VI) Change in Enthalpy: ΔH

Monday, September 11, 2017 2:22 PM

Every reaction involves either an absorption, or a release, of energy, usually in the form of heat. Enthalpy is potential energy that may be evolved (released) or absorbed as heat. (energy)

What is an exothermic reaction? involves the release (exit) of energy usually in the form of heat. energy of products ↓ than the reactants

What is an endothermic reaction? involves the absorption (gain) of energy (heat) energy of products ↑ than the reactants

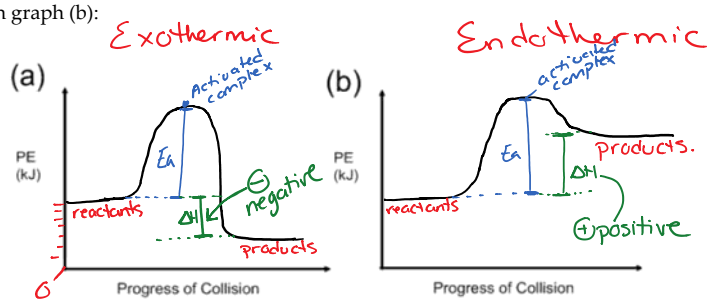
The following reaction is exothermic. Write an 'energy' term on the appropriate side:

$2C_2H_2 + 5O_2 \rightarrow 2H_2O + 4CO_2 +$ energy

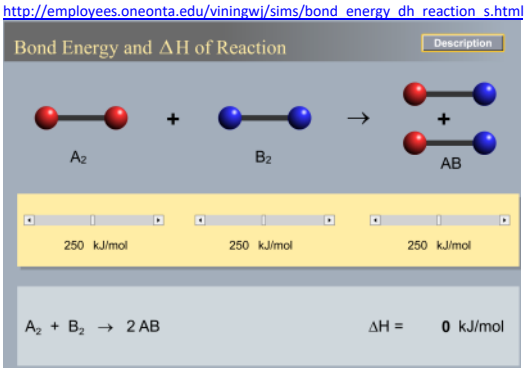
Therefore, where is the 'energy' term written for an endothermic reaction?

energy is a reactant.

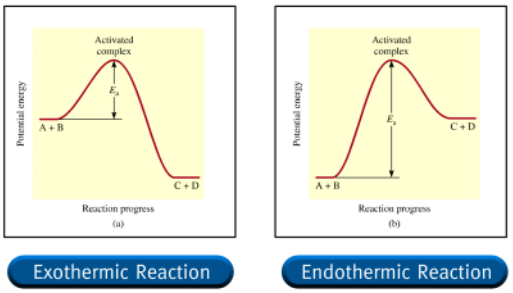
Draw a PE curve for an exothermic reaction on graph (a), and an endothermic reaction on graph (b):



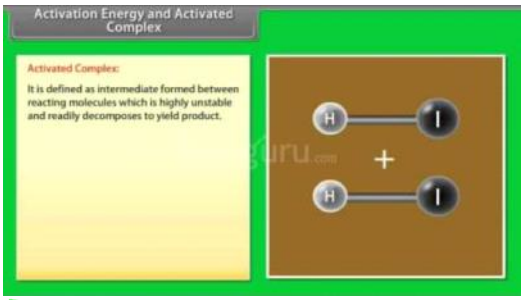
http://employees.oneonta.edu/viningwj/sims/bond_energy_dh_reaction_s.html



http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/activa2.swf



Activation Energy and Activated Complex



Enthalpy (analogous to energy) can be abbreviated as H, and is measured in Joules (J) or kilojoules (kJ). The change in enthalpy, ΔH, for a reaction, is always calculated as:

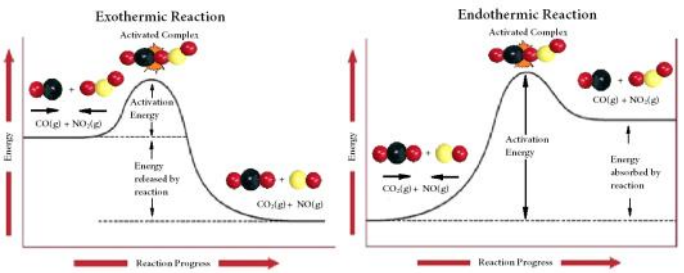
$\Delta H = H_{products} - H_{reactants}$

So looking at the previous two graphs, what characteristic would ΔH have for exothermic reactions?

$-\Delta H$ ⇒ products ↓ energy

For endothermic reactions?

$+\Delta H$ ⇒ products ↑ energy.



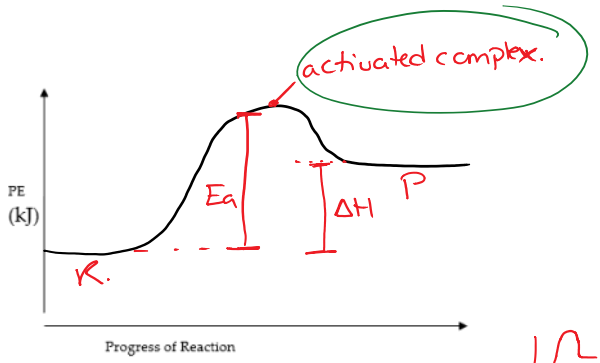
In summary, there are three ways to identify if a reaction is exothermic or endothermic:. What are they?

1) $-\Delta H \rightarrow$ exothermic
   $+\Delta H \rightarrow$ endothermic

2) where is the "energy" term?
   - products (exothermic)
   - reactant (endothermic)

3) On a PE Graph:
   - products will be lower ↓ (exothermic)
   - products will be higher ↑ (endothermic)

Draw an endothermic PE curve and label the reactants, products, activation energy, activated complex, and ΔH. State whether the ΔH is positive or negative.

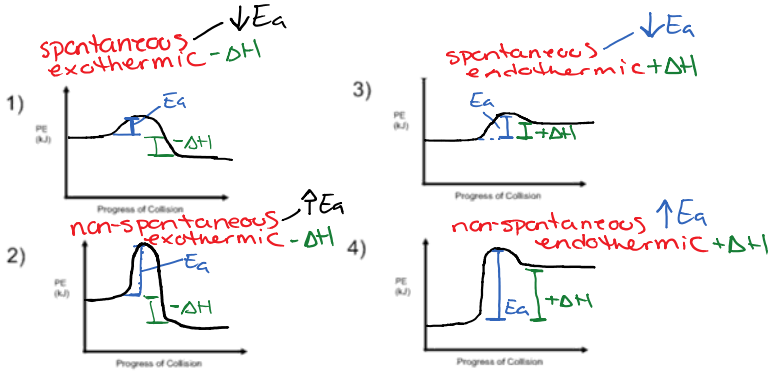


What implications would a large E_a have on reaction rate?

A large Ea means that a large amount of PE is needed to break bonds. This would have a low rxn rate. (or not at all)

What about a small Ea? A small Ea means only a small amount of PE is needed to break bonds ∴ faster rxn rate (+ likely spontaneous)

Draw 4 PE curves below. The first should represent a reaction that is spontaneous and exothermic. The second – non-spontaneous and exothermic. The third – spontaneous and endothermic. The fourth – non-spontaneous and endothermic.



Assignment 4: PE Curve Exercises

Tip: When drawing PE curves, never put the reactants or product energies at zero. Particles always have some potential energy.

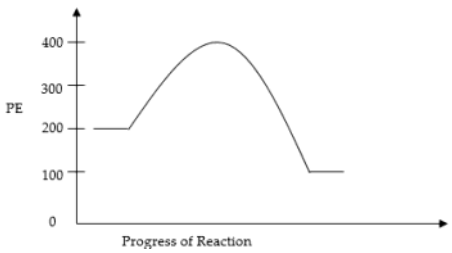
1. Hebden p.25 #41-45
2. Draw a PE curve with labeled axes that has reactant energy of 100kJ, an Ea of 200kJ and a ΔH of 150kJ. On the y axis, make a scale from 0kJ to 400kJ, with increments every 50kJ.

A) Is this reaction exothermic or endothermic?

B) Are the products more stable than reactants?

C) What is the PE of the activated complex?

3. Sketch a PE diagram for a reaction that has an E_a = 20kJ, a ΔH = -30kJ, and a product energy of 10kJ.
4. Does reaction rate depend on activation energy? Why or why not?
5. Does reaction rate depend on ΔH? Why or why not?



6. Read p. 24 & 25 in Hebden, then answer the questions below using the following PE curve:

a) Find the Ea of the forward reaction.
b) Find the Ea of the reverse reaction.
c) Find ΔH for the fwd reaction. Endo or exo?
d) Find ΔH for the reverse reaction. Endo or exo?
e) What would happen to the activation energy if the temperature is increased?

7. Explain in terms of energy changes (kinetic and potential) what occurs when two molecules approach each other, collide, and move away as products. Be very specific and use correct vocabulary.

8. Which of the following is endothermic?

a) $2H_{2(g)} + O_{2(g)} - 25kJ \Rightarrow 2H_2O_{(l)}$ b) $2H_{2(g)} + O_{2(g)} \Rightarrow 2H_2O_{(l)} + 25kJ$

c) $2H_{2(g)} + O_{2(g)} + 25kJ \Rightarrow 2H_2O_{(l)}$ d) $2H_{2(g)} + O_{2(g)} \Rightarrow 2H_2O_{(l)}$ $\Delta H = -25kJ$

9. Draw a picture of an activated complex for the following reaction:

$$H_{2(g)} + Br_{2(g)} \Rightarrow 2HBr_{(g)} \qquad \Delta H = -125kJ$$