General Instructions:
Use scratch paper at the back of the exam to work out answers. Final answers must be recorded at the proper place on the exam itself for credit.
Print your name and ID # on each page.
Please keep your paper covered and your eyes on your own work.
Academic misconduct will lead to failure in the course.

1. (15 pts.) When the following diene is protonated a stabilized cation is formed. Write the three best resonance structures for this cation.

\[
\text{[Diagram of diene and protonation]} \quad \text{[Resonance structures]} \quad \text{[Stabilized cation]}\]

2. (15 pts.) Draw a complete Lewis structure of the following. Use a specific example. Don't use R groups.

a) a conjugated ketone

\[
\text{[Ketone Lewis structure]}\]

b) allyl vinyl ether

\[
\text{[Allyl vinyl ether Lewis structure]}\]

c) a cyclic amide

\[
\text{[Cyclic amide Lewis structure]}\]
3. (25 pts.) Circle the correct structure.

(a) The **strongest** acid.

(b) The **strongest** base.

(c) The **most reactive** chloride when treated with NaSCH₃ in dimethyl formamide.

(d) The bromide which would give the **highest ratio** of E₂ product to Sₙ₂ product when treated with NaOEt in EtOH.

(e) The alkyl halide which would be **most reactive** with acetic acid.
4. (a) (10 pts.) Draw all the stereoisomers of 1,2,4,5-tetramethylcyclohexane in 3-D as hexagons with wedges and dashed lines. Label the meso compounds.

(b) (5 pts.) Draw the most stable isomer in its most stable chair conformation.

5. (15 pts.) Complete the following acid-base reactions. Show all formal charges.
6. (10 pts.) Write a detailed mechanism for the following transformation using correct electron-pushing arrows and showing all intermediates.

(a)

7. (6 pts.) One of the following compounds is chiral. Which is it? Draw a 3-D representation of its enantiomer.

8. (6 pts.) Circle the compounds (if any) that are in the same oxidation state.

9. (12 pts.) Assign the absolute configuration (R,S) of the stereogenic centers in the following prostaglandin. How many stereoisomers are possible for this prostaglandin skeleton?

\[ 2^7 = 128 \]
10. (36 pts.) Write the major products of the following reactions showing stereochemistry in 3-D where necessary. Include all stereoisomers.

(a) \[
\text{Cyclopentene} + \text{Acrolein} \rightarrow \text{Product} \]

(b) \[
\text{Chemistry} \xrightarrow{1. \text{CH}_3\text{MgBr}} \xrightarrow{2. \text{NH}_4\text{Cl}} \text{Product} + \text{Product}
\]

(c) \[
\text{Iteroene} \xrightarrow{1. \text{O}_3} \xrightarrow{2. \text{Zn}, \text{HOAc}} \text{Product} + \text{Product}
\]

(d) \[
\text{Sodium trimethylsilyl carbonate} \xrightarrow{\text{HBr}} \text{Product}
\]
11. (20 pts.) Show how you would accomplish the following transformations. Give all reagents and isolated intermediate products. More than one step is required.

(a) 

\[ \text{step 2} \]

we haven't had yet

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(b) 

step 1

we haven't had yet

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12. (25 pts.) For each of the following structures identify them as conformers, enantiomers, diastereomers, structural isomers or identical.

(a)  

(b)  

(c)  

(d)  

(e)  

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