5.111 Principles of Chemical Science
Fall 2008

Rate Laws

See lecture 31 for a discussion of kinetics versus thermodynamics.

When considering a chemical reaction, one must ask whether the reaction will go (thermodynamics), and how fast the reaction will go (kinetics).

Example from pg. 1 of Lecture 31 notes: Kinetics of glucose oxidation (energy production) in the body

The oxidation of glucose provides energy for the body, which is stored in the form of ATP.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \textit{energy}$$

Consider the **Thermodynamics** for the Oxidation of Glucose

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

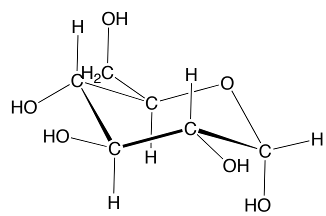
$\Delta G° = \Delta H° - T\Delta S°$

$\Delta H° = -2816$ kJ/mol

$T\Delta S°$ or $\Delta S°$ is (+)

$\Delta G° = -2{,}885$ kJ/mol

Thermodynamically favorable.



Glucose
($C_6H_{12}O_6$)

With such a thermodynamically favorable process, why doesn't candy explode into CO_2 and H_2O when exposed to air (see class activity)?

KINETICS. Glucose oxidation is slow. The body uses protein catalysts called enzymes to speed up the reactions.

Example from Lecture 31 lecture: Diamonds are forever (kinetically speaking)

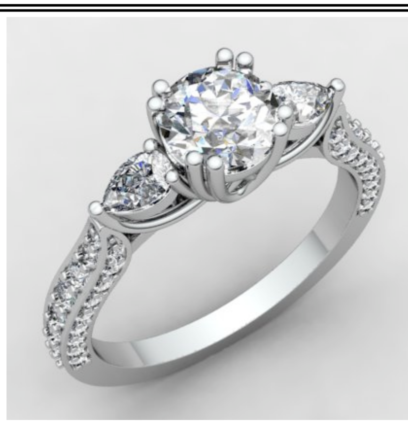


Image courtesy of sirtrentalot on flickr.

Consider the thermodynamics of the conversion of diamonds to graphite:

For 12.01 g (1 mol) of carbon,
$C_{(graphite)}$ is 2,900 J more stable than $C_{(diamond)}$.

This means that graphite formation is thermodynamically favorable and spontaneous!

However, there is a HUGE activation barrier for conversion, so diamonds are kinetically inert.