1. In the reaction
2NO₂ → 2NO + O₂
at 300°C, [NO₂] drops from 0.0100 to 0.00650 M in 100 s. The rate of disappearance of NO₂ for this period is ________ M/s.
   a. 0.35
   b. 0.0035
   c. 0.000035
   d. 0.0070
   e. 0.0018

2. A reaction was found to be second order in carbon monoxide concentration. The rate of the reaction ________ if the concentration of carbon monoxide is doubled with everything else kept the same.
   a. doubles
   b. remains unchanged
   c. triples
   d. increases by a factor of 4
   e. is reduced by a factor of 2.

3. The rate law of a reaction is rate = k[A]^x. The units of k, if the reaction is second order in A, are ________.
   a. M/s
   b. M⁻¹s⁻¹
   c. 1/s
   d. 1/M
   e. s/M²

4. A reaction was found to be third order in A. Increasing the concentration of A by a factor of 3 will cause the reaction rate to ________.
   a. remain constant
   b. increase by a factor of 27
   c. increase by a factor of 9
   d. triple
   e. decrease by a factor of the cube root of 3

   \[ \text{rate} = k [A]^3 \]
   \[ (3)^3 = 27 \]
5. Using the information below, the rate constant for the following reaction is ______ M⁻¹s⁻¹.

\[ A + B \rightarrow P \]

<table>
<thead>
<tr>
<th>Experiment Number</th>
<th>[A] (M)</th>
<th>[B] (M)</th>
<th>Initial Rate (M/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.273</td>
<td>0.763</td>
<td>2.83</td>
</tr>
<tr>
<td>2</td>
<td>0.273</td>
<td>1.526</td>
<td>2.83</td>
</tr>
<tr>
<td>3</td>
<td>0.819</td>
<td>0.763</td>
<td>25.47</td>
</tr>
</tbody>
</table>

(a) 38.0
(b) 0.278
(c) 13.2
(d) 42.0
(e) 2.21

6. The rate constant for a particular reaction is \(1.3 \times 10^{-4} \text{ M}^{-1} \text{s}^{-1}\) at 100°C, and \(1.1 \times 10^{-3} \text{ M}^{-1} \text{s}^{-1}\) at 150°C. What is the overall order of the reaction?

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

7. The rate constant for a particular reaction is \(1.3 \times 10^{-4} \text{ M}^{-1} \text{s}^{-1}\) at 150°C, and \(1.1 \times 10^{-3} \text{ M}^{-1} \text{s}^{-1}\) at 200°C. What is the energy of activation for this reaction at 250°C?

(a) 132
(b) 56
(c) 99
(d) 71
(e) 22

8. The reaction

\[ \text{CH}_3-\text{N}≡\text{C} \rightarrow \text{CH}_3-\text{C}≡\text{N} \]

is a first-order reaction. At 230.3°C, \(k = 6.29 \times 10^{-4} \text{ s}^{-1}\). If \[[\text{CH}_3-\text{N}≡\text{C}]_0 = 0.00100 \text{ M, [CH}_3-\text{C}≡\text{N}] \text{ in M after } 1.000 \times 10^3 \text{ s} \text{ is} \]

\[ \ln [A]_t = -kt + \ln [A]_0 \]

\[ \ln [A]_t = (-6.29 \times 10^{-4})(1.000 \times 10^3 t) + \ln [0.00100] \]

\[ \ln [A]_t = -7.5367 \ldots \]

\[ [A]_t = e^{-7.5367} = 5.33 \times 10^{-4} \text{ M} \]
9. The rate constant for a second-order reaction is 0.13 M\(^{-1}\)s\(^{-1}\). If the initial concentration of reactant is 0.26 mol/L, it takes __________ s for the concentration to decrease to 0.13 mol/L.

a. 0.017  
b. 0.50  
c. 1.0  
d. 30  
e. 4.4 \times 10^{-3}

10. The half-life of a first-order reaction is 13 min. If the initial concentration of reactant is 0.085 M, it takes __________ min for it to decrease to 0.055 M.

a) 8.2  
b. 11  
c. 3.6  
d. 0.048  
e. 8.4

11. The reaction A -> B is first order in [A]. Using the data below, the rate constant for this reaction is __________ s\(^{-1}\).

<table>
<thead>
<tr>
<th>time (s)</th>
<th>[A] (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>1.60</td>
</tr>
<tr>
<td>5.0</td>
<td>0.80</td>
</tr>
<tr>
<td>10.0</td>
<td>0.40</td>
</tr>
<tr>
<td>15.0</td>
<td>0.20</td>
</tr>
<tr>
<td>20.0</td>
<td>0.10</td>
</tr>
</tbody>
</table>

a. 0.013  
b. 0.030  
c. 0.14  
d. 3.0  
e. 3.1 \times 10^{-3}

12. The rate constant of a first-order process that has a half-life of 225 s is __________ s\(^{-1}\).

a. 0.693  
b. 3.08 \times 10^{-3}  
c. 1.25  
d. 12.5  
e. 4.44 \times 10^{-3}
13. One difference between first and second-order reactions is that
   a. the half-life of a first-order reaction does not depend on \([A]_0\); the half-life of a second-order reaction does depend on \([A]_0\)
   b. the rate of a first-order reaction does not depend on reactant concentrations; the rate of a second-order reaction does depend on reactant concentrations
   c. the rate of a first-order reaction depends on reactant concentrations; the rate of a second-order reaction does not depend on reactant concentrations
   d. a first-order reaction can be catalyzed; a second-order reaction cannot be catalyzed
   e. the half-life of a first-order reaction depends on \([A]_0\); the half-life of a second-order reaction does not depend on \([A]_0\)

14. As the temperature of a reaction is increased, the rate of the reaction increases because the 
   a. reactant molecules collide less frequently
   b. reactant molecules collide with greater energy per collision
   c. activation energy is lowered
   d. reactant molecules collide less frequently and with greater energy per collision
   e. reactant molecules collide more frequently with less energy per collision

15. In the potential energy profile of a reaction, the species that exists at the maximum on the curve is called the 
   a. product
   b. activated complex
   c. activation energy
   d. enthalpy of reaction
   e. atomic state

16. The activation energy of a first-order reaction that has a rate constant of \(4.41 \times 10^{-3}\text{s}^{-1}\) at 351K and rate constant of \(9.79 \times 10^{-2}\text{s}^{-1}\) 588K is 
   a. 2.67
   b. 2.90
   c. 0.0589
   d. 22.4
   e. 0.450

17. The stoichiometric equations and rate laws for several reactions are given below. Of these, only— could represent an elementary step.
   a. \(2A \rightarrow P\) 
      \(\text{rate} = k[A]\)
   b. \(A + B \rightarrow P\) 
      \(\text{rate} = k[A][B]\)
   c. \(A + 2B \rightarrow P\) 
      \(\text{rate} = k[A][B]^2\)
   d. \(A + B + C \rightarrow P\) 
      \(\text{rate} = k[A][C]\)
   e. \(A + 2B \rightarrow P\) 
      \(\text{rate} = k[A][B]\)
18. The stoichiometric equation for a reaction is:

\[ 2A + 2B \rightarrow C \]

The mechanism for this reaction is:

(1) \( A + B \rightarrow D \) (slow) \( \leftarrow \)
(2) \( D + B \rightarrow E \) (fast)
(3) \( A + E \rightarrow C \) (fast)

Of the following rate laws, \( \boxed{\text{c}} \) is the correct rate law for this mechanism.

a. Rate = \( k_1[A][B] \)
b. Rate = \( k_3[A][E] \)
c. Rate = \( k_1[A]^2[B]^2 \)
d. Rate = \( k_2[D][B] \)
e. Rate = \( k_2k_3[A][B][D] \)

19. Of the following, \( \boxed{\text{c}} \) will lower the activation energy for a reaction.

a. increasing the concentrations of reactants
b. raising the temperature of the reaction
c. adding a suitable catalyst
d. all of the above
e. none of the above
20. Which one of the following graphs shows the correct relationship between concentration and time for a reaction that is second order in [A]?

a. graph a
b. graph b
c. graph c
d. graph d
e. graph e

21. The graph shown below depicts the relationship between concentration and time for the following chemical reaction.

The slope of this line is equal to

a. k
b. \(-1/k\)
c. \(\ln[A]\)
d. \(-k\)
e. \(1/k\)
22. Which energy difference in the reaction profile below corresponds to the activation energy for the forward reaction?

a. w
b. x

c. y
d. z
e. w and z

Energy

Extent of Reaction

23. What is the order of the reaction with respect to ClO2?

a. 1
b. 0
c. 2
d. 3
e. 4

\[ 0.0248 = (0.060)^x \]

24. What is the order of the reaction with respect to OH-?

a. 0
b. 1
c. 2
d. 3
e. 4

\[ 0.00276 = (0.030)^y \]

25. What is the value of the rate constant for the reaction?

a. \(1.15 \times 10^4\)
b. 4.6
c. 230
d. 115
e. 713

\[ 0.0248 = k [0.060]^2 [0.030]^1 \]

\[ k = 229.6 \]