READ THESE DIRECTIONS CAREFULLY BEFORE STARTING THE EXAMINATION!

It is extremely important that you fill in the answer sheet EXACTLY as indicated, otherwise your test may not be processed; ALL entries are to be made on SIDE 1 of the answer sheet. Use a #2 pencil (or softer); fill in the circles completely and firmly. Erasures must be complete. Use only the following categories:

<table>
<thead>
<tr>
<th>NAME:</th>
<th>Print your name starting at the first space, LAST NAME first, then a space, followed by your FIRST NAME, then another space, followed by your MIDDLE INITIAL. Fill in the correct circles below your printed name corresponding to the letters of your name; for the spaces, fill in the top blank circle.</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDENT NUMBER:</td>
<td>This is VERY IMPORTANT! Under IDENTIFICATION NUMBER, put in your 8 DIGIT STUDENT ID NUMBER (do not use the 9 at the beginning of your number) beginning in column A and continuing through column H, column I will be blank, (do NOT use column J at this time); be sure to fill in the correct circles (a common error to be avoided is mistaking &quot;0&quot; for &quot;1&quot;).</td>
</tr>
<tr>
<td>TEST FORM:</td>
<td>Fill in the &quot;2&quot; blank in the J column under IDENTIFICATION NUMBER (to indicate Hour Examination II).</td>
</tr>
<tr>
<td>SPECIAL CODES:</td>
<td>Use for course and section number; in positions K-P write in one of the following: Dr. Ades 107-001, 107-002</td>
</tr>
<tr>
<td>SIGNATURE:</td>
<td>You MUST sign the examination answer sheet (bubble sheet) on the line directly above your printed name. Use your legal signature.</td>
</tr>
</tbody>
</table>

Answering Questions:

Starting with answer "1" on SIDE 1, fill in the circle indicating the one best answer for each of the 25 questions in this examination. Your score is the sum of the appropriate credit for each response. The day after the examination is finished, an examination key will be posted on Blackboard.

Grading and Reporting:

The examination scores will be posted in Blackboard as soon as possible after the examination. If an error has been made in scoring your answers, tell your instructor within 48 hours of the posting of your score.

BE SURE THAT YOUR TEST HAS 25 QUESTIONS, A PERIODIC TABLE, AND ONE SHEET OF SCRATCH PAPER. You may NOT use your own scratch paper during this examination. Cell phones and pagers are to be turned off and out of sight during the exams.
1. In which of the following cases is the heat of solution most exothermic?

A. when the solute-solvent interaction is stronger than the solute-solute and the solvent-solvent interactions.
B. when the solute-solvent interaction is the same strength as the solute-solute and the solvent-solvent interactions.
C. when the solute-solvent interaction is weaker than the solute-solute and the solvent-solvent interactions.
D. when the solute-solvent interaction is much stronger than the solute-solute and the solvent-solvent interactions.

2. Which will be more soluble in water than in CCl₄?

1. NH₃
2. CS₂
3. C₆H₁₄
4. H₂CO

A. 1 and 2  
B. 2 and 3  
C. 3 and 4  
D. 1 and 4

3. Which of the following are the major differences between solutions and colloids? Both are in the liquid state. (Choose the best answer.)

1. color of the solution or colloid
2. particle size
3. interaction with light
4. density

A. 1 and 2  
B. 2 and 3  
C. 3 and 4  
D. 1 and 4

4. What is the molality of a 45.0 % by mass H₃PO₄ solution?

A. 4.59 m  
B. 12.5 m  
C. 8.35 m  
D. 0.450 m
5. What is the molality of an aqueous 5.97 \textit{M} glycerol (C_{3}H_{8}O_{3}) solution? The density of the solution is 1.10 g/mL.

<table>
<thead>
<tr>
<th>Option</th>
<th>Molality</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>3.61 \textit{m}</td>
</tr>
<tr>
<td>B.</td>
<td>5.43 \textit{m}</td>
</tr>
<tr>
<td>C.</td>
<td>7.97 \textit{m}</td>
</tr>
<tr>
<td>D.</td>
<td>10.8 \textit{m}</td>
</tr>
</tbody>
</table>

6. Which of the following are true?

1. Gases are more soluble in water as the partial pressure of the gas above the liquid increases.
2. Gases are less soluble in water as the temperature increases.
3. Pressure increases greatly affect the solubility of a liquid in another liquid.
4. The solubilities of all ionic compounds in water increase with an increase in temperature.

<table>
<thead>
<tr>
<th>Option</th>
<th>True Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>1 and 2</td>
</tr>
<tr>
<td>B.</td>
<td>2 and 3</td>
</tr>
<tr>
<td>C.</td>
<td>3 and 4</td>
</tr>
<tr>
<td>D.</td>
<td>1 and 4</td>
</tr>
</tbody>
</table>

7. The solubility of nitrogen gas in water at 25°C and a nitrogen pressure of 522 mmHg is $4.4 \times 10^{-4}$ mol/L. What is the solubility of nitrogen gas in water when the nitrogen partial pressure is increased to 2.00 atm?

<table>
<thead>
<tr>
<th>Option</th>
<th>Solubility</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>$1.7 \times 10^{-6}$ mol/L</td>
</tr>
<tr>
<td>B.</td>
<td>$1.5 \times 10^{-4}$ mol/L</td>
</tr>
<tr>
<td>C.</td>
<td>0.11 mol/L</td>
</tr>
<tr>
<td>D.</td>
<td>$1.3 \times 10^{-3}$ mol/L</td>
</tr>
</tbody>
</table>

8. What is the vapor pressure, in mmHg, of a solution prepared by dissolving $3.00 \times 10^{2}$ g of urea (NH$_{2}$)$_{2}$CO (a nonvolatile solute) in $9.00 \times 10^{2}$ g of water at 63.5°C. The vapor pressure of water at 63.5°C is 175 mmHg.

<table>
<thead>
<tr>
<th>Option</th>
<th>Vapor Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>191 mmHg</td>
</tr>
<tr>
<td>B.</td>
<td>15.9 mmHg</td>
</tr>
<tr>
<td>C.</td>
<td>117 mmHg</td>
</tr>
<tr>
<td>D.</td>
<td>159 mmHg</td>
</tr>
</tbody>
</table>
9. A 1.35 \textit{m} aqueous solution of compound X had a freezing point of – 6.8 °C. Which of the following \textbf{most likely} is compound X? The freezing point constant for water is 1.86°C/m.

A. NaCl  
B. MgBr\textsubscript{2}  
C. C\textsubscript{2}H\textsubscript{5}OH  
D. FeCl\textsubscript{3}

10. A 1.50 × 10\textsuperscript{2} mL sample, at 25°C, of an aqueous solution contains 0.0152 g of an unknown nonelectrolyte compound. The osmotic pressure at 25°C was determined to be 8.44 mmHg. What is the molar mass of the compound?

A. 446 g/mol  
B. 345 g/mol  
C. 223 g/mol  
D. 72.9 g/mol

11. Which aqueous solution will have the highest boiling point?

A. 0.80 \textit{m} C\textsubscript{12}H\textsubscript{22}O\textsubscript{11}  
B. 0.40 \textit{m} NH\textsubscript{4}Cl  
C. 0.25 \textit{m} FeCl\textsubscript{3}  
D. 0.30 \textit{m} Ca(NO\textsubscript{3})\textsubscript{2}

12. What is the rate at which O\textsubscript{2}(g) is reacting when NH\textsubscript{3}(g) is reacting at a rate of 0.20 \textit{M}/min according to the following reaction?

\[4 \text{NH}_3(g) + 5 \text{O}_2(g) \rightarrow 4 \text{NO}(g) + 6 \text{H}_2\text{O}(l)\]

A. 0.25 \textit{M}/min  
B. 0.050 \textit{M}/min  
C. 1.0 \textit{M}/min  
D. 0.16 \textit{M}/min

13. For the \textbf{overall} chemical reaction shown below, which of the following statements can you \textbf{rightly} assume?

\[\text{Cl}_2(g) + 3 \text{F}_2(g) \rightarrow 2 \text{ClF}_3(g)\]

1. The reaction is first-order in Cl\textsubscript{2} and third-order in F\textsubscript{2}.
2. The reaction is fourth-order overall.
3. The rate law is rate = \(k[\text{Cl}_2][\text{F}_2]\).
4. The rate law cannot be determined without experimental data.

A. 1 and 2  
B. 1, 2 and 3  
C. 4 only  
D. 3 only
14. A reaction was found to be second order in “A” and zero-order in “B” with a rate constant equal to 2.0 \( M^{-1} \text{s}^{-1} \). What is the rate when the concentration of “A” is 3.0 \( M \) and “B” is 2.0 \( M \)?

A. 18 \( M/\text{s} \)  
B. 12 \( M/\text{s} \)  
C. 36 \( M/\text{s} \)  
D. 9.0 \( M/\text{s} \)

15. A reaction \( (A \rightarrow \text{products}) \) was found to have the rate law: \( \text{rate} = k \). Which of the following are true statements?

1. The reaction is first-order overall.
2. The half-life depends on the initial concentration of the reactant “A”.
3. The units of the rate constant are \( M/\text{time} \).
4. A plot of \( 1/[A] \) versus time will be a straight line with a positive slope.

A. 1 and 2  
B. 2 and 3  
C. 3 and 4  
D. 1 and 4

16. The initial rate data (shown below) were obtained for the aqueous reaction

\[
2 \text{HgCl}_2(aq) + \text{C}_2\text{O}_4^{2-} (aq) \rightarrow 2 \text{Cl}^- (aq) + 2 \text{CO}_2(g) + \text{Hg}_2\text{Cl}_2(s)
\]

<table>
<thead>
<tr>
<th>[HgCl(_2)] ( M )</th>
<th>[C(_2)O(_4)(^{2-})] ( M )</th>
<th>rate ( (M/\text{s}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.164 ( M )</td>
<td>0.15 ( M )</td>
<td>( 3.2 \times 10^{-5} )</td>
</tr>
<tr>
<td>0.164 ( M )</td>
<td>0.45 ( M )</td>
<td>( 2.9 \times 10^{-4} )</td>
</tr>
<tr>
<td>0.082 ( M )</td>
<td>0.45 ( M )</td>
<td>( 1.4 \times 10^{-4} )</td>
</tr>
<tr>
<td>0.246 ( M )</td>
<td>0.15 ( M )</td>
<td>( 4.8 \times 10^{-5} )</td>
</tr>
</tbody>
</table>

What is the rate law for the reaction?

A. Rate = \( k[HgCl_2][C_2O_4^{2-}] \)  
B. Rate = \( k[HgCl_2]^2[C_2O_4^{2-}] \)  
C. Rate = \( k[HgCl_2][C_2O_4^{2-}]^2 \)  
D. Rate = \( k[HgCl_2]^2[C_2O_4^{2-}]^2 \)
17. The radioactive decay of radon follows first-order kinetics and has a half-life of 3.823 days. How many grams of radon will remain after 12.00 days if the sample initially had a mass of 455 g?

A. 105 g  
B. 24.3 g  
C. 39.2 g  
D. 51.7 g

18. A reversible reaction was found to have an activation energy of 102.0 kJ/mol in the forward direction and 38.2 kJ/mol in the reverse direction. What is $\Delta H$ for the reverse reaction?

A. 63.8 kJ/mol  
B. $-63.8$ kJ/mol  
C. 140.2 kJ/mol  
D. $-140.2$ kJ/mol

19. The following mechanism for the gas phase reaction $\text{NO}_2 + \text{CO} \rightarrow \text{NO} + \text{CO}_2$ has been proposed:

\begin{align*}
\text{Step 1} & \quad \text{NO}_2 + \text{NO}_2 \rightarrow \text{NO}_3 + \text{NO} \quad \text{slow} \\
\text{Step 2} & \quad \text{NO}_3 + \text{CO} \rightarrow \text{NO}_2 + \text{CO}_2 \quad \text{fast}
\end{align*}

If this is to be a valid mechanism, the experimental rate law for the overall reaction must be:

A. $\text{Rate} = k[\text{NO}_2][\text{CO}]$  
B. $\text{Rate} = k[\text{NO}_2]^2[\text{CO}]$  
C. $\text{Rate} = k[\text{NO}_2]^2$  
D. $\text{Rate} = k[\text{CO}]$

20. A catalyst

1. decreases the activation energy of a reaction.
2. alters the mechanism of the reaction.
3. increases the concentration of the reactants.
4. increases the temperature of the reaction.

A. 1 and 2  
B. 2 and 3  
C. 3 and 4  
D. 1 and 4
21. The following mechanism has been proposed for a gas phase reaction.

1. \( \text{NO}_2 + \text{SO}_2 \rightarrow \text{NO} + \text{SO}_3 \)
2. \( \text{NO} + \frac{1}{2} \text{O}_2 \rightarrow \text{NO}_2 \)

Which of the following acts as the catalyst for the reaction?

A. NO₂  
B. SO₂  
C. NO  
D. There is no catalyst in the mechanism.

22. Which one of the following is the correct equilibrium constant expression, \( K_c \), for \((\text{NH}_4)_2\text{Se} (s) \rightleftharpoons 2 \text{NH}_3(g) + \text{H}_2\text{Se}(g)\)

A. \[ \frac{[\text{NH}_3]^2[\text{H}_2\text{Se}]}{[(\text{NH}_4)_2\text{Se}]} \]  
B. \[ \frac{[2\text{NH}_3] + [\text{H}_2\text{Se}]}{[(\text{NH}_4)_2\text{Se}]} \]  
C. \[ [\text{NH}_3]^2[\text{H}_2\text{Se}] \]  
D. \[ 2[\text{NH}_3] + [\text{H}_2\text{Se}] - [(\text{NH}_4)_2\text{Se}] \]

23. The entries in the table below represent equilibrium partial pressures of A and B under different initial conditions.

<table>
<thead>
<tr>
<th>( P_A (\text{atm}) )</th>
<th>( P_B (\text{atm}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00</td>
<td>8.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2.15</td>
<td>10.00</td>
</tr>
</tbody>
</table>

What are the coefficients \( a \) and \( b \)?

A. \( a=1, b=2 \)  
B. \( a=3, b=1 \)  
C. \( a=2, b=1 \)  
D. \( a=1, b=3 \)
24. Given \( 2A(s) \rightleftharpoons B(g) + C(g) \quad K_1 = 8.00 \)
\( D(g) \rightleftharpoons \frac{1}{2} B(g) + 2 \ C(g) \quad K_2 = 4.00 \)

what is \( K \) for \( 2 \ D(g) \rightleftharpoons 2 \ A(s) + 3 \ C(g) \)?

A. 2.00  
B. 0.00  
C. 16.0  
D. 8.00

25. The equilibrium constant for the following reaction is \( 4.34 \times 10^{-3} \) at 300\(^\circ\)C. At equilibrium

A. products predominate.  
B. reactants predominate.  
C. only reactants are present.  
D. only products are present.
<table>
<thead>
<tr>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<th>5</th>
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</thead>
<tbody>
<tr>
<td>Correct Answer</td>
<td>D</td>
<td>D</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>A</td>
<td>D</td>
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<td>B</td>
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<td>A,C</td>
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<td>D</td>
<td>D</td>
<td>A,C</td>
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Exam 2
October 21, 2010

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