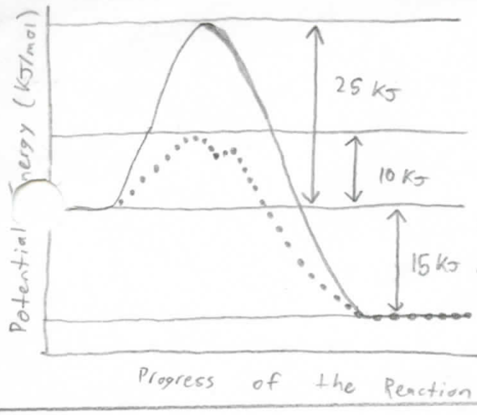
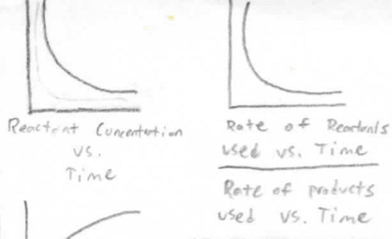
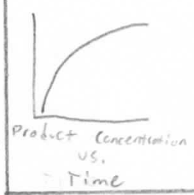


$\Delta H = -15$
exothermic
Ea Cat = 10
Ea uncat = 25
Catalyst = fast
Normal = slow
$Ea_R = 40$
$\Delta H_R = 15$
RDS = Step 1 reverse





Photochemical smog $NO_{(g)}$ Catalyst and in Engines $NO_{(g)}$ is a catalyst

Which Is Fast?

$Pb^{2-}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2(s)}$

- Fast, Ions dissolved in aqueous solutions.

$Pb_{(s)} + Cl_{2(g)} \rightarrow PbCl_{2(s)}$

- Slow, Non Ions, and solids

Ea (Activation Energy) is the minimum ammount of energy that the colliding species must have to form the Activated complex.

Two types of Potential Energy = Nuclear Binding Energy, and Bond Energy (electronic energy).

Whenever bonds are formed, Energy is released. Whenever bonds are broken, Energy is absorbed.

Gibb's Free Energy: $\Delta G = \Delta H - T\Delta S$. If G is negative, Spontaneous to the right. If G is positive the reverse of the equation is spontaneous. If G = 0 the system is at equilibrium

Ways to measure Rates: Colour change/spectrometer, Density/Concentration ÷ Time, Electric Conductivity

Collision Theory: Rate of Reaction is proportional to # of collisions. More collisions = faster reaction. Necessary for effective collisions = correct orientation (Geo...y) of particles, and sufficient KE to overcome Ea.

Limiting vs. Excess

$\overset{1.0mol}{H_2} + \overset{1.6mol}{2NCl} \rightarrow 2HCl + N_2$

$\boxed{1.6mol}$ (2HCl) $\quad \boxed{0.8mol}$ (N_2)

$\boxed{0.8mol} \xleftarrow{\div 2} 1.6mol$

$1.0mol \xrightarrow{\times 2} \boxed{\cancel{2.0mol}}$

Activitated Complex: Temporary arrangment of atoms at the top of PE "hill" or barrier. Transition state between reactants and products

Inhibitors: Chemicals which slow or retard the reaction rate without being consumed themselves. ie: Food preservatives, Medicine, Fire retardents for clothing

Catalyst: A substance which speeds up a chemical reaction but remains unchanged at the end of the reaction. Creates more favourable collision geometry

Entropy: Randomness of a chemical system. Mode... by Δs in Gibb's Free Energy Equation

Q10 General Rule: The rate of a reaction doubles for each 10°C rise in temperature.

$Q10 = \left(\frac{R_2}{R_1}\right)^{\left(\frac{10}{t_2 - t_1}\right)}$

Transition State Theory: When molecules collide they slow down, stop, and fly apart again. Therefore, because of the Law of Conservation of Energy, KE is converted to PE at the time of collision

Atmospheric Chemistry and Catalysts

$O_{2(g)} \xrightarrow{UV} O_{(g)} + O_{(g)}$

$O_{(g)} + O_{2(g)} \rightarrow O_{3(g)}$ Ozone

$O_{(g)} + O_{2(g)} \rightarrow O_{3(g)}$

UV is a catalyst because it provides heat which provides the activation energy for this reaction

$O_{(g)}$ is a catalyst because it is at the beginning of the reaction but it comes out the other side to continue the chain reaction

PhotoChemical Smog

$N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

$NO_{(g)} + O_{2(g)} \rightarrow NO_{2(g)} + O_{(g)}$

$NO_{2(g)} \xrightarrow{UV} NO_{(g)} + O_{(g)}$

$O_{(g)} + O_{2(g)} \rightarrow O_{3(g)}$

$O_{(g)} + O_{2(g)} \rightarrow O_{3(g)}$

Three Modes of Kinetic Energy

- **Rotation:** Molecule can rotate on an imaginary axis ie: Tumble
- **Vibration:** Stretching and bending of bonds ex: H_2O
- **Translation:** Motion between two points

Reaction Mechanisms

Step 1: $Cl_2 + \boxed{AlCl_3} \rightarrow \cancel{AlCl_4^-} + \cancel{Cl^+}$ (Slow)

Step 2: $\cancel{Cl^+} + C_6H_6 \rightarrow C_6H_5Cl + \cancel{H^+}$ (Fast)

Step 3: $\cancel{H^+} + \cancel{AlCl_4^-} \rightarrow \boxed{AlCl_3} + HCl$ (Fast)

$$\boxed{Cl_2 + C_6H_6 \rightarrow C_6H_5Cl + HCl}$$

Catalyst: $AlCl_3$

Intermediates: $AlCl_4^-, Cl^+, H^+$

$Cl_{(g)}$ is a catalyst for the same Reason as $O_{(g)}$

CFC's produce a catalyst that speed up ozone depletion

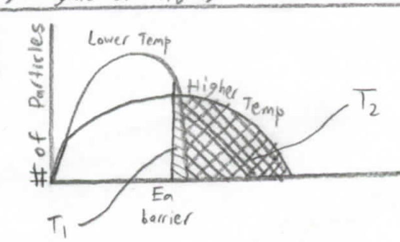
Affects # of collisions/Reaction Rate

- Temperature
- Concentration
- Catalyst
- Nature of Reactants
- Surface Area (for Heterogeneous)
- Agitation (Heterogeneous)
- Pressure (for Gas)

Homogeneous Reaction: only one phase is present. (liquid on liquid or gas on gas)

Heterogeneous Reaction: Multiple phases. (solid on liquid, or gas on liquid, or two immisible liquids)

Boltzmann Distribution Curve



T_2 higher Temp = More Successfull collisions

Hess's Law of Heat Summation: When a reaction can be expressed as the Algabraic sum of two or more other reactions, the heat of the overall reaction is the algebraic sum of the heats of these reactions.