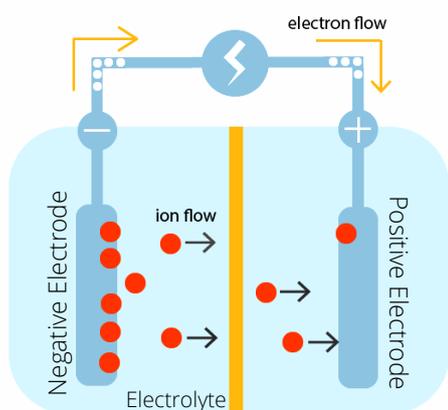


# Building better batteries

**A battery is a device that stores chemical energy and converts it to electrical energy. Batteries are key to a sustainable future.**

They can store energy generated from clean energy sources (such as solar and wind), for use in our everyday lives - from mobile phones to electric vehicles.

## HOW A BATTERY WORKS



Inside a battery

There are 3 main components in a battery: a positive electrode, a negative electrode and an electrolyte.

Ions move through the electrolyte from the negative electrode to the positive electrode.

This flow of ions is balanced by a flow of electrons through an external circuit, providing the electric current used to power our devices.

## DEFINITIONS

**Electrons** - negatively charged particles found in an atom. The flow of electrons produces an electrical current.

**Ion** - electrically charged particle formed by the loss or gain of electrons from an atom.

**Electrode** - a conductor of electricity. The negative electrode likes to give up electrons but the positive electrode likes to receive them.

**Electrolyte** - a liquid, gel or solid substance which allows the flow of ions between the electrodes.

## INVESTIGATIONS

Scientists around the world have done many studies using **neutrons** to understand how we can improve batteries to be cleaner, safer and more powerful.

**Neutron** - particle with no charge found in the nucleus of an atom. They are extremely useful for studying the structure of materials.

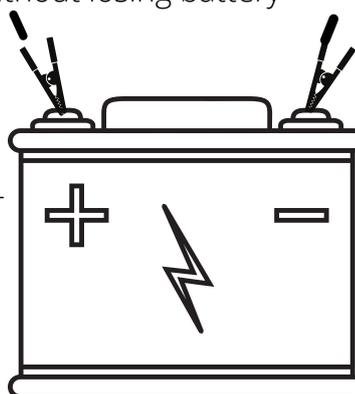
How quickly can batteries be charged and discharged without losing battery life?

Are solid electrolytes better than liquid electrolytes?

How do interactions between electrode and electrolyte affect battery degradation?

How do electrode surfaces change during charging/discharging?

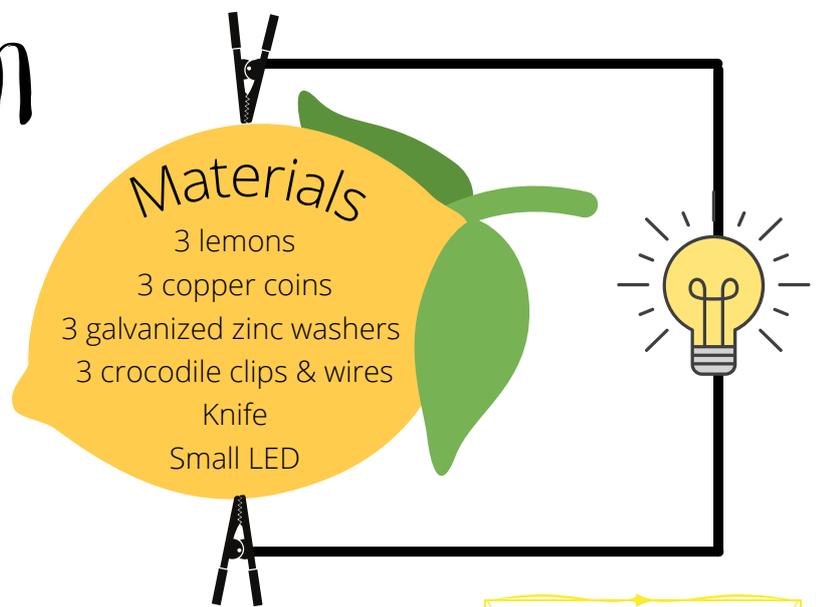
How can we make cheaper and non-toxic electrodes?



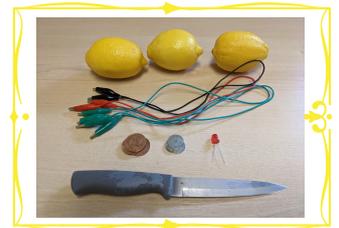
Scan for more information about neutrons!

# Build a Lemon Battery!

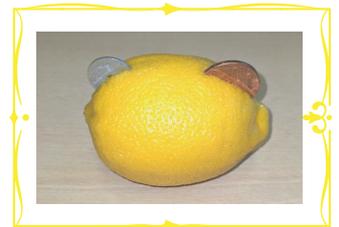
Using neutrons, scientists are investigating different materials for use in batteries. Follow the instructions below to create your own battery using some lemons!



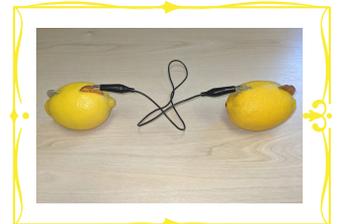
Roll the lemons to soften them. This releases the juice inside.  
**The lemon juice is the electrolyte.**



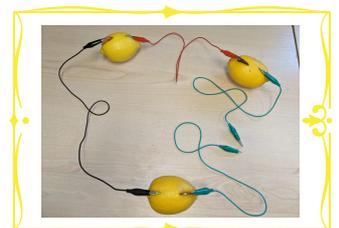
Carefully make two cuts, one at each end of the lemon. Insert one copper coin and one zinc washer into opposite ends of each lemon.  
**The copper coin is the positive electrode and the zinc washer is the negative electrode.**



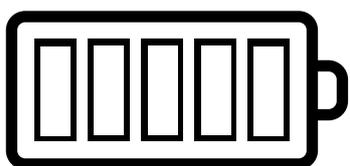
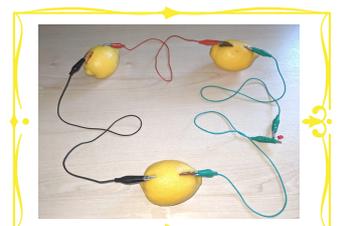
Using the crocodile clips, attach the end of one wire to a zinc washer in a lemon, then attach the same wire but opposite end to a copper coin in another lemon.  
**The wires allow electrons to flow freely between electrodes.**



Repeat Step 3 for all 3 lemons until they are connected, leaving one copper coin on an end lemon and one zinc washer on the lemon at the other end unattached.  
**The acid in the lemon juice reacts with the zinc electrode, creating positively charged zinc ions, and releasing electrons.**



Connect the unattached copper coin to the positive connection (long leg) of the LED, and the unattached zinc washer to the negative connection (short leg) of the LED. The LED should turn on!  
**The electrons released on forming zinc ions flow from the zinc electrode to the copper electrode, generating an electric current and powering our LED. Lemon Power!**



How confident do you feel about batteries? Colour in this battery to show how you feel - for example, if you feel very confident, fill in every single bar!