Part I: Analytical Chemistry

1. What is the molarity of K⁺ in a solution that contains 63.3 ppm of K₃Fe(CN)₆ (329.3 g/mol)? (10 points)

2. The following results were obtained in the replicate determination of the lead content of a blood sample: 0.752, 0.756, 0.752, 0.751 and 0.760 ppm Pb. Calculate the (10 points)
   (a) mean
   (b) median
   (c) standard deviation
   (d) coefficient of variation
   (e) range

3. Explain the difference between
   (a) End point and equivalent point
   (b) Peptization and coagulation of a colloid
   (c) Weak electrolyte and strong electrolyte. (10 points)

4. What is the pH of a solution that is 0.4 M in formic acid and 1.0 M in sodium formate? Kₐ is 1.8x10⁻₄ for formic acid. (10 points)

5. 50 mL of 0.1 M HCl is titrated with 0.1 M NaOH. Please calculate the pH of the solution after the addition of (a) 0 (b) 25 (c) 50 (d) 51 mL of NaOH. (10 points)

Part II: Instrumental Analysis

1. Describe the principle for producing a Laser source. (10 points)

2. (a) What are the major components of a monochromator?
   (b) What is the function of each component?
   (c) What are the major functions of a monochromator? (15 points)

3. (a) Draw the schematic of an apparatus for high-performance liquid chromatography (HPLC).
   (b) Describe briefly the function of each component of a HPLC.
   (c) How can we apply a chromatogram obtained from HPLC for qualitative and quantitative analysis? (15 points)
4. Two substances, A and B, can absorb the light of wavelength at both $\lambda_1$ and $\lambda_2$. The absorbance can be determined utilizing UV/Vis spectrometer. The relationships between the absorbance and the concentrations of standard solutions of A and B are obtained as shown in the table below. The width of the sample cell is 1 cm.

<table>
<thead>
<tr>
<th>Wavelength, $\lambda_1$</th>
<th>Wavelength, $\lambda_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Abs.</td>
<td>Conc., mM</td>
</tr>
<tr>
<td>0.55</td>
<td>11.0</td>
</tr>
<tr>
<td>0.75</td>
<td>15.0</td>
</tr>
<tr>
<td>0.95</td>
<td>19.0</td>
</tr>
<tr>
<td>1.20</td>
<td>24.0</td>
</tr>
<tr>
<td>1.40</td>
<td>28.0</td>
</tr>
</tbody>
</table>

Now, there is a sample that contains both A and B. The absorbance obtained by UV/Vis spectrometer for this sample is 2.20 at wavelength $\lambda_1$ and is 3.35 at wavelength $\lambda_2$. What are the concentrations of both A and B in this sample? (10 points)