19.3 Gibbs Free Energy

Gibbs Free Energy and Temperature

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

i) $\Delta H^\circ > 0$ ... endothermic
$\Delta S^\circ > 0$ ... $-T\Delta S^\circ < 0$

Reaction at low T expected to have a $\Delta G^\circ > 0$.
However at a certain high value of T could expect $-T\Delta S^\circ$ to become large enough that ΔG° becomes < 0.

iii) $\Delta H^\circ > 0$ ... endothermic
$\Delta S^\circ < 0$ ... $-T\Delta S^\circ > 0$

Since both $\Delta H^\circ > 0$ and $-T\Delta S^\circ > 0$, then ΔG° will always be > 0.
Nonspontaneous, react-favored at all values of T.

ii) $\Delta H^\circ < 0$ ... exothermic
$\Delta S^\circ < 0$ ... $-T\Delta S^\circ > 0$

Reaction at low T expected to have a $\Delta G^\circ < 0$.
However at a certain high value of T could expect $-T\Delta S^\circ$ to become large enough that ΔG° becomes > 0.

iv) $\Delta H^\circ < 0$ ... exothermic
$\Delta S^\circ > 0$ ... $-T\Delta S^\circ < 0$

Since both $\Delta H^\circ < 0$ and $-T\Delta S^\circ < 0$, then ΔG° will always be < 0.
Spontaneous, product-favored at all values of T

19.3 Gibbs Free Energy

Gibbs Free Energy and Temperature

Without doing any calculations, match the following thermodynamic properties with their appropriate numerical sign for the following endothermic reaction.

$$2CO_2(g) + N_2(g) = 2CO(g) + 2NO(g)$$

a) ΔH_{rxn}
b) ΔS_{rxn}
c) ΔG_{rxn}
d) ΔS_{univ}

1. >0
2. <0
3. =0
4. >0 low T, <0 high T
5. <0 low T, >0 high T

$\Delta G_{RXN} = \Delta H_{RXN} - T\Delta S_{RXN}$

a) 1. Reaction is endothermic.

b) 1. 3 gas molecules → 4 gas molecules.
$\Delta S_{RXN} = S(products) - S(reactants)$.

c) 4. $\Delta H_{RXN} > 0$; $-T\Delta S < 0$.

d) 5. ΔS_{UNIV} the reverse of ΔG.
Spontaneous $\Delta G < 0$; $\Delta S_{UNIV} > 0$.

19.3 Gibbs Free Energy

Gibbs Free Energy and Temperature

Without doing any calculations, match the following thermodynamic properties with their appropriate numerical sign for the following exothermic reaction.

$$CO(g) + Cl_2(g) = COCl_2(g)$$

a) ΔH_{rxn}
b) ΔS_{rxn}
c) ΔG_{rxn}
d) ΔS_{univ}

1. >0
2. <0
3. =0
4. >0 low T, <0 high T
5. <0 low T, >0 high T

a) 2. Reaction is exothermic.

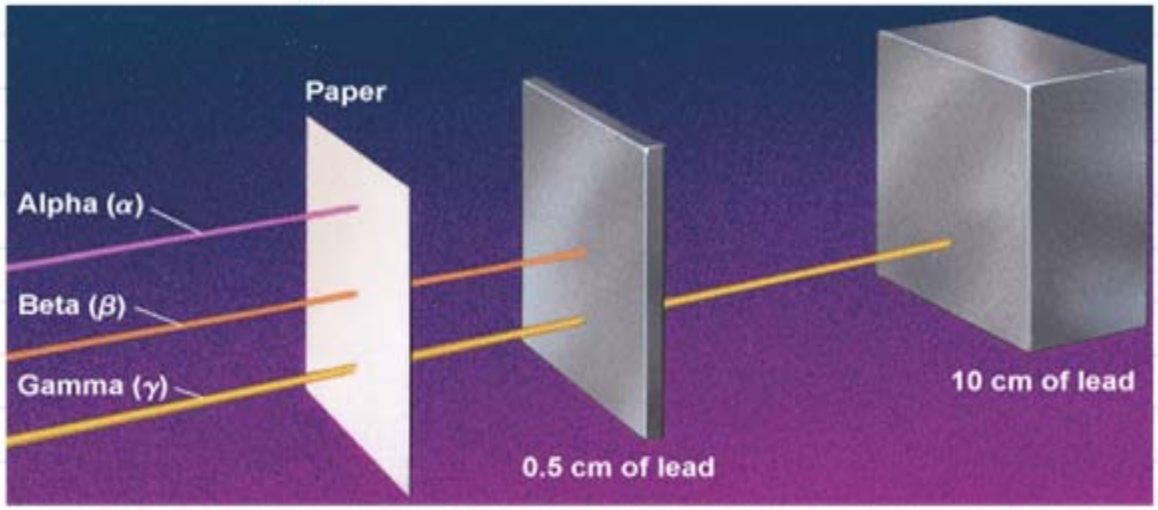
b) 2. 2 gas molecules → 1 gas molecule.
ΔS = S(products) − S(reactants).

c) 5. $\Delta H_{RXN} < 0$; $-T\Delta S_{RXN} > 0$

d) 4. ΔS_{UNIV} the inverse of ΔG.
Spontaneous $\Delta G < 0$; $\Delta S_{UNIV} > 0$.

24.1 Nuclear Reactions

The Penetrating Power of Radiation



Particles: Energy Vs Penetration Power

${}^{4}_{2}He$ OR ${}^{4}_{2}\alpha$	Alpha
${}^{0}_{-1}\beta$ OR ${}^{0}_{-1}e$	Beta
${}^{0}_{+1}\beta$ OR ${}^{0}_{+1}e$	Positron
γ	Gamma

24.2 Nuclear Stability

Band of Stability