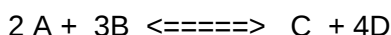


- **Kinetics is about how quickly or slowly a reaction occurs.**
- It has **nothing to do with the extent to which a reaction** will occur, that's governed by thermodynamics (thermo is the study of the energy of chemical systems). There's a distinction between the probability that molecules will react when they meet each other and, once they do react, how stable the product of their reaction is. The first, the probability that the reaction will occur, has to do with an energy barrier or activation energy that must be overcome in order for the thing to go. The second, the extent of the reaction has to do with the energy difference between the products and the reactants. You can have very stable products (meaning once the reactants turn into products they won't ever go back), but very slow kinetics. This is because of a high activation energy; i.e., very few reactants have enough energy to get over the hump for the reaction to occur. On the other hand, the kinetics of a reaction can be very fast, but the products may not be very stable; therefore the extent of reaction will be low. The bottom line here is that you have to be able to articulate the difference between kinetics and thermodynamics (which you'll do later in the year) and what is happening chemically <---- premo essay question stuff.
- In kinetics you study the rate of reaction which is just how fast species are forming or disappearing during the reaction.
- The sign convention can be a little confusing. The rate of a chemical reaction is measured by the decrease in concentration (molar concentration) of a reactant or increase in concentration of a product over a certain period of time.

$$\text{rate} = \frac{\begin{array}{c} \text{Change in molar concentration} \\ \text{of a product} \end{array} \Delta [\text{product}]}{\begin{array}{c} \text{Change in time} \end{array} \Delta t} = - \frac{\begin{array}{c} \text{Change in molar concentration} \\ \text{of a reactant} \end{array} \Delta [\text{reactant}]}{\Delta t}$$

- Δ , in case you didn't know, always refers to change when it's used in an equation. Furthermore, change is always defined as final - initial. That's important because if you do it the other way around, your sign will be screwed up. So in chemistry $\Delta[A]$ means change in the molar concentration of species A and ΔH , the heat of reaction, means the change in enthalpy between the products and reactants, etc.
- The reaction rate, r , may be found in terms of any species in a reaction. Rates found for different species are related to each other by the stoichiometry of the reaction. Use stoichiometric ratios to relate rates just like you would relate reactants used or products formed.
For example, look at how the rates of reaction are related for species in a chemical reaction:



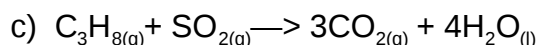
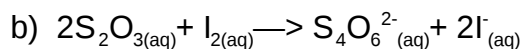
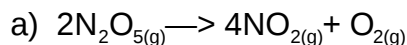
$$r_{\text{A}} = \frac{2}{3} r_{\text{B}} = -2 r_{\text{C}} = -\frac{1}{2} r_{\text{D}}$$

Student Packet: 4.1: Rate of Reaction: AssessMe questions

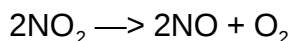
- 1) The rate of a single step reaction is dependent
- A) only on the concentrations of reactants or is a constant.
 - B) only on the concentrations of products or is a constant.
 - C) on both the concentrations of both reactants and products.
 - D) on neither the concentrations of the reactants nor products.
 - E) I'm clueless
- 2) A negative rate indicates:
- A) The species involved is a product.
 - B) The species involved is a reactant.
 - C) There is no such thing as a negative rate of reaction.
 - D) That a very complex mechanism is involved.
 - E) I'm clueless
- 3) The value of $\text{Log}(X)$ where Log refers to (base 10 logarithm) and $X=10^{-3}$ is
- A) 5 B) -9.21 C) -3 D) 0.20 E) I'm clueless
- 4) $\text{Log}(XY/Z)=$
- A) $\text{Log}X + \text{Log}Y + \text{Log}Z$
 - B) $\text{Log}X + \text{Log}Y - \text{Log}Z$
 - C) $-Z \cdot \text{Log}(XY)$
 - D) $\text{Log}X - \text{Log}Y + \text{Log}Z$
 - E) I'm clueless
- 5) The decomposition of N_2O_5 to NO_2 and O_2 is a first order reaction with the reaction rate constant, $k=0.12 \text{ s}^{-1}$ at 374 K. What is the rate when $[\text{N}_2\text{O}_5] = 2 \text{ M}$?
- A) 0.06 M/s B) 0.12 M/s C) 0.24 M/s D) 0.48 M/s E) I'm clueless
- 6) A second order decomposition reaction has a rate constant of $0.1 \text{ M}^{-1} \cdot \text{s}^{-1}$. If the initial concentration of the reactant is 0.5 M, what is the initial rate of reaction?
- A) $0.025 \text{ M} \cdot \text{s}^{-1}$ B) $0.025 \text{ M}^2 \cdot \text{s}^{-1}$ C) $0.05 \text{ M} \cdot \text{s}^{-1}$ D) $0.05 \text{ M}^2 \cdot \text{s}^{-1}$ E) I'm clueless

Student Packet: 4.1: Rate of Reaction: ShowMe questions

- 1) For each of the following reactions, indicate the relationship between the rates of disappearance of each reactant to the rates of appearance of each product:



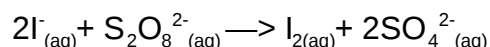
- 2) The concentration of O_2 was measured for the following reaction:



Time (min)	$[\text{O}_2]$ (M)
0	0.0
1	0.5
7	3.4
18	5.5
31	6.9

Calculate the average rate of reaction for the time interval between each measurement.

- 3) Consider the reaction:

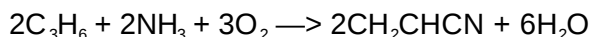


If 0.070 moles of $\text{S}_2\text{O}_8^{2-}$ is consumed in 1.0 L of solution per second, what is the rate of disappearance of I^- ? What is the rate of appearance of I_2 ?

- 4) The reaction $\text{N}_{2(g)} + 3\text{H}_{2(g)} \longrightarrow 2\text{NH}_{3(g)}$ is carried out in a closed container. If the partial pressure of N_2 is decreasing at a rate of 10 mm Hg/min, what is the rate of change of the total pressure of the container?

Student Packet: 4.1: Rate of Reaction: TestMe questions

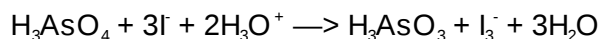
- 1) In the following reaction:



O_2 is being consumed at a rate of 0.49 M/sec. At what rate is acrylonitrile (CH_2CHCN) being produced?

- A) 0.49 M/sec B) 0.74 M/sec C) 0.33 M/sec D) 0.25 M/sec E) 0.16 M/sec

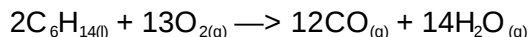
- 2) The following is a reaction between arsenic acid and iodide ions:



In this reaction, which starting material is consumed at the fastest rate? Which product is formed at the fastest rate?

- A) I^- ; H_2O
 B) I^- ; I_3^-
 C) H_3AsO_4 ; H_2O
 D) H_3AsO_4 ; H_3AsO_3
 E) None of the above

- 3) In the following reaction, what is the relationship between the rate of disappearance
- C_6H_{14}
- and the rate of appearance of
- CO
- ?



- A) $-\frac{D[\text{C}_6\text{H}_{14}]}{Dt} = \frac{12D[\text{CO}]}{Dt}$
 B) $-\frac{D[\text{C}_6\text{H}_{14}]}{6Dt} = \frac{D[\text{CO}]}{Dt}$
 C) $\frac{6D[\text{C}_6\text{H}_{14}]}{Dt} = \frac{D[\text{CO}]}{Dt}$
 D) $\frac{D[\text{C}_6\text{H}_{14}]}{Dt} = \frac{6D[\text{CO}]}{Dt}$
 E) $-\frac{6D[\text{C}_6\text{H}_{14}]}{Dt} = \frac{D[\text{CO}]}{Dt}$

- 4) Consider the reaction:
- $\text{H}_2\text{O}_{2(g)} \longrightarrow \text{H}_{2(g)} + \text{O}_{2(g)}$

This gaseous reaction takes place in a closed container. If O_2 appears at a rate of 7 mm Hg/min, what is the rate of change of the total pressure of the container?

- A) +14 mm Hg/min
 B) -7 mm Hg/min
 C) +7 mm Hg/min
 D) +21 mm Hg/min
 E) 0 mm Hg/min

- 5) For the reaction:
- $2\text{NO}_2 + \text{O}_3 \longrightarrow \text{N}_2\text{O}_5 + \text{O}_2$

If NO_2 reacts at a rate of 0.038 M/s, how fast does O_2 form?

- A) 0.15 M/s B) 0.076 M/s C) 0.038 M/s D) 0.019 M/s E) None of the above