Chapter 13 Exam Pool Questions

1. At a constant temperature, which of the following would be expected to affect the rate of a given chemical reaction?

   1. The reaction temperature

   2. The concentration of the reactants

   3. A catalyst

   a) 1 only
   b) 2 only
   c) 3 only
   d) 2 and 3 only
   e) 1, 2, and 3

2. For the reaction
   $IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \rightarrow 3I_2(aq) + 3H_2O(l)$

   the rate of disappearance of $I^-(aq)$ at a particular time and concentration is 2.7×10^{-3} mol/(L · s). What is the rate of appearance of $I_2(aq)$?

   a) -1.6×10^{-3} mol/(L · s)
   b) 8.1×10^{-3} mol/(L · s)
   c) 1.6×10^{-3} mol/(L · s)
   d) 4.5×10^{-3} mol/(L · s)
   e) 6.2×10^{-3} mol/(L · s)

3. For the reaction
   $6CH_2O(aq) + 4NH_3(aq) \rightarrow (CH_2)_6N_4(aq) + 6H_2O(l)$

   the rate of the reaction may be expressed as $\frac{1}{6} \times \frac{\Delta[H_2O]}{\Delta t}$. What is an equivalent expression for the rate of the reaction?

   a) $\frac{1}{2} \times \frac{\Delta[(CH_2)_6N_4]}{\Delta t}$
   b) $6 \times \frac{\Delta[CH_2O]}{\Delta t}$
   c) $-6 \times \frac{\Delta[CH_2O]}{\Delta t}$
   d) $-\frac{1}{4} \times \frac{\Delta[NH_3]}{\Delta t}$
   e) $-\frac{1}{6} \times \frac{\Delta[H_2O]}{\Delta t}$

4. For the reaction of the ammonium ion with nitrous acid, the net reaction is
$NH_4^+(aq) + HNO_2(aq) \rightarrow N_2(g) + 2H_2O(l) + H^+(aq)$

If the initial concentration of nitrous acid is 1.00 *M* and, after 42.6 s has elapsed, the concentration of nitrous acid has fallen to 0.88 *M*, what is the average rate of the reaction over this time interval?

a) 0.021 *M*/s
b) –0.021 *M*/s
c) –0.0028 *M*/s
d) 0.044 *M*/s
e) 0.0028 *M*/s

5. Consider the reaction
$aA + bB \xrightarrow{C} dD + eE$ C = catalyst

The rate law is

Rate = $k[A]^q[B]^r[C]^s$

Which of the following statements is <u>incorrect</u>?

a) The exponents *q*, *r*, and *s* are often integers.
b) The exponents *q* and *r* are always equal to the coefficients *a* and *b*, respectively.
c) The exponent s must be determined experimentally.
d) The symbol *k* represents the rate constant.
e) The overall reaction order is $q + r + s$.

6. For a certain second-order decomposition reaction, the rate is 0.44 mol/(L · s) when the concentration of the reactant is 0.37 mol/L. What is the rate constant for this reaction?
a) 1.19 L/(mol · s)
b) 0.44 L/(mol · s)
c) 0.31 L/(mol · s)
d) 0.84 L/(mol · s)
e) 3.2 L/(mol · s)

7. A rate constant for a particular reaction is 0.0020 s^{-1}. What is the overall order of this reaction?
a) 0
b) 1
c) 2
d) 3
e) 4

8. The reaction
$2H_2(g) + 2NO(g) \rightarrow 2H_2O(g) + N_2(g)$

is first-order in H_2 and second-order in NO at a particular temperature. What is the rate law?

a) Rate = $k[H_2][NO]$
b) Rate = $k[H_2]^2[NO]^2$
c) Rate = $k[H_2][NO]^2$
d) Rate = $k[H_2]^2[NO]$
e) Rate = $k[H_2O]^2[N_2]$

9. The following data were obtained for the hypothetical reaction $2A + B \rightarrow$ products.

$[A]_0$ (*M*)	$[B]_0$ (*M*)	Initial Rate (*M*/s)
0.2	0.1	5
0.2	0.2	20
0.6	0.1	45

What is the overall order of this reaction?

a) 0
b) 1/2
c) 1
d) 3
e) 4

10. At a given temperature, a first-order reaction has a rate constant of 2.8×10^{-3} s^{-1}. How long will it take for the reaction to be 29% complete?

a) 440 s
b) 53 s
c) 1500 s
d) 120 s
e) 1200 s

11. The radioactive nuclide ^{63}Ni decays by a first-order process via the emission of a beta particle. The ^{63}Ni nuclide has a half-life of 100. years. How long will it take for 93% of ^{63}Ni to decay?

a) 10 years
b) 1.8 years
c) 170 years
d) 4.5 years
e) 380 years

12. A reaction that is second-order in one reactant has a rate constant of 2.0×10^{-2} L/(mol · s). If the initial concentration of the reactant is 0.340 mol/L, how long will it take for the concentration to become 0.170 mol/L?

a) 35 s
b) 74 s
c) 150 s
d) 1500 s
e) 350 s

13. For the hypothetical first-order reaction A → products, $k = 0.0782\ s^{-1}$. If the initial concentration of A is 0.852 *M*, how long would it take for A to be 12.1% consumed?

a) 1.65 s

b) 12.8 s

c) 8.86 s

d) 27.0 s

e) 15.0 s

14. The half-life of a reaction is

a) how long the reaction can run before stopping.

b) the time it takes for the reactant concentration to decrease to one-half of its initial value.

c) the time it takes for the amount of product formed to equal half the initial amount of reactant.

d) one-half of the time the reaction will take to go to completion.

e) twice as long for a second-order reaction as it is for a first-order reaction.

15. The reaction $3NO \rightarrow N_2O + NO_2$ is found to obey the rate law Rate = $k[NO]^2$. If the first half-life of the reaction is found to be 2.0 s, what is the length of the fourth half-life?

a) 2.0 s

b) 4.0 s

c) 8.0 s

d) 12.0 s

e) 16.0 s

16. In a first-order reaction, the half-life is 144 minutes. What is the rate constant?

a) $8.02 \times 10^{-5}\ s^{-1}$

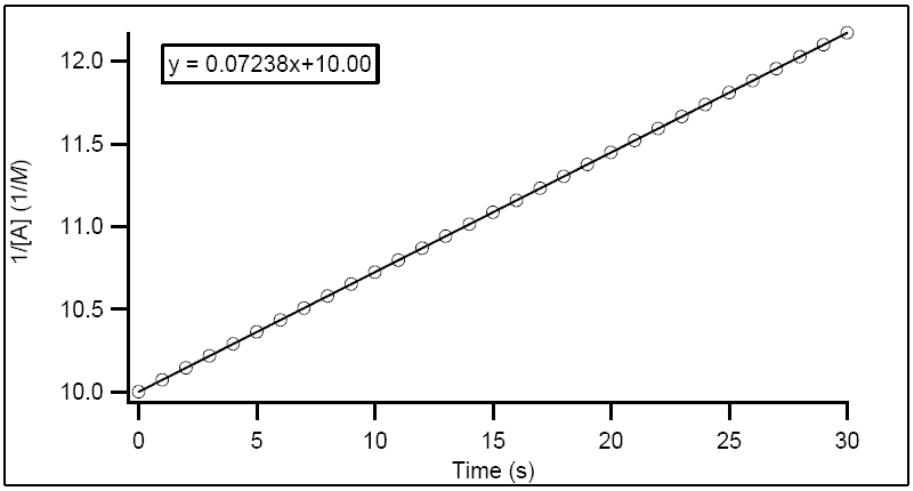
b) $1.16 \times 10^{-4}\ s^{-1}$

c) $5990\ s^{-1}$

d) $0.289\ s^{-1}$

e) $4.81 \times 10^{-3}\ s^{-1}$

17. For the hypothetical reaction A → products, the concentration of A was monitored with time. From the following graph, what is the rate constant for the decomposition of A?



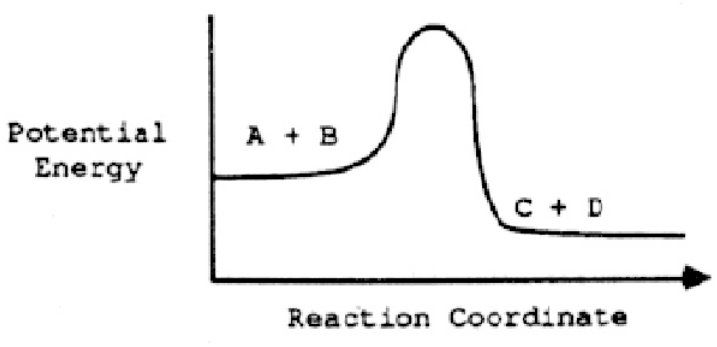
a) 10.00 M^{-1} s^{-1}
b) –10.00 M^{-1} s^{-1}
c) 0.07238 M^{-1} s^{-1}
d) –0.07238 M^{-1} s^{-1}
e) 0.007238 M^{-1} s^{-1}

18. Which of the following statements best describes the condition(s) needed for a successful formation for a product according to the collision model?
a) The collision must involve a sufficient amount of energy, provided from the motion of the particles, to overcome the activation energy.
b) The relative orientation of the particles has little or no effect on the formation of the product.
c) The relative orientation of the particles has an effect only if the kinetic energy of the particles is below some minimum value.
d) The relative orientation of the particles must allow for formation of the new bonds in the product.
e) The energy of the incoming particles must be above a certain minimum value, and the relative orientation of the particles must allow for formation of new bonds in the product.

19. What would happen if the kinetic energy of the reactants were not enough to provide the needed activation energy?
a) The products would be produced at a lower energy state.
b) The rate of the reaction would tend to increase.
c) The activated complex would be converted into products.
d) The reactants would continue to exist in their present form.
e) The products would form at an unstable energy state.

20. When the concentrations of the reactants are increased, the rate of the reaction increases. This is best explained by
a) an increase in the fraction of molecules that have enough energy to react.
b) an increase in the frequency of the molecular collisions.
c) an increase in the rate constant.
d) an increase in the kinetic energy of the molecules.
e) an increase in the average potential energy of the molecules.

21. The potential-energy diagram below describes the hypothetical reaction A + B → C + D.



Which of the following statements is correct?

a) The forward reaction is endothermic.
b) The activation energy for the forward reaction is greater than that for the reverse reaction.
c) The activation energy for the reverse reaction is less than zero.
d) The effect of a temperature change is greater for the reverse reaction than for the forward reaction.
e) A and B are lower in energy than C and D.

22. For the first-order reaction
$\frac{1}{2}N_2O_4(g) \rightarrow NO_2(g)$; $\Delta H = 28.6$ kJ

the activation energy is 53.7 kJ/mol. What is the activation energy for the reverse reaction?

a) 25.1 kJ/mol
b) 15.2 kJ/mol
c) 53.7 kJ/mol
d) 82.3 kJ/mol
e) -53.7 kJ/mol

23. The rate constant for a first-order reaction is 1.8×10^{-2} s^{-1} at 690 K and 3.6×10^{-2} s^{-1} at 876 K. What is the activation energy? R = 8.31 J/(mol•K)

a) 8.1 kJ/mol
b) 19 kJ/mol
c) 2300 kJ/mol
d) 18 kJ/mol
e) 8 kJ/mol

24. For the first-order reaction
$\frac{1}{2}N_2O_4(g) \rightarrow NO_2(g)$; $\Delta H = 28.6$ kJ

the rate constant is $k = 4.64 \times 10^5$ s^{-1} at –3°C, and the activation energy is 53.7 kJ/mol. What is the rate constant at 21°C?

a) 8.71×10^5 s^{-1}
b) 3.27×10^6 s^{-1}
c) 4.64×10^5 s^{-1}
d) 5.05×10^5 s^{-1}
e) 3.96×10^4 s^{-1}

25. Which of the following statements is <u>not</u> a requirement for a valid reaction mechanism?
    a) The elementary reactions of a mechanism must add up to the net chemical reaction.
    b) The rate law predicted by a mechanism must agree with the experimental rate law.
    c) Each elementary reaction must be bimolecular.
    d) A mechanism must have only one rate-determining step.
    e) There must not be net production of any intermediates.

26. A proposed mechanism for the decomposition of N_2O_5 is as follows:

$N_2O_5 \xrightarrow{k_1} NO_2 + NO_3$ slow step

$NO_2 + NO_3 \xrightarrow{k_2} NO_2 + O_2 + NO$ fast step

$NO + N_2O_5 \xrightarrow{k_3} 3NO_2$ fast step

What is the overall chemical equation predicted by this mechanism?

    a) $N_2O_5 \rightarrow NO_2 + NO_3$
    b) $N_2O_5 \rightarrow NO_2 + O_2 + NO$
    c) $N_2O_5 + NO_2 + NO_3 \rightarrow 4NO_2 + O_2$
    d) $2N_2O_5 \rightarrow 4NO_2 + O_2$
    e) $N_2O_5 + NO \rightarrow 3NO_2$

27. Determine the molecularity of the following elementary reaction: $O_3 \rightarrow O_2 + O$.
    a) unimolecular
    b) bimolecular
    c) termolecular
    d) quadmolecular
    e) cannot be determined

28. Which of the following statements is <u>incorrect</u>?
    a) Chemical reactions involve collisions between the participating molecules.
    b) A three-body collision is less likely than a two-body collision.
    c) The slow step in a mechanism generally involves a three-body collision.
    d) Most collisions between reactant molecules do not lead to a product.
    e) After the addition of a catalyst, the collision rate between molecules is still the same.

29. A proposed mechanism for the decomposition of N_2O_5 is as follows:

$N_2O_5 \xrightarrow{k_1} NO_2 + NO_3$ slow step

$NO_2 + NO_3 \xrightarrow{k_2} NO_2 + O_2 + NO$ fast step

$NO + N_2O_5 \xrightarrow{k_3} 3NO_2$ fast step

What is the rate law predicted by this mechanism?

a) Rate = $k_1[N_2O_5]$
b) Rate = $k_2[NO_2][NO_3]$
c) Rate = $k_3[NO][N_2O_5]$
d) Rate = $k_1k_2[N_2O_5][NO_2][NO_3]$
e) Rate = $k_1k_2k_3[N_2O_5]^2$

30. In a chemical reaction at constant temperature, the addition of a catalyst
a) affects the equilibrium constant.
b) increases the fraction of molecules with more than a given kinetic energy.
c) decreases the energy released in the chemical reaction.
d) increases the concentration of the products at equilibrium.
e) provides an alternative reaction pathway with a different activation energy.

ANSWERS

Question	Answer
1	e
2	c
3	d
4	e
5	b
6	e
7	b
8	c
9	e
10	d
11	e
12	c
13	a
14	b
15	e
16	a
17	c
18	e
19	d
20	b
21	d
22	a
23	b
24	b
25	c
26	d
27	a
28	c
29	a
30	e