665-0200 (10-181) Voltaic Cell Kit

Warranty:

We replace all defective parts free of charge. Additional replacement parts may be ordered at 800-875-3214. All products warranted to be free from defect for **90 days.** Does not apply to accident, misuse, or normal wear and tear.

Additional Materials Needed:

- Voltmeter
- Vinegar (5% acetic acid)
- (optional) dilute lemon juice

Related Materials:

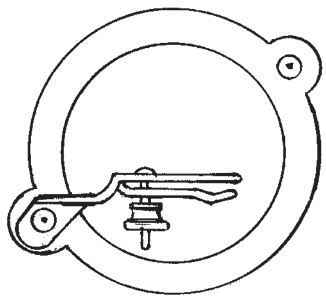
These accessories manufactured by **Science First®** *will expand your experiments with chemical cells.*

Porous Cup	665-0205
Iron (Fe) electrode	615-4600
Carbon (C) electrode (rod)	615-4602
Nickel (Ni) electrode	615-4603
Aluminum (Al) electrode	615-4604
Copper (Cu) electrode	615-4605
Zinc (Zn) electrode	615-4606
Complete Voltaic Cell *includes jar, porous cup, 10 electrodes*	665-0300
Basic Voltaic Cell	665-0210
Electrodes, Set of 10 *1 each: aluminum, carbon, iron, nickel; 2 each, copper, lead, zinc*	665-0400

How To Assemble:

Screw plastic molded ring with attached hardware to the plastic jar, with long screw protruding upward.. Assemble long and short electrode brackets as shown, with short screw pointing outward from center of ring through hole located in midpoint of long bracket. Fasten brackets together with knurl nut.

Attach assembled brackets to long screws protruding from plastic ring and fasten with knurl nuts. Electrode brackets should attach to plastic ring loosely enough to swing inside ring, so you can position your electrodes as desired.



One short and long electrode bracket fastened to plastic ring with knurl nut

Attach copper and zinc electrodes to electrode brackets. Unscrew knurl nuts slightly to allow brackets to open. Slide one end of electrode through opened bracket; screw knurl nuts tight.

Photo shows one bracket swung outward. To use, position both brackets so electrodes protrude into jar.

How To Use:

Attach electrodes to brackets.

Open electrode brackets with knurl nuts, slide zinc and copper electrodes, top down, between electrode brackets with electrode pointing down into your mason jar or tumbler (*we recommend 3-7912-P55 polystyrene 8 oz jar*.)

Fill jar with vinegar.

Fill container with vinegar (5% acetic acid) or other electrolyte. Fill to approximately 2/3 of an 8 oz. jar, so electrodes protrude into the electrolyte. If you require a larger volume of liquid than can be held by an 8 oz jar, use a pint or quart jar.

Hook up cell to voltmeter.

Hook your voltaic cell to a voltmeter by clipping one end of hookup wire to the thumb nut on either the electrode holder or the plastic rim. Repeat for second hookup wire.

Clip free ends of both wires to the terminals on your voltmeter.

Measure the amount of electrical voltage generated.

You should generate *about 1.0 volts.* The zinc electrode should have negative readings.

Experiment with different electrodes and electrolytes such as dilute lemon juice.

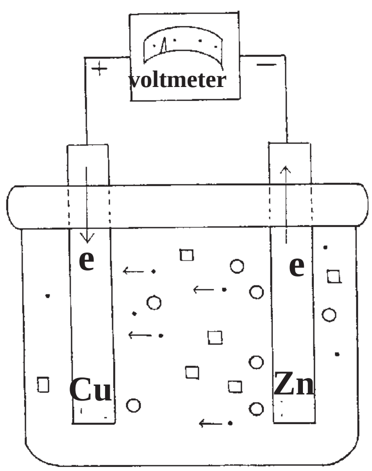
P/N 24-1181

Theory and History

The Voltaic Cell, named after its inventor, Count Alessandro Volta, is based upon principles discovered by Luigi Galvani in 1790, a biologist experimenting with a pair of frogs' legs freshly dissected and suspended from a copper wire. Galvani noticed the legs would jerk as if alive when touched by an iron knife. Wondering if lightning would have the same effect, he hung the legs outside during a thunderstorm on a brass hook connected to an iron bar. The legs kicked even after the storm passed, and he felt that electricity was contained in the muscles of the frog. Volta arrived at a different conclusion: that the metals reacted chemically with the body fluids to generate electric current which caused the twitching. He tested his hypothesis by demonstrating that a potential difference can be generated by two different conductors in contact with liquid containing ions to conduct electricity. One type of cell based on this general principle is the **Voltaic Cell.**

A basic Voltaic Cell transforms chemical energy into kinetic energy. A rod of **zinc** and rod of **copper** are placed in a container holding dilute sulphuric acid (or, with this kit, vinegar.) The rods are the **electrodes** (conductors) and acid is the **electrolyte** (liquid which conducts electricity.) The metal rods are arranged so they do not touch. If wires are connected to the rods and to a voltmeter, the needle on the voltmeter is deflected. This shows that a **potential difference** exists between the two dissimilar conductors. The two wires and voltmeter form a conducting path termed a **circuit.**

All metal tends to dissolve in liquid in varying degrees. In the example in this diagram, the copper and zinc electrodes tend to dissolve when placed in sulfuric acid. As each zinc atom dissolves, it loses two electrons and forms a charged particle, or **ion**, represented by the symbol Zn^{++}. The "lost" electrons collect on the zinc rod, which is charged negatively. As additional Zn^{++} ions form, many are attracted to the zinc electrode, which grows increasingly negative. The Zn^{++} ions form a concentrated positive charge in the liquid near the zinc electrode. The charge stops growing when a Zn^{++} ion returns to



the electrode for each zinc atom that dissolves. A dynamic equilibrium condition prevails at this point, since atoms and ions are continuing to form although the total charge stops increasing.

The copper electrode shows a similar reaction. However, since copper atoms have less tendency to dissolve, they reach an equilibrium condition more quickly. The charge built up on the copper rod is less strong and less negative than on the zinc rod. This makes the copper electrode positive compared to the zinc electrode. In a Voltaic Cell, the metal that dissolves more readily is always negative. The chemical action of the Voltaic Cell establishes a potential difference between the two electrodes.

When the electrodes of the zinc-copper cell are linked externally with a connecting wire, electrons begin to drift through the conductor (wire) from the negative (zinc) electrode to the positive (copper). The charge of each is therefore decreased and the Cell renews its chemical action. Electrons flow from zinc to copper by way of the wire and back from copper to zinc by way of the solution.

How To Make Different Types of Voltaic Cells

Cell Type	Positive Electrode (in Porous Cup)	Porous Cup Electrolyte	Negative Electrode (outside)	Outside Electrolyte
Bunsen	Carbon	10%HNO_3	Zinc	10% H_2SO_4
Bunsen	Carbon	H_2CrO_4	Zinc	10% H_2SO_4
Chromic Acid (single fluid) dilute, mixed	Carbon	No cup	Zinc	H_2SO_4 & $H_2Cr\ O_4$
Daniel *	Copper* cathode	5%H_2SO_4	Zinc - anode	$CuS0_4$
Storage	Lead	No cup	Lead	10% H_2SO_4
Poggendorf	Carbon	No cup	Zinc	H_2SO_4 & K_2CrO_4
Niadut	Carbon	$CaCl_2$	Zinc	NaCl
Fuller **	Carbon **	$ZnCl_2$	Zinc	$K_2Cr_2O_7$ ** & HCl

* Place copper and sulfuric acid inside porous cup
** Place carbon, $K_2Cr_2O_7$ and HCl **outside** porous cup Place Zn and $ZnCl_2$ **inside** porous cup

Chemical Cells

You can make and experiment with a variety of chemical cells using different combinations of electrodes and electrolytes. The **10-180 Student Cell** with porous cup and 10 electrodes can be used for the cells in the table above.

The porous cup is needed if each electrode requires a separate electrolyte. The cup contains the second electrolyte and will ensure that the two electrolytes do not mix. At the same time it allows ions to pass in and out through its walls.