Kinetics: Multiple Choice Review Questions

1. In the rate law, Rate = $k[NO]^2[O_2]$, the reaction is _____ order for NO, _____ order for O_2, and _____ order overall.
    (a) second; first; third
    (b) second; zero; third
    (c) first; second; third
    (d) first; third; first
    (e) third; third; third

2. For the reaction $2A + B \rightarrow C$, experimental data was collected for three trials:

Experiment	[A] (M)	[B] (M)	Appearance of C ($M\ sec^{-1}$)
1	0.40	0.20	5.5×10^{-3}
2	0.80	0.20	5.5×10^{-3}
3	0.40	0.40	2.2×10^{-2}

What is the rate law of the reaction?
    (a) Rate = $k[A][B]$
    (b) Rate = $k[A]^0[B]^2$
    (c) Rate = $k[A]^2[B]^2$
    (d) Rate = $k[A]^2[B]^0$
    (e) Rate = $k[A][B]^2$

3. $2\ NO\ (g) + 2\ H_2\ (g) \rightarrow N_2\ (g) + 2\ H_2O\ (g)$

Which of the following is true regarding the relative molar rates of disappearance of the reactants and the appearance of the products?

    I. N_2 appears at the same rate that H_2 disappears.

    II. H_2O appears at the same rate that NO disappears.

    III. NO disappears at the same rate that H_2 disappears.

    (a) **I** only
    (b) **I** and **II** only
    (c) **I** and **III** only
    (d) **II** and **III** only
   (e) **I**, **II**, and **III**

4. The reaction of elemental chlorine with ozone occurs by the two-step process shown below:

I. $Cl + O_3 \rightarrow ClO + O_2$
II. $ClO + O \rightarrow Cl + O_2$
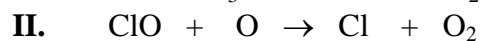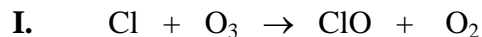
Which of the statements below is true regarding this process?
(a) Cl is a catalyst
(b) O_3 is a catalyst
(c) ClO is a catalyst
(d) O_2 is an intermediate
(e) O is an intermediate

5. The steps below represent a proposed mechanism for the catalyzed oxidation of CO by O_3.

Step 1: $NO_2 (g) + CO (g) \rightarrow NO (g) + CO_2 (g)$

Step 2: $NO (g) + O_3 (g) \rightarrow NO_2 (g) + O_2 (g)$
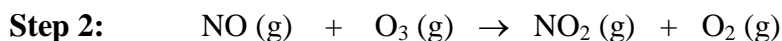
What are the overall products of the catalyzed reaction?
(a) CO_2 and O_2
(b) NO and CO_2
(c) NO_2 and O_2
(d) NO and O_2
(e) NO_2 and CO_2

6. For the reaction sequence shown in problem #5, what substance is an *intermediate* in the reaction?
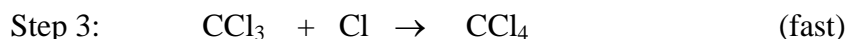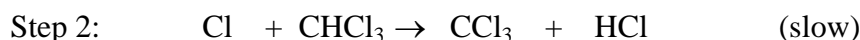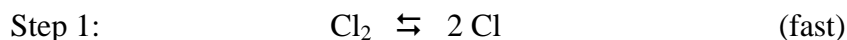(a) CO_2
(b) NO
(c) O_3
(d) NO_2
(e) CO

7. Consider the following reaction: $H_2O_2 + 2 Fe^{2+} + 2 H^{1+} \rightarrow 2 Fe^{3+} + 2 H_2O$

When the concentration of H^{1+} is doubled, there is no change in the reaction rate. This indicates
(a) the H^{1+} is a spectator ion
(b) the rate-determining step does not involve H^{1+}
(c) the reaction mechanism does not involve H^{1+}
(d) the H^{1+} is a catalyst
(e) the rate law is first order with respect to H^{1+}

8. The slow rate of a particular chemical reaction might be attributed to which of the following?
   (a) a low activation energy
   (b) a high activation energy
   (c) the presence of a catalyst
   (d) the temperature is high
   (e) the concentrations of the reactants are high

9. The mechanism below has been proposed for the reaction of $CHCl_3$ with Cl_2.

Step 1:	$Cl_2 \leftrightarrows 2\,Cl$	(fast)
Step 2:	$Cl + CHCl_3 \rightarrow CCl_3 + HCl$	(slow)
Step 3:	$CCl_3 + Cl \rightarrow CCl_4$	(fast)

   Which of the following rate laws is consistent with this proposed mechanism?
   (a) Rate = $k[Cl_2]$
   (b) Rate = $k[CHCl_3][Cl_2]$
   (c) Rate = $k\,[CHCl_3]$
   (d) Rate = $k\,[CHCl_3][Cl_2]^{-1}$
   (e) Rate = $k\,[CHCl_3]\,[Cl_2]^{1/2}$

10. The reaction $A + B \rightarrow C + D$ follows the rate law: Rate = $k\,[A]$.

    What will be the effect of decreasing the concentration of A?
    (a) The rate of the reaction will increase
    (b) More D will form
    (c) The rate of the reaction will decrease
    (d) The reaction will shift to the left
    (e) The equilibrium constant will increase

11. If 87.5% of a sample of pure ^{99}Rh decays in 48 days, what is the half-life of ^{99}Rh?
    (a) 6 days
    (b) 8 days
    (c) 12 days
    (d) 16 days
    (e) 24 days

12. The energy difference between the reactants and the transition state is
    (a) the free energy
    (b) the heat of a reaction
    (c) the activation energy
    (d) the kinetic energy
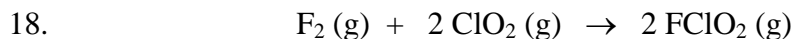   (e) the reaction energy

13. The decomposition of ammonia to its elements is a first-order reaction with a half-life of 200 seconds at a certain temperature. How much time will it take for the partial pressure of ammonia to decrease from 0.100 atm to 0.00625 atm?
    (a) 200 sec
    (b) 400 sec
    (c) 800 sec
    (d) 1000 sec
    (e) 1200 sec

14. A 100-gram sample of pure ^{37}Ar decays by electron capture with a half-life of 35 days. How long will it take for 90 grams of ^{37}Cl to accumulate?
    (a) 31 days
    (b) 39 days
    (c) 78 days
    (d) 116 days
    (e) 315 days

15. The table below gives the initial concentrations and rate for three experiments.

Experiment	[CO] (M)	[Cl$_2$] (M)	Initial Rate of COCl$_2$ (M min^{-1})
1	0.30	0.10	2.1 x 10^{-25}
2	0.10	0.30	2.1 x 10^{-25}
3	0.30	0.30	6.3 x 10^{-25}

The reaction is $CO + Cl_2 \rightarrow COCl_2$. What is the rate law for this reaction?
    (a) Rate = k[CO]
    (b) Rate = k[CO]^2[Cl$_2$]
    (c) Rate = k[Cl$_2$]
    (d) Rate = k[CO][Cl$_2$]^2
    (e) Rate = k[CO][Cl$_2$]

16. The specific rate constant, k, for radioactive beryllium-11 is 0.049 sec^{-1}. What mass of a 0.500 mg sample of beryllium-11 remains after 28 seconds?
    (a) 0.250 mg
    (b) 0.125 mg
    (c) 0.0625 mg
    (d) 0.375 mg
    (e) 0.500 mg

17. A reaction follows the rate law: Rate = k[A]^2. Which of the following plots will give a straight line?
    (a) 1/[A] versus 1/time
    (b) [A]^2 versus time
    (c) 1/[A] versus time
    (d) ln[A] versus time
    (e) [A] versus time

18. F_2 (g) + 2 ClO_2 (g) → 2 $FClO_2$ (g)

Experiment	$[F_2]$ (M)	$[ClO_2]$ (M)	Disappearance of F_2 (M sec^{-1})
1	0.10	0.010	1.2 x 10^{-3}
2	0.20	0.010	2.4 x 10^{-3}
3	0.40	0.020	9.6 x 10^{-3}

Based on these data, which expression is equal to the rate law for the reaction given above?
(a) Rate = $k[F_2]$
(b) Rate = $k[ClO_2]$
(c) Rate = $k[F_2][ClO_2]$
(d) Rate = $k[F_2]^2[ClO_2]$
(e) Rate = $k[F_2] [ClO_2]^2$

19. Use the kinetics data provided in the previous problem to answer this question. What is the rate of
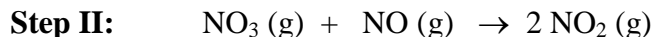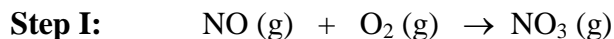disappearance of ClO_2 in Experiment #2?
(a) 1.2 x 10^{-3} M sec^{-1}
(b) 2.4 x 10^{-3} M sec^{-1}
(c) 4.8 x 10^{-3} M sec^{-1}
(d) 7.0 x 10^{-3} M sec^{-1}
(e) 9.6 x 10^{-3} M sec^{-1}

20. If a tree dies and the trunk remains undisturbed for 15,580 years, what percentage of the original
carbon-14 is still present? The half-life of carbon-14 is 5730 years.
(a) 5.20%
(b) 19.0%
(c) 2.20%
(d) 45.0%
(e) 15.2%

21.   2 NO (g) + O_2 (g) → 2 NO_2 (g)
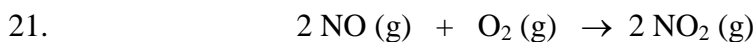
The reaction above occurs by the following two-step process:

    Step I: NO (g) + O_2 (g) → NO_3 (g)

    Step II: NO_3 (g) + NO (g) → 2 NO_2 (g)

Which of the following is true of Step II if it is the rate-limiting step?
(a) Step II has a lower activation energy and occurs more slowly than Step I.
(b) Step II has a higher activation energy and occurs more slowly than Step I.
(c) Step II has a lower activation energy and occurs more quickly than Step I.
(d) Step II has a higher activation energy and occurs more quickly than Step I.
(e) Step II has the same activation energy and occurs at the same speed as Step I.