Turn in the take-home question with your exam. Show all calculations with correct units and significant figures. Read the questions carefully! **GOOD LUCK!!!**

1. Hydrogen, bromine, and hydrogen bromide in the gas phase are in equilibrium in a sealed container that can have its volume adjusted. The reaction is exothermic.

   \[ \text{H}_2 (g) + \text{Br}_2 (g) \rightleftharpoons 2 \text{HBr} (g) \]

   How will each of the following stresses affect the indicated quantities? (16)

<table>
<thead>
<tr>
<th>Stress</th>
<th>How does reaction shift, if at all?</th>
<th>Does the ( K_{eq} ) changes?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add ( \text{H}_2 ) (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Container is heated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume is doubled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{Br}_2 ) (l) is added and instantly vaporizes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Octanitrocubane is placed in a box and allowed to explode (the sealed box survives the explosion). What happens to the balance? Explain. (9)

   \[ \text{C}_8\text{(NO}_2\text{)}_8 \) (s) \rightarrow 4 \text{N}_2 \) (g) + 8 \text{CO}_2 \) (g) + heat

   ![Diagram of 25 mg octanitrocubane on a balanced scale with 25 mg on the other side.]
3. Sketch the rate of a reaction as a function of concentration for the three orders (zero order, first order, and second order) where the general rate law is given by Rate = \( k(X)^n \). Label the axes and the orders clearly. (15)

4. Nitric oxide is a common air pollutant produced by combustion processes by the following reaction:

\[
\text{N}_2 (g) + \text{O}_2 (g) \rightleftharpoons 2 \text{NO} (g)
\]

Write the equilibrium expression for this reaction. (5)

If 1.0 mole of each reactant was placed into a 3.0 L flask, what would the equilibrium concentration of NO be? \( K = 0.050 \) at 2200°C (10)
5. For the reaction $A \rightarrow B$ shown below as a concentration as a function of time graph, address the following questions. (15)

What is the value of $K$?  

\[ \begin{array}{c}
& = 1 & > 1 & < 1 \\
\end{array} \]

At what time does the reaction reach equilibrium?

As time passes at greater than 50, will $(A) = (B)$?  

\[ \begin{array}{c}
& Yes & No \\
\end{array} \]