Heat Capacity and Specific Heat

O The **heat capacity**, *C*, of a substance is the amount of heat required to raise the temperature of the material 1°C.

O The **specific heat** of a substance is the amount of heat required to raise the temperature of *one gram* the material 1°C.

L In other words, the specific heat is the heat capacity for one gram of substance.

sp. ht. = ht. cap./gram

L The **molar heat capacity** is the heat capacity of one mole of substance.

molar ht. cap. = ht. cap./mol

L Heat capacity of a sample:

C = (specific heat) x (grams)

= (molar heat capacity) x (moles)

Specific Heat of Water

O The calorie was originally defined as the amount of heat needed to raise one gram of water 1°C.

L It follows that

sp. ht. H_2O = 1.000 cal/°C@g

O Today we define 1 calorie / 4.184 J; therefore,

sp. ht. H_2O = 4.184 J/°C@g.

Heat Capacity and Temperature Change

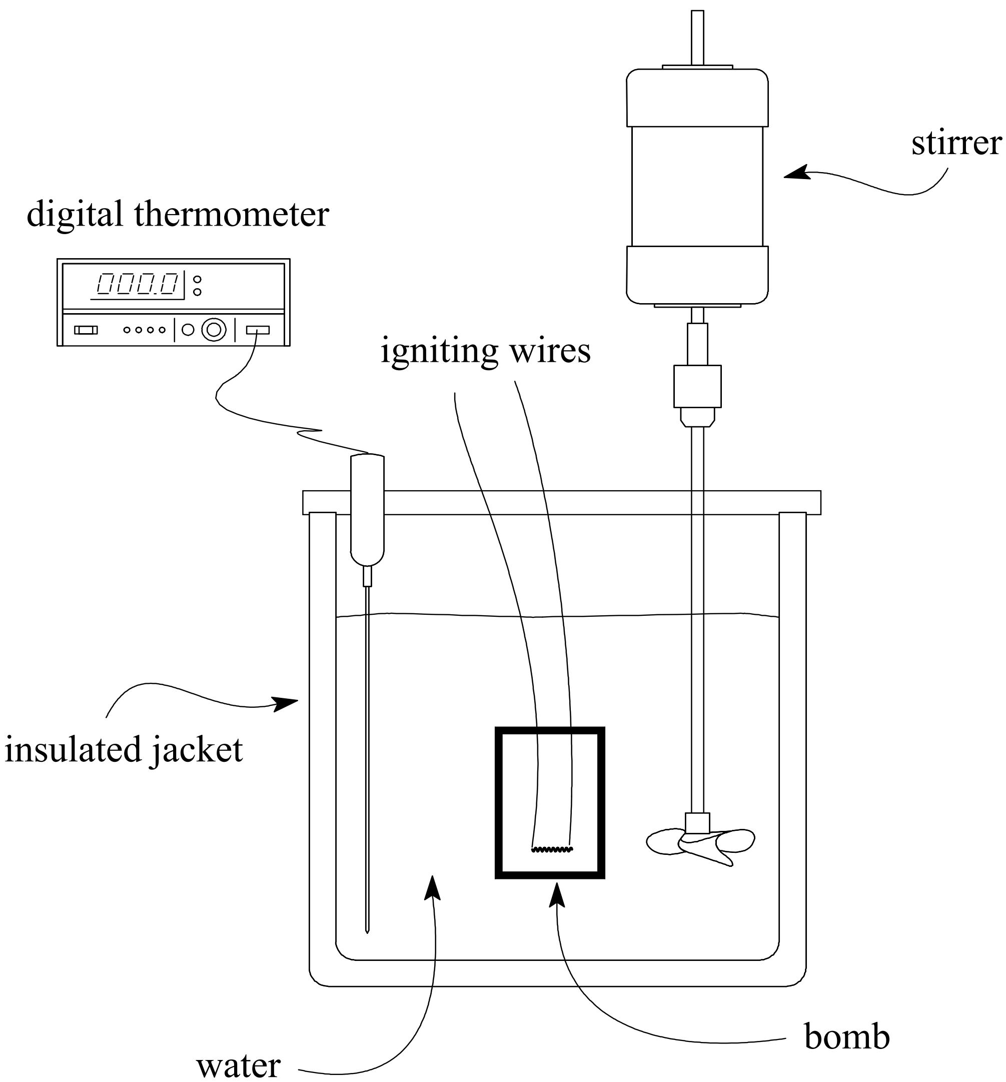
- The heat capacity, C, of a sample determines how susceptible it is to changes in temperature, ΔT, with changes in heat content, q.

$$q = C\Delta T$$

  - Heat capacity varies little for small temperature changes; i.e., it is virtually a constant.

Schematic Diagram of a Bomb Calorimeter

- A **constant volume calorimeter** prevents energy transfer through P@ΔV work, and thus the measured heat change is ΔE.
  - A bomb calorimeter is the common apparatus for carrying out constant volume calorimetric measurements.



Measuring Heats of Reaction with a Calorimeter

- The heat change of the calorimeter (not the reaction itself) is determined from the temperature change of the water surrounding the bomb.

$$q_{cal} = C_{cal}\Delta T$$

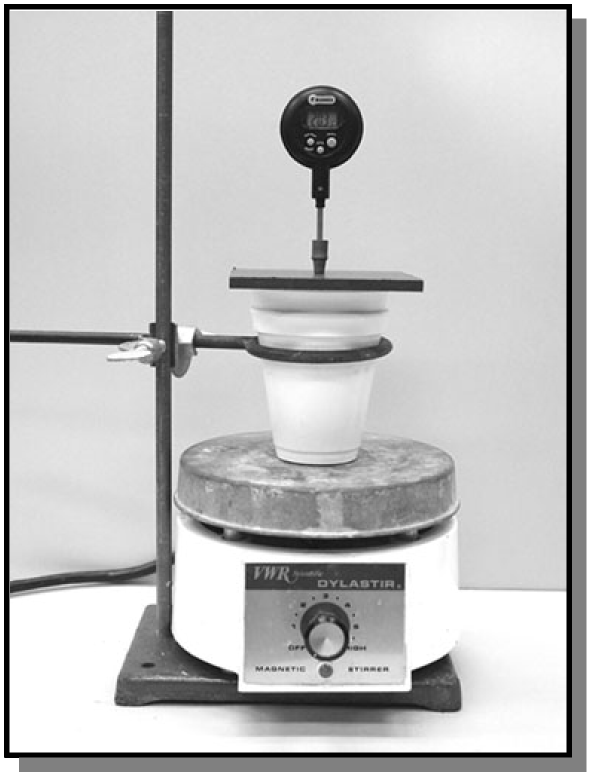
- The heat capacity of the calorimeter must be determined experimentally before using it to determine heats of reaction.

- The heat of the reaction, q_{rxn}, is equal in magnitude but opposite in sign to q_{cal}.

$$q_{rxn} = -q_{cal}$$

ΔT_{cal}	Calorimeter	q_{cal}	Reaction	q_{rxn}
>0	absorbs heat	>0 (endo-)	liberates heat	<0 (exo-)
<0	liberates heat	<0 (exo-)	absorbs heat	>0 (endo-)

Coffee-Cup Calorimeter



- A coffee-cup calorimeter is an example of a **constant pressure calorimeter**.
  - At constant pressure, the measured heat transferred is by definition ΔH.

- As with the bomb calorimeter, the observed temperature change reflects the effect of the reaction on the calorimeter, and $q_{cal} = -q_{rxn}$.