

Sign Name Kan Print Name _____
 (1 pt name) (100 pts, 10 pages + scantron sheet) Colored

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper)
 Circle answers on this form for backup to the scantron.

I. Multiple Choice (2 pts each, 24 pts) Choose the one best answer in each question.

1. About spectra which of the following statements is incorrect ?

- a) In proton NMR spectra the information that one derives is chemical shift, peak area and coupling which gives you information about the hydrocarbon structure.
- b) In IR spectra 4000 cm^{-1} to 1500 cm^{-1} is the functional group region in which peaks which are representative of functional groups appear so you can use IR to find out what functional groups are in the organic molecule.
- c) In IR spectra 1500 cm^{-1} to 400 cm^{-1} is the fingerprint region which can be used to match the finger prints of authentic samples of a compound with an unknown sample of an organic compound.

d) In carbon NMR spectra, one of the ^{best pieces of} most information that one derives is coupling between neighboring carbons because the NMR active carbon has 1.1% natural abundance.

2. For the element As, circle the one incorrect statement.

- a) The atomic mass is 75
- b) The number of electrons for a neutral atom is 5
- c) The atomic number is 33
- d) The number of valence electrons is 5

NA = not attempted

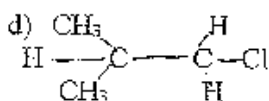
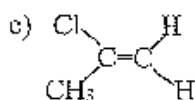
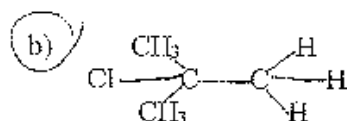
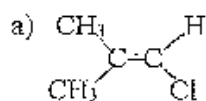
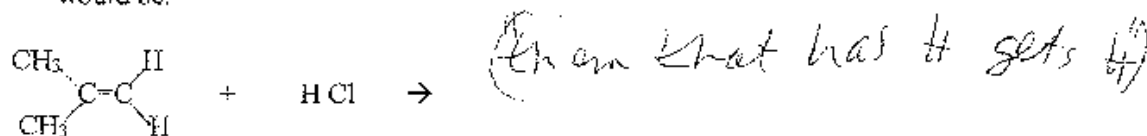
NW = no work

NE = no explanation

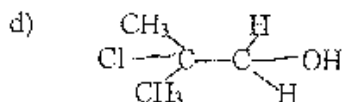
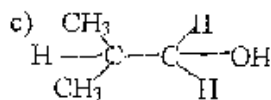
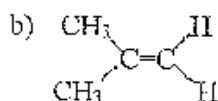
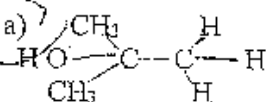
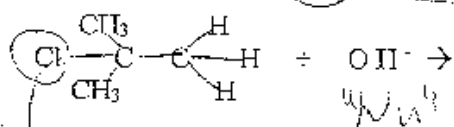
3. With 4 pairs of VSEPR electron pairs around the central atom the molecular geometry is:

- a) trigonal planar geometry, 120° angle
- b) octahedral geometry, 90° angle
- c) tetrahedral geometry, 109.5° angle
- d) trigonal bipyramidal geometry, 90° angle

4. For the Markovnikov's electrophilic reaction of HCl to the alkene below the alkene the product would be:



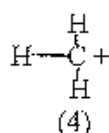
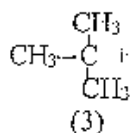
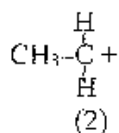
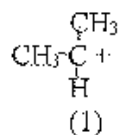
5. The product of an $\text{S}_{\text{N}}1$ reaction of the following substrate is:



6. Circle the one statement below which is incorrect.

- a) In an energy diagram, a transition state is in general between either the reactant & product or between the reactant and the intermediate.
 b) A heterocyclic arrow looks like \rightarrow
 c) An "Electrophile" loves electrons while a "Nucleophile" loves nuclei
 d) In an energy diagram, an intermediate is always at the top of an energy hill. (valley)

7. Put in order of most stable to least stable carbocation by choosing the one best choice:

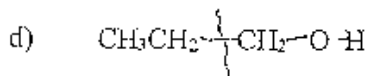
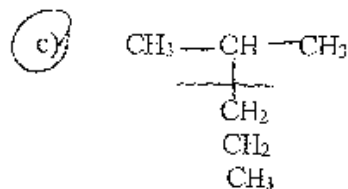
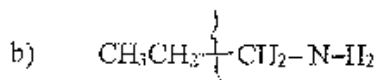
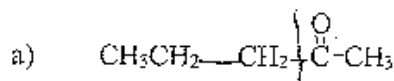


- a) Most stable carbocation to least stable carbocation is (2) > (1) > (3) > (4)
 b) Most stable carbocation to least stable carbocation is (3) > (1) > (2) > (4)
 c) Most stable carbocation to least stable carbocation is (4) > (2) > (1) > (3)
 d) Most stable carbocation to least stable carbocation is (1) > (2) > (3) > (4)

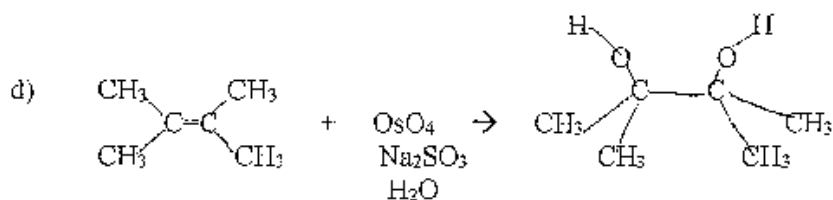
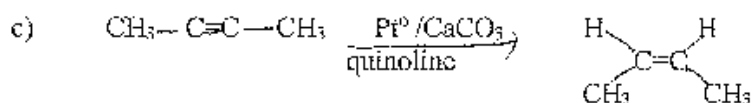
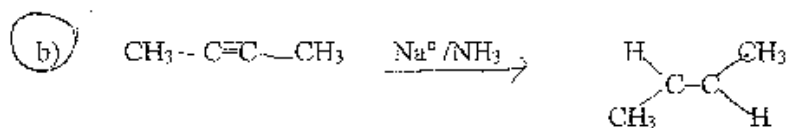
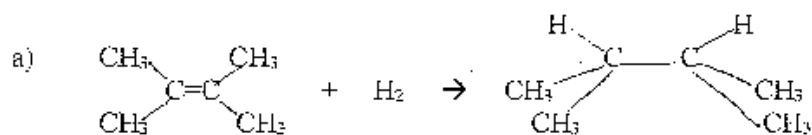
8. Given the following reagents, which is not an oxidation reagent which will react with an alkene?

- a) $\text{OsO}_4 / \text{NaHSO}_4, \text{H}_2\text{O}$
 b) $\text{O}_3, \text{Zn}/\text{H}_2\text{O}$
 c) $\text{KMnO}_4/\text{OH}^-$ cold
 d) $\text{H}_2, \text{Pt}/\text{C}$

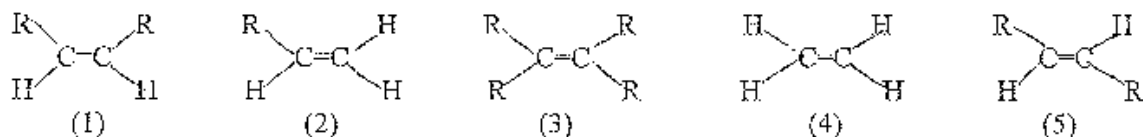
9. In the following mass spectral cleavage indicated by the wavy line circle the one which is not α cleavage.



10. Which of the following reactions does not show a syn product?



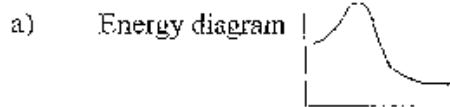
11. According to Zaitsev's (or sometimes spelled Saytzeff's) Rule, the most stable to least stable alkene is: Choose the one best statement. (R ≠ H)



- a) Most stable (3) > (5) > (1) > (2) > (4) Least stable
 b) Most stable (3) > (4) > (5) > (1) > (2) least stable
 c) Most stable (4) > (2) > (1) > (5) > (3) least stable
 d) You can't tell which alkene is stable by looking at the structure. All alkenes are similarly stable.

12. Which of the following does not match the $\text{S}_{\text{N}}2$ reaction mechanism?

choose best statement



- b) The S in $\text{S}_{\text{N}}2$ means substitution
 c) Rate = k [substrate][nucleophile]

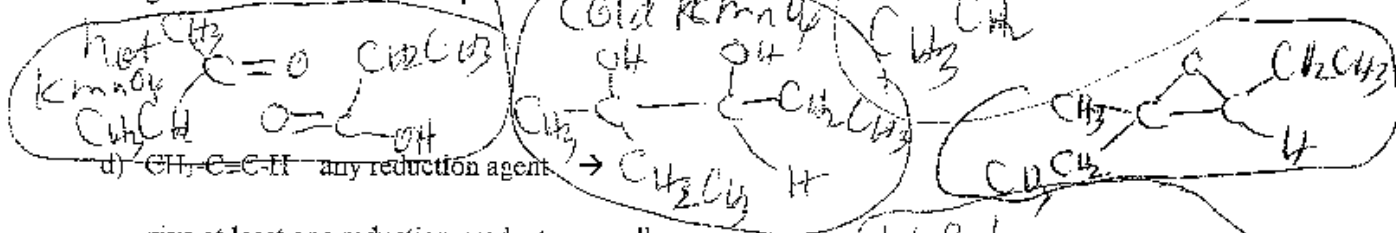
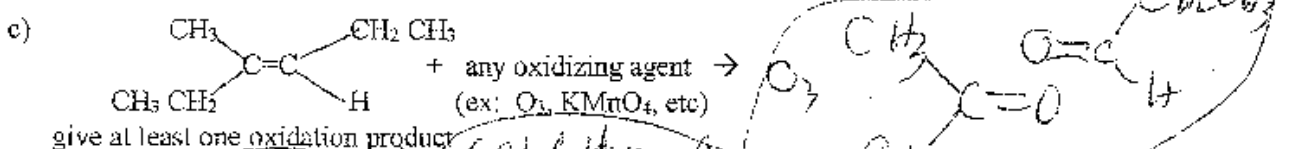
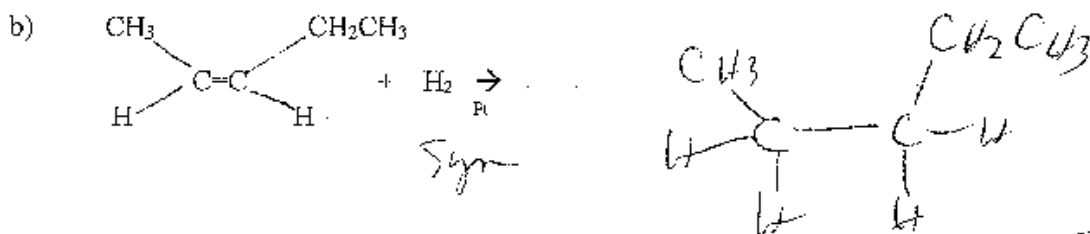
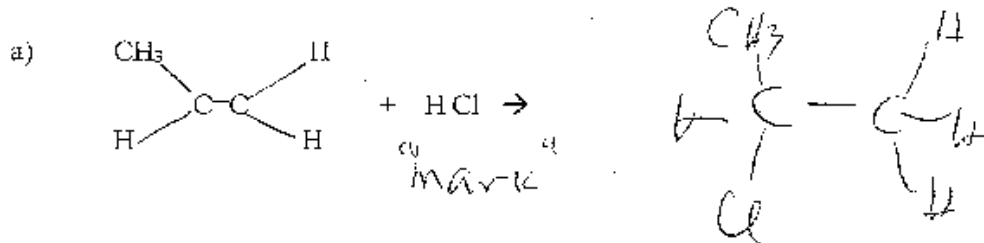
d) All statements above are true about $\text{S}_{\text{N}}2$

II. Short Answers (42 pts)

A. Reactions Part of Short Answers: (2 pts per reaction, 10 pts total)

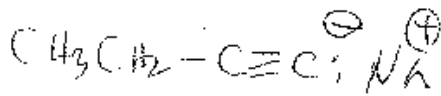
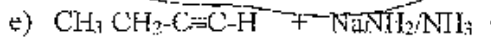
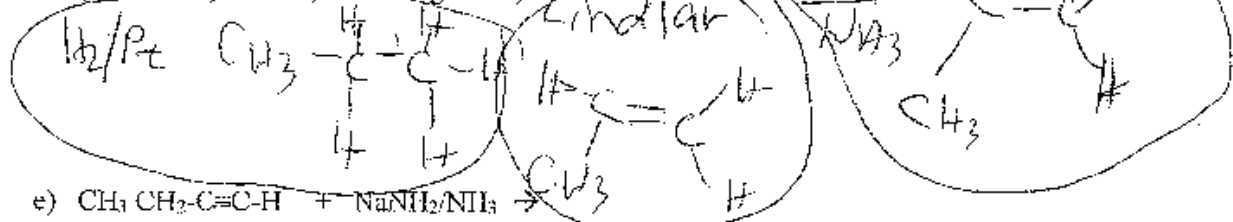
extra wrong - 1/2

Given the following, what is the an expected organic product ?



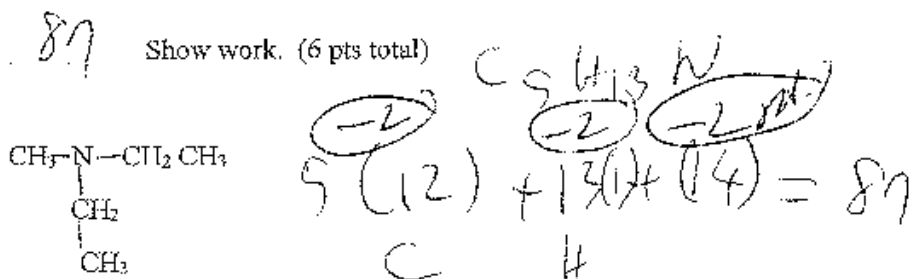
d) CC=CC any reduction agent

give at least one reduction product on an alkyne
 (ex: H₂/Pt, Lindlar, dissolving metal)

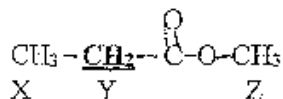


B. Short Answers part of Short Answers: (32 pts)

1. **Mass Spectra:** For the following a molecular ion peak would occur at the mass/charge ratio of



2. **Proton NMR Spectra:** For the following molecule, for a proton NMR spectrum, answer for the **bold underlined** proton shown? (equation is $2n+1$ & $I = \frac{1}{2}$ for proton) Show work. (8 pts total)



a. For a proton NMR spectrum chemical shift put in order on the NMR plot by inputting the letter in the correct place. Explain briefly. (1 pt per blank, 1 pt explain, 4 pts total)

Highest ppm Z Y X lowest ppm

Z is closest to O electronegative O + C=O

b. For the proton NMR spectrum of the peak Y (bold highlighted proton) – show your coupling calculation. (2 pt per blank, 4 pts total)

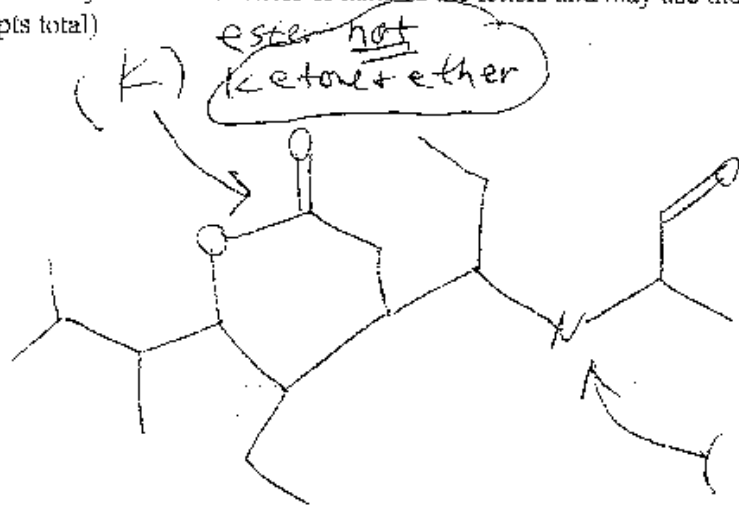
n (for the proton Y is) = 3 coupling is = 4

$n = 3$

$2(3) \frac{1}{2} + 1 = 4$

stowed above
but missed in
blank -
last blank

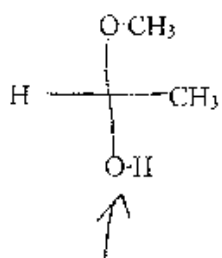
2. Given the following molecule, fill in the parenthesis with the letter of the functional group.
 (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine
 (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid anhydride (You may use all the letters or none of the letters and may use the same letter multiple times) (6 pts each, 12 pts total)



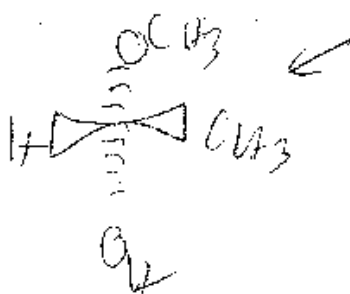
you have to recognize what is a separate functional group

not amide
 amine bc
 carbonyl C
 is one
 bond
 away

3. Given the following Fisher projection formula, draw a corresponding 3 dimensional drawing using the line, dash wedge drawing. (6pts)



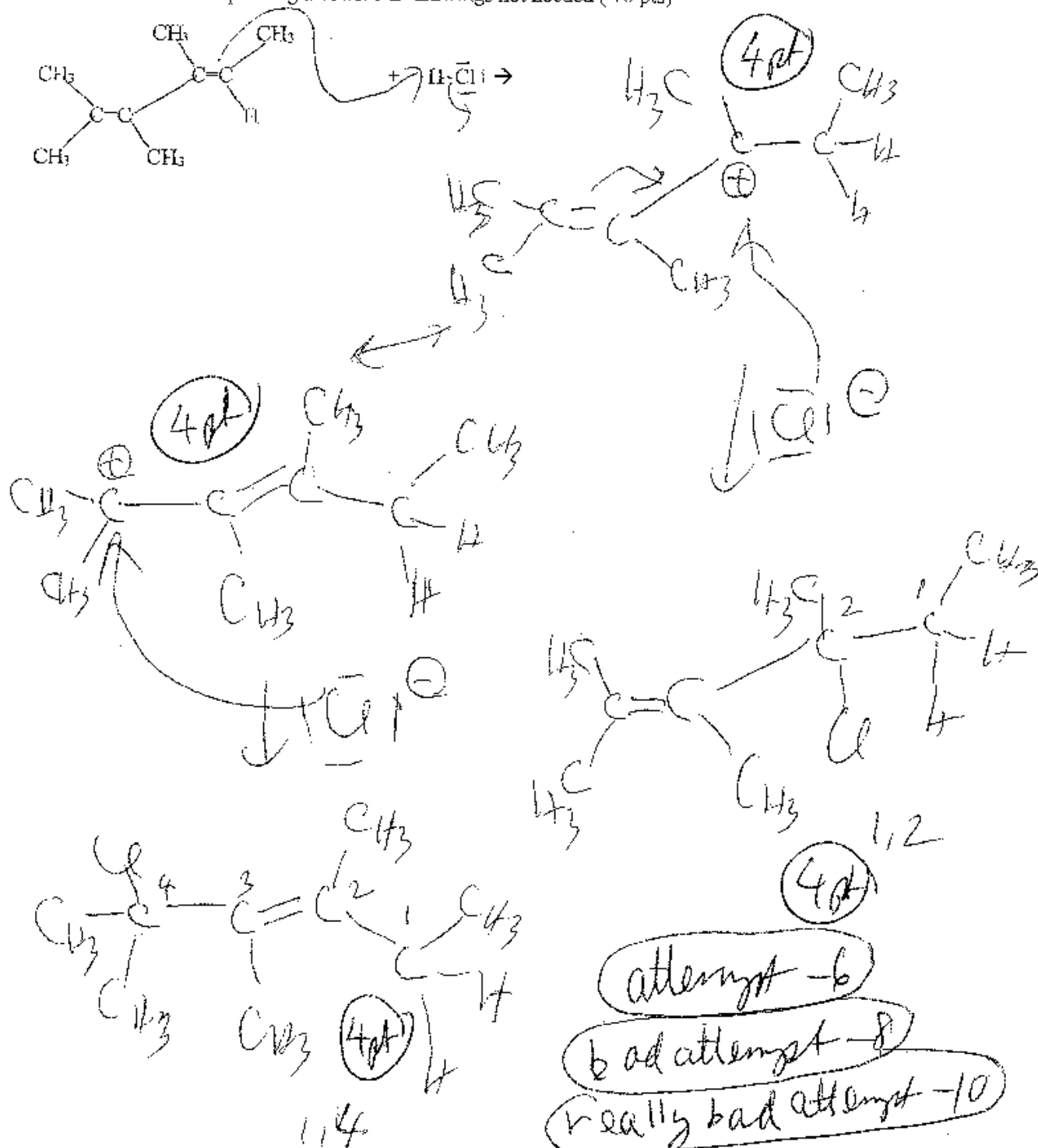
this is
 a Fischer



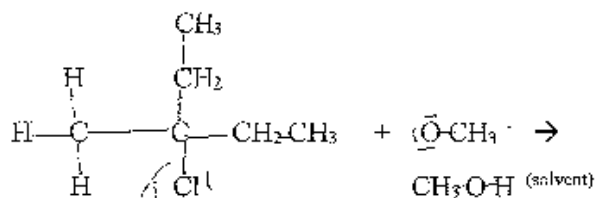
this is a
 line, dash, line
 drawing of
 what the
 Fischer means

Part III. Long Answers (33 pts) Show work where applicable.

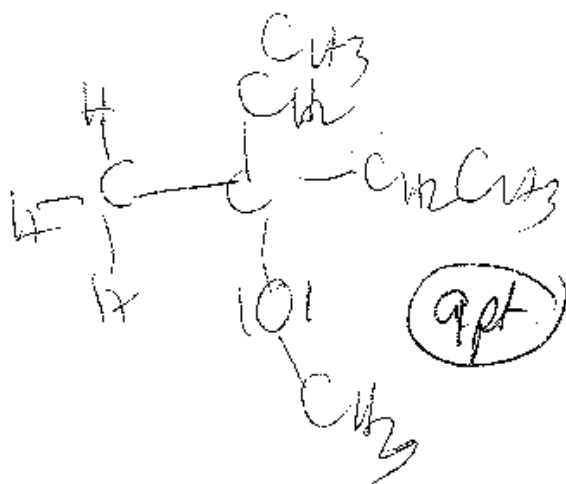
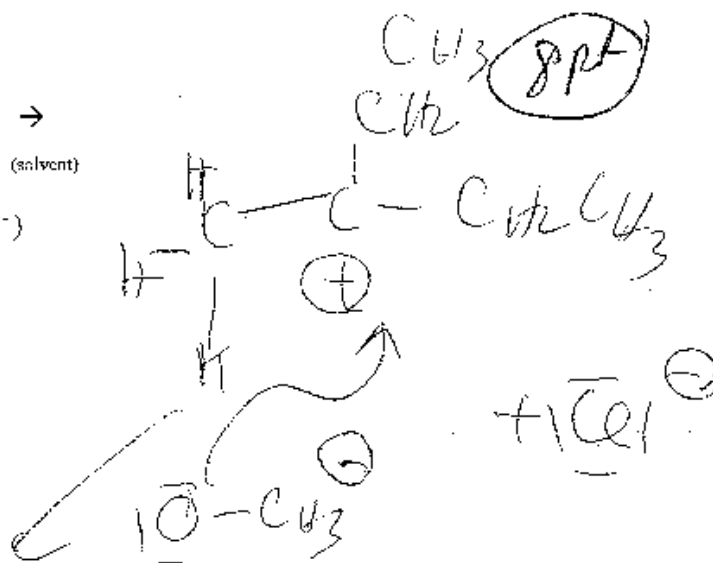
1. Complete the following reaction mechanism: Electrophilic addition of HCl to the substrate shown. Please show the resonance rearrangement product as well as the Show correct Lewis Dot structures & electron pushing arrows. 3 D drawings not needed (16 pts)



2. Complete the following reaction mechanism. (S_N1 reaction mechanism, substitution nucleophilic unimolecular) (Please be sure to do it on the reaction shown below.) (17 pts)



(leaving group is Cl, nucleophile is $\text{O}^- \text{CH}_3$)



attempt -8

bad attempt -10

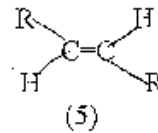
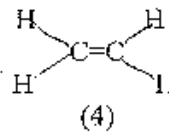
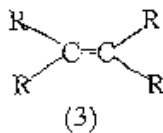
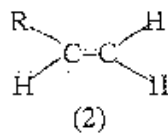
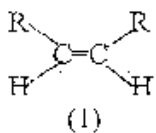
really bad attempt -12

Sign Name K. White Print Name White
 (1 pt name) (100 pts, 10 pages) + scantron sheet)

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper)
 Circle answer on this form for backup to the scantron.

I. Multiple Choice (2 pts each, 24 pts) Choose the one best answer in each question.

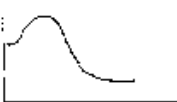
1. According to Zaitsev's (or sometimes spelled Saytzeff's) Rule, the most stable to least stable alkene is: Choose the one best statement. (R ≠ H)



- a) Most stable (3) > (5) > (1) > (2) > (4) Least stable
 b) Most stable (4) > (2) > (1) > (5) > (3) least stable
 c) Most stable (3) > (4) > (5) > (1) > (2) least stable
 d) You can't tell which alkene is stable by looking at the structure. All alkenes are similarly stable.

2. Which of the following does not match the S_N2 reaction mechanism?

a) Rate = k [substrate][nucleophile]

b) Energy diagram 

c) The S in S_N2 means substitution
 d) All statements above are true about S_N2

or best statement

NA = not attempted

NW = no work

NE = no explanation

3. For the element As, circle the one incorrect statement.

- a) The atomic number is 33
 b) The atomic mass is 75
 c) The number of electrons for a neutral atom is 5
 d) The number of valence electrons is 5

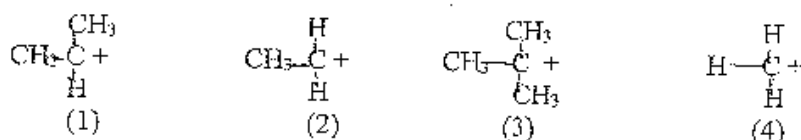
4. With 4 pairs of VSEPR electron pairs around the central atom the molecular geometry is:

- a) trigonal bipyramidal geometry, 90° angle
- b) trigonal planar geometry, 120° angle
- c) tetrahedral geometry, 109.5° angle
- d) octahedral geometry, 90° angle

5. Circle the one statement below which is incorrect.

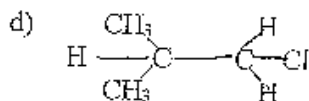
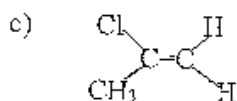
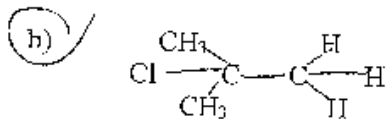
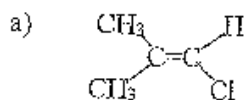
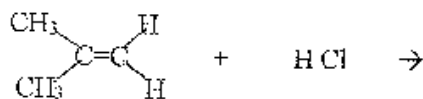
- a) A heterocyclic arrow looks like \rightarrow
- b) An "Electrophile" loves electrons while a "Nucleophile" loves nuclei
- c) In an energy diagram, a transition state is in general between either the reactant & product or between the reactant and the intermediate.
- d) In an energy diagram, an intermediate is always at the top of an energy hill.

6. Put in order of most stable to least stable carbocation by choosing the one best choice:

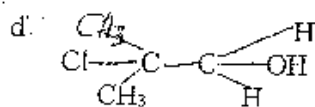
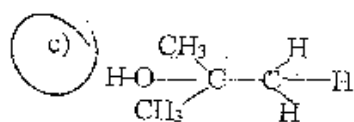
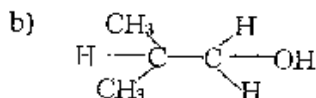
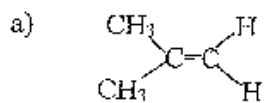
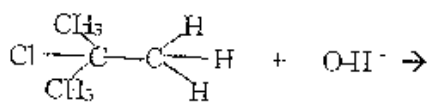


- a) Most stable carbocation to least stable carbocation is (1) > (2) > (3) > (4)
- b) Most stable carbocation to least stable carbocation is (2) > (1) > (3) > (4)
- c) Most stable carbocation to least stable carbocation is (4) > (2) > (1) > (3)
- d) Most stable carbocation to least stable carbocation is (3) > (1) > (2) > (4)

7. For the Markovnikov's electrophilic reaction of HCl to the alkene below, ~~the alkene~~ the product would be:



8. The product of an S_N1 reaction of the following substrate is:



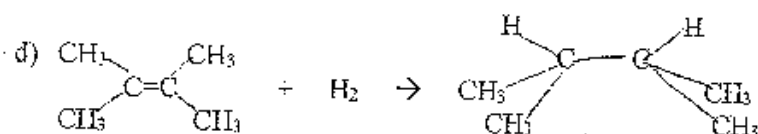
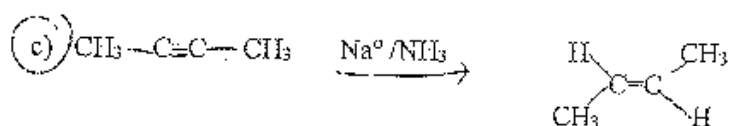
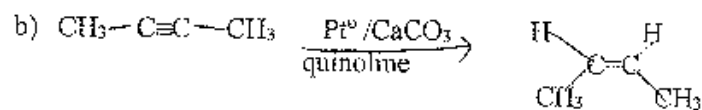
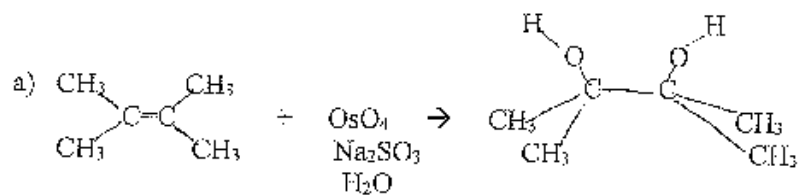
9. Which is not an oxidation reagent which will react with an alkene?

- a) $\text{KMnO}_4/\text{OH}^-$ cold
 b) $\text{H}_2, \text{Pt/C}$
 c) $\text{OsO}_4 / \text{NaHSO}_4, \text{H}_2\text{O}$
 d) $\text{O}_3, \text{Zn}/\text{H}_2\text{O}$

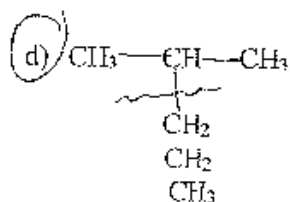
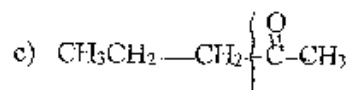
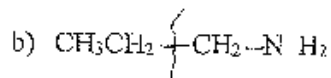
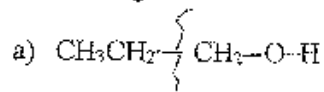
10. About spectra which of the following statements is incorrect?

- a) In proton NMR spectra the information that one derives is chemical shift, peak area and coupling which gives you information about the hydrocarbon structure.
- b) In IR spectra 4000 cm^{-1} to 1500 cm^{-1} is the functional group region in which peaks which are representative of functional groups appear so you can use IR to find out what functional groups are in the organic molecule.
- c) In IR spectra 1500 cm^{-1} to 400 cm^{-1} is the fingerprint region which can be used to match the fingerprints of authentic samples of a compound with an unknown sample of an organic compound.
- d) In carbon NMR spectra, one of the ^{best pieces of} most information that one derives is coupling between neighboring carbons because the NMR active carbon has 1.1% natural abundance.

11 Which of the following reactions does not show a syn product ?



12 In the following mass spectral cleavage indicated by the wavy line circle the one which is not α cleavage.

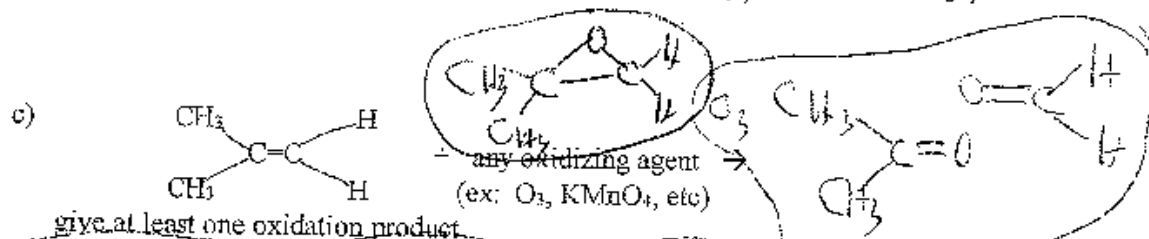
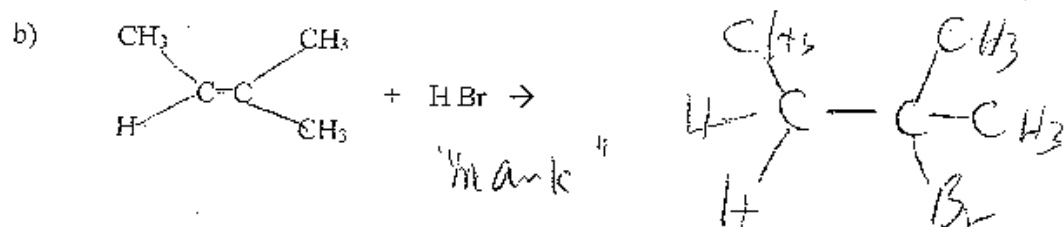
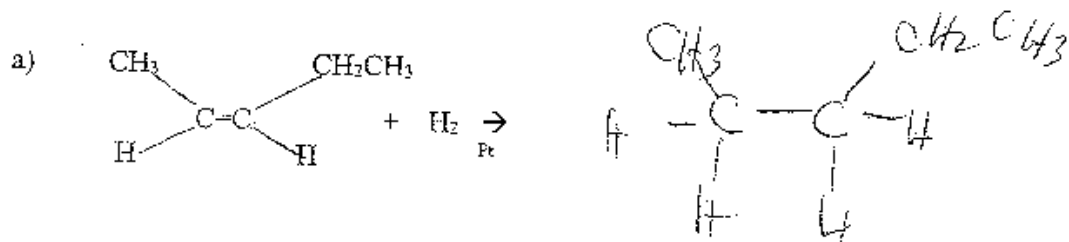


II. Short Answers (42 pts)

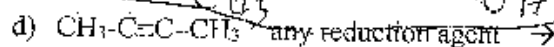
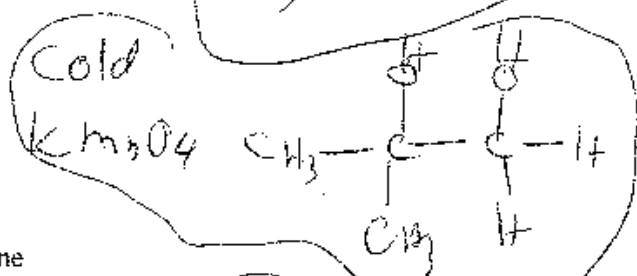
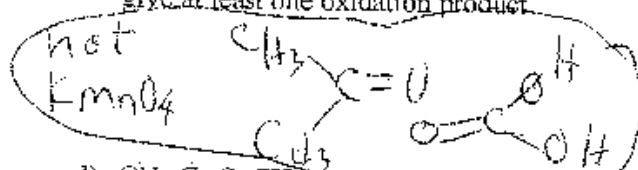
A. Reactions Part of Short Answers: (2 pts per reaction, 10 pts total)

Given the following, what is the an expected organic product?

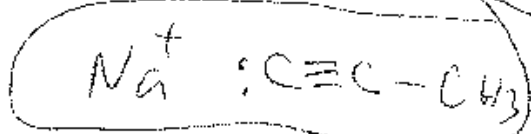
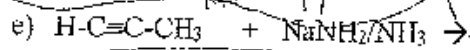
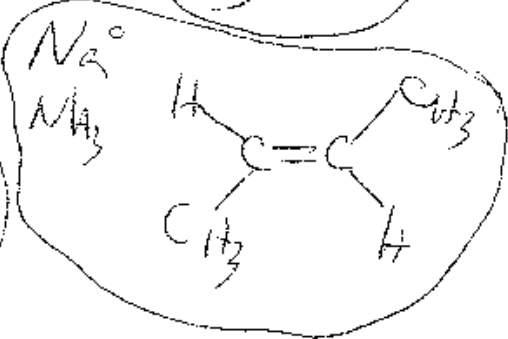
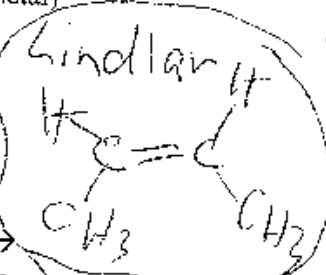
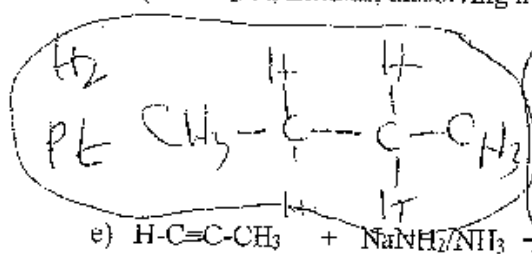
Extra wrong 1/2



give at least one oxidation product

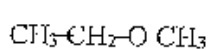


give at least one reduction product on an alkyne (ex: H₂/Pt, Lindlar, dissolving metal)

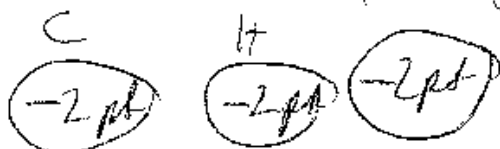


B. Short Answers part of Short Answers: (32 pts)

1. **Mass Spectra:** For the following a molecular ion peak would occur at the mass/charge ratio of 60 Show work. (6 pts total)

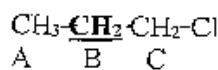


$3(12) + 8 + 16 = 60$



C_3H_8O

2. **Proton NMR Spectra:** For the following molecule, for a proton NMR spectrum, answer for the **bold underlined** proton shown? (equation is $2nI + 1$ & $I = \frac{1}{2}$ for proton) Show work. (8 pts total)



- a. For a proton NMR spectrum chemical shift put in order on the NMR plot by inputting the letter in the correct place. Explain briefly. (1 pt per blank, 1 pt explain, 4 pts total)

Highest ppm C B A lowest ppm

C is closest to EW Cl

(electronegative)

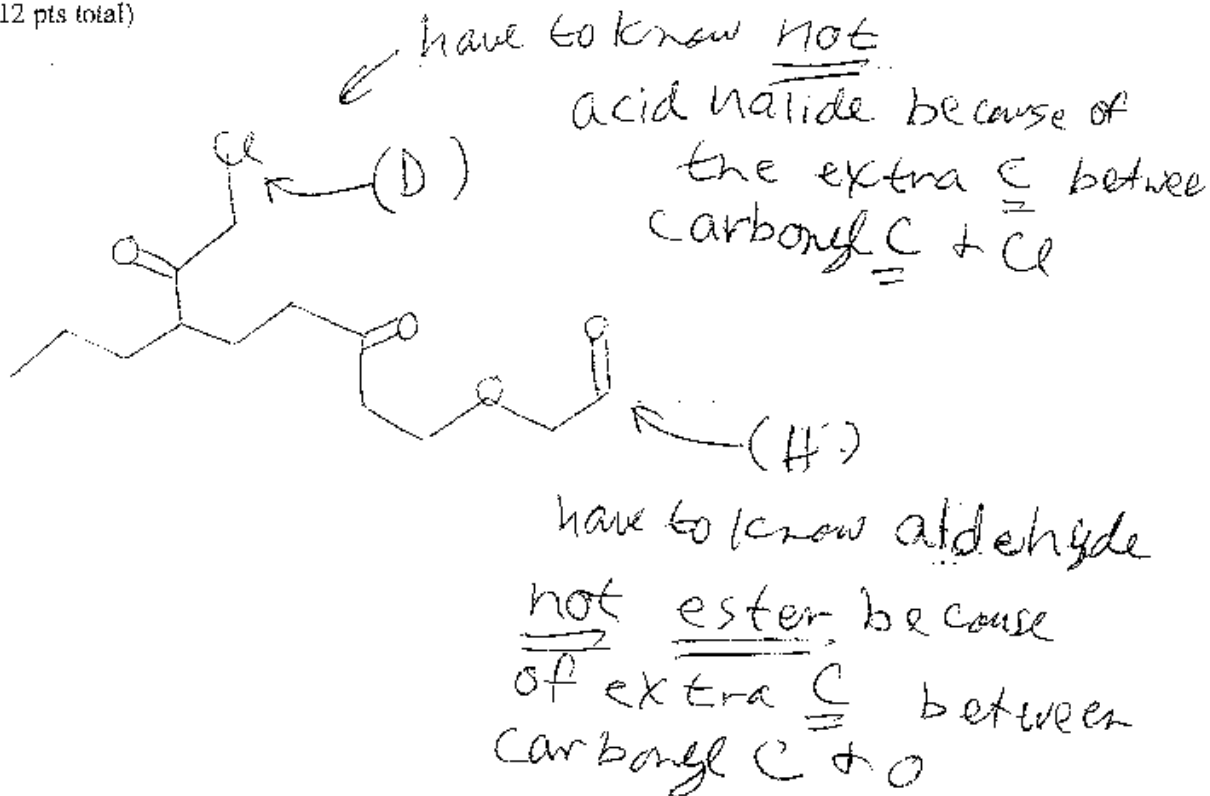
- b. For the proton NMR spectrum of the peak **B** (bold highlighted proton) show your coupling calculation. (2 pt per blank, 4 pts total)

n (for the proton B is) = 5

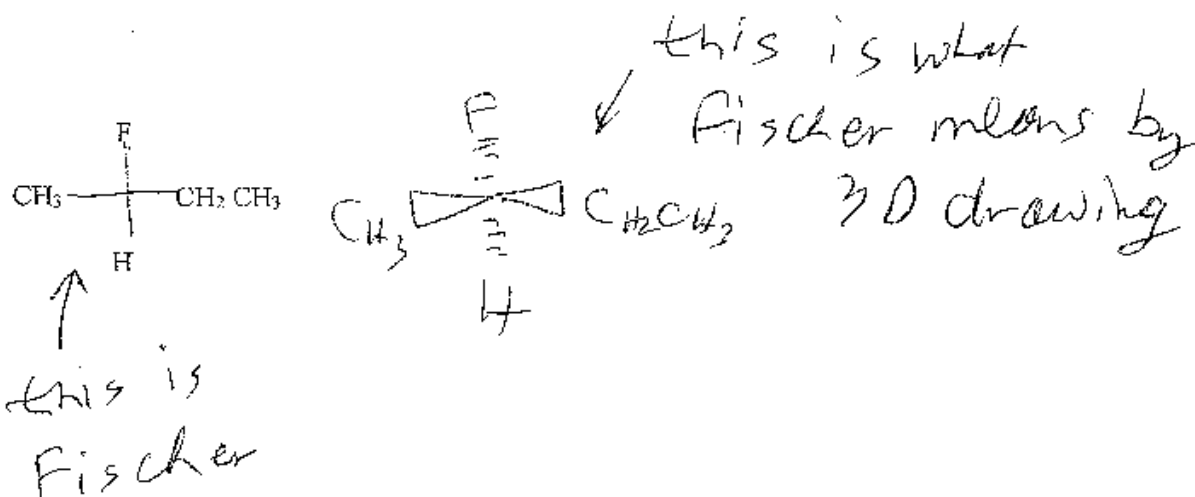
coupling is = 6 $2(5) \frac{1}{2} + 1 = 6$

showed above but missed in blank - 1 each blank

2. Given the following molecule, fill in the parenthesis with the letter of the functional group.
 (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine
 (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid
 anhydride (You may use all the letters or none of the letters and may use the same letter multiple times) (6
 pts each, 12 pts total)

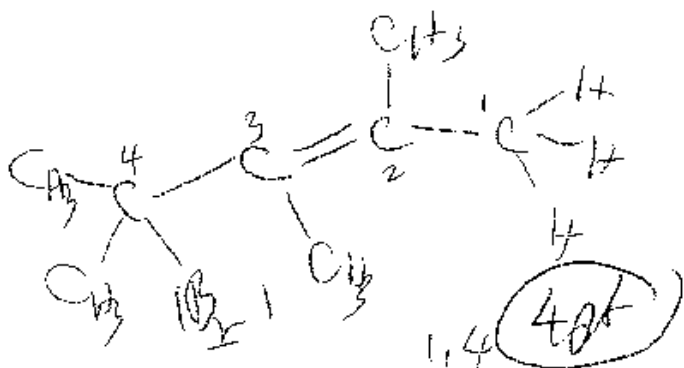
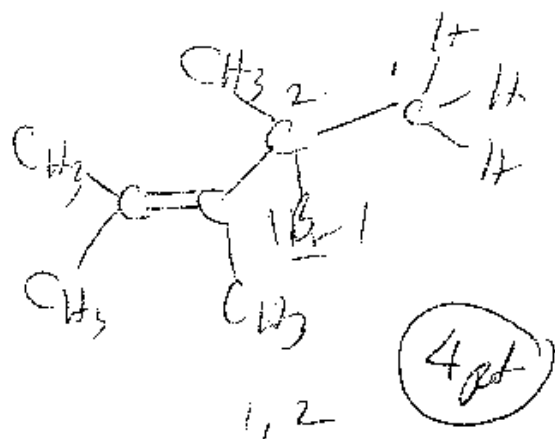
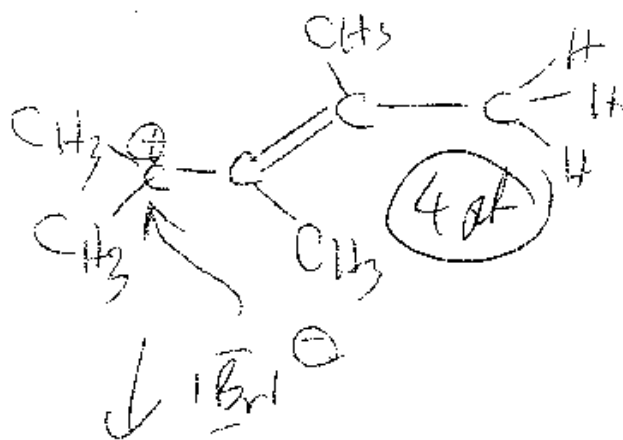
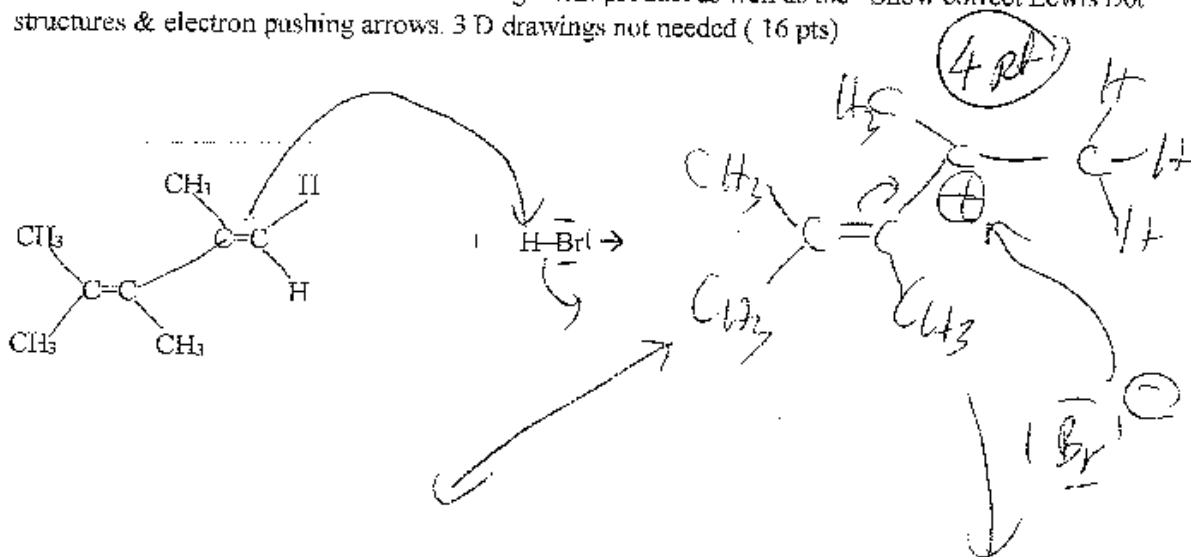


3. Given the following Fisher projection formula, draw a corresponding 3 dimensional drawing using the line, dash wedge drawing. (6pts)



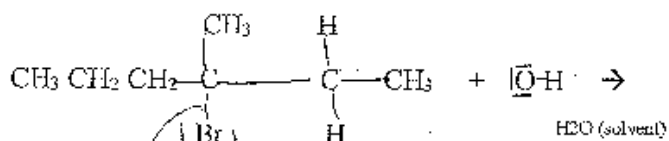
Part III. Long Answers (33 pts) Show work where applicable.

1. Complete the following reaction mechanism: Electrophilic addition of HBr to the substrate shown. Please show the resonance rearrangement product as well as the Show correct Lewis Dot structures & electron pushing arrows. 3 D drawings not needed (16 pts)

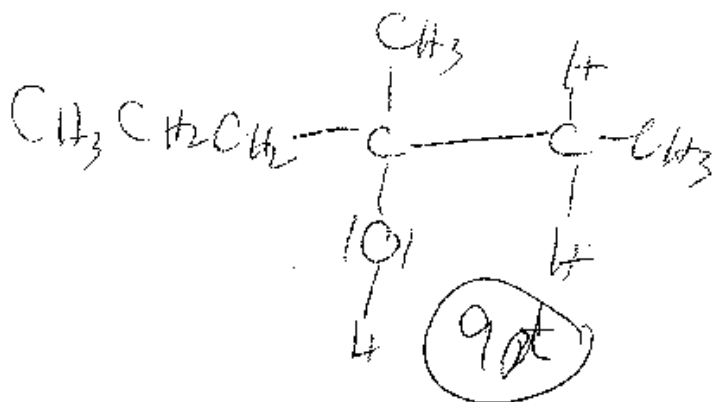
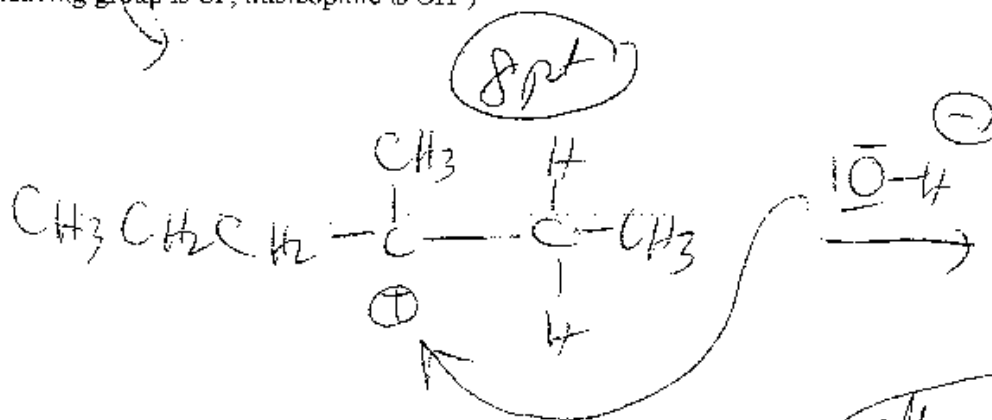


~~attempt - 6~~
~~bad attempt - 8~~
~~really bad attempt - 10~~

2. Complete the following reaction mechanism. (S_N1 reaction mechanism, substitution nucleophilic unimolecular) (Please be sure to do it on the reaction shown below.) (17 pts)



(leaving group is Br^- , nucleophile is OH^-)



attempt - 8
 bad attempt - 10
 really bad attempt - 12

Sign Name _____ Print Name _____
(1 pt name) (100 pts, 10 pages + scantron sheet)

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper)
Circle answers on this form for backup to the scantron.

I. Multiple Choice (2 pts each, 24 pts) Choose the one best answer in each question.

1. About spectra which of the following statements is incorrect?
 - a) In proton NMR spectra the information that one derives is chemical shift, peak area and coupling which gives you information about the hydrocarbon structure.
 - b) In IR spectra 4000 cm^{-1} to 1500 cm^{-1} is the functional group region in which peaks which are representative of functional groups appear so you can use IR to find out what functional groups are in the organic molecule.
 - c) In IR spectra 1500 cm^{-1} to 400 cm^{-1} is the fingerprint region which can be used to match the fingerprints of authentic samples of a compound with an unknown sample of an organic compound.
 - d) In carbon NMR spectra, one of the ~~best~~ ^{best pieces of} information that one derives is coupling between neighboring carbons because the NMR active carbon has 1.1% natural abundance.

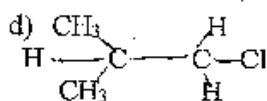
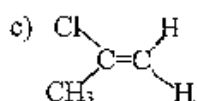
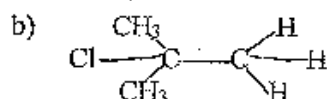
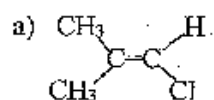
2. For the element As, circle the one incorrect statement.

- a) The atomic mass is 75
- b) The number of electrons for a neutral atom is 5
- c) The atomic number is 33
- d) The number of valence electrons is 5

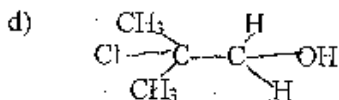
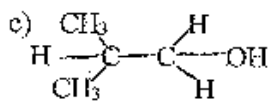
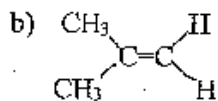
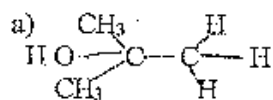
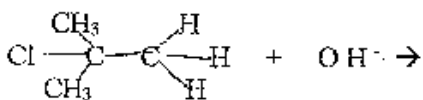
3. With 4 pairs of VSEPR electron pairs around the central atom the molecular geometry is:

- a) trigonal planer geometry, 120° angle
- b) octahedral geometry, 90° angle
- c) tetrahedral geometry, 109.5° angle
- d) trigonal bipyrimidal geometry, 90° angle

4. For the Markovnikov's electrophilic reaction of HCl to the alkene below the alkene the product would be:



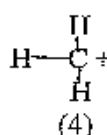
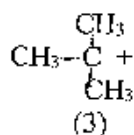
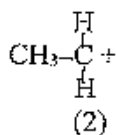
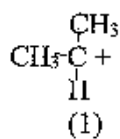
5. The product of an $\text{S}_{\text{N}}1$ reaction of the following substrate is:



6. Circle the one statement below which is incorrect.

- In an energy diagram, a transition state is in general between either the reactant & product or between the reactant and the intermediate.
- A heterocyclic arrow looks like \rightarrow
- An "Electrophile" loves electrons while a "Nucleophile" loves nuclei
- In an energy diagram, an intermediate is always at the top of an energy hill.

7. Put in order of most stable to least stable carbocation by choosing the one best choice:

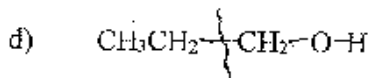
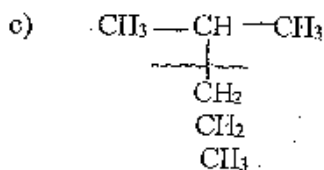
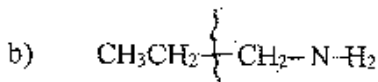
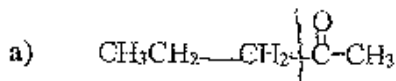


- Most stable carbocation to least stable carbocation is (2) > (1) > (3) > (4)
- Most stable carbocation to least stable carbocation is (3) > (1) > (2) > (4)
- Most stable carbocation to least stable carbocation is (4) > (2) > (1) > (3)
- Most stable carbocation to least stable carbocation is (1) > (2) > (3) > (4)

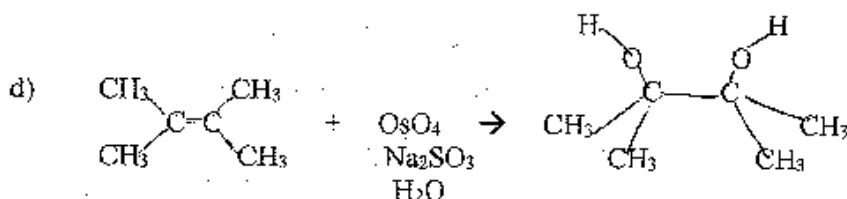
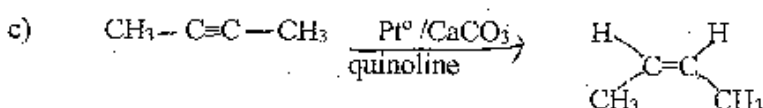
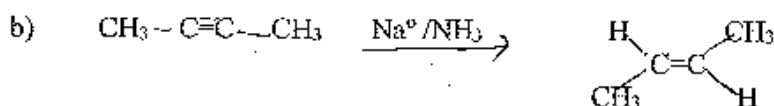
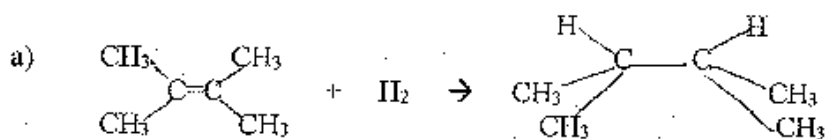
8. Given the following reagents, which is not an oxidation reagent which will react with an alkene?

- $\text{OsO}_4 / \text{NaHSO}_4, \text{H}_2\text{O}$
- $\text{O}_3, \text{Zn}/\text{H}_2\text{O}$
- $\text{KMnO}_4/\text{OH}^-$ cold
- $\text{H}_2, \text{Pt}/\text{C}$

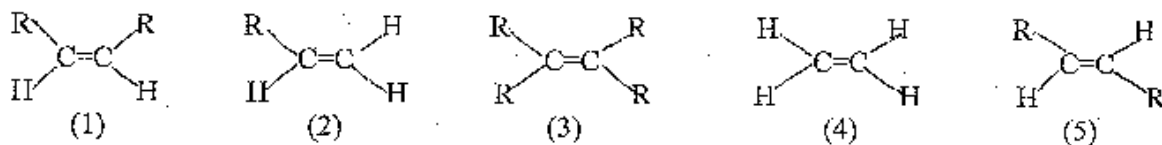
9. In the following mass spectral cleavage indicated by the wavy line circle the one which is not α cleavage.



10. Which of the following reactions does **not** show a **syn** product?

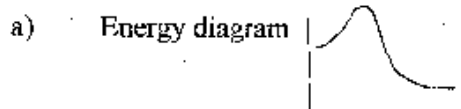


11. According to Zaitsev's (or sometimes spelled Saytzeff's) Rule, the most stable to least stable alkene is: Choose the one best statement. (R ≠ H)



- a) Most stable (3) > (5) > (1) > (2) > (4) Least stable
 b) Most stable (3) > (4) > (5) > (1) > (2) least stable
 c) Most stable (4) > (2) > (1) > (5) > (3) least stable
 d) You can't tell which alkene is stable by looking at the structure. All alkenes are similarly stable.

12. Which of the following does **not** match the $\text{S}_{\text{N}}2$ reaction mechanism?



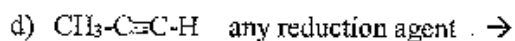
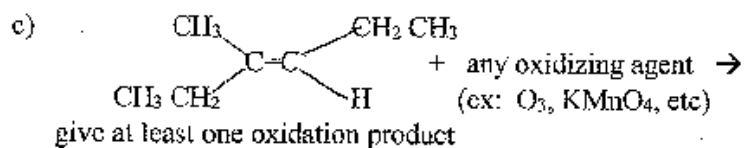
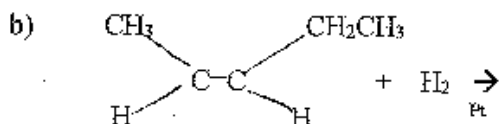
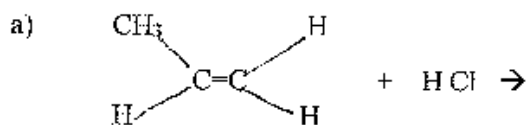
choose best statement

- b) The S in $\text{S}_{\text{N}}2$ means substitution
 c) Rate = k [substrate][nucleophile]
 d) All statements above are true about $\text{S}_{\text{N}}2$

II. Short Answers (42 pts)

A. Reactions Part of Short Answers: (2 pts per reaction, 10 pts total)

Given the following, what is the an expected organic product ?

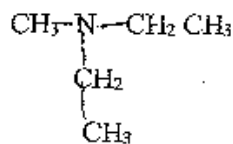


give at least one reduction product on an alkyne
(ex: H₂/Pt, Lindlar, dissolving metal)

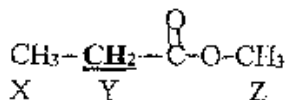


B. Short Answers part of Short Answers: (32 pts)

1. **Mass Spectra:** For the following a molecular ion peak would occur at the mass/charge ratio of _____ Show work. (6 pts total)



2. **Proton NMR Spectra:** For the following molecule, for a proton NMR spectrum, answer for the **bold underlined** proton shown? (equation is $2nI + 1$ & $I = \frac{1}{2}$ for proton) Show work. (8 pts total)



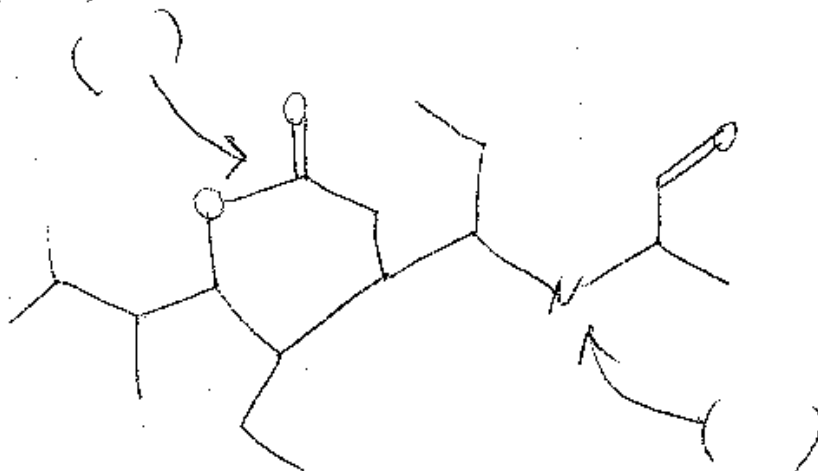
- a. For a proton NMR spectrum chemical shift put in order on the NMR plot by inputting the letter in the correct place. Explain briefly. (1 pt per blank, 1 pt explain, 4 pts total)

Highest ppm _____ lowest ppm

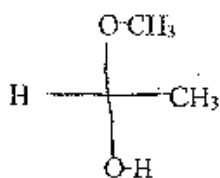
- b. For the proton NMR spectrum of the peak Y (bold highlighted proton) – show your coupling calculation. (2 pt per blank, 4 pts total)

n (for the proton Y is) = _____ coupling is = _____

2. Given the following molecule, fill in the parenthesis with the letter of the functional group.
 (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine
 (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid
 anhydride (You may use all the letters or none of the letters and may use the same letter multiple times) (6
 pts each, 12 pts total)

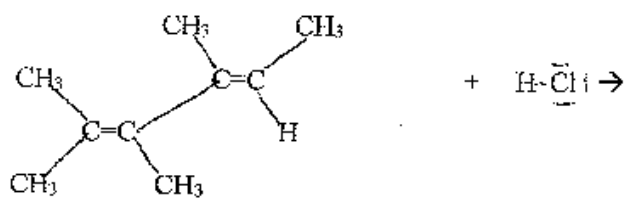


3. Given the following Fisher projection formula, draw a corresponding 3 dimensional drawing using the line, dash wedge drawing. (6pts)

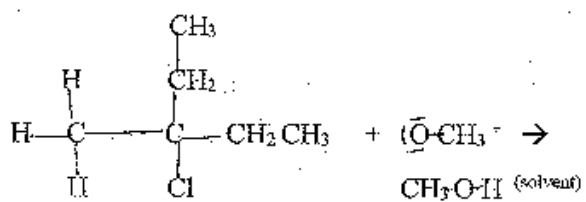


Part III. Long Answers (33 pts) Show work where applicable.

1. Complete the following reaction mechanism: Electrophilic addition of HCl to the substrate shown. Please show the resonance rearrangement product as well as the Show correct Lewis Dot structures & electron pushing arrows. 3 D drawings not needed (16 pts)



2. Complete the following reaction mechanism. (S_N1 reaction mechanism, substitution nucleophilic unimolecular) (Please be sure to do it on the reaction shown below.) (17 pts)



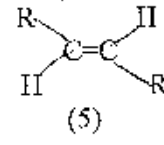
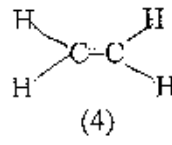
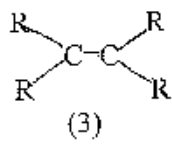
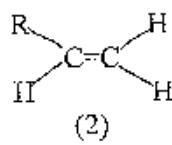
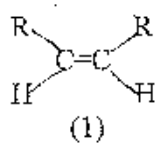
(leaving group is Cl, nucleophile is OCH₃⁻)

Sign Name _____ Print Name _____
 (1 pt name) (100 pts, 10 pages + scantron sheet)

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper)
 Circle answer on this form for backup to the scantron.

I. Multiple Choice (2 pts each, 24 pts) Choose the **one** best answer in each question.

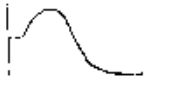
1. According to Zaitsev's (or sometimes spelled Saytzeff's) Rule, the most stable to least stable alkene is: Choose the one best statement. (R ≠ H)



- a) Most stable (3) > (5) > (1) > (2) > (4) Least stable
 b) Most stable (4) > (2) > (1) > (5) > (3) least stable
 c) Most stable (3) > (4) > (5) > (1) > (2) least stable
 d) You can't tell which alkene is stable by looking at the structure. All alkenes are similarly stable.

2. Which of the following does not match the S_N2 reaction mechanism ?

a) Rate = k [substrate][nucleophile]

b) Energy diagram 

c) The S in S_N2 means substitution

d) All statements above are true about S_N2

3. For the element As, circle the one incorrect statement.

- a) The atomic number is 33
 b) The atomic mass is 75
 c) The number of electrons for a neutral atom is 5
 d) The number of valence electrons is 5

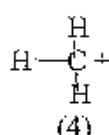
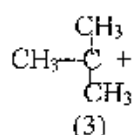
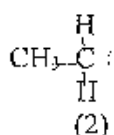
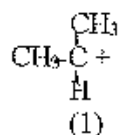
4. With 4 pairs of VSEPR electron pairs around the central atom the molecular geometry is:

- a) trigonal bipyramidal geometry, 90° angle
- b) trigonal planar geometry, 120° angle
- c) tetrahedral geometry, 109.5° angle
- d) octahedral geometry, 90° angle

5. Circle the one statement below which is incorrect.

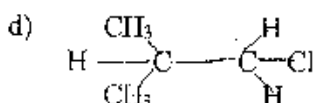
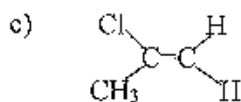
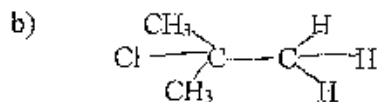
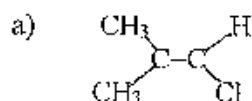
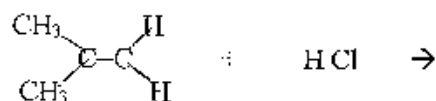
- a) A heterocyclic arrow looks like \rightarrow
- b) An "Electrophile" loves electrons while a "Nucleophile" loves nuclei
- c) In an energy diagram, a transition state is in general between either the reactant & product or between the reactant and the intermediate.
- d) In an energy diagram, an intermediate is always at the top of an energy hill.

6. Put in order of most stable to least stable carbocation by choosing the one best choice:

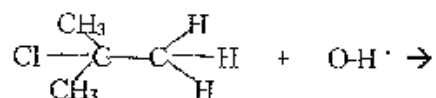


- a) Most stable carbocation to least stable carbocation is (1) > (2) > (3) > (4)
- b) Most stable carbocation to least stable carbocation is (2) > (1) > (3) > (4)
- c) Most stable carbocation to least stable carbocation is (4) > (2) > (1) > (3)
- d) Most stable carbocation to least stable carbocation is (3) > (1) > (2) > (4)

7. For the Markovnikov's electrophilic reaction of HCl to the alkene below the alkene the product would be:



8. The product of an S_N1 reaction of the following substrate is:



- a) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{C}-\text{C}-\text{H} \\ | \quad | \\ \text{CH}_3 \quad \text{H} \end{array}$
- b) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}-\text{C}-\text{C}-\text{OH} \\ | \quad | \\ \text{CH}_3 \quad \text{H} \end{array}$
- c) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}-\text{O}-\text{C}-\text{C}-\text{H} \\ | \quad | \\ \text{CH}_3 \quad \text{H} \end{array}$
- d) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{Cl}-\text{C}-\text{C}-\text{H} \\ | \quad | \\ \text{CH}_3 \quad \text{OH} \end{array}$

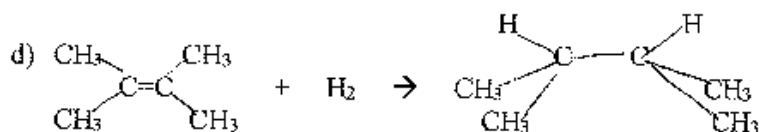
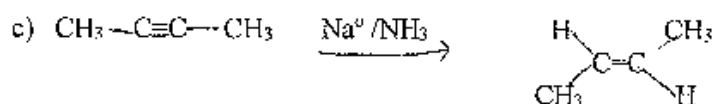
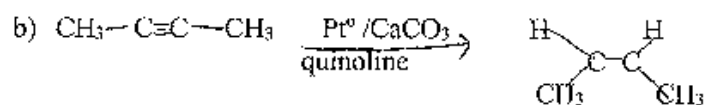
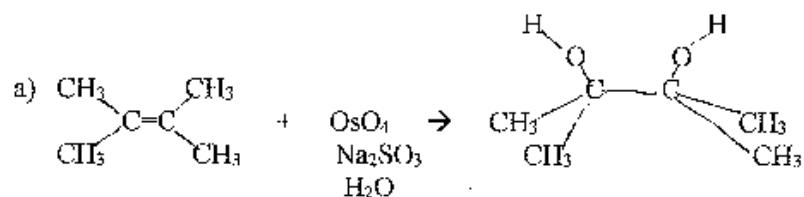
9. Which is **not** an oxidation reagent which will react with an alkene ?

- a) $\text{KMnO}_4/\text{OH}^-$ cold
 b) $\text{H}_2, \text{Pt/C}$
 c) $\text{OsO}_4 / \text{NaHSO}_3, \text{H}_2\text{O}$
 d) $\text{O}_3, \text{Zn/H}_2\text{O}$

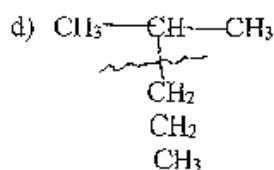
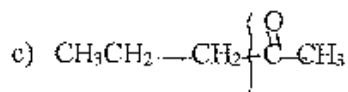
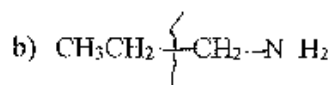
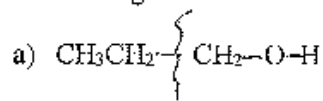
10. About spectra which of the following statements is incorrect ?

- a) In proton NMR spectra the information that one derives is chemical shift, peak area and coupling which gives you information about the hydrocarbon structure.
- b) In IR spectra 4000 cm^{-1} to 1500 cm^{-1} is the functional group region in which peaks which are representative of functional groups appear so you can use IR to find out what functional groups are in the organic molecule.
- c) In IR spectra 1500 cm^{-1} to 400 cm^{-1} is the fingerprint region which can be used to match the fingerprints of authentic samples of a compound with an unknown sample of an organic compound.
- d) In carbon NMR spectra, one of the most information that one derives is coupling between neighboring carbons because the NMR active carbon has 1.1% natural abundance.

11 Which of the following reactions does not show a syn product ?



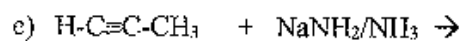
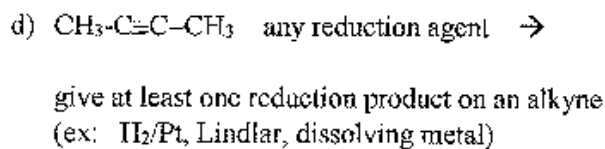
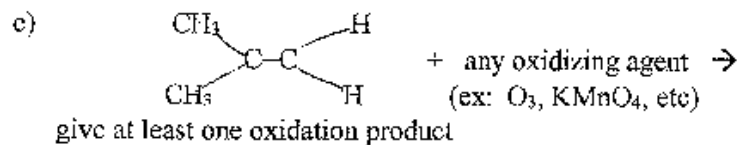
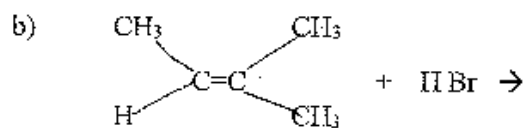
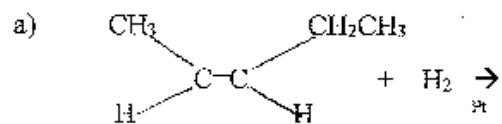
12 In the following mass spectral cleavage indicated by the wavy line circle the one which is not α cleavage.



II. Short Answers (42 pts)

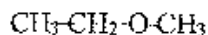
A. Reactions Part of Short Answers: (2 pts per reaction, 10 pts total)

Given the following, what is the an expected organic product ?

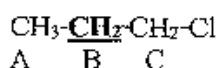


B. Short Answers part of Short Answers: (32 pts)

1. **Mass Spectra:** For the following a molecular ion peak would occur at the mass/charge ratio of _____. Show work. (6 pts total)



2. **Proton NMR Spectra:** For the following molecule, for a proton NMR spectrum, answer for the **bold underlined** proton shown? (equation is $2nI + 1$ & $I = \frac{1}{2}$ for proton) Show work. (8 pts total)



- a. For a proton NMR spectrum chemical shift put in order on the NMR plot by inputting the letter in the correct place. Explain briefly. (1 pt per blank, 1 pt explain, 4 pts total)

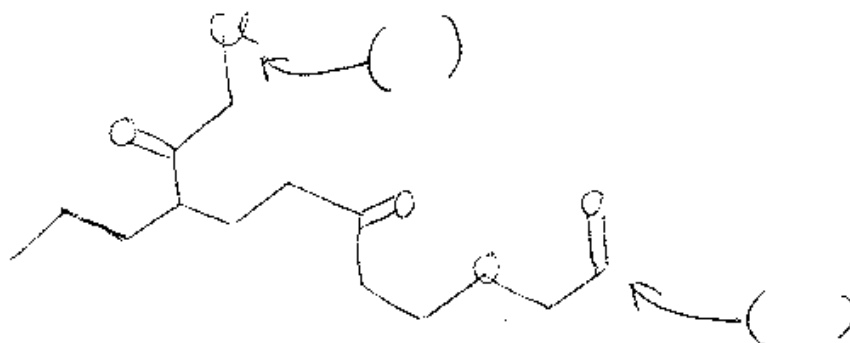
Highest ppm _____ lowest ppm

- b. For the proton NMR spectrum of the peak B (bold highlighted proton) – show your coupling calculation. (2 pt per blank, 4 pts total)

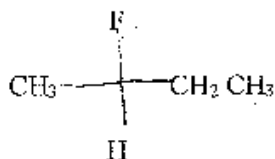
n (for the proton B is) = _____

coupling is – _____

2. Given the following molecule, fill in the parenthesis with the letter of the functional group.
 (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine
 (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid
 anhydride (You may use all the letters or none of the letters and may use the same letter multiple times) (6
 pts each, 12 pts total)

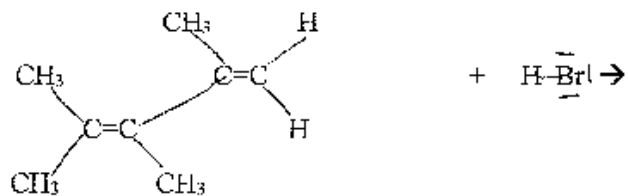


3. Given the following Fischer projection formula, draw a corresponding 3 dimensional drawing using the line, dash wedge drawing. (6pts)

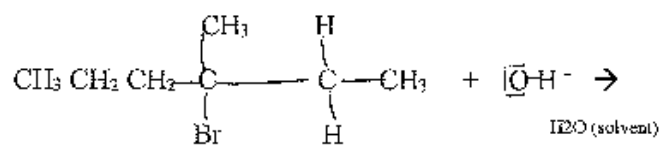


Part III. Long Answers (33 pts) Show work where applicable.

1. Complete the following reaction mechanism: Electrophilic addition of HBr to the substrate shown. Please show the resonance rearrangement product as well as the Show correct Lewis Dot structures & electron pushing arrows. 3 D drawings not needed (16 pts)



2. Complete the following reaction mechanism. (S_N1 reaction mechanism, substitution nucleophilic unimolecular) (Please be sure to do it on the reaction shown below.) (17 pts)



(leaving group is Cl^- , nucleophile is OH^-)