

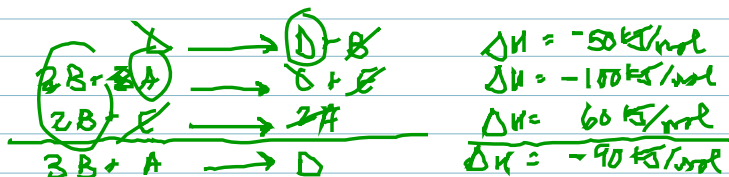
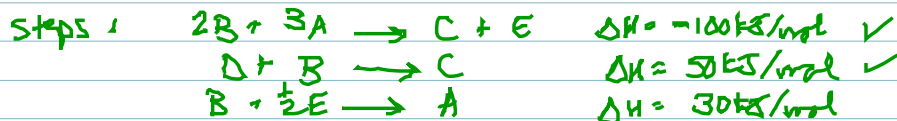
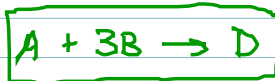
Hess's Law

→ For a reaction that can be carried out in steps, $\Delta H_{rxn} = \sum \Delta H_{steps}$

INDIRECT METHOD

Step reactions → multiply coefficients → multiply ΔH
 swap reactants & products → swap sign on ΔH

find ΔH_{rxn}

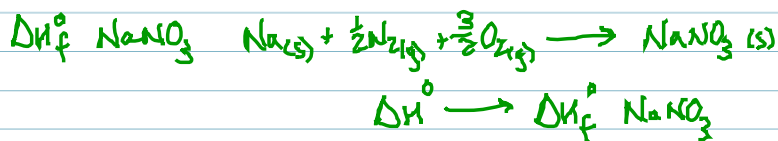


* Watch out for physical states

DIRECT METHOD

HEAT OF FORMATION ΔH_f° ← Standard conditions
 → $P = 1 \text{ atm}$, $M = 1 \text{ M}$
 $T = 298 \text{ K}$

formation reaction
 → produces 1 mole of a substance from its elements in their standard states



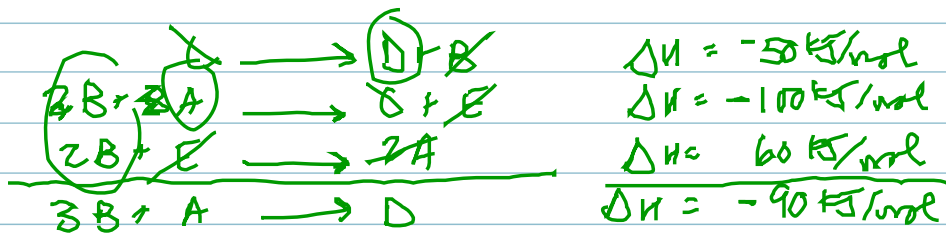
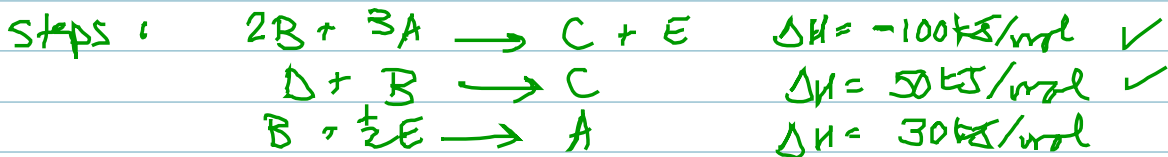
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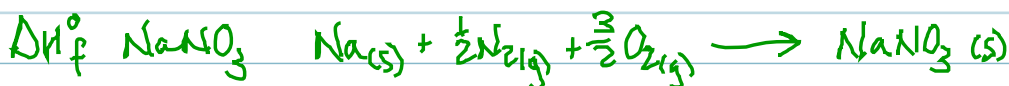


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DIRECT METHOD

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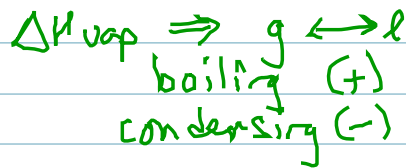
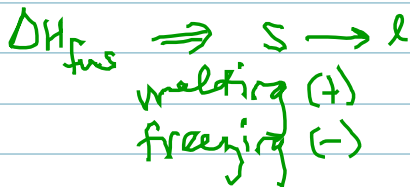




$$\Delta H_{rxn}^{\circ} = \sum \Delta H_f^{\circ} \text{ products} - \sum \Delta H_f^{\circ} \text{ reactants}$$

$$\Delta H_{rxn}^{\circ} = [c \Delta H_f^{\circ} C + d \Delta H_f^{\circ} D] - [a \Delta H_f^{\circ} A + b \Delta H_f^{\circ} B]$$

if ΔH_{rxn}° is determined through calorimetry, and ΔH_f° A, B, C are known, ΔH_f° D can be calculated



$\Delta H_{soln} \Rightarrow$ the heat gained or lost when a solid is dissolved

ENDOTHERMIC (+) $T H_2O \downarrow NH_4NO_3$
EXOTHERMIC (-) $T H_2O \uparrow CaCl_2$

IONIC SOLIDS DISSOLVING IN H_2O

(1) SOLID \rightarrow gaseous ions Lattice E (+)

(2) gaseous ions $\xrightarrow{H_2O}$ aqueous ions $\Delta H_{hydration}$ (-)

$$\Delta H_{soln} = \text{lattice } E + \Delta H_{hydration}$$

large lattice E \Rightarrow more stable compound
 \rightarrow less soluble

$$\Delta G = \Delta H - T\Delta S$$

(-) (+)

\rightarrow more (+) ΔH_{soln}
wherever a solid dissolves
ENTROPY INCREASES