**Chemical Reactions and ΔS & ΔG Examples**

*Chemistry, 7th ed.*, Zumdahl & Zumdahl, sections 16.5-16.6



## EXAMPLE 1a: ΔH° for Chemical Reaction EXAMPLE (acetylene torch*)

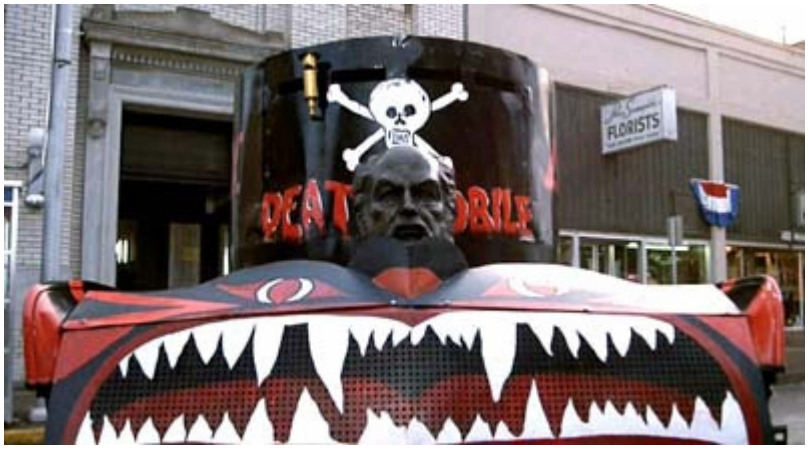
Find ΔH° for the reaction: $2\ C_2H_{2(g)} + 5\ O_{2(g)} \rightarrow 2\ H_2O_{(g)} + 4\ CO_{2(g)}$

From appendix 4 (pp. A19-A22, *Chemistry 7th ed.*, Zumdahl):

| Substance (@ 25°C & 1 atm) | $\Delta H_f°$ (kJ/mol) | $\Delta G_f°$ (kJ/mol) | S° (J / mol•K) |
|---|---|---|---|
| $C_2H_{2(g)}$ | 227 | | 201 |
| $O_{2(g)}$ | 0 | | 131 |
| $H_2O_{(g)}$ | -242 | | 189 |
| $CO_{2(g)}$ | -394 | | 214 |

mnemonic: "$\Delta H_{reaction}° = \Delta H_f°(\text{products}) - \Delta H_f°(\text{reactants})$"

*In the 1978 movie *Animal House*, the character D-Day uses an acetylene torch to modify one of the fraternity brother's car into the Deathmobile:



## EXAMPLE 1b: ΔS° for Chemical Reaction

Find ΔS° for the reaction: $2\ C_2H_{2(g)} + 5\ O_{2(g)} \rightarrow 2\ H_2O_{(g)} + 4\ CO_{2(g)}$

From appendix 4 (pp. A19-A22, *Chemistry 7th ed.*, Zumdahl):

| Substance (@ 25°C & 1 atm) | $\Delta H_f°$ (kJ/mol) | $\Delta G_f°$ (kJ/mol) | S° (J / mol•K) |
|---|---|---|---|
| $C_2H_{2(g)}$ | 227 | | 201 |
| $O_{2(g)}$ | 0 | | 131 |
| $H_2O_{(g)}$ | -242 | | 189 |
| $CO_{2(g)}$ | -394 | | 214 |

mnemonic: "$\Delta S_{reaction}°$ = S°(products) – S°(reactants)"

## EXAMPLE 2: ΔG° for Chemical Reactions using relationship between ΔG°, ΔH°, ΔS° & T

GIVEN: $2\ C_2H_{2(g)} + 5\ O_{2(g)} \rightarrow 2\ H_2O_{(g)} + 4\ CO_{2(g)}$

$\Delta H° =$ _____ (*from example 1a, p. 1*)

$\Delta S° =$ _____ (*from example 1b, p. 2*)

2a. FIND $\Delta G°$ for this reaction at 298 K; is this reaction favorable at this temperature?

2b. FIND (*approx.*) $\Delta G°$ for this reaction at 200. K; is this reaction favorable at this temperature?

2c. At what temperature is this reaction NON favorable?

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**EXAMPLE 3: ΔG° for Chemical Reactions using Hess' Law**

GIVEN: $2\ C_2H_2(g) + 5\ O_2(g) \rightarrow 2\ H_2O(g) + 4\ CO_2(g)$ $\Delta G_{react}° = -2{,}452$ kJ

$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$ $\Delta G_{react}° = -484$ kJ

FIND ΔG° for $2\ C_2H_2(g) + 8\ H_2O(g) \rightarrow 10\ H_2(g) + 4\ CO_2(g)$