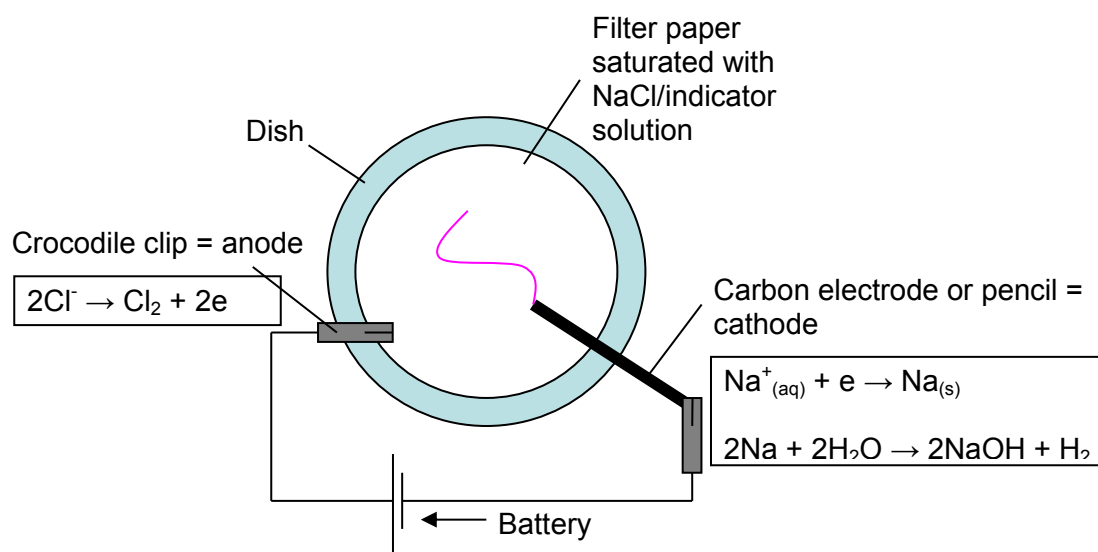


# Electrochemical Writing Teachers' Notes

## Background Chemistry

The carbon electrode when attached to the negative terminal of the battery acts as the cathode. The NaCl solution contains  $\text{Na}^+$  and  $\text{Cl}^-$  ions and water. When the circuit is complete some water will dissociate to form  $\text{H}^+$  and  $\text{OH}^-$  ions. As the standard reduction potential of  $\text{H}^+$  ions is less negative than that of  $\text{Na}^+$  ions, the  $\text{H}^+$  ions will gain the electrons preferentially to form hydrogen gas. The  $\text{OH}^-$  ions left in solution are basic so a change in colour of the pH indicator is seen where the carbon electrode touches the filter paper.



When the carbon electrode is attached the other way round to the positive terminal, it acts as the anode and attracts the chlorine ions to it. These ions lose an electron and form chlorine atoms which do not form a basic solution so a colour change is not seen.

## Relevance to solar energy

Solar cells use two electrodes, one where oxidation occurs and one where reduction occurs. Here the battery is providing the energy to cause the oxidation and reduction reactions but in a solar cell, the sun's energy causes this to happen in order to create a current and make electricity. In an excitonic solar cell, the sun oxidises a light-absorbing polymer or dye at the working electrode.

## Experimental

If the graphite core of the pencil is broken internally, there may be a gap in the circuit (however this is unlikely as it should still be very compact, so there should be at least some contact between the graphite pieces). If the experiment doesn't work the first time, try using another pencil.

It is possible to extract the graphite core of a pencil and use this as the carbon electrode. This should be done prior to the class by the teacher. Details of this procedure are in the Equipment List.

Phenolphthalein gives a better effect than Universal Indicator because this indicator is colourless when neutral or acidic so the colour is only seen when basicity occurs.

## Variations and Extensions

- Experiment with different indicators and explore colour changes

## Links to the curriculum

- Electrodes and electrochemical cells
- Acids and bases
- Electricity and electrical circuits
- Oxidation and reduction

## Safety

Below is some general safety information for the chemicals used in this experiment. See appropriate Hazcards for more details.

### Universal Indicator

- Emergency Harmful if swallowed: Do not induce vomiting, call for medical aid. Wash off skin with plenty of water. Flush out eye with plenty of water.
- Highly flammable Treat as if it was pure ethyl alcohol
- Protection Wear safety glasses.
- Disposal Dispose of with plenty of water down the sink.

### Phenolphthalein Indicator

- Emergency Harmful if swallowed: Do not induce vomiting, get medical aid. Wash off skin with plenty of water. Flush out eye with plenty of water.
- Protection Wear safety glasses.
- Disposal Dispose of with plenty of water down the sink.

## References

Based on the experiment from The RSC Classic Chemistry Experiments handbook.