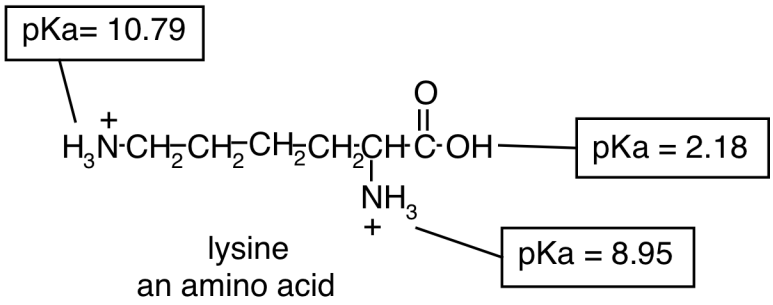
"Grade or Education" = 1

CHEM 2060/01
Summer 14
Final Exam
Chapters 1 - 17

1. A naturally occuring amino acid such as lysine has a carboxylic acid group and an amine group attached to the same alpha carbon, and often a third group, any of which can be charged or not, depending on the pH of the solution containing the amino acid. The pKa values of the three ionizable groups in the amino acid lysine are shown. Pick the choice which **CORRECTLY** states what charges the three ionizable groups will have at physiological pH (pH = 7.3).



__ A. At pH 7.3 the group with pKa 10.79 will have a +1 charge, the group with pKa 2.18 will have a –1 charge, and the group with pKa 8.95 will have a +1 charge.

__ B. At pH 7.3 the group all three groups will have no charge.

__ C. At pH 7.3 the group with pKa 10.79 will have a +1 charge, the group with pKa 2.18 will have no charge, and the group with pKa 8.95 will have a +1 charge.

__ D. At pH 7.3 the group with pKa 10.79 will have a –1 charge, the group with pKa 2.18 will have a +1 charge, and the group with pKa 8.95 will have a –1 charge.

__ E. At pH 7.3 the group with pKa 10.79 will have no charge, the group with pKa 2.18 will have no charge, and the group with pKa 8.95 will have a +1 charge.

Rationale:
Problem 2.17

2. Find the structure of glutamic acid and the pKa values of its ionizable functional groups in the tables at the rear of this exam and calculate its pI (isoelectric point) value. What value do you get?

__ A. 6.95

__ B. 5.95

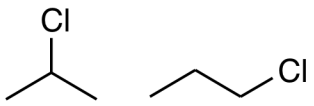
__ C. None of the other values is correct.

__ D. 6.00

__ E. 3.25

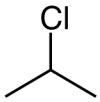
Rationale:
Problem 16.5

3. 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.

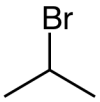


a1

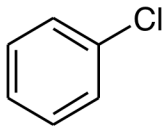
a2



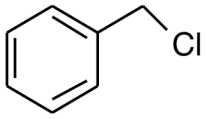
b1



b2



c1



c2

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

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

__ C. **a2**, **b1**, and **c2** react faster via S_N1.

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

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

Rationale:
Problem 9.11

4. 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'-...AGUCCGAUACAC...-3'?

__ A. 3'-...UCAGGCUAUGUG...-5'

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

__ C. 3'-...GUGUAUCGGACU...-5'

__ D. 3'-...AGTCCGATACAC...-5'

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

Rationale:
Problem 17.12

5. 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. $CH_3NH_2 + CH_3COOH \rightarrow CH_3NH_3^+ + CH_3COO^-$
3. $CH_3O^- + CH_3NH_2 \rightarrow CH_3OH + CH_3NH^-$
4. $NH_3 + CH_3NH_3^+ \rightarrow NH_4^+ + CH_3NH_2$
5. $CH_3COO^- + NH_4^+ \rightarrow CH_3COOH + NH_3$

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 3 lies to the right (toward product) as indicated.

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

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

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

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

Rationale:
Problem 2.10

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

__ A. Br^+ is a nucleophile

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

__ C. H_3O^+ is a nucleophile.

__ D. NH_3 is a nucleophile.

__ E. HO^- is an electrophile.

Rationale:
Problem 4.14

7. The multiple choices in this problem deal with substances, which, according to their chemical formulas should make good soaps, good detergents, or neither. Statements are made concerning which of these three categories each of these substances fall into and why. Most of these statements are wrong. Pick the choice which gives a **CORRECT** statement about the chemical compound given.

__ A. The substance with the formula $CH_3(CH_2)_{16}SO_3^-\ Na^+$ should make a good detergent because it is has a long hydrophobic region containing at least ten carbon atoms and a very hydrophilic ionic head group, but it cannot be a soap because it is not a fatty acid salt.

__ B. The substance with the formula $CH_3CO_2^-\ Na^+$ should make a good soap because it is the sodium salt of a carboxylic acid.

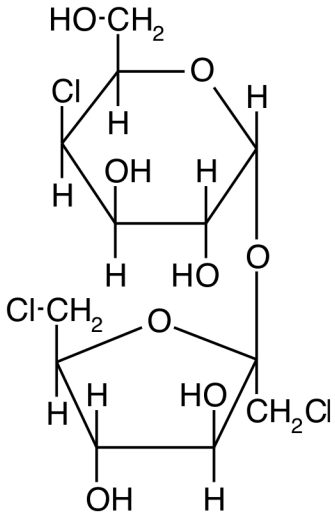
__ C. The substance with the formula NaCl should make both a good soap and a good detergent because it is ionic.

__ D. The substance with the formula $CH_3(CH_2)_{16}CH_3$ should make a good detergent because it is hydrophobic and will therefore dissolve grease and oil, but cannot be a soap because it is not a fatty acid salt.

__ E. The substance with the formula $[CH_3(CH_2)_{16}CO_2^-]_2\ Ca^{2+}$ should make a good soap because it is the salt of a fatty acid.

Rationale:
Problem 15.18

8. Shown below is the structure of the disaccharide artificial sweetner sucralose (Splenda-TM). What is the proper specification for the glycosidic bond that connects the two sugar units in sucralose?



__ A. β,α-1,2

__ B. α,α-1,2

__ C. α,β-1,1

__ D. α,β-1,2

__ E. β,β-1,2

Rationale:
Problem 14.25

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

__ A. Hydrogen bonding between N-H and amide C=O groups in the backbone of a protein holds together the 3° structure of the protein.

__ B. 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.

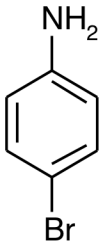
__ C. The 1° structure of a protein is maintained via hydrogen bonding in the backbone.

__ D. 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.

__ E. The disulfide linkages which are formed by the sidechains in cysteine can show up in either the 3° or 4° structure of a protein.

Rationale:
Problem 16.29

10. Pick the choice which gives a **CORRECT** synthesis of p-bromoaniline (structure below) starting with benzene.



__ A. React the benzene first with H_2/Pd. Next react with $Br_2/FeBr_3$. Finally react with HNO_3/H_2SO_4.

__ B. React the benzene first with HNO_3/H_2SO_4. Next react with H_2/Pd. Finally react with $Br_2/FeBr_3$.

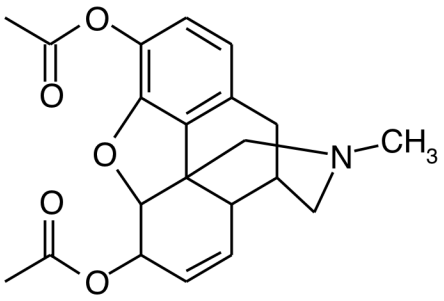
__ C. React the benzene first with H_2/Pd. Next react with HNO_3/H_2SO_4. Finally react with $Br_2/FeBr_3$.

__ D. React the benzene first with $Br_2/FeBr_3$. Next react with H_2/Pd. Finally react with HNO_3/H_2SO_4.

__ E. React the benzene first with $Br_2/FeBr_3$. Next react with HNO_3/H_2SO_4. Finally react with H_2/Pd.

Rationale:
Problem 8.34

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



__ A. 3

__ B. 1

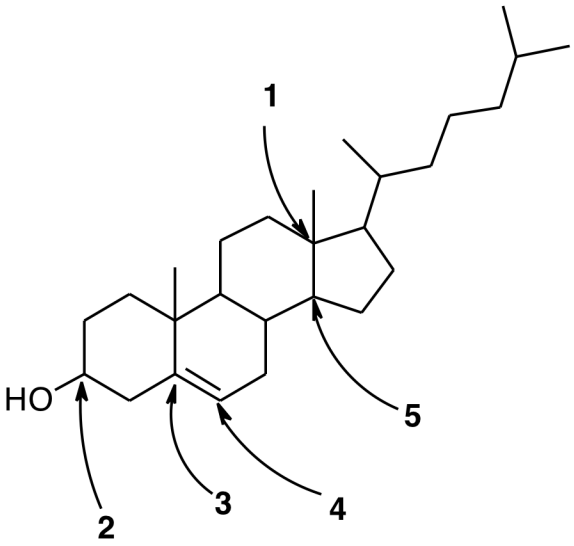
__ C. 5

__ D. 2

__ E. 4

Rationale:
Problem 6.21

12. Shown below is the structure of a molecule of cholesterol. 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 bt arrow **2** is attached to 2 hydrogen atoms.

__ B. The carbon pointed to bt arrow **3** is attached to 1 hydrogen atoms.

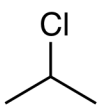
__ C. The carbon pointed to bt arrow **4** is attached to 0 hydrogen atoms.

__ D. The carbon pointed to bt arrow **1** is attached to 0 hydrogen atoms.

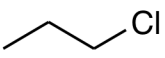
__ E. The carbon pointed to bt arrow **5** is attached to 2 hydrogen atoms.

Rationale:
Problem 3.9

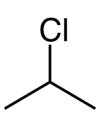
13. In each of the three pairs of structures shown below circle the label of the structure of the compound which would react faster in an S_N2 reaction. Pairs of structures share the same letter in their labels, like **a1** and **a2**. Pick the choice which lists all of the structure labels that you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



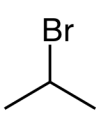
a1



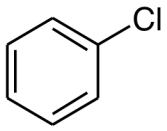
a2



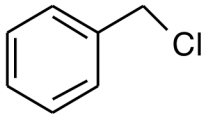
b1



b2



c1



c2

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

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

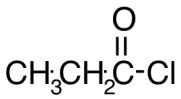
__ C. **a1**, **b1**, and **c2** react faster via S_N2.

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

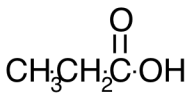
__ E. **a1**, **b1**, and **c1** react faster via S_N2.

Rationale:
Problem 9.10

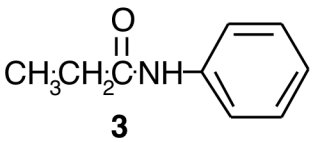
14. Figure out the structures of the reaction products resulting from the reaction of propionyl chloride (structure **1** below) with all of the substances mentioned in the multiple choices. Which of the multiple choices gives the **WRONG** structure for the reaction product?



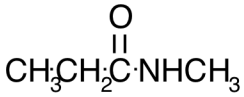
1



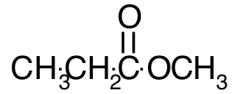
2



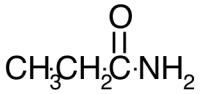
3



4



5



6

__ A. Reaction of **1** with water gives the product with structure **2**.

__ B. Reaction of **1** with ammonia gives the product with structure **6**.

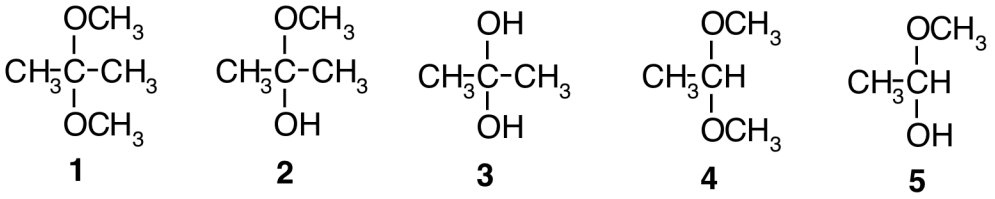
__ C. Reaction of **1** with aniline gives the product with structure **3**.

__ D. Reaction of **1** with dimethylamine gives the product with structure **4**.

__ E. Reaction of **1** with methanol gives the product with structure **5**.

Rationale:
Problem 11.28

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



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

__ A. **4** is a ketal.

__ B. **1** is an acetal.

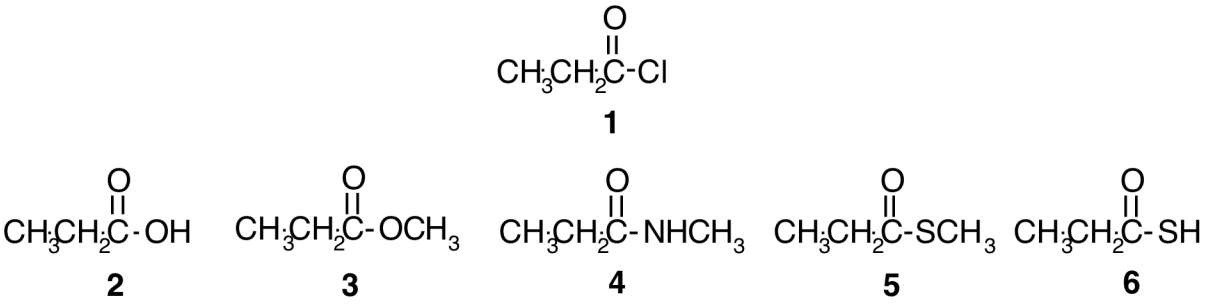
__ C. **3** is a hydrate.

__ D. **5** is a hemiketal.

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

Rationale:
Problem 12.17

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



1

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

__ A. When **1** reacts with CH_3COOH the product with structure **3** is produced.

__ B. When **1** reacts with CH_3NHCH_2OH the product with structure **4** is produced.

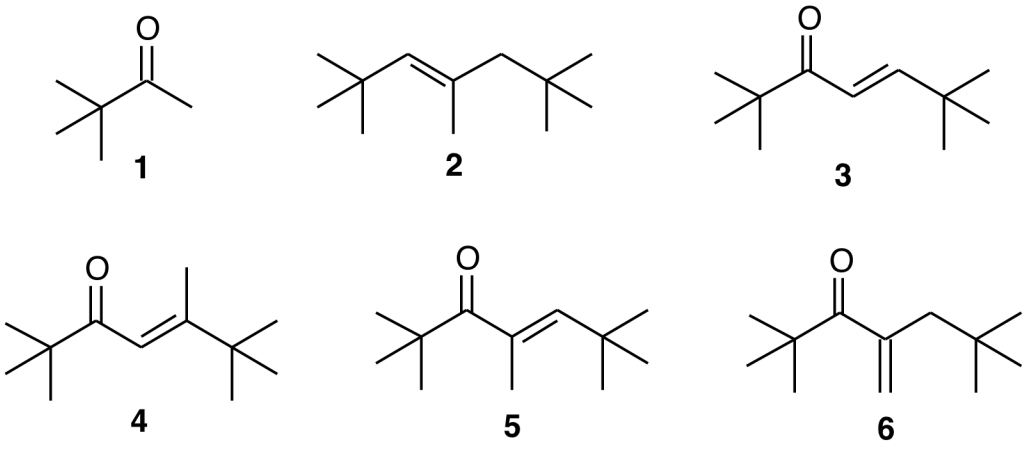
__ C. When **1** reacts with CH_3SH the product with structure **5** is produced.

__ D. When **1** reacts with CH_3SCH_2OH the product with structure **6** is produced.

__ E. When **1** reacts with CH_3CH_2OH the product with structure **2** is produced.

Rationale:
Problem 11.10

17. 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**

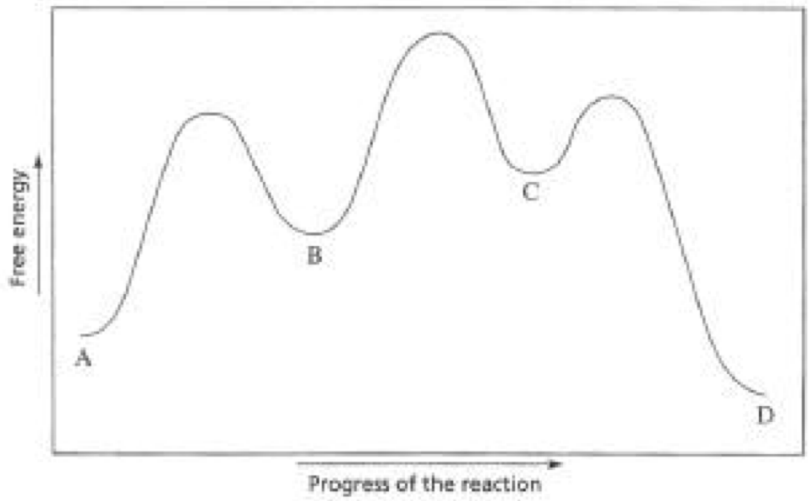
__ D. **3**

__ E. **4**

Rationale:
Problem 13.12

18. Shown below is the reaction coordinate diagram for the reaction which converts **A** sequentially into **B,** then **C**, and finally **D**, as indicated by the reaction below. Choose the statement which is **CORRECT** about this reaction from the multiple choices.

$$A \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} B \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} C \underset{k_{-3}}{\overset{k_3}{\rightleftharpoons}} D$$



__ A. There are two intermediates and three transition states in this reaction.

__ B. The fastest step in the forward direction is the one which converts **B** into **C**.

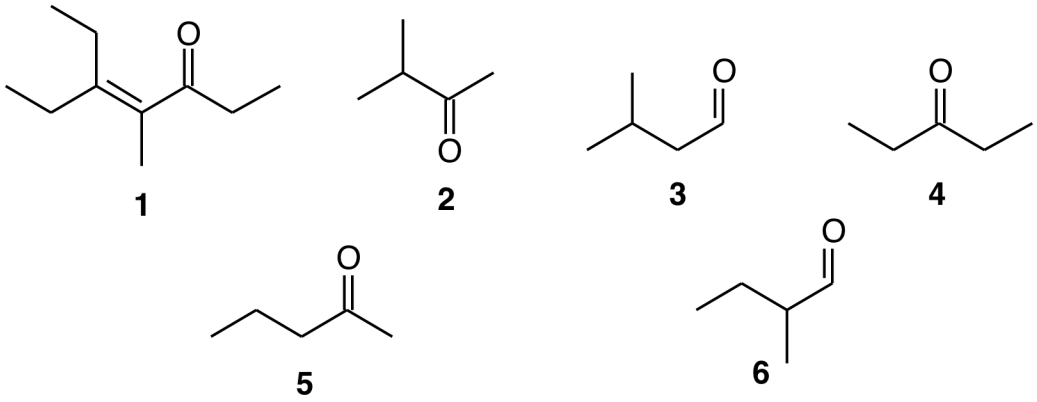
__ C. The rate constant for conversion of **C** to **D** (k_3) has the lowest value of any of the 6 rate constants shown.

__ D. The slowest step in the forward direction is the one which converts **A** into **B**.

__ E. Reactant **A** is more stable than product **D**.

Rationale:
Problem XXX

19. 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. **4**

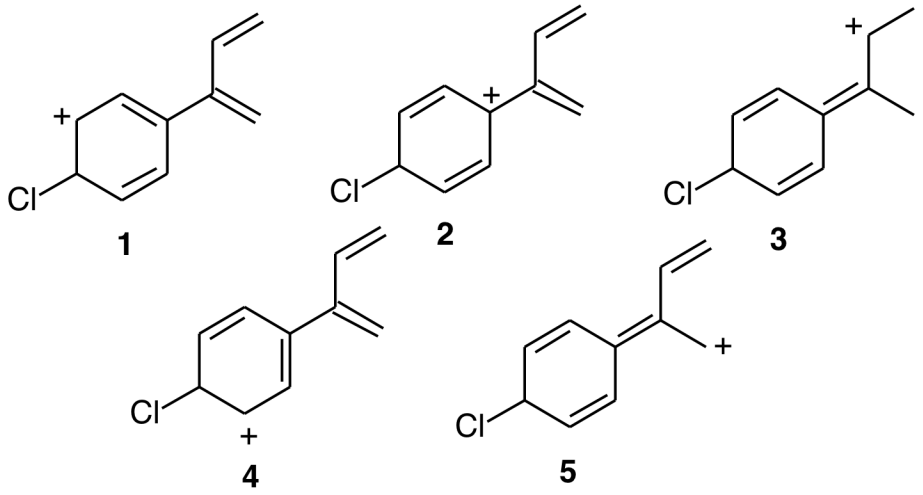
__ C. **6**

__ D. **3**

__ E. **5**

Rationale:
Problem 13.13a

20. 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 strucyure 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'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. **2**
__ C. **4**
__ D. **3**
__ E. **5**

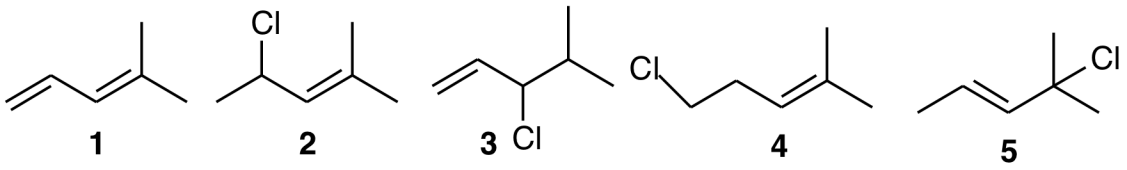
Rationale:
Problem 7.23

21. Draw the most stable structure of trans-1-isopropyl-4-methylcyclohexane. What positions (axial or equatorial) are the two substituents in?

__ A. The methyl group is axial and the isopropyl group is equatorial.
__ B. Both substituents are in the axial position.
__ C. The methyl group is equatorial and the isopropyl group is axial.
__ D. Both substituents are in the equatorial position.
__ E. None of the other statements is correct.

Rationale:
Problem 3.55

22. Find the structures of the products of the reaction of 4-methyl-1,3-pentadiene (structure **1** below) with one equivalent of HCl.



__ A. The products of this reaction have structures **2** and **5**.

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

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

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

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

Rationale:
Problem 7.46

23. 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'-...UAUCAUAAUGAU...-3'

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

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

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

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

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

Rationale:
Problem 17.8

24. 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 Ile-Leu sidechain interaction would involve a hydrophilic interaction.

__ B. The Glu-Arg sidechain interaction would involve a hydrophobic interaction.

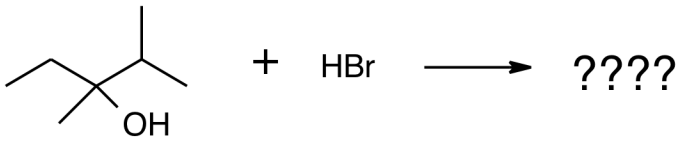
__ C. The Met-Met sidechain interaction would involve a disulfide linkage.

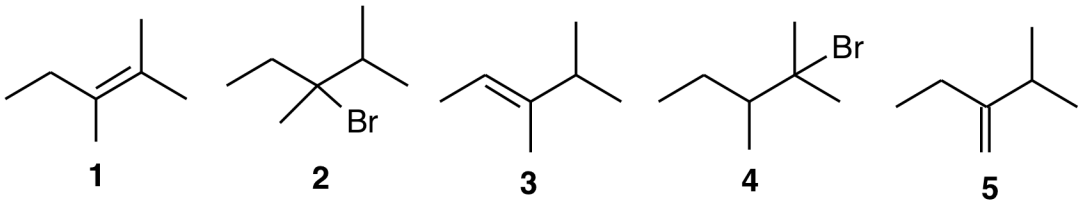
__ D. The Ser-His sidechain interaction would involve hydrogen bonding.

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

Rationale:
Problem 16.30

25. Find the structure of the major product of the reaction shown below from among the numbered structures and pick the choice which gives its numerical structure label.





__ A. **3**

__ B. **4**

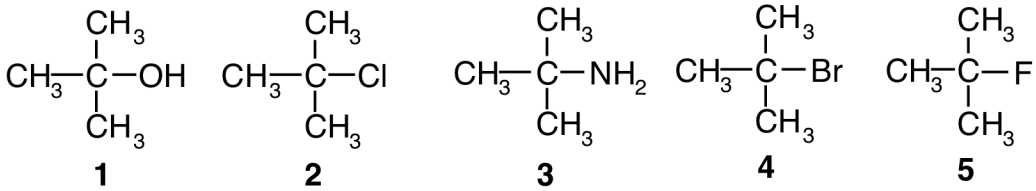
__ C. **2**

__ D. **5**

__ E. **1**

Rationale:
Problem 10.6

26. 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.



__ A. Structure **2** is primary.

__ B. Structure **5** is primary.

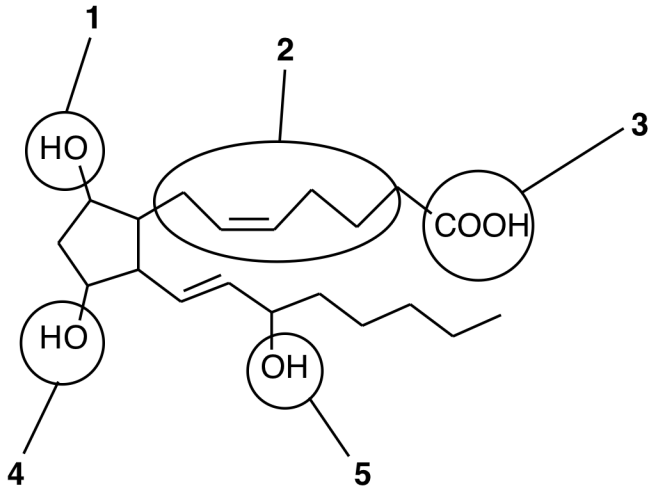
__ C. Structure **1** is primary.

__ D. Structure **4** is primary.

__ E. Structure **3** is primary.

Rationale:
Problem 3.15

27. Shown below is the structure of the lipid Prostaglandin $F_{2\alpha}$ (Dinoprost-TM). This prostaglandin is used to induce labor in pregnant women. Five regions of the prostaglandin molecule are circled and numerically labelled. Figure out which of these regions are hydrophobic and which are hydrophilic. Pick the **CORRECT** statement from the multiple choices.



__ A. Region **1** is hydrophobic.

__ B. Region **2** is hydrophilic.

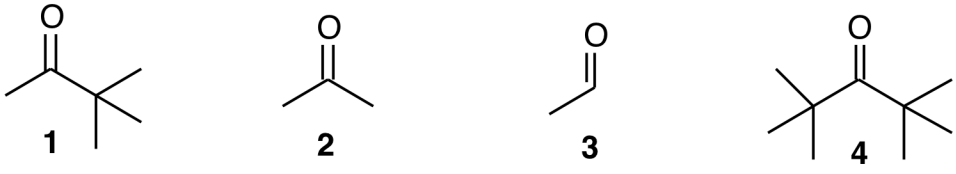
__ C. Region **5** is hydrophobic.

__ D. Region **4** is hydrophilic.

__ E. Region **3** is hydrophobic.

Rationale:
Problem 15.9

28. 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. **1** > **2** > **3** > **4**

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

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

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

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

Rationale:
Problem 12.22

29. What is the molecular formula of a hydrocarbon with 20 carbons, two triple bonds, a double bond, and two rings?

__ A. $C_{20}H_{28}$

__ B. $C_{20}H_{30}$

__ C. $C_{20}H_{36}$

__ D. $C_{20}H_{32}$

__ E. $C_{20}H_{42}$

Rationale:
Problem 4.32

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

__ A. 5'-...TCGAGCCAATGC...-3'

__ B. 5'-...AGCUCGGUUACG...-3'

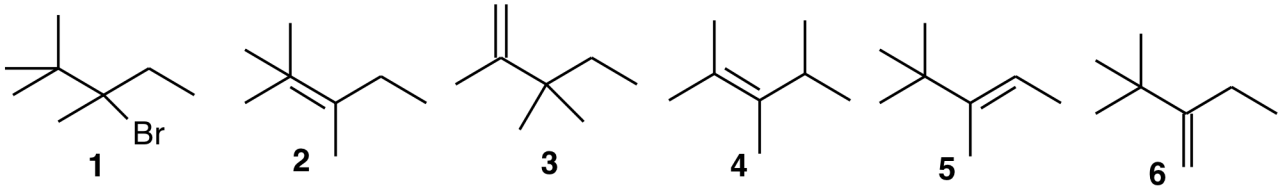
__ C. 5'-...CGUAACCGAGCU...-3'

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

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

Rationale:
Problem 17.12

31. 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. **2**

__ B. **6**

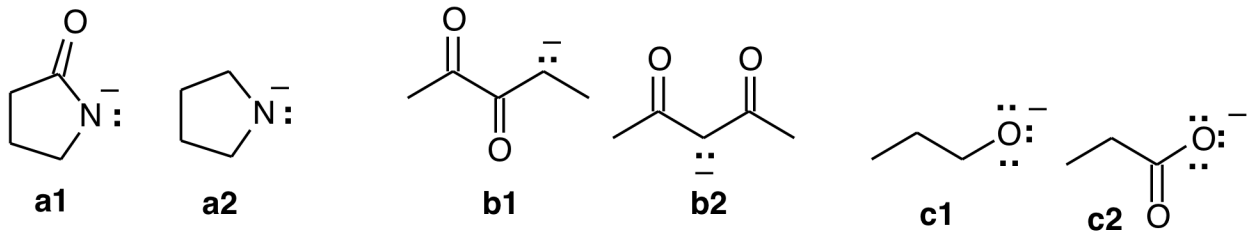
__ C. **3**

__ D. **5**

__ E. **4**

Rationale:
Problem 9.15

32. 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 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.

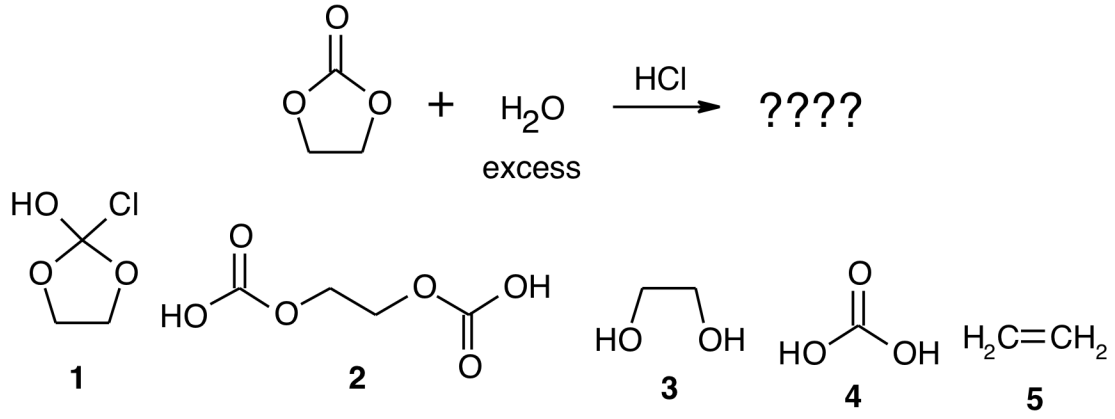
__ C. **a2**, **b2**, and **c2** are the most stable structures.

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

__ E. **a2**, **b1**, and **c1** are the most stable structures.

Rationale:
Problem 7.31

33. When the reaction suggested is carried out carbon dioxide and one other organic product are produced. What is the structure of the other organic product?



__ A. **3**

__ B. **4**

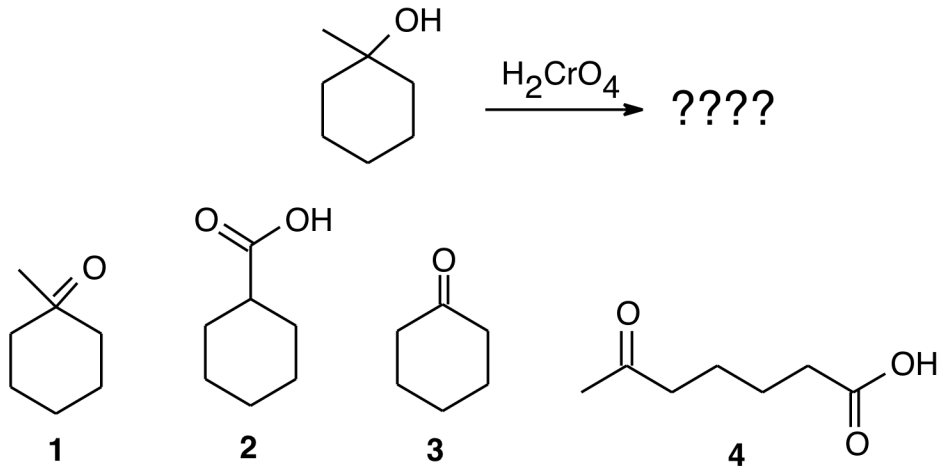
__ C. **5**

__ D. **2**

__ E. **1**

Rationale:
Problem 11.38

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



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

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

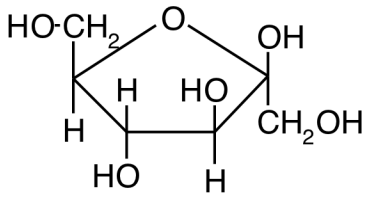
__ C. The compound with structure **1** is formed.

__ D. No reaction occurs.

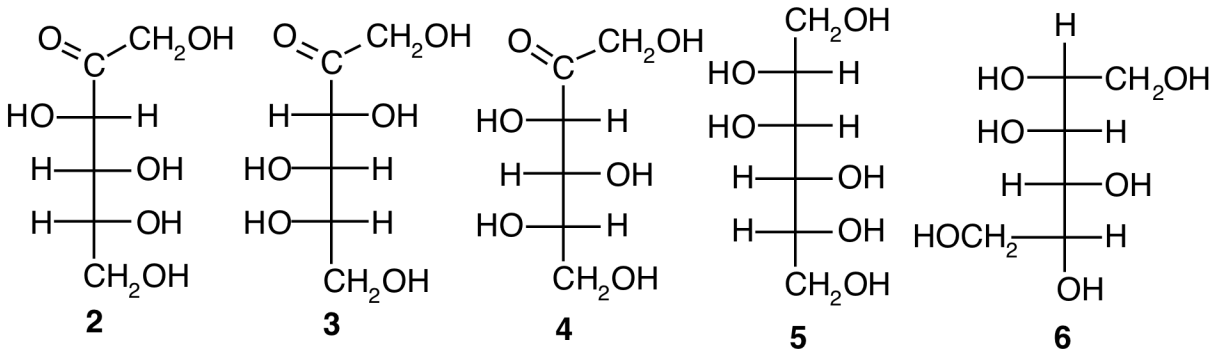
__ E. The compound with structure **2** is formed.

Rationale:
Problem 10.12

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



1



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

__ A. **4**

__ B. **2**

__ C. **5**

__ D. **6**

__ E. **3**

Rationale:
Problem 14.22

36. This problem has several statements that deal with the similarities and differernce between DNA and RNA. Choose the **CORRECT** statement.

__ A. Both DNA and RNA use the same four heterocyclic bases (A, C, G, and T) in their monomer units.

__ B. DNA is single-stranded whereas RNA is double stranded.

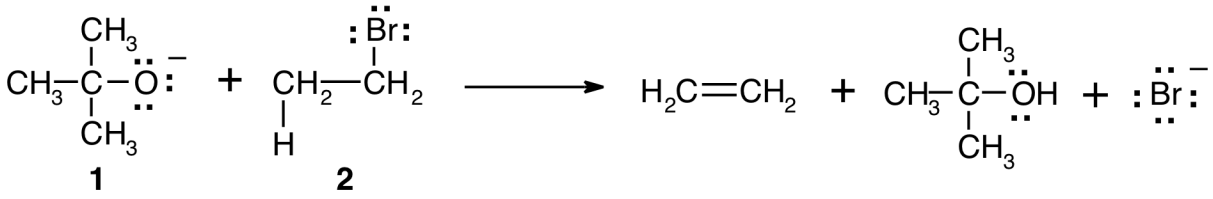
__ C. DNA is found in both the nucleus and in the cytoplasm of a cell, whereas RNA is found only in the nucleus.

__ D. Both DNA and RNA use the same sugar (2-deoxy-D-ribose) in their monomer units.

__ E. DNA is built from the nucleotides with one-letter abbreviations A, C, G, and T, whereas RNA uses U (uridine) in place of T (thymidine).

Rationale:
Problem 17.10

37. 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 two curved arrows involved in this process.

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

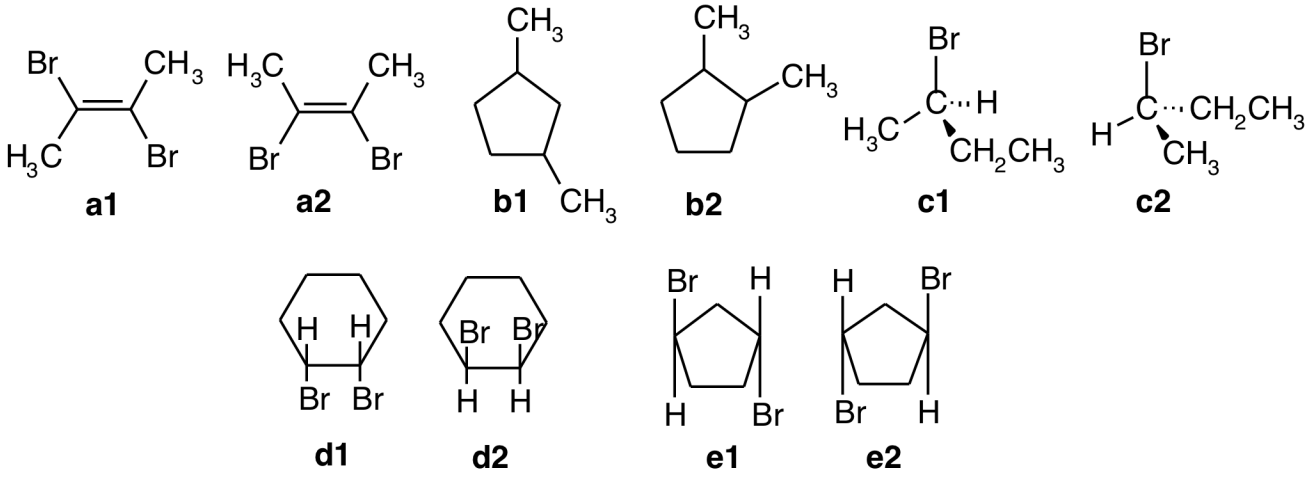
__ C. The particle with structure **2** is the nucleophile and **1** is the electrophile in this reaction.

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

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

Rationale:
Problem 5.52

38. 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 represents 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. **c1** and **c2** are identical compounds.

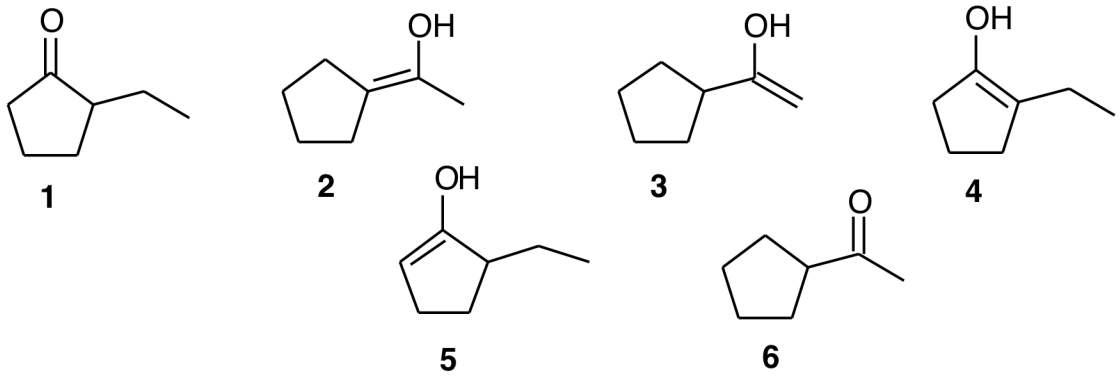
__ C. **a1** and **a2** are constitutional isomers.

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

__ E. **e1** and **e2** are identical compounds.

Rationale:
Problem 6.36

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



__ A. **2** is an enol tautomer of **6**.

__ B. **1** is the keto tautomer of **5**.

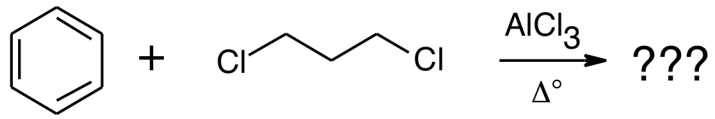
__ C. **1** is the keto tautomer of **4**.

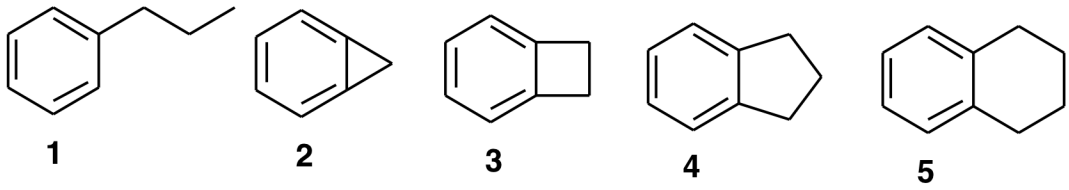
__ D. **3** is an enol tautomer of **6**.

__ E. **1** is the keto tautomer of **2**.

Rationale:
Problem 5.64

40. Find the product of the reaction shown below from among the numbered structures.





__ A. **4**

__ B. **1**

__ C. **3**

__ D. **2**

__ E. **5**

Rationale:
Problem 8.40

Answer Key

"Grade or Education" = 1

CHEM 2060/01
Summer 14
Final Exam
Chapters 1 - 17

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

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