CHEMISTRY 1220

CHAPTER 14 PRACTICE EXAM

1. Under certain conditions, the average rate of *appearance* of oxygen gas in the reaction

$$2O_3(g) \rightarrow 3O_2(g)$$

is 1.2×10^{-3} atm·s^{-1}. What is the average rate, expressed in atm·s^{-1}, for the *disappearance* of O_3?

(A) 8.0×10^{-4} (B) 1.2×10^{-3} (C) 1.8×10^{-3} (D) 5.3×10^{-3} (E) 3.6×10^{-3}

2. The rate law for the reaction

$$H_2O_2 + 2H^+ + 2I^- \rightarrow I_2 + 2H_2O$$

is rate = $k[H_2O_2][I^-]$. The overall order of the reaction is

(A) five. (B) three. (C) two. (D) one.

(E) cannot be determined without knowing the order with respect to H^+.

3. For the reaction of chlorine and nitric oxide,

$$2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)$$

doubling the concentration of chlorine doubles the rate of reaction. Doubling the concentration of both reactants increases the rate of reaction by a factor of eight. The reaction is

(A) first order in both NO and Cl_2
(B) first order in NO and second order in Cl_2
(C) first order in NO, Cl_2, and NOCl
(D) second order in NO and first order in Cl_2
(E) second order in both NO and Cl_2

4. The reaction between ethyl bromide (C_2H_5Br) and hydroxide ion (OH^-) in ethyl alcohol at 330 K is first order each in ethyl bromide and hydroxide ion.

$$C_2H_5Br(alc) + OH^-(alc) \rightarrow C_2H_5OH(l) + Br^-(alc)$$

How would the rate of ethyl bromide change if the solution were diluted by adding an equal volume of pure ethyl alcohol to the solution?

(A) no change
(B) decrease by a factor of two
(C) increase by a factor of four
(D) increase by a factor of two
(E) decrease by a factor of four

5. The gas-phase reaction, $A_2 + B_2 \rightarrow 2AB_2$, proceeds by bimolecular collisions between A_2 and B_2 molecules. If the concentration of A_2 and B_2 are doubled, the reaction rate will change by a factor of

   (A) ½ (B) $\sqrt{2}$ (C) 2 (D) 4 (E) 16

6. The half-life for the first order conversion of cyclobutane to ethylene,

   $$C_4H_8(g) \rightarrow 2C_2H_4(g)$$

   is 22.7 seconds. How many seconds are needed for the partial pressure of cyclobutane to decrease from 100 mmHg to 10 mmHg?

   (A) 52.0 s (B) 75.4 s (C) 90.0 s (D) 204 s (E) 227 s

7. Which function of the concentration of X, plotted against time, will give a straight line for a second order reaction?

   (A) [X] (B) $[X]^2$ (C) ln [X] (D) $1/[X]$ (E) $1/[X]^2$

8. The reaction between acetone and bromine in acid solution is represented by the equation

   $CH_3OCH_3(aq) + Br_2(aq) + H_3O^+(aq) \rightarrow$ products

   The tabulated kinetic data were gathered. Based on these data, the experimental rate law is

Initial Concentrations, M; Initial Rates, $M \cdot s^{-1}$				
Exp	CH_3OCH_3	Br_2	H_3O^+	Rate
1	0.30	0.050	0.050	5.8×10^{-5}
2	0.30	0.100	0.050	5.8×10^{-5}
3	0.30	0.050	0.100	1.2×10^{-4}
4	0.40	0.050	0.200	3.2×10^{-4}

   (A) rate = $k[CH_3OCH_3]^1[Br_2]^1[H_3O^+]^1$
   (B) rate = $k[CH_3OCH_3]^1[Br_2]^0[H_3O^+]^2$
   (C) rate = $k[CH_3OCH_3]^0[Br_2]^0[H_3O^+]^2$
   (D) rate = $k[CH_3OCH_3]^1[Br_2]^1[H_3O^+]^0$
   (E) rate = $k[CH_3OCH_3]^1[Br_2]^0[H_3O^+]^1$

9. A change in temperature from 10 ˚C to 20 ˚C is found to double the rate of a particular chemical reaction. How did the change in temperature affect the reacting molecules?

(A) The average velocity of the molecules doubled.
(B) The average kinetic energy of the molecules doubled.
(C) The number of collisions per second doubled.
(D) The number of molecules above the reaction energy threshold doubled.
(E) The collision orientation of the molecules was twice as favorable.

10. The data below show the concentration of cylcobutane(C_4H_8) for the following reaction.

$$C_4H_8(g) \rightarrow 2C_2H_4(g)$$

[redacted]	
0	1.000
10	0.894
20	0.799
30	0.714
40	0.638
50	0.571
60	0.510
70	0.456
80	0.408
90	0.364
100	0.326

The reaction is
(A) zero order. (B) ½ order. (C) first order. (D) second order. (E) third order.

11. The value for the rate constant of a reaction can generally be expected to

(A) decrease with increasing temperature.
(B) increase with increasing temperature.
(C) increase with increasing temperature only when the reaction is exothermic.
(D) increase with increasing temperature only when the reaction is endothermic.
(E) decrease with increasing temperature only when the reaction is exothermic.

12. Consider the reaction

$$Cl_2(aq) + H_2S(aq) \rightarrow S(s) + 2H^+(aq) + 2Cl^-(aq)$$

The rate equation for this reaction is

$$\text{rate} = k[Cl_2][H_2S]$$

Which of these mechanisms is (or are) consistent with the rate equation?

I $Cl_2 + H_2S \rightarrow H^+ + Cl^- + Cl^+ + HS^-$ (slow)

$Cl^+ + HS^- \rightarrow H^+ + Cl^- + S$ (fast)

II $H_2S \leftrightarrow H^+ + HS^-$ (fast equilibrium)

$Cl_2 + HS^- \rightarrow 2\ Cl^- + H^+ + S$ (slow)

(A) **I** only (B) **II** only (C) Both **I** and **II** (D) Neither **I** or **II**

13. A certain reaction has a $\Delta H = -75$ kJ and an activation energy of 40 kJ. A catalyst is found to that lowers the activation energy of the forward reaction by 15 kJ. What is the activation energy of the reverse reaction in the presence of the same catalyst?

(A) 25 kJ (B) 60 kJ (C) 80 kJ (D) 90 kJ (E) 100 kJ

14. The decomposition of hydrogen peroxide in the presence of iodide ion is believed to occur via this mechanism.

$H_2O_2(aq) + I^-(aq) \rightarrow H_2O(l) + IO^-(aq)$
$H_2O_2(aq) + IO^-(aq) \rightarrow H_2O(l) + O_2(g) + I^-(aq)$

In this mechanism $I^-(aq)$ is best described to be

(A) a catalyst (B) a reactant in the overall reaction

(C) the transition state (D) a product of the overall reaction

(E) the activated complex

15. Consider the reaction $4\ PH_3(g) \rightarrow P_4(g) + 6\ H_2(g)$. The rate of consumption of PH_3 is 2.4×10^{-3} M/min. What are the rates of production of P_4 and H_2?

a) 1.2×10^{-3} M/min, 6.0×10^{-4} M/min
b) 2.4×10^{-3} M/min, 6.0×10^{-4} M/min
c) 2.4×10^{-3} M/min, 1.2×10^{-4} M/min
d) 6.0×10^{-4} M/min, 3.6×10^{-3} M/min
e) 4.8×10^{-3} M/min, 6.0×10^{-3} M/min

16. Using the format given in your text, which of the following rate equalities is correct for the following reaction?

$$4\ NH_3(g) + 7\ O_2(g) \rightarrow 4\ NO_2(g) + 6\ H_2O(g)$$

a) $\frac{1}{4}\frac{\Delta[NH_3]}{\Delta t} = \frac{1}{7}\frac{\Delta[O_2]}{\Delta t}$

b) $-\frac{1}{4}\frac{\Delta[NO_2]}{\Delta t} = -\frac{1}{6}\frac{\Delta[H_2O]}{\Delta t}$

c) $-\frac{1}{6}\frac{\Delta[H_2O]}{\Delta t} = -7\frac{\Delta[O_2]}{\Delta t}$

d) $-\frac{1}{7}\frac{\Delta[O_2]}{\Delta t} = \frac{1}{6}\frac{\Delta[H_2O]}{\Delta t}$

e) $-\frac{1}{4}\frac{\Delta[NH_3]}{\Delta t} = -\frac{1}{4}\frac{\Delta[NO_2]}{\Delta t}$

Answer: D

17. The following rate data were obtained at 37^0C for the following reaction.
What is the rate law expression for the reaction?

$$2\ MnO_4^{2-}(aq) + H_3IO_6^{2-}(aq) \rightarrow 2\ MnO_4^{-}(aq) + IO_3^{-}(aq) + 3\ OH^{-}(aq)$$

Exp.	$[MnO_4^{2-}]$	$[H_3IO_6^{2-}]$	Rate (M/min)
1	3.20×10^{-4}	6.20×10^{-4}	2.6×10^{-6}
2	1.28×10^{-3}	6.20×10^{-4}	4.1×10^{-5}
3	3.20×10^{-4}	1.24×10^{-3}	2.6×10^{-6}

a) rate = $k[MnO_4^{2-}]^2$
b) rate = $k[MnO_4^{2-}]^2[H_3IO_6^{2-}]^2$
c) rate = $k[MnO_4^{2-}][H_3IO_6^{2-}]$
d) rate = $k[MnO_4^{2-}]^2[H_3IO_6^{2-}]$
e) rate = $k[MnO_4^{2-}][H_3IO_6^{2-}]^2$

Answer: A

18. A reaction was found to be second order in carbon monoxide concentration. If the concentration of carbon monoxide is tripled, the rate of the reaction
a) remains unchanged
b) doubles
c) triples
d) increases by a factor of 9
e) increases by a factor of 4

19. A reaction is zero order in [A] and the rate constant is 4.68×10^{-3} M s^{-1}. The concentration of A is 0.295 M at 6.25 minutes. What was the original concentration of A? Assume a = 1.

a) 0.478 M
b) 2.05 M
c) 8.45 M
d) 0.925 M
e) 17.8 M

20. A plot of 1/concentration of A (M^{-1}) vs time (min) gave a straight line with the following formula: y = 0.20x + 2.0. Which of the following is the correct expression for the rate law? Assume a =1.

a) Rate = 0.2 M^{-1} min^{-1}
b) Rate = 0.2 M^{-1} min^{-1} [A]
c) Rate = -0.2 M^{-1} min^{-1} [A]
d) Rate = 0.2 M^{-1} min^{-1} $[A]^2$
e) Rate = -0.2 M^{-1} min^{-1} $[A]^2$

21. The half life of a first order reaction is 44.4 seconds. What is the first order rate constant (s^{-1})? (Assume a =1)

a) $6.56 \times 10^{-3}\ s^{-1}$
b) $9.10 \times 10^{-3}\ s^{-1}$
c) $1.56 \times 10^{-2}\ s^{-1}$
d) $1.25 \times 10^{-1}\ s^{-1}$
e) $2.25 \times 10^{-2}\ s^{-1}$

22. The gas phase decomposition of NOBr is second order in [NOBr], with $k = 1.62 \times 10^{-2}\ M^{-1}\ s^{-1}$ at 20°C. If the initial concentration (M) of NOBr was 2.91×10^{-3} M and the concentration of NOBr remaining is 2.75×10^{-3} M NOBr, how much time (minutes) has passed?

$$2\ NOBr(g) \rightarrow N_2(g) + O_2(g) + Br_2(g)$$

a) 0.945 minutes
b) 1.65 minutes
c) 3.56 minutes
d) 7.48 minutes
e) 10.3 minutes

23. In 6 M HCl, the complex ion, $Ru(NH_3)_6^{3+}$ decomposes to a variety of products. The reaction is first order in $Ru(NH_3)_6^{3+}$ and has a half life of 14 hours at 250C. Under these conditions, how long will it take for $Ru(NH_3)_6^{3+}$ to decrease to 12.5% of its initial value?

a) 28 hours b) 35 hours c) 2.7 hours d) 14 hours e) 42 hours

24. The energy of activation of a first order reaction is 105 kJ/mole. The rate constant is $3.54 \times 10^{-5}\ s^{-1}$ at 45^0C. What is the rate constant at 60^0C?

a) $4.24 \times 10^{-5}\ s^{-1}$
b) $6.75 \times 10^{-5}\ s^{-1}$
c) $1.02 \times 10^{-4}\ s^{-1}$
d) $1.50 \times 10^{-4}\ s^{-1}$
e) $2.12 \times 10^{-4}\ s^{-1}$

25. The rate of a reaction depends on

a) collision frequency b) collision energy c) collision orientation d) none of the above
e) all of the above

26. The activation energy of a reaction is given by

a) +(slope of a plot of ln k vs 1/T) / R
b) -(slope of a plot of ln k vs 1/T) (R)
c) +(slope of a plot of ln k vs 1/T) (R)
d) -(slope of a plot of ln k vs 1/T) / R
e) –R / (slope of a plot of ln k vs 1/T)

27. Ozone is believed to decompose according to the following mechanism. What would be the rate expression if the mechanism is correct?

$$2\ O_3(g) \rightarrow 3\ O_2(g) \text{ (balanced equation)}$$
$$O_3 \rightarrow O_2 + O \text{ (fast)}$$
$$O_3 + O \rightarrow 2\ O_2 \text{ (slow)}$$

a) rate = $k[O_2]^2$
b) rate = $k[O_3]^2/[O_2]$
c) rate = $k[O_2]$
d) rate = $k[O_3]^2[O]$
e) rate = $k\ [O_3]^2$

28. Chymotrypsin assists in digestion by breaking proteins down into smaller peptides. However, this process is not as efficient in the presence of 2-phenylethyl boronic acid. Which of the following responses identifies the correct order of Inhibitor, Substrate, Enzyme

a) Chymotrypsin, 2-phenylethyl boronic acid, proteins
b) 2-phenylethyl boronic acid, proteins, Chymotrypsin
c) proteins, Chymotrypsin, 2-phenylethyl boronic acid
d) 2-phenylethyl boronic acid, Chymotrypsin, proteins
e) Chymotrypsin, proteins, 2-phenylethyl boronic acid

29. The following mechanism is proposed:

$$SO_3^{2-}(aq) + H^+(aq) \leftrightarrows HSO_3^-(aq) \quad \text{(fast)}$$

$$BrO_3^-(aq) + HSO_3^-(aq) \rightarrow SO_4^{2-}(aq)\ \ HBrO_2(aq) \quad \text{(slow)}$$

$$HBrO_2(aq) + SO_3^{2-}(aq) \leftrightarrows HBrO(aq) + SO_4^{2-}(aq) \quad \text{(fast)}$$

$$HBrO(aq) + SO_3^{2-}(aq) \leftrightarrows SO_4^{2-}(aq) + H^+(aq) + Br^-(aq) \quad \text{(fast)}$$

Which of the following statements is incorrect about this mechanism?

a) H^+ is the catalyst for the mechanism.
b) HSO_3^-, $HBrO_2$ and HBrO are intermediates.
c) The rate law is: Rate = $k[BrO_3^-][H^+][SO_3^{2-}]$
d) The overall reaction is: $3\ SO_3^{2-}(aq) + BrO_3^-(aq) \leftrightarrows 2\ SO_4^{2-}(aq) + Br^-(aq)$
e) The rate-determining step has the highest activation energy.

Answer: D