City College, Chemistry Department  
Chemistry 10401, sections H*, Prof. T. Lazaridis  
SAMPLE questions for the first midterm exam

Note: these are just examples. Any question similar to homework could be asked in an exam.

1. a. (6) Describe the intermolecular forces that exist between the following species:

i) I$_2$ and CCl$_4$

ii) CH$_3$Br and CH$_3$Cl

iii) CH$_3$OH and CH$_3$NH$_2$

b. (4) Do you expect the boiling point of NO to be higher or lower than that of N$_2$ and O$_2$, and why?

2. (10) Lead crystallizes in a cubic lattice with a unit cell edge of 495.05 pm. The density of lead is 11.3 g/cm$^3$. Calculate the number of atoms per unit cell and identify the lattice type.

3. (10) The phase diagram of CO$_2$ is given below. What is the most stable state of CO$_2$ at a) 10 atm and 25 °C, b) 75 atm and -20 °C, c) 150 atm and 100 °C?

(source: Wikipedia)
4. (10) A solution of sulfuric acid contains 10.0 g of H$_2$SO$_4$ for every 90.0 g of water. Its density is 1.07 g/mL. Calculate a) the molarity, b) the mole fraction, and c) the molality of sulfuric acid in the solution.

5. (10) A solution contains 100 g of ethyl acetate (CH$_3$COOC$_2$H$_5$) and 100 g of carbon disulfide (CS$_2$) at 27 °C. Assuming ideal behavior, calculate the partial pressure of each component above the solution. The vapor pressures of ethyl acetate and CS$_2$ are 100 and 390 torr, respectively, at 27 °C.

6. (10) Reserpine is a natural product. The boiling point of a solution containing 3.00 g of reserpine in 20.0 g of chloroform is 0.893 °C higher than the boiling point of pure chloroform. Calculate the molar mass or reserpine. $K_b$ of chloroform is 3.63 °C kg/mol.

7. (5) Consider the reaction \(2\text{CO} (g) + \text{O}_2 (g) \rightarrow \text{2CO}_2 (g)\)

Express the rate of formation of CO$_2$ in terms of the rate of disappearance of CO and of O$_2$.

8. (15) The following initial rates were obtained for the reaction \(\text{A}+\text{B} \rightarrow \text{products}\)

<table>
<thead>
<tr>
<th>Run</th>
<th>[A]</th>
<th>[B]</th>
<th>rate (mol/Ls)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.10</td>
<td>0.60</td>
<td>0.012</td>
</tr>
<tr>
<td>2</td>
<td>0.30</td>
<td>0.60</td>
<td>0.108</td>
</tr>
<tr>
<td>3</td>
<td>0.10</td>
<td>0.30</td>
<td>0.006</td>
</tr>
</tbody>
</table>

a) Determine the order of the reaction with respect to A and B.
b) Write the rate law and calculate the rate constant (include units)
c) What is the rate of the reaction when A and B are each 0.010 M?
9. (10) The half life of a first-order decomposition, A->products, is 32.0 min. How many minutes would it take for the concentration of A to drop from 0.256 M to 0.0160 M?

10. (10) The reaction
\[ 2\text{ClO}_2 (g) + \text{F}_2 (g) \rightarrow 2\text{FClO}_2 (g) \]
is first order in \( \text{ClO}_2 \) and first order in \( \text{F}_2 \). Write the rate law, and devise a two-step mechanism consistent with the rate law.

11. (10) The following data were obtained for a 1st order reaction

\[
\begin{array}{c|c}
T (\degree \text{C}) & k (\text{M}^{-1}\text{s}^{-1}) \\
\hline
25 & 1.6 \times 10^{-20} \\
45 & 8.7 \times 10^{-19} \\
\end{array}
\]

Determine the activation energy for this reaction.

12. (15) The following data have been obtained for this reaction:
\[
\text{NH}_4\text{NCO (aq)} \rightarrow (\text{NH}_2)_2\text{CO (aq)}
\]

\[
\begin{array}{c|c}
t (\text{min}) & [\text{NH}_4\text{NCO}] \\
\hline
0 & 0.1000 \\
45.0 & 0.0808 \\
72.0 & 0.0716 \\
107.0 & 0.0638 \\
230.0 & 0.0463 \\
\end{array}
\]

Show that this reaction is 2nd order and find the value of the rate constant.