where $\Delta E$=energy added in joules, m=mass of material in kilograms, $\Delta T$=temperature change in degrees Celsius (or kelvin)*

We can describe the specific heat capacity as:

*"the energy required to raise the temperature of 1 kilogram of a material by 1 degree Celsius"*

*(1) Looking at the equation, above, what are the units for specific heat capacity?*

*(2) 21000J of energy was used to heat 1 litre (mass=1kg) of water. This raised the temperature of the water by 5°C. Use the equation, above, to calculate the specific heat capacity of water.*

### Using an electric heater

A common practical is to use an electric (immersion) heater to heat a material. The energy supplied ($\Delta E$) can be worked out from the power ($P$) of the heater and the time ($\Delta t$) it is switched on for:

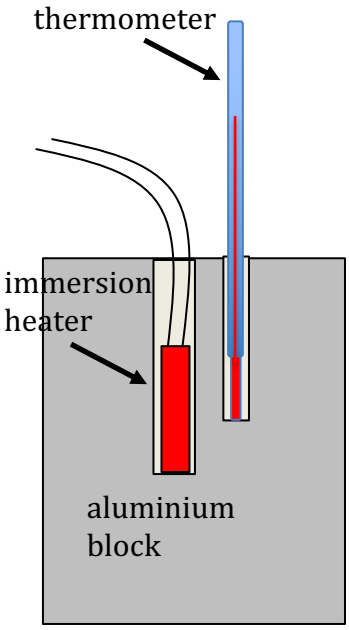
$$\Delta E = P \times \Delta t$$

The power is usually monitored by measuring the current ($I$) supplied to the heater and the potential difference ($V$) dropped across the heater:

$$P = I \times V$$

*(3) Substitute for P in the first equation to get an expression for the energy supplied to the heater in terms of I, V and $\Delta t$.*

*(4) Draw a circuit diagram to show the position of the voltmeter and ammeter. What device could be used to adjust the power supplied to the heater? Show this in your circuit diagram.*




In the experiment, left, an immersion heater is inserted into a 1kg block of aluminium. A thermometer is inserted into an adjacent slot to monitor the temperature at different times after the heater has been switched on. The following results were obtained:

| time (s) | potential difference (V) | current (A) | temperature (°C) |
|---|---|---|---|
| 0 | 12.0 | 2.0 | 21.0 |
| 60 | 12.0 | 2.0 | 22.5 |
| 120 | 12.0 | 2.0 | 24.0 |
| 180 | 12.0 | 2.0 | 26.0 |
| 240 | 12.0 | 2.0 | 27.5 |
| 300 | 12.0 | 2.0 | 29.0 |

*(5) Using the equation from question (3), above, work out the total energy ($\Delta E$) supplied to the heater?*

*(6) What is the rise in temperature ($\Delta t$) of the aluminium block?*

*(7) Using the equation (from the start of the worksheet), calculate the specific heat capacity of aluminium?*

*(8) Why is the value obtained using this method likely to be an over estimate of the true value?*