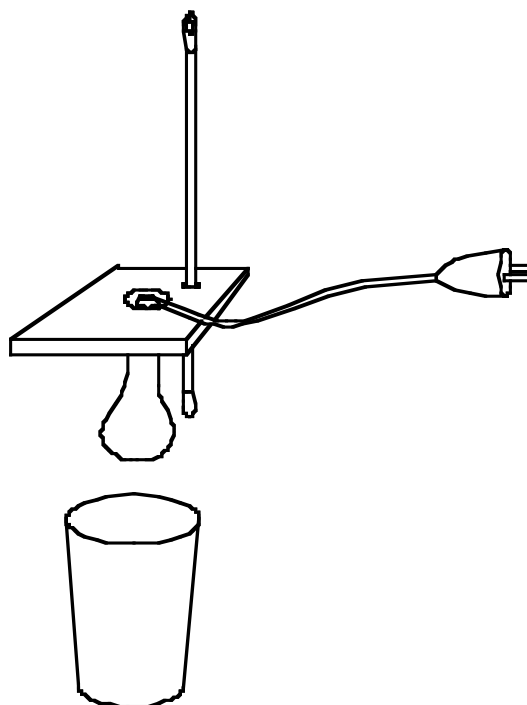


**3. Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.** As a basis for understanding this concept:  
**a. Students know heat flow and work are two forms of energy transfer between systems.**

**Activity to measure the relationship between work and heat.**

Commercial apparatus is available to reproduce Joule's determination of the mechanical equivalent of heat, but a fairly simple and inexpensive duplicate of this experiment can be made using a standard 60-watt light bulb.

The basic apparatus is a 60 watt light bulb that has been attached to a line cord through a hole in a piece of 1" thick Styrofoam. (Details on how this is constructed next page.) A hole through the Styrofoam top cover allows a thermometer to be pass through it. Using a Styrofoam cup large enough to accommodate the bulb, an amount of water is filled in the cup to completely submerge the bulb when lowered into the cup. (Do not plug in the bulb until it is completely submerged in the water.) The idea behind the experiment is to carefully time how long the bulb is on while submerged in the water. The temperature change is recorded during the time the bulb is on. Multiplying the power of the bulb times the seconds it was on would give the joules of energy put into the bulb. The mass of the water times the temperature change will give the amount of heat delivered to the water.



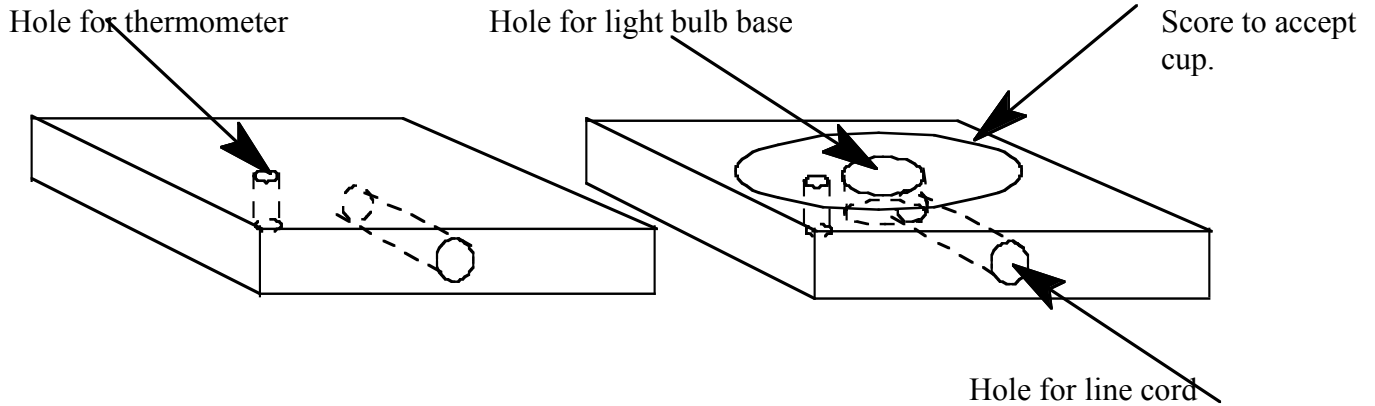
One error in this experiment will be the energy loss as visible light through the sides of the cup. Lining the cup with aluminum foil can minimize this. Also, to minimize the effect of loss heat through the walls of the cup, one could start the experiment with the temperature below room temperature and heat it to the same temperature above room temperature.

**Details on constructing the apparatus for the "Light Bulb Joule Equivalent Lab".**

The cover block of the apparatus was cut from a 4' X 8' sheet of 1 ¼" thick rigid Styrofoam. These sheets can be purchased from a building supply warehouse and at only 6" square required for each apparatus, enough material will be available from a single sheet to supply many schools equipment needs.

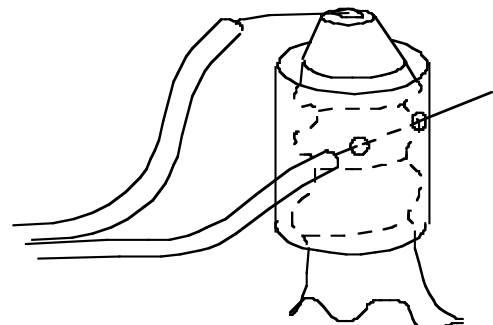
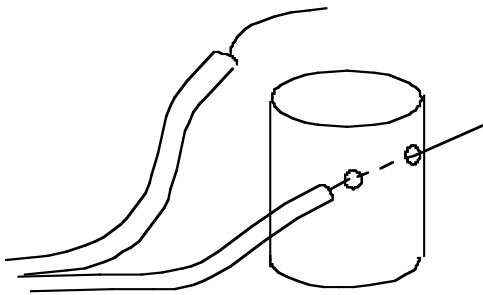
### Top View of Styrofoam block

### Bottom view of Styrofoam block



The Styrofoam top cover is machined as shown. A large hole saw is required to score the bottom of the cover to about  $\frac{1}{4}$ " to accept the top of a 16 oz Styrofoam cup. The hole for the bulb base is drilled partway through in a diameter that will accept the outside diameter of a piece of 1" schedule 40 PVC pipe. (A Forestner bit accomplishes this nicely.)

### Detail on constructing the 1" piece of PVC pipe that will act as the base for the light bulb.



Two holes are drilled in the pipe to accept the neutral wire from the AC line which will contact the screw base of the light bulb.

Hot wire is soldered to the base of the light bulb.

Be sure to pass the line cord through the hole for the line cord before you connect it as shown above to the PVC base.

After bulb is soldered, it can no longer be unscrewed.

### Tags that should be attached to the top Styrofoam cover to prevent accidental unscrewing of the bulb that would damage the solder connection to the bulb.

Do NOT twist bulb. If bulb must be removed, first pull straight out. Then unsolder wire attached to center of bulb. Etc. as required.	Do NOT twist bulb. If bulb must be removed, first pull straight out. Then unsolder wire attached to center of bulb
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Source of 60 watt incandescent bulbs: (As little as \$0.36 each)

<http://1000bulbs.com/category/60-watt-standard-shape-light-bulbs/>

Also try Home Depot:

[http://www.homedepot.com/Electrical-Light-Bulbs-Incandescents-Light-Bulbs/h\\_d1/N-bmg1Z5yc1v/h\\_d2/Navigation?langId=-1&storeId=10051&catalogId=10053&searchNav=true&cm\\_mmc=SEM|THD|GID|SKID27E|LightBulbs|General&skwid=TC|17346|incandescent%20light%20bulbs||Slpl11552882414&mid=s6VqDnE2R|dc\\_mtid\\_8903o6225187\\_perid\\_11552882414\\_pkw\\_incandescent%20light%20bulbs\\_pmt\\_p](http://www.homedepot.com/Electrical-Light-Bulbs-Incandescents-Light-Bulbs/h_d1/N-bmg1Z5yc1v/h_d2/Navigation?langId=-1&storeId=10051&catalogId=10053&searchNav=true&cm_mmc=SEM|THD|GID|SKID27E|LightBulbs|General&skwid=TC|17346|incandescent%20light%20bulbs||Slpl11552882414&mid=s6VqDnE2R|dc_mtid_8903o6225187_perid_11552882414_pkw_incandescent%20light%20bulbs_pmt_p)

