

Chemistry 2541, Fall 2017 Final Exam

(200 points)

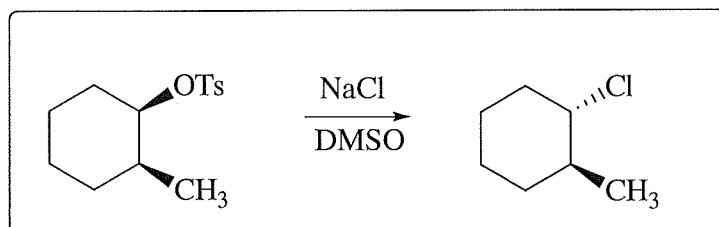
Key

Important notes:

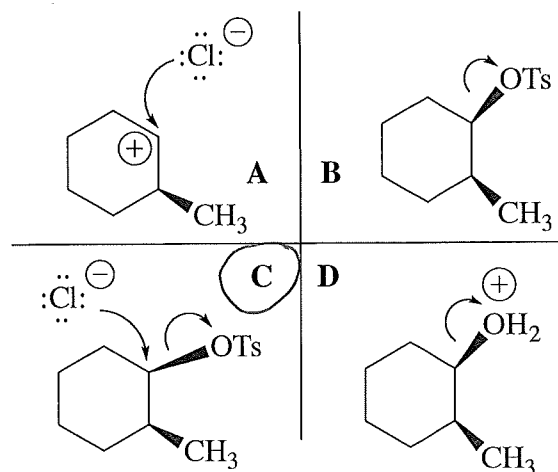
- Please use the provided Scantron form for your answers; you can keep the sheet with the questions and can use it as scratch paper
- Do not forget to write your name on the Scantron form
- You will not receive credit for unmarked answers or for more than one mark on answer line
- Your scores will be posted on eGradebook; graded Scantron forms will not be returned to students.

Questions 1-50 (150 pts): Please mark the appropriate box on the front of the Scantron form (3 pts each).

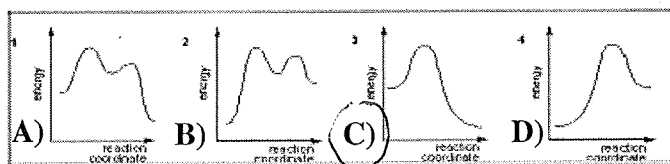
1. Which one of the following four schemes (A-D) represents a **step** in the **mechanism** of the reaction in the box?



S_N2 mechanism



2. What is the **energy diagram** for the reaction shown above in **Question 1**?



3. What type of **mechanism** the reaction shown in **Question 1** has?

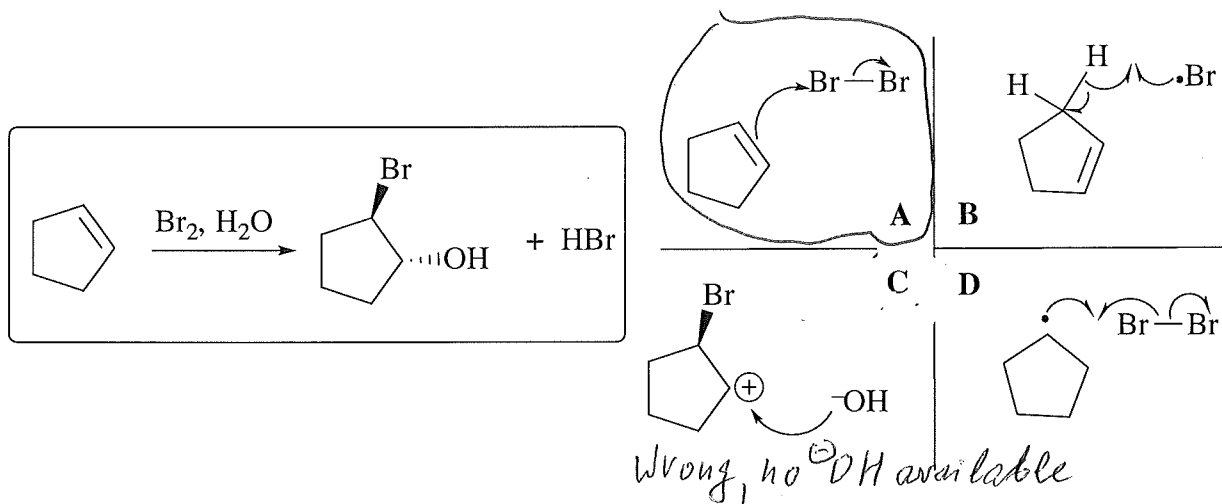
A) S_N1

B) S_N2

C) E1

D) E2

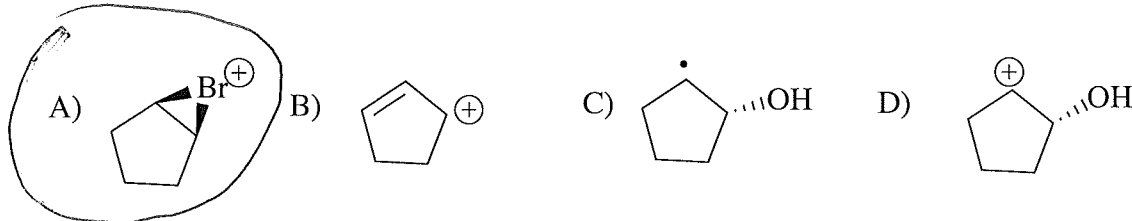
4. Which one of the following four schemes (A-D) represents a **step** in the **mechanism** of the reaction in the box?



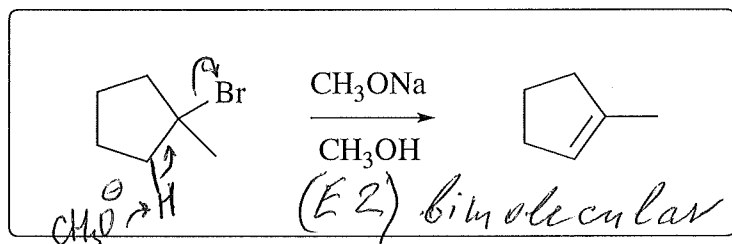
5. What type of **mechanism** the reaction shown in **Question 4** has?

- A) Radical substitution B) Radical addition **C) Electrophilic addition** D) S_N1

6. What is the structure of an **intermediate** in the reaction shown in **Question 4**?

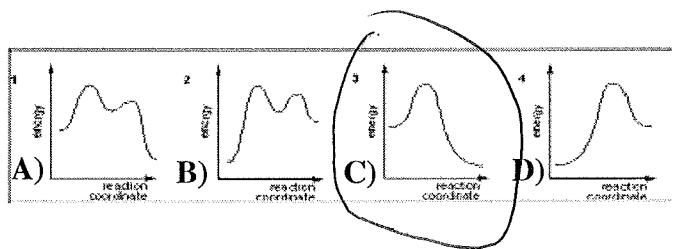


7. What is the **rate equation** for the reaction in the box?



- A) Rate = k [CH₃OH]
 B) Rate = k [RBr]
 C) Rate = k [RBr][CH₃OH]
D) Rate = k [RBr][CH₃ONa]

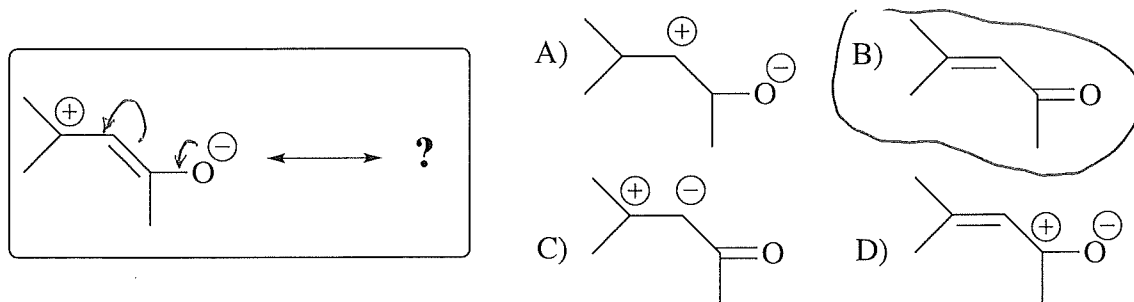
8. What is the **energy diagram** for the reaction shown above in **Question 7**?



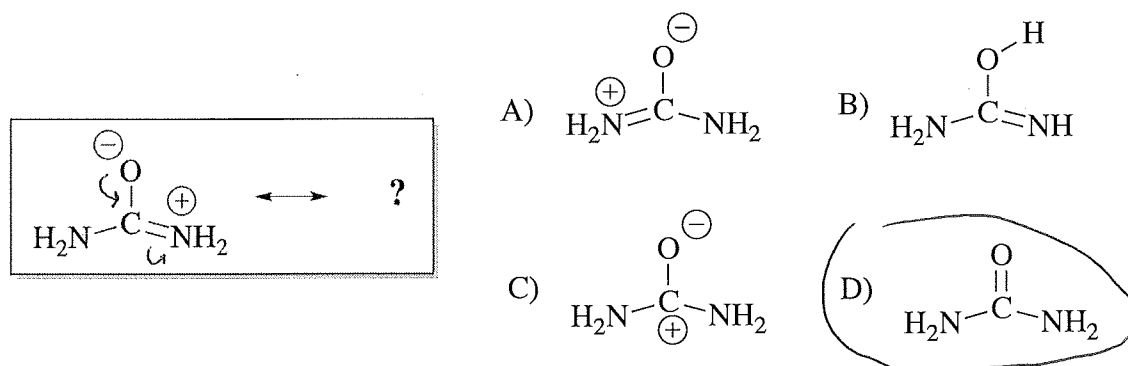
9. What type of **mechanism** the reaction shown in **Question 7** has?

- A) E1 B) S_N1 **C) E2** D) S_N2

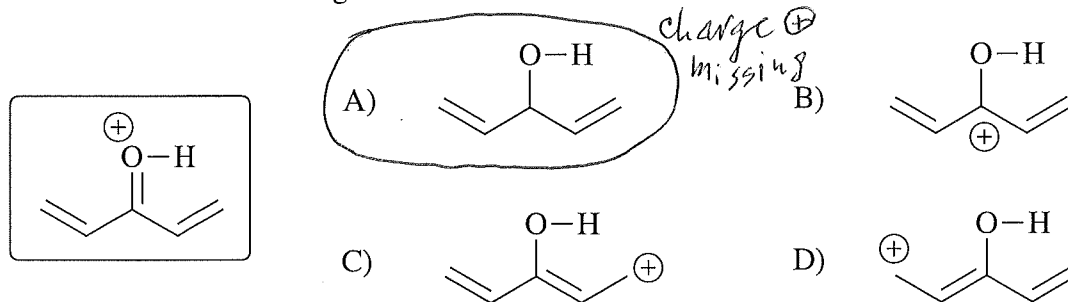
10. Which of the following structures represents the **major** resonance contributor of molecule in the box?



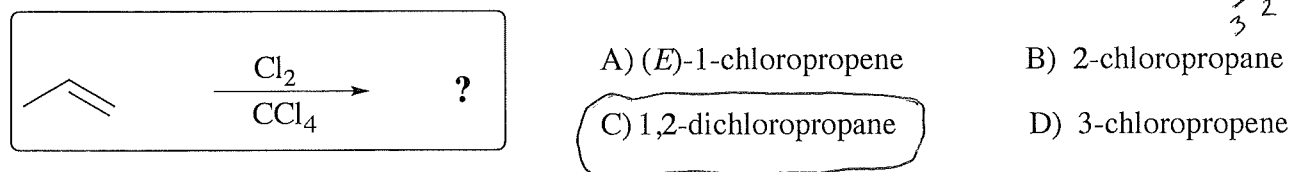
11. Which of the following structures represents the **major** resonance contributor of molecule in the box?



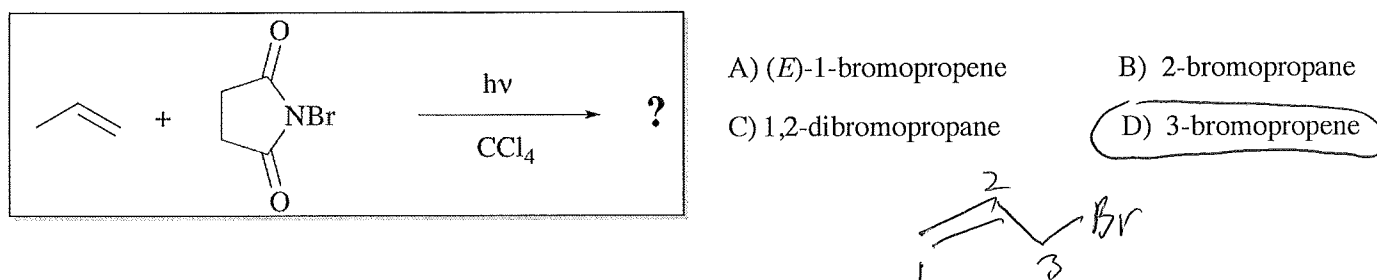
12. Which of the following is **NOT** a resonance structure of the molecule shown in the box?



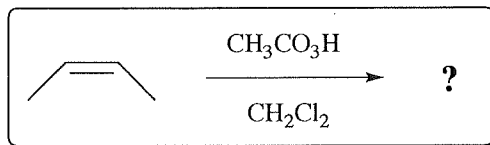
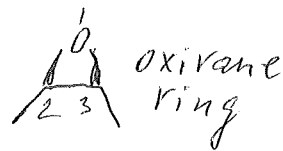
13. What is the IUPAC name of the major **product** for the reaction shown in the box?



14. What is the IUPAC name of the major **product** for the reaction shown in the box?

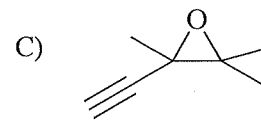
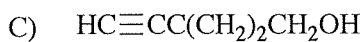
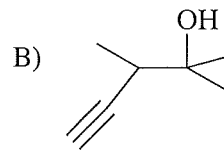
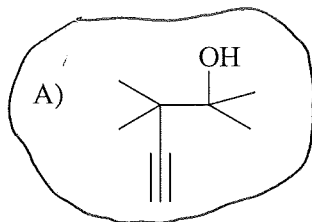
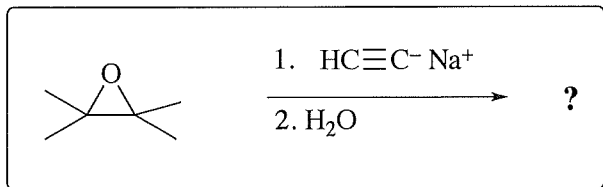


15. What is the IUPAC name of the major **product** for the reaction shown in the box?

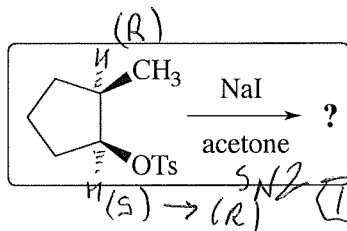


- A) *cis*-3,4-dimethyloxirane B) *trans*-2,3-dimethyloxirane
 C) *trans*-2,3-dimethyloxirane D) *cis*-2,3-dimethyloxirane

16. What is the main **product** of the reaction shown in the box?



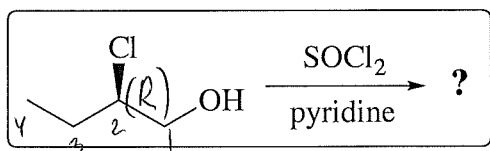
17. What is the IUPAC name of the major **product** for the reaction shown in the box?



- A) (1*S*,2*S*)-1-iodo-2-methylcyclopentane B) (1*R*,2*R*)-1-iodo-2-methylcyclopentane
 C) (1*S*,2*R*)-1-iodo-2-methylcyclopentane D) (1*R*,2*S*)-1-iodo-2-methylcyclopentane

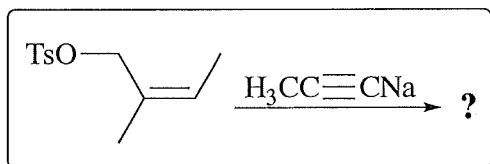


18. What is the IUPAC name of the major **product** for the reaction shown in the box?

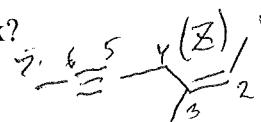


- A) (2*S*,3*S*)-2,3-dichlorobutane B) (2*R*,3*S*)-2,3-dichlorobutane
 C) (*R*)-1,2-dichlorobutane D) (*S*)-1,2-dichlorobutane

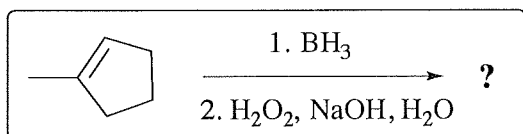
19. What is the IUPAC name of the major **product** for the reaction shown in the box?



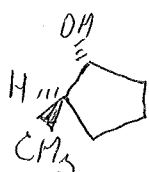
- A) (*Z*)-3-methyl-2-hepten-5-yne B) (*E*)-3-methyl-2-hepten-5-yne
 C) (*Z*)-3-methyl-2-octen-6-yne D) (*E*)-3-methyl-2-octen-6-yne



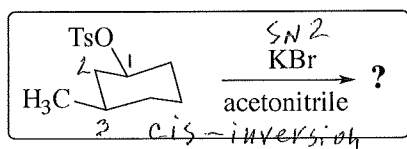
20. What is the IUPAC name of the major **product** for the reaction shown in the box?



- A) *cis*-2-methylcyclopentanol B) *trans*-2-methylcyclopentanol
 C) 1-methylcyclopentanol D) 1-methylcyclopentene

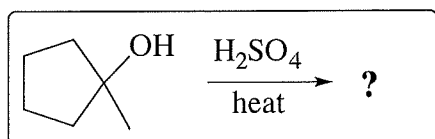


21. What is the IUPAC name of the major **product** for the reaction shown in the box?



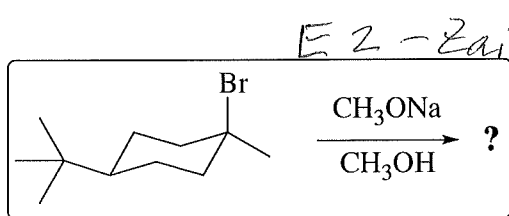
- A) *cis*-1-bromo-4-methylcyclohexane B) *cis*-1-bromo-3-methylcyclohexane
 C) *trans*-1-bromo-4-methylcyclohexane D) *trans*-1-bromo-3-methylcyclohexane

22. What is the IUPAC name of the major **product** for the reaction shown in the box?



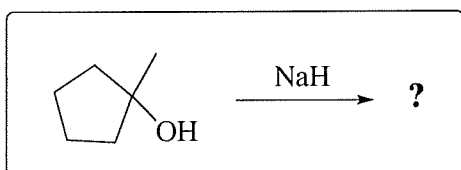
- A) methylenecyclopentane B) 3-methylcyclopentene
 C) 4-methylcyclopentene D) 1-methylcyclopentene

23. What is the main **product** of the reaction shown in the box?



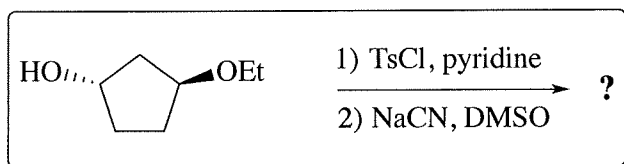
- A) $(\text{CH}_3)_3\text{C}$ (axial) and CH_3 (equatorial) on a cyclohexene ring
 B) $(\text{CH}_3)_3\text{C}$ (axial) and CH_3 (axial) on a cyclohexene ring
 C) $(\text{CH}_3)_3\text{C}$ (axial) and OCH_3 (equatorial) on a cyclohexane ring
 D) $(\text{CH}_3)_3\text{C}$ (axial) and CH_2 (axial) on a cyclohexane ring

24. What is the main **product** of the reaction shown in the box?



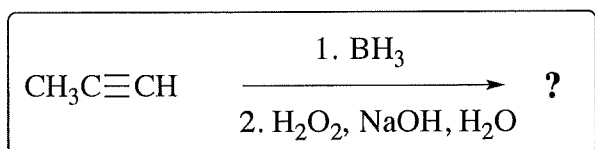
- A) 1-methylcyclopentene
 B) 1-methylcyclopentane sodium salt
 C) 1-methylcyclopentene sodium salt
 D) 1-methylcyclopentoxide (labeled 'alkoxide')

25. What is the main **product** of the reaction shown in the box?



- A) 1-ethoxy-2-tosyloxycyclopentane
 B) 1-cyano-2-hydroxycyclopentane
 C) 1-ethoxy-2-cyanocyclopentane (labeled 'SN2')
 D) 1-ethoxy-2-cyanocyclopentane

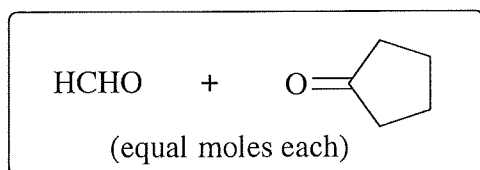
26. What is the main **product** of the reaction shown in the box?




- A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ B) $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
 C) CH_3COCH_3 D) $\text{CH}_3\text{CH}_2\text{CHO}$

hydroboration-oxidation

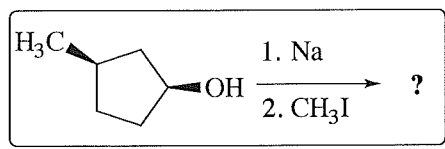
27. What **alkene** when treated with **ozone** and then with $(\text{CH}_3)_2\text{S}$ gives the products shown in the box?



- A) methylenecyclopentane
 C) allylcyclopentane

- B) vinylcyclopentane
 D) 1-methylcyclopentene
- 

28. What is the IUPAC name of the major **product** for the reaction shown in the box?



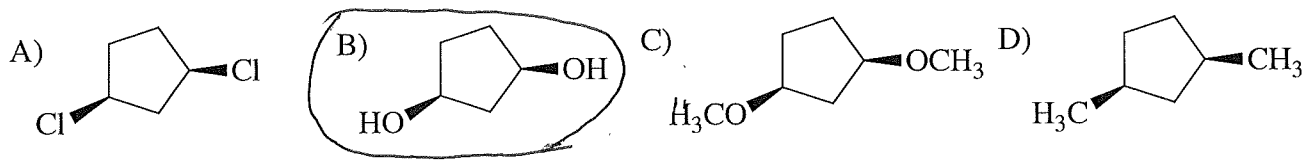
- A) *trans*-1-methoxy-3-methylcyclopentane
 C) *cis*-1-methoxy-3-methylcyclopentane

- B) *cis*-3-methoxycyclopentanol
 D) 3-methylcyclopentene

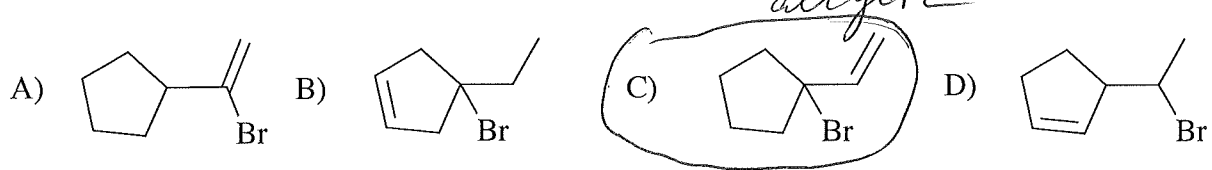
29. Which one of the following compounds is the **strongest acid**?

- A) *t*-BuOH B) $\text{CH}_3\text{CH}_2\text{Br}$ C) CH_3NH_2 D) $\text{CH}_3\text{CO}_2\text{H}$

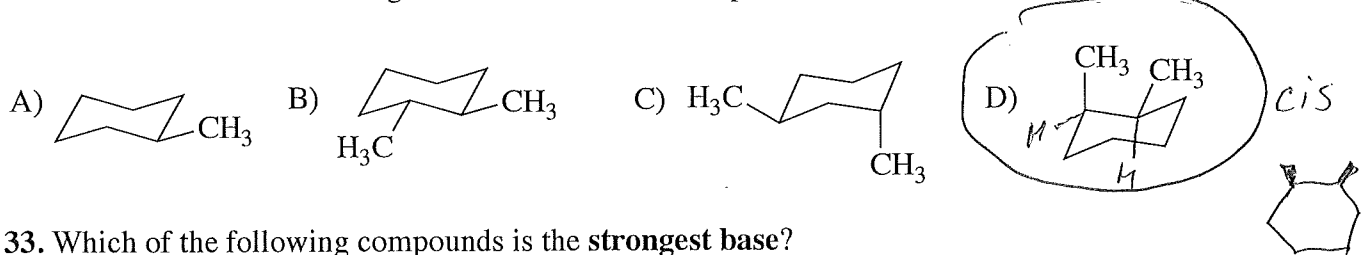
30. Which one of the following compounds has the highest **solubility in water**?



31. Which molecule is the best substrate for $\text{S}_{\text{N}}1$ reaction?



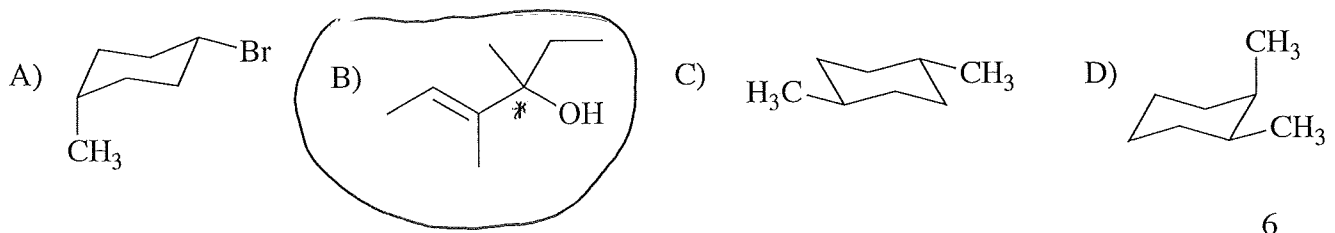
32. Which one of the following molecules is a **meso** compound?



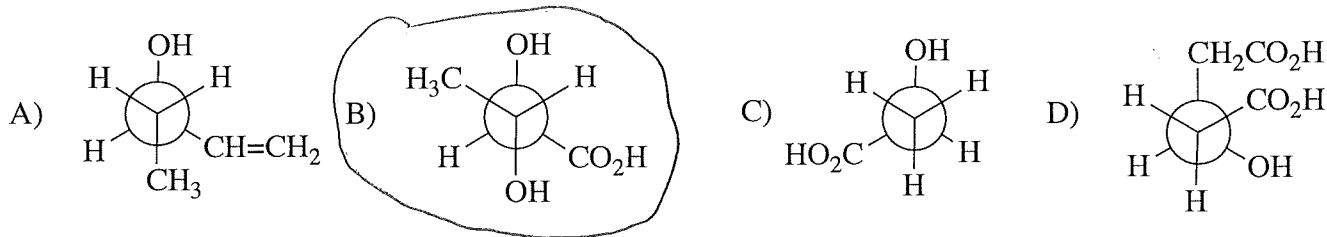
33. Which of the following compounds is the **strongest base**?

- A) $\text{NaN}(\text{CH}_3)_2$ B) NaF C) NaOEt D) NaI

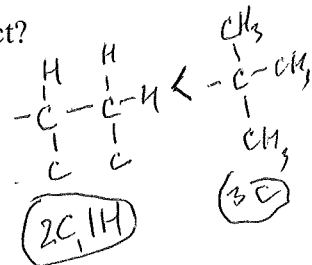
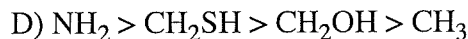
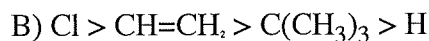
34. Which one of the following molecules is **chiral**?



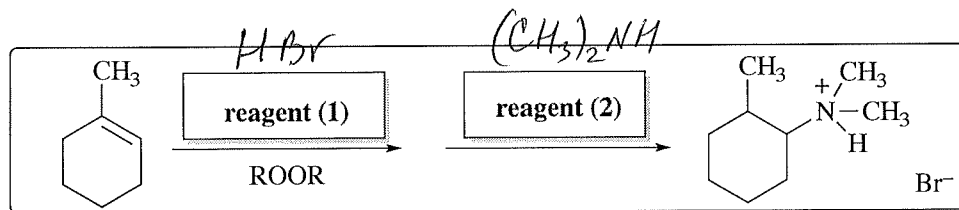
35. Which of the following molecules contains **two chiral centers**?



36. Consider the following **orders of priority** (highest to lowest). Which order is incorrect?

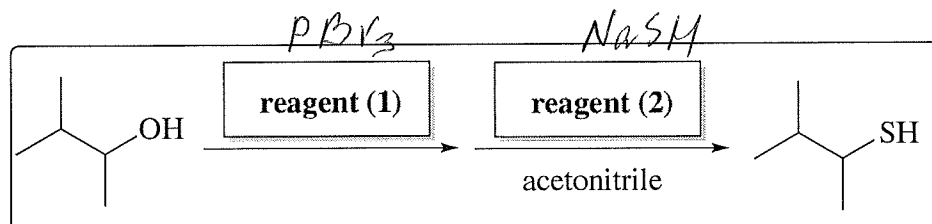


37. Which sequence of **reagents** can be used for the reaction shown in the box?



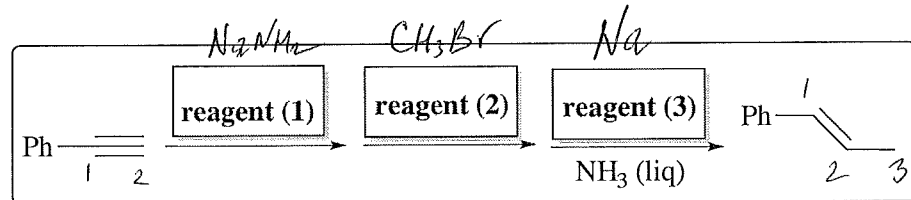
- A) (1) NBS, (2) $\text{NaN}(\text{CH}_3)_2$
 B) (1) HBr, (2) $(\text{CH}_3)_2\text{NH}$
 C) (1) Br_2 , (2) $(\text{CH}_3)_2\text{NH}$
 D) (1) HBr, (2) NaNH_2

38. Which sequence of **reagents** can be used for the reaction shown in the box?



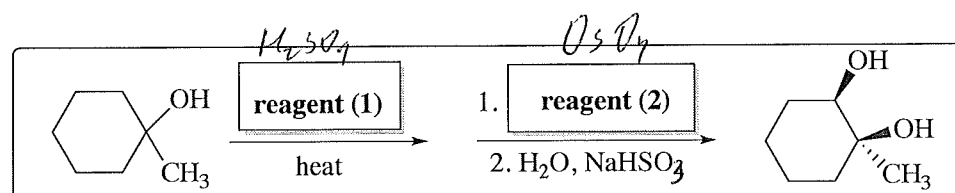
- A) (1) HBr, (2) NaSCH_3
 B) (1) NBS, (2) NaSCH_3
 C) (1) Br_2 , (2) NaSH
 D) (1) PBr_3 , (2) NaSH

39. Which sequence of **reagents** can be used for the reaction shown in the box?



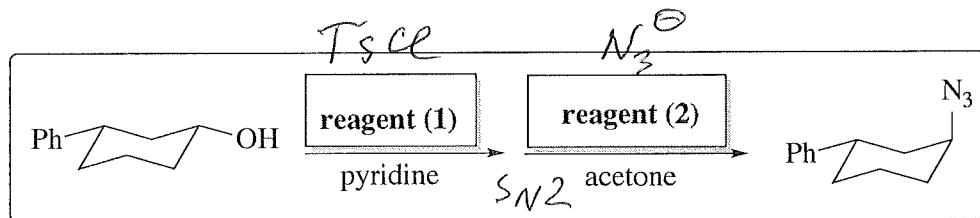
- A) (1) Br_2 , (2) NaNH_2 , (3) Na
 B) (1) CH_3Br , (2) NH_3 , (3) Na
 C) (1) CH_3Br , (2) NaNH_2 , (3) H_2
 D) (1) NaNH_2 , (2) CH_3Br , (3) Na

40. Which sequence of **reagents** can be used for the reaction shown in the box?



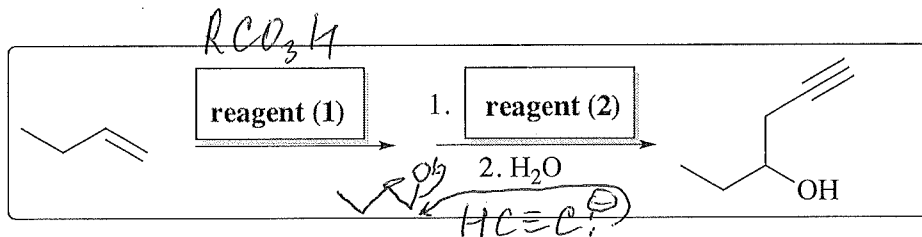
- A) (1) H_3PO_4 , (2) O_3
 B) (1) H_2SO_4 , (2) OsO_4
 C) (1) $\text{CH}_3\text{CH}_2\text{ONa}$, (2) OsO_4
 D) (1) PCC, (2) H_2SO_4

41. Which sequence of reagents can be used for the reaction shown in the box?



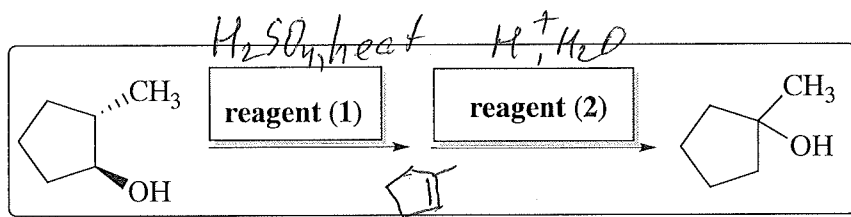
- A) (1) TsCl, (2) NaN_3
 B) (1) $SOCl_2$, (2) NaCN
 C) (1) TsCl, (2) NH_3
 D) (1) PCC, (2) NaN_3

42. Which sequence of reagents can be used for the reaction shown in the box?



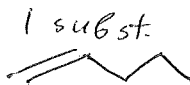
- A) (1) Br_2 , (2) NaCN
 B) (1) HBr, (2) NaCN
 C) (1) RCO_3H , (2) NaN_3
 D) (1) RCO_3H , (2) $HC\equiv C^- Na^+$

43. Which sequence of reagents can be used for the reaction shown in the box?



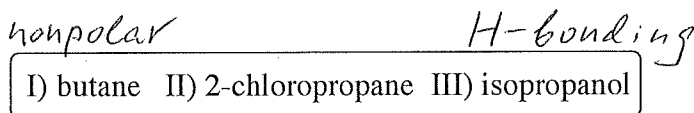
- A) (1) CH_3CH_2ONa , (2) NaOH, H_2O
 B) (1) $H_2SO_4, heat$, (2) H_2SO_4, H_2O
 C) (1) IBX, (2) NaOH, H_2O
 D) (1) PCC, (2) H_2SO_4, H_2O

44. Which is the least stable alkene?



- A) 2-methyl-2-pentene B) *trans*-2-pentene C) 1-pentene D) 2,3-dimethyl-2-pentene

45. Arrange the compounds in the box in order of decreasing boiling point.



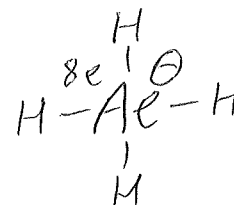
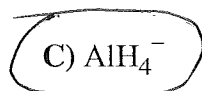
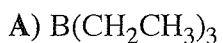
- A) (highest) I > II > III B) (highest) III > II > I C) (highest) II > III > I D) (highest) II > I > III

46. Which of the following represents the order of increasing acidity for compounds the box?

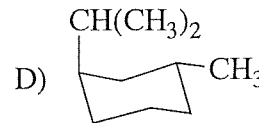
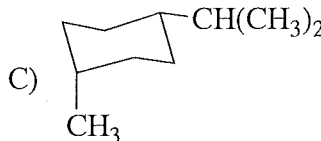
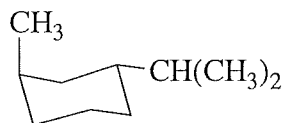
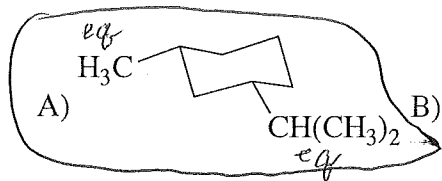
- (1) CH_3Br (2) CH_3CO_2H (3) CH_3CH_2OH (4) FCH_2CO_2H (5) HI

- A) 1 (strongest) > 2 > 4 > 3 > 5 (weakest) B) 5 (strongest) > 4 > 2 > 3 > 1 (weakest)
 C) 4 (strongest) > 1 > 2 > 3 > 5 (weakest) D) 5 (strongest) > 1 > 4 > 2 > 3 (weakest)

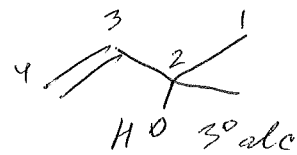
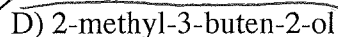
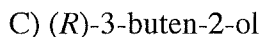
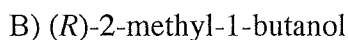
47. Which species is **NOT** a Lewis acid?



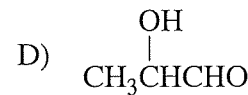
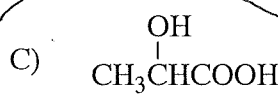
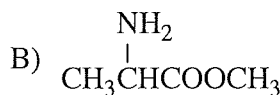
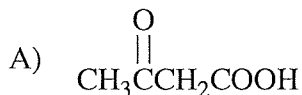
48. Which one of the following structures has the lowest **diaxial interactions**?



49. Which of the following is a **tertiary alcohol**?

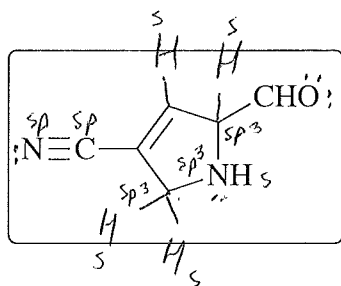


50. Which of the following molecules contains both an **acid** AND an **alcohol** functional group?



PLEASE MARK YOUR ANSWERS IN THE APPROPRIATE BOX ON THE BACK OF THE SCANTRON FORM (50 points total):

Question 51 (30 pts): Consider the molecule shown below and answers the following questions. Indicate your answers by marking the appropriate number in **boxes 51-60** on the back of the Scantron form (3 pts each).



3 **Box 51:** Number of σ bonds formed by overlap of sp^2 and sp^3 orbitals

2 **Box 52:** Number of π bonds formed by overlap of sp and sp orbitals

1 **Box 53:** Number of σ bonds formed by overlap of sp^2 and sp orbitals

4 **Box 54:** Number of σ bonds formed by overlap of s and sp^3 orbitals

2 **Box 55:** Number of σ bonds formed by overlap of sp^3 and sp^3 orbitals

2 **Box 56:** Number of π bonds formed by overlap of sp^2 and sp^2 orbitals

2 **Box 57:** Number of σ bonds formed by overlap of sp^2 and sp^2 orbitals

15 **Box 58:** Total number of σ bonds

4 **Box 59:** Total number of π bonds

8 **Box 60:** Total number of non-bonding electrons in this molecule

(Continued on the next page)

Question 52 (20 pts): Please write your answers in **boxes 66-70** on the back of the Scantron form. Provide the **reagents** that give indicated products in high yield (4 pts each):

