Theory of Bomb Calorimetry:

The purpose of this experiment is to learn how to apply the laws of thermodynamics to chemical reactions. In this particular experiment we will use a bomb calorimeter to study heats associated with combustion reactions.

A bomb calorimeter is a device used for measuring the standard heat of combustion associated with a chemical reaction. The standard heat of combustion for a substance is defined as the enthalpy change, $\Delta\overline{H}^{0}_{T_1}$ accompanies a process in which one mole of a substance undergoes a combustion reaction with oxygen. It can be found according to equation 1.

1) $$\Delta\overline{H}^{0}_{T_1} \cong \Delta\overline{U}^{0}_{S,T_1} + RT\,\Delta n_{gas}$$

H- Enthalpy; R - Gas Constant; n – number of moles; U – Internal Energy; s – denotes sample combusted; 0 - denotes standard state (25C, 1bar).

The internal energy change of the sample is found from from equation 2, where change in temperature is obtained from experiment and heat capacity of the calorimeter is obtained from standardization of the bomb calorimeter (see Preparations section). The heat capacity of the wire is usually known.

2) $$\Delta U_{S,T_1} = -(C_{v,calorimeter} + C_{v,w})\,T_2 - T_1$$

T- temperature; C_v w – denotes iron wire.

Gas constant, R, can be taken to be 8.315 J/K mol or a more precise value can be obtained from literature.

Temperature, T, is the standard state temperature=25C.

Change in moles of gas, Δn,

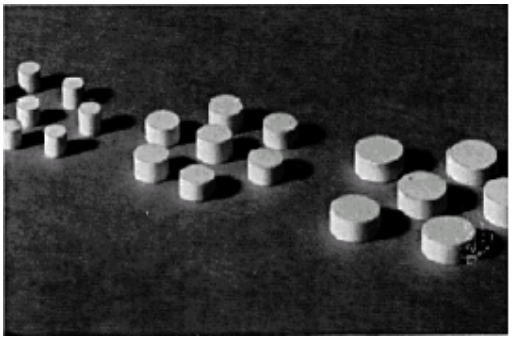
3) $$C_{12}H_{10}(s) + 14.5O_2(g) \longrightarrow 12CO_2(g) + 5H_2O(l)$$

From equation 3 we can see that the change in moles of gas is Δn =12-14.5=-2.5

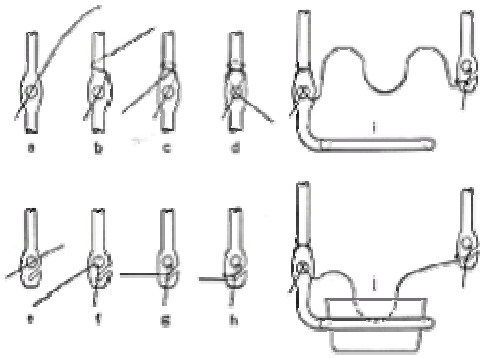
At this point we have enough information to calculate the standard heat of combustion!

Experimental Setup

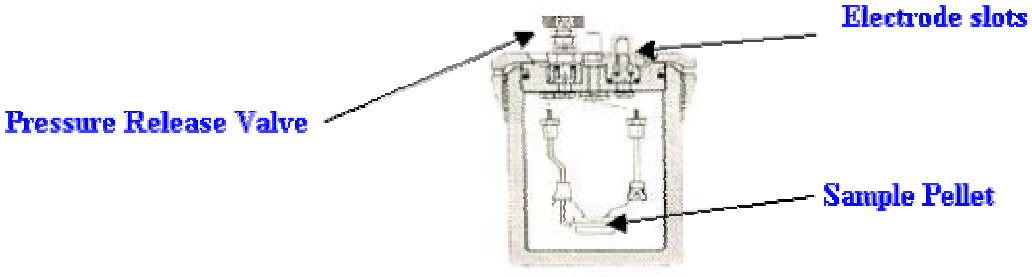
1. Make sure all connections to electrical outlet are disconnected.
2. Make sure all the parts to the bomb calorimeter are at hand.
3. Make a sample pellet (Figure1) using a pellet press.



4. Fuse a metal wire into the pellet of the chemical whose heat of combustion is to be determined
5. Attach the ends of the wire onto the two center poles of the cap that is screwed onto the bomb cavity as show in Figure2.



6. Screw the lid onto the bomb cavity (**make sure that the lid is on tight**). At this point your bomb should look like the bomb in Figure3.



Warning: DO NOT ALLOW THE BOMB TO SHAKE ONCE THE PRESSURE INSIDE IT HAS BEEN INCREASED.

7. Close the bomb valve and raise the pressure inside the bomb with the help of a pressure tank until 25 atm is r eached.

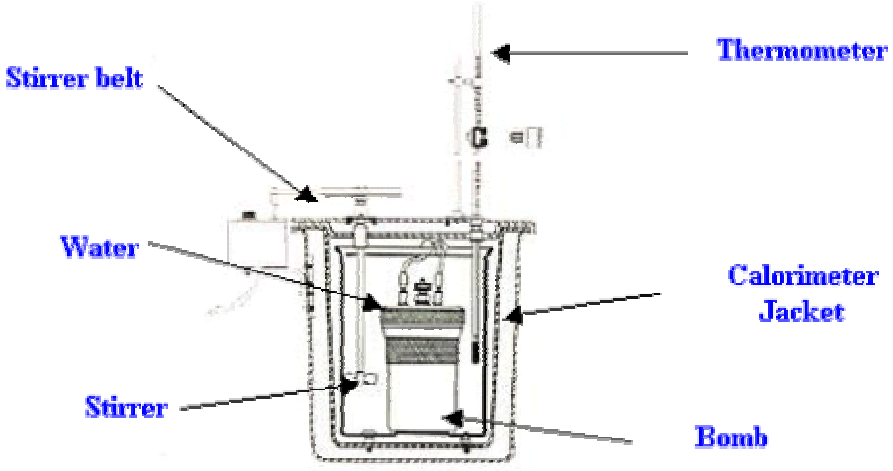
8. Purge the bomb of the Nitrogen gas by opening the pressure release valve (Figure3) and releasing the gas.

Point the bomb away from yourself and others while purging it of Nitrogen gas.

9. Raise the pressure inside the bomb with the hel p of a pressure tank until 25 atm is reached.

10. Attach the electrodes to the electrode slots on the cap shown in Figure 3.

11. Place bomb in metal pail placed inside the calorimeter jacket, filled with 1L of Distilled water as show in Figure 4.



12. Place the calorimeter lid on top of jacket, ensuring that the thermometer and stirrer are inside the water as show in Figure4.

13. Attach the stirrer belt to the apparatus (Figure4) and plug the stirrer into electrical outlet.

14. Plug in the ignition unit.

- Running the experiment

16. Start the stirrer.

17. Begin taking temperature reading with the thermometer every 10 seconds.

18. Allow system to run for 5-10 minutes.

19. Ignite the pellet with the ignition unit and continue to measure the temperature until 5 minutes after the temperature peaks.

20. Unplug all the electrical connections.

21. Next remove jacket lid, and remove the bomb from the water

22. In a designated area of the class room release the gas inside of the bomb by opening the pressure release valve.

23. Once all the gas is removed, unscrew the cap and measure the mass of wire remaining, and ensure th at all of the pellet was combusted

24. Begin the calculation process (refer to the theory section).

- Calculations

In performing the calculations the data recorded in this experiment needs to be used to make a Time versus Temperature graph. The graph should be similar to the following graph.