"Grade or Education" = 1

CHEM 2060/01
Summer 15
Final Exam
Chapters 1 - 17

1. Five acid-base reactions are shown below, numbered 1 through 5. By using the pKa table below the reactions figure out which of these reactions will proceed in the direction indicated (ie. the position of equilibrium is in the product direction).

   1. $CH_3OH + CH_3COOH \rightarrow CH_3OH_2^+ + CH_3COO^-$
   2. $CH_3NH_2 + CH_3OH \rightarrow CH_3NH_3^+ + CH_3O^-$
   3. $CH_3OH + OH^- \rightarrow CH_3O^- + H_2O$
   4. $NH_4^+ + CH_3NH_2 \rightarrow NH_3 + CH_3NH_3^+$
   5. $CH_3COO^- + CH_3OH \rightarrow CH_3COOH + CH_3O^-$

Formula	pKa	Formula	pKa	Formula	pKa
HCl	-7	CH_3OH	15.5	CH_3NH_2	40
H_3O^+	-1.7	$CH_3OH_2^+$	-2.5	$CH_3NH_3^+$	10.7
H_2O	15.7	CH_3COOH	4.8	NH_4^+	9.4

__ A. The equilibrium for reaction 5 lies to the right (toward product) as indicated.

__ B. The equilibrium for reaction 2 lies to the right (toward product) as indicated.

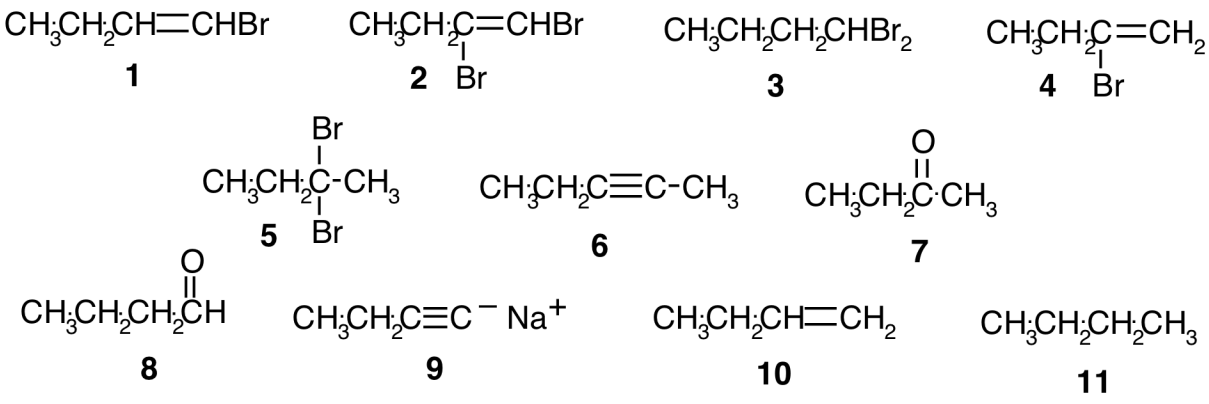
__ C. The equilibrium for reaction 1 lies to the right (toward product) as indicated.

__ D. The equilibrium for reaction 3 lies to the right (toward product) as indicated.

__ E. The equilibrium for reaction 4 lies to the right (toward product) as indicated.

Rationale:
Problem 2.10

2. Figure out the structure of major product of the reaction of 1 mol of 1-butyne with each of the reagents specified in the multiple choices. Choose the **CORRECT** statement from these choices. Use the numbered structures below for reference.



__ A. 1 mol of 1-butyne reacts with H_2/Lindlar catalyst to form product with structure **10**.

__ B. 1 mol of 1-butyne reacts with 1 mol of HBr to form product with structure **1**.

__ C. 1 mol of 1-butyne reacts with excess H_2, Pt/C to form product with structure **10**.

__ D. 1 mol of 1-butyne reacts with 2 mol of HBr to form product with structure **3**.

__ E. 1 mol of 1-butyne reacts with aqueous H_2SO_4 to form product with structure **8**.

Rationale:
Problem 5.57

3. Find the **CORRECT** statement regarding hierarchy in protein structure.

__ A. Subunit designations like $\alpha_2\beta_2$ where the Greek letters α and β are used to designate the subunits refer to the 3° structure of a protein.

__ B. The 1° structure of a protein is maintained via hydrogen bonding in the backbone.

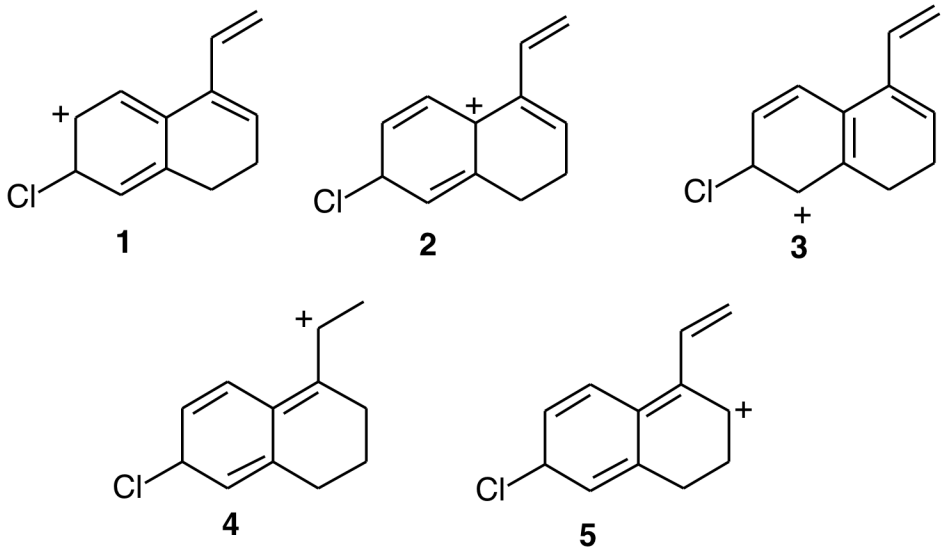
__ C. The disulfide linkages which are formed by the sidechains in cysteine can show up in either the 1° or 2° structure of a protein.

__ D. Hydrogen bonding between amide N-H and amide C=O groups in the backbone of a protein holds together the 2° structure of the protein.

__ E. Hydrogen bonding between N-H and amide C=O groups in the sidechains of two different amino acids of a protein can be involved in creating the the 2° structure of the protein.

Rationale:
Problem 16.29

4. Look at the structures below. All of these structures are resonance contributors for the same ion (and for one another) except for one. Find the structure which is **NOT** a resonance contributor for the same ion as the others. Hint: pick a structure and draw a resonance contributor for it. If your structure matches one of the other structures on the test page then it is not the bad structure, so you can draw all of the other contributors for the structure you picked and get the bad structure by eliminating the others. If the contributor you drew for the structure you picked to work with doesn't match any of the structures on the page then your original pick is the bad resonance structure. Which is the bad resonance structure?



__ A. **1**

__ B. **1**

__ C. **4**

__ D. **1**

__ E. **1**

Rationale:
Problem 7.23

5. Draw the most stable structure of cis-1-isopropyl-3-methylcyclohexane. What positions (axial or equatorial) are the two substituents in?

__ A. None of the other statements is correct.

__ B. The methyl group is axial and the isopropyl group is equatorial.

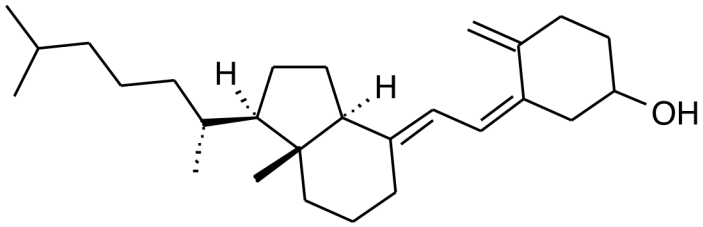
__ C. Both substituents are in the equatorial position.

__ D. The methyl group is equatorial and the isopropyl group is axial.

__ E. Both substituents are in the axial position.

Rationale:
Problem 3.55

6. Shown below is the molecular structure of vitamin D_3. Carefully mark all of the carbons which are assymetric centers (ie. chiral carbons). How many assymetric carbons are there?



__ A. 2

__ B. 3

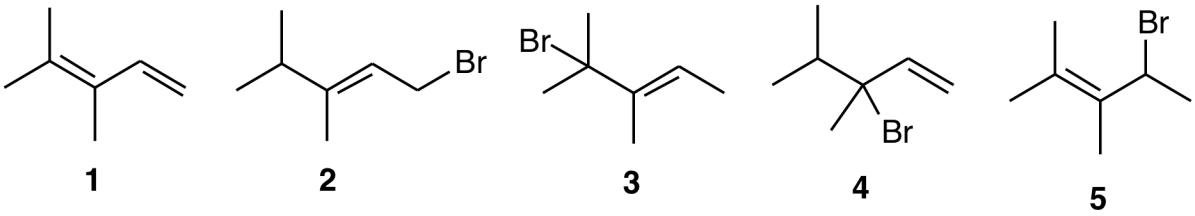
__ C. 5

__ D. 1

__ E. 4

Rationale:
Problem 6.21

7. Find the structures of the products of the reaction of 3,4-dimethyl-1,3-pentadiene (structure **1** below) with one equivalent of HBr



1 **2** **3** **4** **5**

.

__ A. The products of this reaction have structures **3** and **5**.

__ B. The products of this reaction have structures **2** and **3**.

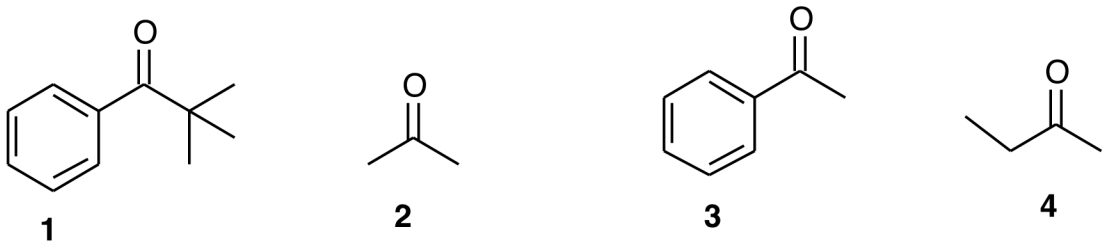
__ C. The products of this reaction have structures **4** and **5**.

__ D. The products of this reaction have structures **2** and **4**.

__ E. The products of this reaction have structures **3** and **4**.

Rationale:
Problem 7.46

8. Pick the choice which lists the compounds whose structures are shown below in order of **DECREASING** reactivity toward nucleophilic attack (most reactive compound structure listed first).



__ A. **4** > **1** > **2** > **3**

__ B. **1** > **2** > **3** > **4**

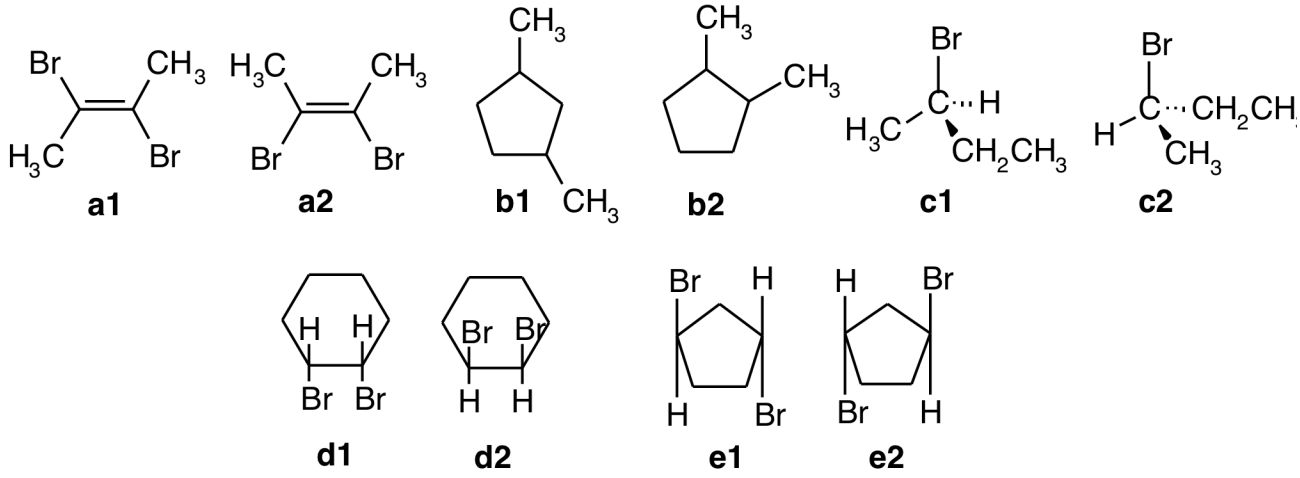
__ C. **3** > **2** > **1** > **4**

__ D. **2** > **4** > **3** > **1**

__ E. **3** > **1** > **4** > **2**

Rationale:
Problem 12.22

9. Examine the pairs of structures below. A pair of structures shares the same letter in its label, like **a1** and **a2**. Figure out whether each pair of structures represent identical compounds, enantiomers, diasteriomers, or constitutional isomers. Pick the choice which gives the **CORRECT** relationship between one of these pairs of structures.



__ A. **d1** and **d2** are enantiomers.

__ B. **a1** and **a2** are constitutional isomers.

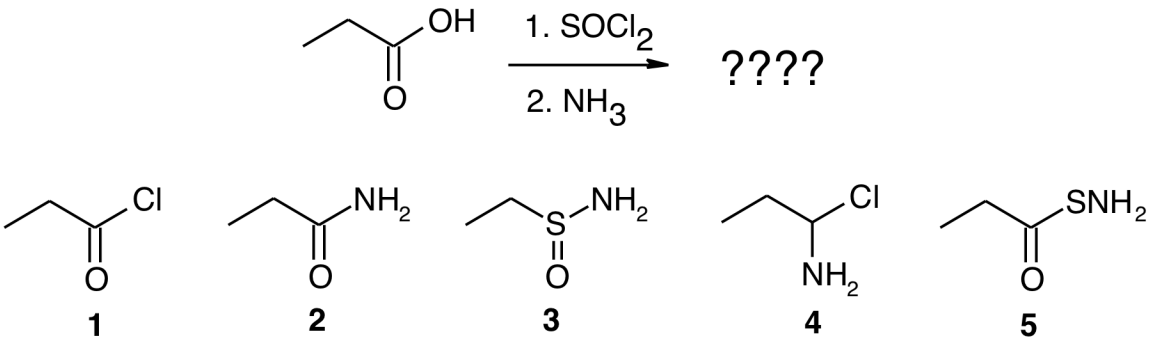
__ C. **b1** and **b2** are diasteriomers.

__ D. **e1** and **e2** are enantiomers.

__ E. **c1** and **c2** are enantiomers.

Rationale:
Problem 6.36

10. Find the structure of the reaction shown below from among the numbered structures shown below the reaction. What is the correct structure of the organic product of this reaction?



__ A. **4**

__ B. **5**

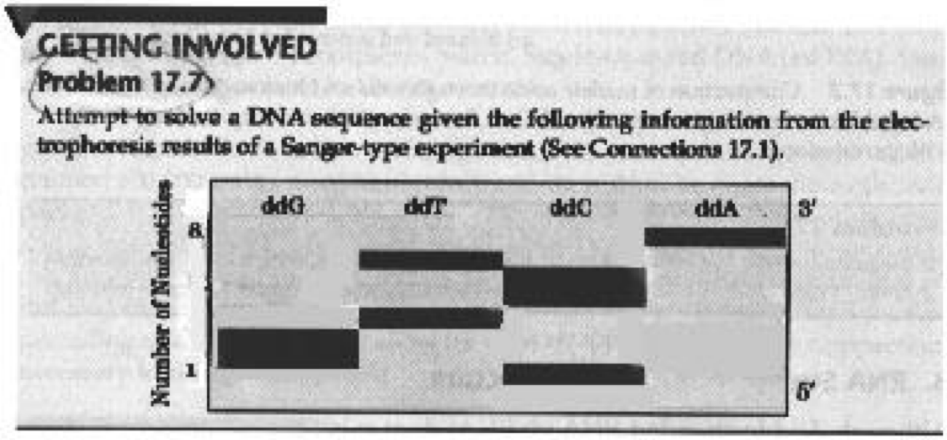
__ C. **2**

__ D. **3**

__ E. **1**

Rationale:
Problem 11.38

11. Shown below is a depiction of a Sanger-type gel experiment for determining a DNA sequence. Choose the correct DNA sequence corresponding to the information shown in the figure below.



__ A. 5'-dC dG dG dT dC dC dT dA-3'

__ B. 5'-dA dT dC dC dT dG dG dC-3'

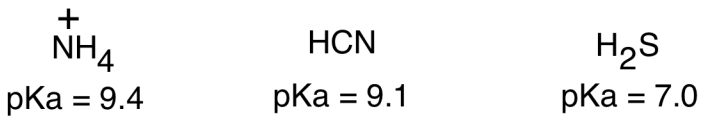
__ C. 5'-dC dA dA dG dC dC dT dA-3'

__ D. 5'-dA dC dC dC dT dT dG dG-3'

__ E. 5'-dG dG dT dT dC dC dC dA-3'

Rationale:
Problem 17.7

12. For each of the acidic compounds shown below whose pK_a values are shown below them figure out which form predominates at the pH values given in the multiple choices and pick the choice which is **CORRECT**.



__ A. HCN is predominantly in the CN^- form if pH = 10.

__ B. HCN is predominantly in the CN^- form if pH = 3.

__ C. H_2S is predominantly in the H_2S form if pH = 14.

__ D. H_2S is predominantly in the HS^- form if pH = 6.

__ E. NH_4^+ is predominantly in the NH_4^+ form if pH = 14.

Rationale:
Problem 2.21

13. In this problem pairs of amino acids are designated by their three-letter abbreviations. Figure out the names of these amino acids and look up their structures using the tables at the rear of this exam. By examining the sidechains of these pairs of amino acids figure out what kind of interaction(s) these pairs of sidechains might have in helping to create 3° and/or 4° structure in a protein. Pick the **CORRECT** statement from the multiple choices.

__ A. The Glu-Arg sidechain interaction would involve the formation of a salt bridge.

__ B. The Ser-His sidechain interaction would involve a hydrophobic interaction.

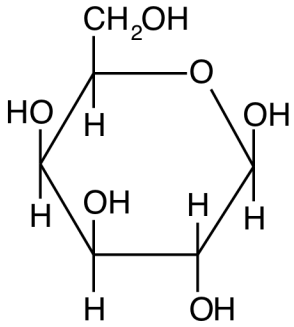
__ C. The Met-Met sidechain interaction would involve a disulfide linkage.

__ D. The Val-Leu sidechain interaction would involve the formation of a salt bridge.

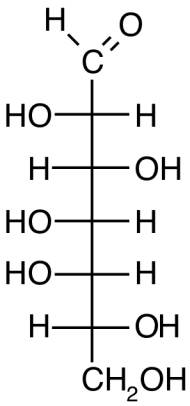
__ E. The Ile-Leu sidechain interaction would involve a hydrophilic inderaction.

Rationale:
Problem 16.30

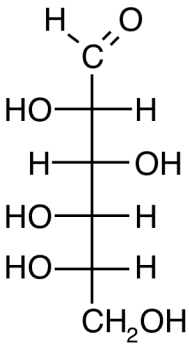
14. Shown below is the structure of β-D-galactose, in Haworth projection form, labelled structure **1**. Find the Fisher projection for the open-chain form of D-galactose from among the other numbered structures. Which structure is it?



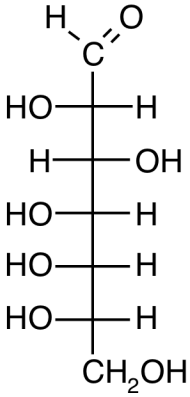
1



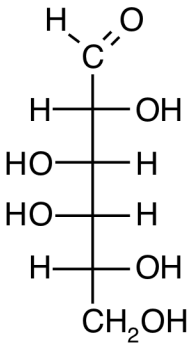
2



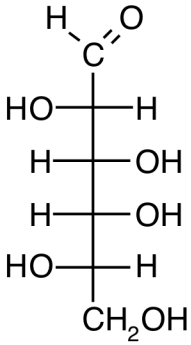
3



4



5



6

__ A. **6**

__ B. **5**

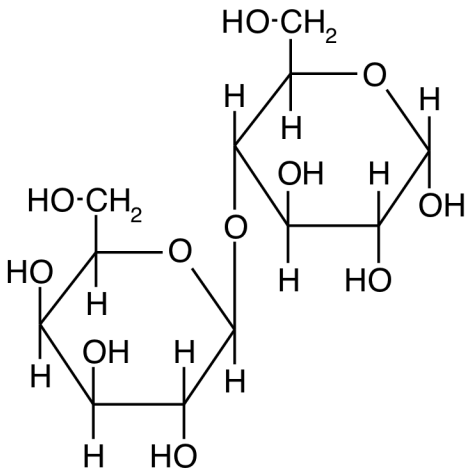
__ C. **4**

__ D. **2**

__ E. **3**

Rationale:
Problem 14.22

15. Shown below is the structure of the disaccharide lactose (milk sugar). What is the proper specification for the glycosidic bond that connects the two sugar units in lactose?



__ A. α-1,4

__ B. β,α-1,4

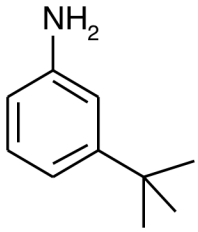
__ C. α,α-1,4

__ D. α,β-1,4

__ E. β-1,4

Rationale:
Problem 14.25

16. Pick the choice which gives a **CORRECT** synthesis of 3-tert-butylaniline (structure below) starting with benzene.



__ A. React the benzene first with H_2/Pd. Next react with tert-butyl chloride/$AlCl_3$. Finally react with HNO_3/H_2SO_4.

__ B. React the benzene first with H_2/Pd. Next react with HNO_3/H_2SO_4. Finally react with tert-butyl chloride/$AlCl_3$.

__ C. React the benzene first with tert-butyl chloride/$AlCl_3$. Next react with HNO_3/H_2SO_4. Finally react with H_2/Pd.

__ D. React the benzene first with tert-butyl chloride/$AlCl_3$. Next react with H_2/Pd. Finally react with HNO_3/H_2SO_4.

__ E. React the benzene first with HNO_3/H_2SO_4. Next react with tert-butyl chloride/$AlCl_3$. Finally react with H_2/Pd.

Rationale:
Problem 8.34

17. By using the amino acid tables on the rear of your exam calculate the pI of histidine. Figure out which electric pole histidine would migtate toward in an electric field at a pH = 5.5, pH = 7.5, and pH = 9.5. Choose the **CORRECT** statement from the multiple choices.

__ A. At pH = 7.5 histidine will not migrate toward either electric pole.

__ B. At pH = 5.5 histidine will migrate toward the positive electric pole.

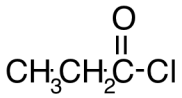
__ C. At pH = 9.5 histidine will migrate toward the negative electric pole.

__ D. At pH = 7.5 histidine will migrate toward the positive electric pole.

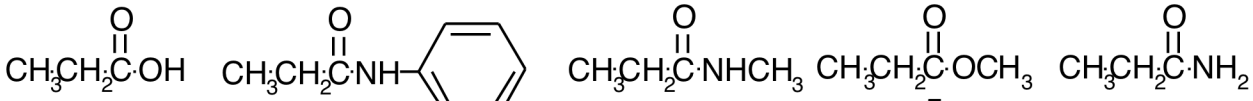
__ E. At pH = 7.5 histidine will migrate toward the negative electric pole.

Rationale:
Problem 16.4

18. Figure out the structures of the reaction products resulting from the reaction of propionyl chloride (structure **1** below) with all of the substances mentioned in the multiple choices. Which of the multiple choices gives the **CORRECT** structure for the reaction product?



1



2 **3** **4** **5** **6**

__ A. Reaction of propionyl chloride with dimethylamine, CH_3NHCH_3, gives the product with structure **4**.

__ B. Reaction of propionyl chloride with acetic acid, CH_3COOH, gives the product with structure **2**.

__ C. Reaction of propionyl chloride with ethanol, CH_3CH_2OH, gives the product with structure **5**.

__ D. Reaction of propionyl chloride with ammonia, NH_3, gives the product with structure **6**.

__ E. Reaction of propionyl chloride with benzoic acid, C_6H_5COOH gives the product with structure **3**.

Rationale:
Problem 11.28

19. Pick the statement which **CORRECTLY** identifies a formula as that of a nucleophile or an electrophile.

__ A. CH_3NH_2 is an electroophile.

__ B. $CH_3C{\equiv}C^-$ is an electrophile.

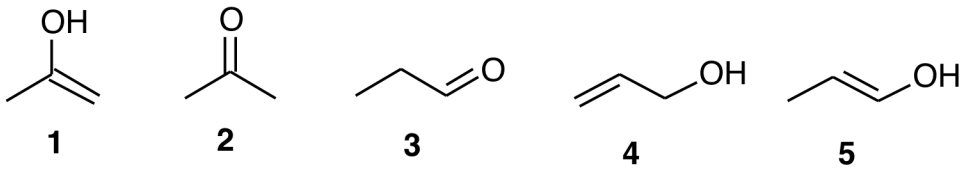
__ C. NO_2^+ is a nucleophile

__ D. H_3O^+ is a nucleophile.

__ E. CH_3O^- is a nucleophile.

Rationale:
Problem 4.14

20. Look at the labelled structures below. Identify the structures which are keto-enol tautomers of one another and pick the **CORRECT** statement from the multiple choices.



1 **2** **3** **4** **5**

__ A. **5** is an enol tautomer of **2**.

__ B. **1** is the enol tautomer of **3**.

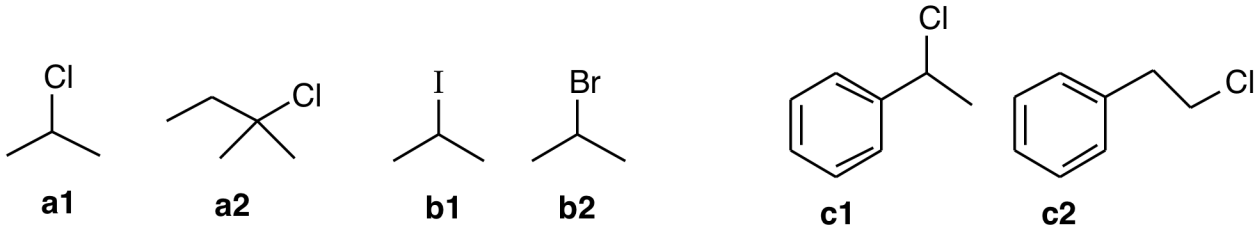
__ C. **4** is the enol tautomer of **3**.

__ D. **1** is an enol tautomer of **2**.

__ E. **4** is the enol tautomer of **2**.

Rationale:
Problem 5.64

21. In each of the three pairs of structures shown below circle the label of the structure of the compound which would react faster in an S_N1 reaction. Pairs of structures share the same letter in their labels, like **a1** and **a2**. Pick the choice which lists all of the structure labels that you circled.



__ A. **a1**, **b2**, and **c2** react faster via S_N1.

__ B. **a1**, **b1**, and **c1** react faster via S_N1.

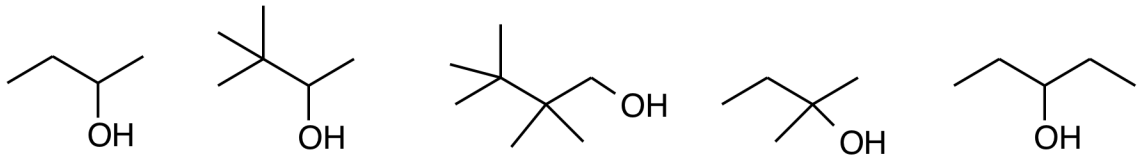
__ C. **a1**, **b2**, and **c1** react faster via S_N1.

__ D. **a2**, **b1**, and **c1** react faster via S_N1.

__ E. **a1**, **b1**, and **c2** react faster via S_N1.

Rationale:
Problem 9.11

22. Examine the structures of the alcohols shown below and figure out whether each structure is that of a primary, secondary, or tertiary alcohol. Choose the **CORRECT** statement from the multiple choices.



__ A. The compound with structure **5** is a tertiary alcohol.

__ B. The compound with structure **4** is a secondary alcohol.

__ C. The compound with structure **1** is a primary alcohol.

__ D. The compound with structure **3** is a primary alcohol.

__ E. The compound with structure **2** is a tertiary alcohol.

Rationale:
Problem 10.2

23. Think about whether or not each of the chemicals referred to in the multiple choices would make a good soap or detergent and select the choice which is **CORRECT**.

__ A. $CH_3(CH_2)_{16}SO_3^-Na^+$ would make a good detergent because has at least ten carbons and also an ionic group on one end which is not a carboxylate.

__ B. $CH_3(CH_2)_{16}SO_3^-Na^+$ would make a good soap because has at least ten carbons and also an ionic group on one end which is not a carboxylate.

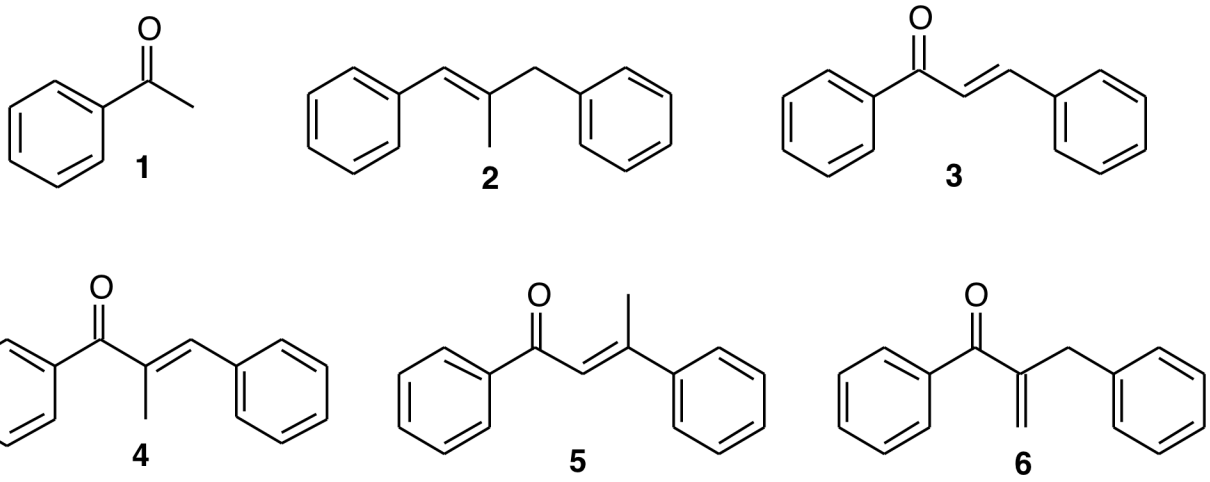
__ C. $CH_3CH_2CH_2COO^-Na^+$ would make a good soap because it is the salt of a fatty acid.

__ D. $CH_3CH_2CH_2COOH$ would make a good soap because it is a fatty acid.

__ E. $CH_3(CH_2)_{16}COO^-Na^+$ would make a good detergent because it is the salt of a fatty acid.

Rationale:
Problem 15.18

24. Find the structure of the product obtained from the aldol condensation of the ketone with structure **1** shown below, after dehydration, from among the other numbered structures below. Which is the correct structure?



__ A. **5**

__ B. **6**

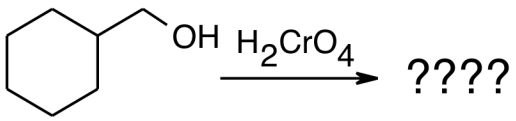
__ C. **2**

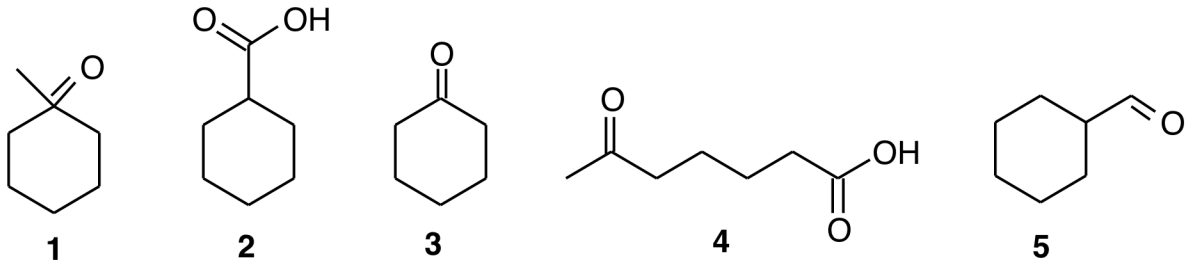
__ D. **3**

__ E. **4**

Rationale:
Problem 13.12

25. What happens when the compound whose structure is shown below is treated with chromic acid?





__ A. The compound with structure **2** is formed.

__ B. The compound with structure **1** is formed.

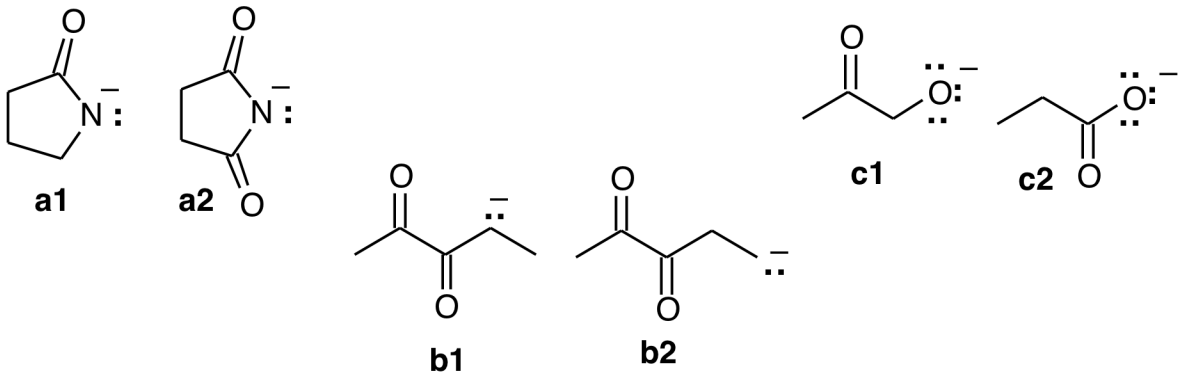
__ C. The compound with structure **3** is formed.

__ D. The compound with structure **5** is formed.

__ E. The compound with structure **4** is formed.

Rationale:
Problem 10.12

26. In each of the three pairs of structures shown below circle the label of the more stable structure. Pairs of structures share the same letter in their labels, like **a1** and **a2**. Pick the choice which lists all of the (more stable) structure labels that you circled.



__ A. **a1**, **b1**, and **c1** are the most stable structures.

__ B. **a1**, **b2**, and **c2** are the most stable structures.

__ C. **a2**, **b2**, and **c2** are the most stable structures.

__ D. **a1**, **b2**, and **c1** are the most stable structures.

__ E. **a2**, **b1**, and **c2** are the most stable structures.

Rationale:
Problem 7.31

27. What is the molecular formula of a hydrocarbon which has 40 carbons, three triple bonds, two double bonds, and one ring?

__ A. $C_{40}H_{62}$

__ B. $C_{40}H_{64}$

__ C. $C_{40}H_{68}$

__ D. $C_{40}H_{22}$

__ E. $C_{40}H_{70}$

Rationale:
Problem 4.32

28. Arachidonic acid is an $\omega 6$ fatty acid with the shorthand designation $C_{20:4}$. At what positions is this fatty acid unsaturated?

__ A. 2, 5, 8, 11, 14, and 17

__ B. 6, 9, 12, and 15

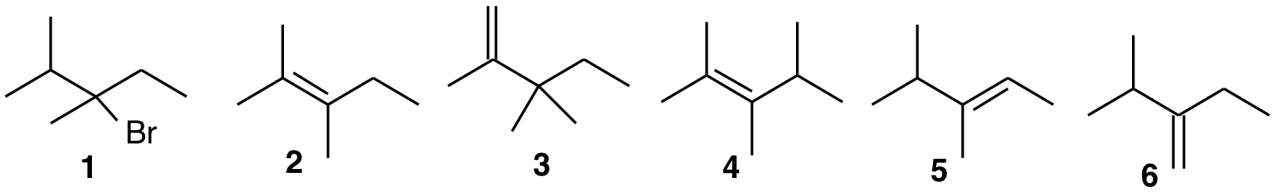
__ C. 1, 4, 7, 10, 13, and 16

__ D. 5, 8, 11, and 14

__ E. 2, 6, 10, and 14

Rationale:
Problem 15.17

29. Find the structure of the major elimination product which results from the reaction of the substance with structure **1** (see below) with hydroxide ion. Pick the choice which gives the correct structure label for this product.



__ A. **6**

__ B. **4**

__ C. **2**

__ D. **5**

__ E. **3**

Rationale:
Problem 9.15

30. By examining the m-RNA code table at the rear of this exam find the proper amino acid sequence which would be produced from a segment of m-RNA with the sequence 5'-...GAUAAUCAUUAU...-3'

__ A. H_2N...Tyr-Ser-Stop-Stop...COOH

__ B. H_2N...Tyr-His-Asn-Asp...COOH

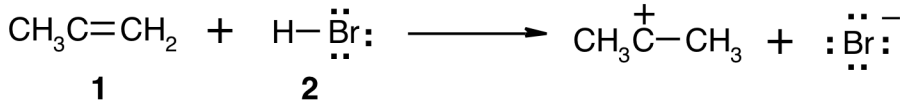
__ C. H_2N...Ser-Pro-Thr-Ala...COOH

__ D. H_2N...Asp-Asn-His-Tyr...COOH

__ E. H_2N...Ala-Thr-Pro-Ser...COOH

Rationale:
Problem 17.8

31. Identify the electrophile and the nucleophile in the reaction shown below. Then draw curved arrows on the test to illustrate the bond-making and bond-breaking processes involved in this reaction. Pick the **CORRECT** statement from the multiple choices.



1 **2**

__ A. There are four curved arrows involved in this process.

__ B. One of the curved arrows originates at a nonbonding pair of electrons on the Br atom in particle **2** and points to a H atom attached to the middle C atom in particle **1**.

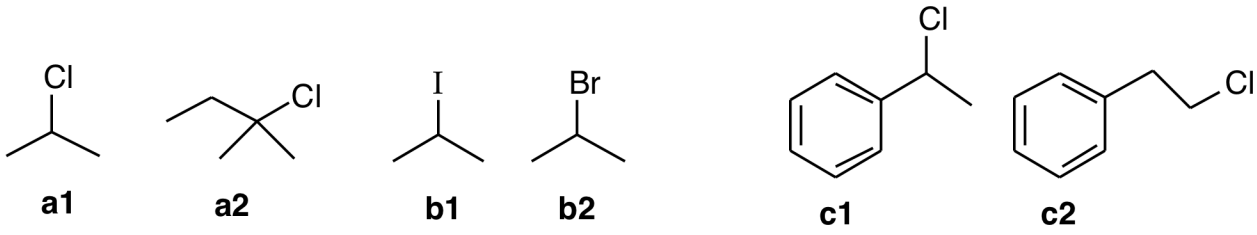
__ C. One of the curved arrows originates at the bond between H and Br in particle **2** and points to the double bond between two C atoms in particle **1**.

__ D. The particle with structure **1** is the nucleophile and **2** is the electrophile in this reaction.

__ E. One of the curved arrows originates at the hydrogen atom attached to particle **2** and points to the double bond in particle **1**.

Rationale:
Problem 5.52

32. In each of the three pairs of structures shown below circle the label of the structure of the compound which would react faster in an S_N2 reaction. Pairs of structures share the same letter in their labels, like **a1** and **a2**. Pick the choice which lists all of the structure labels that you circled.



a1 **a2** **b1** **b2** **c1** **c2**

__ A. **a1**, **b1**, and **c1** react faster via S_N2.

__ B. **a2**, **b2**, and **c2** react faster via S_N2.

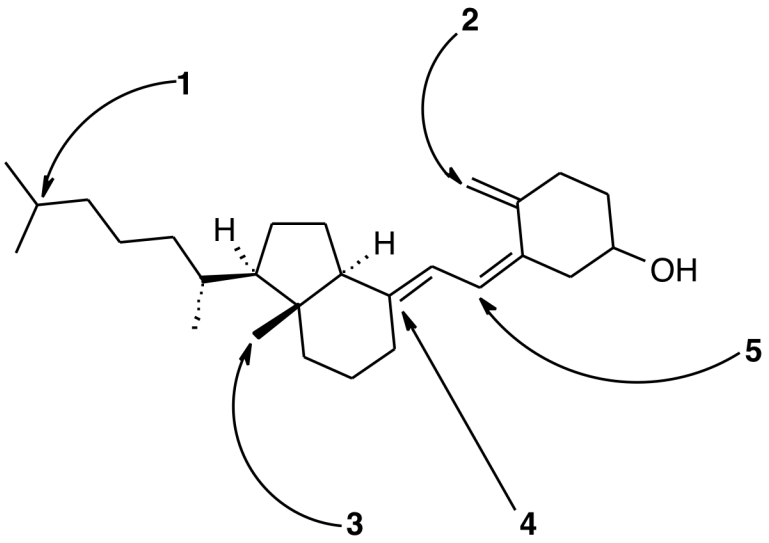
__ C. **a1**, **b2**, and **c1** react faster via S_N2.

__ D. **a1**, **b1**, and **c2** react faster via S_N2.

__ E. **a2**, **b1**, and **c2** react faster via S_N2.

Rationale:
Problem 9.10

33. Shown below is the structure of a molecule of vitamin D_3. Figure out how many hydrogens are attached to each of the carbons pointed to by the numbered arrows and choose the **CORRECT** statement from the multiple choices.



__ A. The carbon pointed to by arrow **5** is attached to 2 hydrogen atoms.

__ B. The carbon pointed to by arrow **1** is attached to 0 hydrogen atoms.

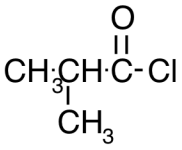
__ C. The carbon pointed to by arrow **3** is attached to 1 hydrogen atoms.

__ D. The carbon pointed to by arrow **4** is attached to 1 hydrogen atom.

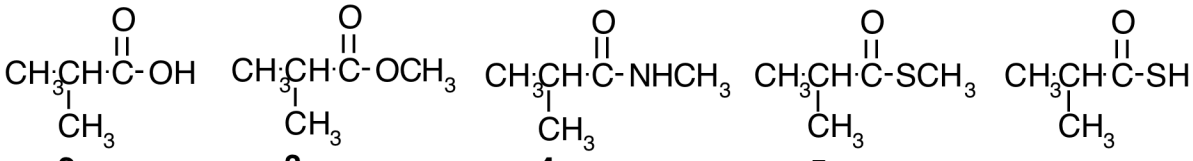
__ E. The carbon pointed to by arrow **2** is attached to 2 hydrogen atoms.

Rationale:
Problem 3.9

34. Figure out what nucleophile needs to be reacted with 2-methylpropionyl chloride (structure **1** below) to produce all of the products whose structures are shown below the structure of 2-methylpropionyl chloride. Pick the **CORRECT** statement from the multiple choices.



1



2 **3** **4** **5** **6**

__ A. When 2-methylpropionyl chloride reacts with CH_3NHCH_3 the product with structure **4** is produced.

__ B. When 2-methylpropionyl chloride reacts with CH_3COOH the product with structure **2** is produced.

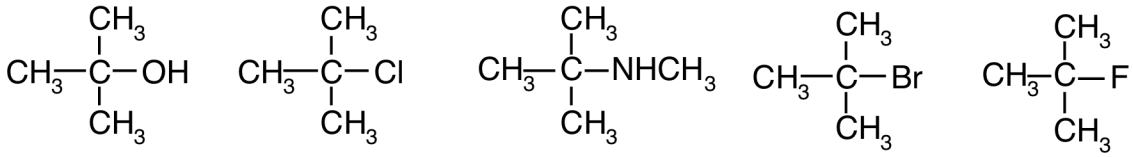
__ C. When 2-methylpropionyl chloride reacts with CH_3SH the product with structure **6** is produced.

__ D. When 2-methylpropionyl chloride reacts with CH_3OH the product with structure **3** is produced.

__ E. When 2-methylpropionyl chloride reacts with CH_3SCH_3 the product with structure **5** is produced.

Rationale:
Problem 11.10

35. Look at the structures below and decide whether the functional group in each one is primary, secondary or tertiary. Choose the **CORRECT** answer from the multiple choices.



1 **2** **3** **4** **5**

__ A. Structure **1** is secondary.

__ B. Structure **5** is secondary.

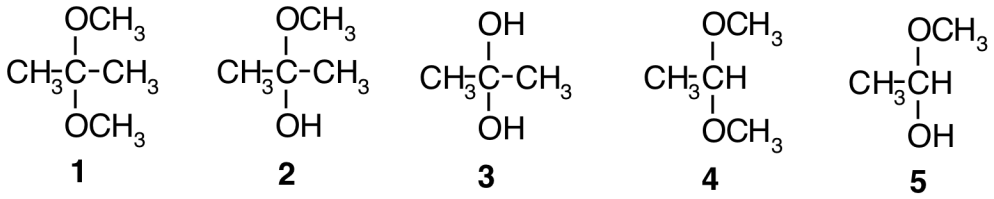
__ C. Structure **3** is secondary.

__ D. Structure **4** is secondary.

__ E. Structure **2** is secondary.

Rationale:
Problem 3.15

36. Look at the numerically-labelled structures below. Figure out whether each structure is an acetal, hemiacetal, ketal, hemiketal, or hydrate. Pick the **CORRECT** choice from the multiple choices.



1 **2** **3** **4** **5**

__ A. **1** is an acetal.

__ B. **3** is a ketal.

__ C. **5** is a hemiketal.

__ D. **4** is an acetal.

__ E. **2** is a hemiacetal.

Rationale:
Problem 12.17

37. What m-RNA sequence would be generated by the DNA sequence 3'-...GCATTGGCTCGA...-5'?

__ A. 5'-...AGCUCGGUUACG...-3'

__ B. 5'-...CGUAACCGAGCU...-3'

__ C. 5'-...TCGAGCCAATGC...-3'

__ D. 5'-...CGTAACCGAGCT...-3'

__ E. 5'-...UCGAGCCAAUGC...-3'

Rationale:
Problem 17.12

38. What would be the order of the anticodon bases in t-RNA which would lay down on a strand of m-RNA with the sequence 5'-...CACAUAGCCUGA...-3'?

__ A. 3'-...AGTCCGATACAC...-5'

__ B. 3'-...TCAGGCTATGTG...-5'

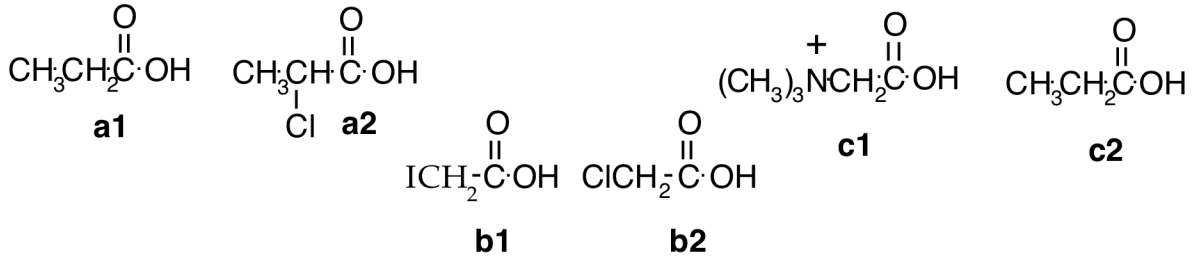
__ C. 3'-...UCAGGCUAUGUG...-5'

__ D. 3'-...GUGUAUCGGACU...-5'

__ E. 3'-...CACAUAGCCUGA...-5'

Rationale:
Problem 17.12

39. In each of the three pairs of structures shown below circle the label of the structure of the compound which is more acidic. Pairs of structures share the same letter in their labels, like **a1** and **a2**. Pick the choice which lists all of the structure labels that you circled.



__ A. **a2**, **b1**, and **c2** are more acidic.

__ B. **a1**, **b2**, and **c2** are more acidic.

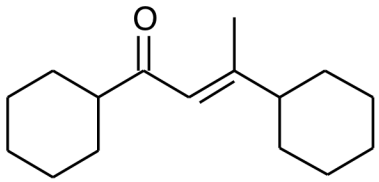
__ C. **a1**, **b1**, and **c1** are more acidic.

__ D. **a1**, **b1**, and **c2** are more acidic.

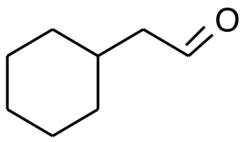
__ E. **a2**, **b2**, and **c1** are more acidic.

Rationale:
Problem 8.22

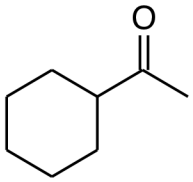
40. If you wanted to prepare the compound with structure **1** shown below using an aldol condensation, what would be the structure of the compound you would start with?



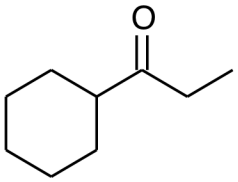
1



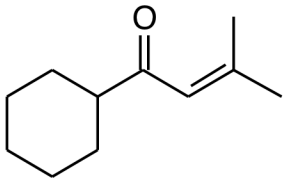
2



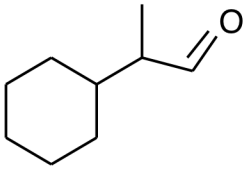
3



4



5



6

__ A. **2**
__ B. **6**
__ C. **5**
__ D. **3**
__ E. **4**

Rationale:
Problem 13.13a

Answer Key

"Grade or Education" = 1

CHEM 2060/01
Summer 15
Final Exam
Chapters 1 - 17

1. ERROR
2. A
3. D
4. ERROR
5. C
6. C
7. A
8. D
9. D
10. C
11. A
12. A
13. A
14. B
15. E
16. E
17. A
18. D

19. E
20. D
21. D
22. D
23. A
24. A
25. A
26. E
27. B
28. D
29. C
30. D
31. D
32. D
33. E
34. D
35. C
36. D
37. B
38. D
39. E
40. D