**Coffee Cup Calorimeter**

A coffee cup [calorimeter](https://www.thoughtco.com/definition-of-calorimeter-in-chemistry-604397) is essentially a polystyrene (Styrofoam) cup with a lid. The cup is partially filled with a known volume of water and a thermometer is inserted through the lid of the cup so that its bulb is below the water surface. When a chemical reaction occurs in the coffee cup calorimeter, the heat of the reaction is absorbed by the water. The change in water temperature is used to calculate the amount of heat that has been absorbed (used to make products, so water temperature decreases) or evolved (lost to the water, so its temperature increases) in the reaction.

**Heat flow** (q) is calculated using the relation:

q = (specific heat) x m x Δt

Where q is heat flow, m is [mass in grams](https://www.thoughtco.com/definition-of-gram-molecular-mass-604515), and Δt is the change in temperature. The specific heat is the amount of heat required to raise the temperature of 1 gram of a substance 1 degree Celsius. The specific heat of water is 4.18 J/(g·°C).

For example, consider a chemical reaction that occurs in 200 grams of water with an initial temperature of 25.0 C. The reaction is allowed to proceed in the coffee cup calorimeter. As a result of the reaction, the temperature of the water changes to 31.0 C. The heat flow is calculated:

qwater = 4.18 J/(g·°C) x 200 g x (31.0 C - 25.0 C)

qwater = +5.0 x 103 J

The products of the reaction evolved 5,000 J of heat, which was lost to the water. The [enthalpy change](https://www.thoughtco.com/definition-of-enthalpy-change-605090), ΔH, for the reaction is equal in magnitude but opposite in sign to the heat flow for the water:

ΔHreaction = -(qwater)

**Bomb Calorimeter**

A coffee cup calorimeter is great for measuring heat flow in a solution, but it can't be used for reactions that involve gases since they would escape from the cup. The coffee cup calorimeter can't be used for high-temperature reactions, either, because they would melt the cup. A bomb calorimeter is used to measure heat flows for gases and ​high-temperature reactions.

A bomb calorimeter works in the same manner as a coffee cup calorimeter, with one big difference: In a coffee cup calorimeter, the reaction takes place in the water, while in a bomb calorimeter, the reaction takes place in a sealed metal container, which is placed in the water in an insulated container. Heat flow from the reaction crosses the walls of the sealed container to the water. The temperature difference of the water is measured, just as it was for a coffee cup calorimeter. Analysis of the heat flow is a bit more complex than it was for the coffee cup calorimeter because the heat flow into the metal parts of the calorimeter must be taken into account:

qreaction = - (qwater + qbomb)

where qwater = mCpΔT = 4.18 J/(g·°C) x mwater x Δt

The bomb has a fixed mass and specific heat. The mass of the bomb multiplied by its specific heat is sometimes termed the calorimeter constant, denoted by the symbol C with units of joules per degree Celsius. The calorimeter constant is determined experimentally and will vary from one calorimeter to the next. The [**heat flow**](https://www.thoughtco.com/calorimetry-and-heat-flow-worked-problem-602419) (q) of the bomb is:

qbomb = C Δt

q = heat (J)

C = heat capacity (J/°C)

ΔT = temp change (°C)

Heat capacity = heat required to raise temp by 1°C

Specific heat = heat capacity of 1g of substance

Example:

3.00 g of glucose (C6H12O6) was burned in an excess of oxygen in bomb calorimeter with metal holder (“bomb”) heat capacity of 2.21 kJ/°C. and 1.2 kg of water where

water has a specific heat capacity of 4.184 kJ/kg°C. The temp change upon

combustion of glucose and oxygen was 19.0°C to 25.5 °C

Question– what is the heat evolved from the combustion of 1.00 mol of glucose?

Total heat capacity

Ctotal = Cbomb + CH2O

= (2.21 kJ/°C ) + ( 1.2 kg ) ( 4.18 kJ/kg°C )

= (7.23 kJ/°C)

Heat absorbed by calorimeter and water

q = Ctotal (ΔT)

q = 7.23 kJ/°C ( 25.5 -19 °C )

q = +47.0 kJ absorbed by water calorimeter

ΔH° = -q

so therefore q= -47.0 kJ for heat released from combustion of glucose and per mole

Heat evolved = ( -47.0 kJ / 3.00g glucose )( 180.16 g glucose/1 mol glucose)

ΔH° = - 2.82 x 103 kJ/mol of glucose

Reaction

C6H12O6 (s) + 6O2 (g) → 6CO2 (g) + 6H2O (l)

ΔH°= -2.82 x 103kJ/mol