

N8 - KINETICS

Quick Review

N8 - KINETICS

Target: I can refresh my memory from Honors Chem about how we measure reaction rates.

Kinetics

Study of

- reaction rates
- reaction mechanisms

Reaction Rate

Reaction Rate - The speed of a chemical reaction

How fast products are made or
How fast reactants are used.

The ability to control the speed of a chemical reaction is important! Speeding them up is sometimes good, slowing them down is sometimes good.

Defining Rate

Rate

How much a quantity changes in a given period of time.

Example:

Speed of a car — distance the car travels (miles)
in a given period of time (1 hour).

So, the rate of your car has units of mi/hr.

$$\text{Rate} = -\frac{\Delta[\text{I}_2]}{\Delta t}$$

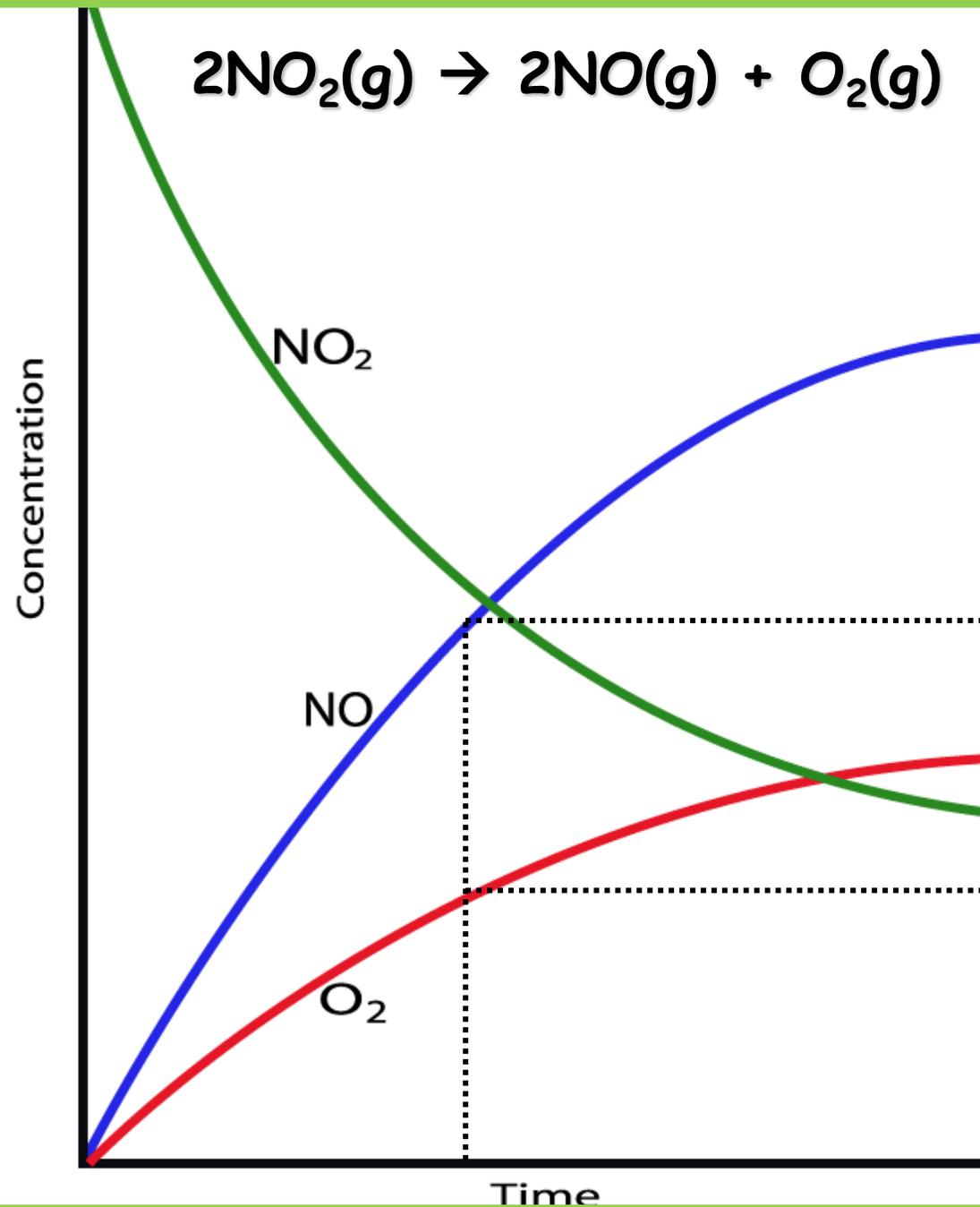
Defining Reaction

Rate for a chemical reaction – change in concentration in a given amount of time.

- Could be how fast products are made = +
- Could be how fast reactants are used up = -

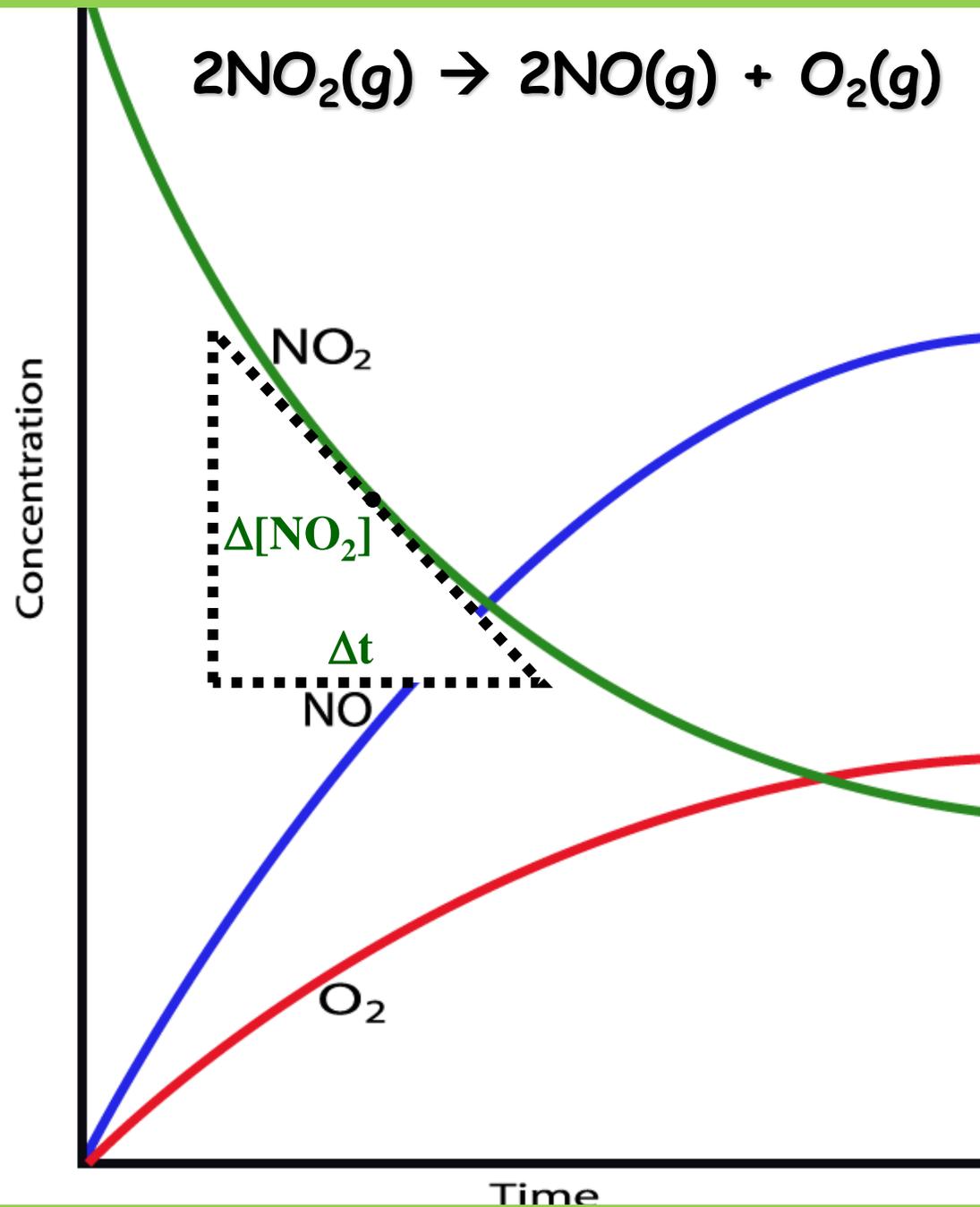
For reactants, a negative sign is placed in front of the definition.

$$\text{Rate} = -\frac{\Delta[\text{H}_2]}{\Delta t} = -\frac{[\text{H}_2]_{t_2} - [\text{H}_2]_{t_1}}{t_2 - t_1}$$



Reaction Rates:

1. Can measure disappearance of reactants
2. Can measure appearance of products
3. Are proportional stoichiometrically

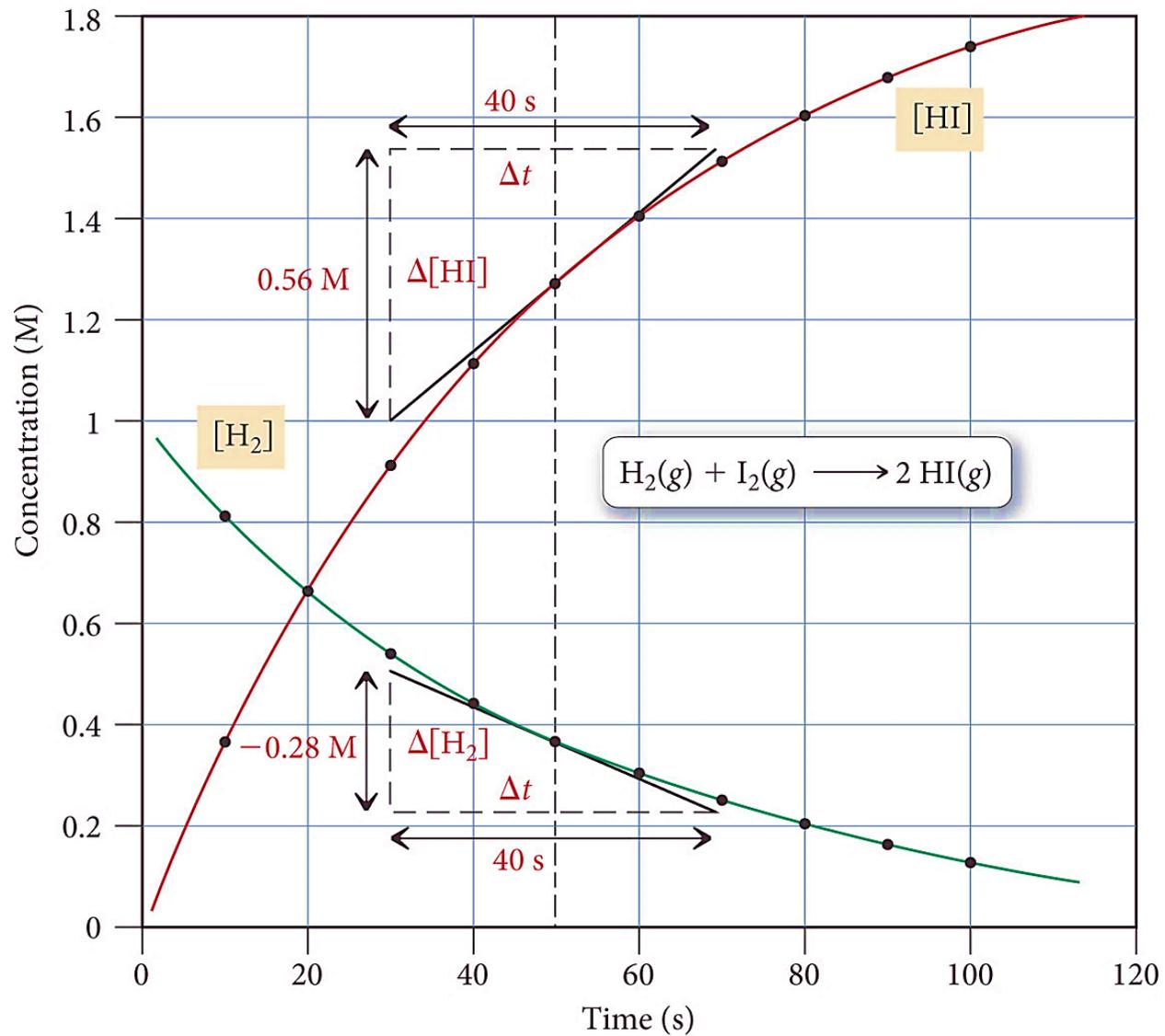


Reaction Rates:

4. Are equal to the slope tangent to that point
5. Change as the reaction proceeds, if the rate is dependent upon concentration

$$\frac{\Delta[\text{NO}_2]}{\Delta t} \neq \text{constant}$$

Reactant and Product []s as a Function of Time



Reaction Rate and Stoichiometry

In most reactions, the coefficients of the balanced equation are not all the same.



Reaction Rate and Stoichiometry



For these reactions, the change in the number of molecules of one substance is a multiple of the change in the number of molecules of another.

- For every 1 mole of H_2 used, 1 mole of I_2 will also be used and 2 moles of HI made.

Therefore, the rate of change will be different!

Reaction Rate and Stoichiometry

To be consistent, the change in the concentration of each substance is multiplied by $\frac{1}{\textit{coefficient}}$

$$\text{Rate} = -\frac{1}{a} \frac{\Delta[A]}{\Delta t} = -\frac{1}{b} \frac{\Delta[B]}{\Delta t} = +\frac{1}{c} \frac{\Delta[C]}{\Delta t} = +\frac{1}{d} \frac{\Delta[D]}{\Delta t}$$

Average Rate vs. Instantaneous Rate

Average Rate

The change in concentrations over any particular time period.

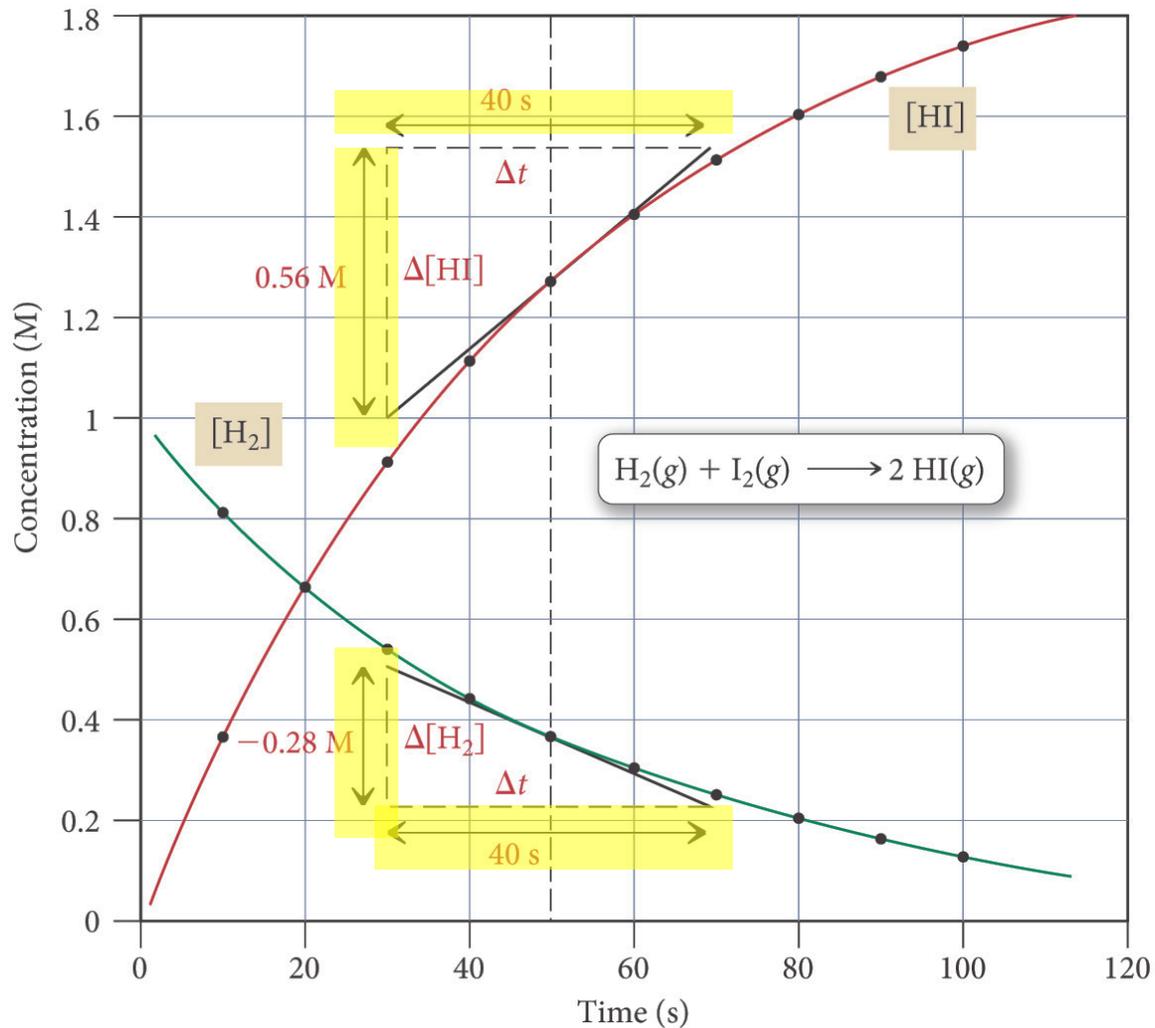
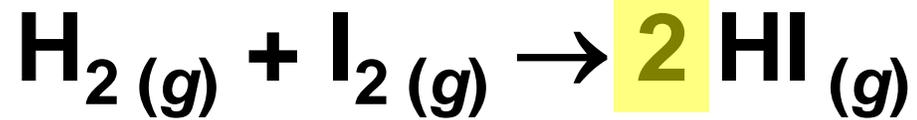
- Linear approximation of a curve
- The larger the time interval, the more the average rate deviates from the instantaneous rate.

Average Rate vs. Instantaneous Rate

Instantaneous Rate

The change in concentration at a specific, particular time.

- Slope at one point of a curve
- Found by taking the slope of a line tangent to the curve at that particular point.
 - » First derivative of the function
(for all of you calculus fans)
(no we won't be doing calculus)



Using $[\text{H}_2]$, the instantaneous rate at 50 s is as follows:

$$\text{Rate} = \frac{-0.28 \text{ M}}{40 \text{ s}}$$

$$\text{Rate} = 0.0070 \frac{\text{M}}{\text{s}}$$

Using $[\text{HI}]$, the instantaneous rate at 50 s is as follows:

$$\text{Rate} = \left(\frac{1}{2}\right) \frac{0.56 \text{ M}}{40 \text{ s}}$$

$$\text{Rate} = 0.0070 \frac{\text{M}}{\text{s}}$$

Factors Affecting Reaction Rates

Nature of the Reactants

What kind of reactant molecules and what physical condition they are in.

- Small molecules tend to react faster than large molecules.
- Gases tend to react faster than liquids, which react faster than solids.

Factors Affecting Reaction Rates

Nature of the Reactants

- Powdered solids are more reactive than “blocks.”
 - More surface area for contact with other reactants
- Certain types of chemicals are more reactive than others.
 - For example, K is more reactive than Na
- Ions react faster than molecules.
 - No bonds need to be broken.

Factors Affecting Reaction Rates

Temperature - Increasing temp increases the reaction rate.

Chemist's rule - for each 10 °C rise in temperature, the speed of the reaction doubles.

- Just an approximation, doesn't always work.

There is a mathematical relationship between the absolute temperature and the speed of a reaction discovered by Svante Arrhenius, which will be examined later.

Factors Affecting Reaction Rates

Catalysts

Substances that affect the speed of a reaction without being consumed. They are still there after the reaction is over.

Positive Catalysts – Most common kind, used to speed up a reaction

Negative Catalysts - Used to slow a reaction, also called **inhibitors**.

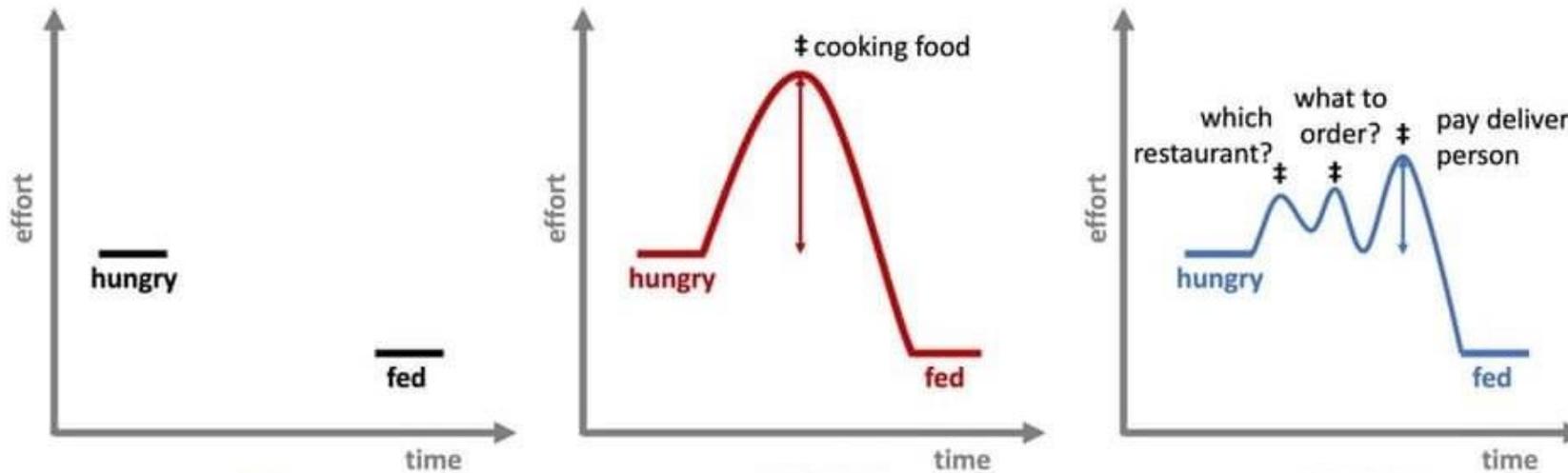
Homogeneous - present in same phase

Heterogeneous - present in different phase

Factors Affecting Reaction Rates

Catalysts

Provide an alternative pathway that has a lower activation energy.



Factors Affecting Reaction Rates

Reactant Concentration

- Generally, the larger the concentration of reactant molecules, the faster the reaction.
 - This increases the frequency of reactant molecules colliding with each other.
- Concentration of gases depends on the partial pressure of the gases.
 - Higher pressure = higher concentration
- Concentrations of solutions depend on the solute-to-solution ratio (molarity).

**Remember
Collision
Theory???**

YouTube Link to Presentation

<https://youtu.be/c3JIH98mA0U>