Experiment -Calibration of a calorimeter

Purpose

To calibrate a calorimeter by measuring the increase in temperature that results from a measured input of electrical energy.

Keep electricity switched off until the apparatus is fully assembled.

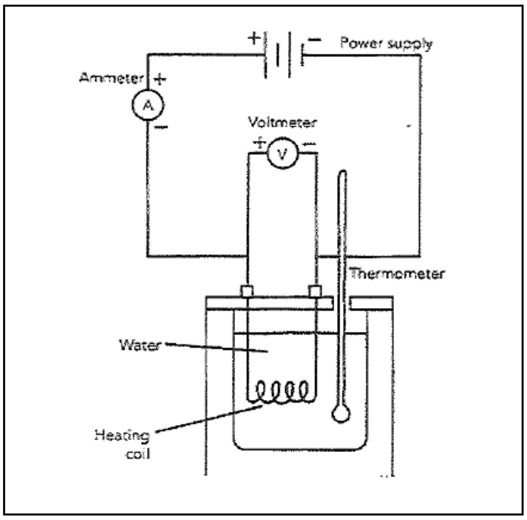
Duration 30 minutes

Materials

100 ml measuring cylinder calorimeter (with a code number for identification); DC power supply; 5 x wire leads; thermometer, -10 to 50°C; stopwatch; ammeter; voltmeter.

Procedure

1	Record the code number of your calorimeter. You may need to use this calorimeter for future experiments once you have calibrated it.
2	Pour 100 ml of water into the calorimeter. Allow the temperature of the water to stabilise (around 2 - 3 mins) and record the temperature.
3	Now the temperature is steady, apply a measured voltage of approximately 6 V for exactly 3 minutes using the circuit shown. Stir continuously and record the temperature everv 30 seconds.
4	Record the potential difference (voltage) and current while the water is heating. After 3 minutes turn off the power supply. Continue to stir the water in the calorimeter and record its temperature every 30 seconds for a further 3 minutes.
5	Discard the water in the calorimeter and repeat steps 1-4 using a fresh supply of water.



Results

Time (sec)	0	30	60	90	120	150	180	210	240	270	300	330	360	390
Temperature °C trial 1														
Temperature °C trial 2														

Theory

The calorimeter and its contents absorb thermal energy which is generated as an electric current passes through a heating coil in the calorimeter. The amount of thermal energy supplied is calculated using the formula:

energy Joules) = voltage (volts) x current (amps) x time (seconds)

The temperature of the calorimeter increases in proportion to the amount of energy supplied by the heating coil. The calibration factor (Joules of energy required per degree Celsius of temperature increase) is determined by measuring the temperature increase that results from a measured energy input. The value of the calibration factor depends upon the characteristics of the particular calorimeter. Once calibrated, the calorimeter can be used to measure enthalpy changes in chemical reactions.

Questions

Calculations

1. Graph the two sets of data you collected using the graph paper supplied, plotting temperature against time.

2. For each set of data, determine the temperature increase over the three-minute heating period.

3. For each set of data, calculate the thermal energy supplied by the heating coil in the calorimeter.

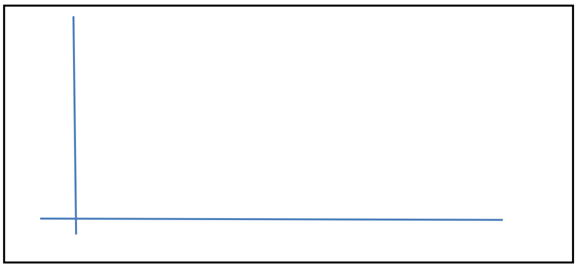
4. Once you have determined how much thermal energy was supplied to the calorimeter and the subsequent increase in temperature, calculate the calibration factor for each set of data. Find the mean value of the two calibration factors.

General questions

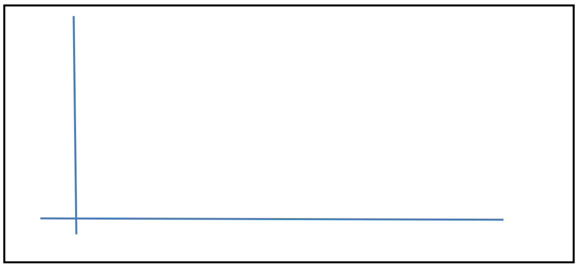
5. What energy transformations occur when the calorimeter and its contents are being heated?

6. Sketch a temperature vs time graph that you would expect to obtain for:

   (i) a poorly insulated calorimeter;



   (ii) (ii) a well-insulated calorimeter.



7. Comment on the insulation of your own calorimeter.

8. What would be the effect on the calibration factor obtained from this experiment if you used 50 ml of water instead of 100 ml, of water to calibrate the calorimeter?

9. In future experiments, what volume of solution should you place in the calorimeter to measure the enthalpy changes of chemical reactions?

10. Suggest some practical improvements that could be made to the calorimeter you have calibrated.

Experiment – Determining Enthalpy change in a chemical reaction using a calibrated calorimeter.

Purpose To determine the energy change in a chemical reactions using a calibrated calorimeter.

Wear safety glasses, gloves and a laboratory coat for this experiment.

- Magnesium powder may ignite near a flame.
- HCl is corrosive

Duration 20 minutes

Materials

150 ml of 1.0 M hydrochloric acid; 0.25 g magnesium powder; 2 x 100 ml. measuring cylinders; calorimeter (previously calibrated), thermometer, -10 to 50°C or temperature probe and data collection system; spatula; watch glass, electronic balance;

Procedure

1	Pour 100 ml of 1.0 M hydrochloric acid into a calorimeter. Stir and record the temperature of the acid.
2	Add between 0.20 and 0.25 g of accurately weighed magnesium powder to the calorimeter. Stir the mixture and record the highest temperature it reaches.

Results

Questions

1. Write an equation for the reactions that occurs in this experiment.

2. Using your measurements of the changes in temperature and the calibration factor of the calorimeter, calculate the energy change, in joule, that occurred during the reaction.

3. Calculate the heat of reaction (ΔH) for the reaction between HCl and Mg metal.

4. For the reaction that occurs in this experiment, which is the greater: the energy required to break the bonds in the reactants or the energy released when new bonds are formed to make the products? To explain your answer draw a diagram to illustrate the energy change.

5. Energy is neither created nor destroyed in a chemical reaction. Explain where the energy released (or absorbed) by the reactions comes from (or goes to).

Conclusion