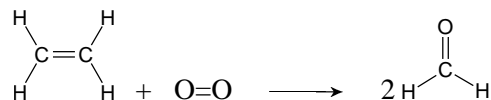


Thermodynamics: Practice Problems

1. For each of the following changes, indicate the sign (positive or negative) expected for ΔH and ΔS .

	Reaction	ΔH	ΔS
(a)	$2 \text{N}_{(gas)} \longrightarrow \text{N}_{2(gas)}$	+ or -	+ or -
(b)	$\text{Fe}_{(solid)} \longrightarrow \text{Fe}_{(liquid)}$	+ or -	+ or -
(c)	$\text{N}_2\text{O}_{4(gas)} \longrightarrow 2 \text{NO}_{2(gas)}$	+ or -	+ or -
(d)	$\text{C}_8\text{H}_{16(lig)} + 10 \text{O}_{2(gas)} \longrightarrow 6 \text{CO}_{2(gas)} + 8 \text{H}_2\text{O}_{(gas)}$ <i>(C₈H₁₆ is a component in gasoline)</i>	+ or -	+ or -
(e)	hemoglobin \longrightarrow 574 amino acids <i>(Hemoglobin is a protein, built from smaller amino acids)</i>	+ or -	+ or -

2. Using the table of bond energies given below, calculate the enthalpy changes (ΔH) for the following chemical reaction.



Bond breaking				Bond Formation			
Bond Type	#	Bond Energy	Totals	Bond Type	#	Bond Energy	Totals
Total Energy Required to Break all Bonds =				Total Energy Released when all Bonds Formed			
			$\frac{kJ}{mol}$				$\frac{kJ}{mol}$

Standard Single Bond Energies - $\frac{kJ}{mole}$

	H	C	O	F	Cl
H	432	-	-	-	-
C	411	346	-	-	-
O	459	358	142	-	-
F	565	485	190	155	-
Cl	428	327	218	249	240

Standard Multiple Bond Energies - $\frac{kJ}{mole}$

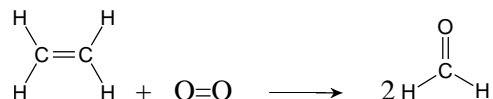
C=C	C=O	O=O	C≡C
602	799	494	835

Thermodynamics: Answers to Practice Problems

1. For each of the following changes, indicate the sign (positive or negative) expected for ΔH and ΔS .

	Reaction	ΔH	ΔS	Comments
(a)	$2 \text{N}_{(gas)} \longrightarrow \text{N}_{2(gas)}$	-	-	Makes bond Fewer particles
(b)	$\text{Fe}_{(solid)} \longrightarrow \text{Fe}_{(liquid)}$	+	+	Heat added to melt solid Liquids more disordered than solids
(c)	$\text{N}_2\text{O}_{4(gas)} \longrightarrow 2 \text{NO}_{2(gas)}$	+	+	Breaks bond More particles
(d)	$\text{C}_8\text{H}_{16} + 10 \text{O}_2 \longrightarrow 6 \text{CO}_2 + 8 \text{H}_2\text{O}$	-	+	Fuels release heat More particles
(e)	hemoglobin \longrightarrow 574 amino acids	+	+	Have to break bonds More particles

2. Using the table of bond energies given below, calculate the enthalpy changes (ΔH) for the following chemical reaction.



Bond breaking				Bond Formation			
Bond Type	#	Bond Energy	Totals	Bond Type	#	Bond Energy	Totals
C=C	1	602	602	C=O	2	799	1598
C-H	4	411	1644	C-H	4	411	1644
O=O	1	494	494				
Total Energy Required to Break all Bonds =			+2740 $\frac{\text{kJ}}{\text{mol}}$	Total Energy Released when all Bonds Formed			-3242 $\frac{\text{kJ}}{\text{mol}}$

$$\Delta H_{\text{reaction}} = +2740 - 3242 = -502 \frac{\text{kJ}}{\text{mol}}$$

Reaction is spontaneous