Unit 4: Kinetics

Name: _____ Pd____

CHAPTER 13 – 14 PRACTICE QUIZ

MULTIPLE CHOICE – NO CALCULATOR ALLOWED

←Linked at 10:03

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

9. Which of the following will most likely increase the rate of the reaction represented above?

(A) Decreasing the temperature of the reaction system

(B) Adding a heterogeneous catalyst to the reaction system

(C) Increasing the volume of the reaction vessel using a piston

(D) Removing some $H_2(g)$ from the reaction system

Experiment	Mass of Zinc	Form of Zinc	Concentration of HCl(*aq*)	Temperature of HCl(*aq*)
1	10.0 g	powdered zinc	1.0 *M*	25.0°C
2	10.0 g	zinc metal strip	0.10 *M*	25.0°C
3	10.0 g	powdered zinc	1.0 *M*	50.0°C
4	10.0 g	zinc metal strip	1.0 *M*	25.0°C

10. In a certain experiment, zinc metal reacted with hydrochloric acid. Based on the information in the table above, which of the following lists of experiments is arranged in order of increasing reaction rate?

(A) 2 < 1 < 4 < 3

(B) 2 < 4 < 1 < 3

(C) 2 < 4 < 3 < 1

(D) 4 < 2 < 1 < 3

$$\underset{\textit{violet}}{C_{25}H_{30}N_3^+(aq)} + OH^-(aq) \rightarrow \underset{\textit{colorless}}{C_{25}H_{30}N_3OH(aq)}$$

The reaction between $C_{25}H_{30}N_3^+(aq)$ and $OH^-(aq)$, as represented above, is studied to determine the reaction rate. A 10.0 mL sample of 0.10 *M* NaOH(*aq*) is mixed with a 10.0 mL sample of 2.4×10^{-5} *M* $C_{25}H_{30}N_3^+(aq)$. A 5.0 mL sample of the reaction mixture is quickly transferred to a clean cuvette and placed in a spectrophotometer, and the progress of the reaction is measured. The data are given in the table below.

Time (s)	0	30	60	90	120	150	180	210	240	270	300
Absorbance	0.62	0.54	0.47	0.41	0.36	0.31	0.27	0.23	0.20	0.17	0.15

11. Approximately how long did it take for 75 percent of the initial amount of $C_{25}H_{30}N_3^+(aq)$ to react?

(A) 60 s

(B) 120 s

(C) 150 s

(D) 300 s

Skip #12.

$$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$$

The decomposition of $H_2O_2(aq)$ is represented by the equation above. A student monitored the decomposition of a 1.0 L sample of $H_2O_2(aq)$ at a constant temperature of 300. K and recorded the concentration of H_2O_2 as a function of time. The results are given in the table below.

Time (s)	$[H_2O_2]$ (mol/L)
0	2.7
200.	2.1
400.	1.7
600.	1.4

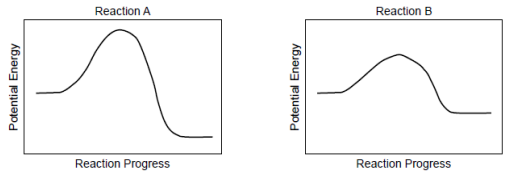
13. Which of the following statements is a correct interpretation of the data regarding how the order of the reaction can be determined?

(A) The reaction must be 1st order because there is only one reactant species.

(B) The reaction must be 2nd order because 2 is the coefficient of H_2O_2 in the equation.

(C) The reaction is 1st order if the plot of ln $[H_2O_2]$ versus time is a straight line.

(D) The reaction is 1st order if the plot of $1/[H_2O_2]$ versus time is a straight line.



14. Based on the potential energy diagrams shown above, which of the following statements is the best conclusion regarding Reaction A and Reaction B?

(A) Reaction A is faster than Reaction B because it releases more energy.

(B) Reaction A is slower than Reaction B because it has a higher activation energy.

(C) Reaction B is slower than Reaction A because its enthalpy has a smaller magnitude.

(D) Reactions A and B occur at approximately the same rate because they are both exothermic reactions.

Questions 15 and 16 refer to the information below.

$$2\ N_2O_5(g) \rightarrow 4\ NO_2(g) + O_2(g)$$

A sample of N_2O_5 was placed in an evacuated container, and the reaction represented above occurred. The value of $P_{N_2O_5}$, the partial pressure of $N_2O_5(g)$, was measured during the reaction and recorded in the table shown below.

Time (min)	$P_{N_2O_5}$ (atm)	$\ln(P_{N_2O_5})$	$\frac{1}{P_{N_2O_5}}$ (atm^{-1})
0	150	5.0	0.0067
100	75	4.3	0.013
200	38	3.6	0.027
300	19	2.9	0.053

15. Which of the following correctly describes the reaction?

(A) The decomposition of N_2O_5 is a zero-order reaction.

(B) The decomposition of N_2O_5 is a first-order reaction.

(C) The decomposition of N_2O_5 is a second-order reaction.

(D) The overall reaction order is 3.

16. Based on the information in the data table above, which of the following best represents the correct numerical value and the correct units of the rate constant (k) from this experiment?

	Numerical Value of k	Units of k
(A)	0.007	min^{-1}
(B)	0.007	$atm^{-1}\ min^{-1}$
(C)	0.7	min^{-1}
(D)	0.7	$atm^{-1}\ min^{-1}$

$$2\ NO_2(g) + F_2(g) \rightarrow 2\ NO_2F(g)$$

17. The rate law for the reaction represented by the equation above is rate = $k\,[NO_2][F_2]$. Which of the following could be the first elementary step of a two-step mechanism for the reaction if the first step is slow and the second step is fast?

(A) $F_2(g) \rightarrow 2\ F(g)$

(B) $NO_2(g) + F_2(g) \rightarrow NO_2F(g) + F(g)$

(C) $NO_2(g) + F(g) \rightarrow NO_2F(g)$

(D) $2\ NO_2(g) + F_2(g) \rightarrow 2\ NO_2F(g)$

$$X_2 + Y_2 \rightarrow X_2Y_2 \qquad \text{rate} = k\,[X_2]$$

A reaction and its experimentally determined rate law are represented above. A chemist proposes two different possible mechanisms for the reaction, which are given below.

Mechanism 1

$X_2 \rightarrow 2\ X$ (*slow*)

$X + Y_2 \rightarrow XY_2$ (*fast*)

$X + XY_2 \rightarrow X_2Y_2$ (*fast*)

Mechanism 2

$X_2 \rightarrow 2\ X$ (*slow*)

$X + Y_2 \rightarrow XY + Y$ (*fast*)

$X + XY \rightarrow X_2Y$ (*fast*)

$X_2Y + Y \rightarrow X_2Y_2$ (*fast*)

18. Based on the information above, which of the following is true?

(A) Only mechanism 1 is consistent with the rate law.

(B) Only mechanism 2 is consistent with the rate law.

(C) Both mechanism 1 and mechanism 2 are consistent with the rate law.

(D) Neither mechanism 1 nor mechanism 2 is consistent with the rate law.

$$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$$

Consider the following mechanism for the reaction represented above.

Step 1: $2\ NO \rightleftarrows N_2O_2$ (fast reversible)

Step 2: $N_2O_2 + O_2 \longrightarrow 2\ NO_2$ (slow)

19. Which of the following statements is true?

(A) Step 1 represents a unimolecular reaction.

(B) Increasing the concentration of NO will decrease the overall rate of the reaction.

(C) Raising the temperature will have no effect on the numerical value of the rate constant.

(D) The rate law that is consistent with the mechanism is rate = $k[NO]^2[O_2]$.

$$NO(g) + NO_3(g) \rightarrow 2\ NO_2(g)$$

$$\text{rate} = k\,[NO][NO_3]$$

20. The reaction represented above occurs in a single step that involves the collision between a particle of NO and a particle of NO_3. A scientist correctly calculates the rate of collisions between NO and NO_3 that have sufficient energy to overcome the activation energy. The observed reaction rate is only a small fraction of the calculated collision rate. Which of the following best explains the discrepancy?

(A) The energy of collisions between two reactant particles is frequently absorbed by collision with a third particle.

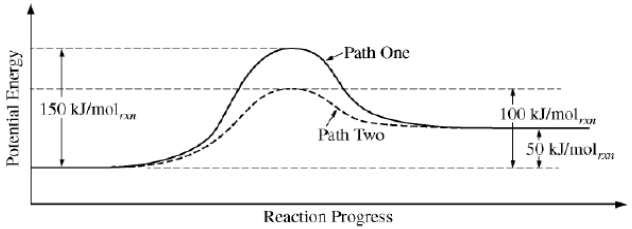
(B) The two reactant particles must collide with a particular orientation in order to react.

(C) The activation energy for a reaction is dependent on the concentrations of the reactant particles.

(D) The activation energy for a reaction is dependent on the temperature.

$$XY_2 \rightarrow X + Y_2$$

The equation above represents the decomposition of a compound XY_2. The diagram below shows two reaction profiles (path one and path two) for the decomposition of XY_2.



21. Which of the following most likely accounts for the difference between reaction path one and reaction path two?

(A) A higher temperature in path one
(B) A higher temperature in path two
(C) The presence of a catalyst in path one
(D) The presence of a catalyst in path two

CHAPTER 13 – 14 PRACTICE QUIZ

FREE RESPONSE – CALCULATOR IS ALLOWED

←Linked, begin at 25:11

2. The decomposition of hydrogen peroxide to form water and oxygen gas is studied in a kinetics experiment. A proposed mechanism for the reaction is represented by the three equations below.

Step #1: $H_2O_2 \rightarrow 2\ HO\bullet$ (slow)

Step #2: $H_2O_2 + HO\bullet \rightarrow H_2O + HOO\bullet$ (fast)

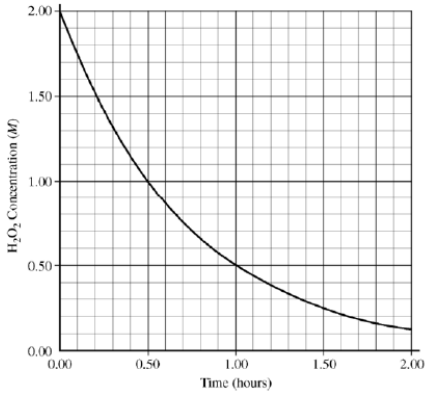
Step #3: $HOO\bullet + HO\bullet \rightarrow H_2O + O_2$ (fast)

(a) Use the proposed mechanism to write the balanced equation for this decomposition reaction.

(b) Identify all of the substances that behave as intermediates in the proposed mechanism.

(c) Write the rate law that is consistent with the proposed mechanism.

The rate of the decomposition reaction was studied in an experiment, and the resulting data were plotted in the graph shown below.



(d) Information from this graph can be used to determine if the reaction is zero-order, first-order or second-order with respect to H_2O_2.

(i) Identify the order of this reaction, based on the information in the graph.

(ii) Justify your answer, based on the information from the graph.

(e) Is the order of the reaction (as determined from the experimental data)

consistent with the rate law that was written in part (c)? _____

(f) Use the data from the graph to calculate the value of the rate constant (k) for this reaction. Include units in your answer.

(g) The decomposition of $H_2O_2(aq)$ is slow at 298 K, but adding a suitable catalyst to the solution increases the rate of the reaction. For each of the following quantities,

indicate whether its value in the catalyzed reaction at 298 K would be

higher than, lower than, or the same as

its value in the uncatalyzed reaction at 298 K.

For each prediction, justify your answer.

(i) The overall enthalpy change for the decomposition reaction, ΔH

(ii) The activation energy for the decomposition reaction, E_a

(iii) The half-life ($t_{1/2}$) of H_2O_2

(iv) The rate constant, k