SAN DIEGO MESA COLLEGE **NAME**________________________

PHYSICS 197 LAB REPORT **DATE**________________**TIME**________

PARTNERS________________________

TITLE: Electricity and Heat

REFERENCE:

OBJECTIVE: To determine the relationship between energy transferred by electricity and energy transferred by heat, known as the "electrical equivalent of heat".

THEORY: **HEAT** is done on an object by subjecting the object to a temperature difference. The energy transferred by heat is measured by the product of the object's mass, its specific heat, and the temperature change which occurs:

$Q = m\,c\,\Delta t$, where Q is the energy transferred by heat in **calories**.

By definition, the specific heat of water is **1** calorie/g C°.

The energy transferred by electricity comes from a source of electric potential energy difference such as a battery, a convenience outlet, or some form of 'power supply'. The potential difference is defined as the work done per unit charge by the source on the electric charge that passes through it. The unit of potential difference is the **volt (V)**.

The energy is carried through the circuit by the moving charge, or electric current. Electric current is measured by the amount of charge passing a given point per unit time. The unit of current is the **ampere (A)**.

The rate at which energy is delivered to any electrical component of a circuit is the **power**. The unit of power is the **watt (W)**.

Power, electric potential difference, and electric current are very simply related by their basic definitions:

$$\text{Power} = \text{potential difference} \times \text{current}$$

$$= \frac{\text{work done}}{\text{charge}} \times \frac{\text{charge}}{\text{time}}$$

$$= \text{volts} \times \text{amps} = \text{watts}$$

EXPERIMENTAL TECHNIQUES, DIAGRAM AND DATA:

This laboratory exercise will be done in two parts. In Part I the energy delivered to an incandescent lamp by an electric current is transformed into the internal energy of opaque water. The change in temperature of the water is used to determine the energy transferred by heat.

The ratio **OF** the energy delivered by the current (in joules) **TO** the heat done (in calories) is the "electrical equivalent of heat".

In Part II measurements will be taken to determine the efficiency of the incandescent lamp.

IMPORTANT PRECAUTIONS

Do not fill the jar with water beyond the line indicated on the jar.
Do not increase the potential of the power supply beyond **12** V.
Illuminate the lamp **only** when it is immersed in the water.

Circuit Diagram:

1. Record the room temperature on the data table.

2. Measure and record the mass of the jar (with lid).

3. Remove the lid and fill the jar to the indicated water line. **DO NOT OVERFILL.**

4. Add about ten drops of India ink to the water. Take a minute to enjoy the "chaos"!

5. Cool the water in the jar to about ten degrees below room temperature in the ice bath provided. Dry the outside of the jar after removing from the bath.

6. Connect the electric circuit as instructed, **and have it checked by the Instructor.**

7. Turn on the power supply, adjust the potential to about 12 V., and insert the jar into the styrofoam calorimeter. **At the same time**, start the stopwatch, stir the water in the jar and record the initial temperature of the water.

8. Record the current through the lamp and the potential drop across the lamp, as measured by the ammeter and voltmeter. Check these values during the experiment to be sure they do not change significantly. Stir the water occasionaly.

9. When the temperature of the water is as far above room temperature as it started below room temperature, shut off the power supply and stop the watch. Continue stirring the water. Watch the thermometer until the temperature peaks and starts to drop. Record the peak temperature.

10. Measure and record the mass of the jar and water.

DATA:	Part I	Part II
Room temperature		
Mass of jar		
Current		
Potential Drop		
Initial temperature		
Final temperature		
Time interval		
Mass of jar and water		

EXPERIMENTAL TECHNIQUES:

PART II: The efficiency of the lamp is found by repeating the experimental procedure of Part I **without the ink or styrofoam cup** to prevent the escape of radiant energy. The efficiency of the lamp is defined as the energy transformed to light divided by the energy delivered to the lamp by the electric current (**E**). By assuming that all of the energy that does not contribute to **Q** is released as light, the equation for the efficiency becomes:

$$\text{efficiency} = \frac{(E - Q)}{E}$$

ANALYSIS:

PART I: **E** = electric energy delivered to the lamp = V x I x t

$$= \text{volts x amps x sec} = \frac{\text{energy}}{\text{charge}} \times \frac{\text{charge}}{\text{time}} \times \text{time}$$

=

Q = energy transferred to water by heat = $m^* \times c \times \Delta t$

=

*Note: Some energy is transferred into the plastic jar. For accurate results, the heat capacity of the jar must be recognized. The jar is equivalent to 23 grams of water.

Electrical Equivalent of Heat =

ANALYSIS:

PART II: Calculate the electric energy delivered to the lamp:

Calculate the energy transferred to the water and jar by heat:

Calculate the efficiency of the lamp (expressed as a percentage):

SUMMARY OF RESULTS: