You have 3 hours to complete all 5 questions.

1. (20 pts) The absorbance of alizarin, an acidic dye (MW = 240.21; designated HAlz), is pH dependent. In the acid form, ε_{430}=750 M^{-1} cm^{-1} while ε_{430}=2500 M^{-1} cm^{-1} for deprotonated alizarin. What is the pH of a solution prepared by diluting 2x10^{-5} moles of alizarin to 0.1L using an aqueous buffer solution if the absorbance at 430 nm in a 1 cm cell is 0.250? Calculate the fractional composition of the acid and base forms of alizarin at the pH above.

2. (20pts) Consider the cell -

\[
\text{Pt(s)} | \text{solution} \parallel \text{SCE}
\]

The solution contains 2.00 mM Fe(NH₄)(SO₄)₂ (MW = 266.02), 1.00 mM FeCl₂ (MW = 126.75), 4.00 mM Na₂H₂Y (MW = 294.26), 0.0125M CH₃CO₂H (MW = 60.05) and 0.2222M CH₃CO₂Na (MW = 82.03). Draw a diagram of the cell showing the chemical species in contact with each electrode. Calculate the cell potential.

3. (20 pts) The planet Araganose is made mostly of the mineral aragonite, CaCO₃(MW 100.09). The oceans, pH 6.74, are saturated with aragonite. The atmosphere consists of methane (MW 16.01) and carbon dioxide (MW 44.01), each at 0.10 atm. Calculate the calcium (AW 40.08g) content of Araganose seawater in g/L.

4. (20 pts) One model used to explain the absorption of drugs, such as aspirin (MW = 180.15; designated HAsp), is called ion trapping. In the ion trapping model, it is assumed that ions do not penetrate the membrane, but the undissociated form migrates freely across the membrane.

\[
\begin{align*}
\text{Membrane} & \quad | \\
\text{Blood Plasma} & \quad | \quad \text{Stomach} \\
\text{pH}=7.45 & \quad | \quad \text{pH} = 1.0 \\
\text{H}^+ + \text{Asp}^- \rightarrow \text{HAsp} \leftrightarrow \text{HAsp} \rightarrow \text{H}^+ + \text{Asp}^- & \\
\end{align*}
\]

Calculate the ratio of total drug concentration in the plasma to total drug concentration in the stomach.

5. (20 pts) A mixture contains only Al₂O₃ (MW 101.96g) and Fe₂O₃ (MW 159.70g) and weighs 2.019g. When heated under a stream of H₂, the Al₂O₃ is unaffected, but Fe₂O₃ is converted to metallic iron and steam(MW18.0g). The dry residue weighs 1.774g. Calculate the weight percent of iron(AW 55.85g) and aluminum(AW 26.98g) in the mixture.
Electrode Potentials -

\[ \text{F}_2 + 2e \rightarrow 2\text{F}^- \]
\[ \text{MnO}_4^- + 8\text{H}_2\text{O} + 5e \rightarrow \text{Mn}^{2+} + 12\text{H}_2\text{O} \]
\[ \text{Ag}^+ + e \rightarrow \text{Ag(s)} \]
\[ \text{Fe}^{3+} + e \rightarrow \text{Fe}^{2+} \]
\[ \text{Hg}_2\text{Cl}_2 + 2e \rightarrow 2\text{Hg(l)} + 2\text{Cl}^- \]
\[ \text{AgCl} + e \rightarrow \text{Ag(s)} + \text{Cl}^- \]
\[ 2\text{H}^+ + 2e \rightarrow \text{H}_2 \]

\[ E^0 = +2.890V \]
\[ E^0 = +1.507V \]
\[ E^0 = +0.799V \]
\[ E^0 = +0.771V \]
\[ E^0 = +0.241V \text{ (sat'd KCl)} \]
\[ E^0 = +0.197V \text{ (sat'd KCl)} \]
\[ E^0 = +0.000V \]

Equilibrium Constants* -

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Alizarin (HAlz)</td>
<td>( K_a = 3.98 \times 10^{-6} )</td>
<td>Aspirin (HAsp)</td>
<td>( K_a = 1.05 \times 10^{-3} )</td>
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<tr>
<td>Acetic Acid (CH(_3)CO(_2)H)</td>
<td>( K_a = 1.75 \times 10^{-5} )</td>
<td>Carbonic Acid (H(_2)CO(_3))</td>
<td>( K_{a1} = 4.45 \times 10^{-7} )</td>
<td>( K_{a2} = 4.69 \times 10^{-11} )</td>
<td>( K_t = 10.00 )</td>
</tr>
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<tbody>
<tr>
<td>CaCO(_3)</td>
<td>( K_{sp} = 6.02 \times 10^{-9} )</td>
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<tr>
<td>FeY(^{-})</td>
<td>( K_t = 1.26 \times 10^{25} )</td>
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<tr>
<td>FeY(^{-2})</td>
<td>( K_t = 2.09 \times 10^{14} )</td>
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*\( H_4Y = \text{EDTA} \)

** \( K_{CO_2} \) - Henry's Law constant

\[ \text{in mol/L} \cdot \text{atm} \]
\[ K_t : \text{CO}_2(\text{aq}) + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{CO}_3(\text{aq}) \]

---

Fractional Composition of Free EDTA, \( \alpha_{Y^+} \) -

<table>
<thead>
<tr>
<th>pH</th>
<th>( \alpha_{Y^+} )</th>
<th>pH</th>
<th>( \alpha_{Y^+} )</th>
<th>pH</th>
<th>( \alpha_{Y^+} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<tr>
<td>1</td>
<td>1.9 \times 10^{-18}</td>
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<td>5.4 \times 10^{-2}</td>
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<td>2</td>
<td>3.3 \times 10^{-14}</td>
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<td>0.98</td>
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<tr>
<td>3</td>
<td>2.6 \times 10^{-11}</td>
<td>11</td>
<td>0.85</td>
<td>13</td>
<td>1.00</td>
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<tr>
<td>4</td>
<td>3.8 \times 10^{-9}</td>
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<td>0.98</td>
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