GCSE Physics required practical activity: Specific heat capacity

The method involves using the electric heaters to raise the temperature of the blocks. You may have blocks made for this experiment. The blocks usually have a mass of 1 kg and have holes that fit the heater and the thermometer. The heaters fit snugly but there is usually an air gap around the thermometer. A drop of water provides a better thermal contact. The blocks should be insulated to reduce heat loss to the surroundings.

The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.

What is the specific heat capacity of copper?

In this investigation you will heat up a block of copper using an electric heater.

You will measure:

- mass
- work done by the heater
- temperature.

You will plot a graph of temperature against work done. The gradient of this graph and the mass of the block will be used to determine the specific heat capacity of copper.

Method

You are provided with the following:

- copper block wrapped in insulation, with two holes for a thermometer and heater
- thermometer
- pipette to put water in the thermometer hole
- 30 W heater
- 12 V power supply
- insulation to wrap around the blocks
- ammeter and voltmeter
- five 4 mm leads
- stop watch or stop clock
- balance.

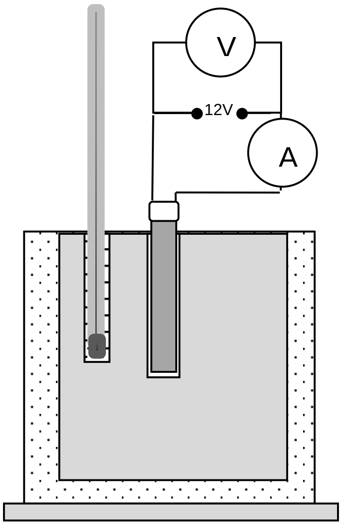
Read these instructions carefully before you start work.

1. Measure and record the mass of the copper block in kg.

2. Place a heater in the larger hole in the block.

3. Connect the ammeter, power pack and heater in series.

4. Connect the voltmeter across the power pack.



5. Use the pipette to put a small amount of water in the other hole.

6. Put the thermometer in this hole.

7. Switch the power pack to 12 V. Switch it on.

8. Record the ammeter and voltmeter readings. These shouldn't change during the experiment.

9. Measure the temperature and switch on the stop clock.

10. Record the temperature every minute for 10 minutes.

    Add your results to a table such as the one below.

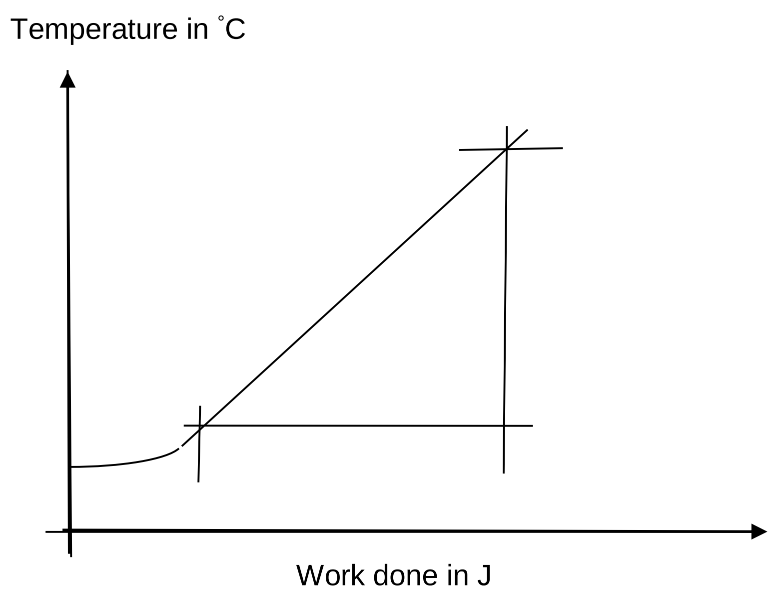
Time in seconds	**Work done in J**	**Temperature in ˚C**
0		
60		
120		
180		

240		
300		
360		
420		
480		
540		
600		

11. Calculate the power of the heater in watts.

    To do this, multiply the ammeter reading by the voltmeter reading.

12. Calculate the work done by the heater. To do this, multiply the time in seconds by the power of the heater.
13. Plot a graph of temperature in ^{o}C against work done in J.



14. Draw a line of best fit. Take care as the beginning of the graph may be curved.

15. Mark two points on the line you have drawn and calculate the change in temperature *(θ)* and the change in work done *(E)* between these points

16. Calculate the specific heat capacity of the copper (*c*) by using the equation

$c = \frac{E}{m \times \theta}$ where *m* is the mass of the copper block

17. Repeat this experiment for blocks made from other materials such as aluminium and iron.

Sources of error – the main source of error is that some of the energy may not be transferred directly to the metal block but may cause the internal energy(heat) of the air to increase. To prevent this happening the metal block should be insulated. This will minimise this source of error but will not completely get rid of it.

GCSE Physics required practical activity: Resistance

Required practical activity
Use circuit diagrams to set up an appropriate circuit to investigate a factor/the factors that affect the resistance of an electrical component. This should include: • the length of a wire at constant temperature • combinations of resistors in series and parallel.

There are two parts to this practical:

1. **Investigating how the resistance of a wire varies with its length**
2. **Investigating resistance in series and parallel circuits.**

Activity 1: Investigating how the resistance of a wire varies with its length

A dimmer switch allows you to control the brightness of a lamp.

You will investigate how the dimmer switch works. You will construct a circuit to measure the potential difference across a wire and the current in the wire. You will do this for different lengths of wire.

Method

You are provided with the following:

- a battery or suitable power supply
- ammeter or multimeter
- voltmeter or multimeter
- crocodile clips

- resistance wire eg constantan
- connecting leads.

Read these instructions carefully before you start work.

1. Connect the circuit.

   It may be helpful to start at the positive side of the battery or power supply. This may be indicated by a red socket.

2. Connect a lead from the red socket to the positive side of the ammeter.

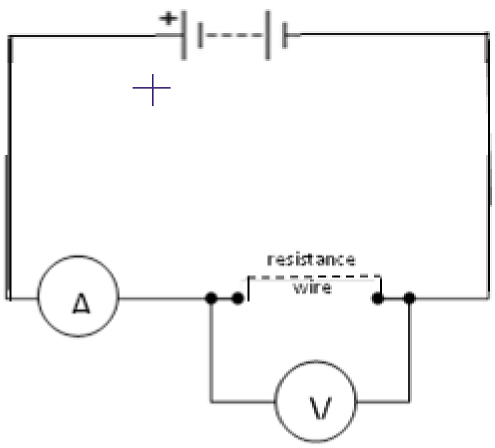
3. Connect a lead from the negative side of the ammeter (this may be black) to the crocodile clip at the zero end of the ruler.

4. Connect a lead from the other crocodile clip to the negative side of the battery.

   The main loop of the circuit is now complete. Use this lead as a switch to disconnect the battery between readings.

5. Connect a lead from the positive side of the voltmeter to the crocodile clip the ammeter is connected to.

6. Connect a lead from the negative side of the voltmeter to the other crocodile clip.



7. Record on a table the:
   - length of the wire between the crocodile clips

- the readings on the ammeter
- the readings on the voltmeter.

You will need four columns in total.

Length of wire in cm	**Potential difference in V**	**Current in A**	**Resistance in Ω**

8. Move the crocodile clip and record the new ammeter and voltmeter readings. Note that the voltmeter reading may not change.

   Repeat this to obtain several pairs of meter readings for different lengths of wire.

9. Calculate and record the resistance for each length of wire using the equation:

$$\text{resistance in } \Omega = \frac{\text{potential difference in V}}{\text{current in A}}$$

10. Plot a graph with:
    - 'Resistance in Ω' on the y-axis
    - 'Length of wire in cm' on the x-axis.

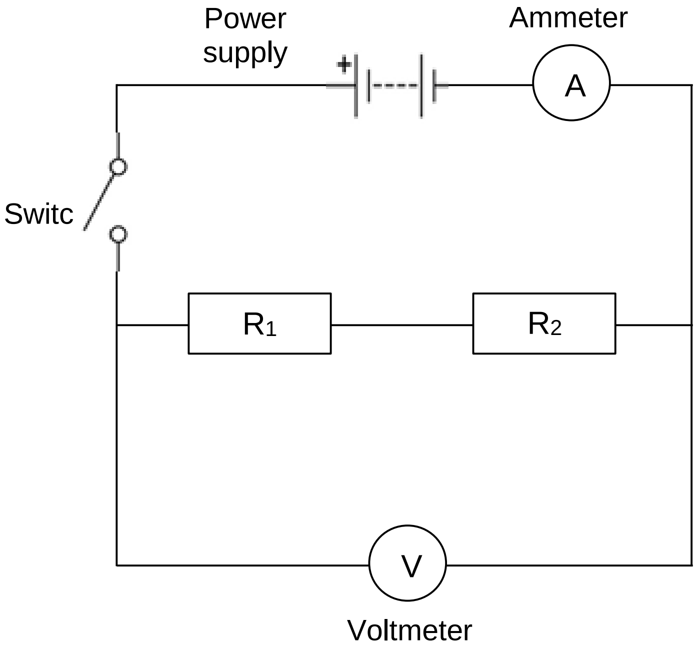
11. You should be able to draw a straight line of best fit although it may not go through the origin.

Everytime a current goes through a wire there will be a heating effect. This will cause the resistance to increase and so will affect the results. Therefore it is best to wait for a few minutes between each reading to ensure that the wire has not heated up.

Activity 2: Investigating resistors in series and in parallel

You are provided with the following:

- a battery or suitable power supply
- ammeter or multimeter
- voltmeter or multimeter
- crocodile clips
- two 10Ω resistors
- connecting leads.



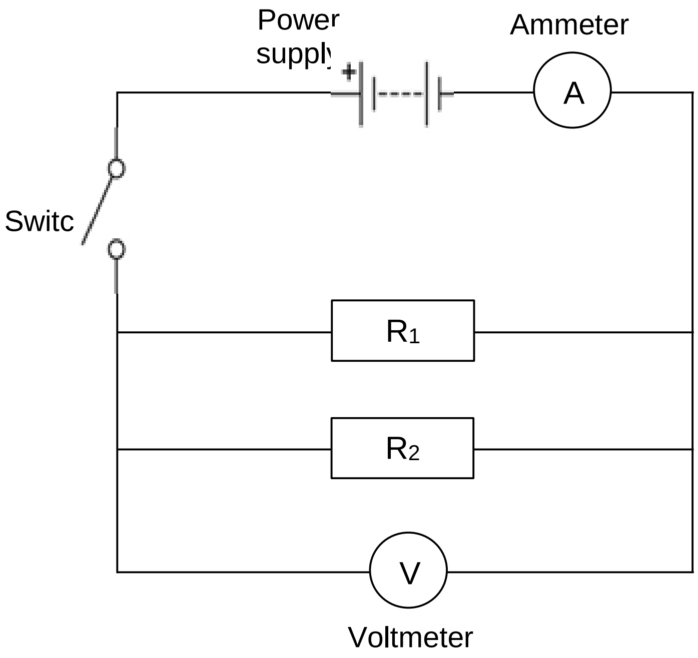
Read these instructions carefully before you start work.

1. Connect the circuit for two resistors in series, as shown in the diagram.

2. Switch on and record the readings on the ammeter and the voltmeter.

3. Use these readings to calculate the total resistance of the circuit.

4. Now set up the circuit for two resistors in parallel.



5. Switch on and record the readings on the ammeter and the voltmeter.

6. Use these readings to calculate the total resistance of the circuit.

7. With one single resistor in the circuit, the total resistance would be 10 ohms. What is the effect on the total resistance of adding:

   a. another identical resistor in series

   b. another identical resistor in parallel?

8. You could also try setting up a circuit with three resistors in series and one with three resistors in parallel.

9. What conclusions can you come to about the effect of adding resistors

   a. In series

   b. In parallel.

The total resistance in series will increase if you add more resistors. In parallel the total resistance will decrease if you add more resistors in parallel.

GCSE-Physics required practical activity: I-V characteristics

Required practical activity
Use circuit diagrams to construct appropriate circuits to investigate the I-V characteristics of variety of circuit elements including a filament lamp, a diode and a resistor at constant temperature.

What happens to the current when the pd across a component changes?

There are **three** activities. In each one you are going to measure electric current in a component as you change the potential difference (Pd) across the component.

You will then plot a graph of current in against potential difference in V. You will investigate the behaviour of a resistor, a lamp and a diode.

Method

You are provided with the following:

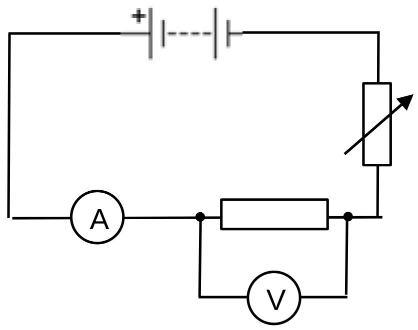
- ammeter and milliammeter, or multimeter
- voltmeter or multimeter
- component holders
- 12 V, 24 W lamp eg a ray box lamp
- resistor
- diode and protective resistor eg 10 Ω
- rheostat eg 10 Ω, 5 A
- connecting leads.

Read these instructions carefully before you start work.

Activity 1: The characteristic of a resistor

1. Connect the circuit. It may be helpful to start at the positive side of the battery or power supply. This may be indicated by a red socket.

2. Connect a lead from the red socket to the positive side of the ammeter.



3. Connect a lead from the negative side of the ammeter (this may be black) to one side of the resistor.

4. Connect a lead from the other side of the resistor to the variable resistor.

5. Connect a lead from the other side of the variable resistor to the negative side of the battery.

   The main loop of the circuit is now complete. Use this lead as a switch to disconnect the battery between readings.

6. Connect a lead from the positive side of the voltmeter to the side of the resistor the ammeter is connected to.

7. Connect a lead from the negative side of the voltmeter to the other side of the resistor.

8. Record the readings on the ammeter and voltmeter in a suitable table.

9. Adjust the variable resistor and record the new ammeter and voltmeter readings. Repeat this to obtain several pairs of readings.

10. Swap the connections on the battery. Now the ammeter is connected to the negative terminal and the variable resistor to the positive terminal.

    The readings on the ammeter and voltmeter should now be negative.

11. Continue to record pairs of readings of current and potential difference with the battery reversed.

12. Plot a graph with:

    - ‘Current in A’ on the y-axis
    - ‘Potential difference in V’ on the x-axis.

    As the readings include negative values the origin of your graph will be in the middle of the graph paper.

13. You should be able to draw a straight line of best fit through the origin. This is the characteristic of a resistor.

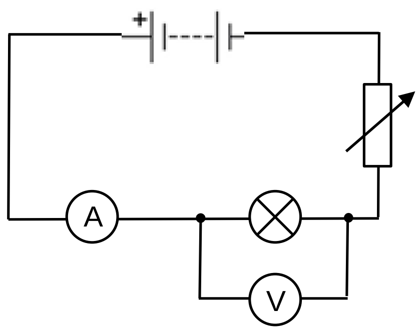
Read these instructions carefully before you start work.

Activity 2: The characteristic of a lamp

1. Swap the leads on the battery back to their original positions.

2. Replace the resistor with the lamp.

   If you are making the circuit from the beginning, follow steps 1-7 in the procedure for the resistor above. For these instructions, use a lamp in place of the resistor.



3. The lamp will get hot. Take care not to touch it.

4. Follow steps **8–11** in the procedure for the resistor above. Remember to swap the leads on the battery to obtain negative readings.
5. Plot a graph with:

   - 'Current in A' on the y-axis
   - 'Potential difference in V' on the x-axis.

   The origin will be in the middle of the paper.

   Draw a curved line of best fit for your points.

Read these instructions carefully before you start work.

Activity 3: The characteristic of a diode

1. Swap the leads on the battery back to their original positions.

2. If you can, reduce the battery potential difference to less than 5 V.

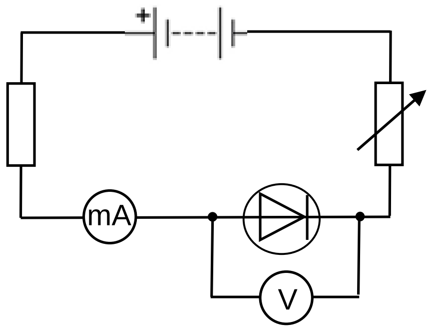
3. Remove the lead from the positive side of the battery. Connect it to the extra resistor labelled **P**.

4. Connect the other end of resistor **P** to the positive side of the battery.

5. Replace the ammeter with a milliammeter

   or

   change the setting on the multimeter.



6. Replace the lamp with the diode. Connect the positive side of the diode to the milliameter.

7. Repeat steps **1–6** above to obtain pairs of readings of potential difference and current for the diode.

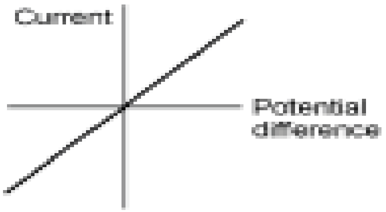
8. Plot a graph with:

   - ‘Current in A’ on the y-axis
   - ‘Potential difference in V’ on the x-axis.

The origin will probably be in the middle of the bottom of your graph paper.
There should not be any negative values of current.

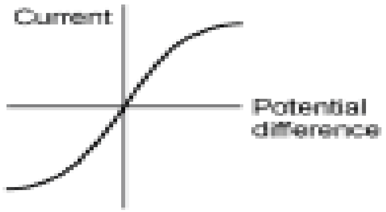
Students should be able to explain that, for some resistors, the value of R remains constant but that in others it can change as the current changes.

The current through an ohmic conductor (at a constant temperature) is directly proportional to the potential difference across the resistor. This means that the resistance remains constant as the current changes.

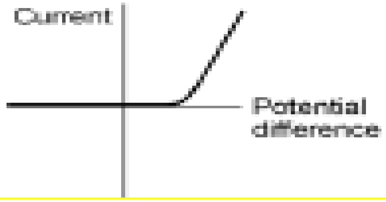


The resistance of components such as lamps, diodes, thermistors and LDRs is not constant; it changes with the current through the component.

The resistance of a filament lamp increases as the temperature of the filament increases.



The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction.



The current in a filament bulb starts to level out because the resistance increases as the voltage increases so causing a decrease in the current.

GCSE Physics required practical activity: Density

Required practical activity
Use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids. Volume should be determined from the dimensions of regularly shaped objects and by a displacement technique for irregularly shaped objects. Dimensions to be measured using appropriate apparatus such as a ruler, micrometre or Vernier callipers

Identifying a substance from its density

There are **three** activities. In each one you are going to measure the density of an object. You will then use this value to find out what the substance is. You will be expected to work as accurately as possible.

Activity 1: you will determine the density of a regular shaped object using a ruler and balance.

Activity 2: you will measure the mass of an object in the same way as activity 1. You will also measure its volume from the amount of water it displaces.

Activity 3: you will find the density of a liquid.

Method

Activity 1: Regular shaped objects

You are provided with the following:

- 30 cm ruler marked off in mm
- digital balance
- regular shaped objects.

Read these instructions carefully before you start work.

1. For each object measure the:
   - length
   - width
   - height.
2. Record your results in a table.

   Include columns for:
   - volume
   - mass
   - density
   - substance.
3. Measure the mass of each object using the digital balance. Record the results.
4. Calculate and record the volumes (length × width × height).
5. Calculate and record the densities (mass ÷ volume).
6. Use the table below to identify the substance each object is made from.

Substance	**Aluminium**	**Zinc**	**Iron**	**Copper**	**Gold**
Density in g/cm^3	2.7	7.1	7.9	8.9	19.3

Activity 2: Irregular shaped objects.

You are provided with the following:

- digital balance
- displacement can and something to stand it on (eg a brick)
- various measuring cylinders
- beaker of water and an extra empty beaker
- paper towels
- cotton or thin string
- irregularly shaped objects.

Read these instructions carefully before you start work.

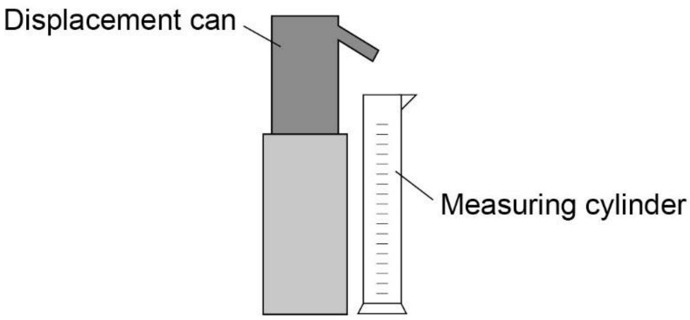
1. Measure the mass of one of the irregular shaped objects.
2. Record your result in a table.

   It will need columns for:

   - volume
   - density
   - mass
   - substance.

3. Place a displacement can on a brick. Put an empty beaker under the spout and fill the can with water. Water should be dripping from the spout.
4. Wait until the water stops dripping. Then place a measuring cylinder under the spout instead of the beaker.

   Choose the measuring cylinder you think will give the most precise reading.



5. Tie the object to a piece of cotton. Very carefully lower it into the displacement can so that it is completely submerged.

   Collect all of the water that comes out of the spout in the measuring cylinder.

6. Measure and record the volume of the collected water. This volume is equal to the volume of the object.

7. Calculate and record the density of the object.

   Try to find out what substance it is made from.

8. Repeat steps **1–7** for some other objects.

   Remember to refill the can each time.

Activity 3 – liquids

You are provided with the following:

- digital balance
- 250 ml beaker
- 100 ml measuring cylinder
- suitable liquid eg sugar solution.

Read these instructions carefully before you start work.

1. Measure the mass of the empty beaker.

2. Record your results in a table.

   Your table will need columns for the:

   - mass of the empty beaker
   - mass of the beaker with the liquid in
   - mass of the liquid
   - volume of the liquid

- density of the liquid.

3. Pour about 100 ml of liquid into the measuring cylinder.

   Measure and record the volume.

4. Pour this liquid into the beaker.

   Measure and record the mass of the beaker and liquid.

5. Calculate and record the volume of the liquid.

6. Calculate the density of the liquid.

7. The density of water is 1 g/cm^3.

8. Determine the mass of sugar per cm^3 dissolved in the water. Assume the sugar does **not** affect the volume of the water.