Specific Heat Capacity

The temperature of something isn't quite the same thing as the energy stored in the substance's thermal energy store. That's where specific heat capacity comes in...

Specific Heat Capacity Relates Temperature and Energy

Internal energy is actually the sum of the energy in the kinetic and potential stores of the particles. You can usually ignore energy in potential stores though.

1) Heating a substance increases the energy in its thermal energy store (or the kinetic energy stores of its particles, see p.156). You may sometimes see this referred to as the internal energy of a substance.
2) So in kinetic theory, temperature is a way of measuring the average internal energy of a substance.
3) However, it takes more energy to increase the temperature of some materials than others. E.g. you need 4200 J to warm 1 kg of water by 1 °C, but only 139 J to warm 1 kg of mercury by 1 °C.
4) Materials that need to gain lots of energy to warm up also release loads of energy when they cool down again. They store a lot of energy for a given change in temperature.
5) The change in the energy stored in a substance when you heat it is related to the change in its temperature by its specific heat capacity. The specific heat capacity of a substance is the change in energy in the substance's thermal store needed to raise the temperature of 1 kg of that substance by 1 °C. E.g. water has a specific heat capacity of 4200 J/kg°C (that's pretty high).
6) You need to know how to use the equation relating energy, mass, specific heat capacity and temperature.

$$\Delta Q = m \times c \times \Delta\theta$$

ΔQ: Change in thermal energy (J); m: Mass (kg); c: Specific heat capacity (J/kg°C); $\Delta\theta$: Temperature change (°C)

Δ just means 'change in'.

You can Find the Specific Heat Capacity of Water

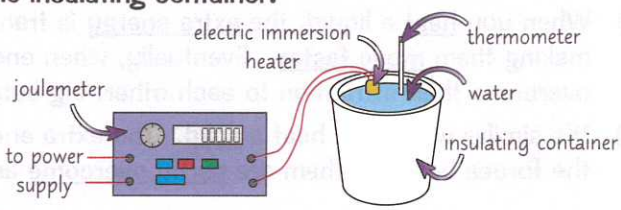
PRACTICAL

You can use the experiment below to find the specific heat capacity of water — or any liquid for that matter. (There's another experiment on page 203 that investigates how water behaves when it changes state.)

If you can, you should use a thermally insulated container for both of these experiments to reduce energy wasted to the surroundings (p.159).

You can use this set up with solid blocks to find the SHC of solids.

1) Use a mass balance to measure the mass of the insulating container.
2) Fill the container with water and measure the mass again. The difference in mass is the mass of the water in the container.
3) Set up the experiment as shown — make sure the joulemeter reads zero and place a lid on the container if you have one.



4) Measure the temperature of the water, then turn on the power.
5) Keep an eye on the thermometer. When the temperature has increased by e.g. ten degrees, stop the experiment and record the energy on the joulemeter, and the increase in temperature.
6) You can then calculate the specific heat capacity of the water by rearranging the equation above, and plugging in your measurements.
7) Repeat the whole experiment at least three times, then calculate an average of the specific heat capacity (p.6).

You could also use a voltmeter and ammeter instead of a joulemeter, time how long the heater was on for, then calculate the energy supplied (p.190).

I wish I had a high specific fact capacity...

Make sure you practise using that equation — it's a bit of a tricky one.

Q1 If a metal has a specific heat capacity of 420 J/kg°C, calculate how much the temperature of a 0.20 kg block of the metal will increase by if 1680 J of energy are supplied to it. [2 marks]

Q2 Describe an experiment you could do to find the specific heat capacity of water. [4 marks]

Specific Heat Capacity

Warm-Up

Which of the following is the correct definition of specific heat capacity? Tick **one** box.

- The energy transferred when an object is burnt. ☐
- The maximum amount of energy an object can store before it melts. ☐
- The energy needed to raise 1 kg of a substance by 10 °C. ☐
- The energy needed to raise 1 kg of a substance by 1 °C. ☐

PRACTICAL

1 A student uses the equipment listed below to investigate the specific heat capacity of different liquids.

Grade 6–7

- Insulated flask
- Thermometer
- Mass balance
- Power supply
- Joulemeter
- Immersion heater

a) Describe how the student could use the apparatus listed above to calculate the specific heat capacities of different liquids.

.....

.....

.....

.....

.....

.....

.....

[5]

b) 15 kJ of energy was supplied to each sample. The student then recorded her results, shown in **Figure 1**. Complete **Figure 1** to show the specific heat capacity of liquid C.

Figure 1

Liquid	Mass (kg)	Temperature change (°C)	Specific heat capacity (J/kg °C)
A	0.30	12	4200
B	0.30	23	2200
C	0.30	25	.....

[3]

[Total 8 marks]