Organic Chemistry

Mock Exam

Part I: Multiple-Choice Questions (20%)

1. Ionic reaction:

   A. undergoes a heterolytic reaction process

   B. must have at least one carbocation intermediate

   C. usually has only one step

   D. contains free radicals to propagate reaction chain

2. Which of the following species is a nucleophile:

   A. methyl carbocation (H_3C^+)

   B. butane ($CH_3CH_2CH_2CH_3$)

   C. hydroxide (OH^-)

   D. none of above

3. What is S_N2 stand for:

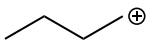
   A. bimolecular nucleophilic substitution

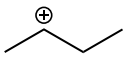
   B. two-molecular nucleophilic substitution

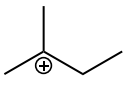
   C. unimolecular nucleus subtraction

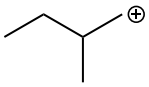
   D. double-molecular electrophilic substitution

4. Which of the following carbocation is the most stable:

   A. 

   B. 

   C. 

   D. 

5. Which of the following species is the best leaving group:

   A. chloride (Cl^-)

   B. iodide (I^-)

   C. hydroxide (-OH)

   D. alkoxide (-OR)

6. The rate law for the S_N1 reaction is:

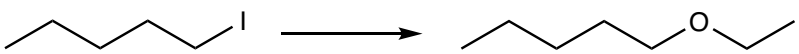
   A. $\text{rate} = k\,[\text{substrate}]$

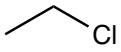
   B. $\text{rate} = k\,[\text{nucleophile}]$

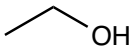
   C. $\text{rate} = k\,[\text{substrate}][\text{nucleophile}]$

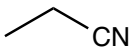
   D. $\text{rate} = k$

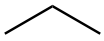
7. Identify the reagent used for the following transformation:



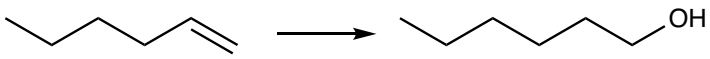
   A. 

   B. 

   C. 

   D. 

8. Identify the reagent(s) used for the following transformation:



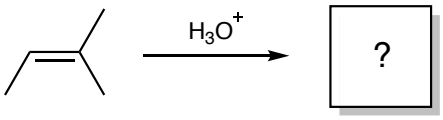
   A. H_2O_2

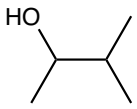
   B. H_3O^+

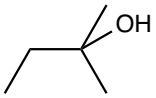
   C. 1) $Hg(OAc)_2$, H_2O; 2) $NaBH_4$

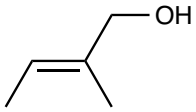
   D. 1) $BH_3 \cdot THF$; 2) H_2O_2, NaOH

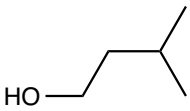
9. Identify the major product of the following reaction:



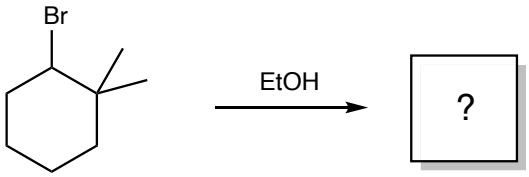
A. 

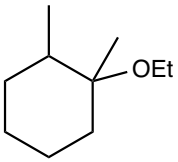
B. 

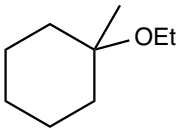
C. 

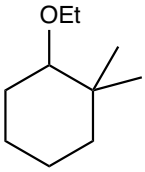
D. 

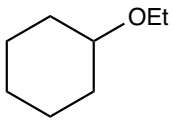
10. Identify the major product of the following reaction:



A. 

B. 

C. 

D. 

Part II: Fill-in-Blank and Short Answer Questions (20%)

11. The S_N2 reaction is characterized by the inversion of stereochemical configuration, or the Walden inversion. This feature is called _____.
12. Because elimination reaction has a _____ value of ΔG at low temperature, and its ΔS is _____, heat is needed to add for a greater yield.
13. Markovnikov addition is to add hydrogen to the carbon which links to _____ hydrogen atoms.
14. A molecule which has a reflectional symmetry must _____ chirality.
15. Explain the difference between transition state and intermediate.

_____

_____

_____

16. Describe the shape of the potential energy curve of a S_N2 reaction with core steps and two proton transfer processes (before and after the core step). You can draw a graph to support your answer.

_____

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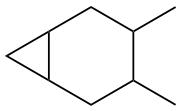
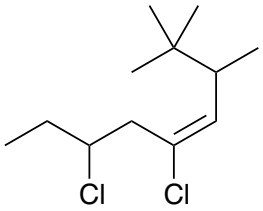
Part III: Free-Response Questions (60%)

17. Name the following molecules.





18. Draw a skeletal formula for each of the following compounds.

(a) 2-cyclobutyl-1,3-diethyl-5-isopropylcyclohexane

(b) (1*R*,2*R*,3*S*,5*R*)-1-bromo-3-ethyl-2,5-dimethylcyclohexane

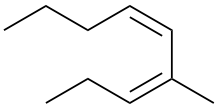
(a)	(b)

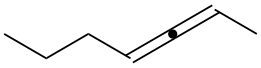
19. Dienes are compounds that possess two carbon-carbon double bonds.

(a) Depending on the proximity of the π bonds, dienes are classified as cumulated, conjugated, or isolated.

- In **cumulated dienes**, also called allenes, the π bonds are adjacent.
- In **conjugated dienes**, the π bonds are separated by exactly one σ bond.
- In **isolated dienes**, the π bonds are separated by two or more σ bonds.

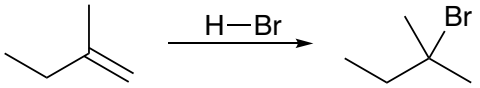
For the two dienes shown below, give them the relevant classification (cumulated diene, conjugated diene, or isolated diene).



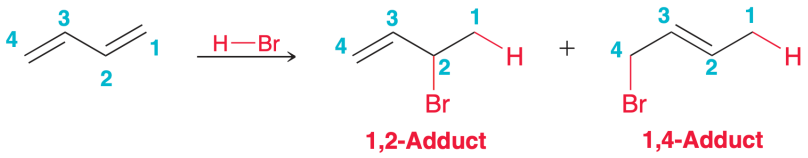


(b) When undergo addition reactions, conjugated dienes usually have different regiochemical preferences compared with the addition reactions on normal (isolated) alkenes.

(i) Propose a mechanism for the following addition reaction of an isolated alkene.



When butadiene is treated with HBr, a similar process takes place, but two major products are observed. These compounds are said to be the products of **1,2-addition** and **1,4-addition**, respectively. This terminology derives from the fact that the starting diene contains a π system spread over four atoms, and the positions of H and Br are either at C1 and C2 or at C1 and C4. The products are called the **1,2-adduct** and the **1,4-adduct**, respectively.



(ii) By considering the carbocation formed in the reaction process, propose a plausible mechanism to explain the formation of the 1,4-adduct.

(iii) The exact product distribution (the ratio of products) of this reaction is temperature dependent. At high temperature, the 1,4-adduct is preferable, while at low temperature, the reaction favors to produce 1,2-adduct. Given that the production of the 1,4-adduct is under thermodynamic control, draw an energy diagram to illustrate this reaction phenomenon.

20. Using acetylene as your only source of carbon atoms, from a retrosynthetic approach, design a synthesis of *trans*-5-decene: