Practice Final Exam, Chemistry 2220, Organic Chemistry II

1. Rank the designated protons by chemical shift (δ), highest δ first.

\[
\begin{align*}
\text{I} & : \text{H} \\
\text{II} & : \text{O} \\
\text{III} & : \text{H} \\
\text{IV} & : \text{H}
\end{align*}
\]

A. IV > III > II > I  
B. IV > II > III > I  
C. III > IV > II > I  
D. III > IV > I > II

2. What are the products, if any, expected from the following reaction?

\[
\begin{align*}
\text{CH}_3\text{O}^+\text{Na}^+ & + \text{CH}_3\text{S-H} \\
\rightarrow & \\
\text{CH}_3\text{OCH}_3 + \text{NaHS} & \quad \text{CH}_3\text{SCH}_3 + \text{NaOH} & \quad \text{CH}_3\text{O-H} + \text{CH}_3\text{S}^+\text{Na}^+ \quad \text{no reaction}
\end{align*}
\]

A.  
B.  
C.  
D.  

3. What is the IUPAC name for the following compound?

\[
\begin{align*}
\text{OH} & \\
\text{OH} & \\
\text{OH} & \\
\text{OH} & \\
\text{OH} & \\
\end{align*}
\]

A. cis-1,2-cyclopentanediol  
B. meso-1,2-cyclopentanediol  
C. (1R,2R)-1,2-cyclopentanediol  
D. (1R,2S)-1,2-cyclopentanediol

4. Which statement explains why cyclohexanol has a pK_a of 18 and phenol has a pK_a of 10?

A. Phenolate is a stronger base than the conjugate base of cyclohexanol.  
B. The conjugate base of cyclohexanol is resonance stabilized.  
C. The conjugate base of phenol is resonance stabilized.  
D. Phenol is a weaker acid than cyclohexanol.

5. Which one of the following compounds is NOT a product of the reaction between 1,3-butadiene and HBr?

A. (S)-3-bromo-1-butene  
B. (R)-3-bromo-1-butene  
C. (Z)-2-bromo-2-butene  
D. (E)-1-bromo-2-butene
6. Predict the product of the following reaction.

7. Choose the reagents necessary to carry out the following conversion.

8. Which one of the following compounds is aromatic?

9. Predict the product for the following reaction.
10. Predict the product for the following reaction.

\[ \text{OH} \quad \text{O} \quad \text{NaOH} \quad \rightarrow \]

[Diagram of a reaction with reactants and products labeled A, B, C, and D]

11. Rank the following carboxylic acid derivatives in decreasing order (most to least) of reactivity towards nucleophilic acyl substitution.

\[ \text{O} \quad \text{O} \quad \text{H}_2\text{N} \quad \text{H}_3\text{CO} \quad \text{Cl} \]

I II III IV

A. I > IV > III > II  B. II > III > I > IV
C. IV > I > III > II  D. III > I > II > IV

12. Predict the product for the following reaction sequence:

[Reaction sequence diagram]

A.  
B.  
C.  
D.  

13. Amino acids are connected to each other by__________. 

A. an ether linkage  B. an acetal linkage
C. an ester linkage  D. an amide linkage
14. Predict the product for the following reaction.

```
1. (CH₃CH₂CH₂)₂CuLi
2. H₃O⁺
```

```
14. Predict the product for the following reaction.

```
1. (CH₃CH₂CH₂)₂CuLi
2. H₃O⁺
```

```
A. B. C. D.
```

15. Rank the following compounds in decreasing order of basicity, strongest to weakest.

```
(CH₃)₃C-NH₂
(CH₃)₂N-CH²F₃
(CH₃)₂N-CH²NH₂
(CH₃)₂N-CH²NH₂
```

```
A. III > IV > I > II
B. I > II > IV > III
C. IV > III > I > II
D. IV > I > II > III
```

16. Predict the product for the following reaction sequence.

```
1. excess CH₃I
2. Ag₂O, H₂O heat
```

```
A. B. C. D.
```

```
A. B. C. D.
```
17. Predict the product for the following reaction sequence.

\[
\text{C} \quad \text{O} \quad \text{Cl} \quad \text{AlCl}_3 \quad (\text{CH}_3)_2\text{NH} \quad \text{H}^+, \text{H}_2/\text{Pt}
\]

18. Which of the following D-aldoses will produce an optically inactive product when treated with \( \text{NaBH}_4/\text{H}_2\text{O} \)?

A. \( \text{CH}_2\text{OH} \)  B. \( \text{CH}_2\text{OH} \)  C. \( \text{CH}_2\text{OH} \)  D. \( \text{CH}_2\text{OH} \)

19. What is the pI of the following amino acid?

A. 2.76  B. 5.74  C. 6.62  D. 7.5
20. Which one of the following is the correct structure for polyisobutylene?

A. \[
\begin{array}{c}
\text{H} \\
\text{Ph}
\end{array}
\overbrace{\text{C} \quad \text{C}}^n
\begin{array}{c}
\text{CH}_3 \\
\text{H}
\end{array}
\]

B. \[
\begin{array}{c}
\text{H} \\
\text{CN}
\end{array}
\overbrace{\text{C} \quad \text{C}}^n
\begin{array}{c}
\text{H} \\
\text{H}
\end{array}
\]

C. \[
\begin{array}{c}
\text{H} \\
\text{Ph}
\end{array}
\overbrace{\text{C} \quad \text{C}}^n
\begin{array}{c}
\text{H} \\
\text{H}
\end{array}
\]

D. \[
\begin{array}{c}
\text{H} \\
\text{CH}_3
\end{array}
\overbrace{\text{C} \quad \text{C}}^n
\begin{array}{c}
\text{H} \\
\text{H}
\end{array}
\]

21. Please choose an appropriate oxidizing agent for the following reaction.

\[
\text{OH} \quad \rightarrow \quad \text{O} \quad \text{OH}
\]

A. LiAlH₄  B. H₂/Pt  C. PCC  D. H₂CrO₄

22. Which of these compounds best fits these data? It is soluble in water, and turns red litmus blue. It has only one major IR band, at 2950 cm⁻¹, and has the following ¹H NMR spectrum: 2.7 ppm, 2H; 2.2 ppm, 6H; 1.0 ppm, 3H.

A. N,N-dimethylethanamine  
B. propanoic acid  
C. 2-propanol  
D. 2-methylpropane

23. What is the major product for the following reaction?

\[
\text{Br}_2/\text{CCl}_4 \quad \text{cold, dark}
\]

A.  
B.  
C.  
D.  
24. Which position is most likely to undergo an EAS reaction?

A. 

B. 

C. 

D. 

25. How would you convert an unsaturated fatty acid into a saturated fatty acid?

A. KMnO₄, OH⁻, heat
B. OH⁻, H₂O, heat; then H₃O⁺
C. H₂, Ni, pressure
D. H₃O⁺, H₂O, heat

26. What structure has the following proton NMR spectrum?

¹H NMR: doublet, 6.6 ppm, 2H
doublet, 7.8 ppm, 2H
broad singlet, 4.2 ppm, 2H
singlet, 2.1 ppm, 3H
27. Which of the following is the correct synthesis of the compound shown?

![Diagram of synthesis](image)

A. 
B. 
C. 
D. 

28. Which one is the correct intermediate for the *major product* of following reaction?

![Diagram of reaction](image)

A. 
B. 
C. 
D. 

29. Which of the following molecules has the lowest boiling point?

A. CH₃CH₂CH₂NH₂  
B. CH₃CH₂NHCH₃  
C. (CH₃)₃N  
D. (CH₃)₃NHCl
30. Which is the correct synthesis of the compound shown, from benzene?

A. \( \text{Br}_2/\text{FeBr}_3 \)

B. \( \text{Br}_2/\text{FeBr}_3 \)

C. \( \text{Mg/Ether} \)

D. \( \text{H}_2\text{C}=\text{O} \)

31. What is the major product for the following reaction?

A. \( \text{KOC(CH}_3)_3 \)

B. \( \text{H}_2\text{O}^- \)

C. \( \text{Cl}_2 \)

D. \( \text{H}_3\text{O}^- \)

32. What is the IUPAC name for the following compound?

A. 1-methyl-N-butyl-1-butanimine

B. 4-methyl-5-octanamine

C. 1-ethyl-N-propyl-1-pentanamine

D. N-propyl-2-pentanamine
33. A pentapeptide has the molecular composition: Arg, Glu, Ile, Phe, Leu. After partial hydrolysis, the fragments are: Glu-Ile, Leu-Arg, Phe-Leu, Arg-Glu. What is the sequence?

A. Phe-Leu-Arg-Glu-Ile
B. Ile-Glu-Arg-Leu-Phe
C. Arg-Glu-Ile-Phe-Leu
D. Phe-Leu-Glu-Ile-Arg

34. Predict the product for the following reaction.

\[
\text{Cyclopentane} \xrightarrow{1. \text{O}_3} \xrightarrow{2. \text{Zn, H}_3\text{O}^+} \text{Product}
\]

A. OH
B. OH
C. OH
D. OH

35. What is the product of the following reaction?

\[
\text{NH} \xrightarrow{\text{KOH}} \xrightarrow{\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}} \xrightarrow{\text{H}_3\text{O}^+, \text{H}_2\text{O}} \text{Product}
\]

A. \(\text{H}_2\text{N} - \text{CH}_2\text{CH}_2\text{NH}_2\)
B. \(\text{NH}_2\)
C. \(\text{Br} - \text{CH}_2\text{CH}_2\text{NH}_2\)
D. \(\text{CH}_2\text{NH}_2\)

36. Which of the following compounds is able to undergo a self-aldol condensation?

A. phenylethanal
B. formaldehyde
C. benzaldehyde
D. 2,2-dimethylpropanal
37. The best synthesis of 1,4-dimethyl-2-nitrobenzene is:

A. Benzene \[ \text{HNO}_3, \text{H}_2\text{SO}_4 \rightarrow 2\text{ CH}_3\text{Cl}, 2\text{ AlCl}_3 \]

B. Toluene \[ \text{HNO}_3, \text{H}_2\text{SO}_4 \rightarrow \text{CH}_3\text{Cl}, \text{AlCl}_3 \]

C. p-xylene \[ \text{HNO}_3, \text{H}_2\text{SO}_4 \]

D. m-nitrotoluene \[ \text{CH}_3\text{Cl}, \text{AlCl}_3 \]

38. Which of these is the most reliable way to make 3-heptene?

A. \( \text{CH}_3\text{CH}_2\text{CHBrCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 + \text{NaOCH}_3, \text{heat} \)

B. \( \text{CH}_3\text{CH}_2\text{CH}=\text{O} + \text{Ph}_3\text{P}=\text{CHCH}_2\text{CH}_2\text{CH}_3 \)

C. \( \text{CH}_3\text{CH}_2\text{CHOHCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 + \text{H}_2\text{SO}_4, \text{heat} \)

D. \( \text{CH}_3\text{CH}_2\text{C}≡\text{CCH}_2\text{CH}_2\text{CH}_3 + \text{H}_2/\text{Pt} \)

39. Predict the major product for the following reaction.

\[
\begin{align*}
\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4/\text{H}_2\text{O} & \rightarrow 1. \text{Br}_2/\text{PBr}_3 \\
2. \text{H}_2\text{O} & 
\end{align*}
\]

A. Br

B. Br

C. Br

D. Br

40. Please indicate the # of signals in the \( ^{13}\text{C} \) NMR and \( ^1\text{H} \) NMR spectra for the following compound:

A. \( ^4^{13}\text{C} \) NMR and \( ^4^1\text{H} \) NMR

B. \( ^{10}^{13}\text{C} \) NMR and \( ^7^1\text{H} \) NMR

C. \( ^6^{13}\text{C} \) NMR and \( ^4^1\text{H} \) NMR

D. \( ^8^{13}\text{C} \) NMR and \( ^5^1\text{H} \) NMR
41. What is the major product of this reaction?

\[
\begin{array}{c}
\text{HO} \\
\text{B.} \\
\text{OH} \\
\text{D.}
\end{array}
\]

42. Predict the product of the following reaction.

\[
\begin{array}{c}
\text{A.} \\
\text{B.} \\
\text{C.} \\
\text{D.}
\end{array}
\]

43. What is the IUPAC name for:

\[
\text{A. 5-hydroxy-2-phenyl-3-hexanone}
\text{B. 2-hydroxy-5-phenyl-4-hexanone}
\text{C. 2-hydroxypropyl-1-phenylethylketone}
\text{D. 5-hydroxy-3-keto-2-phenylhexane}
\]
44. Which step is not part of the base-catalyzed aldol condensation mechanism?

A. 

B. 

C. 

D. 

45. Which is true for aromatic but not antiaromatic compounds?

A. Are cyclic and planar
B. Are monocyclic
C. Have a conjugated system with p orbital at every vertex
D. Satisfy Hückel’s rule
46. What is the major product of this reaction?

\[
\begin{array}{c}
\text{H}_2\text{SO}_4 \\
\text{(CH}_3\text{)}_2\text{NH} \\
\text{(-H}_2\text{O)}
\end{array}
\]

[Chemical structures: A, B, C, D]

47. A compound with the molecular formula C₈H₁₄O₄ shows an IR band at 1740 cm⁻¹ but not 2500-3500 cm⁻¹. The proton NMR spectrum consists only of a triplet at 1.3 ppm, a triplet at 2.6 ppm and a singlet at 4.2 ppm. The most likely structure is:

[Chemical structures: A, B, C, D]

48. Predict the product(s) for the following reaction.

[Chemical structures: A, B, C, D]
49. Rank the reactivity of the following dienes with maleic anhydride, starting with the fastest.

A. IV > I > II > III  
B. III > IV > II > I  
C. III > II > I > IV  
D. IV > III > II > I  

50. How many pi electrons are there in the following aromatic compound?

A. 14  
B. 16  
C. 12  
D. 18