Chemistry Study Sheet on Heat Transfer, Reversible Reactions, and… stuff (Kinetics)

Chemical Kinetics deals with:

Rate of Chemical Reactions, and reaction pathways (catalyzed and uncatalyzed)

Energy is needed for a chemical reaction to occur

Energy may be absorbed (endothermic) or released (exothermic):

Enthalpy is change in heat or ΔH.

If ΔH is negative, the reaction is exothermic

If ΔH is positive, the reaction is endothermic

(Enthalpy is recorded in Kilojoules)

In terms of chemical equations:

 If the heat is shown on the side of the products, then the reaction is exothermic:

2N2 + 2O2 -> 2NO + 45.6 Kj This is considered to be negative energy. (i.e. if your given ΔH = -45.6kj)

 If the heat is shown on the side of the reactants, then the reaction is endothermic

2N2 + 2O2 + 45.6 Kj -> 2NO This is considered to be positive energy. (i.e. if your given ΔH = 45.6 kj)

The breaking of bond is endothermic because energy needs to be applied to the bonds in order to break them.

The formation of a bond is exothermic because energy is released when the bond breaks.

In an exothermic reaction, the energy released in bond formation is greater than the energy used to break old bonds.

In an endothermic reaction, the energy absorbed in breaking old bonds is greater than the energy released when new bonds are formed.

(Examples: Combustion is a exothermic reaction, Neutralization reactions (acid + base) are also exothermic, the addition of water to an anhydrous compound produces heat, and is therefore exothermic)

Photosynthesis is an endothermic reaction, dissolving certain salts (ionic compounds) in water is endothermic.

Reactants and products exist at given energy levels (This is known as their potential energy)

The energy absorbed or released in a reaction is the difference in the potential energies of the products or the reactions. This is called the heat of reaction and is represented by delta H.

In exothermic reactions:

The products have a lower potential energy than the reactants.

The difference in height represents energy given out per mole. (Delta H is negative in the case of exothermic reactions)

The initial rise in the line represents the energy needed to break the old bonds (activation energy)

In endothermic reactions:

The products have a higher potential energy than the reactants.

The difference in height represents the energy taken in pre mole. (Thus delta H is positive)

The activation energy represents the minimum energy needed by reacting particles for the reaction to occur. This energy is used to break the bonds in the reactants.

A catalyst makes reactions happen faster by lowering the activation energy needed. (However, catalysts do not affect delta H or, the overall change in energy) This also means that the reactions will happen at a lower temperature.

Catalysts work most effectively when they are in the form of powder. This is because the large surface area allows more particles to react with the catalyst at the same time.

The mass of the catalyst is never lost throughout the course of the chemical reaction.

The energy needed to form the activated complex is called the activation energy. (On a reaction graph, the activation energy is the difference of the energies of the activated complex and the reactants.)

Enthalpy or Heat of Reaction is calculated by finding the difference between the potential energy of the products and reactants. (They must be done in that order : product – reactants)

Collision Theory:

The rate of the reaction depends on how often and how hard the reacting particles collide with each other. The particles must have sufficient energy and the correct orientation to collide (to produce effective collisions)

Higher temperature increases the number of collisions. When the temp is increased, the particles move faster with more energy, thus increasing the probability that a collision will occure.

At higher concentration, the number of reactant particles knocking about increases, and the probability of reacting particles increases.

Smaller Particles (or substances with a generally larger surface area) increases the rate of the reaction because the particles of the other reactants will have more room to work.

A catalyst increases the rate of the reaction, or the successful number of effective collisions by lowering the activation energy. In the end the amount of collisions will be the same, they will just happen faster with the catalyst.

Higher temperature also increases the energy of the collisions. Faster collisions are only caused by higher temperature.

Soluble Ionic Compounds react faster than covalent compounds since there are no initial bonds to break.

Entropy is disorder of particles in a substance.

In solids there is no entropy because the particles are in a fixed position.

In liquids there is higher entropy because the particles can move around freely.

In gases, there is very high entropy because there are no forces of attraction that limit the movements of gas particles.

The states of matter in increasing entropy are solid – liquid – gas

Particles will naturally move to increase the entropy of a substance. Gases diffuse to fill all available space because there is more ways of arranging particles in a larger space.

When a solute dissolves, solute particles spread out in the solvent and entropy increases.

It takes more energy to maintain a low-entropy state.

Thus systems will always change to have a low energy and high entropy state.

This concludes Heat Transfer, I’ll finish the rest tomorrow.

Reversible Reactions:

A reversible reaction can go in both directions. In other words, the products can form reactants and the reactants can form products.

**If a reversible reaction is in a closed system, a state of equilibrium will always be reached**.

Equilibrium means that the relative quantities of the reactants and products will reach a certain balance and stay there.

Dynamic Equilibrium – Happens in a closed system (basically what was just explained) both reactions of the reversible reactions are happening at the same rate thus having no overall effect on the system because the reactions cancel each other out. (both reactions are taking place at exactly the same rate.

If we deliberately alter the temperature and pressure of the mixture of products and reactants, to give more product or less reactant (or visa versa) at the equilibrium state.

All reactions are endothermic or exothermic, by changing the temperature or pressure we can change which one is favored within the reversible reaction.

If we **increase the temperature**, the **endothermic reaction** will be favored. (More heat absorption)

If we **decrease the temperature**, the **exothermic reaction** will be favored. (More heat released)

(The below applies to gases only)

If we increase the pressure, the reaction that produces less volume (in moles) will be favored.

If we decrease the pressure, the reaction that produces more volume (in moles) will be favored.

La Chatelier’s principle is that if you change the conditions within a closed system, the position of equilibrium will shift to oppose change. (The position of equilibrium is the relative amounts of reactants and products)

If you add salt to a saturated solution, solution equilibrium is established. (Crystallization and Fusion happening at the same time this is called a physical equilibrium)

This is not a reversible reaction, it is a reversible physical process or a “phase equilibrium”.

Changing phase is always a reversible process.

Remember that when disturbed a physical equilibrium will balance itself out again.

Therefore, in a closed container, if the amount of vapor increases and the amount of liquid decreases, the rate of condensation increases, and the rate of vaporization decreases to create more liquid.

This can also happen in the reverse order.

When the rates of both phase changes are equal, you have what is called equilibrium (however just because you are at equilibrium doesn’t mean you have the same amount of both substances). (For example if you increased the temperature, there would be more vapor.

In order to explain concentration I’m going to use the model equation:

 A + B -> C + D

If you increase the concentration of A, the forward reaction is favored. If you decrease the amount of D, you also favor the forward reaction.

Assuming A,B,C, and D are all gases, if you increase the pressure, you will favor the reaction that has a lower volume.

If you have a reaction in which both the products and the reactants have an equal number of moles, pressure application does not shift the equilibrium.