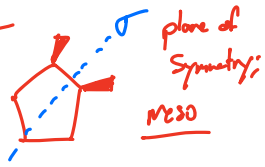
CHEM 223 (2024) SI Summary Session 2

Learning Objectives: By the end of this session, students should be able to:

- Crush Exam 2!

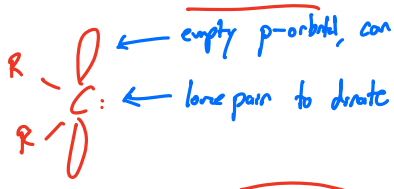
Section 1: Multiple Choice

1. Which of the following incorrectly describes cis-1,2-dimethylcyclopentane?
   a. It is a meso compound
   b. It is achiral
   c. It contains two asymmetric carbons
   d. Its diastereomer is trans-1,2-dimethylcyclopentane
   e. It has an enantiomer



2. Which of the following intermediates maintains an sp^3 configuration?
   a. Methyl carbanion
   b. Dibromocarbene
   c. Tertiary carbocation
   d. Secondary Alkyl Radical
   e. B and C

3. Which reactive intermediate is both strongly nucleophilic and strongly electrophilic?
   a. Carbocations
   b. Carbanions
   c. Carbenes
   d. Carbon Radicals



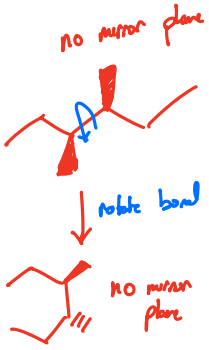
4. Which reactive intermediate is both strongly nucleophilic and strongly basic?
   a. Carbocations
   b. Carbanions
   c. Carbenes
   d. Carbon Radicals

5. What term best describes the structural relationship between (1S,2R,4S)-1,2,4-trichlorocyclohexane and (1R,2S,4S)-1,2,4-trichlorocyclohexane?
   a. Not isomers
   b. Constitutional Isomers
   c. Enantiomers
   d. Diastereomers

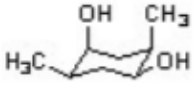
6. If (S)-glyceraldehyde has a specific rotation of +8.7 degrees, what is the specific rotation of (R)-glyceraldehyde?
   a. +8.7 degrees
   b. 0 degrees
   c. -8.7 degrees
   d. Must be determined experimentally

optical rotation of enantiomers is opposite

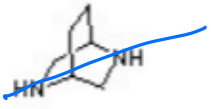
7. Which of the following statements is true for (3R, 4R)-3,4-dimethylhexane?
   a. The compound is chiral
   b. The enantiomer of the compound is (3S, 4S)-3,4-dimethylhexane
   c. A diastereomer of the compound is (3R, 4S)-3,4-dimethylhexane
   d. All of the above
   e. None of the above



8. Which of the following structures are achiral and meso?



1



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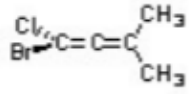

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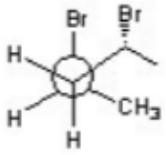

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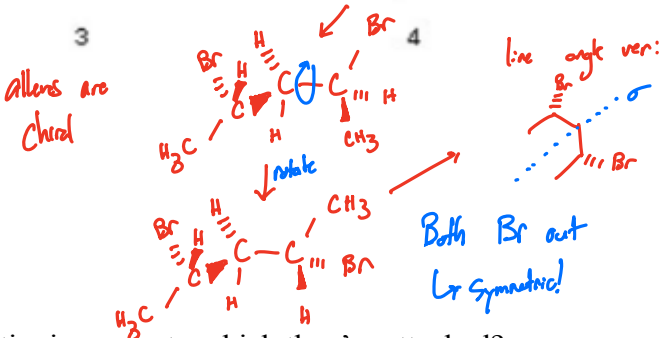
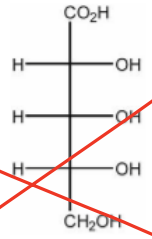


   a. 1
   b. 2
   c. 3
   d. 4

9. How do alkyl substituents stabilize a carbocationic center to which they're attached?
   a. Through inductive donation of electron density
   b. Through inductive removal of electron density
   c. Through hyperconjugation
   d. Both A and C
   e. Both B and C

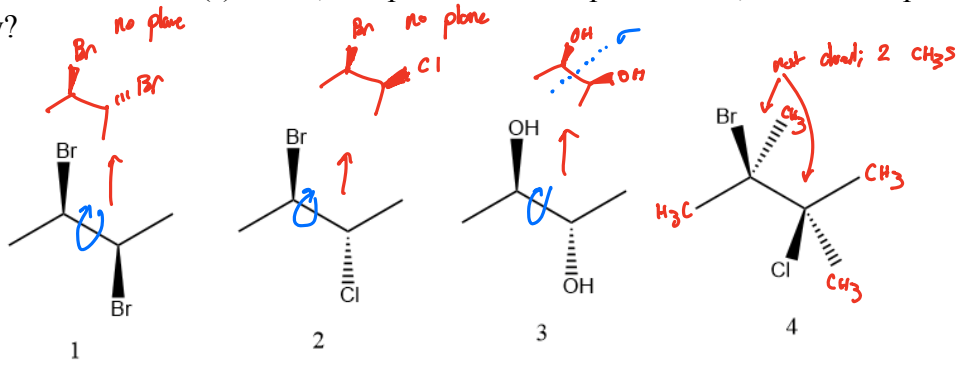
10. How many enantiomers are there of the compound shown below?



ignore this one

a. 0
b. 1
c. 2
d. 3
e. 6

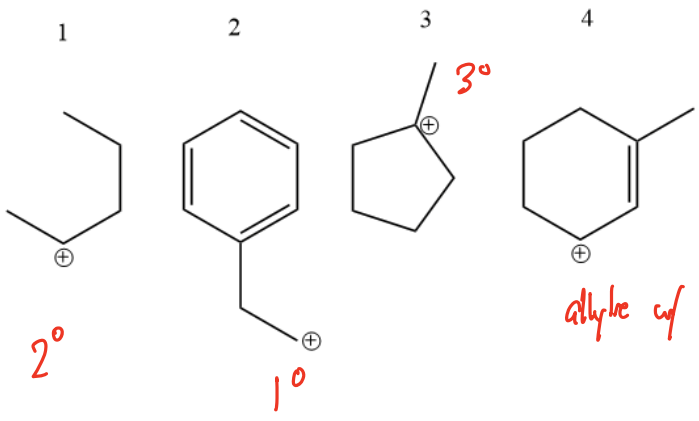
11. Which of the molecule(s) below, if separated in their purest form, will show optical activity?



a. Both 1 and 2
b. Both 1 and 3
c. Both 2 and 3
d. Both 3 and 4
e. Only 3

optical activity => molecule must be chiral.

12. Rank the carbocations in order of decreasing stability (Most stable first; no hydride shifts)



a. 3 > 2 > 1 > 4
b. 4 > 3 > 1 > 2
c. 4 > 1 > 3 > 2
d. 2 > 4 > 3 > 1

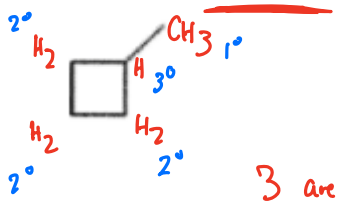
13. Energy is ___ when bonds are formed, and is ___ when bonds are broken; therefore, BDEs are always ___

a. Released, consumed, endothermic.
b. Released, consumed, exothermic.
c. Consumed, released, endothermic.
d. Consumed, released, exothermic.

14. The rate of a reaction usually increases as temperature increases because

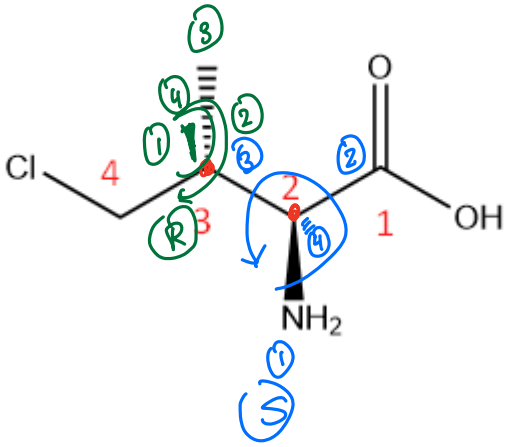
a. The proportion of molecules with energy greater than Ea increases
b. The activation energy increases
c. The activation energy decreases
d. The proportion of molecules colliding with the wall increases

15. The number of primary, secondary and tertiary hydrogens in the molecule below is



a. 1, 3, 1
b. 3, 6, 2
c. 3, 6, 1
d. 1, 6, 0

16. Which configuration corresponds to the structure below?



a. (2R, 3S)
b. (2S, 3R)
c. (2R, 3R)

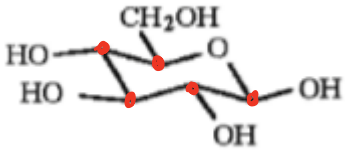
d. (2S, 3S)

17. What type of intermediate is present in the reaction of 1-methylcyclopentane with diatomic bromine in the presence of heat and light?
    a. Carbocation
    b. Free Radical
    c. Carbene
    d. Carbanion

18. Which of the following will react most quickly with methanol in the presence of heat?
    a. $ClCH_2CH_2CH(CH_3)_3$ 1°
    b. $ClCH_2CH_2CH(CH_3)_2$ 1°
    c. $(CH_3)_2CClCH_2CH_3$ 3°
    d. $(CH_3)_2CHCHClCH_3$ 2°

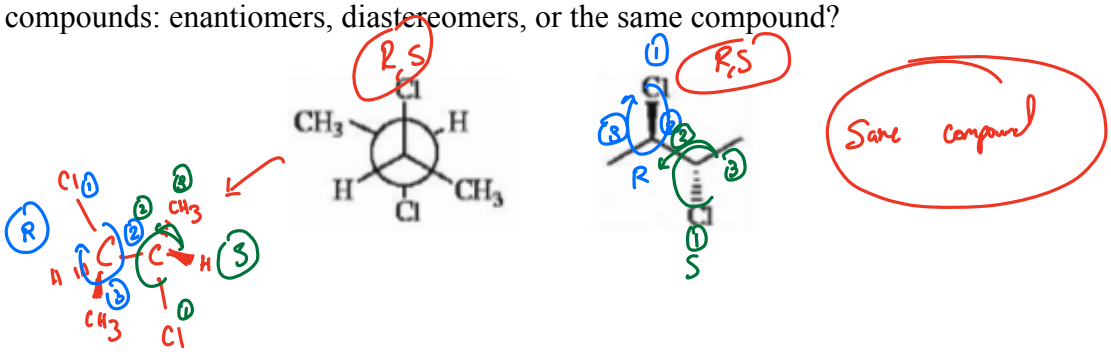
Section 2: Short Answer

19. How many asymmetric carbons are in the compound below?

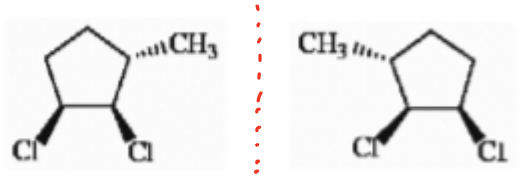


5

20. Which of the following terms best describes the relationship between the two compounds: enantiomers, diastereomers, or the same compound?

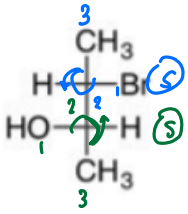


21. Which of the following terms best describes the relationship between the two compounds: enantiomers, diastereomers, or the same compound?

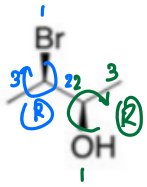


enantiomers; they are mirror images

22. Will a 50:50 mixture of the two compounds below yield an optically active solution? Explain.



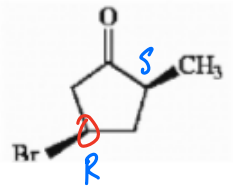
S, S

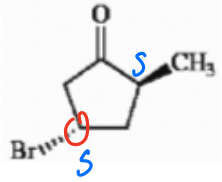


R, R

they are enantiomers so a 50/50 mixture would not be optically active.

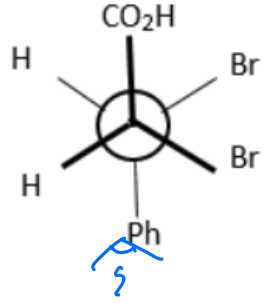
23. Is it possible to separate the two compounds below via distillation? Explain.





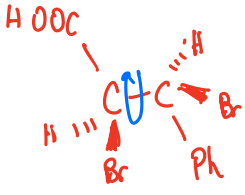
Yes; they are diastereomers and thus have different physical properties.

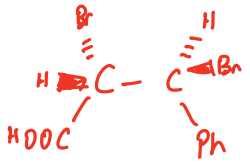
24. Convert the Newman projection to a fischer projection. (NOTE: You can use Ph as an abbreviation)



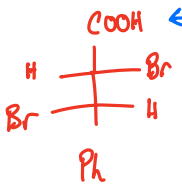
main chain highlighted in red

Ph =



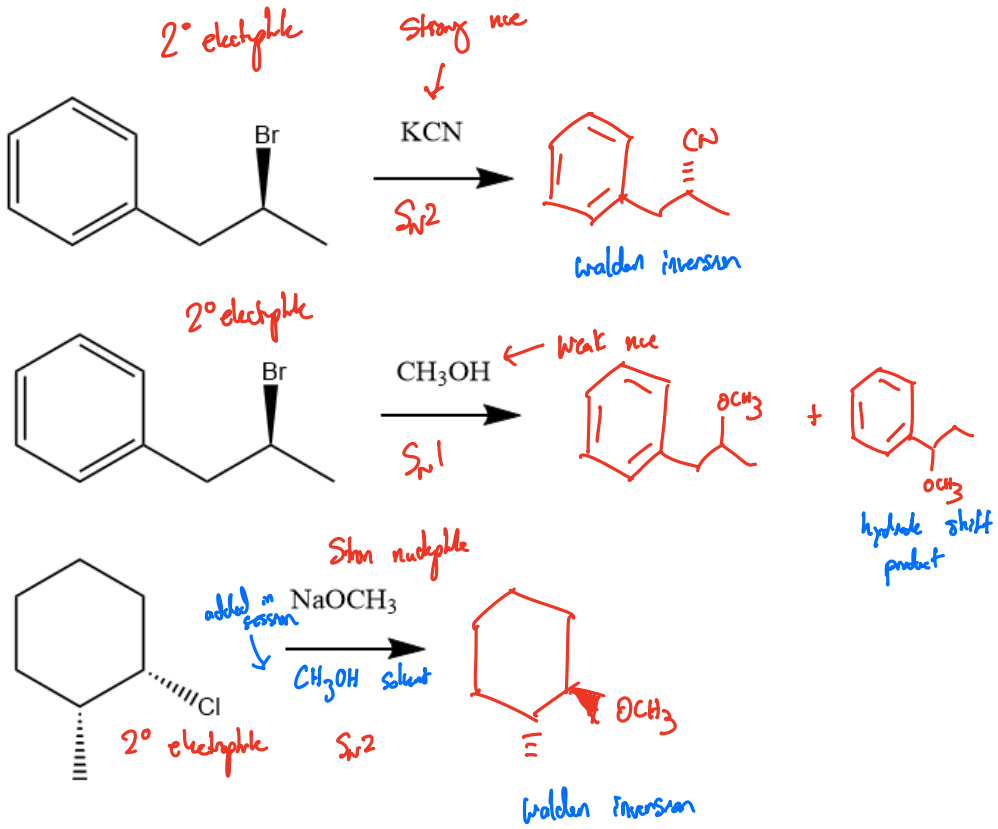


look from above for a fischer



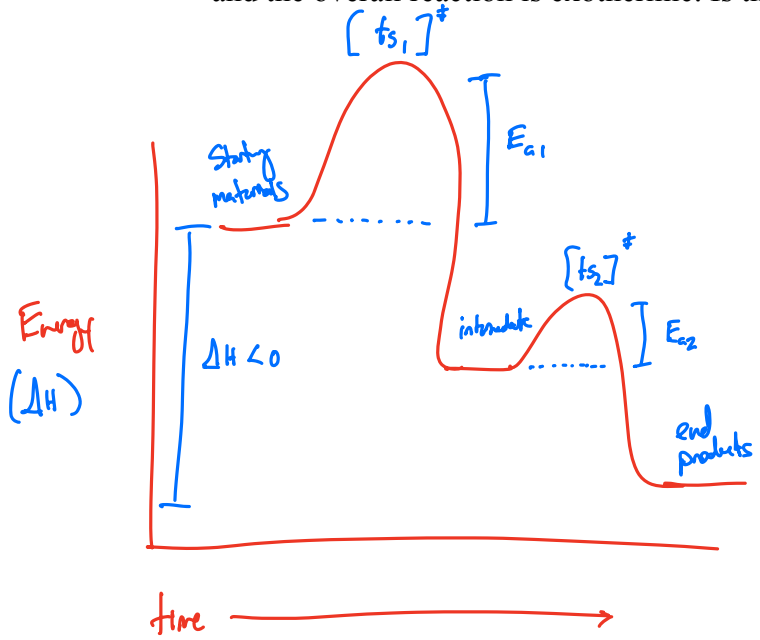
must be on top; most oxidized carbon.

25. Provide the major organic products of the reactions below



Part 3: Long Answer

26. Draw a reaction coordinate diagram for a 2-step reaction where the structure of the transition state of the rate-determining step most closely resembles the starting materials and the overall reaction is exothermic. Is this consistent with Sn2 or Sn1? Explain.



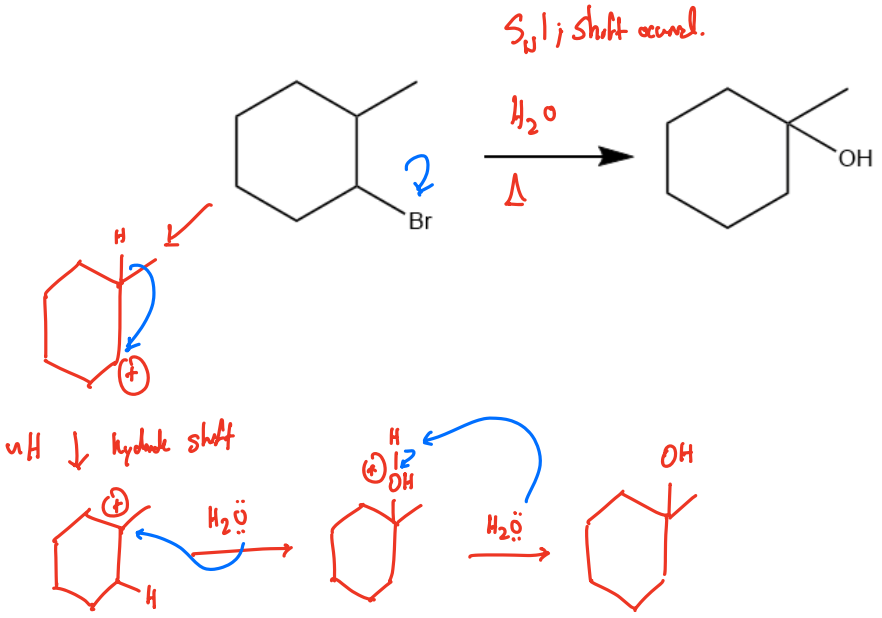
$E_{a1} > E_{a2}$, so 1st step is rate limiting.

$[ts_1]^‡$ resembles the starting materials as it is closest in energy to them.

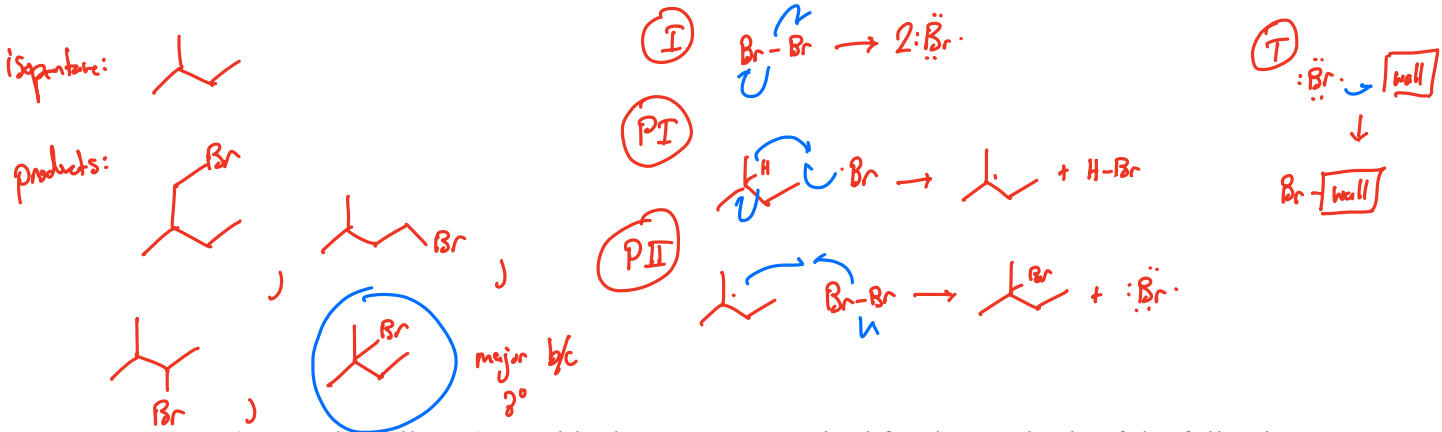
$\Delta H < 0$, so this is exothermic.

This is inline with S_N1; S_N1 is 2 steps, and has step 1 as the rate limiting step (forming the carbocation). However, Step 1 of S_N1 is endothermic, so this is not completely align with S_N1.

27. Provide the missing reagents required to perform the reaction below. Provide a mechanism to explain the generation of the product.



28. Draw the four possible products that can result from the bromination of <u>isopentane</u> and circle the major product. Draw a mechanism for the generation of the major product.



29. (Bonus / Challenge) Provide the reagents required for the synthesis of the following product from the given starting material. (NOTE: Need multiple steps)