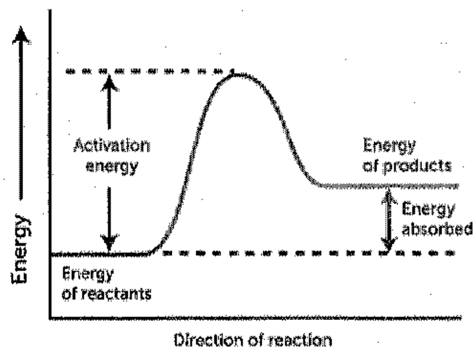
Enthalpy and Thermochemical Equations

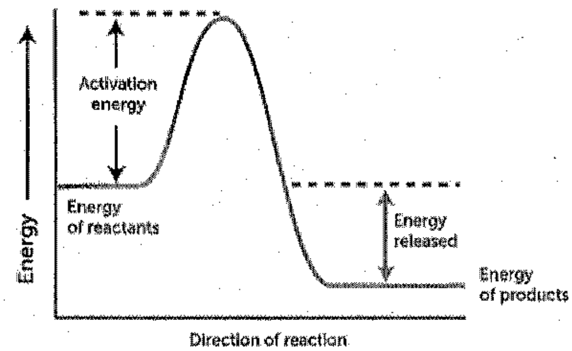
Enthalpy Change (ΔH): amount of energy absorbed or released as heat by a system *per mole of reaction (mol_{rxn})* when the pressure is constant; measured in units of J/mol_{rxn} = $\frac{\#J}{1\,mol_{rxn}}$

$$\Delta H_{rxn} = \frac{q}{mol_{rxn}}$$

Endothermic Reaction



Exothermic Reaction



- The magnitude of ~~enthalpy~~ energy change is directly proportional to the moles of reactants and products involved in the change.
- Activation energy is the minimum amount of energy the reactants need for the reaction to proceed.

Thermochemical equation: chemical equation that includes the enthalpy change (the energy value)

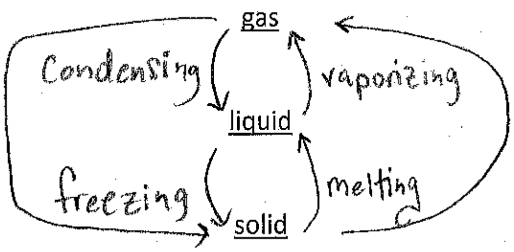
energy enters! **Endothermic** feels cold		energy exits **Exothermic** feels warm	
Energy is absorbed by system		Energy is released by system	
Heat energy from surroundings is changed to potential energy of the system – temperature of the system doesn't necessarily increase!		Potential energy of the system is changed to heat energy of the surroundings – temperature of the system doesn't necessarily decrease!	
$\frac{+q}{mol_{rxn}} = +\Delta H_{rxn}$		$\frac{-q}{mol_{rxn}} = -\Delta H_{rxn}$	
Break "end" bonds/attractions		Form new bonds/attractions	
The energy required to break reactant bonds is greater than the energy released by forming product bonds.		The energy required to break reactant bonds is less than the energy released by forming product bonds.	
Energy appears in reactants		Energy appears in products	
3 examples of the SAME information:		3 examples of the SAME information:	
$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$	**ΔH_{rxn} = +92 kJ/mol_{rxn}**	$N_2 + 3H_2 \rightarrow 2NH_3$	**ΔH_{rxn} = −324 kJ/mol_{rxn}**
positive = add(+) to **reactants**		negative = add(+) to **products**	
92 kJ + $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$		$N_2 + 3H_2 \rightarrow 2NH_3$ + 324 kJ	

Phase changes and enthalpy:

Exo! deposition

(−ΔH)

*system releases energy



Sublimation

Endo!

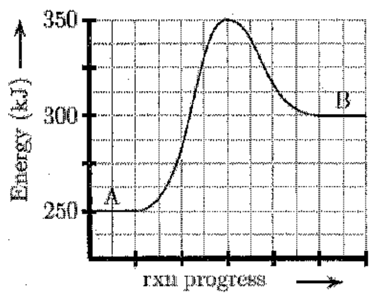
(+ΔH)

*system gains energy

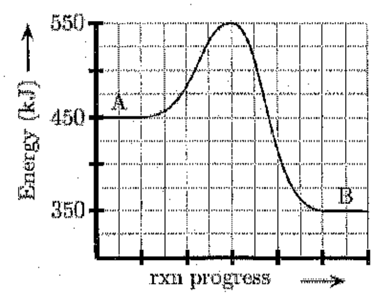
increasing energy

Let's Try! Complete the chart below.

Equation with Separate ΔH°_{rxn}	ΔH°_{rxn} within the Equation	Endo- or exothermic?
$K + M \rightarrow N$ $\Delta H^\circ_{rxn} = -45 \frac{kJ}{mol_{rxn}}$	$K + M \rightarrow N + 45$ kJ	exo
$D \rightarrow E + F$ $\Delta H^\circ_{rxn} = 127$ kJ/mol$_{rxn}$	$D + 127$ kJ $\rightarrow E + F$	endo
$A + B \rightarrow C + D$ $\Delta H^\circ_{rxn} = -35$ kJ/mol$_{rxn}$	$A + B \rightarrow C + D + 35$ kJ	exo



1. What is the change in enthalpy (ΔH) for the reaction
   $A \rightarrow B$
   $300 - 250 = +50$ kJ
2. Is this reaction endothermic or exothermic?
   endo (+ΔH)



3. What is the change in enthalpy (ΔH) for the reaction
   $A \rightarrow B$
   $350 - 450 = -100$ kJ
4. Is this reaction endothermic or exothermic?
   exo (−ΔH)

5. For each example below, identify if the process is endothermic or exothermic, and explain why.

Process	Endo or Exothermic?	Why?
$H(g) + H(g) \rightarrow H_2(g)$	exo (−ΔH)	forming new bond
$F(g) + e^- \rightarrow F^-(g)$	exo (−ΔH)	forming an attraction
$F^-(g) \rightarrow F(g) + e^-$	endo (+ΔH)	ending an attraction
$N_2(g) \rightarrow N_2(l)$	exo (−ΔH)	going to a lower energy phase ↳ forming IMFs! (attractions)