

Thermochemistry – q , w , C_p , ΔH

General Thermo

Define-
system:

surroundings:

work:

energy:

1st law of Thermodynamics:

List the different types of systems -

1.

2.

3.

List the different types of work –

1.

2.

3.

Relate the 1st law of Thermo to the different types of systems –

1.

2.

3.

Heat Capacity

Define-
heat capacity:

specific heat capacity:

molar heat capacity:

calorimeter:

Examples-

A layer of copper welded to the bottom of a skillet weighs 125 g. How much heat is needed to raise the temperature of the copper layer from 25 °C to 300 °C? ($C_{sp}^{Cu} = 0.387$ J/gK)

Find the heat transferred (in kJ) when 5.50 L of ethylene glycol ($d=1.11$ g/mL, $C_{sp}=2.42$ J/gK) in a car radiator cools from 37.0 °C to 25.0 °C.

You place 50.0 mL of 0.500 M NaOH in a coffee-cup calorimeter at 25.00 °C and add 25.0 mL of 0.500 M HCl, also at 25.00 °C. After stirring, the final temperature is 27.21 °C. Calculate q_{soln} (in J) and ΔH_{rxn} (in kJ/mol).

Assume: the total volume is the sum of the individual volumes and that the final solution has the same density and specific heat capacity as water ($d=1.00$ g/mL, $C_{sp}=4.184$ J/gK)

In a purity check for industrial diamonds, a 10.25 carat (1 carat = 0.2000 g) diamond is heated to 74.21 °C and immersed in 26.05 g of water in a constant-pressure calorimeter. The initial temperature of the water is 27.20 °C. Calculate ΔT of the water and of the diamond. ($C_{sp}^{diamond}=0.519$ J/gK)

A manufacturer claims that its new diettetic dessert has “fewer than 10 Calories per serving.” To test the claim, a chemist at the Department of Consumer Affairs places one serving in a bomb calorimeter and burns it in O_2 ($C_p^{\text{calorimeter}}=8.151 \text{ kJ/K}$). The temperature increases 4.937°C . Is the manufacturer’s claim correct?
Important: 1 Calorie = 1 kcal = 4.184 kJ.

A Chemist burns 0.8650 g of graphite (a form of carbon) in a new bomb calorimeter, and CO_2 forms. If 393.5 kJ of heat is released per mold of graphite and T increases 2.613 K, what is the heat capacity of the bomb calorimeter?

Hess’s Law

Define-

Hess’s law of heat summation:

state function:

enthalpy:

Using Hess’s Law – application in the case of oxidation of sulfur to sulfur trioxide.
There are three equations in this case:

Equation 1:

Equation 2:

Equation 3:

We know from Hess’s law that if we manipulate equations 1 and/or 2 so that they add up to equation 3, ΔH_3 is the sum of the manipulated ΔH values of equations 1 and 2.

3 steps in calculating an unknown ΔH –

1.

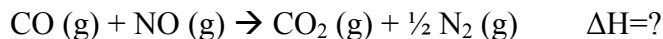
2.

3.

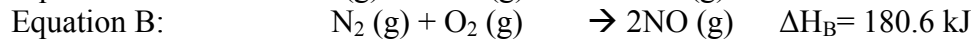
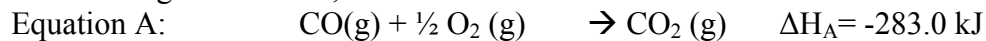
Apply these steps to the sulfur example:

More examples:

Two gaseous pollutants that form in auto exhaust are CO and NO. An environmental chemist is studying ways to convert them to less harmful gases through the following equation:



Given the following information, calculate the unknown ΔH :



Nitrogen oxides undergo many interesting reactions in the environment and in industry.

Given the following information, calculate ΔH for the overall equation.

