

Vocabulary

Matter

Energy

Kinetic Energy

Potential Energy

Temperature

Heat

Work

System

Surroundings

Open System

Closed System

Isothermal System

Adiabatic System

Heat Capacity

Specific Heat

Exothermic

Endothermic

calorie vs

Calorie vs

Joule

Heat and Work Quantified

Equation for Heat

Equation for Work

1) How much heat is absorbed when 15.0 g of water (heat capacity 1.00 cal/gram degree) is heated from 10.0°C to 15.0°C?

2) What temperature change is associated with 25.0 g of water (heat capacity 4.184 joule/gram degree) absorbing 50.0 joules of heat?

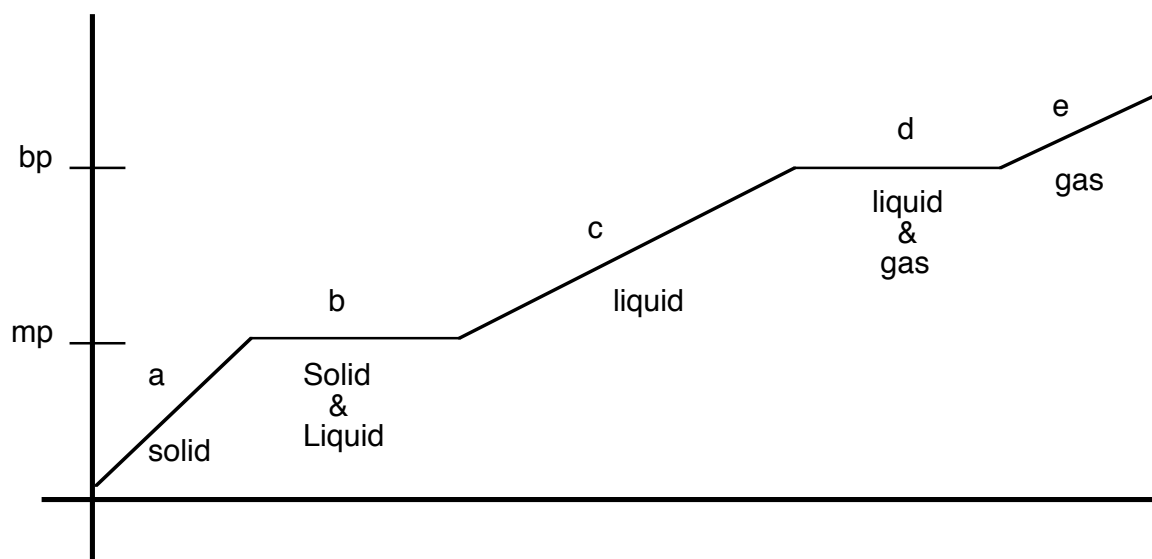
Phase Change Lecture

What is the difference between a solid, liquid, and gas?

What happens when you heat a substance?

What are the six phase changes?

Heating Curves



Latent Heat

Heat of fusion

Heat of vaporization

Let's heat 100.0 g of water from -15°C to 110°C . How much heat will it require?

Step 1

Step 2

Step 3

Step 4

Step 5

The First Law of Thermodynamics:

What is Enthalpy?

Enthalpy is a State Function?

What does this mean to us? What is the funny little circle?

Let's define Enthalpy Mathematically

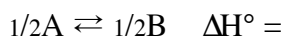
Given the reaction:

We calculate the change in enthalpy by:

Hess' LawGiven: $A \rightleftharpoons B$

$$\Delta H^\circ = -10 \text{ kJ}$$

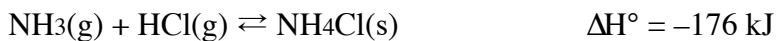
Find:



Given:

Find: ΔH° for $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$

Given:

Find: $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{HCl}(\text{g}) \quad \Delta H^\circ = ?$

The Second Law

We have a guiding question for this chapter:

Spontaneity

The quality or act of being spontaneous.

A spontaneous process is one that will proceed on its own without further input from the rest of the universe; one that is thermodynamically stable. Spontaneity has nothing to do with time, i.e. a spontaneous reaction may proceed very slowly and still be spontaneous.

Three Ice Cubes?

Entropy

States of Matter

The condition of your bedroom!

The Laws of Thermodynamics

The Second Law of Thermodynamics

General Statement

The entropy of the universe is constantly increasing.

Clausius Statement

It is impossible to have a natural process whose sole outcome is the transfer of heat from a colder body to a hotter body.

Kelvin Statement

It is impossible to have a natural process whose sole outcome is the transfer of energy as heat perfectly to work.

Andrews Statement

The properties of an isolated system eventually quit changing. They reach equilibrium.

How can we put this into an equation?

The Third Law of Thermodynamics

It is acceptable to define the entropy of a perfect crystal to be zero at absolute zero.

The Zeroth Law of Thermodynamics

If object A is in thermal equilibrium with object B and object B is in thermal equilibrium with object C then object A is in thermal equilibrium with object C

Why Zeroth?

Spontaneity

Does your room spontaneously clean itself?

Drop a piggy bank and let it break.

Free Energy

Josiah Willard Gibbs

The Problem with understanding free energy

When is a reaction spontaneous?

Free Energy is a state function.

The Gibbs Equation

What is “The Driving Force”?

Do you need to do any work to heat up a Tea Kettle?

Do you need to do any work to let a Tea Kettle cool off?

Do you have to do work to clean your room?

Do you have to do work to let your room get messy?

Who is going to do the work?

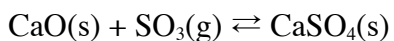
The single most important table in all of chemistry.

Enthalpy	Entropy	Free Energy	Best Conditions for Spontaneity

Predicting Thermodynamic Change

Without doing any calculations make the following predictions:

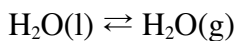
The following reaction is spontaneous:



What are the signs of:

ΔG ΔS ΔH

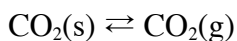
The following phase change at 298 Kelvin:



What are the signs of:

ΔG ΔS ΔH

The following phase change at 298 Kelvin:

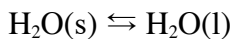


What are the signs of:

ΔG ΔS ΔH

Now what if we changed the temperature to something other than normal:

The following phase change at 271 Kelvin:



What are the signs of:

ΔG ΔS ΔH