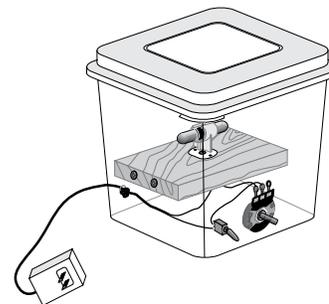


ICE Devices

Magnetic Stirrer

This stirring plate is very inexpensive to make. You may wish to have the “shop” class prepare the wooden blocks. Background information about soldering appears at the end of these directions.



Disclaimer. This publication is intended for use by teachers or other adults or by students with proper supervision. Users are expected to follow normal safety precautions when performing the activities described in this manual. Neither the authors nor the publisher assume liability for the use of information in this publication.

Copyright © 1994, 2015 by University of Wisconsin Board of Regents; ICE Publication: *ICE Devices*

Creative Commons License Deed. Attribution-NonCommercial-ShareAlike 3.0 Unported [<http://creativecommons.org/licenses/by-nc-sa/3.0/>] A portion of this document is below; see complete license online.

You are free to

Share—copy and redistribute this material in any medium or format;

Adapt—remix, transform, and build upon the material.

You may do so as long as you follow the license terms:

- **Attribution**—You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
- **Noncommercial**—You may not use the material for commercial purposes.
- **Share Alike**—If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.
- **No additional restrictions**—You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Permission to copy: You have our permission to make as many printed copies as are needed for students in your classes of any or all of these activities.

ICE Institute for Chemical Education

Contact Information

ICE, Institute for Chemical Education

University of Wisconsin–Madison
Department of Chemistry
1101 University Avenue
Madison, WI 53706

toll free 888-220-9822 (toll-free number, U.S.)

telephone 608/262-3033

fax 608/265-8094

email ice@chem.wisc.edu and iceorders@chem.wisc.edu

(sorry, we cannot accept credit card orders by email)

Visit the ICE Website

Information about all ICE Kits and Publications as well as our Order Form may be found on our web site at <http://ice.chem.wisc.edu>. The site also has information about our programs in Outreach, Education, and Research as well as the Nanoscience theme that runs through what we do and what we publish.

Magnetic Stirrer

by Nüsret Hıslm with modifications by Kelly Jetzer

This stirring plate is adapted from a previous stirrer design [Bennett, C.; Dyer, J. *J. Chem. Educ.* 1992, 69, 415–416]. The changes should make the device much less expensive. You may wish to have the “shop” class prepare the wooden blocks.

Materials

- 1 single pole, double throw mini toggle switch with solder lugs *
- 1 6-12 VDC motor with 1"-long shaft *
- 1 500 ohm potentiometer *
- 1 9VDC, 300 mA transformer (AC adapter)*
- 1 knob to fit 1/4" shaft *
- 4 wood screws and screw driver
- hot glue gun and glue sticks
- utility knife
- wire cutter
- wire stripper
- power drill and 1" spade bit
- soldering iron and solder [NOTE: tips and directions for soldering can be found on pages 10A–10C]
- 1 square plastic food container, about the size of a standard magnetic stirrer, approx. 4" × 6" × 6" (can be smaller), with slightly sloping sides
- 1 3/4" dia. 3" long bovine (cow) magnet (available at farm supply stores as well as from Flinn Scientific)
- 1 magnetic stir bar (Flinn Scientific, #API088 or other supplier) or use ceramic magnets from a crafts or hardware store
- 1 1" × 3" wood scrap, long enough so that its bottom face rests inside the food container about 2-1/2" from the top of the closed cover
- 1 15/16" long, 4mm diameter wall anchor to fit over motor shaft (wall anchors are used to help hold screws or nails in concrete walls)
- 1 1/2" long, 9/16" inner diameter snap-on strap (snap-on straps are used to attach cable or pipe to walls)
- [optional] four rubber feet and a 1-pt zipper-lock plastic bag of sand or plastic 9-oz. cup (2.75" tall) filled with hardened plaster of Paris to weigh down the stirrer

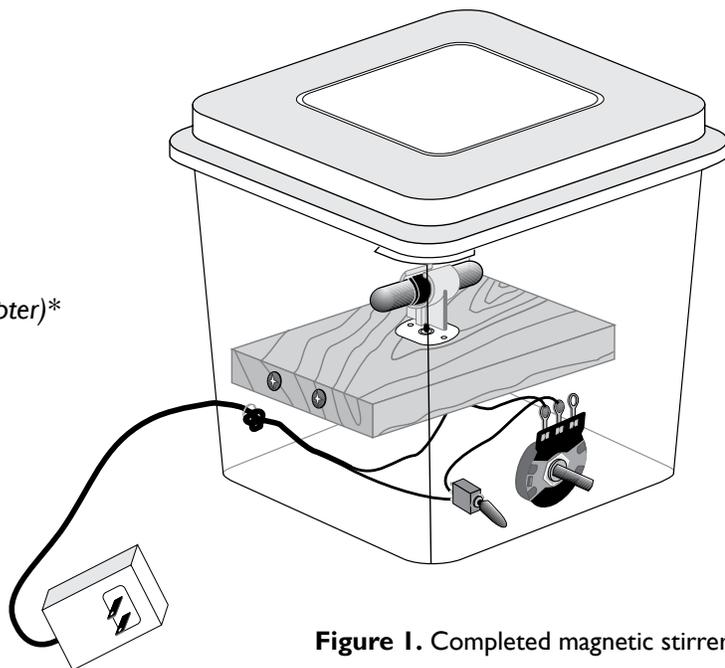
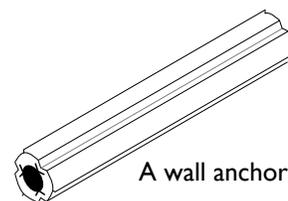


Figure 1. Completed magnetic stirrer



A wall anchor

* **Electronic parts:** These parts may be ordered from All Electronics Corporation, 14928 Oxnard Street, Van Nuys, CA 91411; <http://www.allelectronics.com>. Other suppliers of electronics include Radio Shack (www.radioshack.com), Mouser Electronics (www.mouser.com), as well as many others that can be found by an online search.

Procedure

- If you are using a plastic cup filled with plaster of Paris as a hold-down weight for the stirrer, mix the plaster in the cup now and set it aside to dry.
- Prepare the plastic food container:
 - Using the tip of the hot soldering pen, melt a small hole in the back of the container, near the bottom. The adapter wire will pass through this hole. (Soldering tips can be found on pages 10A–10C.)

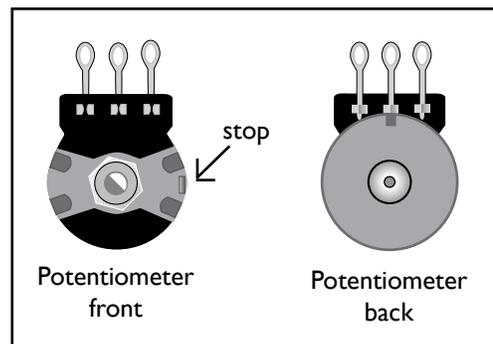
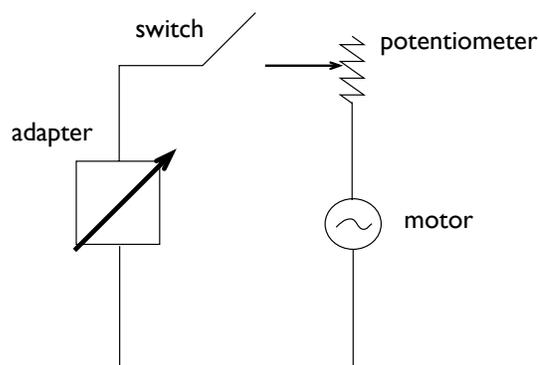


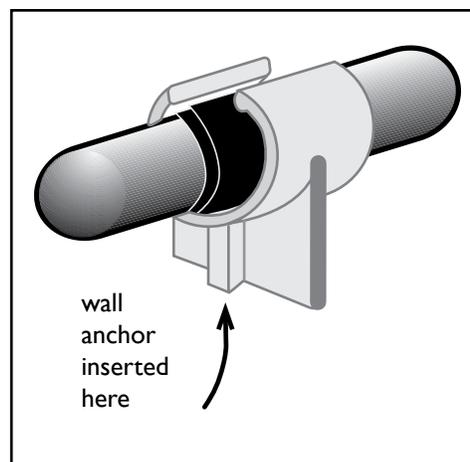
Figure 2.

- On the front wall of the container, about 1" from the bottom, melt a 1/4" hole. The shaft of the potentiometer (pot) will be inserted through this hole. The pot has a small metal stop on its front that prevents the pot from rotating when its shaft is turned. Insert the pot from the inside of the container so that the connecting lugs are at the top and mark where the stop hits the container. Make a small hole at this mark for the stop to pass through.
 - About 1.5" to the left of the potentiometer hole melt a small hole to fit the on/off switch.
 - If necessary, use a utility knife to scrape off any excess melted plastic from around the holes.
- Prepare the wire:
 - Cut off the pin connector from the adapter cord; cut as close to the connector as possible.
 - Insert the adapter cord into the container and knot it so that about 15" of cord remains in the container.
 - Separate the two wires of the cord about 10" and cut a 6" piece from each wire.
 - Strip about 1/2" of insulation from all the ends of all the wires.
 - Construct the circuit. Refer to the circuit diagram.



- Solder one of the adapter wires to one of the outer lugs of the switch.
 - Solder a 6" wire piece to the center lug of the switch. Solder the other end of the wire to the center lug of the pot.
 - Solder another 6" wire piece to the left lug of the pot (viewed with the pot shaft pointing towards you). Solder the other end of this wire to one of the motor leads.
 - Solder the other adapter wire to the other lead of the motor.
- Test the circuit: plug in the adapter, flip the switch to "ON", turn the shaft of the pot clockwise: the motor shaft should rotate with increasing speed.

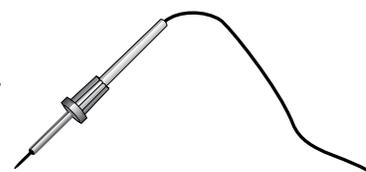
5. Prepare the wood block.
 - a. If the block is not pre-cut, clamp it firmly and cut it to the length that will allow its bottom to rest about 2-1/2" from the top of the *closed* container, with its edges touching the sides (**not** the front and the back) of the container.
 - b. With the wood clamped firmly, drill a 1" hole through the center. The motor should fit snugly in this hole. Use coarse sandpaper to enlarge the hole if necessary.
6. Hot glue the motor into the wooden block. Make sure that the top side of the motor is flush with the top of the wood.
7. Mount the cow magnet onto the motor shaft:
 - a. Wrap enough electrical tape around the middle of the magnet to make the snap-on-strap fit very snugly.
 - b. Cut the wall anchor in half. Slip one piece over the motor shaft as far as possible but without touching the motor body.
 - c. Slip the snap-on-strap over the anchor-covered motor shaft.
 - d. Retest the circuit. Does the magnet turn freely and evenly? If needed, center the magnet again.
8. Put the wood block into the container (onto the cup of plaster, if you are using it). On the container side walls, mark the positions at which you wish the mounting screws to be placed to hold the wood block in place. (See Figure 1.) Melt small holes at these marks. You may also need to make starter holes in the wood block with a hammer and nail. Do not yet fasten the block to the container.
9. Remove the hex nut and one washer from the switch shaft. Insert the switch into its hole orienting it so that the soldered lugs are at the middle and lower positions. (In this orientation, when the toggle is up the switch is on and when the toggle is down it is off.) Replace the washer and replace and tighten the outer hex nut.
10. Remove the hex nut and one washer from the potentiometer shaft. Insert the shaft and the stop of the potentiometer through the holes in the front of the container. Replace the washer and hex nut and tighten the nut. Attach the knob to the potentiometer shaft. (A drop of hot glue may be needed to hold the knob on the shaft.)
11. If you are using them, put the cup containing the plaster of Paris, or the bag of sand into the center of the container. Secure the wood block with wood screws.
12. If you are using them, attach the rubber feet. Cover the container.



Soldering

The notes on pages 10A–10C provide background information on these facets of soldering:

- Equipment
- Soldering Procedure—Soldering wire leads to a PC board, Soldering wire leads to a wire, and Soldering wire leads to multistrand wire
- Wire Stripping.



Appendix: Soldering

Text by Carl Houtman, Illustrations by Christine L. Cargille

NOTE

To see a useful video about soldering, go to:

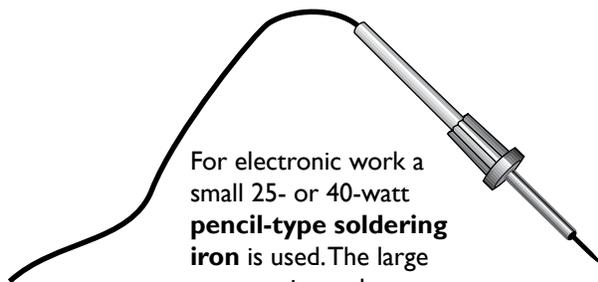
www.youtube.com/watch?v=BLfXXRfRIzY

⚠ CAUTION ⚠

The tip of a soldering iron is extremely hot. Soldering is inherently a three-hand job: you need to hold the soldering tool and both pieces to be joined. However, it is best to use a vise or a clamp for the third hand, rather than a human assistant.

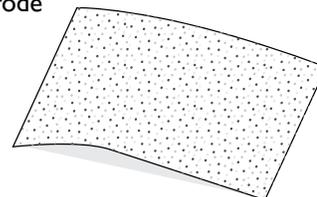
The equipment

Soldering is a way to join two metal surfaces. For the “glue”, one uses a low-melting-point alloy. For electronic or electrical work an alloy that is 40% tin and 60% lead is best, in contrast to the 50/50 solder that is used for plumbing connections. **Electronic solder** often has a rosin core to act as a flux to improve the “wetting”, or coating, of the metal surfaces to be joined.



For electronic work a small 25- or 40-watt **pencil-type soldering iron** is used. The large gun-type irons do not have a fine enough tip.

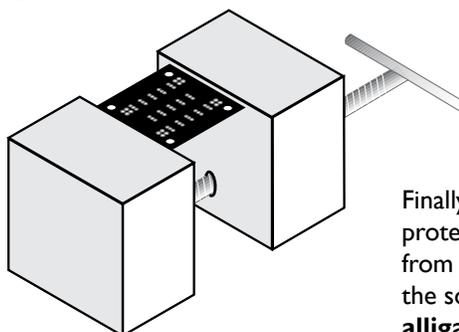
To clean and re-tin the soldering iron tip, use **tip cleaning paste** for electronic work from an electronics store. Do not use acid cleaners or acid flux—they will corrode your work. You can also gently **sand** the surface of the soldering iron tip until you have exposed the base metal.



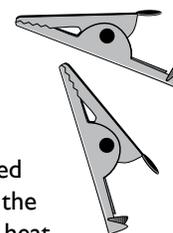
You will need **tweezers or pliers** or some other tools to hold small, very hot, delicate objects.



It will infinitely simplify your task if you have a **vise** or a **C-clamp** to hold one of the parts that you will be soldering—either the printed circuit (PC) board, if you are soldering components to it, or one of the wires, if you are soldering to a wire.



Finally, you may need to protect certain components from overheating during the soldering process. Small **alligator clips** can be clamped between the component and the joint to be soldered to act as heat sinks.



Soldering procedure

1.  Clear away a work space on a flameproof surface. Put on safety goggles to protect your eyes from hot rosin which might spatter.
2. Take a sponge, or fold a paper towel into quarters or eighths and wet it; place it next to the soldering pencil.
3. Plug in the soldering pencil and allow it a few minutes to get hot. **Check the tip:** Touch the tip of the soldering pencil to some solder. It should melt and coat the tip. If the solder rolls off the tip and does not coat it at all, you may need to clean the tip as described above. Then the solder will wet the tip surface.

While soldering, **wiping the tip** on the damp paper towel (or sponge) will help clean it by removing the oxide that forms on the surface of molten solder. Wiping on a damp towel also keeps the tip from overheating and oxidizing. To wipe the tip, simply stroke it over the folded paper towel that is lying on the table.

4.  Do NOT pick up the towel and rub it over the tip! If you do, you will severely burn your fingers.
4. The most important step in obtaining good solder joints is to **clean all the surfaces** carefully. Solder does not wet oxidized surfaces. When working on a printed-circuit board, rub the metal surfaces with fine steel wool. Other electronic components typically have non-oxidizing wires that don't need cleaning. Copper wires may need to be stripped to expose fresh metal. For help in wire stripping, see the relevant section below.

The next few steps will describe how to solder a wire lead of an electronics component to a printed-circuit (PC) board and how to solder a wire to a post or to another wire. An important point to remember when soldering *any* joint is that it is not sufficient to melt the solder and drip it all over the joint as one might do with glue. The pieces to be joined must be at the same temperature as the molten solder in order for the bond to be strong. Thus, *the soldering iron is used to heat the pieces to be joined, which in turn heat the solder.*

A. How to solder wire leads to a PC board

5. **Insert the wire leads** of the electronics component into the appropriate sockets of the PC board.
6. **Secure the board** in a vise or clamp.
7. If necessary, **clamp an alligator clip** between the joint and the (heat-sensitive) electronics component to minimize the heat transferred up the wire lead.
8. A *small* amount of solder should be on the tip of the soldering pencil to aid the flow of heat to the surfaces. Hold the soldering pencil in one hand and the solder in the other. Touch the hot tip of the soldering pencil to one side of the wire lead and to the soldering trace on the board. When the surfaces are hot (after about 30 seconds or so), touch the solder (not the pencil) to the other side of the wire lead. Do not let the solder touch the soldering pencil directly.

After about 25 seconds, the heat from the soldering pencil should penetrate through the wire lead and melt the solder. The solder will flow onto the wire and onto the copper trace. The solder only flows onto hot surfaces.

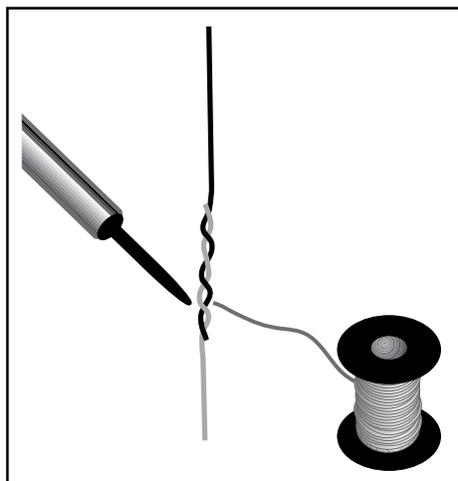
9. Do not use too much solder or it will overflow onto adjacent leads or traces, creating a “solder bridge”. If you make a solder bridge, first rub off any excess solder from the pencil tip on a damp paper towel. Reheat the joint to melt and remove the bridge. If this does not work, heat the joint until *all* the solder is molten and then tap the board on the table. If the solder is molten you should be able to shake it from the board.

B. How to solder wire leads to wire

10. Make a **firm mechanical connection** by twisting or crimping the wires together. Then, follow instruction number 8 above.

If you do not make a good mechanical connection, you may make what is called a “cold solder joint”.

Cold solder joints form when the wires are moved as the solder is cooling. One can spot cold solder joints because they often have a rough surface while good joints have a smooth surface. Simply reheating a cold solder joint will correct the problem.



C. How to solder wire leads to multistrand wire

11. Strip 1–1.5” of insulation from the multistrand wire. Twist the strands so that they spiral together. “Pre-tin” the strands: Hold the tip of the soldering pencil to one side of the wire and the solder to the other side. When the wire is hot enough, the solder will melt and penetrate among the strands. Allow to cool. Then, follow instruction number 10 above.

Wire Stripping

“Stripping” a wire refers to removing the insulation casing and exposing the copper wire. The easiest way to strip wire is to use wire strippers. These are designed to cut the insulation but leave the metal wire intact—they are like scissors with a small notch in the cutting edge. Care is required, however, since many wires are bigger than the notch.

Place the wire in the jaws of the stripper at the position where you want to remove the casing. Squeeze the stripper carefully. [If you are uncertain about how hard you need to close down the stripper, practice by trying to remove a very short piece (1 cm) of insulation.] You may want to rotate the stripper around the whole wire to get an even cut all the way around the insulation.

Once the insulation is cut, shove the stripper along the wire towards the end to push the casing off the bare wire inside. This is like taking off a sock by pushing it down from the top instead of pulling it by the toe.