Chemistry 2541, Fall 2015
Final Exam

Key

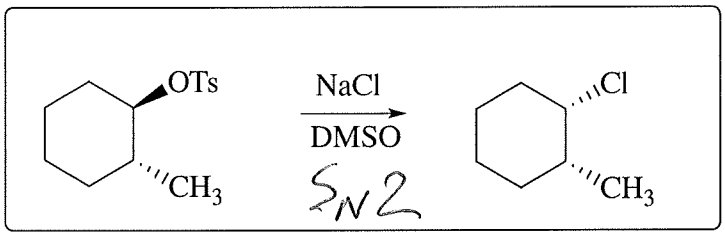
(200 points)

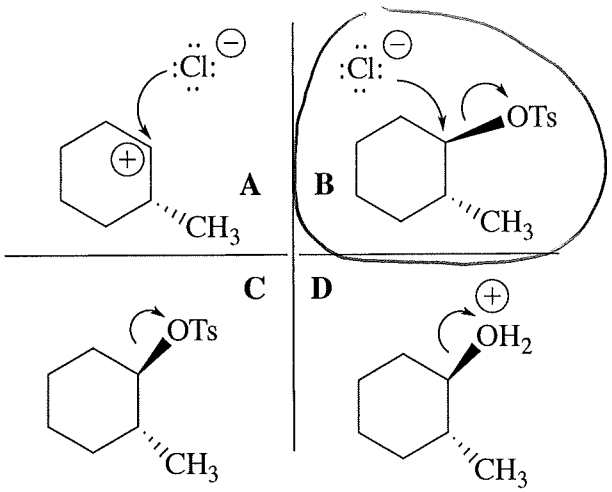
Important notes:

- 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.

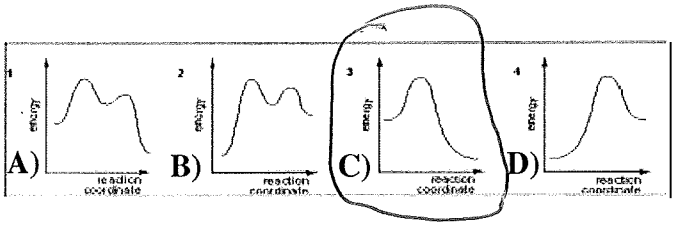
Questions 1-50 (150 pts): Please mark the appropriate box on the front of the Scantron form (3 pts each).

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





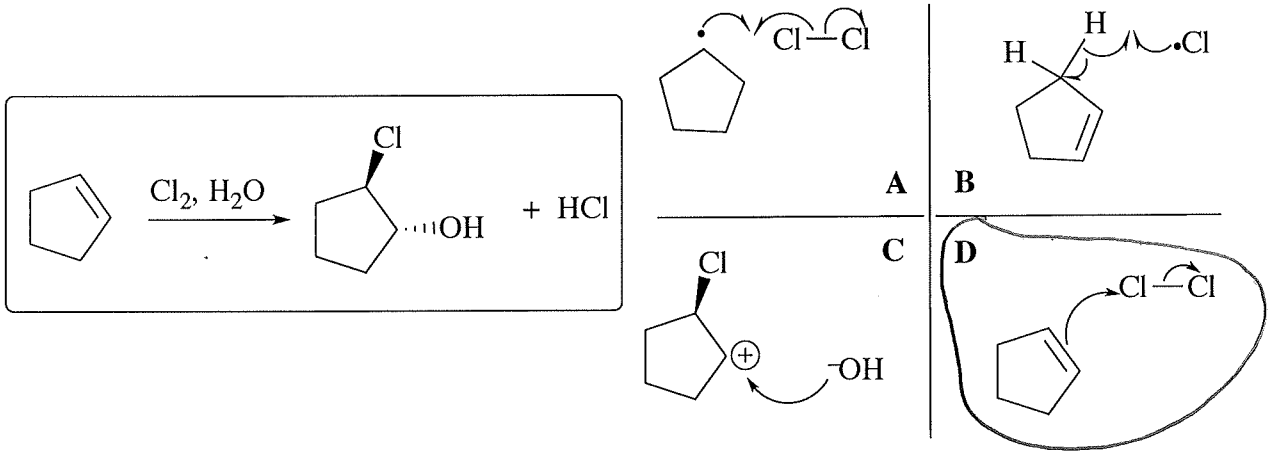
2. What is the **energy diagram** for the reaction shown above in **Question 1**?



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

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

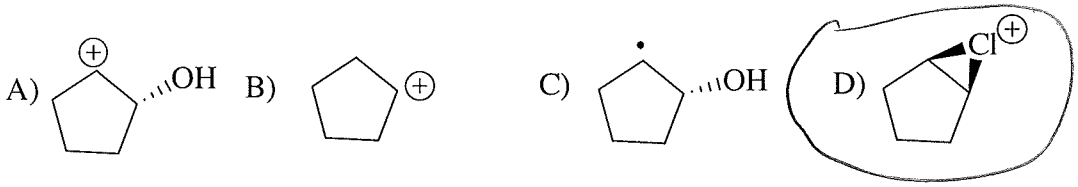
4. Which one of the following four schemes (**A-D**) represents a **step** in the **mechanism** of the reaction in the box?



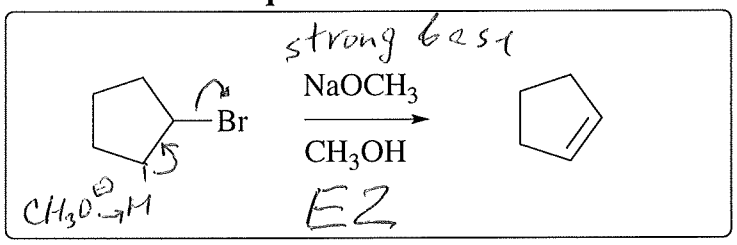
5. What type of **mechanism** the reaction shown in **Question 4** has?

A) Electrophilic addition B) E2 C) Radical addition D) S_N2

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?



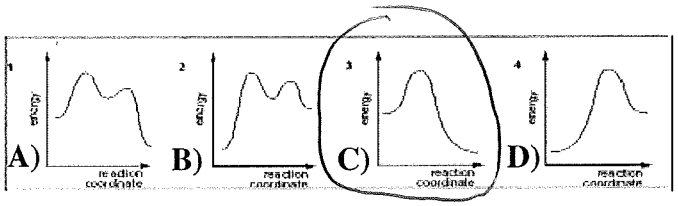
A) Rate = k [RX][$NaOCH_3$]

B) Rate = k [RX]

C) Rate = k [RX][CH_3OH]

D) Rate = k [CH_3OH]

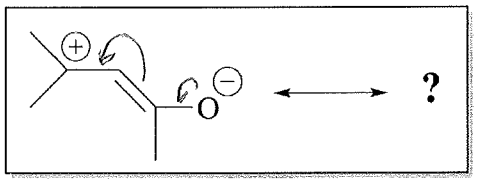
8. What is the **energy diagram** for the reaction shown above in **Question 7**?

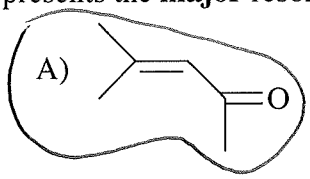


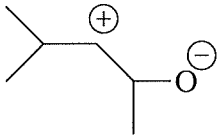
9. What type of **mechanism** the reaction shown in **Question 7** has?

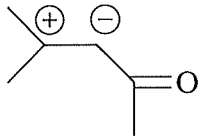
A) E1 B) E2 C) S_N1 D) S_N2

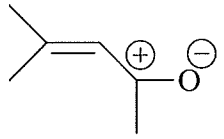
10. Which of the following structures represents the **major** resonance contributor of molecule in the box?



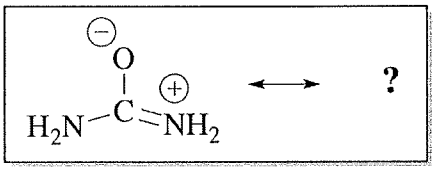
A) 

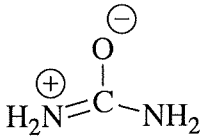
B) 

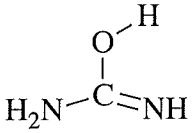
C) 

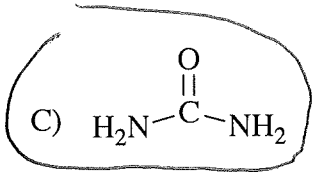
D) 

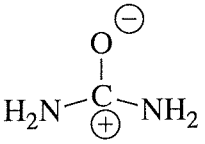
11. Which of the following structures represents the **major** resonance contributor of molecule in the box?



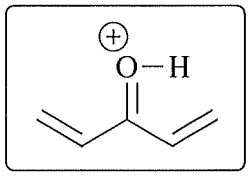
A) 

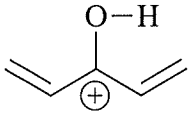
B) 

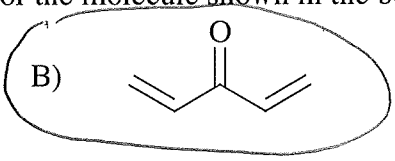
C) 

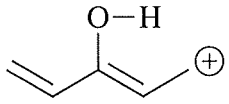
D) 

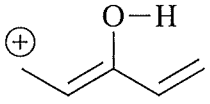
12. Which of the following is **NOT a resonance structure** of the molecule shown in the box?



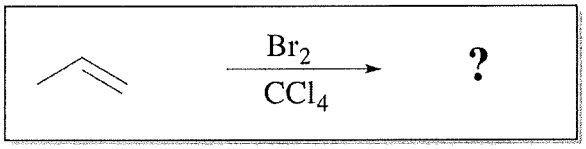
A) 

B) 

C) 

D) 

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



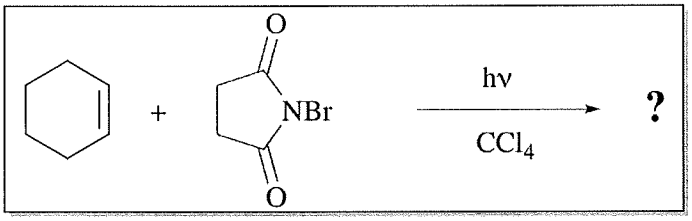
A) (*E*)-1-bromopropene

B) 1,2-dibromopropane

C) 2-bromopropane

D) 3-bromopropene

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



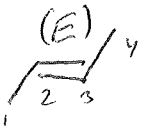
A) 4-bromocyclohexene

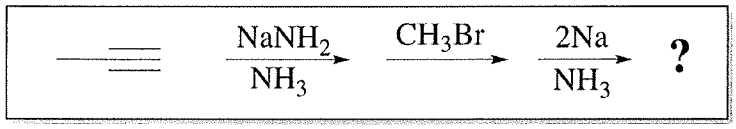
B) 3-bromocyclohexene

C) bromocyclohexane

D) 1-bromocyclohexene

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

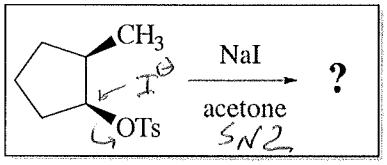




A) (*Z*)-2-butene B) (*Z*)-2-pentene

C) (*E*)-2-butene D) (*E*)-2-pentene

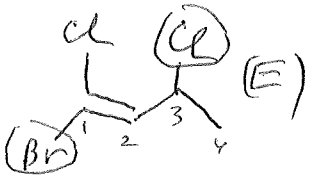
16. What is the IUPAC name of the major **product** for the reaction shown in the box?

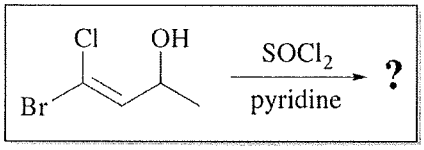


A) (1*S*,2*S*)-1-iodo-2-methylcyclopentane B) (1*R*,2*S*)-1-iodo-2-methylcyclopentane

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

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

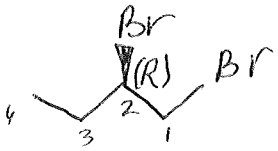


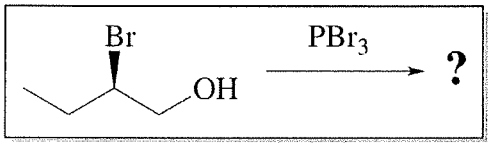


A) (*E*)-1-bromo-1,3-dichloro-1-butene B) (*Z*)-1-bromo-1,3-dichloro-1-butene

C) (*E*)-1-bromo-1,3-dichloro-2-butene D) (*Z*)-1-bromo-1,3-dichloro-2-butene

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

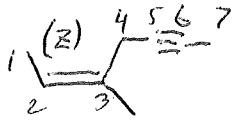


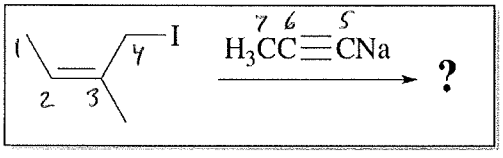


A) (2*S*,3*S*)-2,3-dibromobutane B) (2*R*,3*S*)-2,3-dibromobutane

C) (*R*)-1,2-dibromobutane D) (*S*)-1,2-dibromobutane

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

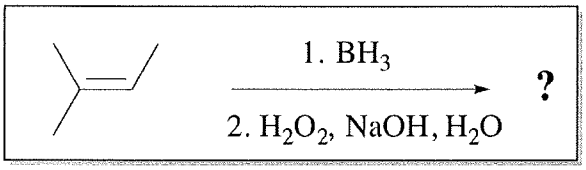




A) (*Z*)-3-methyl-2-hepten-5-yne B) (*E*)-3-methyl-2-hepten-5-yne

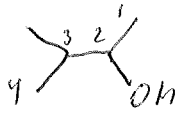
C) 2-methyl-2-heptyne D) 2-methyl-1-hepten-5-yne

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

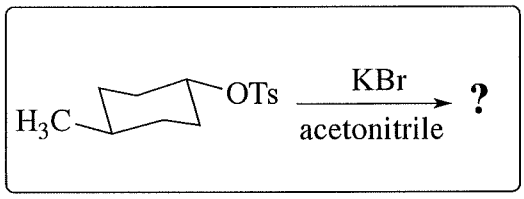


A) 2-methyl-2-butanol B) 3-methyl-2-butanol

C) 3-methyl-1-butanol D) 2-methyl-4-butanol



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

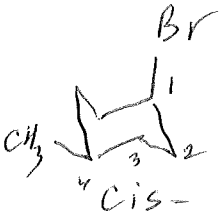


A) *cis*-1-bromo-4-methylcyclohexane

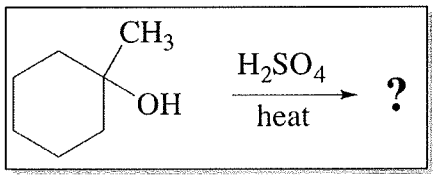
B) *trans*-1-bromo-4-methylcyclohexane

C) *cis*-1-bromo-3-methylcyclohexane

D) *trans*-1-bromo-3-methylcyclohexane



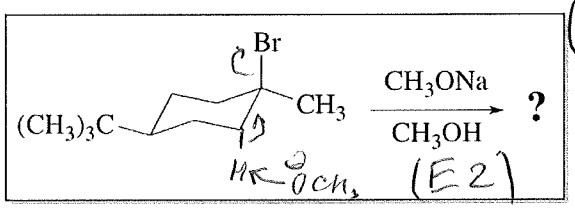
22. What is the main **product** of the reaction shown in the box?

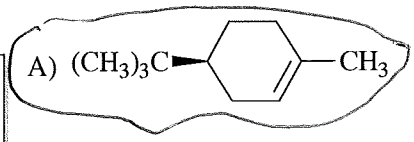


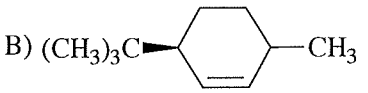
A) 1-methylcyclohexene B) 3-methylcyclohexene

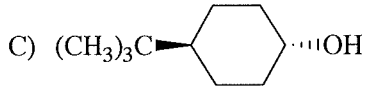
C) 4-methylcyclohexene D) methylenecyclohexene

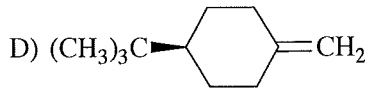
23. What is the main **product** of the reaction shown in the box?



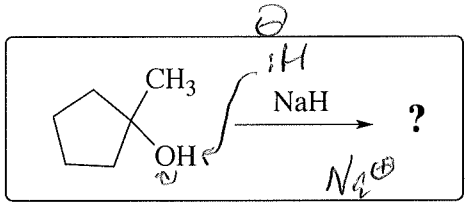
A) 

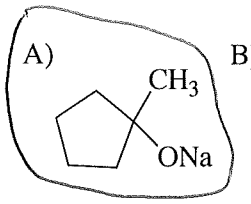
B) 

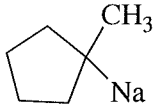
C) 

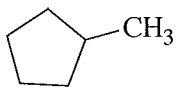
D) 

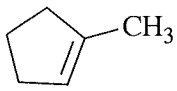
24. What is the main **product** of the reaction shown in the box?



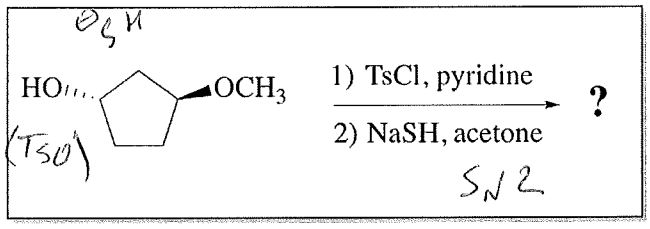
A) 

B) 

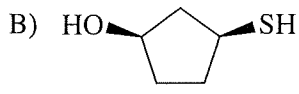
C) 

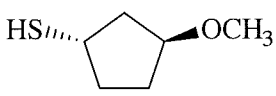
D) 

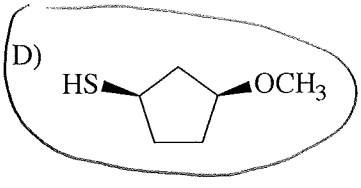
25. What is the main **product** of the reaction shown in the box?



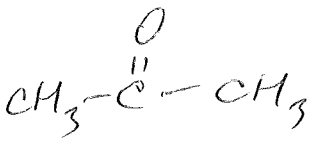
A) 

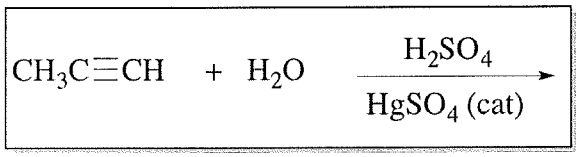
B) 

C) 

D) 

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

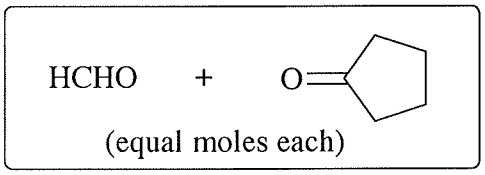




A) $CH_3CH_2CH_2OH$ B) $CH_3CH(OH)CH_3$

C) CH_3COCH_3 D) CH_3CH_2CHO

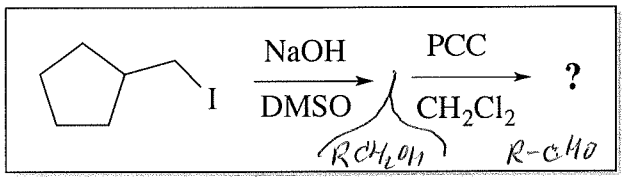
27. What **alkene** when treated with **ozone** and then with $(CH_3)_2S$ gives the products shown in the box?

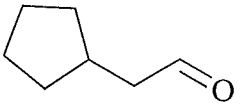


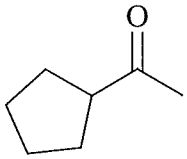
A) 1-methylcyclopentene B) vinylcyclopentane

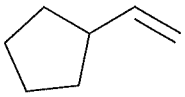
C) methylenecyclopentane D) allylcyclopentane

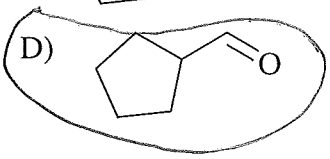
28. What is the main **product** of the reaction sequence shown in the box?



A) 

B) 

C) 

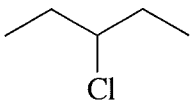
D) 

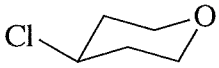
29. Which one of the following compounds is the **strongest acid**?

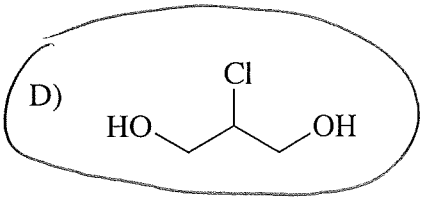
A) CH_3CO_2H B) CH_3CH_2Br C) CH_3NH_2 D) *t*-BuOH

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

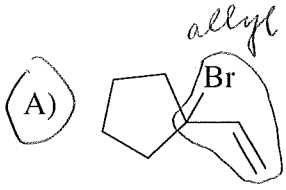
A) $CHCl_3$

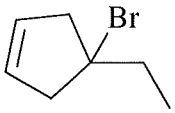
B) 

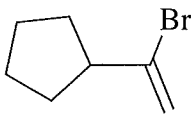
C) 

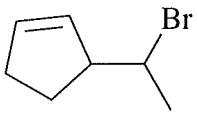
D) 

31. Which molecule is the best substrate for $\mathbf{S_N1}$ reaction?

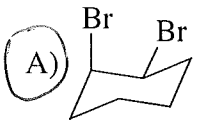
A) 

B) 

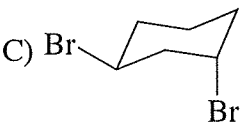
C) 

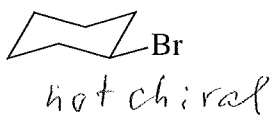
D) 

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

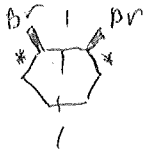
A) 

B) 

C) 

D) 

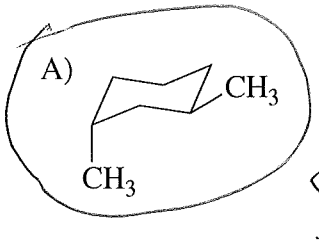
not chiral

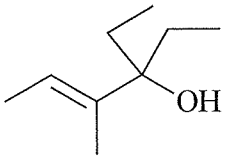


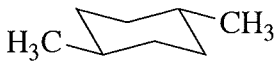
33. Which of the following compounds is the **strongest base**?

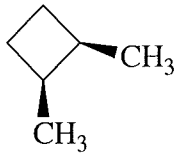
A) NaF B) $NaN(CH_3)_2$ C) $NaOCH_3$ D) NaI

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

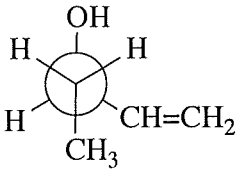
A) 

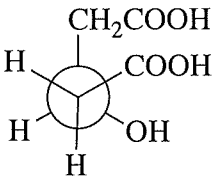
B) 

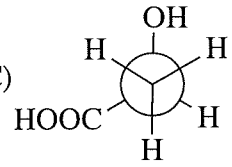
C) 

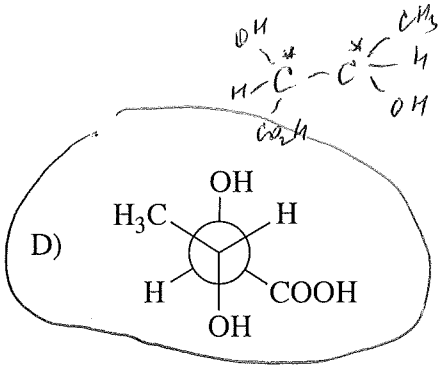
D) 

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

A) 

B) 

C) 

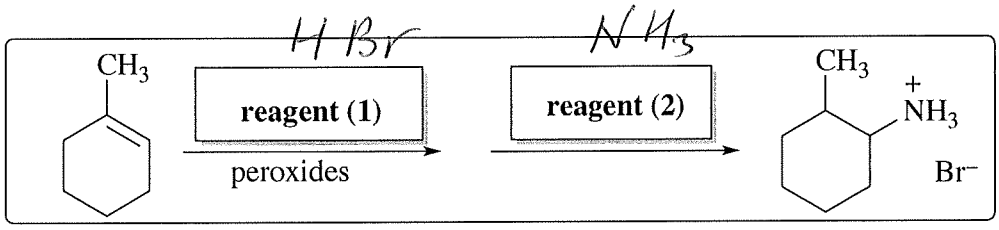
D) 

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

A) $Cl > CH_2CH_3 > CH_3 > H$ B) $Cl > CH{=}CH_2 > CH_3 > H$

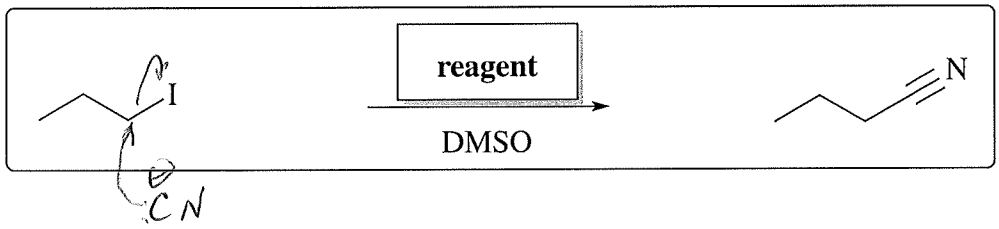
C) $OH > CH_2CH_2OH > CHO > CH_3$ D) $NH_3^+ > CH_2SH > CH_2OH > CH_3$

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



A) (1) HBr, (2) NH_3
B) (1) NBS, (2) NH_3
C) (1) $NaNH_2$, (2) Br_2
D) (1) NBS, (2) $NaNH_2$

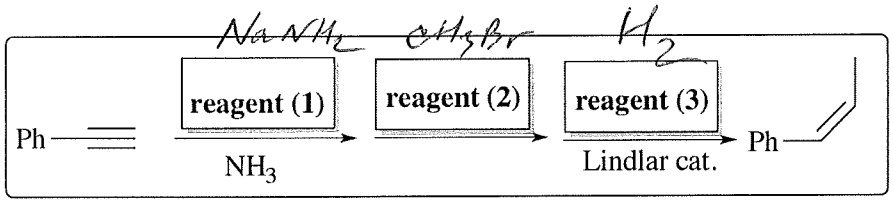
38. Which **reagent** can be used for the reaction shown in the box?



A) NaCN B) CH_3CN

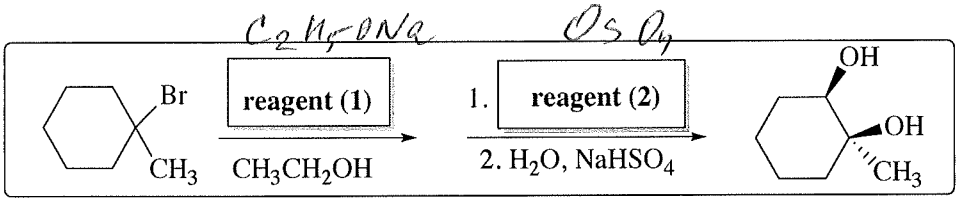
C) NaN_3 D) NH_3

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



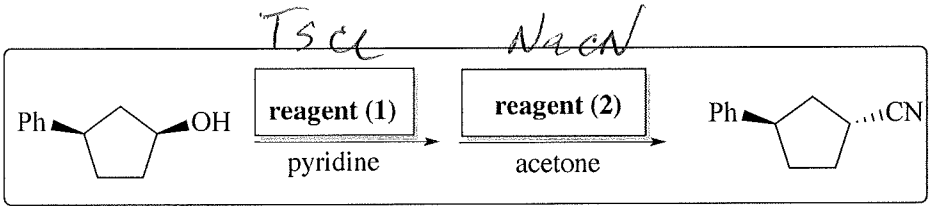
A) (**1**) Br_2, (**2**) $NaNH_2$, (**3**) H_2
B) (**1**) CH_3Br, (**2**) NH_3, (**3**) Na
C) (**1**) CH_3Br, (**2**) $NaNH_2$, (**3**) H_2
D) (**1**) $NaNH_2$, (**2**) CH_3Br, (**3**) H_2

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



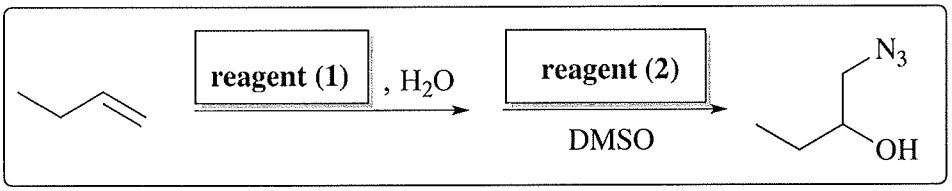
A) (**1**) NH_3, (**2**) O_3
B) (**1**) CH_3CH_2ONa, (**2**) OsO_4
C) (**1**) CH_3CH_2ONa, (**2**) O_3
D) (**1**) PCC, (**2**) OsO_4

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



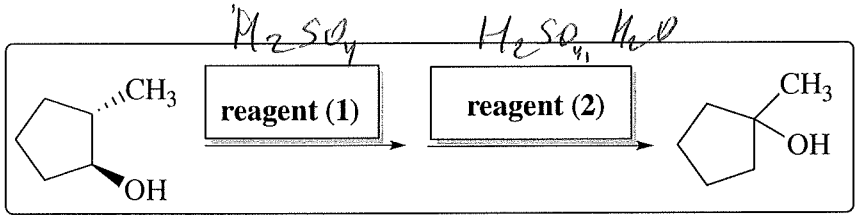
A) (**1**) TsCl, (**2**) NaCN
B) (**1**) CH_3CH_2ONa, (**2**) NaCN
C) (**1**) TsCl, (**2**) NH_3
D) (**1**) PCC, (**2**) NaCN

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



A) (**1**) TsCl, (**2**) NaN_3
B) (**1**) CH_3CH_2ONa, (**2**) NaN_3
C) (**1**) Cl_2, (**2**) NaN_3
D) (**1**) TsCl, (**2**) NaCN

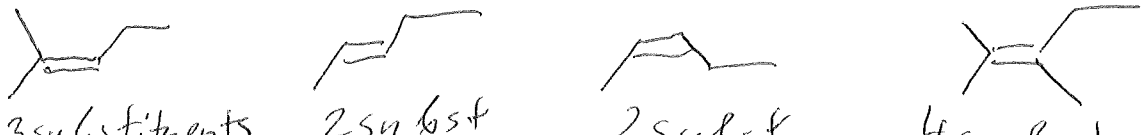
43. Which sequence of **reagents** can be used for the reaction shown in the box?



A) (**1**) H_2SO_4, heat, (**2**) H_2SO_4, H_2O
B) (**1**) CH_3CH_2ONa, (**2**) NaOH, H_2O
C) (**1**) HBr, (**2**) NaOH, H_2O
D) (**1**) PCC, (**2**) H_2SO_4, H_2O

44. Which is the **most stable** alkene?

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



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

I) 1-butanol II) 1-chlorobutane III) pentane

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

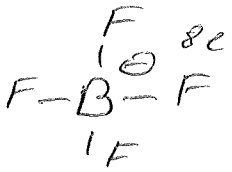
46. Which of the following represents the order of increasing **acidity** for compounds the box?

(**1**) CH_3Br (**2**) CH_3CO_2H (**3**) CH_3CH_2OH (**4**) FCH_2CO_2H (**5**) HCl

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

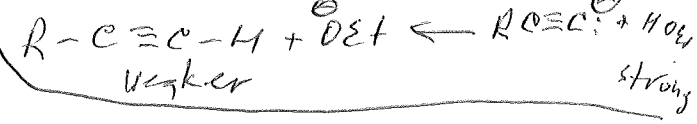
47. Which species is **NOT a Lewis acid**?

A) $B(CH_2CH_3)_3$ B) BF_4^- C) $AlCl_3$ D) $(CH_3)_3C^+$



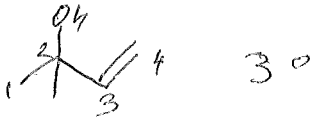
48. A terminal alkyne, **1-butyne** is NOT deprotonated by the **ethoxide ion**. What does this indicate?

A) 1-Butyne is the conjugate base of ethanol. B) 1-Butyne is stronger base than ethanol.
C) Alkynyl ion is a weaker base than the hydroxide ion. D) Ethanol is a stronger acid than 1-butyne.



49. Which of the following is a tertiary alcohol?

A) 3-buten-1-ol B) (*R*)-2-methyl-1-butanol
C) 2-methyl-3-buten-2-ol D) (*R*)-3-buten-2-ol



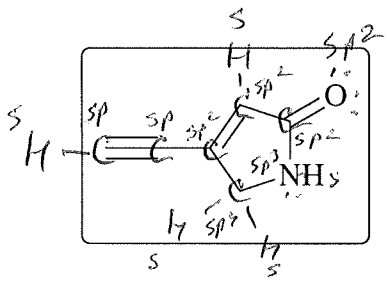
50. Which of the following molecules contains both an **acid** AND an **alcohol** functional group?

A) $CH_3\overset{\overset{O}{\|}}{C}CH_2COOH$ B) $CH_3\overset{\overset{NH_2}{|}}{C}HCOOCH_3$ C) $CH_3\overset{\overset{OH}{|}}{C}HCOOH$ D) $CH_3\overset{\overset{OH}{|}}{C}HCHO$

SEE NEXT PAGE FOR THE QUESTIONS ON THE BACK OF THE SCANTRON FORM (50 points total):

Question 51 (30 pts): Please mark your answers in boxes 51-60 on the back of the Scantron form

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).



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

Box 52: Number of σ 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 1

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

Box 55: Number of σ bonds formed by overlap of *s* and sp^2 orbitals 1

Box 56: Number of σ bonds formed by overlap of *s* and *sp* orbitals 1

Box 57: Number of σ bonds formed by overlap of sp^2 and sp^2 orbitals 3

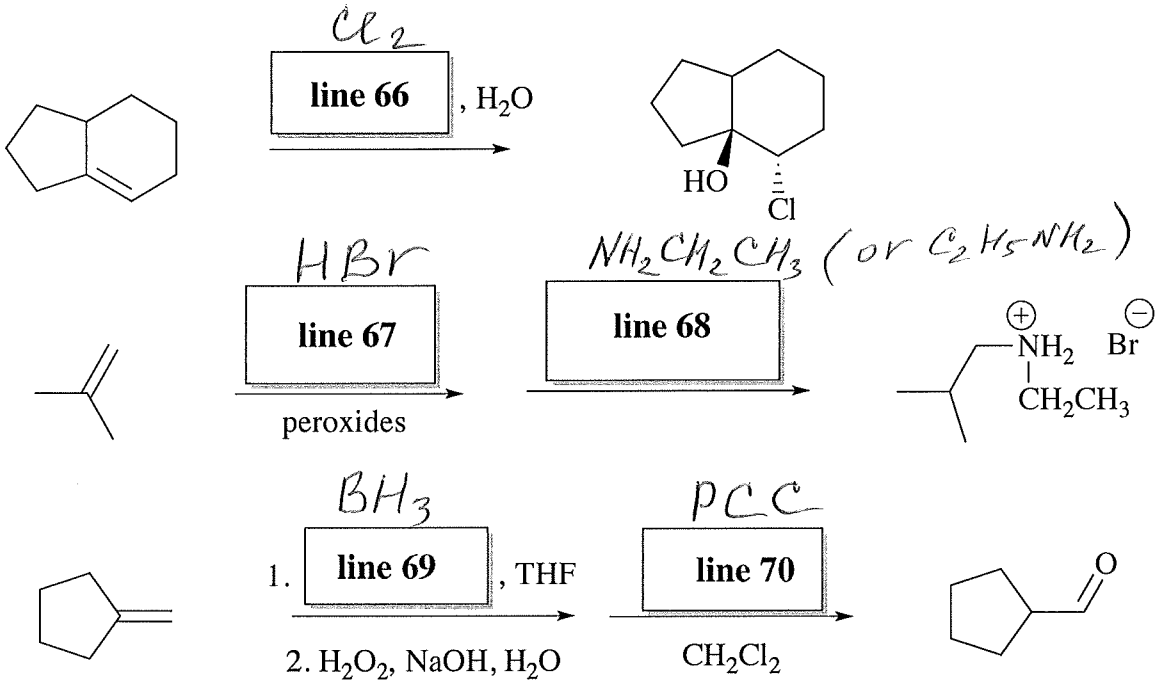
Box 58: Total number of σ bonds 13

Box 59: Total number of π bonds 4

Box 60: Total number of non-bonding electrons in this molecule 6

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):



(sia)$_2$BH is also OK

PCC or