

### HEAT OF DILUTION

(+)  $\Delta H_{\text{soln}}$   $\Rightarrow$  add more  $\text{H}_2\text{O}$ , more heat absorbed  
 $\rightarrow$  may see  $T_{\text{H}_2\text{O}} \downarrow$

(-)  $\Delta H_{\text{soln}}$   $\Rightarrow$  add more  $\text{H}_2\text{O}$ , more heat released,  
 \* conc. acids, esp.  $\text{H}_2\text{SO}_4$

### BOND ENERGY (chapter 9)

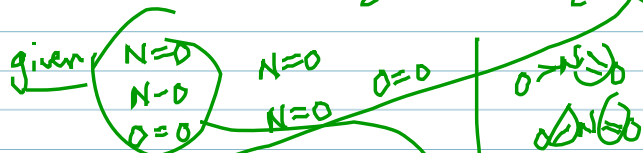
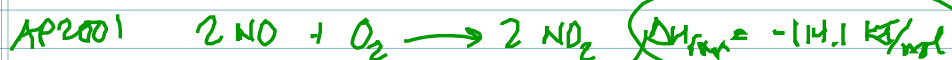
BOND BREAKING IS ENDOOTHERMIC  
 BOND FORMATION IS EXOTHERMIC

$$\Delta H_{\text{rxn}} = \sum \text{BE}_{\text{reactants}} - \sum \text{BE}_{\text{products}}$$

(+)
(+)

$$= \sum \text{BE}_{\text{broken}} + \sum \text{BE}_{\text{formed}}$$

(+)
(-)



$$\Delta H_{\text{rxn}} = [2(\text{N}=\text{O}) + \text{O}=\text{O}] - [4\text{N}=\text{O}]$$

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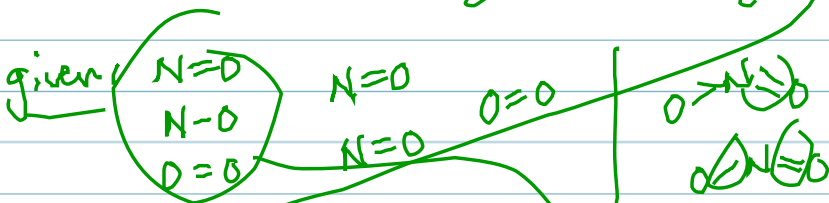
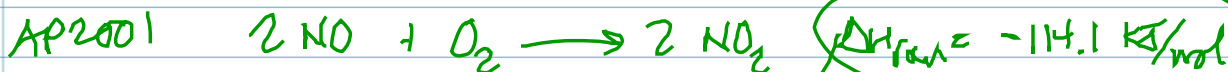
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## BOND ENERGY (chapter 9)

BOND BREAKING IS ENDOOTHERMIC

BOND FORMATION IS EXOTHERMIC

$$\begin{aligned}\Delta H_{\text{rxn}} &= \sum \text{BE}_{\text{reactants}} - \sum \text{BE}_{\text{products}} \\ &= \sum \text{BE}_{\text{broken}} + \sum \text{BE}_{\text{formed}}\end{aligned}$$



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THERMODYNAMICS → the interconversion of heat with other types of E

"STATE" of the system → T, P, V, E<sub>internal</sub>  
composition

STATE FUNCTION

↳ change in 1 or more of path independent ↗

q + w ⇒ are NOT state functions

1st Law of Thermodynamics  
"conservation of energy"

$$\Delta E_{\text{system}} + \Delta E_{\text{surroundings}} = 0$$

$$\Delta E = q + w$$

heat ↗ work ↖

SIGN CONVENTION

ENDOTHERMIC  
EXOTHERMIC

$$q(+), q > 0$$
$$q(-), q < 0$$

E is added to the system

SYSTEM does work ON the SURROUNDINGS W(-)  
SURROUNDINGS do work ON the SYSTEM W(+)

WORK = FORCE × DISTANCE

for a gas changing volume  $w = -P\Delta V$

external ↖

SURROUNDINGS PUSH IN ON THE SYSTEM (compression)  $\Delta V = (-)$   
SYSTEM PUSHES OUT AGAINST THE SURROUNDINGS  $\Delta V = (+)$   
(expansion)

$$\text{Work} = -P\Delta V \Rightarrow \text{atm} \cdot \text{L} \cdot 101.3 \Rightarrow \text{J}$$

$$P = \frac{\text{force}}{\text{area}} = \frac{\text{N}}{\text{m}^2} \cdot \text{m}^2 = 1 \text{ N}\cdot\text{m} = 1 \text{ J}$$

Example

reaction produces a gas

reactant volume = 0  $\rightarrow$   $\Delta V \rightarrow V$  of gas produced

$P_{\text{air}} = 0.95 \text{ atm}$  ;  $V = 3.00 \text{ L}$   $W = ?$   
(external)

$$W = \ominus (0.95 \text{ atm})(3.00 \text{ L}) \times 101.3 = \ominus 288 \text{ J}$$

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Whenever a reaction results in a net increase in moles of gas, the system does work on the surroundings (EXPANSION)

If  $P_{\text{external}}$  is constant (open air)

$$\Delta H = \Delta E + P\Delta V$$

$$\Delta E = \Delta H - P\Delta V \quad (\Delta E = q + w)$$

$$= \Delta H - \Delta(PV)$$

$$\Delta E = \Delta H - RT\Delta n$$

Constant volume  
(BOMB CALORIMETER)

$$W = -P\Delta V \quad \Delta V = 0$$

$$W = 0$$

$$\Delta E = q + w = q$$