FORM A is EXAM II, VERSION 2 (v2)

Name________________________________

1. DO NOT TURN THIS PAGE UNTIL DIRECTED TO DO SO.
2. These tests are machine graded; therefore, be sure to use a No. 1 or 2 pencil for
   marking the answer sheets.
3. Completely blacken the answer circle. If you change an answer, erase completely
   the previous mark.
4. You may remove your answer sheet from this booklet. If you have a pink test, test
   form A should be darkened (B for Blue), if it is not, notify your instructor
   immediately.
5. Fill in your last name, first name, and initial. Blacken the corresponding letters.
6. Fill in your ID number. CAREFULLY, blacken the corresponding numbers below
   this section.
7. Fill in the Dept. Course No. and Section. The Dept. = CHEM, the Course No. = 102,
   and your section.
8. If you want your scores posted by a portion of your ID #, mark A under the option
   column.
9. READ THE TEST CAREFULLY. The time limit on this test is 50 minutes.
10. Use the test for scratch paper.
11. Mark your answers in this booklet as well as on the answer sheet so you can check
   your score with the key after the test.
12. There are 17 questions. Each counts 6 points for a total of 102 points. NO GRADES
   OVER 100 WILL BE RECORDED.
13. Your score will be calculated from the number of correct answers. There is no
   penalty for guessing.
14. Turn in your scan sheet, show your ID, and have your calculator checked. You will
   also turn in your test.
15. A key will be on the electronic class bulletin board at 2:15PM. This is accessed
   through the class homepage

IMPORTANT INFORMATION:

S for liquid water is 4.184 J/g • degree C
R = 0.082 L • atmos/K • mol or R = 8.314 J/K mol
F = 1.8 C + 32

S_liquid_water = 4.184 J/g•°C

q = ms△t
Kp = Kc(RT)^Δn
ΔG = ΔH - TΔS
S_liquid_water = 4.184 J/g•°C

ln[A] = -akt + ln [A]_0
[A] = -akt + [A]_0
ln[A] = -akt + ln [A]_0

[A] = -akt + [A]_0
lnk = -Ea/R (1/T) + ln A

[A]_0 = t_{1/2}
2ak

-\frac{1}{ak[A]_0} = t_{1/2}
-\frac{0.693}{ak} = t_{1/2}

\frac{1}{[A]} = \frac{1}{akt + [A]_0}

ln \left[ k_2 \right] = \frac{Ea}{R} \left[ \frac{1}{T_2} - \frac{1}{T_1} \right]

ln \left[ k_1 \right] = \frac{Ea}{R} \left[ T_1 - T_2 \right]
1. Use the table of data shown below to calculate the average rate of the reaction between 10 s and 30 s in M/s.

\[
\begin{array}{|c|c|}
\hline
\text{time (seconds)} & [A] \text{ mol/L} \\
\hline
0 & 0.124 \\
10 & 0.110 \\
20 & 0.088 \\
30 & 0.073 \\
40 & 0.054 \\
\hline
\end{array}
\]

A. 0.0012  
B. -0.0019  
C. 0.0019  
D. -0.0012  
E. 0.037

2. Which of the following is closest to the instantaneous rate for the reaction 2A $\rightarrow$ B at 75 seconds.

A. $4.0 \times 10^{-5}$ M/s  
B. $2.5 \times 10^{-5}$ M/s  
C. $1.0 \times 10^{-4}$ M/s  
D. $2.0 \times 10^{-4}$ M/s  
E. $1.5 \times 10^{-4}$ M/s

3. Consider the initial-rate data below for the reaction:

\[
2M + 7Z \rightarrow M_2Z_7
\]

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Expt.} & [M] & [Z] & \text{Rate (mol/L s)} \\
\hline
1 & 0.100 & 0.100 & 4.0 \times 10^{-5} \\
2 & 0.200 & 0.100 & 1.6 \times 10^{-4} \\
3 & 0.100 & 0.200 & 8.0 \times 10^{-5} \\
\hline
\end{array}
\]

The order of the reaction is:

A. 0  
B. 3  
C. 2  
D. 4  
E. 1
4. A student found the rate law for the equation below to be: 
\[ \text{rate} = k [A]^2 [B] \]
\[ 2A + B \rightarrow C \]

The correct rate constant in \( \text{L}^2/(\text{mol}^2 \times \text{s}) \) is:

<table>
<thead>
<tr>
<th>Expt.</th>
<th>[A]</th>
<th>[B]</th>
<th>Rate (mol/L s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.0 x 10^-4</td>
<td>2.0 x 10^-3</td>
<td>4.0 x 10^2</td>
</tr>
<tr>
<td>2</td>
<td>0.200</td>
<td>0.100</td>
<td>2.0 x 10^10</td>
</tr>
<tr>
<td>3</td>
<td>0.100</td>
<td>0.200</td>
<td>1.0 x 10^10</td>
</tr>
</tbody>
</table>

A. 1.0 x 10^9  
B. 1.0 x 10^-9  
C. 5.0 x 10^{12}  
D. 5.0 x 10^{11}  
E. 2.0 x 10^{-13}

5. Which of the following graphs is linear for \( 2A \rightarrow \text{products} \)?

A. \( \ln [A] \) vs. \( t \) if 2nd-order in A  
B. \( 1/[A] \) vs. \( t \) if 1st-order in A  
C. \( \ln [A] \) vs. \( t \) if 1st-order in A  
D. \( [A]^2 \) vs. \( t \) if 2nd-order in A  
E. \( 1/[A]^2 \) vs. \( t \) if 2nd-order in A

6. Consider the reaction: 
\[ \text{N}_2(g) + 3 \text{H}_2(g) \rightarrow 2\text{NH}_3(g) \]

Which of the following expressions for the reaction rate are NOT CORRECT? (\( t = \text{time} \))

\[
\begin{array}{ccc}
(#1) & -\Delta[N_2] & (#2) 1 \Delta[H_2] & (#3) 1 \Delta[NH_3] \\
\Delta t & 3 \Delta t & 2 \Delta t \\
\end{array}
\]

A. #1 only  
B. #2 only  
C. #3 only  
D. #1 and #3  
E. all are correct

7. A catalyst:

A. never participates in the rate-determining step  
B. always appears in the overall balanced reaction  
C. changes the equilibrium position of a reaction  
D. achieves its effect by lowering the overall activation energy  
E. never has its concentration appear in the rate law

8. What is the activation energy in kJ of a reaction whose rate constant increases by a factor of 10 upon increasing the temperature from 303K to 333K?

A. 64  
B. 33  
C. 89  
D. 30  
E. 46
9. The initial concentration of reactant in a first order reaction is 0.27 M. \[ \text{A} \rightarrow \text{B} \]
The rate constant for the reaction is 0.75 s\(^{-1}\). What is the concentration (in mol/L) of reactant after 1.5 seconds?
A. 11.4  
B. 1.7  
C. 0.088  
D. 0.020  
E. 3.8

10. Consider the following reaction and its associated rate law.
A + B \rightarrow C \quad \text{rate} = k \ [A]^1
Which of the following is FALSE?
A. the units on k are M\(^{-1}\) seconds\(^{-1}\)
B. increasing the concentration of reactant B will not change the rate
C. doubling the concentration of reactant A will double the rate
D. increasing the temperature of the reaction will increase the rate constant
E. increasing the temperature increases the number of reactant molecules with the minimum energy for effective collisions for reaction.

11. Which of these procedures will be ineffective to increase the rate of reaction?
CoO(s) + CO(g) \rightleftharpoons Co(s) + CO\(_2\)(g)
A. Divide the solid reactant into small pieces
B. Introduce more CO gas, keeping volume constant.
C. Increase the temperature, keeping pressure constant.
D. Double the pressure by introducing He gas.
E. All are effective

12. Chlorine atoms photochemically derived from Freons help destroy stratospheric ozone in the two-step mechanism below.
\[
\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2
\]
\[
\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2
\]
We classify the species Cl and ClO for the overall balanced reaction respectively as:
A. catalyst and intermediate  
B. Both intermediates
C. Both catalysts  
D. intermediate and catalyst
E. both activated complexes
13. Two reaction pathways are indicated: one for the uncatalyzed reaction and one for the reaction in the presence of a catalyst.

Assuming that all substances are aqueous and at constant pressure, what is the $\Delta H$ for the REVERSE reaction in the presence of this catalyst?

A. 150 kJ  
B. 100 kJ  
C. 75 kJ  
D. -100 kJ  
E. -75 kJ

14. Consider the proposed mechanism:

$2A + B \rightleftharpoons C$  fast
$D + C \rightarrow E + F$  slow
$F + A \rightarrow E + D$  fast

Which statements are true?

I. The overall equation is:  $3A + B \rightarrow 2E$
II. C functions as an intermediate
III. D functions as a catalyst
IV. The rate law for the overall reaction is $k[A]^2[B][D]$

A. Only I  
B. Both II and IV  
C. Only III, and IV  
D. Both I and III  
E. All are correct

15. At equilibrium, which is/are true?

A. All chemical processes have ceased.
B. The rate of the forward reaction equals that of the reverse.
C. The rate constant for the forward reaction equals that of the reverse.
D. Both the rate of the forward reaction equals that of the reverse and the rate constant for the forward reaction equals that of the reverse.
E. All of the above
16. The value of $K_c$ for this reaction is 0.13 at 200°C. What is the value of $K_p$ for the reaction?

$$\text{BaS(s)} + 2\text{O}_2(\text{g}) \rightleftharpoons \text{BaSO}_4(\text{s})$$

A. 0.13 B. $2.0 \times 10^2$ C. $8.6 \times 10^{-5}$ D. $4.8 \times 10^{-4}$ E. $3.3 \times 10^{-3}$

17. Consider the reaction shown below.

$$\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$$

Determine the value of the equilibrium constant for this reaction if an initial concentration of $\text{N}_2\text{O}_4(\text{g})$ of 0.0400 mol/L is reduced to 0.0055 mol/L at equilibrium. There is no $\text{NO}_2(\text{g})$ present at the start of the reaction.

A. 0.87 B. 0.022 C. 0.22 D. 1.2 E. 13

18. The value of $K_c$ for the following reaction is 0.25

$$\text{SO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g}) + \text{NO}(\text{g})$$

What is the value of $K_c$ for the reaction shown below?

$$2\text{SO}_2(\text{g}) + 2\text{NO}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) + 2\text{NO}(\text{g})$$

A. 0.12 B. 0.25 C. 0.062 D. 0.50 E. 0.33

19. Consider a reaction: $\text{A} + 2\text{B} \rightarrow 3\text{C}$

At one point of the reaction, the concentration of $\text{A} = 3$ moles, $\text{B} = 7.5$ moles, and $\text{C} = 7.5$ moles in a 1.5-liter container. If the $K$ for this reaction is 3.2, then which of the following is (are) TRUE:

I. $Q$ for this reaction is 2.5
II. The forward reaction will predominate until equilibrium is reached.
III. The reaction will proceed in reverse until equilibrium is reached
IV. $Q > K$

A. I & II B. II & III C. III & IV D. II only E. III only

Key

<table>
<thead>
<tr>
<th>question</th>
<th>6 pts each (unless noted)</th>
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<tbody>
<tr>
<td>1</td>
<td>C (B=2 pts)</td>
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<td>2</td>
<td>C (D,E = 3pts)</td>
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