1. Which best represents a step in the mechanism for the saponification of methyl acetate?

(A) 

(B) 

(C) 

(D) 

2. A mixture of the following four compounds is dissolved in diethyl ether and shaken with a 2M NaOH solution. Which compound(s) remain in the organic (ether) phase?

(A) A, B and D 
(B) B and C 
(C) B, C, and D 
(D) B and D
3. The correct chair conformation of the following structure is:

![Diagram of chair conformations]

4. Which of the following molecules are expected to have a net dipole moment?

- (A) BF$_3$
- (B) CCl$_4$
- (C) CH$_2$O
- (D) CH$_4$

Using Information:

<table>
<thead>
<tr>
<th>Group</th>
<th>pK$_a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arg Sidechain</td>
<td>12.5</td>
</tr>
<tr>
<td>Asp Sidechain</td>
<td>3.7</td>
</tr>
<tr>
<td>Glu Sidechain</td>
<td>4.3</td>
</tr>
<tr>
<td>Lys Sidechain</td>
<td>10.5</td>
</tr>
<tr>
<td>His Sidechain</td>
<td>6.0</td>
</tr>
<tr>
<td>Pepide Amine Group</td>
<td>8.0</td>
</tr>
<tr>
<td>Peptide Carboxylate Group</td>
<td>3.4</td>
</tr>
</tbody>
</table>

5. For the dipeptide shown below (Glu-Ala), which structure represents the most abundant form at physiological pH (pH = 7.4)?

![Diagram of dipeptide structures]
6. For the dipeptide in question 1 above, what is the overall charge at pH = 7.4?

(A) -1
(B) +1
(C) 0
(D) -2

7. You are given a solution containing a mixture of two dipeptides, Glu-Ala and Val-Ala (nonionic structures shown below). You have access to an anion exchange chromatography column, a cation exchange chromatography column, a pH = 7.4 buffer, a pH = 4.0 buffer, a pH = 9.0 buffer, and a chromatography system with a fraction collector. Which purification strategy below would be best for separating the two dipeptides into two different flasks using chromatography?

(A) Dilute the solution containing Glu-Ala and Val-Ala into the pH 4.0 buffer, load it to the anion exchange column. Elute the column first with pH 7.4 buffer collecting one fraction, then with pH 9.0 buffer collecting a second fraction.
(B) Dilute the solution containing Glu-Ala and Val-Ala into the pH 9.0 buffer, load it to the anion exchange column. Elute the column first with pH 7.4 buffer collecting one fraction, then with pH 4.0 buffer collecting a second fraction.
(C) Dilute the solution containing Glu-Ala and Val-Ala into the pH 4.0 buffer, load it to the cation exchange column. Elute the column first with pH 7.4 buffer collecting one fraction, then with pH 9.0 buffer collecting a second fraction.
(D) Dilute the solution containing Glu-Ala and Val-Ala into the pH 9.0 buffer, load it to the cation exchange column. Elute the column first with pH 4.0 buffer collecting one fraction, then with pH 7.4 buffer collecting a second fraction.
8. Which of the four dipeptides below would be expected to be the most soluble in aqueous solution at pH = 12.0? Note: for uniformity, the dipeptides are depicted in their nonionic forms, but your answer should be based on the appropriate states of ionization that would be adopted by the ionizable groups at pH = 12.0.

(A)  

(B)  

(C)  

(D)  

9. You desire quantitative information about a protein sample of unknown concentration and decide to use a dye-binding assay. You obtain the standard curve data shown below. A 10 µL aliquot of your protein sample is diluted to 1.0 mL with the appropriate assay buffer and the absorbance measured, giving a visible absorbance of 0.34. What is the protein concentration of the original protein solution?

(A) 0.35 mg/mL  
(B) 35 mg/mL  
(C) 0.68 mg/mL  
(D) 33 mg/mL
10. Which solution should be mixed with 50.0 mL of 0.050 M HF to make an effective buffer?

(A) 50.0 mL of 0.10 M NaOH  
(B) 25.0 mL of 0.10 M NaOH  
(C) 50.0 mL of 0.050 M NaOH  
(D) 25.0 mL of 0.050 M NaOH

11. In the dissociation of a monoprotic weak acid in aqueous solutions, HA, which leads to the assumption that \([H^+] \approx [A^-]?)

(A) The autoprotolysis of water is the dominant source of \(H^+\)  
(B) The concentration of the acid is sufficiently high such that the dissociation of the acid is the dominant source of \(H^+\)  
(C) The concentration of the acid has no effect on the approximation; \([H^+]\) is always approximately equal to \([A^-]\)

12. The confidence interval for a set of measurements represents for a defined confidence level that

(A) The true value lies within a certain range about the mean value  
(B) The results from two different methods will agree with each other  
(C) The variances of two different methods will agree with each other  
(D) An experimental value lies within a certain range about the mean value

13. Which choice is not a requirement of a primary standard solid?

(A) Its reactions must be known and stoichiometric  
(B) It can be dried to remove surface moisture  
(C) Its purity must be accurately known  
(D) It must have a low formula weight

14. Glass pH electrodes must be soaked in water prior to conducting measurements in order to

(A) Clean the glass surface  
(B) Allow the internal reference electrode to reach its equilibrium potential  
(C) Hydrate the glass to allow ion-exchange between the sample solution and the glass surface  
(D) Adjust the concentration of the internal filling solution with respect to the external sample solution

15. The addition of traces of antimony to crystalline silicon produces a material having

(A) a lower conductivity than silicon.  
(B) a higher conductivity than silicon.  
(C) no conductivity  
(D) superconductivity  
(E) metallic conductivity
16. The bonding interactions in SmF$_3$ are stronger than the bonding interactions in SmI$_3$. Therefore, one can conclude that

I. Sm$^{3+}$ is a soft acid.
II. Sm$_2$O$_3$ will be more stable than Sm$_2$S$_3$.
III. Sm$^{5+}$ is a hard acid.

(A) only I 
(B) only III 
(C) I and II 
(D) II and III

17. What substitution mechanism is most common for square planar complexes?

(A) associative 
(B) dissociative 
(C) migratory insertion 
(D) reductive elimination

18. In a dissociative reaction, how does an increase in the nucleophilicity of the incoming ligand affect the rate of the reaction?

(A) The rate of the reaction increases 
(B) The rate of the reaction decreases 
(C) The rate of the reaction is unchanged 
(D) The change in the rate of the reaction depends on the oxidation state of the metal.

19. Square planar complexes containing metal atoms in a low oxidation state typically undergo

(A) ligand dissociation 
(B) migratory insertion 
(C) oxidative addition 
(D) reductive elimination

20. How does “negative overlap” in Molecular Orbital Theory lead to “antibonding” between atoms?

(A) The opposing charges of two orbitals cancel each other out. 
(B) The opposing phases of two orbitals cancel each other out. 
(C) The like charges of two orbitals repel each other. 
(D) The concentration of electron density between nuclei pushes them apart. 
(E) The negative phases of two orbitals repel each other.