

## 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  $1^{\circ}\text{C}$ .
- O The **specific heat** of a substance is the amount of heat required to raise the temperature of *one gram* the material  $1^{\circ}\text{C}$ .
- L In other words, the specific heat is the heat capacity for one gram of substance.

$$\text{sp. ht.} = \text{ht. cap./gram}$$

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

$$\text{molar ht. cap.} = \text{ht. cap./mol}$$

- L Heat capacity of a sample:

$$C = (\text{specific heat}) \times (\text{grams})$$

$$= (\text{molar heat capacity}) \times (\text{moles})$$

## 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

$$\text{sp. ht. H}_2\text{O} = 1.000 \text{ cal/}^\circ\text{C@g}$$

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

$$\text{sp. ht. H}_2\text{O} = 4.184 \text{ J/}^\circ\text{C@g}.$$

## Heat Capacity and Temperature Change

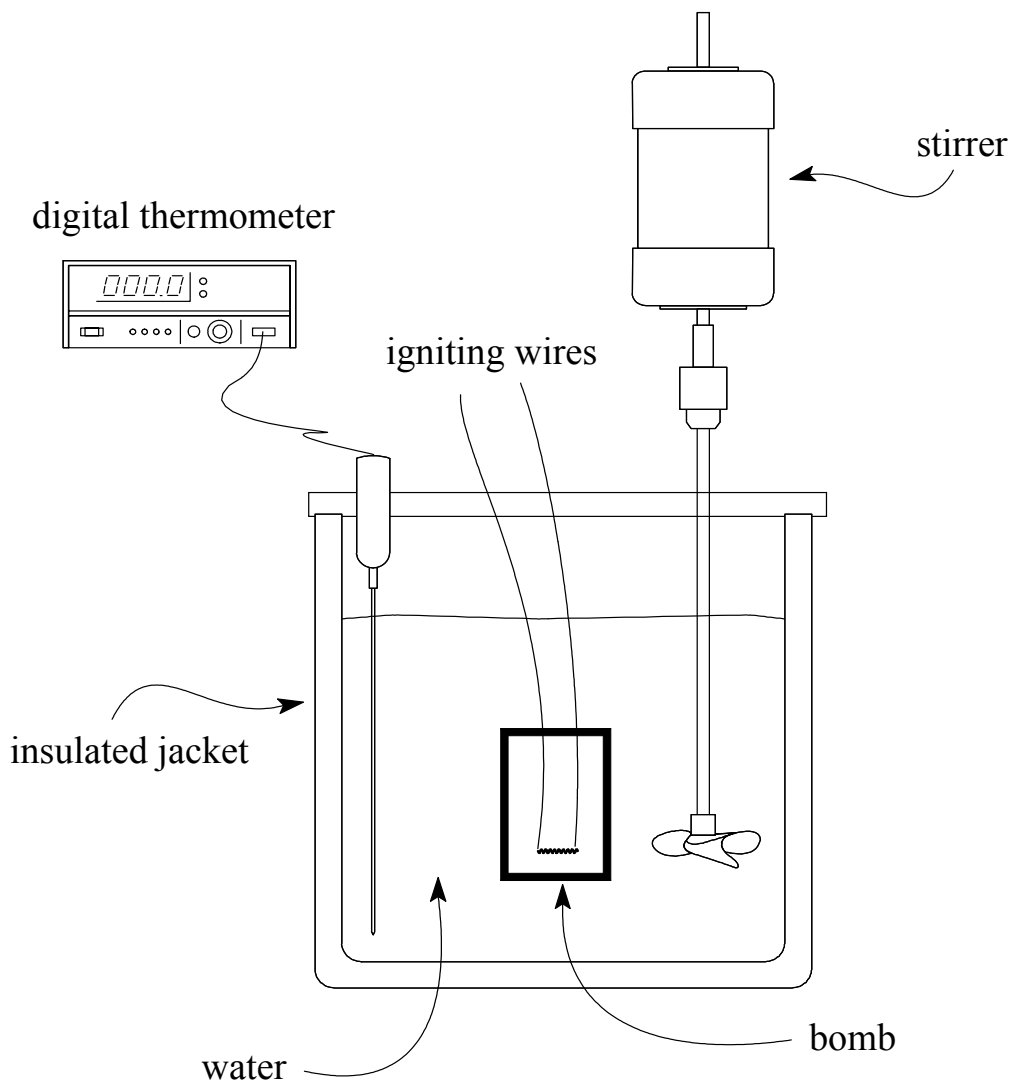
- O The heat capacity,  $C$ , of a sample determines how susceptible it is to changes in temperature,  $\Delta T$ , with changes in heat content,  $q$ .

$$q = C\Delta T$$

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

## Schematic Diagram of a Bomb Calorimeter

- O A **constant volume calorimeter** prevents energy transfer through  $P@V$  work, and thus the measured heat change is  $\Delta E$ .
- U A bomb calorimeter is the common apparatus for carrying out constant volume calorimetric measurements.



## Measuring Heats of Reaction with a Calorimeter

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

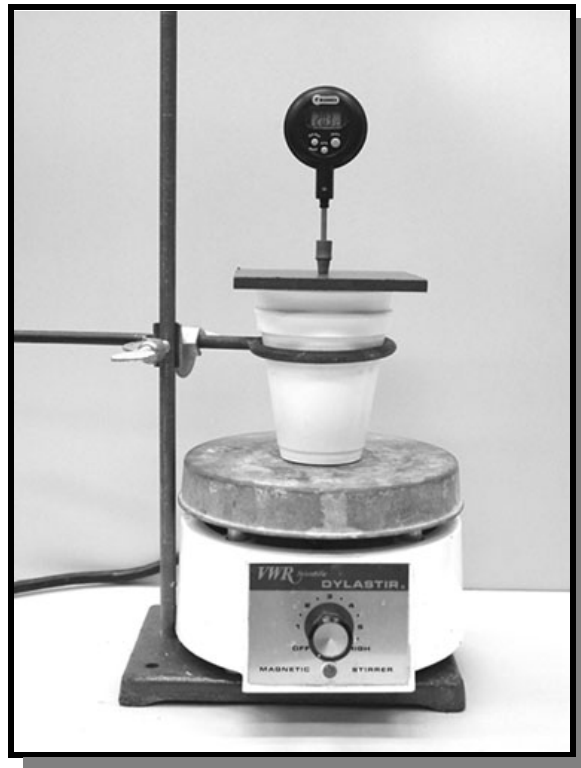
$$q_{\text{cal}} = C_{\text{cal}}\Delta T$$

- L The heat capacity of the calorimeter must be determined experimentally before using it to determine heats of reaction.
- L The heat of the reaction,  $q_{\text{rxn}}$ , is equal in magnitude but opposite in sign to  $q_{\text{cal}}$ .

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

$\Delta T_{\text{ca}}$	Calorimeter	$q_{\text{cal}}$	Reaction	$q_{\text{rxn}}$
>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**.
  - U At constant pressure, the measured heat transferred is by definition  $\Delta H$ .
  
- As with the bomb calorimeter, the observed temperature change reflects the effect of the reaction on the calorimeter, and  $q_{\text{cal}} = -q_{\text{rxn}}$ .