Multi-Cell Battery

A single cell made of two metals can produce only a small "push" of charge. To increase this push, several cells can be wired together. This arrangement of side by side cells forms an electrical device known to scientists as a battery.

Materials
- 3 pennies
- 3 iron washers
- Steel wool
- Blotter paper
- Salt
- Water
- A pair of scissors
- A current meter (assembled in "Meet a Meter" experiment)

To Do
Polish the coins and washers with steel wool. Use a pair of scissors to cut the blotter paper into four penny-sized circles.
Soak the paper in salt water. Sandwich a damp paper circle between a penny and a washer. Test the generation of electricity with your current meter by touching one lead of the meter to the coin, the other to the washer. How does the meter react?
Stack up the other metal pieces, alternating pennies and washers, to make two other sandwiches. Pile the three sandwiches so that there is a circle of saltwater-soaked blotter paper separating each sandwich. No two pieces of metal should make direct contact.
Use tape to secure this three-cell stack. Retest the current. Is it stronger?
Can you explain your observations?

The Science
The simple penny/washer cell produced a very small amount of electricity. As the cells were joined together, they formed a battery. The three-cell battery generated three times the electricity of a single cell. This increase produced a more noticeable deflection of the meter's needle.
Check It Out! A car battery is made of six side by side but separate cells. These cells are wired together to produce six times the energy available from only a single cell.
Here we connect several batteries together in series to get enough voltage to register. That means we connect the (+) terminal of one battery to the (-) terminal of another.

It is also why we do not put the salt-water soaked paper between individual battery cells. If you look closely, you'll see doing that connects a zinc-copper battery to a copper-zinc battery. In other words, if you use the wet paper between cells, you will have a (-) nickel terminal connected to a (+) copper terminal, then the same (+) copper terminal is immediately connected to a different (-) nickel terminal when you put the next nickel on the stack. You can think of this as positive voltage going one way, but being immediately cancelled out by negative voltage going the other way. The net effect is no total voltage.

By leaving the wet paper (electrolyte) off between each individual battery cell, there is no electrolyte to force copper and zinc ions to flow. Only free charge will flow from one cell to another through the metal-to-metal contact. When more than one battery cell is included, the voltage increase becomes additive, and you see the effect we saw during the experiment.

This was first performed by Alessandro Volta in something he called a voltaic pile way back in 1800. He used alternating copper and zinc or silver and zinc discs that were separated by cardboard or cloth soaked in salt water, just like we did above. Since some metals have more free electrons to give up or accept in ionic form than others, some dissimilar metal combinations work better as batteries than others. If you tried different coins above, you should have seen that effect. If you tried two of the same coins together, penny - paper - penny for example, you would also see that coins with the same metal in them will not give you a battery at all.

As long as we choose the right coins for our terminals, and are careful about how we connect them together, we can turn pocket change into a battery. Each individual coin battery, one penny, one piece of salt water soaked paper and one nickel for example, is too small to light a bulb on its own, but it is still the same process that happens in a battery you buy at the store. We also learned that if we connect enough of the coin batteries together in the right way, we really can turn on a light bulb.