Chem 213
Chemical Analysis
Exam 1
October 4, 2004

1 _______ (of 20)
2 _______ (of 10)
3 _______ (of 10)
4 _______ (of 10)
5 _______ (of 10)
6 _______ (of 10)
7 _______ (of 10)
8 _______ (of 10)
9 _______ (of 10)

Σ______ (of 100)
%

Name: _______________________________________
(please print)
1. The mass spectrometric signals for known concentrations of methane in H₂ were found to be:

<table>
<thead>
<tr>
<th>CH₄ (vol%)</th>
<th>0</th>
<th>0.062</th>
<th>0.122</th>
<th>0.245</th>
<th>0.486</th>
<th>0.971</th>
<th>1.921</th>
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</thead>
<tbody>
<tr>
<td>Signal (mV)</td>
<td>9.1</td>
<td>47.5</td>
<td>95.6</td>
<td>193.8</td>
<td>387.8</td>
<td>812.5</td>
<td>1671.9</td>
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</tbody>
</table>

a. Subtract the blank value (9.1) from all other values. Then determine the equation of the least-squares straight line through these data points in the form \( y = [m(\pm s_m)]x + [b(\pm s_b)] \) (15 points)

b. Replicate measurements of an unknown gave 151.1, 154.9, 153.9, and 155.1 mV. Find the concentration of the unknown and its uncertainty. (5 points)
2. A reliable assay shows that the ATP (adenosine triphosphate) content of a certain cell type is 111 µmol/100 mL. You developed a new assay, which gave the following values for replicate analyses: 117, 119, 111, 115, 120 µmol/100 mol. Can you be 95% confident that your result differs from the “known” value? (10 points) (A simple “yes” or “no” without any calculations is not a sufficient answer and will receive no credit!)
3. A 100.0-mL solution of spring water was treated to convert any iron present to Fe$^{2+}$. Addition of 25.00 mL of 0.002107 M K$_2$Cr$_2$O$_7$ resulted in the reaction:

$$6 \text{Fe}^{2+} + \text{Cr}_2\text{O}_7^{2-} + 14 \text{H}^+ \rightarrow 6 \text{Fe}^{3+} + 2 \text{Cr}^{3+} + 7 \text{H}_2\text{O}$$

The excess K$_2$Cr$_2$O$_7$ was back-titrated with 7.47 mL of a 0.00979 M Fe$^{2+}$ solution. Calculate the parts per million of iron in the original sample. (10 points)
4. A solution of \( \text{Ba(OH)}_2 \) was standardized against 0.1016 g of primary-standard-grade benzoic acid \( \text{C}_6\text{H}_5\text{COOH} \) (122.12 g/mol). An end point was observed after addition of 44.42 mL of base.

   a. Calculate the molarity of the base. (3 points)

   b. Calculate the standard deviation of the molarity if the standard deviation for weighing was ±0.1 mg and that for the volume measurement was ±0.03 mL. (4 points)

   c. Assuming an error of -0.3 mg in weighing, calculate the absolute and relative systematic error in the molarity. (3 points)
5. A solution was prepared by dissolving 6.34 g of KCl\(\cdot\)MgCl\(_2\)\(\cdot\)6H\(_2\)O (277.85 g/mol) in sufficient water to give 2.00 L. Calculate

a. the molar concentration of Cl\(^-\). (3 points)

b. the weight/volume percentage (w/v\%) of KCl\(\cdot\)MgCl\(_2\)\(\cdot\)6H\(_2\)O. (2 points)

c. ppm K\(^+\). (2 points)

d. pMg for the solution. (3 points)
6. A solid mixture weighing 1.372 g containing only sodium carbonate (105.99 g/mol) and sodium bicarbonate (84.01 g/mol) required 29.11 mL of 0.7344 M HCl for complete titration:

\[
\text{Na}_2\text{CO}_3(\text{aq}) + 2 \text{HCl(aq)} \rightarrow 2\text{NaCl (aq)} + \text{H}_2\text{O(l)} + \text{CO}_2(\text{g})
\]

\[
\text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2(\text{g})
\]

Find the mass of each component of the mixture. (10 points)
7. The solubility-product constant of K₂PdCl₆ is \(6.0 \times 10^{-6}\) (\(K_{sp} = 2K^+ + PdCl_6^-\)). What is the \(K^+\) concentration of a solution prepared by mixing 50.0 mL of 0.400 M KCl with 50 mL of

a. 0.100 M PdCl₆⁻? (5 points)

b. 0.400 M PdCl₆⁻? (5 points)
8. The addition of dimethylglyoxime, H$_2$C$_2$H$_6$O$_2$N$_2$, to a solution containing nickel(II) ion gives rise to a precipitate:

$$\text{Ni}^{2+} + \text{H}_2\text{C}_2\text{H}_6\text{O}_2\text{N}_2 \rightarrow 2\text{H}^+ + \text{Ni(HC}_4\text{H}_6\text{O}_2\text{N}_2)_2$$

Nickel glyoxime is a bulky precipitate that is inconvenient to manipulate in amounts greater than 175 mg. The amount of nickel in a type of permanent-magnet alloy ranges between 24 and 35%. Calculate the sample size that should not be exceeded when analyzing these alloys for nickel. (10 points)
9. Titration of the I$_2$ produced from 0.1238 g of primary-standard-grade KIO$_3$ (equation 1) required 41.27 mL of sodium thiosulfate (equation 2):

\[
\text{IO}_3^- + 5\text{I}^- + 6\text{H}^+ \rightarrow 3\text{I}_2 + 3\text{H}_2\text{O} \quad (1) \\
\text{I}_2 + 2\text{S}_2\text{O}_3^{2-} \rightarrow 2\text{I}^- + \text{S}_4\text{O}_6^{2-} \quad (2)
\]

Calculate the concentration of the Na$_2$S$_2$O$_3$ solution.
## Values of Student's t

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<tr>
<th>Degree's of freedom</th>
<th>50</th>
<th>90</th>
<th>95</th>
<th>98</th>
<th>99</th>
<th>99.5</th>
<th>99.9</th>
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<tbody>
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