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Warning

GSC's products are intended for use in labs and classroom settings under the supervision of qualified professionals. The products are not toys and are not intended for children under the age of 13.

The item contains small parts. This is not a toy – adult supervision required.

Warning: Never Use 115 Volts AC

#4-31001 Conductivity of Solutions Apparatus

Contents:

The conductivity of solutions kit contains a plastic top consisting of one copper and one carbon wire. One wire is running to one of the two banana knob connectors and the other is connected to the light bulb. We recommend a 3.2 volt light bulb. A glass tumbler is also provided.

Electrical leads, copper sulfate and either a battery or small power supply, no more than 3 volts, are to be supplied by the user.

Purpose:

The purpose of the apparatus is to show the relative conductivity of various solutions.

Instructions:

The glass tumbler will allow the leads of the apparatus to be suspended while the top of the apparatus is held up by the rim of the glass. The tumbler should be filled with ordinary tap water to the point that approximately 1 inch of the leads are covered. In no case should the glass be filled so full that the line terminals on the bottom of the mounting plate could be in the water. The 3.2 volt light bulb should be screwed firmly into the socket. Next, a 3 volt source, battery or DC power supply, should be connected to the banana terminals on the top of the apparatus.

Even though power has been supplied to the banana terminals, the bulb will not light. However, a bubbling activity will be seen at one of the electrodes. Which one? Why?

Next add a few small crystals of copper sulfate to the water and observe what happens to the bulb as the crystals dissolve.

The battery established an electrical potential difference between the two leads (i.e., one is positive – the anode and the other is the negative – cathode). The electrical potential difference tries to pull the water molecules apart and creates ions, but cannot. Impurities present in ordinary tap water are affected as evidenced by the bubbles, but not enough ions are present to cause an appreciable current between the wires. Thus, the bulb does not light. Dissolving a few crystals of copper sulfate causes a plentiful production of two ions in the solution, namely CU++

and SO 4.   It is important to note, the formation of these ions is independent of any action of the battery. But the positive and negative nature of the leads from the battery cause migration of the positive ions to the negative ions to the positive wire. Since current is nothing more than the motion of charges in time, a current has been established and the bulb glows.

In more quantitative terms, each Cu++ ion has a charge of 2e and mass m, so if N ions reach the cathode they will deposit an amount of charge N(2e) and mass M-Nm. One finds from careful experimental measurements that the ratio Q/M is constant, which means that 2e/m must also be constant. When 63.54 gm of Cu (the atomic weight of Cu is 63.54 gm/mole) have been deposited on the cathode, a charge equal to Avogadro's number times the charge of each ion, namely 2 (96,519) coulombs will have been deposited. Based on the constancy of the Q/M ratio, all one has to do to determine the current in the solution is measure the change in mass of coulombs time the ratio of the measured change in mass to 63.54 gm all divided by the time in seconds. The general procedure of producing a current in this fashion is known as electrolysis. Any ionic dissociation of an acid, base, or salt in water will result in the formation of ions, and so it will cause the bulb to grow. Prime examples are acids such as sulfuric or hydrochloric. Your students might be encouraged to try many materials just to see what happens. If you have them do this, you might wish to have them report their results in some semi-quantitative fashion such as:

Chemical Type: Material Name (acid, base, salt)

Bulb Reaction: (bright, medium, dim)

The number of ions produced will depend on the type of material and on it's concentration. The relative ease with which the resultant solution allows ions to pass to the electrodes is called conductivity, with high conductivity resulting in greater brightness of the bulb, all else being equal.

Care and Storage:

This apparatus must be kept clean to work properly.   Metal will be deposited on the cathode and oxides on the anode and should be removed before trying other solutions or before storing the apparatus. Never leave the apparatus in the tumbler where reactions will continue to take place over long periods of time.

CAUTION:

Always use eye protection when performing this experiment and when preparing the sulfuric acid solution. Always add the acid to water, slowly. Safety gloves and goggles should be worn when handling the acid solution.

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