Enthalpy

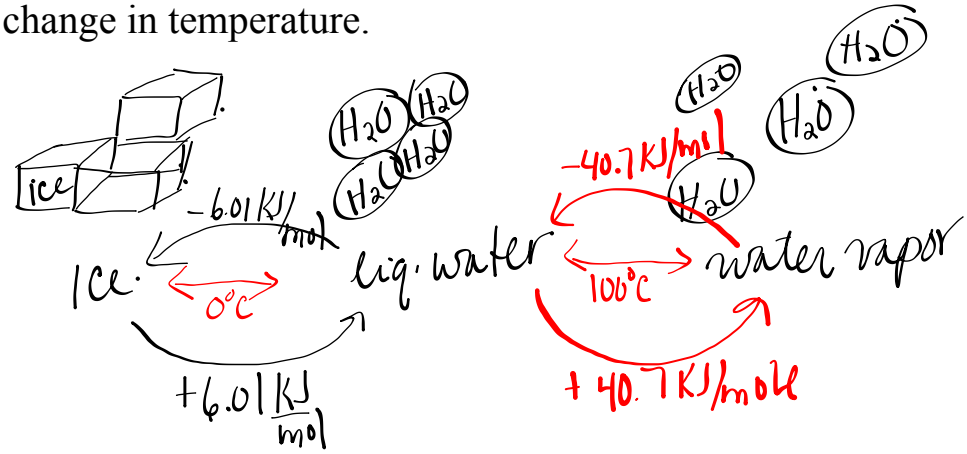
Enthalpy is denoted H, thus a change in enthalpy is denoted ΔH

What is Enthalpy

ENTHALPY changes do not occur during a temperature change

Enthalpy changes occur during a phase change, chemical change or nuclear change. Enthalpy changes are determined from the energy changes of the surroundings.

Energy is needed to overcome forces or bonds that hold particles together. This energy flows from the surrroundings in the form of heat. The result is a change in potential energy of the particles. It is not a change in temperature.

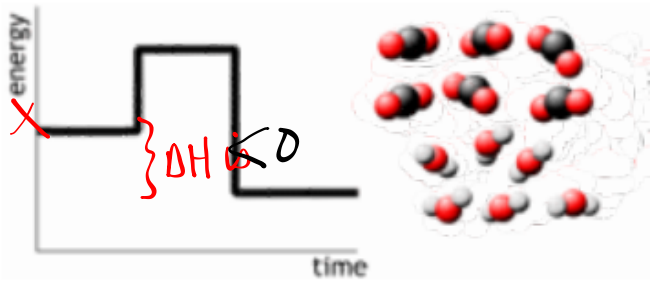


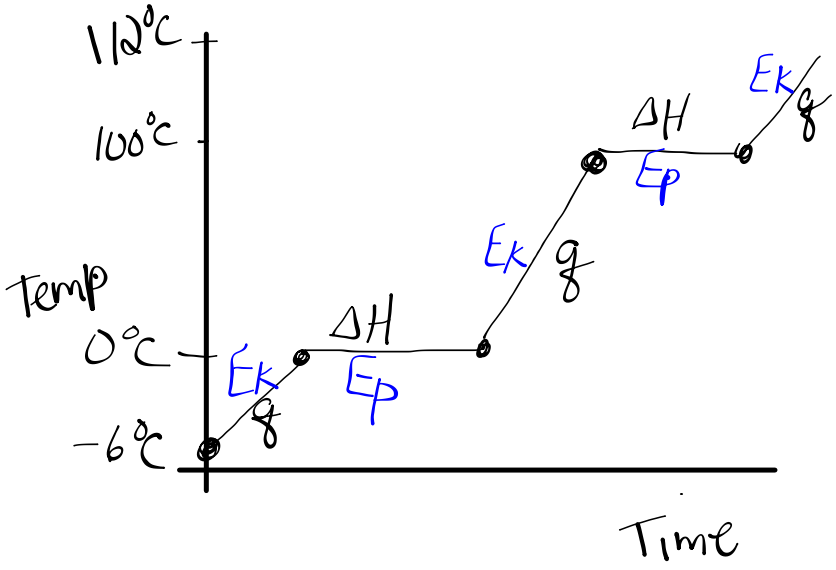
← 40.8 KJ/mol ←
released

Temp Change ⇒ motion: particles are moving faster/slower [KINETIC] (q) $q = mc\Delta T$

Phase Change ⇒ molecules are breaking apart or bonding [POTENTIAL] H $\Delta H = n\,H$

If the energy released from ~~making~~ breaking bonds is more than the energy required to make bonds, then overall the reaction will release energy - this is what happens when you burn something. So, when you burn glucose, the amount of energy required to break the bonds in glucose and oxygen is not as much as the amount of energy released when you form carbon dioxide and water.





H_2O

$-6°C$ to $112°C$

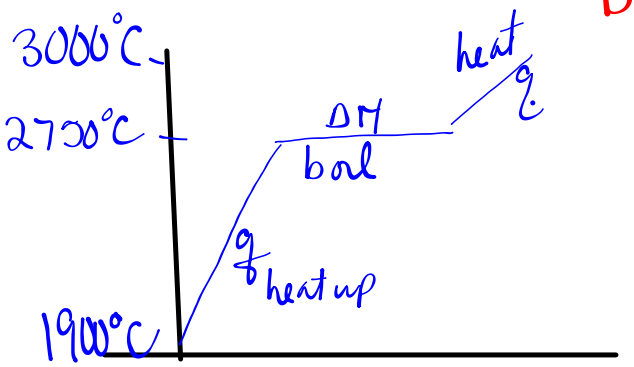
mp: $0°C$

bp $100°C$

energy is added: 5 energy changes:

Iron is heated from 1900°C to 3000°C

MP = 1535°C
BP = 2750°C



SOLID ↔ LIQ LIQ ↔ GAS

Table 17.3

Heats of Physical Change

Substance	ΔH_{fus} (kJ/mol)	ΔH_{vap} (kJ/mol)
Ammonia (NH_3)	5.65	23.4
Ethanol (C_2H_5OH)	4.60	43.5
Hydrogen (H_2)	0.12	0.90
Methanol (CH_3OH)	3.16	35.3
Oxygen (O_2)	0.44	6.82
Water (H_2O)	6.01	40.7
Nickel	17.6	370.4
Nitrogen	0.72	5.56
Sulfur	1.73	45
Lead	4.77	179.5
Antimony	19.79	193.43
Silver	11.28	250.58
Sodium	2.60	97.42
Copper	13.26	300.4

Types of Enthalpy Change ⇒ change in PE

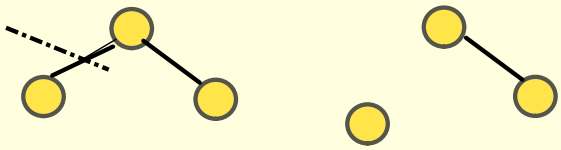
Many chemical and physical changes do not involve a change in temperature (kinetic energy); instead, they involve a change in potential energy.

For example, when the molecules in an ice cube at 0° C absorb energy from their surroundings, they become liquid water at 0°C. The change doesn't involve a change in temperature - the kinetic energy of the molecules is unchanged. Instead, the molecules undergo an increase in potential energy - a change in their relative positions.

Changes in position often involve bond breaking and bond forming. These processes are often the result of absorption or release of energy.

Endothermic and Exothermic Processes

Absorption of UV light by ozone.



Bond breaking is an **endothermic** process - it requires the absorption of energy.

Formation of HCl.

Bond forming is an **exothermic** process - it results in the release of energy.

Enthalpy and Enthalpy Change

When a system undergoes a potential energy change without a change in temperature, it is said to have undergone an **enthalpy change** (ΔH).

Another way to say it is:
an enthalpy change involves a change in the potential energy of a system at constant pressure.

Enthalpy is the "total internal energy of a substance at constant pressure". The enthalpy of a substance cannot be measured. Chemists and physicists measure changes in enthalpy.

To measure the change in Enthalpy:

$$\Delta H = nH$$

where n = # of moles of the substance
H= enthalpy of the substance

Note: H can have many different values
For example:

$H_{combustion}$	$H_{combustion}$
$H_{vaporation}$	$H_{condensation}$
$H_{formation}$	$H_{reaction(rxn)}$
H_{fusion}	$H_{freezing}$

phase
chemical
nuclear
} ΔH

These two share the same value for a specific substance with the exception of the energy flow

For a phase change :

fusion (melting) **solid** ⇒ **liquid**
freezing **liquid** ⇒ **solid**

$H \} + H_f - H$

vaporization **liquid** ⇒ **gas**
condensation **gas** ⇒ **liquid**

$H \}^{+}_{-}$

These two share the same value for a specific substance with the exception of the energy flow

fusion
H_2O

$6.03 \frac{kJ}{mol}$

$H_2O_{(s)} \xrightarrow{fusion} H_2O_{(l)}$ 0°C

$\xleftarrow{freezing} -6.03\ kJ/mol$

More on phase changes

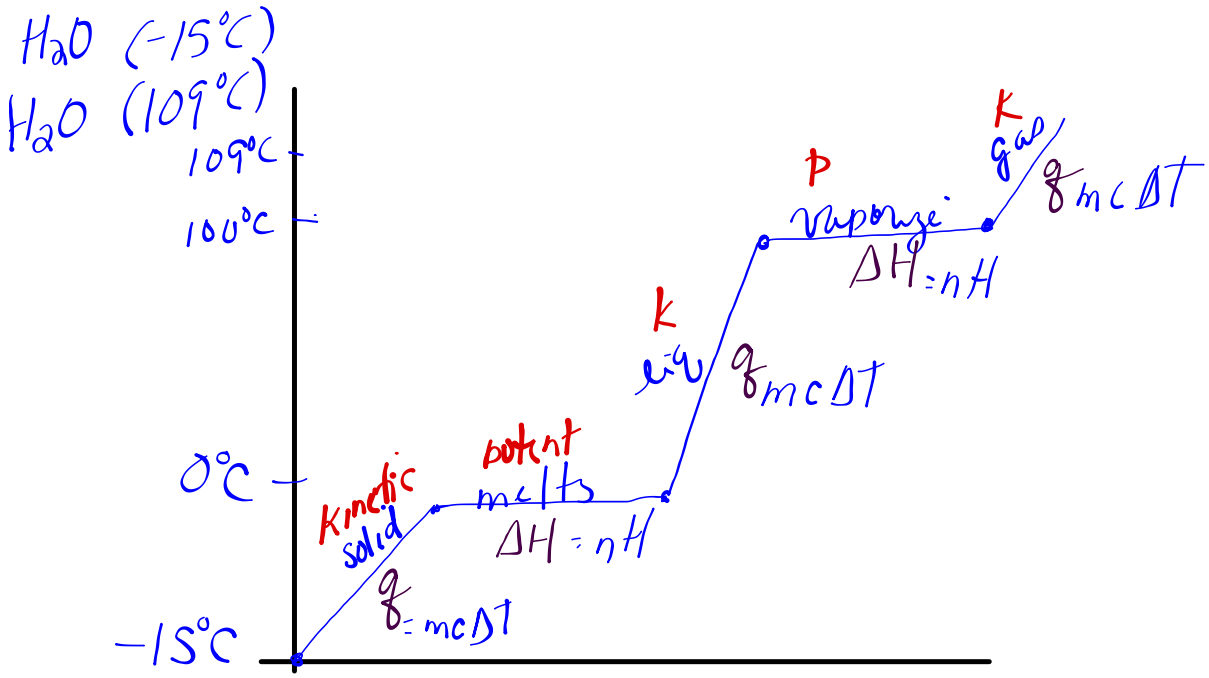
$40.8\ kJ/mol$

$H_2O_{(l)} \xrightarrow{vaporizing} H_2O_{(g)}$ 100°C

$\xleftarrow{condensing} -40.8\ kJ/mol$

Chlorine Gas MP = −101°C
FP → 101°C

BP → −34.6°C


H2O (-15°C)
H2O (109°C)
109°C
100°C
0°C
-15°C
Kinetic
solid
q = mcΔT
point
melts
ΔH = nH
K
liq
q mcΔT
P
vapour
ΔH = nH
K
gas
q mcΔT