

# Question Bank

CHO 4103

1. The hybridization of the central carbon in  $\text{CH}_3\text{C}\equiv\text{N}$  and the bond angle  $\text{CCN}$  are

- a.  $sp^2$ ,  $180^\circ$ .
- b.  $sp$ ,  $180^\circ$ .
- c.  $sp^2$ ,  $120^\circ$ .
- d.  $sp^3$ ,  $109^\circ$ .

2. Which of the following statements about  $sp$  hybridized carbon is FALSE?

- a. It is divalent.
- b. It forms bonds that are linear.
- c. It has two p orbitals.
- d. It always forms triple bonds to carbon.

3. Which molecule has the largest dipole moment?

- a.  $\text{HCl}$
- b.  $\text{CCl}_4$
- c.  $\text{H}_2\text{S}$
- d.  $\text{CO}_2$

4. What are the hybridizations of carbons 1 and 2 respectively in the **Cyclopentene**?

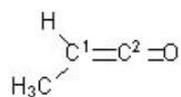
- a.  $sp^3$  and  $sp^2$
- b.  $sp^2$  and  $sp^3$
- c.  $sp^3$  and  $sp$
- d.  $sp^2$  and  $sp^2$

5. What are the hybridizations of atoms 1 and 2 respectively in the **Pyridine**?

- a.  $sp^3$  and  $sp^2$

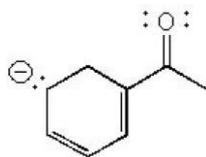
- b.  $sp^2$  and  $sp^3$
- c.  $sp^3$  and  $sp$
- d.  $sp^2$  and  $sp^2$

6. What are the hybridizations of atoms 1 and 2 respectively in the following structure?



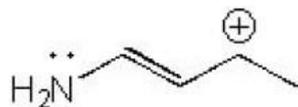
- a.  $sp^3$  and  $sp^2$
- b.  $sp^2$  and  $sp^3$
- c.  $sp^3$  and  $sp$
- d.  $sp^2$  and  $sp^2$

7. How many **total resonance structures** can be drawn for the following anion (include those without separation of charge)?



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

8. How many **resonance structures** can be drawn for the following molecule?

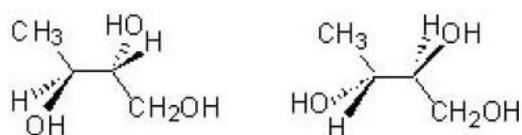


- a. 1
- b. 4
- c. 3
- d. 2

9. The correct geometry around oxygen in CH<sub>3</sub>OCH<sub>3</sub> is

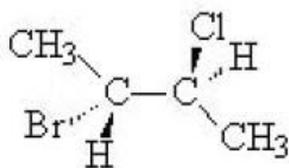
- a. linear.
- b. bent.
- c. tetrahedral.
- d. trigonal planar

10. Determine the relationship between the two molecules shown.



- a. constitutional isomers
- b. enantiomers
- c. diastereomers
- d. identical molecules

11. What is the correct name for this molecule?

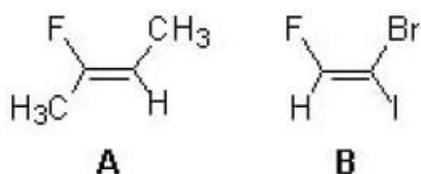


- a. (2*R*,3*R*)-2-bromo-3-chlorobutane
- b. (2*S*,3*R*)-2-bromo-3-chlorobutane
- c. (2*S*,3*S*)-2-bromo-3-chlorobutane
- d. (2*R*,3*S*)-2-bromo-3-chlorobutane

12. Which of the following physical properties differ for each of a pair of enantiomers?

- a. solubility in ethanol
- b. direction of rotation of plane-polarized light
- c. boiling point and melting point
- d. index of refraction

13. Determine the double bond stereochemistry (*E* or *Z*) for the following molecules.



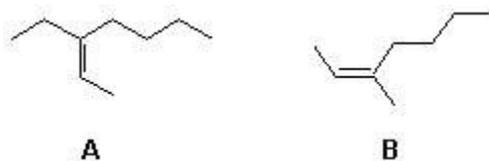
a. **A**: *E*; **B**: *E*

b. **A**: *Z*; **B**: *Z*

c. **A**: *E*; **B**: *Z*

d. **A**: *Z*; **B**: *E*

14. Determine the double bond stereochemistry (*E* or *Z*) for the following molecules.



a. **A**: *E*; **B**: *E*

b. **A**: *Z*; **B**: *Z*

c. **A**: *E*; **B**: *Z*

d. **A**: *Z*; **B**: *E*

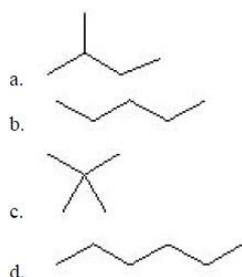
15. Which of the following cycloalkanes has the MOST strain energy?

- a. cyclobutane
- b. cyclopentane
- c. cyclohexane
- d. cycloheptane

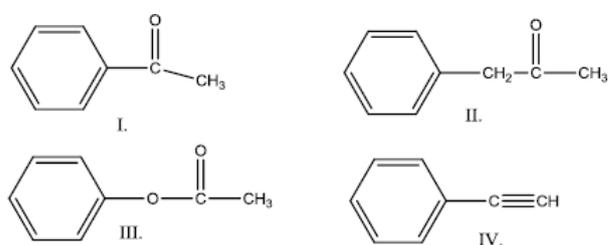
16. Which compound has the highest melting point?

- a. decane
- b. 2,2,3,3-tetramethylbutane
- c. 2,2,3-trimethylpentane
- d. 4-methylnonane

17. Which of the following alkanes will have the lowest boiling point?

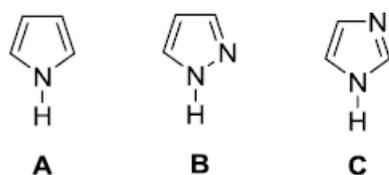


18. Circle the letter which correctly ranks the following compounds from fastest to slowest as they react in an EAS reaction with  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$ . (If  $a > b$ , a is faster than b)



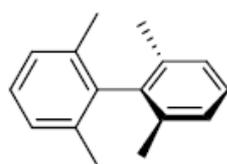
- a) I > II > III > IV  
 b) IV > III > II > I  
 c) III > IV > II > I  
 d) III > II > I > IV

19. The correct basicity order for the following heterocycles is:



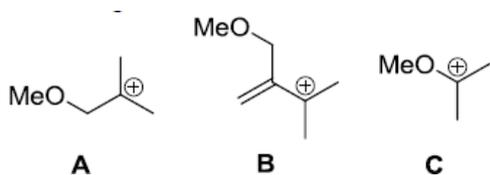
1. A > C > B  
 2. C > A > B  
 3. C > B > A  
 4. B > A > C

20. The number of signals observed in the proton decoupled  $^{13}\text{C}$  NMR of the following compound is,



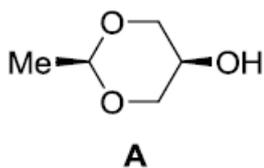
1. five  
 2. six  
 3. ten  
 4. thirteen

21. The correct order of stability of following cation is,



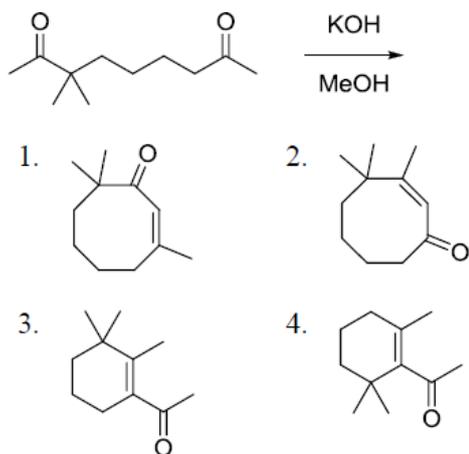
1. **A > C > B**
2. **B > C > A**
3. **C > A > B**
4. **C > B > A**

22. Among the structures given below, the one that corresponds to the most stable conformation of compound A is,

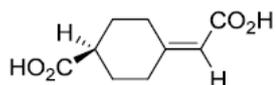


- 1.
- 2.
- 3.
- 4.

23. The major product formed in the following reaction is,



24. The following molecule has:



1. plane of symmetry
2. *R* configuration
3. *S* configuration
4. centre of symmetry

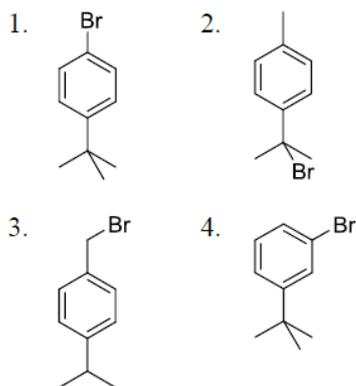
25. Correct match of the following compounds in Column P with the IR stretching frequencies (cm<sup>-1</sup>) in column Q is:

	Column P		Column Q
I		A	1865
II		B	1770
III		C	1745

1. I - B; II - C; III - A
2. I - C; II - A; III - B
3. I - C; II - B; III - A
4. I - A; II - C; III - B

26. The organic compound that displays following data is;

<sup>1</sup>H NMR (400 MHz): δ 7.38 (d), 7.25 (d),  
1.29 (s) ppm



27. Choose the INCORRECT statement for the phosphomolybdate anion, [PMo<sub>12</sub>O<sub>40</sub>]<sup>3-</sup>:

- 1 It has a Keggin structure.
- 2 Phosphorus is in +5 oxidation state.
- 3 It is extremely basic.
4. It forms crystalline precipitates with [R<sub>4</sub>N]<sup>+</sup> (R = bulky alkyl or aryl group)

28. The number of optically active stereoisomers possible for  $\text{CH}_3\text{-CH(OH)-CH(OH)-CH}_3$  is:

1. two
2. four
3. six
4. eight

29. Which of the following alcohol would undergoes dehydration the fastest?

- a. 2-phenyl-2-butanol
- b. 2-methyl-2-butanol
- c. 2-butanol
- d. 1-butanol

30. Which of the following is NOT stereospecific reaction.

- a. epoxidation of cyclohexene with m-CPBA
- b. elimination of HBr from 2-bromo-2-methylpropane by sodium ethoxide'
- c. dehydration of 1-methylcyclohexanol by heating with  $\text{H}_2\text{SO}_4$ .
- d. reaction of 2-bromobutane with NaOH.

31. Reaction of a secondary alkyl halide with a weak base would likely result in

- a.  $\text{S}_{\text{N}}1$  reaction
- b.  $\text{S}_{\text{N}}2$  reaction
- c.  $\text{E}1$  Reaction
- d. mixture of  $\text{S}_{\text{N}}1$  and  $\text{E}1$
- e.  $\text{E}2$  elimination
- f. mixture of  $\text{S}_{\text{N}}2$  and  $\text{E}2$

32. Which of the following is the stronger acid?

- a. ethanol
- b. ethanethiol
- c. acetylene
- d. butane

33. Which of the following would be the most soluble in water?

- a. diethyl ether
- b. methanol
- c. 1-butanol
- d. dimethylsulfide

34. Which of the following would undergo  $\text{S}_{\text{N}}2$  reaction the fastest?

- a.  $\text{CH}_3\text{I} + \text{HO}^- \text{Na}^+$
- c.  $\text{CH}_3\text{I} + \text{HS}^- \text{Na}^+$
- b.  $\text{CH}_3\text{CH}_2\text{I} + \text{HO}^- \text{Na}^+$
- d.  $(\text{CH}_3)_2\text{CHI} + \text{HO}^- \text{Na}^+$
- e.  $(\text{CH}_3)_2\text{CHI} + \text{HS}^- \text{Na}^+$

**A. Write a short notes on the following.**

1. Inductive effect affecting basicity
2. Prochiral relationship
3. Benzenoid compounds
4.  $\text{S}_{\text{N}}\text{i}$  mechanism
5. Non-classical carbocation
6. Crown ether
7. Proton sponge

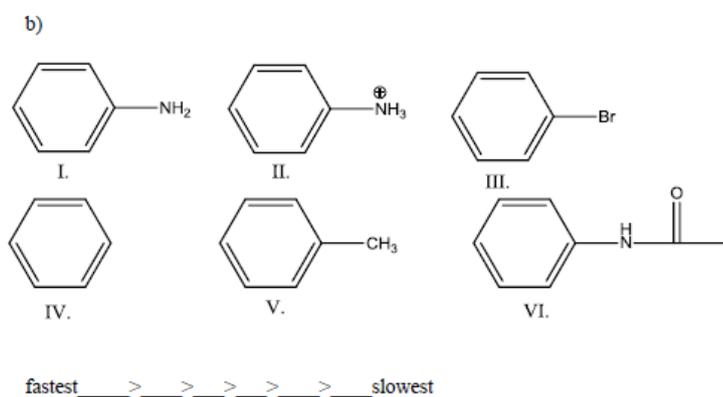
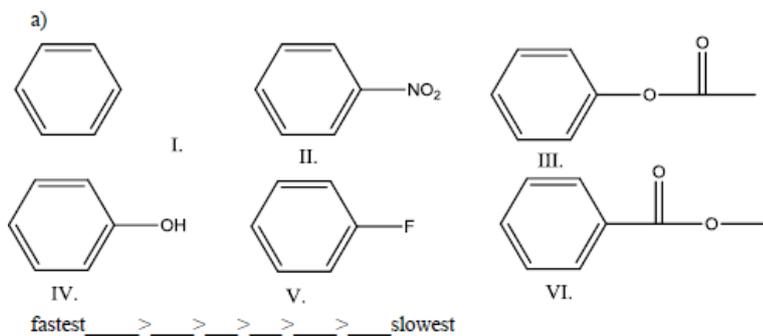
8. Ambident nucleophile
9. Tautomerism
10. Stability of carbanion
11. Chloromethylation of aromatic compounds
12. Hyper conjugation.
13. Carbocation
14. Carboanion
15. Aromatic nucleophilic substitution
16. Carbene
17. Nitrene
18. Aromatic electrophilic substitution
19. NGP

**B. Answer in one sentence.**

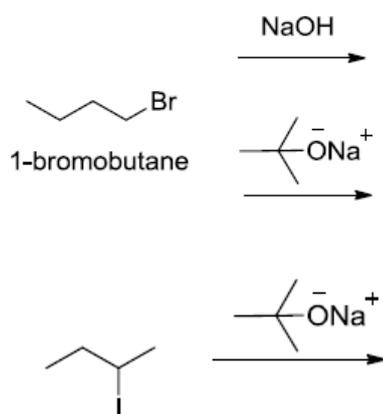
- 1) Describe regioselectivity in ambident nucleophile.
- 2) Write any one reaction involving SET mechanism.
- 3) Explain hydrolysis of 2-bromopropionic acid.
- 4) What is  $S_N^2$  reaction.
- 5) Explain Benzyne intermediate.
- 6) Formic acid is stronger than acetic Acid, Explain.
- 7) Aniline is less basic than cyclohexyl amine, Explain.
- 8) 2,4,6 trinitro phenol is known as Picric acid, Explain.
- 9) Explain the factors affecting strengths of organic Acids and Bases.
- 10) N,N Dimethyl 2, 6 dimethyl aniline is more basic than Aniline, Explain.
- 11) Write a short note on H-bonding.
- 12) Write general structure of carbocation.
- 13) Write general structure of carbene
- 14) Write general structure of nitrene
- 15) Write stability order of carboanion
- 16) Write any method for formation of carbocation
- 17) Write any method for formation of carboanion
- 18) Write any method for formation of carbene
- 19) Write any method for formation of Nitrene
- 20) Write any rearrangement involving carbocation
- 21) Write any rearrangement involving carbene
- 22) Write any rearrangement involving Nitrene

**C. Short answer question.**

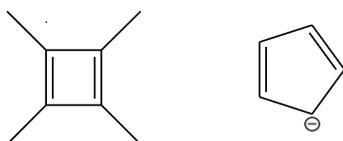
1. Rank the following compounds from fastest to slowest as they react in an EAS with  $Br_2/FeBr_3$  and justify your answer.



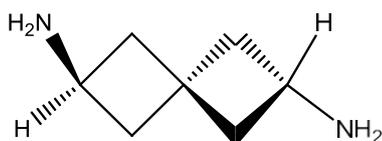
2. Predict the products.



3. Comment on the aromaticity or the following compound.



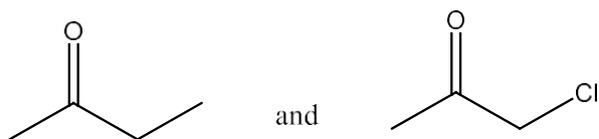
4. Comment on the optical activity of the following with justification.



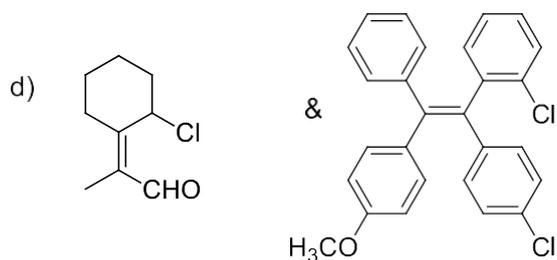
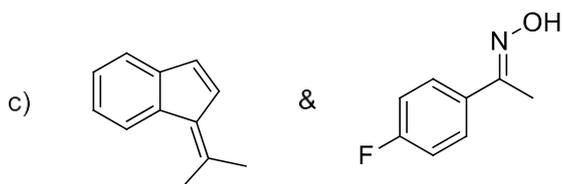
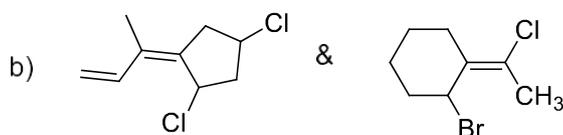
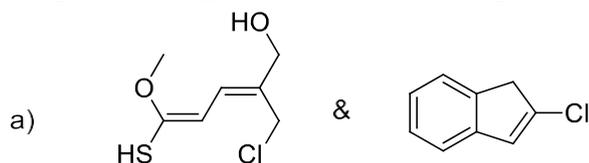
5. Assign Re and Si face labels to the following compounds.



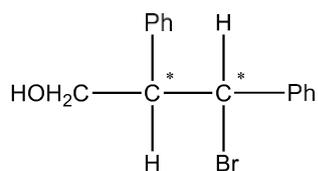
6. Explain which of the following will have higher pKa values



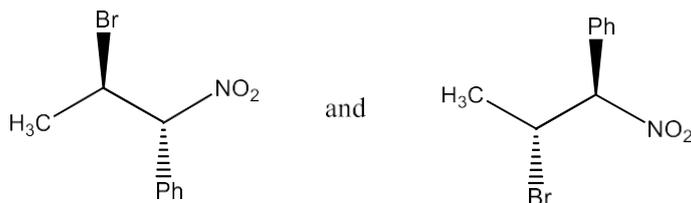
7. Assign E/Z designation to the following.



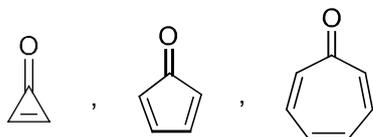
8. Assign R/S label to the chiral carbons and justify.



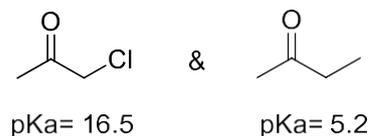
9. What is the stereochemical relationship between the following compounds?



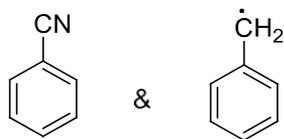
10. Explain stability order of the following.



11. Explain the pKa values of the following compounds.



12. Draw resonance structures of the following.



13. Which of the following compound is optically active? Justify your answer.



14. Comment on the stabilities of the following.



15. Discuss the acidity of the following.



16. pKa value of 4-nitroanisole is less than 3-nitroanisole. Explain.

17. Anti-elimination occurs readily than syn elimination.

18. PhCOCH<sub>2</sub>Cl reacts with KI in acetone about 32000 times faster than n-butyl chloride.

19. m-chloroanisole on reaction with sodamide in liquid ammonia gives p-anisidine.

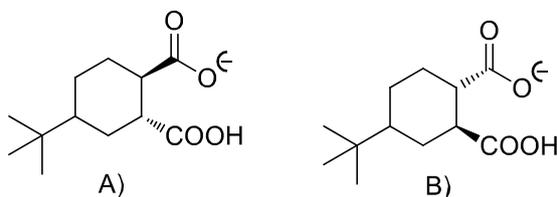
20. Addition of Br<sub>2</sub> to cis-butene is stereospecific. Explain.

21. Cis-4-hydroxy cyclohexane carboxylic acid lactonized on heating but trans does not. Explain.

22. What are Lewis acids? Give uses of Lewis acids in organic synthesis.

23. Electrophilic as well as nucleophilic substitutions of naphthalene occurs at α-position. Explain.

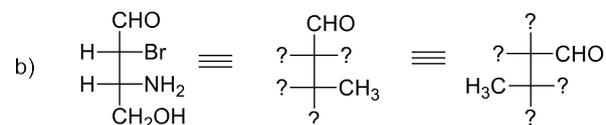
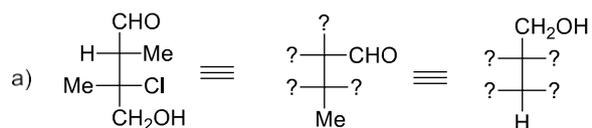
24. Which of the following is more acidic? Why?



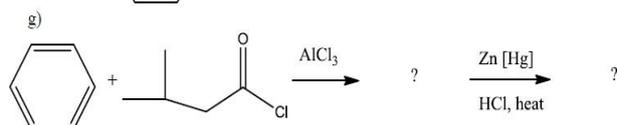
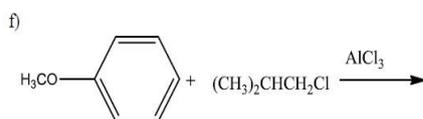
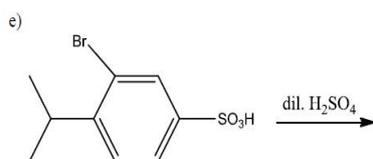
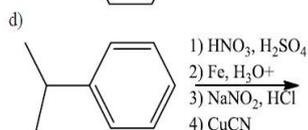
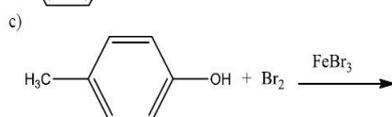
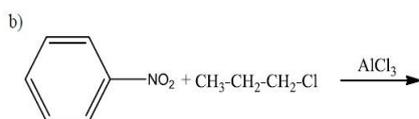
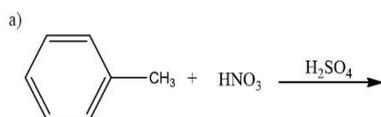
#### D. Long answer question.

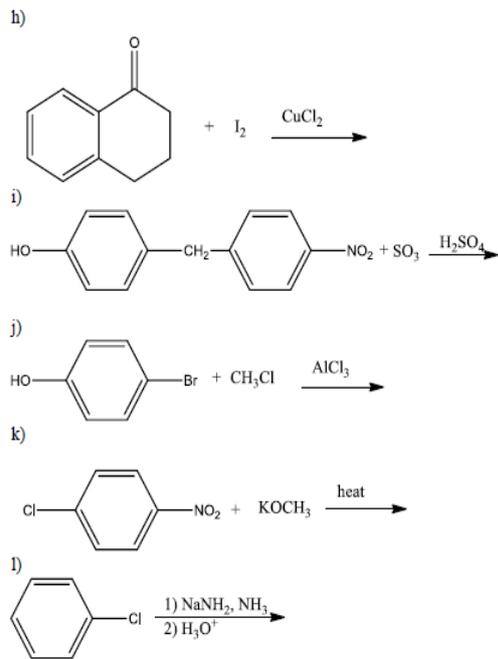
- 1) Explain with suitable examples. Benzenoid and non-benzenoid compounds.
- 2) Comment on the conformational analysis of cyclic compounds.
- 3) Annulenes are aromatic. Why?
- 4) Discuss in brief stereoselective analysis of cyclic compounds.
- 5) Explain diastereomeric relationship.

- 6) Explain structure and stability of carbenes.  
 7) Write equivalent structures.

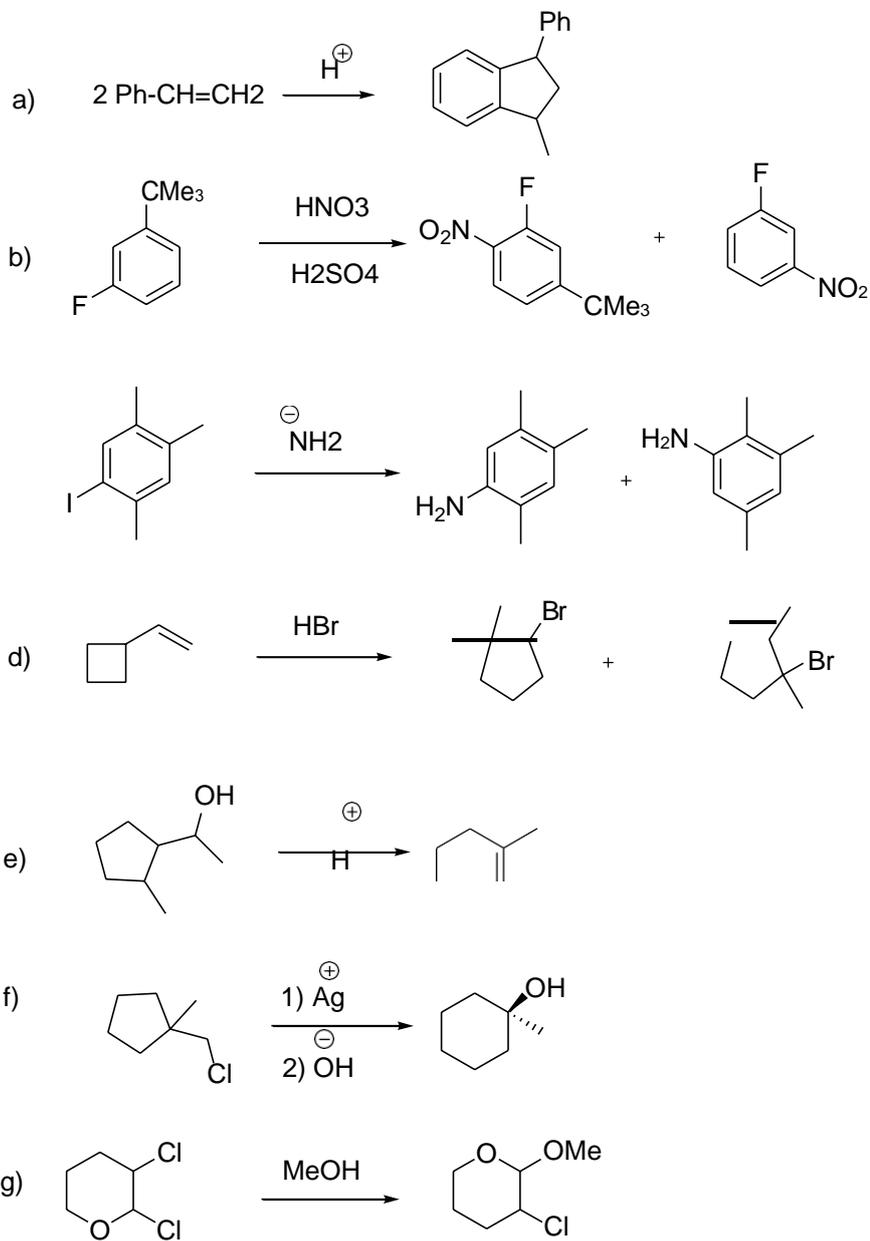


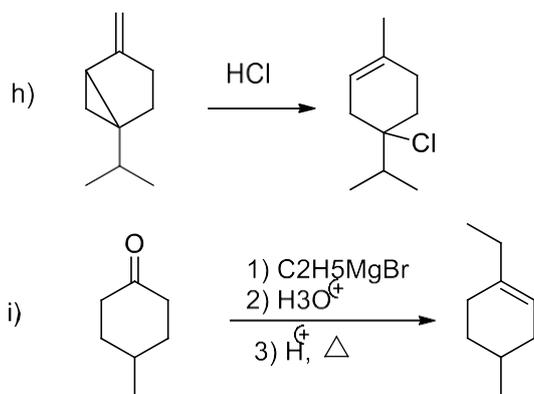
- 8) Explain chemoselectivity in addition reactions.  
 9) What is  $\text{S}_{\text{N}}\text{i}$  mechanism?  
 10) Discuss in brief conjugate addition.  
 11) Explain non-classical carbocation with suitable examples.  
 12) What is difference between  $\text{E}2$  and  $\text{E}1\text{cb}$  mechanism.  
 13) Predict the product/products:



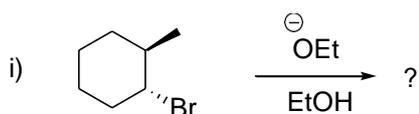
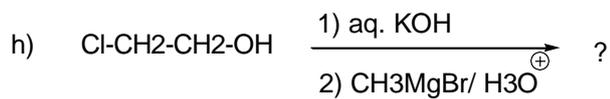
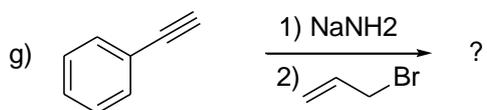
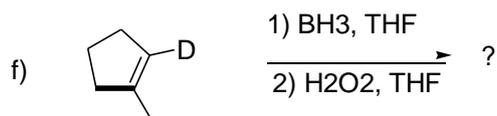
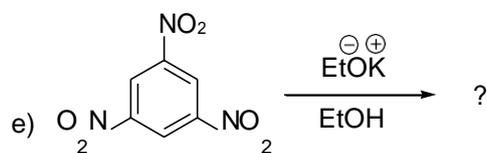
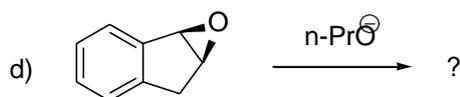
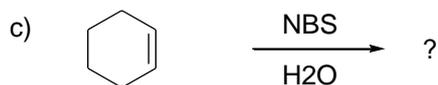
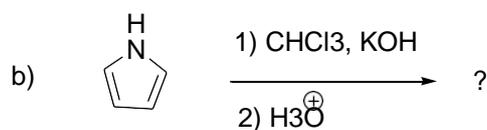
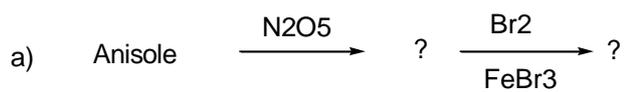


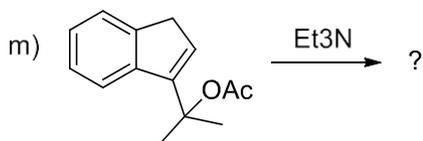
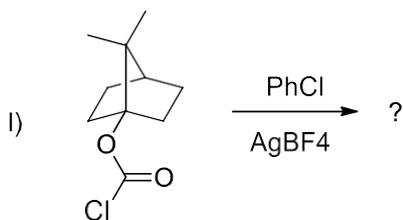
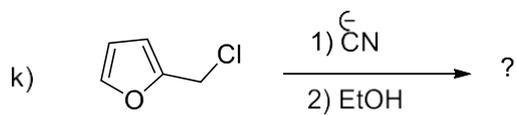
14) Suggest the mechanism.



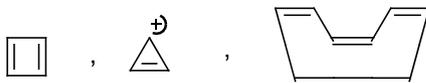


15) Predict the product with mechanism.



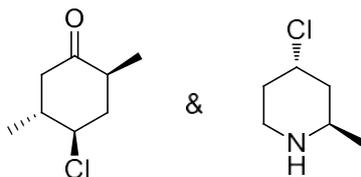


- 16) Identify aromatic, anti-aromatic and non-aromatic compounds.



- 17) Acetamide is neutral but phthalimide is acidic. Explain.

- 18) Assign total number of stereo-isomers of the following.



- 19) Discuss in brief stereoselective reactions.

- 20) Why indene and fluorine are acidic?

- 21) What is concept of anti-aromaticity?

- 22) Cyclohexanone does not exist in planar form. Give reason.

- 23) What is concept of NGP?

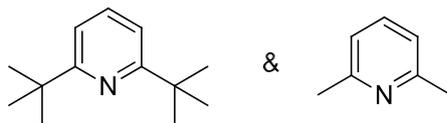
- 24) Discuss the structure and stability of carbene.

- 25) Chlorobenzene resists hydrolysis whereas benzyl chloride undergoes hydrolysis. Explain.

- 26) Comment on the optical activity of biphenyls.

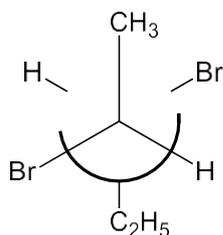
- 27) 3-hydroxy-2-butanone on reduction with sodium borohydride gives meso compound. Explain.

- 28) Comment on the basicity of the following.

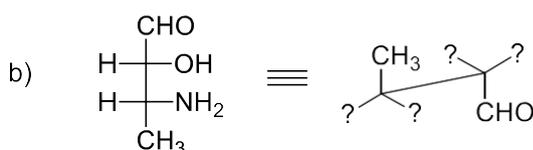
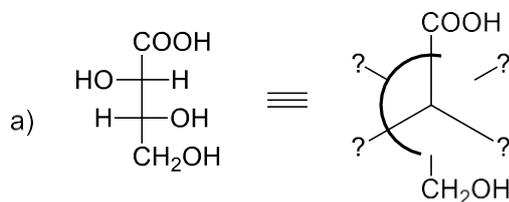


- 29) Describe the stereochemistry of the product formed by the reaction of maleic acid with osmium tetroxide.

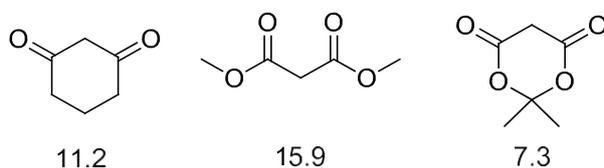
- 30) Make the conversion from Newmann projection into Fischer projection and assign the configuration at each chiral centres.



31) Convert Fischer projection to Newmann/ Sawhorse projection as shown below.



32) Explain the pKa values.

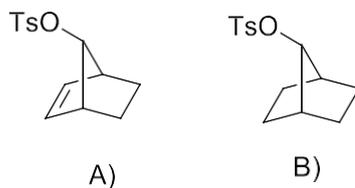


33) Explain SN1 reaction with suitable examples.

34) Comment on stability of 3,2 and 1 carbocation.

35) Explain with suitable examples Si and Re face.

36) Acetolysis of compound A is 10 times faster than compound B. Why?



37) Explain advantages of Friedel-Craft acylation over F.C. alkylation with a suitable example.

38) Give a brief account of ortho effect in aromatic nucleophilic substitution reaction.

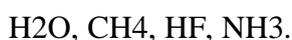
39) Nitration of N,N-dimethylaniline gives mainly m-nitro derivative when conc-HNO<sub>3</sub> + conc-H<sub>2</sub>SO<sub>4</sub> is used but mainly gives o and p-nitro derivatives in less acidic conditions.

40) Explain the terms enantiomers and diastereomers with suitable examples.

41) What are characteristics of Hard acids?

42) Write a short note on nucleophilicity and basicity.

43) Arrange the following in decreasing order of acid strength and justify.

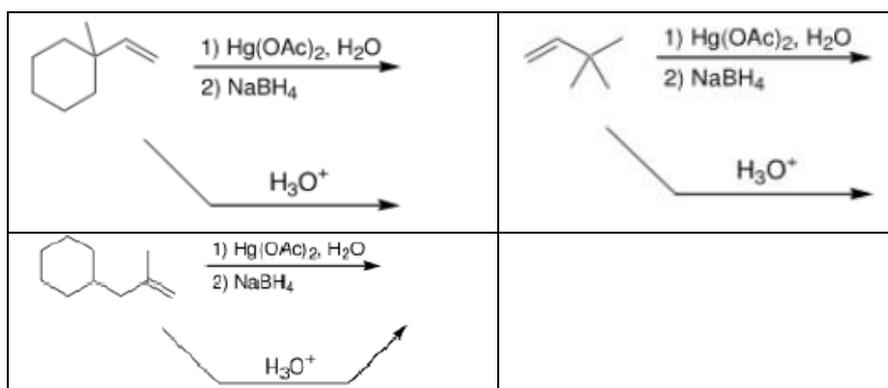


44) Explain the effect of leaving group on SN2 reaction suitable examples.

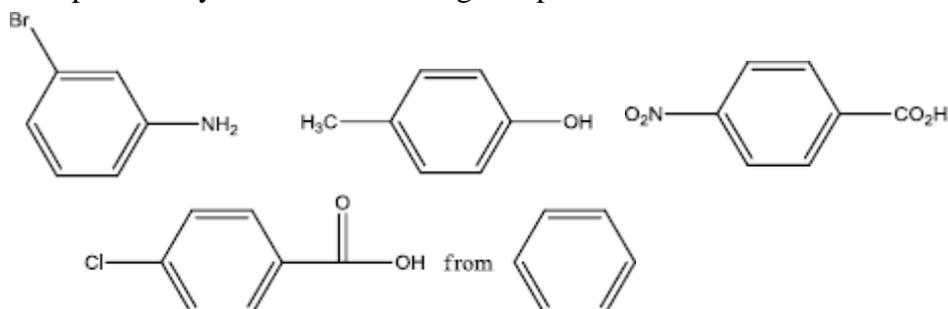
45) Acetolysis of both 4-methoxy-1-pentyl brosylate and 5-methoxy-2-pentyl brosylate give the same product. Explain.

46) Elimination of HBr from meso-1,2-dibromo-1,2-diphenyl ethane gives cis-2-

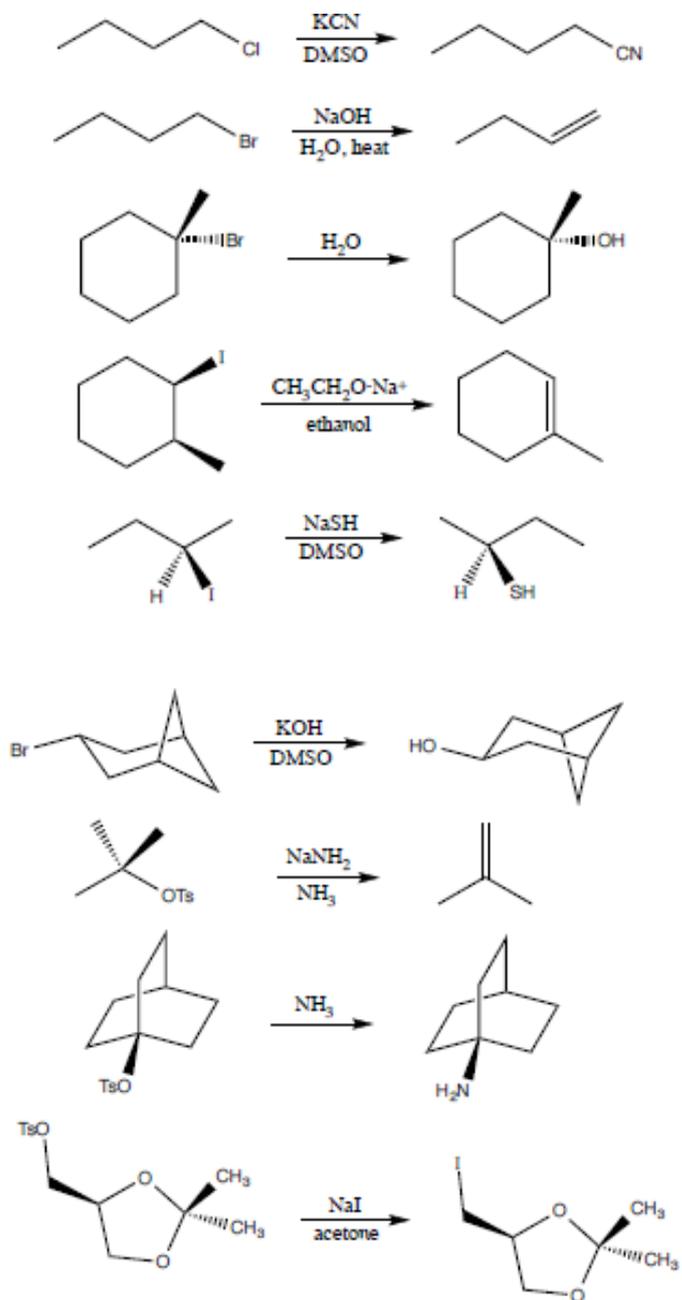
- bromostilbene. Explain.
- 47) What is Hoffman elimination reaction? Explain with suitable example.
  - 48) Nucleophilic substitution reactions at bridge-head carbons are almost impossible. Explain.
  - 49) Addition of HBr to propene in the presence of hydrogen peroxide gives 1-bromopropane. Explain.
  - 50) Draw all possible conformational isomers of 1-chloro-3-methylcyclohexane.
  - 51) Differentiate between protic and aprotic solvents.
  - 52) Cyclo-octatetraene is not aromatic. Explain.
  - 53) Explain IPSO substitution with suitable example. Explain the terms Aromatic, Anti aromatic and Non Aromatic compound, with suitable Example?
  - 54) Tropone shows high Dipole moment, Explain ?
  - 55) Justify the term homoaromaticity and quaziaromaticity with examples?
  - 56) Cyclopentadiene is acidic, Explain?
  - 57) Explain the term Prochirality with examples?
  - 58) Explain the term Atropisomerism with examples?
  - 59) Explain Hard and Soft acid concept with examples?
  - 60) Mercury is toxic and used only when necessary for synthesis. In class we learned that the oxymercuration/demercuration scheme could be used to give products of alkene hydration without rearrangements. For each of the following reactions, give the product of each and indicate you would obtain by simple hydration in aqueous acid.



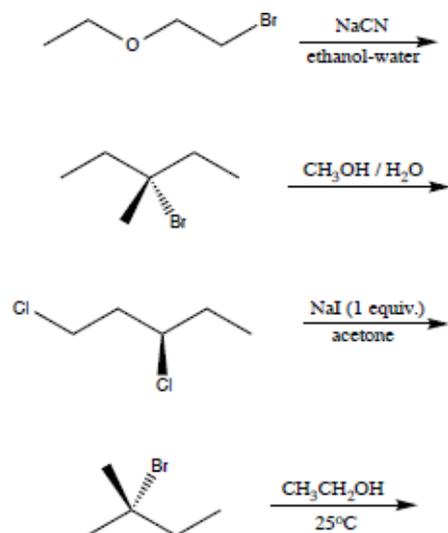
- 61) Propose the synthesis of following compound from benzene



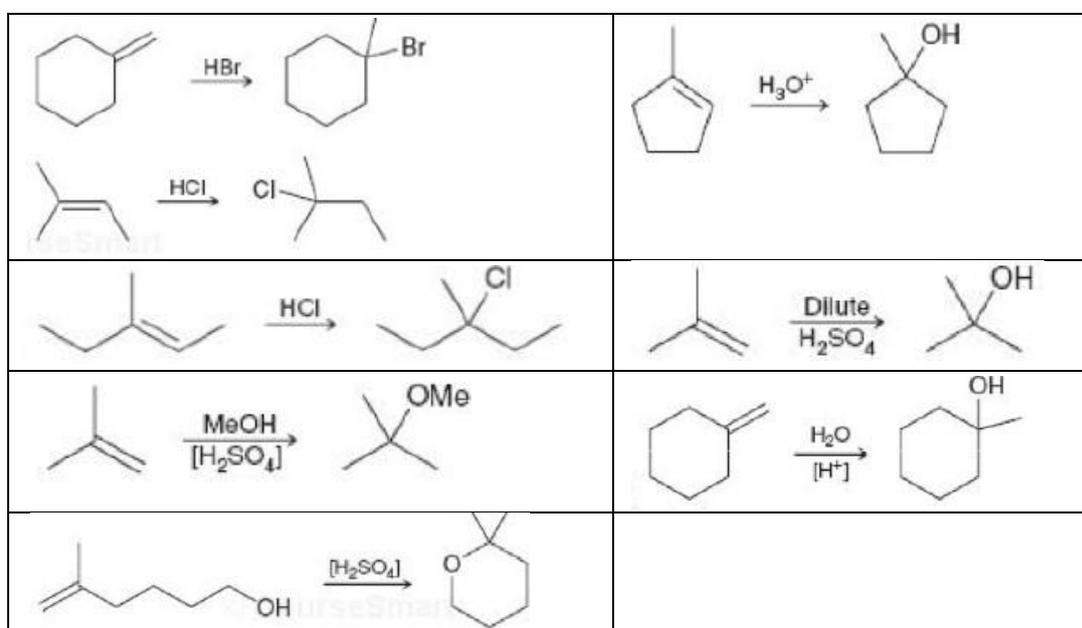
- 62) Describe the following chemical reactions as  $S_N1$ ,  $S_N2$ ,  $E_1$ ,  $E_2$ . Draw a curved arrow mechanism for each reaction.



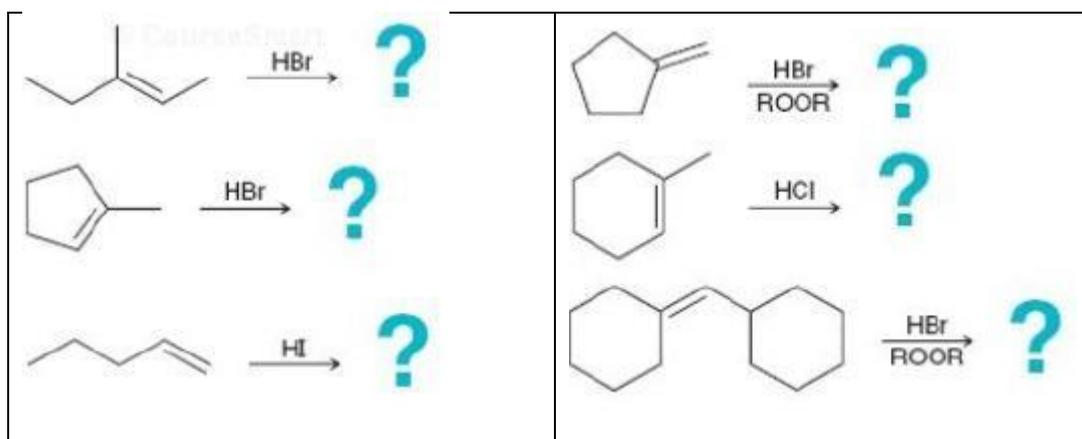
- 63) For each of the chemical substitution reaction below identify the major products and whether the reaction is likely an  $S_N1$  or  $S_N2$ .

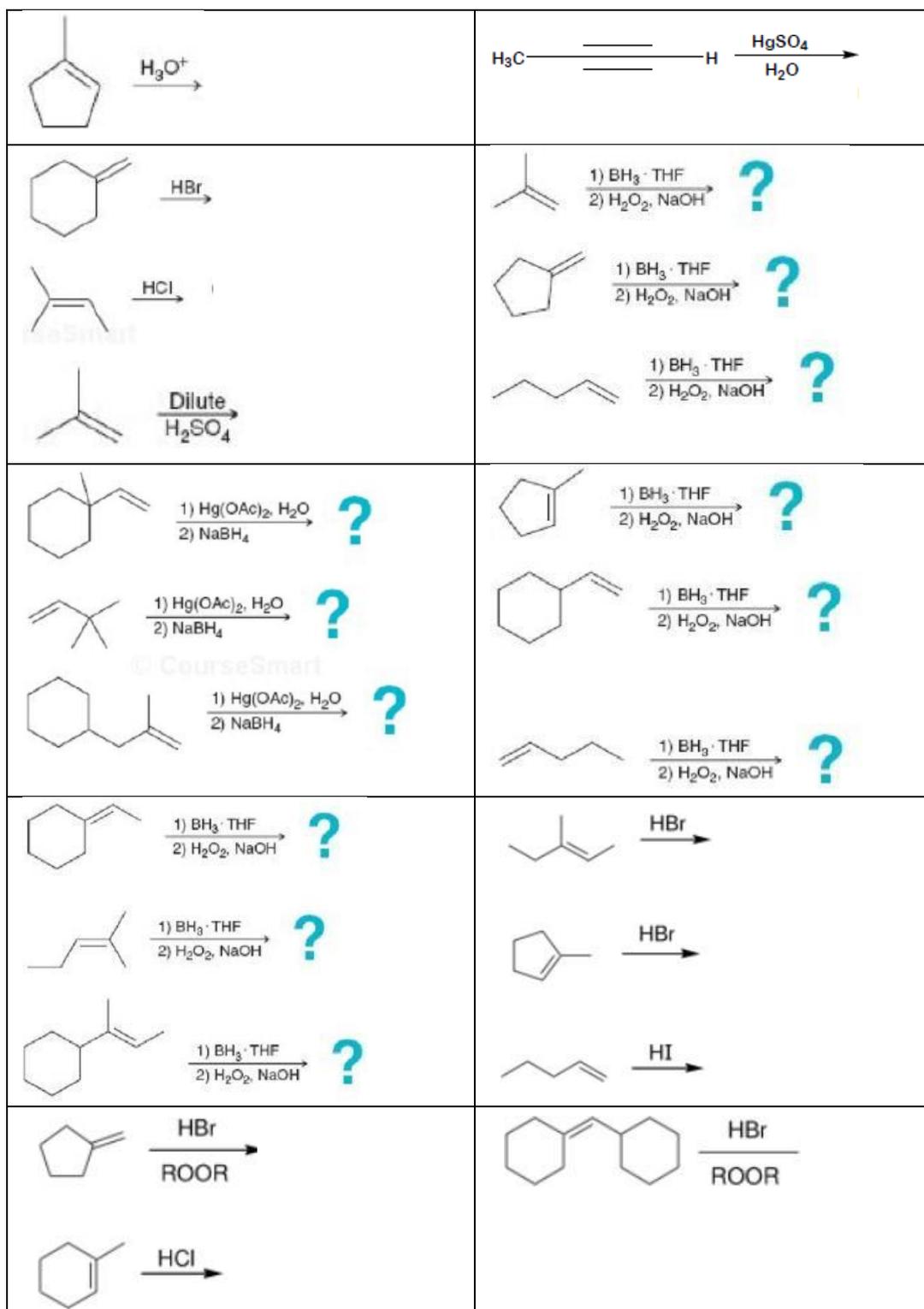


64) Propose the mechanism of the following:

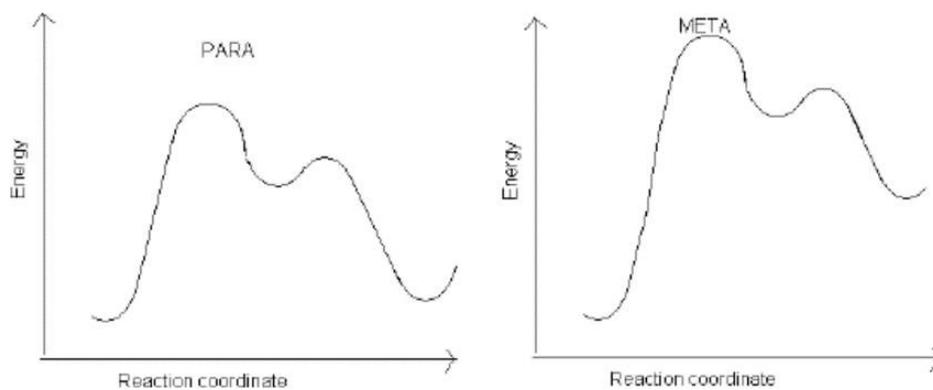


65) Complete the following examples of hydroboration/oxidation. Indicate proper stereochemistry.

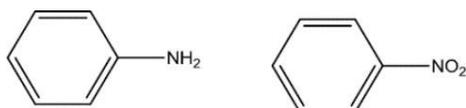




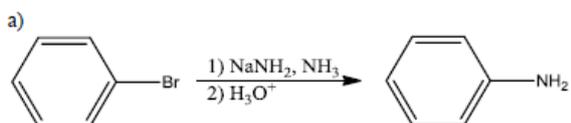
66. Below are two reaction energy coordinates for a para and meta chlorination of an aromatic structure.



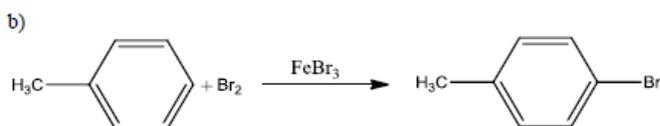
67. Which one of the following two materials could be responsible? Explain why?



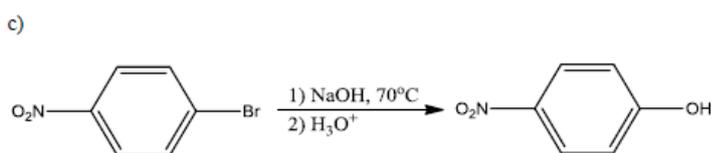
68. Under each reaction, circle the correct operating mechanism:



EAS,  $S_NAr$ , or Elimination-Addition

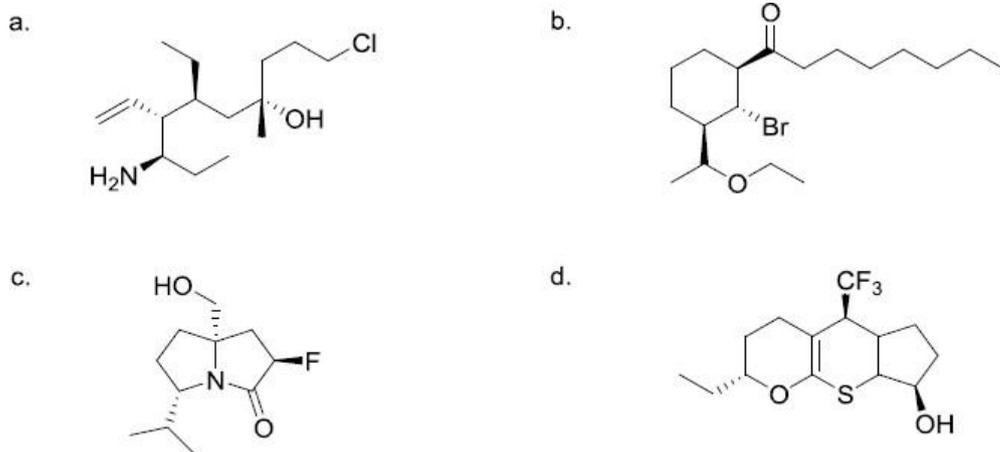


EAS,  $S_NAr$ , or Elimination-Addition

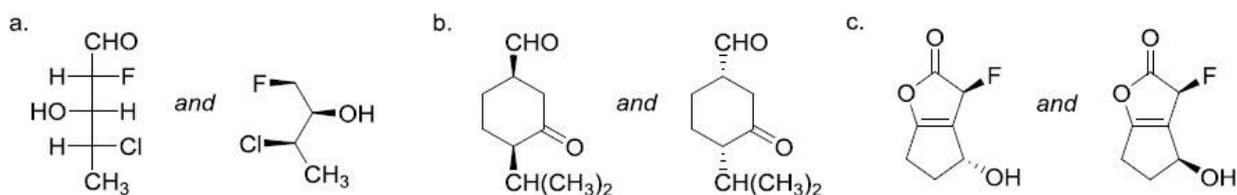


EAS,  $S_NAr$ , or Elimination-Addition

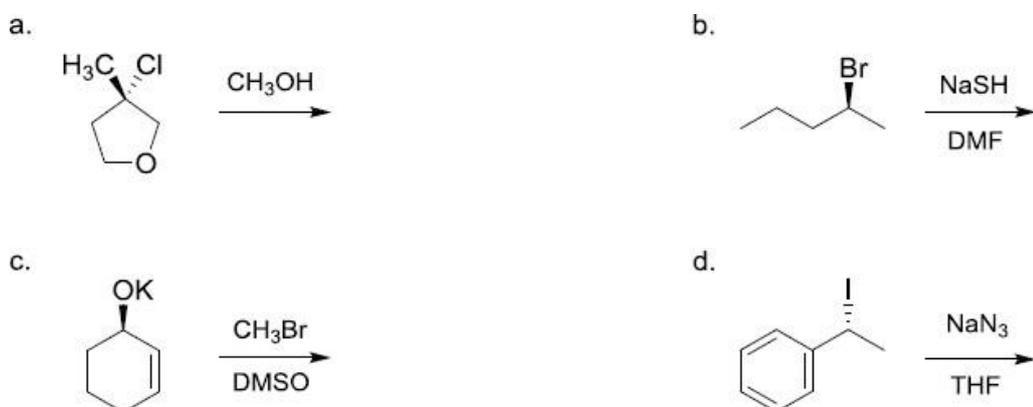
69. Identify any chiral carbons in the following molecules and using the Cahn-Ingold-Prelog rules, label their configuration as either *R* or *S*.



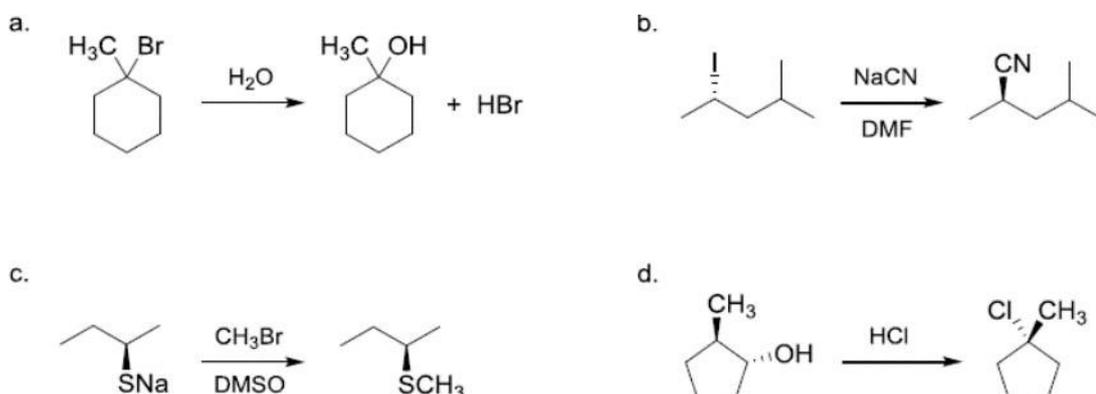
70. Within each of the following pairs of molecules, identify the relationship between them as being either enantiomers, diastereomers or identical.



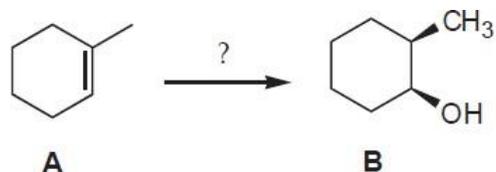
71. Provide the products expected to be formed under each of the following sets of conditions.



72. Draw detailed mechanism for the following reactions that use “curved arrows” to show the breaking and forming of bonds and identify the mechanism that is operating.

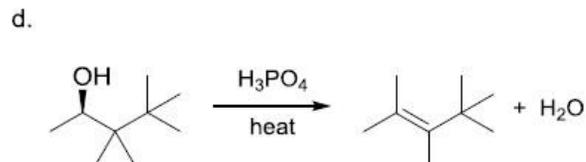
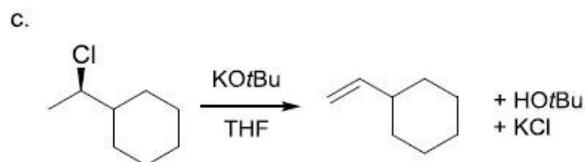
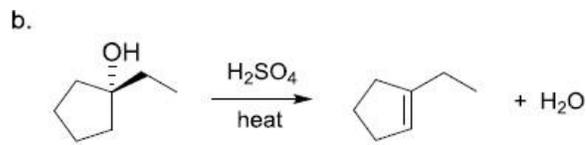
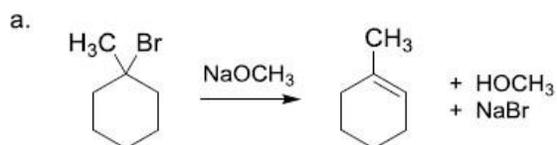


73. Can you make B from A by hydroboration-oxidation?



Notice that the methyl and the alcohol group are *cis* to each other.

74. Draw the detailed mechanism for the following reactions that use “curved arrows” to show the breaking and forming of bonds and identify the mechanism that is operating.



75. Show the addition reaction of following.

