

## What factors affect current flowing through an acid? – teaching ideas

### Possible contexts

This investigation can be used at KS4 in either chemistry or physics or as a project showing the overlap between both areas. In chemistry, it would support work on electrolysis and concentration and in physics, it would support work on current- voltage graphs, the use of ammeters and voltmeters and calculating resistance. At KS5 chemistry it could be used in the teaching of the differences between weak and strong acids and in the context of pH.

It is an excellent investigation for developing science skills, including ranges, intervals, risk assessments, reliability and also areas for further investigation. There will be no current until a certain voltage is reached, how could that threshold voltage be found? The graph starts as a line but may turn into a curve, why is that? (The bubbles building up on the electrodes affect the contact of the solution with the electrode.)

### Risks

The main risks are associated with the use of acid. Obviously safety specs need to be worn and appropriate spill resources be available. Use dilute sulfuric acid (do not use hydrochloric acid, as it will pump chlorine into the lab! Avoid sniffing the gases given off from the other acids as hydrogen gas can cause choking.)

**NB: Always carry out a full risk assessment and refer to CLEAPPS for further advice.**

### Apparatus

The apparatus should be set up as if you were measuring the resistance of a wire but the wire replaced with the beaker of acid with electrodes dipping in.

- sulfuric acid 1M
- beakers
- carbon electrodes
- crocodile clips
- ammeters
- voltmeters
- battery packs
- a variable resistor may be useful but just by changing the voltage on the battery pack you will get a perfectly acceptable range of results.

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### Possible investigations

There are a large variety of different factors that can be investigated but what is being investigated is the effect of these factors on the current. Current is what is being measured, resistance, can if you want, be calculated from the current and the voltage.

$$\text{resistance } (\Omega) = \text{voltage or p.d (V)} \div \text{current (A)}$$

The students could investigate any of the following. The entire list below has been successfully carried out by students.

1. Voltage or p.d on battery pack.
2. Depth of electrodes within the liquid.
3. Distance apart of the electrodes.
4. Concentration of the acid. Care with this one, if the students simply add water then the current initially rises rather than dropping as there is now more solution in contact with the electrodes. The students need to find a way of changing the concentration while keeping the volume the same. Alternatively, you could have different concentrations already prepared.
5. They could try different acids but this will only yield a bar chart. Remember, don't use hydrochloric acid as it will produce chlorine gas, but you could use other organic acids as a way of investigating how disassociated weak acids are compared to strong acids. If you did that then use a pH probe so that pH could be graphed against current to give a line graph.

From experience, changing the temperature doesn't seem to work very well though increasing the temperature should increase the conductivity by giving the ions more energy.

### Applying the results

In physics, the current - voltage graph for an acid could be compared to those of a resistor, filament lamp and diode. What similarities are there, what differences? Resistance could be calculated and plotted.

In chemistry, the results should be related to the ions within the acid, why does diluting the acid reduce the current? Why does changing the depth of the electrode immersed change the current?

### Extension

Further investigation could be determining the threshold voltage of the acid. Why does it have a threshold voltage? In what ways, isn't the experiment a fair test? (Changing temperature/bubbles being produced on electrodes) Are there ways of improving the experiment to minimise these problems?