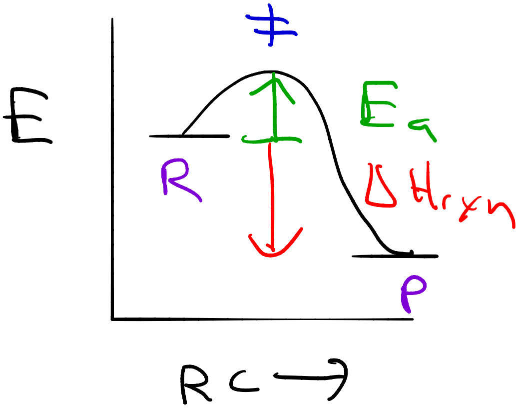
May the 4th, 2020

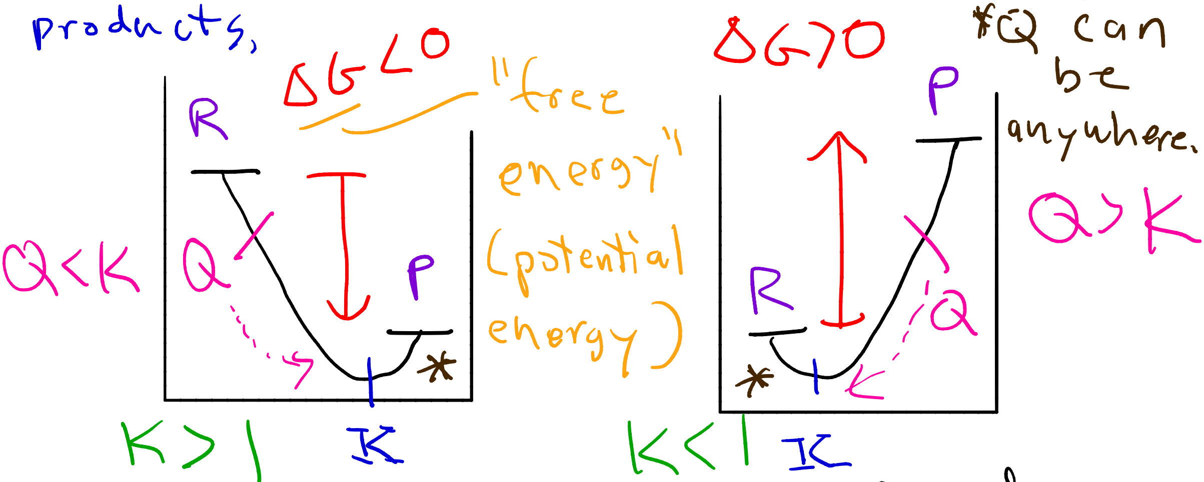
16.5 – Reaction coordinate Diagram



A RCD represents the energy a single set of reagents has as they are converted into products

20.4 – Reaction Progress Diagram

A RPD represents the energy of a system (multiple sets of reagents) as it is converted from 100% reactants to 100% products,



$$K = \frac{\text{products}}{\text{reactants}} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

K Equilibrium constant – only calculated at equilibrium

Q Reaction quotient – represents the progress of the reaction at that moment (may or may not be at equilibrium),

$Q = \frac{\text{products}}{\text{reactants}}$

- When Q<K, there are too many reactants or too few products, so the rxn moves forward (more products, less reactants)
- When Q>K, there are too many products or too few reactants, so the rxn moves backwards (more reactants, less products)
- When Q=K, the reaction is at equilibrium.

$N_2(g) + O_2(g) \rightleftharpoons 2\,NO(g)$

$K_c = 0.10$ @ 2000°C

A 5-L container contains 0.40 mol N_2, 0.40 mol O_2, and 0.80 mol NO.

Is the rxn at equilibrium? If not, which way will the rxn go?

$K_c \rightarrow$ based on concentration [ ] (molarity)

$K_p \rightarrow$ based on partial pressure

The only factor that can change K_c is a change in temperature.

Is Q = K? If Q ≠ K, is Q < K or Q > K?

K = 0.10

K < 1, so there will be more reactants than products at equilibrium (reactant-favored)

$$Q = \frac{[NO]^2}{[N_2][O_2]}$$

$$[N_2] = \frac{0.40 \text{ mol } N_2}{5.0} = 0.080\,M = [O_2]$$

$$[NO] = \frac{0.80 \text{ mol } NO}{5.0} = 0.16\,M$$

$$Q = \frac{[NO]^2}{[N_2][O_2]} = \frac{0.16^2}{(0.080)(0.080)}$$

$$= \frac{(0.16)^2}{(.080)^2} = 2^2 = 4 > K$$

$Q \neq K$ ∴ the rxn is not @ equilibrium.

Q > K, so the rxn will go in reverse

$$H_2(g) + I_2(g) \rightleftarrows 2HI(g)$$

$$K_c = 8.36 \times 10^{-2}$$

1.8 mol H_2, 1.8 mol I_2, 0.60 mol HI in 1.5 L container.

$$[H_2] = \frac{1.8}{1.5} = 1.2 \quad [I_2] = \frac{1.8}{1.5} = 1.2 \quad HI = \frac{0.60}{1.5} = 0.40$$

$$Q_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{(0.4)^2}{(1.2)(1.2)} = 0.111 \quad Q > K$$

What will the concentrations be at equilibrium? L5

	H_2	I_2	HI
Initial	1.2	1.2	0.40
Change	$+x$	$+x$	$-2x$
Equilibrium	$1.2+x$	$1.2+x$	$0.40-2x$

$$K_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{(0.40-2x)^2}{(1.2+x)(1.2+x)} = 8.36 \times 10^{-2}$$

$$\sqrt{\frac{(0.40-2x)^2}{(1.2+x)^2}} = \sqrt{8.36 \times 10^{-2}}$$

$$\frac{0.40-2x}{1.2+x} = 0.289$$ (x must be positive)

$$0.40 - 2x = 0.3468 + 0.289x$$

$$0.0532 = 2.289x$$

$$x = 0.0232$$

$[H_2]_e = 1.2232$ M $[I_2]_e = 1.2232$ M

$[HI] = 0.3536$ M