1. Concept Analysis for Rate of Chemical Reaction

- **Concept Label :** rate of chemical reaction
- **Concept Definition** : rate of chemical reaction is the change in the concentrations
- **Concept Type** : abstract
- **Attribute :**
  a. **Critical** : rate of chemical reaction, concentration of reactants or products, function of time
  b. **Variable** : time, temperature , concentration , catalyst , activation energy , nature of reactants, average reaction rate, instaneous reaction rate, initial reaction rate, order of reaction, half life time
- **Concept Position :**
  a. **Supperordintae:** Chemical kinetics
  b. **Coordinate** : equilibrium reaction
  c. **Subordinate:** rate law
- Example : A → B, rate = $\frac{\Delta[A]}{\Delta t}$, the rate of decomposition of N_2O_5 is $\frac{\Delta[N_2O_5]}{\Delta t}$
- Non example : the rate of decomposition of N_2O_5 is $\frac{\Delta[NO_2]}{\Delta t}$

2. Concept Analysis for Collision Theory

- **Concept Label** : collision theory
- **Concept Definition** : collision theory states that in order for a chemical reaction to occur the reactant atom or molecules must collide with each other
- **Concept Type** : abstract
- **Attribute :**
  a. **Critical :** chemical reaction, collision theory , reactant atoms or molecules, collision,
  b. **Variable** : activation energy, frequency of collision, kinetic energy, proper orientation, temperature , transition state
- **Position** :
  a. **Supper Ordinate**: chemical kinetics
  b. **Coordinate**: transition state theory
  c. **Subordinate** : effective collision

- **Example :** the collision between the molecules of O_3 and NO will produce NO_2 and O_2
- **Non Example** : ineffective collosion b/n the molecules of I_2 and H_2 will produce HI

3. Concept Analysis for Activation Energy

- **Concept Label** : activation energy
- **Concept Definition** : activation energy is the minimum amount of energy required for a successful collision of reactants or particles
- **Concept Type** : abstract
- **Attribute :**
    a. **Critical** : activation energy, minimum amount of energy , successful collision of reactant
    b. **Variable** : catalyst , temperature,
- **Concept Position :**
    a. **Supper Ordinate** : collision theory
    b. **Coordinate :** activation energy barrier
    c. **Subordinate:** heat of reaction
- **Example : activation energy on potential energy diagram for a chemical reaction**
- **Non example** : reaction mechanisms

4. Concept Analysis for Catalyst

- **Concept Label** : catalyst
- **Concept Definition:** a catalyst is a substance that increases the rate of reaction without being changed at the end the reaction or a substance that permits reactions to proceed at lower energy than normally required.
- **Concept Type :** concrete
- **Attribute :**
    a. **Critical** : catalyst, increases rate of reaction, without being changed
    b. **Variable** : activation energy , heat of reaction, speed of reaction, time, rate of reaction, mechanism of reaction ,type of catalyst
- **Concept Position :**
    a. **Supper Ordinate:** none
    b. **Coordinates**: reaction inhibitors

c. **Subordinates:** none

- **Example** : Pt, Fe, Ni, enzymes , H_2SO_4, NaOH
- **Non Examples** : Na, water,

5. Concept Analysis for Rate Laws

- **Concept Label** : rate laws
- **Concept Definitions** : the rate law for a chemical reaction is an equation that links the rate with concentration or pressure of reactants and constant parameters
- **Concept Type** : Abstract
- **Attribute :**
    a. **Critical** : rate law, rate of chemical reaction, equation links rate with concentration and constant parameter s
    b. **Variable** : integrated rate law, differential rate law, concentration, order of reaction , rate constant, type of reaction
- **Concept Position :**
    a. **Supper Ordinates** ; chemical kinetics
    b. **Coordinates:** law of mass action
    c. **Subordinates**: reaction order
- **Example** : the rate law for general reaction
  aA + bB → cC + dD is , $v = k[A]^m[B]^n$
- **Non Example** ;$K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$

6. Concept Analysis For reaction order

- **Concept Label** : rate order
- **Concept Definition**: the order of reaction with respect to certain reactant is defined as the exponent to which its concentration term in rate equation is raised.
- **Concept Type**: abstract
- **Attribute :**
    a. **Critical** : order of reaction, reactants, exponents , rate equation, concentration
    b. **Variable:** concentration ,reactants, exponents
- **Concept Position :**
    a. **supper ordinate** : rate law
    b. **coordinate** : none
    c. **sub ordinate** : half life time

- **Example** : first order reaction, second order reaction , zero order reaction,
- **Non Example** : coefficients of reactants in chemical reaction

7. Concept Analysis for Half life Time

- **Concept Label :** Half life time
- **Concept Definition:** half life time is the time taken for the concentration of a reactant to drop to half of its original value.
- **Concept Type** : Abstract
- **Attribute :**
    a. **Critical** : half life time, haif of original value ,reactant concentration
    b. Variable : time , concentration, rate constant,
- **concept position :**
    a. **Supper Ordinates** : rate law
    b. **Coordinate** : none
    c. **Subordinate:** none
- **Examples**: half life time of 1st order reaction, half life time of 2nd order reaction.
- **Non Example** : the time difference between initial time and final time of reaction

8. Concept Analysis For Reaction Mechanisms

- **Concept Label :** reaction mechanisms
- **Concept Definition :** reaction mechanism is the step by step pathway by which a reaction occurs
- **Concept Type** : abstract
- **Attribute :**
    a. **Critical** : reaction mechanism, step by step, pathway
    b. **Variable** : rate determining step, steady state, reaction intermidiate, transition state, activation energy,reactant, product
- **Concept Position** :
    a. **supper ordinate** : rate of chemical reaction
    b. coordinate : none
    c. **subordinate :** elementary reaction
- **Example :** the reaction between NO_2 and CO takes two steps

    $NO_2 + NO_2 \rightarrow NO_3 + NO$

    $NO_3 + CO \rightarrow NO_2 + CO_2$
- **Non Eample : the reaction between** NO_2 and CO produces NO and CO_2

9. Concept Analysis for Transition State Theory

- **Concept Label :** Transition State Theory
- **Concept definition** : transition state theory explains the reaction resulting from the collision of two molecules interms of an activated complex.
- **Concept Type** : Abstract
- **Attribute :**

  a**. Critical** : transition state theory, collision b/n two molecules, activated complex,

  b. Variable : activation energy, reaction mechanisms, catalyst, temperature, activated complex , concentration .
- **Concept Position** :

  a. **supperordinate** : chemical kinetics

  b. **coordinate :** collision theory

  c. **subordinate**: none

  Example: the activated complex for the reaction between CO and NO_2 is $CO{---}O^{-}{--}NO^{+}$

  Non Example: the product or the activated complex for the reaction between CO and NO_2 is CO_2 and NO.