Kinetics Study Guide – Multiple Choice

∴ 12.5% remains after 24 days

1. If 87.5 percent of a sample of pure ^{131}I decays in 24 days, what is the half-life of ^{131}I?
   (A) 6 days
   (B) 8 days
   (C) 12 days
   (D) 24 days

100% ① → 50% ② → 25% ③ → 12.5%

24 days total
3 half-lives

$\therefore t_{1/2} = \frac{24 \text{ days}}{3} = 8 \text{ days}$

$$X + 2Y \rightarrow Z + 3Q$$

2. For the reaction represented above, the initial rate of decrease in [X] was 2.8×10^{-3} mol L^{-1} s^{-1}. What was the initial rate of decrease in [Y]?
   (A) 7.0×10^{-4} mol L^{-1} s^{-1}
   (B) 1.4×10^{-3} mol L^{-1} s^{-1}
   (C) 2.8×10^{-3} mol L^{-1} s^{-1}
   (D) 5.6×10^{-3} mol L^{-1} s^{-1}

X : Y
1 : 2

rate Y is twice that of X $= (2.8 \times 10^{-3})(2) = 5.6 \times 10^{-3}$

3. Which of the following statements best explains why an increase in temperature of 5-10 Celsius degrees can substantially increase the rate of a chemical reaction?
   ~~(A)~~ The activation energy for the reaction is lowered. catalysts lower E_a
   (B) The number of effective collisions between particles is increased. greater # of particles w/ sufficient E
   ~~(C)~~ ΔH for the reaction is lowered.
   ~~(D)~~ ΔG for the reaction becomes more positive. > Thermodynamics does not predict speed of rxn

Step 1: $NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$

Step 2: $NO_2(g) + O(g) \rightarrow NO(g) + O_2(g)$

4. A reaction mechanism for the destruction of ozone, $O_3(g)$, is represented above. In the overall reaction, NO(g) is best described as
   (A) a catalyst - reactant then product; doesn't appear in overall eqn.
   (B) a reactant - doesn't cancel; will appear in overall eqn.
   (C) an intermediate - product then reactant
   (D) a product - doesn't cancel; will appear in overall eqn.

5. The rate law for the reaction of nitrogen dioxide and chlorine is found to be rate = $k\,[NO_2]^2[Cl_2]$. By what factor does the rate of the reaction change when the concentrations of both NO_2 and Cl_2 are doubled?
   (A) 2
   (B) 3
   (C) 6
   (D) 8

rate $= k[NO_2]^2[Cl_2]$

rate $= k(2)^2(2) = 8$

6. A kinetics experiment is set up to collect the gas that is generated when a sample of chalk, consisting primarily of solid $CaCO_3$, is added to a solution of ethanoic acid, CH_3COOH. The rate of reaction between $CaCO_3$ and CH_3COOH is determined by measuring the volume of gas generated at 25°C and 1 atm as a function of time. Which of the following experimental conditions is most likely to increase the rate of gas production?
   (A) Decreasing the volume of ethanoic acid solution used in the experiment.
   (B) Decreasing the concentration of the ethanoic acid solution used in the experiment.
   (C) Decreasing the temperature at which the experiment is performed.
   (D) Decreasing the particle size of the $CaCO_3$ by grinding it into a fine powder. smaller particles = incr. surface area = faster rxn rate

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

7. Consider the following mechanism for the reaction represented above.

   Step 1: $2\ NO \leftrightarrow N_2O_2$ (*fast reversible*)
   Step 2: $N_2O_2 + O_2 \rightarrow 2\ NO_2$ (*slow*) = rate-determining step

   Which of the following statements is true?
   ~~(A)~~ Step 1 represents a unimolecular reaction. step 1 is bimolecular
   ~~(B)~~ Increasing the concentration of NO will decrease the overall rate of the reaction. rate would increase
   ~~(C)~~ Raising the temperature will have no effect on the numerical value of the rate constant. rate constant, k, changes w/ T
   (D) The rate law that is consistent with the mechanism is *rate* = $k[NO]^2[O_2]$.
   Add up to and include slow step, use coefficients of remaining reactants for orders

   Step 1: $Cl(g) + O_3(g) \rightarrow ClO(g) + O_2(g)$
   Step 2: $ClO(g) + O(g) \rightarrow Cl(g) + O_2(g)$
   ∴ Cl is a catalyst

8. A proposed mechanism for destruction of ozone gas in the stratosphere is represented above. Which of the following is evidence that the mechanism is occurring?
   (A) The presence of Cl(g) increases the rate of the overall reaction.
   ~~(B)~~ The presence of Cl(g) decreases the rate of the overall reaction.
   (C) The presence of Cl(g) increases the equilibrium constant of the overall reaction.
   (D) The presence of Cl(g) decreases the equilibrium constant of the overall reaction.
   catalysts do not affect K_{eq}

9. If the carbon isotope ^{11}C has a half-life of 20 minutes ($t_{1/2}$), what fraction of a sample of pure ^{11}C remains after 1 hour (total time)?

   (A) $\frac{1}{4}$

   (B) $\frac{7}{30}$

   (C) $\frac{1}{8}$

   (D) $\frac{1}{16}$

$$\#\ \text{half-lives} = \frac{\text{total time}}{t_{1/2}} = \frac{60\ \text{min}}{20\ \text{min}} = 3$$

$$1 \xrightarrow[\text{Divide by 2}]{1} \frac{1}{2} \xrightarrow{2} \frac{1}{4} \xrightarrow{3} \frac{1}{8}$$

$$A + B \rightarrow C + D$$

10. The rate law for the reaction shown above is as follows: rate = k[A]. Which of the following changes to the system will increase the rate of the reaction?

I. An increase in the concentration of A. A is in the rate law, thus ↑[A] causes ↑rate

~~II.~~ An increase in the concentration of B. B is not in rate law, thus [B] doesn't affect rate

III. An increase in the temperature. causes k to increase ∴ rate increases

(A) I only
(B) I and II only
(C) I and III only
(D) I, II and III

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

11. 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 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

Which of the following correctly describes the reaction?

(A) The decomposition of N_2O_5 is zero-order reaction.
(B) The decomposition of N_2O_5 is a first-order reaction. $\ln(P_{N_2O_5})$ vs. time is linear
(C) The decomposition of N_2O_5 is a second-order reaction.
(D) The overall reaction order is 3.

Use the reaction below to answer questions 12-16.

$$A(aq) + 2\ B(aq) \rightarrow 3\ C(aq) + D(aq)$$

12. Which of the following best represents the ratio of the initial rate of appearance of C with the initial rate of disappearance of B?

(A) 1 : 2
(B) 2 : 3
(C) 3 : 1
(D) 3 : 2

C : B
3 : 2

13. Which of the following is a correct expression for the rate of the reaction above?

(A) $\frac{-\Delta[A]}{2\Delta t}$

$-\frac{1}{1}\frac{\Delta[A]}{\Delta t} = -\frac{1}{2}\frac{\Delta[B]}{\Delta t} = \frac{1}{3}\frac{\Delta[C]}{\Delta t} = \frac{1}{1}\frac{\Delta[D]}{\Delta t}$

(B) $\frac{-\Delta[B]}{\Delta t}$

(C) $\frac{\Delta[C]}{3\Delta t}$

(D) $\frac{\Delta[D]}{3\Delta t}$

14. Five trials for the reaction above were carried out at 30°C. The following data were obtained.

Experiment	$[A]_0$ (mol/L)	$[B]_0$ (mol/L)	Initial Rate of Reaction (mol/L · hr)
1	0.240	0.480	8.00
2	0.240	0.120	2.00
3	0.360	0.240	9.00
4	0.120	0.120	0.500
5	0.240	0.0600	1.00

2nd 1st ×4 ×4 2x ÷4

Which of the following is the correct rate expression for the reaction?

(A) Rate = k $[A][B]^2$
(B) Rate = k [A][B]
(C) Rate = k $[A]^2[B]$
(D) Rate = k [A]

15. What is the overall reaction order?

(A) 1
(B) 2
(C) 3
(D) 4

16. If the concentration of A was tripled and B was doubled, then how would the rate of reaction change?

(A) Rate would increase by a factor of 6.
(B) Rate would increase by a factor of 9.
(C) Rate would increase by a factor of 12.
(D) Rate would increase by a factor of 18.

$[A]^2[B]$

$(3)^2(2) = 18$