Chem 250

This exam is composed of 50 questions.

As discussed in the course syllabus, honesty and integrity are absolute essentials for this class. In fairness to others, dishonest behavior will be dealt with to the full extent of University regulations.

I hereby state that all answers on this exam are my own and that I have neither gained unfairly from others nor have I assisted others in obtaining an unfair advantage on this exam.

Signature

PERIODIC TABLE OF THE ELEMENTS
1. Which molecule below has the lowest boiling point?

 octane
 hexane
 2,3-dimethylbutane

1) octane  2) hexane  3) 2,3-dimethylbutane

2. Which two molecules above are constitutional isomers?

1) A and B  2) C and D  3) B and C  4) A and D  5) none are constitutional isomers of each other

3. The molecule at right is

1) a cis isomer  2) a trans isomer  3) not an isomer

4. In the molecule at right, the ideal bond angle around the 4-carbon is:

1) 120°  2) 109°  3) 90°  4) 180°
5. The addition reaction product of the reaction of HCl and 3-hexene is:
   1) 1-dodecene  
   2) 6-dodecane  
   3) 1-chlorohexane  
   4) 3-chlorohexane  
   5) 3,4-dichlorohexane

6. Which molecule below has the lowest boiling point?
   ![butane and 1-propanol](image)
   1) butane  
   2) 1-propanol

7. Which is the stronger acid?
   1) cyclohexanol  
   2) phenol  
   3) they are the same

8. In the molecule at right, which atom is a chiral center?
   ![molecule with atoms A to E](image)
   1) A  
   2) B  
   3) C  
   4) D  
   5) E

9. How many stereoisomers are possible for the molecule at right?
   ![molecule with OH group](image)
   1) 0  
   2) 1  
   3) 4  
   4) 6  
   5) 8

10. Which is the strongest base?
    ![ammonia, hydrazine, hydroxide, and ether](image)
    1)  
    2)  
    3)  
    4)  
    5) 

11. Ketones are reduced by H₂ and an appropriate catalyst to
    1) esters  
    2) alcohols  
    3) carboxylic acids  
    4) the parent alkanes  
    5) ketones are not readily reduced
12. The molecules shown at right represent
   1) Tautomers – two inteconverting, but different molecules
   2) Tautomers – two ways of looking at the same molecule
   3) Resonance Forms – two interconverting, but different molecules
   4) Resonance Forms – two ways of looking at the same molecule

13. The reaction of butanoic acid and LiAlH$_4$ in water yields:
   1) CO$_2$ and propanal
   2) CO$_2$ and propanoic acid
   3) water and butanol
   4) water and butanal
   5) nothing. No reaction occurs.

14. From what parent molecules can the molecule at right be synthesized?
   1) toluene and methyl acetate
   2) benzoic acid and methanol
   3) benzene and acetic acid
   4) acetic acid and phenol

15. Heating the molecule at right yields which products?
   1) propanoic acid and carbon dioxide
   2) acetic acid and propanoic acid
   3) butanoic anhydride
   4) 2-butanone and carbon dioxide
   5) no reaction occurs
16. The products of the following reaction are

\[
\begin{align*}
1) & \quad \text{O} \quad \text{O} \quad \text{NH}_2 + \\
2) & \quad \text{O} \quad \text{NH}_2 \quad \text{O} + \\
3) & \quad \text{O} + \quad \text{NH}_2 \\
4) & \quad \text{N} \quad \text{H} \quad \text{O} + \\
5) & \quad \text{None of the above}
\end{align*}
\]

17. Hydrolysis of propyl anhydride is represented by which reaction below?

\[
\begin{align*}
1) & \quad \text{O} \quad \text{O} \quad \text{H} \quad \text{O} \quad \text{O} \quad \text{H} \quad \text{O} \\
2) & \quad \text{O} \quad \text{O} \quad \text{H} \quad \text{O} \quad \text{O} \quad \text{H} \quad \text{O} \\
3) & \quad \text{O} \quad \text{O} \quad \text{H} \quad \text{O} \quad \text{O} \quad \text{H} \quad \text{O} \\
4) & \quad \text{O} \quad \text{O} \quad \text{H} \quad \text{O} \quad \text{O} \quad \text{H} \quad \text{O}
\end{align*}
\]
18. In the conversion of ATP to ADP, which is most likely?
   1) water attacks the γ phosphate
   2) water attacks the α phosphate
   3) the sugar 2’OH attacks the α phosphate
   4) the sugar 2’OH attacks the γ phosphate
   5) oxygen on the γ phosphate attacks the α phosphate

19. Compare the linear and circular forms of glucose. Carbon 5’ in the linear form corresponds to which carbon in the circular form?
   1) A  2) B  3) C  4) D  5) E

20. The geometry at the 3’ carbon in the linear form of glucose is:
   1) tetrahedral  2) square planar  3) trigonal planar

21. Glycolipids contain what characteristic head group?
   1) sphingosines  2) carbohydrates  3) cholesterol
   4) steroids  5) phosphates

22. Triglycerides are based on which chemical framework?

23. In metabolism, CoA-SH usually reacts directly with
   1) alcohols  2) esters  3) anhydrides
   4) carboxylic acids  5) water
24. In the Citric Acid cycle, succinate reacts with FAD. In this reaction, succinate:
   1) isomerizes
   2) is phosphorylated
   3) is dephosphorylated
   4) is oxidized
   5) is reduced

25. In respiration, a $H^+$ gradient across the mitochondrial membrane is used to drive the following unfavorable reaction:
   1) $\text{ADP} + P_i \rightarrow \text{ATP}$
   2) $\text{ATP} \rightarrow \text{ADP} + P_i$
   3) $\text{NAD}^+ \rightarrow \text{NADH} + H^+$
   4) $\text{NADH} + H^+ \rightarrow \text{NAD}^+$
   5) $\beta$ oxidation of fatty acids

26. In one of the reactions of glycolysis, glucose is phosphorylated:

   ![Glucose phosphorylation](image)

Which common metabolite is another reactant in this process?
   1) Coenzyme A  
   2) NADH  
   3) FAD  
   4) ATP  
   5) Pyruvate

27. In one of the reactions of glycolysis, pyruvate is converted to lactate:

   ![Pyruvate conversion](image)

Which common metabolite is another reactant in this process?
   1) Coenzyme A  
   2) NADH  
   3) FAD  
   4) ATP  
   5) ACP

28. The reactions of gluconeogenesis are simply the reactions of glycolysis run in reverse
   1) True  
   2) False

29. In the synthesis of fats, fatty acids are activated by reaction with:
   1) NADH  
   2) Coenzyme A  
   3) FAD  
   4) ATP  
   5) Pyruvate
30. In the amino acid linkage shown at right, which bond has a high energy cost for rotation?
   1) 1  2) 2  3) 3  4) 4

31. Which of the following amino acids is most likely to be found in the interior of a protein?
   1) Ile  2) Lys  3) Asn  4) Arg  5) Ser

32. Which of the following amino acids is best at forming two simultaneous hydrogen bonds with another functional group in a protein or nucleic acid?
   1) Ile  2) Lys  3) Pro  4) Ser  5) Gln

33. Which interaction below involves hydrogen bonds between amino acids separated by less than 5 residues in primary sequence?
   1) disulfide linkages  2) β-sheets  3) α-helices  4) electrostatics

34. A stretch of a protein contains the sequence –Leu-Asn-Ile-Arg-Val-Asp-Ile-Lys-Val-
   This stretch most likely lies in
   1) in an α-helix on the surface of the folded protein
   2) in an α-helix in the interior of the folded protein
   3) in a β-sheet on the surface of the folded protein
   4) in a β-sheet in the interior of the folded protein
   5) in a turn buried in the interior of the folded protein

35. An enzyme can increase the rate of a reaction by
   1) raising the energy of the reactants
   2) lowering the energy of the products
   3) lowering the energy of the transition state
   4) raising the temperature of the reactants
   5) increasing homeopathic vibrations
36. In the reaction below, “feedback control” refers to:

\[ \text{A} \xrightarrow{E_1} \text{B} \xrightarrow{E_2} \text{C} \xrightarrow{E_3} \text{D} \]

1) Enzyme E₃ binds to reactant A, preventing its reaction with enzyme E₁
2) Enzyme E₃ is redirected to generate product A, rather than product D
3) Enzyme E₃ binds to and inhibits enzyme E₁
4) Binding of product D to enzyme E₁ inhibits the enzyme
5) Binding of intermediate B to enzyme E₃ inhibits the enzyme

37. Which class of enzyme most likely utilizes NAD⁺ as a reactant?
1) transferase 2) dehydrogenase 3) isomerase 4) hydrolase 5) ligase

38. Allostery refers to
1) modifications such as phosphorylation, that modulate enzyme activity
2) binding of a regulatory molecule at an enzyme site different from the active site
3) induced fit binding of a substrate in an active site
4) the biosynthesis of different forms of an enzyme in different tissues
5) a change in structure of the active site to better fit the bound substrate

39. Which amino acid side chain is most likely phosphorylated by ATP by the kinase enzyme? (note you are not expected to know this, but to deduce it from what you’ve learned in this course)
1) Gly 2) Arg 3) Leu 4) Ala 5) Tyr

40. Which statement below is most correct?
1) Chemical messengers are cells that bind to other cells, injecting chemical signals
2) Chemical messengers penetrate cell membranes to bind to proteins inside the cell
3) Chemical messengers are ligands that bind to protein receptors on cell membranes
4) Chemical messengers react with other messengers to trigger changes in the cell
5) Chemical messengers ride bicycles to deliver key messages
41. In the cytidine base at right, which most completely lists the H–bond donors?
   1) B, C, and D
   2) A and B
   3) A and E
   4) D and E
   5) D, C, and E

42. DNA and RNA can be best characterized as
   1) nonpolar
   2) polar
   3) charged
   4) all of the above

43. DNA and RNA polymerase active sites distinguish Watson-Crick base pairs from other base pairs by
   1) interactions with the sugar and phosphate backbone
   2) interactions in the major groove
   3) interactions in the minor groove
   4) the intrinsic strength of the base pair
   5) channeling with the spirit of Francis Crick

44. Which is more likely to have enzyme-like activity?
   1) RNA
   2) DNA
   3) they have the same likelihood

45. Which base pair above is not a Watson-Crick pair?
   1) A
   2) B
   3) C
46. Which amino acid is best for recognizing a GC base pair via major groove interactions?
   1) Gln  2) Ser  3) Lys  4) Arg  5) Pro

47. In eukaryotes, genes contain
   1) introns and ribozymes  2) introns and exons  3) exons and gluons
   4) introns and promoters  5) klingons and muggles

48. Water is a unique molecule in that it
   1) is very low in mass
   2) has polar and nonpolar parts
   3) can solubilize anything
   4) is small and can simultaneously accept 2 and donate 2 H-bonds
   5) can be mass-marketed

49. Which arrow below represents the nucleophilic attack that would be required in formation of the GA dinucleotide?

50. What is the course number of this class?
   1) 111  2) 250  3) 496  4) 728