Quiz 6.1 – Equilibrium

Name: _____

The Equilibrium Constant

Consider the reaction below:

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ $\qquad K_C(25°C) = 0.0160$

○ Find the value of K_p for this reaction at $25°C$

○ Find the value of $\Delta G^{\ominus}_{rxn}$ for this reaction at $25°C$
(*Note that the standard state for all chemical species in this reaction is a gas at $1\ bar$*)

○ Find the value of ΔG_{rxn} when $p_{PCl_5} = 0.53\ bar$, $p_{PCl_3} = 0.22\ bar$, and $p_{Cl_2} = 0.47\ bar$

Le Châtelier's Principle

Syngas, a mixture of carbon monoxide and hydrogen gas, can be produced by reacting methane with water in the reaction below:

$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3\,H_2(g)$ $\qquad \Delta_{rxn}H^{\ominus}(273\ K) = 206.13\ {}^{kJ}/_{mol}$

You are a chemical engineer designing a new syngas production plant, and you want to maximize the amount of syngas produced (maximize ξ) at equilibrium.*

○ Should you run the reaction at high or low temperature?

○ Should you run the reaction with high partial pressures or low partial pressures?

*Really, chemical engineers consider far more diverse and complex factors when designing plants

The van't Hoff Equation

Consider the reaction below:

$$H_2(g) + Br_2(g) \rightleftharpoons 2\,HBr(g)$$

This reaction is carried out at two temperatures while monitoring equilibrium composition. At $25°C$, the reaction has $K = 62.5$, and at $175°C$ the reaction has $K = 0.00343$.
Use these data to find $\Delta H^{\ominus}_{rxn}$ for this reaction.

What is the value of K at $-15°C$?

At what temperature is $K = 1.00$?

At right, draw a rough van't Hoff plot for this reaction, including:

- Equation for the best fit line
- Relationship for the slope
- K in the high temperature limit
- K in the low temperature limit

God Says Yes to Me

By Kaylin Haught

I asked God if it was okay to be melodramatic
and she said yes
I asked her if it was okay to be short
and she said it sure is
I asked her if I could wear nail polish
or not wear nail polish
and she said honey
she calls me that sometimes
she said you can do just exactly
what you want to
Thanks God I said
And is it even okay if I don't paragraph
my letters
Sweetcakes God said
who knows where she picked that up
what I'm telling you is
Yes Yes Yes