Rates of Reactions

Chemical Kinetics

* Thermodynamics gives NO information about HOW FAST a change will take place

* Chemical kinetics is the study of REACTION RATES and MECHANISMS (events at molecular level that control the speed and outcome of a reaction)

Reaction Rates

* **Reaction rate (r):** determined by measuring the rate at which a product is formed or the rate at which a reactant is consumed over a series of time intervals

* properties like mass, colour, conductivity, volume, pressure or concentration may be measured to determine the reaction rate

Reaction Rates

* Reaction rate is expressed as change in quantity over time

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$$\text{Rate} = \frac{\Delta\ \text{quantity}}{\Delta\ t}$$

$$\text{Rate} = \frac{[A]_{final} - [A]_{initial}}{\Delta\ t}$$

* Reaction rate is often measured by change in concentration

Example

* Measurements taken during the following reaction showed a concentration of carbon monoxide (CO) of 0.019 mol/L at 27 min and of 0.013 mol/L at 45 min. Calculate the average rate of the loss of carbon monoxide (CO) AND the gain of carbon dioxide (CO_2).

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

* Given
  * T_i = 27 min, T_f = 45 min
  * C_i = 0.019 mol/L , C_f = 0.013 mol/L

$$\text{Rate} = \frac{[A]_{final} - [A]_{initial}}{\triangle t}$$

* Given

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$$\text{Rate} = \frac{[A]_{final} - [A]_{initial}}{\triangle t}$$

Solution:

$$\text{Rate} = \frac{(0.013 \text{ mol/L}) - (0.019 \text{ mol/L})}{(45)(60) \text{ sec} - (27)(60) \text{ sec}}$$

$$\text{Rate} = \frac{(-0.005 \text{mol/L}}{1080 \text{ s}}$$

Rate of CO loss = 5.6×10^{-6} mol/Ls

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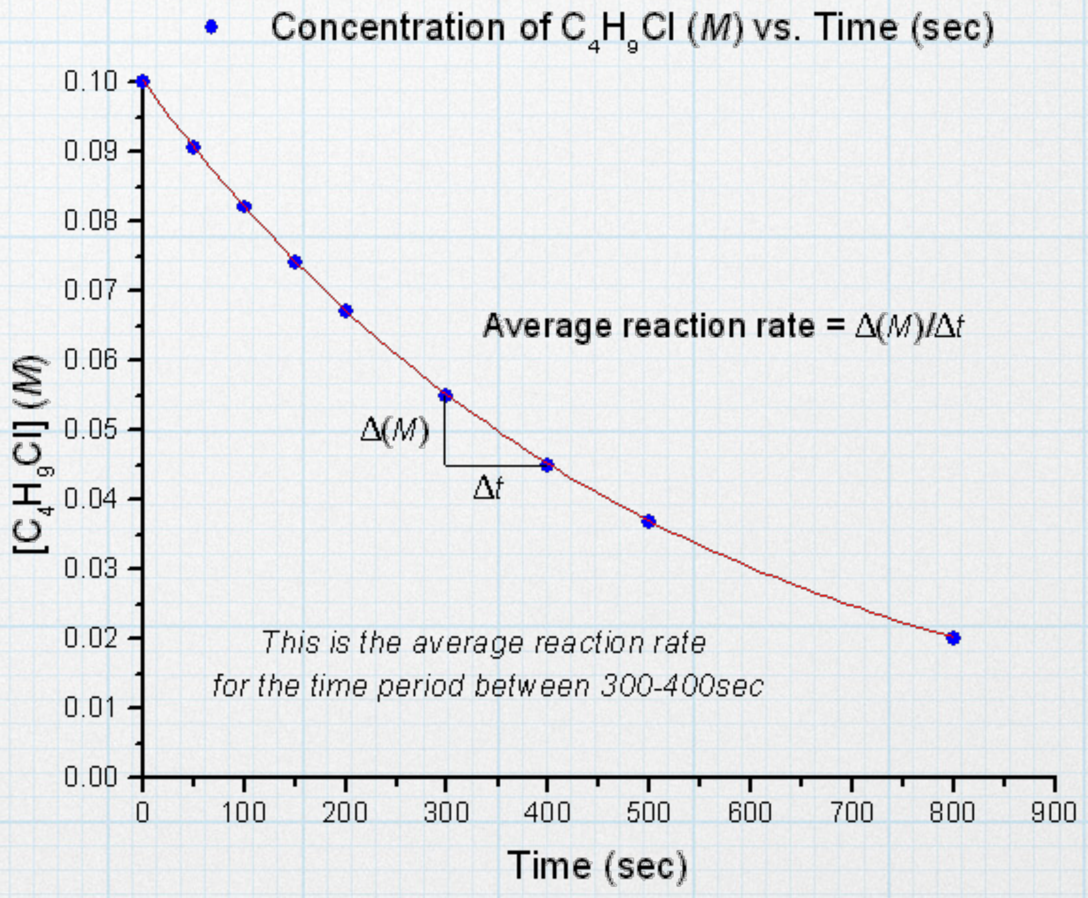
Rate of CO loss = 5.6×10^{-6} mol/Ls

Since $CO:CO_2$ is 1:1, the rate of gain of CO_2 is also 5.6×10^{-6} mol/Ls

Average Rate of Reaction

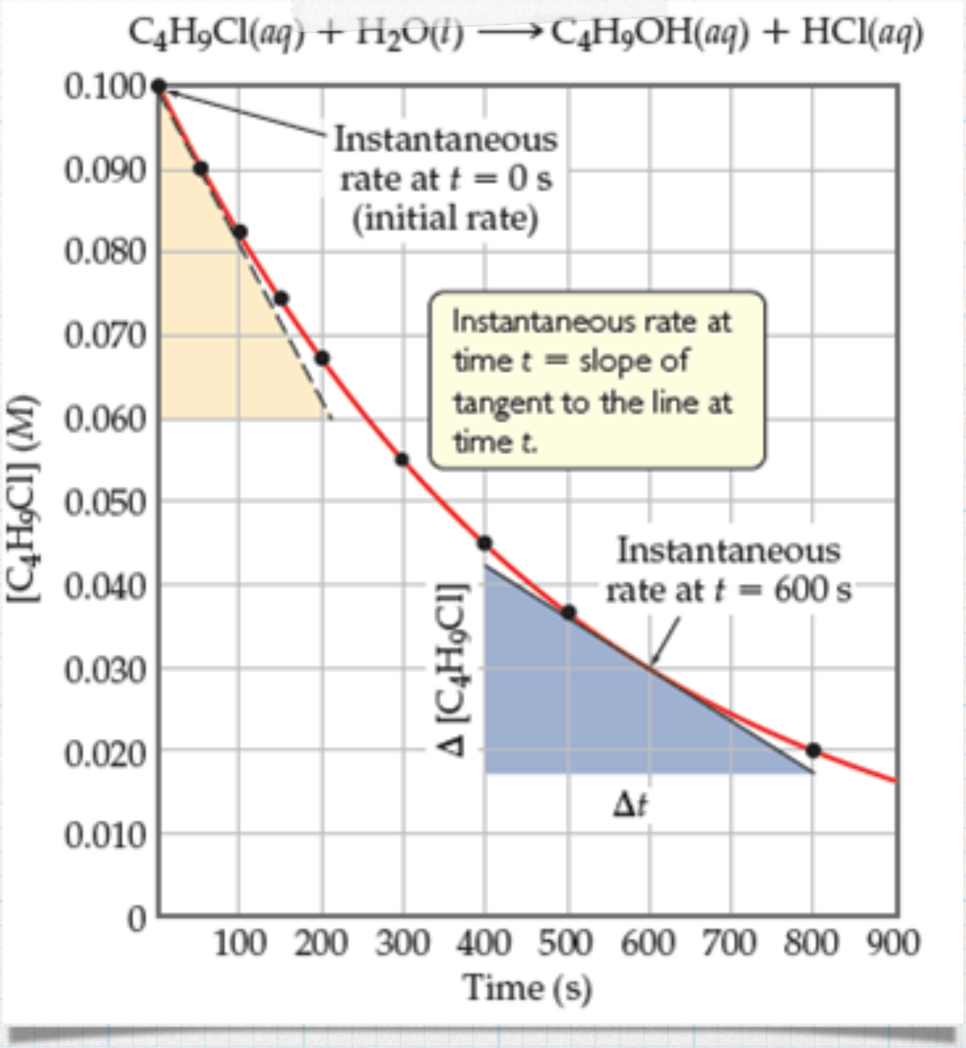
* Typically in a reaction, the reaction rate is not constant

* The average rate of reaction gives an overall idea of how quickly the reaction is progressing over a particular time interval



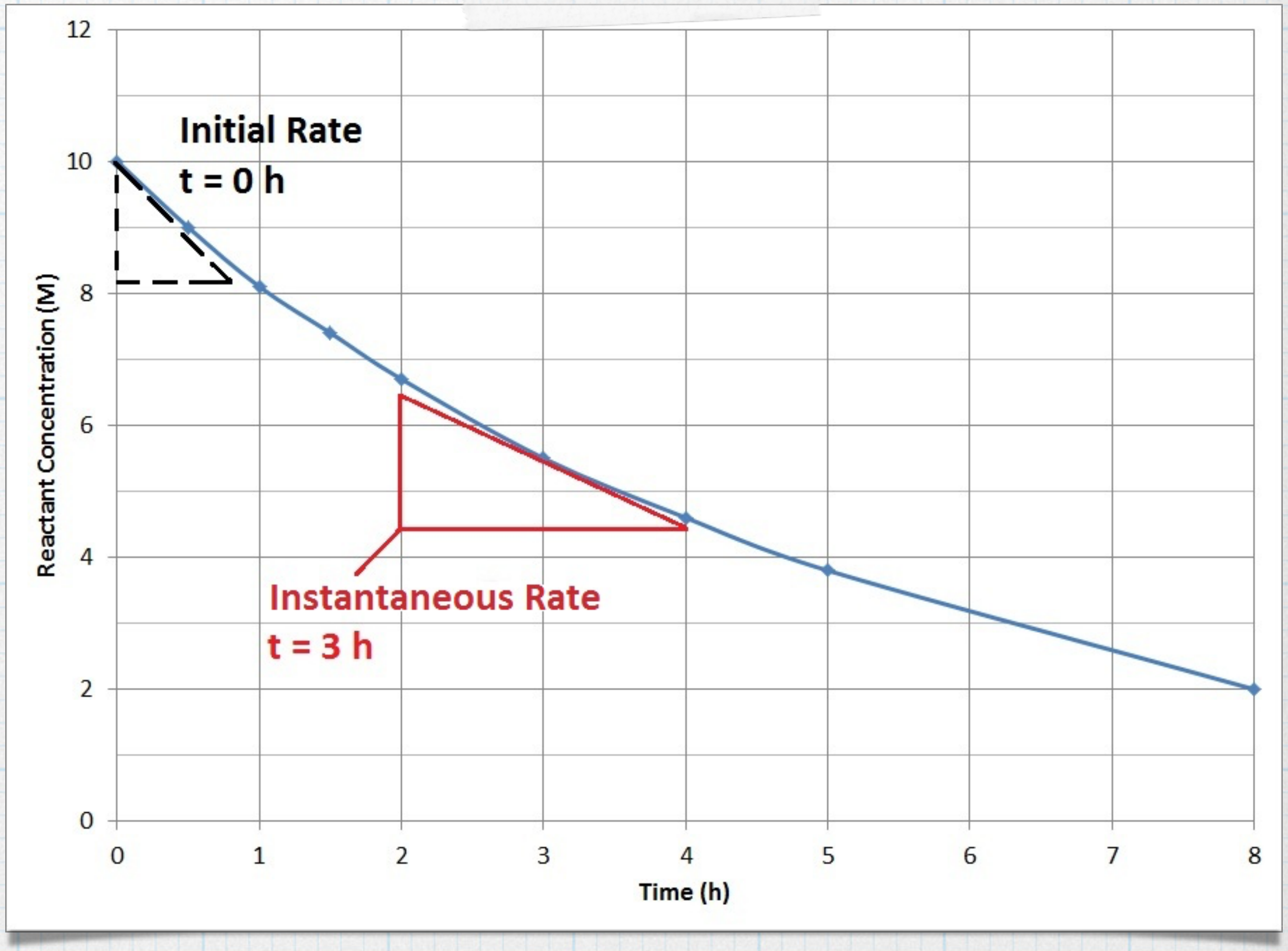
Instantaneous Rate of Reaction

* The instantaneous rate of reaction is the rate of reaction at a particular time during the reaction



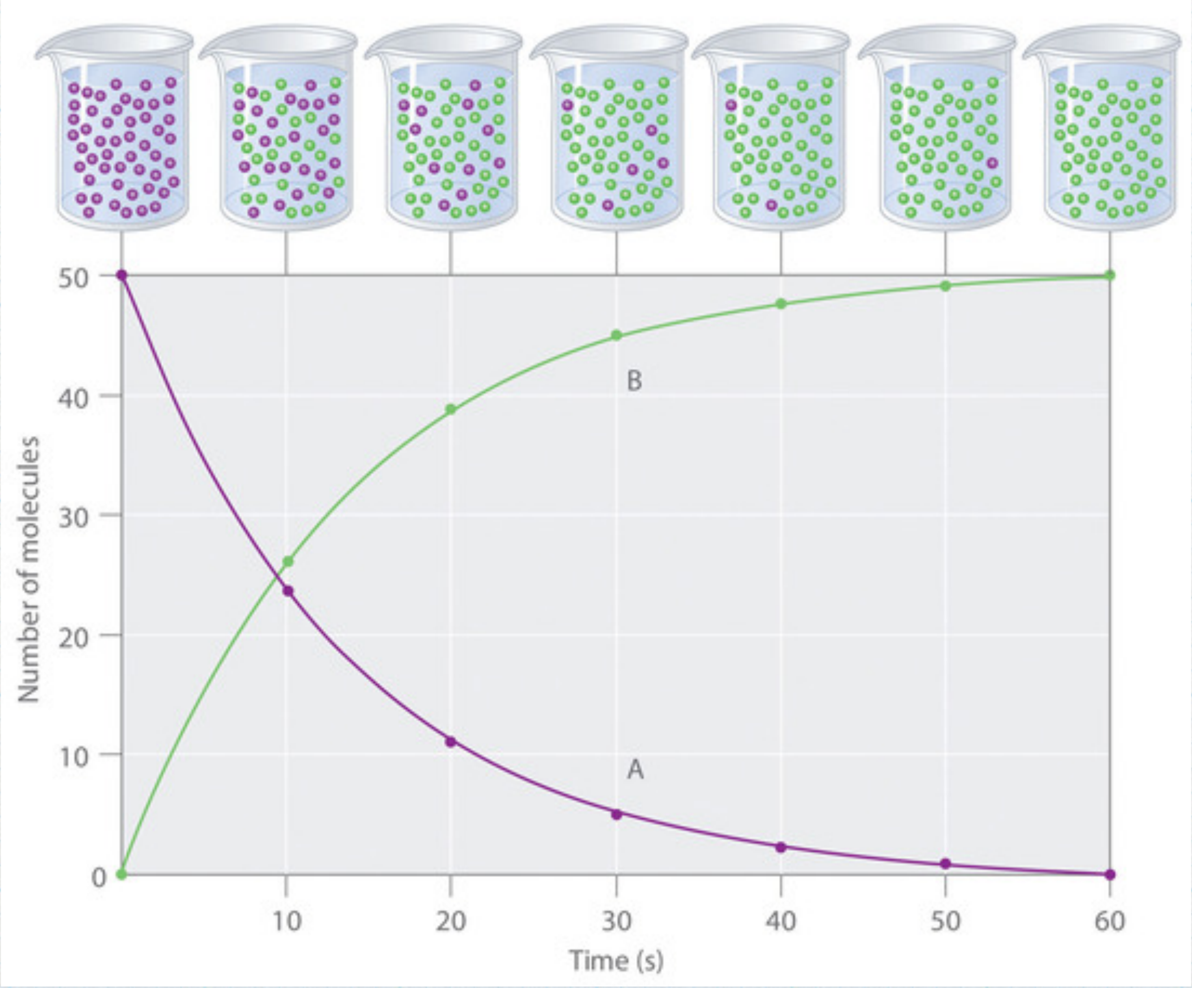
Initial Rate and Graphing

* **Initial Rate of Reaction:** the speed of the reaction the instant the reactants are mixed (t = 0)



Concentration-Time Graphs

* Concentration of reactant decreases over time, therefore slope will be negative
* Concentration of product increases over time, therefore slope will be positive



Homework

* pg 364 #2,3,6,9