

## Announcements

Wednesday, November 04, 2009

Exam 2 will be returned on Monday

Ch 6 MasteringChemistry due this Friday, Nov 6

Exp 10 lab report due next Monday, Nov 9

Materials lists due in D2L dropbox by 5pm tonight

## $\Delta H$ and Hess's Law

Thermochemical state functions like  $\Delta H$  are given for a certain chemical equation, where coefficients = # mol

1. Doubling coefficients doubles  $\Delta H$ , etc.

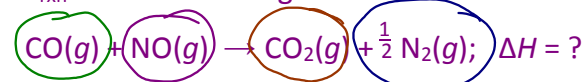


2. Reversing an equation changes the sign of  $\Delta H$

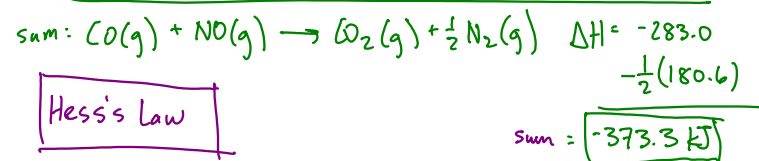
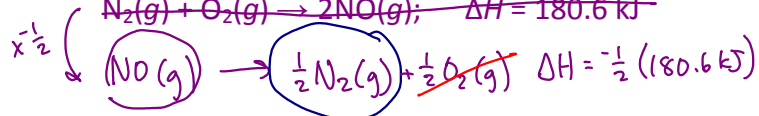


3. Adding equations adds their  $\Delta H$  values

Find  $\Delta H_{\text{rxn}}$  for the following reaction:

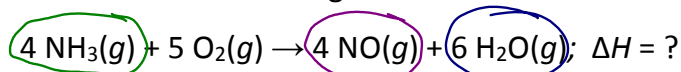


Use the following reactions with known  $\Delta H$  values:

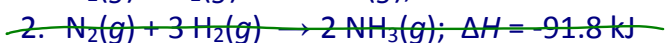


## Hess's law practice

Find  $\Delta H_{\text{rxn}}$  for the following reaction:



Use the following reactions with known  $\Delta H$  values:

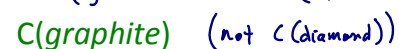


## Standard enthalpies of formation

### Standard thermodynamic states:

- gases: 1 atm
- liquids or solids: most stable form, 1 atm, 25 °C
- solutions: 1 M concentration

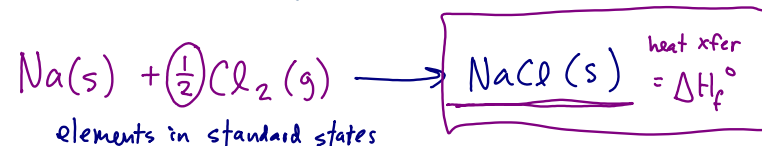
### Some common standard states:



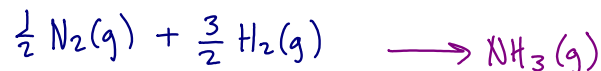
### Standard enthalpy of formation: $\Delta H_f^\circ$ ← standard state

enthalpy change when 1 mol of a compound is formed from its elements in their standard states

Write the chemical equation for  $\Delta H_f^\circ$  of  $\text{NaCl}(\text{s})$



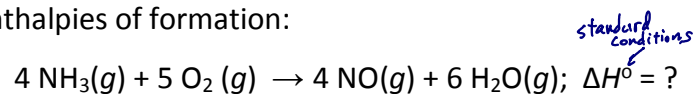
Write the chemical equation for  $\Delta H_f^\circ$  of  $\text{NH}_3(\text{g})$



**$\Delta H_f^\circ$  for any element in its standard state = 0**

Using standard enthalpies of formation

Calculate  $\Delta H^\circ$  for the following reaction using standard enthalpies of formation:



**Compound    $\Delta H_f^\circ$  (kJ/mol)**

$\text{NH}_3(g)$       -45.9

$\text{O}_2(g)$       0

$\text{NO}(g)$       90.3

$\text{H}_2\text{O}(g)$       -241.8

$$\Delta H^\circ_{\text{rxn}} = \sum \left[ n \Delta H_f^\circ (\text{products}) \right] - \sum \left[ n \Delta H_f^\circ (\text{reactants}) \right]$$

*coeff*      *from table*

$$= 4 \cancel{\text{mol}} (90.3 \text{ kJ}/\cancel{\text{mol}}) + 6 \cancel{\text{mol}} (-241.8 \text{ kJ}/\cancel{\text{mol}}) \quad \text{Products}$$

$$- \left[ 4 \cancel{\text{mol}} (-45.9 \text{ kJ}/\cancel{\text{mol}}) + 5 \cancel{\text{mol}} (0 \text{ kJ}/\cancel{\text{mol}}) \right] \quad \text{Reactants}$$

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$$\boxed{-906 \text{ kJ}}$$