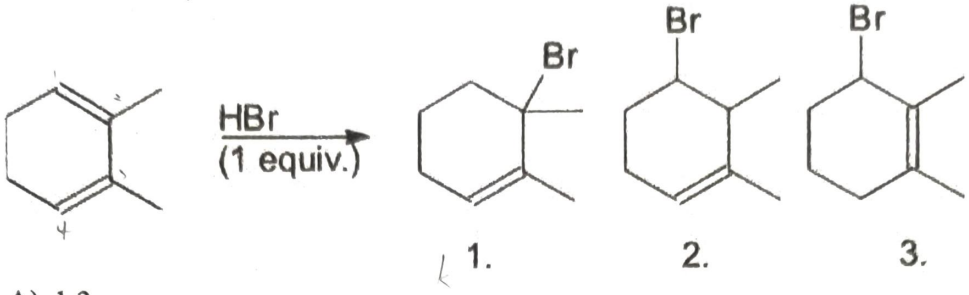
Name: _____ ; Student ID number: _____ ; Score: _____/301

I. Mutiple choice (5 point each; total 115 point)

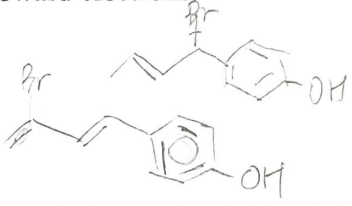
B 1. Which products are, respectively, the kinetic and thermodynamic product?



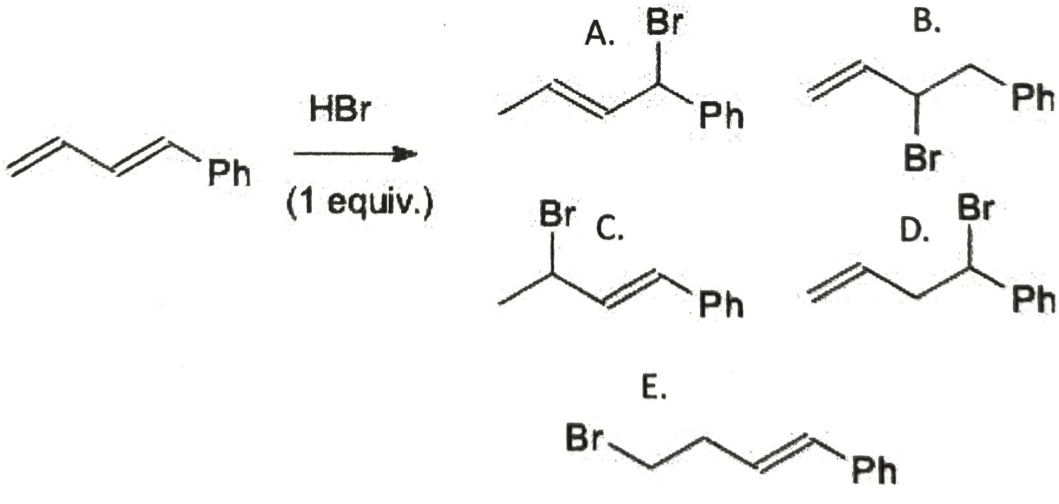
A) 1,2
B) 1,3
C) 2,1
D) 2,3
E) 3,1

B 2. Which of the following is not acceptable when drawing resonance structures?

A) Move electrons to *sp* or sp^2 hybridized atoms.
B) Positive charges are moved toward electrons.
C) Move lone-pair electrons.
D) Never move atoms.
E) Move pi electrons.



C 3. Which of the following products is the result of either 1,2 or 1,4-addition of HBr and is the most stable? (Ph = phenyl)



4. What happens in the following S_N2 reaction if the concentration of both reagents is doubled?

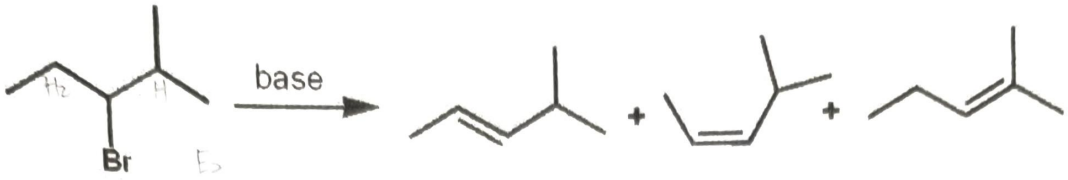
A) The reaction rate doubles.
B) The reaction rate triples.
C) The reaction rate is quadrupled.
D) The reaction rate is unaffected.
E) The reaction rate is halved.

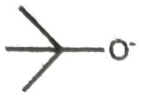
5. Which of the following species is the best nucleophile in methanol? CH_3OH
A) F^-
B) NH_3
C) CH_3S^-
D) CH_3O^-
E) DBN

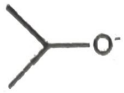
6. Which of the following best explains a partial racemization?
A) a good leaving group
B) an S_N2 reaction
C) formation of an intimate ion pair
D) completely dissociated ions
E) a polar solvent

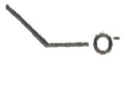
7. Which of the following statements is not true about the S_N1 reaction of an alkyl halide?
A) Tertiary alkyl halides and benzyl and allyl halides undergo S_N1 reactions.
B) The rate is dependent upon the stability of the carbocation.
C) The rate is dependent upon the concentration of the nucleophile.
D) The reaction requires a good leaving group.
E) The reaction is favored in a polar protic solvent.

A 8. In the following reaction, which base most favors the anti-Zaitsev product?



A. 

B. 

C. 

D. 

E. 

D 9. Which of the following statements is false?

A) Increasing solvent polarity decreases the reaction rate when any reactant is charged.

B) Increasing solvent polarity increases the reaction rate when none of the reactants is charged.

C) An E2 reaction is favored by a high concentration of a strong, hindered base.

D) An E1 reaction is favored by a secondary alkyl halide.

E) An E2 is favored by a strong base.

B 10. Assuming no other changes, what is the effect of doubling only the concentration of the alkyl halide in the above S_N2 reaction?

A) no change

B) doubles the rate

C) triples the rate

D) quadruples the rate

E) rate is halved

E 11. Which of the following compounds will undergo an S_N2 reaction most readily?

A) $(CH_3)_3CCH_2I$

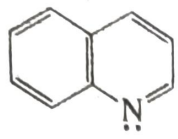
B) $(CH_3)_3CCl$

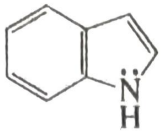
C) $(CH_3)_2CHI$

D) $(CH_3)_2CHCH_2CH_2CH_2Cl$

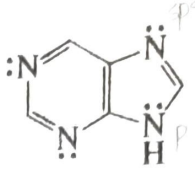
E) $(CH_3)_2CHCH_2CH_2CH_2I$

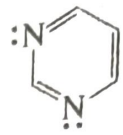
B 12. Which of the following compound does not possess a basic nitrogen?


quinoline


indole


imidazole


purine


pyrimidine

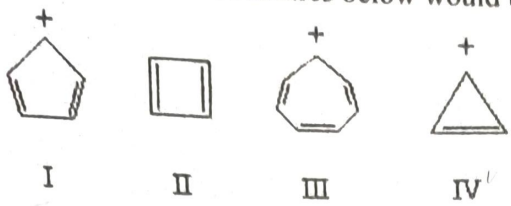
A) quinoline.
B) indole.
C) imidazole.
D) purine.
E) pyrimidine.

D 13. Which of the following factors has no effect on the rate of S_N1 reactions?
A) the nature of the alkyl halide
B) the nature of the leaving group
C) the concentration of the alkyl halide
D) the concentration of the nucleophile
E) the value of the rate constant

C 14. Which of the following iodides undergoes S_N1 solvolysis in water the fastest?
A) 1-iodo-3-methylpentane
B) 2-iodopentane
C) 2-iodo-2-methylpentane
D) 3-iodopentane
E) 1-iodo-2,2-dimethylpentane

15. Due to electron delocalization, one would predict that the carbon-oxygen bond in acetamide, CH_3CONH_2
A) is nonpolar.
B) has more double bond character than the carbon-oxygen bond of acetone, $(CH_3)_2CO$.
C) is longer than the carbon-oxygen bond of dimethyl ether, $(CH_3)_2O$.
D) is longer than the carbon-oxygen bond of acetone, $(CH_3)_2CO$.
E) is formed by overlapping sp^3 orbitals.

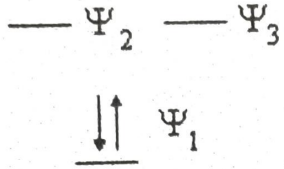
16. Which of the structures below would be aromatic?

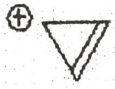


I II III IV

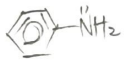
A) I and IV
B) I, III, and IV
C) III and IV
D) II

17. Which species is represented by the following distribution of π electrons in the molecular energy diagram?



I.  II.  III.  IV.  V. 

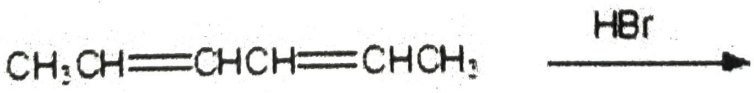
A) I
B) II
C) III
D) IV
E) V



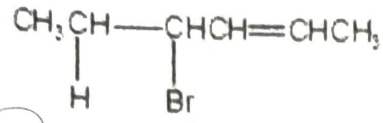
18. Which of the following ions is most acidic?

A) $C_6H_5NH_3^+$
B) $C_6H_5CH_2NH_3^+$
C) $(CH_3)_2CHNH_3^+$
D) $CH_3CH_2NH_3^+$
E) $CH_3NH_3^+$

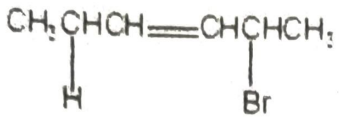
19. Give the major organic product(s) for the reaction. (You may choose more than one answer). Please show the reaction



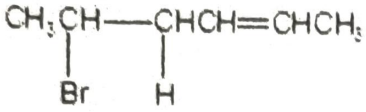
A)



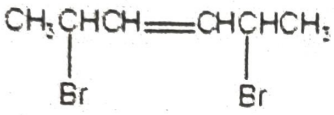
B)



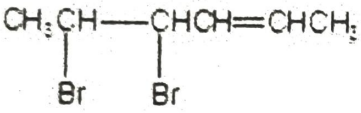
C)



D)



E)



20. Which of the following is a correct statement considering thermodynamic versus kinetic control of organic reactions?

A) When a reaction is under thermodynamic control, the relative amounts of products depend on the activation energies of the steps leading to their formation.

B) The kinetic product always predominates when the reaction is reversible.

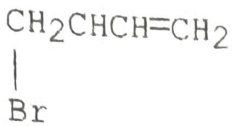
C) Higher temperatures and longer reaction times typically favor the kinetic product over the thermodynamic product.

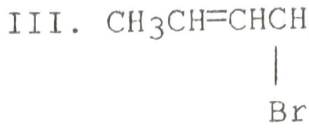
D) When the products are in equilibrium under the reaction conditions, the relative amounts of products depend on their stabilities and the reaction is under thermodynamic control.

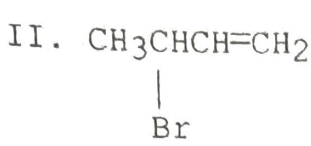
E) none of the above

B

21. What is/are the product(s) from the following reaction?

I. 

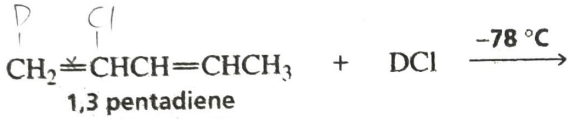
III. 

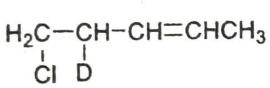
II. 

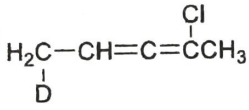
A) II Minor, III Major
B) II Major, III Minor
C) III only
D) I and II
E) II and III

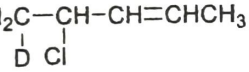
C

22. What is/are the product(s) from the following reaction?



(I) 

(II) 

(III) 

A) I only
B) II only
C) III only
D) I and II
E) II and III

E

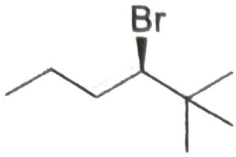
23. Which of the following solvent or additive can NOT solvate a metal cation?

(A) $P(O)(NMe_2)_3$ (B) $CH_3S(O)CH_3$ (C) *t*-BuOMe (D) $HC(O)NMe_2$ (E) H_2O

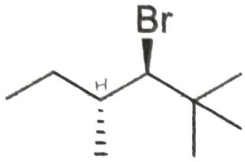
II. Provide suitable structure(s) or explanation(s) for the following questions. (total 186 points)

1. Determine the major products (5 point each; total 40 point)

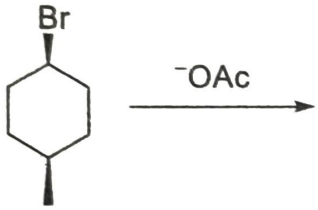
(a) major product when undergo an E2 reaction



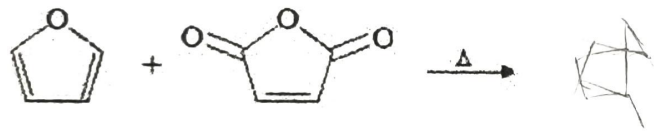
(b) major product when undergo an E2 reaction



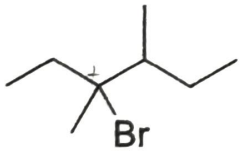
(c) major product when undergo an S_N2 reaction



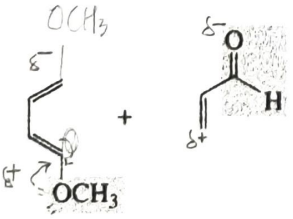
(d) major product and HOMO_LUMO interaction when undergo Diels–Alder reaction



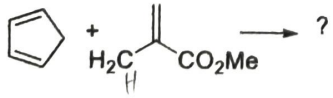
(e) Major product when undergo E1 reaction



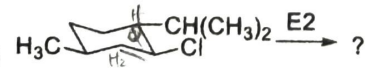
(f)



(g)



(h)



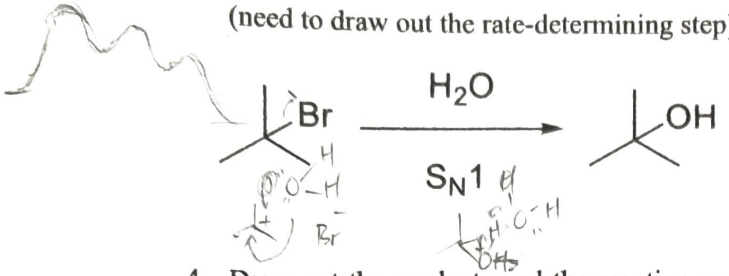
2. Explained the reason (need to provide suitable drawing(s) to support the answer) (10 point)

F^- is the best nucleophile in an aprotic polar solvent.

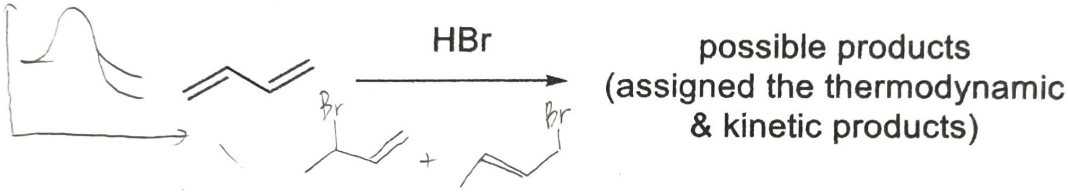
I^- is the best nucleophile in a protic polar solvent.

3. Draw the mechanism of the reaction and the corresponding reaction coordinate diagram (20 point)

(need to draw out the rate-determining step)

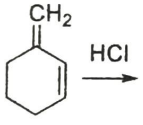


4. Draw out the products and the reaction coordinate diagram with explanation (20 point)



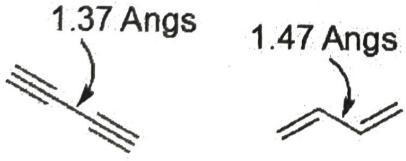
5. Predicted the products and assigned which the thermodynamic and kinetic product

(10 point)

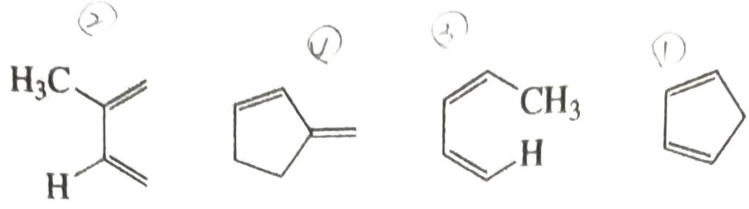


possible products
(assigned the thermodynamic
& kinetic products)

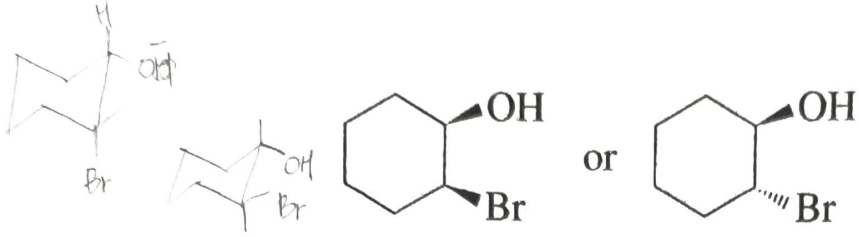
6. Explain the reason for the difference in bond lengths below: (10 point)



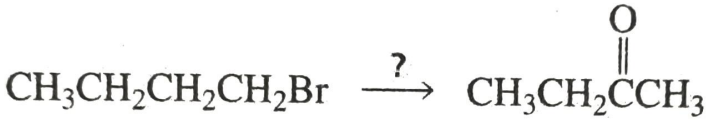
7. Rank the following dienes from most reactive to least reactive in a Diels–Alder reaction: (10 point)



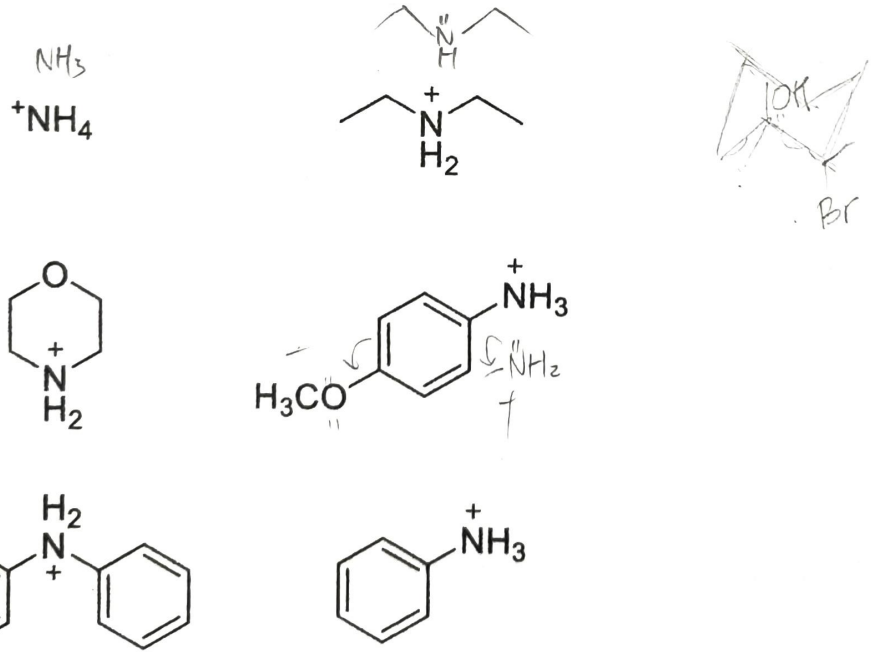
8. Which of the following compounds forms an epoxide as a result of reacting with sodium hydride (NaH)? Explaine the result with a reasinable mechanism. (15 point)



9. How can 2-butene be converted to 2-butyne? Provided the procedure of the reaction. (15 point)

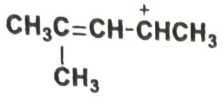


10. Which of the following is the strongest acid? Explained the reason. (15 point)

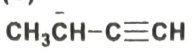


11. Provide other reasonable resonance contributors of the following species. (3 point each; 21 point)

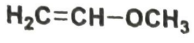
(A)



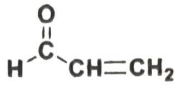
(B)



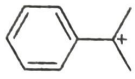
(C)



(D)



(E)



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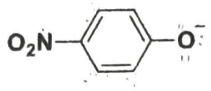

(G)