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Effects of an Electric Current

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General science should acquaint the pupil with the common important scientific facts of his own environment in order to give him a better understanding and appreciation of the world in which he lives. The authors of this course should be commended for having kept this in mind in the selection of the material for the course. While there are errors in a few places, and these should be corrected, the course should be very valuable for high school teachers of general science.

The writer of this review being a biologist has reviewed closely only the biological material of the course.

C. W. Lantz.

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EFFECTS OF AN ELECTRIC CURRENT

In two preceding articles, the writer has discussed the nature of an electric current and the three practical ways of producing it. The question now naturally follows: What are the uses of an electric current? Speaking generally, we use an electric current for lighting, for heating, for chemical work, for mechanical work, and for therapeutic or physiological treatments of various human ailments.

We will consider first the chemical effect of an electric current, which is the basis of a number of industrial projects of the day. To a chemist matter consists of elements and compounds. A compound like sugar or common table salt consists of a combination of two or more elements. The elements in a compound are firmly held together by electrical attraction. This being true, it is only natural that an electric current should be able to break up a compound into its constituent parts. Water, which is a compound of hydrogen and oxygen, is readily decomposed into these constituent gaseous elements by a current possessing an electromotive force of about three volts. A battery of two dry cells will easily do the work.

The experiment can be set up in a few minutes. Connect the two dry cells in series. Use copper pole-wires about one foot in length and attach to each of them a six inch piece of common aluminum wire. Fill a tumbler three-fourths full of water and add about a tablespoonful of concentrated sulphuric acid. Finally dip the aluminum ends of the two pole-wires into the dilute solution of sulphuric acid, keeping them about one-half an inch apart. Note carefully what takes place at the surface of the aluminum wires. Tiny bubbles will rise from the one attached to the positive pole of the battery, while much larger bubbles will rise from the one attached to the negative pole. The tiny bubbles consist of oxygen gas and the much larger bubbles consist of hydrogen gas. In volume, there is just twice as much hydrogen freed as oxygen. This fact is denoted in the familiar chemical formula for water, H2O. In the ordinary high school physics text the experiment described above is represented in a more elaborate way. (See fig. 1.)

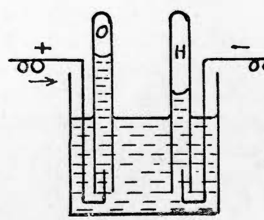

Fig. 1

The simple experiment described above, however, will create much interest when performed by the individual student of a high school physics class. The pole wires are tipped with aluminum wires in this experiment because aluminum is not readily soluble in dilute sulphuric acid.

The decomposition of water is practically applied in charging storage batteries. When a storage battery, Fig. 2, is charged, the water of the electrolyte is separated into hydrogen and oxygen.

The oxygen gas thus liberated from the water combines with the positive plates of the storage cell, and in so doing converts the electrical energy of the charging current into atomic energy. This stored atomic energy is reconverted into electrical energy as the battery is discharged. The hydrogen gas freed from the water in charging a storage cell bubbles up out of the battery solution. It is necessary to add distilled water periodically to a storage cell to replace that which is decomposed in the charging process.

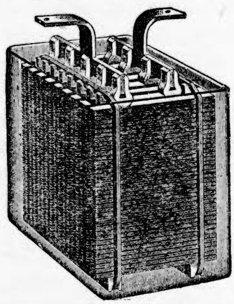

Fig. 2

In charging a six volt storage battery one should use a current whose electromotive force is larger than six volts. A current of nine or ten volts will do very well. In connecting the charging circuit to the storage battery, its positive terminal must be connected to the positive pole and its negative terminal to the negative pole of the storage battery. In other words, the charging current must always directly oppose the battery current. The charging current must not be larger than the normal discharge rate of the storage battery. An ammeter connected in the charging circuit will enable one to adjust the current properly.

A more important experiment illustrating the chemical effect of an electric current is found in the decomposition of metallic salts. A normal metallic salt is a chemical combination of a metal and an acid element or radicle. Copper sulphate, for instance, commonly called blue vitriol, is a salt consisting of metallic copper combined with the SO4 radicle of sulphuric acid. Sodium chloride, or common table salt, consists of a combination of metallic sodium and the acid element chlorine.

When an electric current is run through a solution of a metallic salt, the salt is decomposed into its metallic and acid constituents. A simple experiment, easily performed, will show this to be true. Prepare a twenty per cent solution of potassium or sodium sulphate. Pour the solution into a bent piece of glass tubing (figure 3) proper-

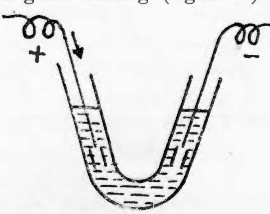

Fig. 3

ly supported. Add to the salt solution a few drops of strong blue litmus solution. Use a battery of three dry cells. The pole wires of the battery should be tipped with platinum foil or with short pieces of aluminum wire. Immerse the ends of the pole wires in the solution in the bent tube, one on each side, keeping them about one half inch apart. Finally close the key of the circuit and let the current flow for about ten minutes. At the end of that time it will be noted that the solution is pink in color around the positive end of the battery circuit, indicating the presence of an acid. The blue litmus around the negative end of the battery circuit will change its tint but remains blue indicating the presence of a base.

The principle of the experiment just described, like that of the decomposition of water, is much exploited in the industries. Such industries as electroplating, electrotyping, and the electrolytic processes employed to separate pure metals from their ores in the mining industry are all practical applications of the electric decomposition of metallic salts. One of the most important industries of Cedar Falls is the manufacture of farm gates. These gates are constructed of iron rods and piping. To protect them from rust, they are covered with a coating of zinc by means of an electroplating process. In carrying out the process, the surface of the iron is thoroughly cleaned. The gates are then attached to the negative terminal of a low voltage dynamo and hung in a solution of zinc sulphate contained in a large vat. The positive terminal of the dynamo is connected to a slab of zinc which is hung in the solution of zinc sulphate opposite the suspended gate. A current with an E.M.F. of about five volts is then turned on and allowed to run for some time. By the action of this current, the zinc sulphate is decomposed, the zinc going to the surface of the gate, where it adheres firmly. The acid radicle SO4 goes to the zinc slab with which it combines to form zinc sulphate that replaces the salt decomposed in the solution.

There are many forms of electroplating, such as silver plating, copper plating, and nickel plating. The salt used depends upon the kind of metal that is to be electroplated. In silver plating and copper plating the salts are silver cyanide and copper cyanide. In silver plating a solid piece of silver is attached to the positive terminal of the electroplating cell while in copper plating a solid piece of copper is thus attached. In the copper mines of Montana and the silver mines of Utah ores of these metals are found in the form of salts. To obtain the pure metals the salts are brought into solution from which the metals are separated by the same process as is employed in electroplating.

Most books are printed from electrotypes. These electrotypes are made in the following manner: The type is first set and formed up into pages. An impression is then made of the type in wax. This wax impression is covered with powdered graphite to make it conducting. Thus prepared, the wax impression is firmly attached to the negative terminal of an electroplating circuit and suspended in a copper plating bath. A coating of copper about the thickness of cardboard is thus deposited upon the wax impression. This film of copper is removed and backed up with type metal to make a firm plate for the printing press.

The decomposition of a chemical compound by means of an electric current is technically called electrolysis. The negative terminal of the current used in such a process is denoted the cathode and the positive terminal the anode. The object to be plated is always attached to the cathode. The anode always ends in a piece of solid metal identical with that which is plated. The laws of electrolysis were first accurately stated by the renowned Faraday. Electrolysis is an accurate mathematical process dependent upon known characteristics of the atom. To understand Faraday's laws, one should be versed in the fundamentals of general chemistry. L. Begeman.

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WEATHER LORE

General Science

Are you one of the great throng that believe in superstition? Do you look with gloom and dismay upon future weather if, on ground-hog day, this harmless animal should be so unfortunate as to see his noon day shadow and then hie himself to mother earth for another six weeks' period? Do you think it makes any difference if you plant your garden seeds in the light of the moon or lay shingles in the dark of the moon? Do you believe that the extra large house of the muskrat, the commodius nest of the timber squirrel, the thick onion skins or heavy husks on ears of corn are forecasts of cold winters? Do you believe that aching corns and bunions, crowing cockerels at even-