Prof. S. Gambarotta

Your Name: _____ Student #: _____

Your course TA (Dave, Derek, Marc): _____

Exercise	key	Exercise	key	Exercise	key	Exercise	key
1		16		31		46	
2		17		32		47	
3		18		33		48	
4		19		34		49	
5		20		35		50	
6		21		36		51	
7		22		37		52	
8		23		38			
9		24		39			
10		25		40			
11		26		41`			
12		27		42			
13		28		43			
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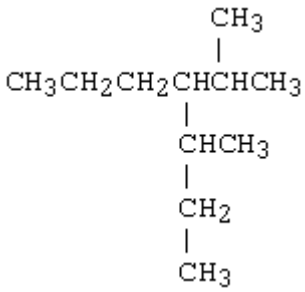
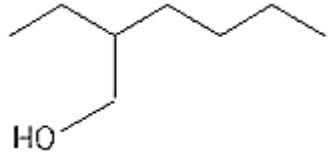
1. Please deliver only this page. You can keep the text.
2. Scratch paper is at the end.
3. Solution key will be posted today.
4. Marks will be posted on Virtual Campus ASAP.
5. This is a **Open BOOK** exam. **Use your molecular models.**

1. 

An IUPAC name for is:

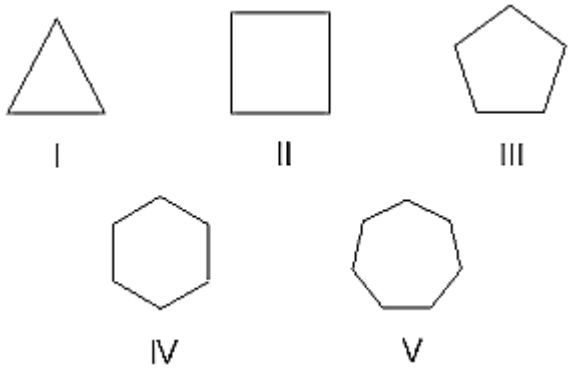
A) 5-Methyl-4-(1-methylpropyl)hexane
B) 2-Methyl-3-(1-methylpropyl)hexane
C) 2-Methyl-3-(2-methylpropyl)hexane
D) 3-Methyl-4-(1-methylethyl)heptane
E) 5-Methyl-4-(1-methylethyl)heptane

2. What is the correct IUPAC name for the following compound?



A) 3-Hydroxymethylheptane
B) 3-Hydroxymethylhexane
C) 3-Methyloxyheptane
D) 2-Ethyl-1-hexanol
E) 2-Ethyl-1-heptanol

3. Which cycloalkane has the largest heat of combustion per CH_2 group?

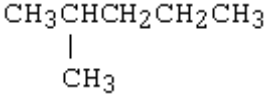
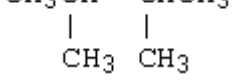
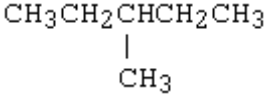


A) I
B) II
C) III
D) IV
E) V

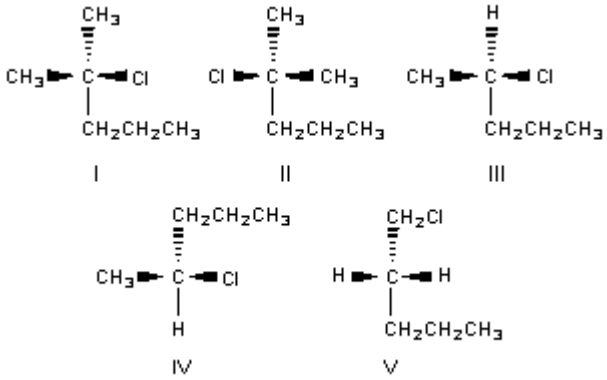
4. The most stable conformation of trans-1-tert-butyl-2-methylcyclohexane is the one in which:
   A) the tert-butyl group is axial and the methyl group is equatorial.
   B) the methyl group is axial and the tert-butyl group is equatorial.
   C) both groups are axial.
   D) both groups are equatorial.
   E) the molecule is in the half chair conformation.

5. The most stable conformation of cis-1-tert-butyl-4-methylcyclohexane is the one in which:
   A) the tert-butyl group is axial and the methyl group is equatorial.
   B) the methyl group is axial and the tert-butyl group is equatorial.
   C) both groups are axial.
   D) both groups are equatorial.
   E) the twist boat conformation is adopted.

6. The twist boat conformation is the preferred conformation for this compound.
   A) cis-1,4-Di-tert-butylcyclohexane
   B) trans-1,4-Di-tert-butylcyclohexane
   C) cis-1,3-Di-tert-butylcyclohexane
   D) trans-1,2-Di-tert-butylcyclohexane
   E) None of these

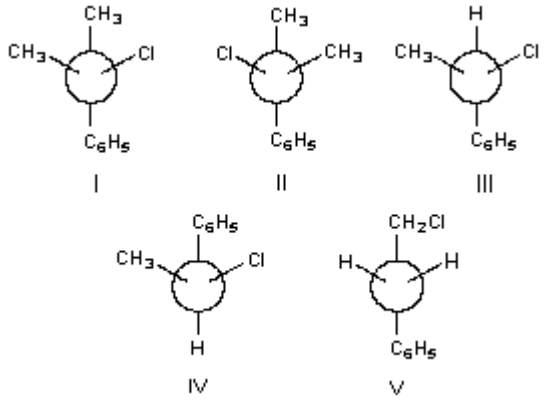
7. When chlorinated, an alkane, C_6H_{14}, gives only two products with the formula $C_6H_{13}Cl$. The structure of the alkane is:
   A) $CH_3CH_2CH_2CH_2CH_2CH_3$
   B) 
   C) 
   D) $(CH_3)_3CCH_2CH_3$
   E) 

8. Pairs of enantiomers are:



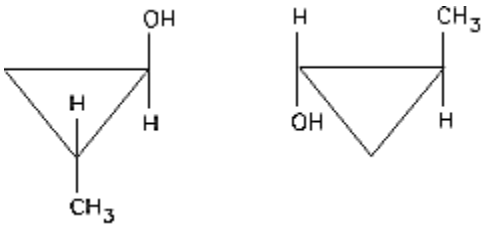
A) I, II and III, IV
B) I, II
C) III, IV
D) IV, V
E) None of the structures

9. Chiral molecules are represented by:



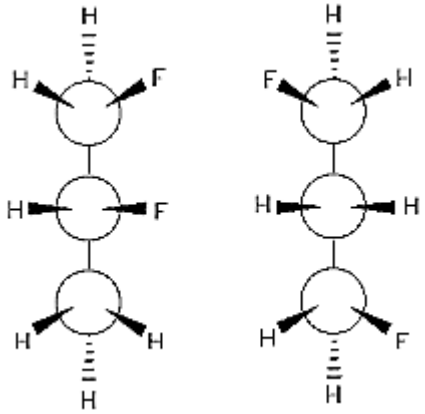
A) I, II, III, IV and V
B) I, II, III and IV
C) I and II
D) III and IV
E) IV alone

10. The molecules shown are:



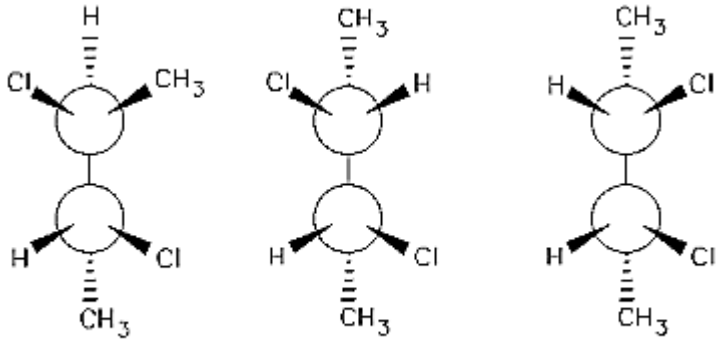
A) constitutional isomers.
B) enantiomers.
C) diastereomers.
D) identical.
E) None of these

11. The molecules below are:



A) constitutional isomers.
B) enantiomers.
C) diastereomers.
D) identical.
E) None of these

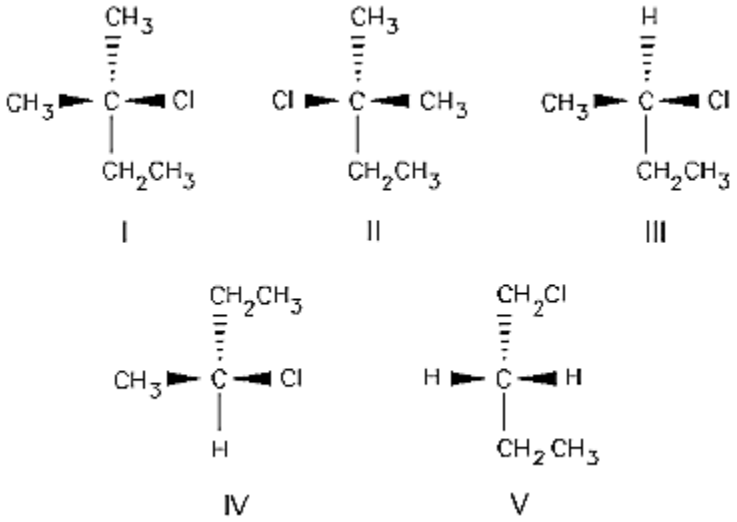
12. Which of the following is(are) meso compound(s)?



I II III

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

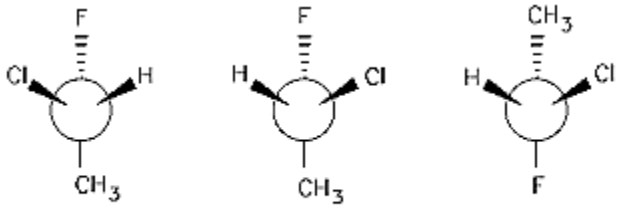
13. (R)-2-Chlorobutane is represented by:



I II III IV V

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

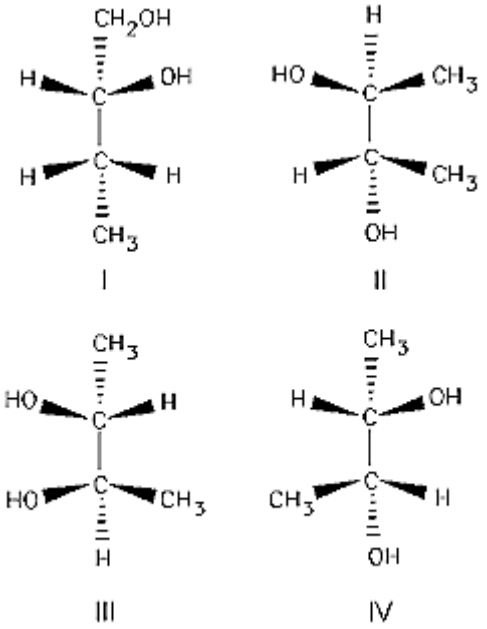
14. Which structure represents (S)-1-chloro-1-fluoroethane?



I II III

A) I
B) II
C) III
D) More than one of the above
E) None of the above

15. Consider the following compounds:



I II III IV

Which compound above is (2R,3R)-2,3-butanediol?

A) I
B) II
C) III
D) IV
E) None of these

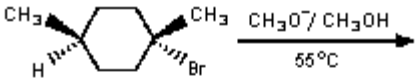
16. Consider the S_N1 reaction of tert-butyl chloride with iodide ion.

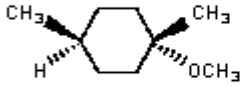
$(CH_3)_3C–Cl + I^- \longrightarrow (CH_3)_3C–I + Cl^-$

Assuming no other changes, how would it affect the rate if one simultaneously doubled the concentration of tert-butyl chloride and iodide ion?

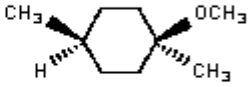
A) No effect
B) It would double the rate.
C) It would triple the rate.
D) It would quadruple the rate.
E) It would increase the rate five times.

17. What would be the major product of the following reaction?





I



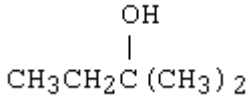
II

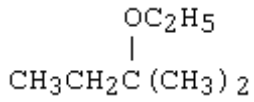
III

IV

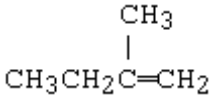
A) I
B) II
C) III
D) IV
E) An equimolar mixture of I and II

18. When tert-pentyl chloride undergoes solvolysis in aqueous ethanol at room temperature, there is/are formed:

A) 

B) 

C) $CH_3CH{=}C(CH_3)_2$

D) 

E) All of these

19. When 0.10 mol of $ICH_2CH_2CH_2CH_2Cl$ reacts with 0.10 mol of $NaOCH_3$ in CH_3OH at 40°C, the major product is:

A) $CH_3OCH_2CH_2CH_2CH_2Cl$

B) $CH_3OCH_2CH_2CH_2CH_2I$

C) $CH_3OCH_2CH_2CH_2CH_2OCH_3$

D) $CH_2{=}CHCH_2CH_2Cl$

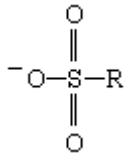
E) $CH_2{=}CHCH_2CH_2I$

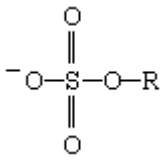
20. Which of the following is not a good leaving group?

A) OH^-

B) Cl^-

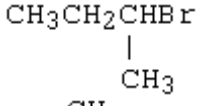
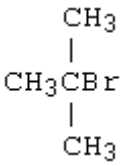
C) Br^-

D) 

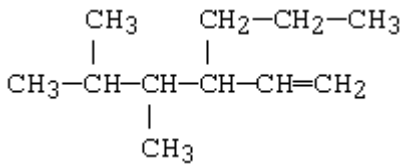
E) 

21. Consider the substitution reaction that takes place when (R)-3-bromo-3-methylhexane is treated with methanol. Which of the following would be true?
    A) The reaction would take place only with inversion of configuration at the stereogenic center.
    B) The reaction would take place only with retention of configuration at the stereogenic center.
    C) The reaction would take place with racemization.
    D) No reaction would take place.
    E) The alkyl halide does not possess a stereogenic center.

22. Which alkyl halide would you expect to undergo S_N1 hydrolysis most rapidly?
    A) $(CH_3)_3CI$
    B) $(CH_3)_3CBr$
    C) $(CH_3)_3CCl$
    D) $(CH_3)_3CF$
    E) They would all react at the same rate.

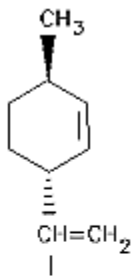
23. Which alkyl halide would give the highest yield of the elimination product when treated with sodium ethoxide in ethanol?
    A) CH_3CH_2Br
    B) $CH_3CH_2CH_2Br$
    C) $CH_3CH_2CH_2CH_2Br$
    D) 
    E) 

24. The correct IUPAC name for the following compound is:

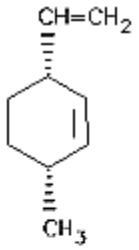


    A) 4,5-Dimethyl-3-propyl-2-hexene
    B) 4,5-Dimethyl-3-propyl-1-hexene
    C) 3-(2,3-Dimethylpropyl)-1-hexene
    D) 2,3-Dimethyl-4-isopropyl-5-hexene
    E) 2,3-Dimethyl-4-propyl-5-hexene

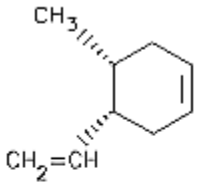
25. Select the structure for <u>cis</u>-3-methyl-6-vinylcyclohexene.



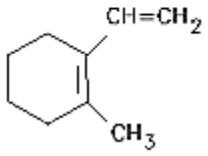
I



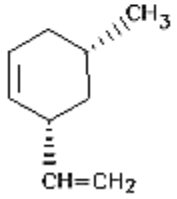
II



III



IV



V

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

26. Which of the following carbocations would be likely to undergo rearrangement?

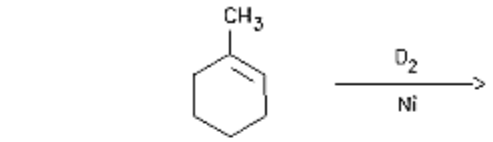
A) $CH_3-\overset{+}{C}H-\underset{\displaystyle CH_3}{\underset{|}{C}}H-CH_3$

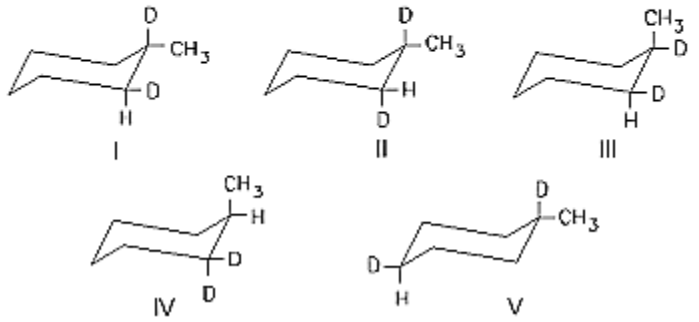
B) $CH_3-CH-\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}-CH_3$

C) $CH_3-\overset{\displaystyle CH_3}{\overset{|}{C}}-CH_2-CH_3$

D) More than one of the above
E) All of the above

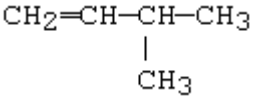
27. Which would be the major product of the following reaction?

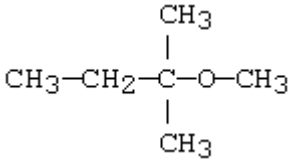


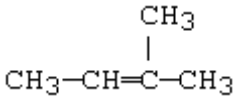


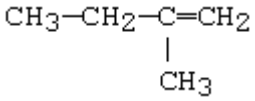
A) I
B) II
C) III
D) IV
E) V

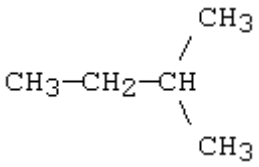
28. What would be the major product of the following reaction?

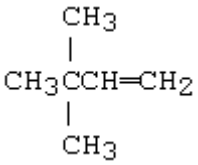
A) 

B) 

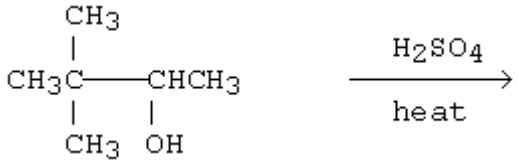
C) 

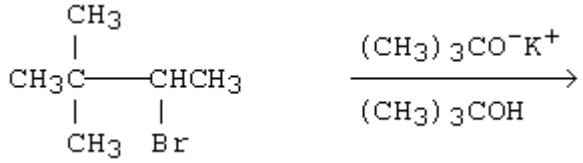
D) 

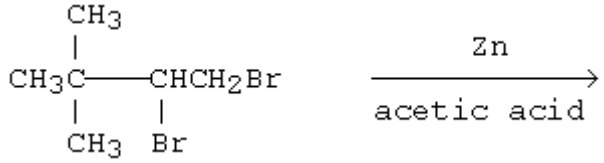
E) 

29. 

Which of the following reactions would yield in a reasonable percentage yield (i.e., greater than 50%)?

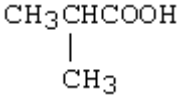
A) 

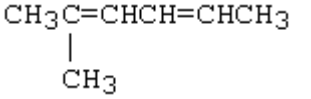
B) 

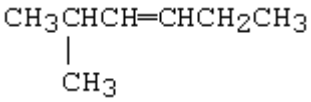
C) 

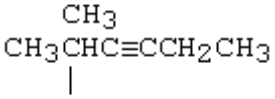
D) All of these

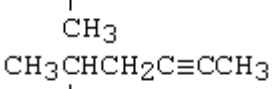
E) Answers B) and C) only

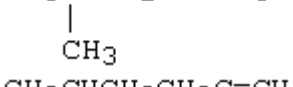
30. An unknown compound, A, has the molecular formula C_7H_{12}. On oxidation with hot aqueous potassium permanganate, A yields CH_3CH_2COOH and  . Which of the following structures best represents A?

A) 

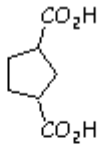
B) 

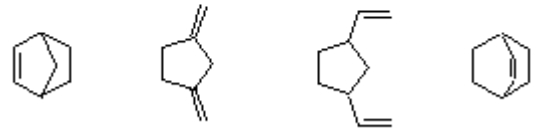
C) 

D) 

E) 

31. An alkene, X, with the formula C_7H_{10} adds one mole of hydrogen on catalytic hydrogenation. On treatment with hot basic $KMnO_4$ followed by acidification, X yields





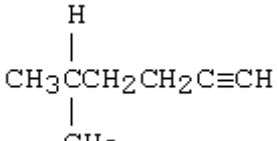
I II III IV

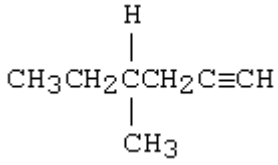
Which is a possible structure for X?

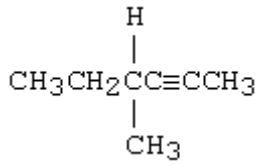
A) I
B) II
C) III
D) IV
E) None of these

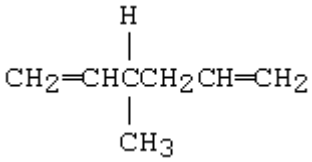
32. An optically active compound, Y, with the molecular formula C_7H_{12} gives a positive test with cold dilute $KMnO_4$ and shows IR absorption at about 3300 cm^{-1}. On catalytic hydrogenation, Y yields Z(C_7H_{16}) and Z is also optically active. Which is a possible structure for Y?

A) $CH_3CH_2CH_2CH_2CH_2C{\equiv}CH$

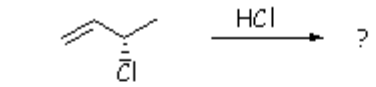
B)


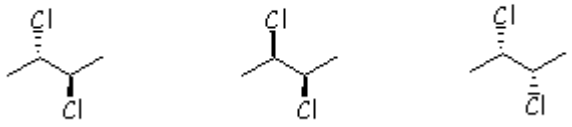
C)


D)


E)


33. Addition of hydrogen chloride to the following molecule would produce:

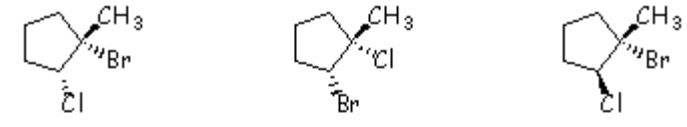


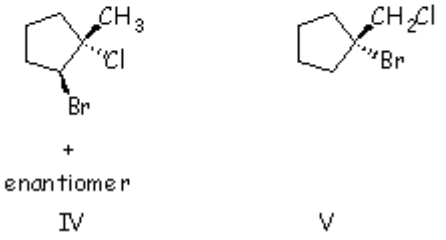


I II III

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

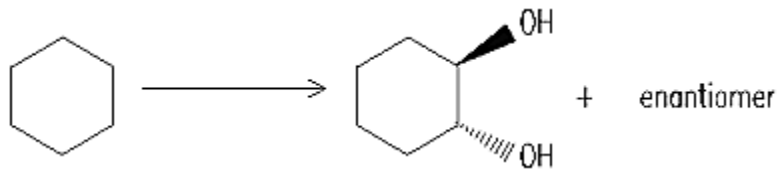
34. The reaction of BrCl (bromine monochloride) with 1-methylcyclopentene will produce as the predominant product:





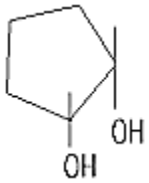
A) I
B) II
C) III
D) IV
E) V

35. How could the following synthesis be accomplished?



A) (1) Cl_2/hν; (2) t-BuOK; (3) peroxy acid; (4) H_3O^+
B) (1) t-BuOK; (2) Cl_2/hν; (3) peroxy acid; (4) H_3O^+
C) (1) H_3O^+; (2) t-BuOK; (3) peroxy acid; (4) H_2O
D) (1) Cl_2/hν; (2) peroxy acid; (3) t-BuOK; (4) H_3O^+
E) (1) Cl_2/hν; (2) H_3O^+; (3) t-BuOK; (4) peroxy acid

36. What sequence of reactions could be used to prepare the compound below from cyclopentane?



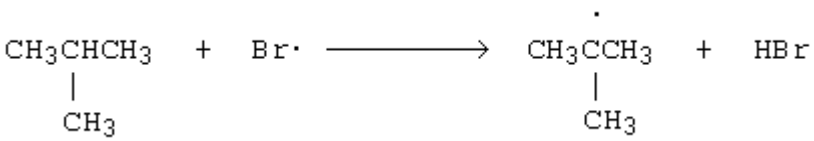
A) (1) Cl_2, hν; (2) t-BuOK/t-BuOH; (3) OsO_4; (4) $NaHSO_3/H_2O$
B) (1) t-BuOK/t-BuOH; (2) Cl_2, hν; (3) $NaOH/H_2O$
C) (1) Cl_2, hν; (2) t-BuOK/t-BuOH; (3) H_2O_2
D) (1) $NaOH/H_2O$; (2) Br_2; (3) $NaNH_2$(2eq.)/liq.NH_3; (4) $KMnO_4$, $NaOH/H_2O$, 5°C
E) (1) Cl_2, hν; (2) t-BuOK/t-BuOH; (3) $RCOO_2H$; (4) H_3O^+

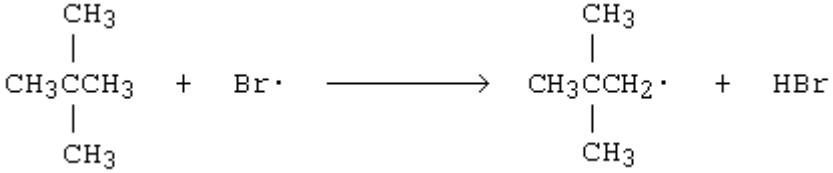
37. For which reaction would the transition state be most product-like?

A) $CH_4 + Br\cdot \longrightarrow CH_3\cdot + HBr$

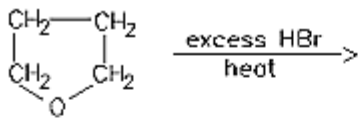
B) $CH_3CH_3 + Br\cdot \longrightarrow CH_3CH_2\cdot + HBr$

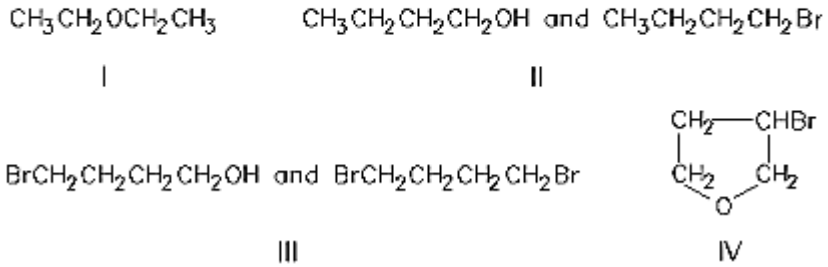
C)


D)


E)


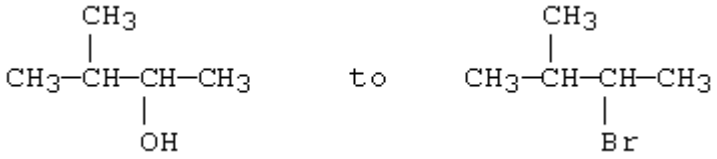
38. The product(s) of the following reaction





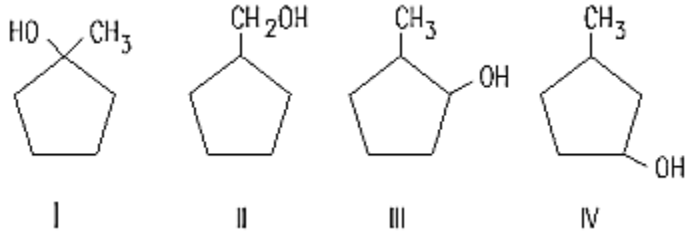
A) I
B) II
C) III
D) IV
E) None of these

39. <u>trans</u>-3-Methylcyclopentanol is treated with CH_3SO_2Cl in the presence of base. The product of this reaction is then heated with KI in methanol. What is the final product?
A) <u>trans</u>-1-Iodo-3-methylcyclopentane
B) <u>cis</u>-1-Iodo-3-methylcyclopentane
C) 1-Methylcyclopentene
D) 2-Methylcyclopentene
E) 3-Methylcyclopentene

40. 

The conversion of is best achieved through use of which of these reagents in a low temperature reaction?
A) Concd. HBr
B) Br_2
C) NaBr, H_2SO_4
D) PBr_3
E) HBr, peroxide

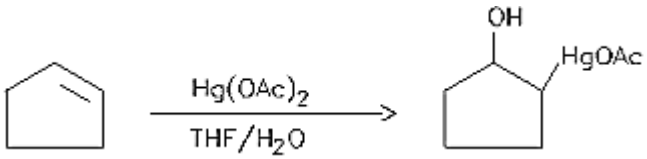
41. Oxymercuration-demercuration of 3-methylcyclopentene produces this/these product(s):



I II III IV

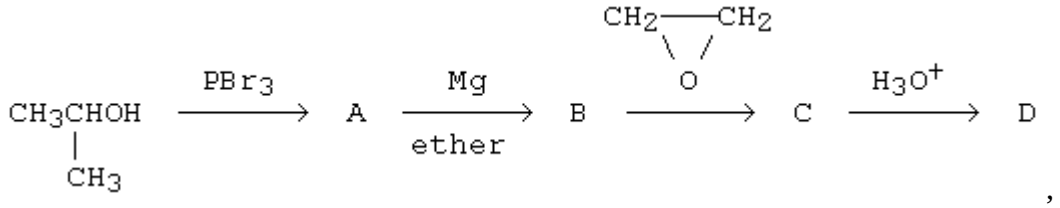
A) I
B) II
C) III
D) IV
E) Both III and IV

42. What is the electrophilic species involved in the initial step of the reaction below?



A) ^{+}OH
B) $^{+}HgOAc$
C) H_3O^{+}
D) THF
E) the THF/H_2O complex

43. The final product, D, in the following reaction sequence,



,

would be?

A) $CH_3CHOCH_2CH_2OH$ (CH3 branch)

B) $CH_3CHCH_2CH_2Br$ (CH3 branch)

C) $CH_3CHCH_2CH_2OH$ (CH3 branch)

D) $CH_3CHOCH_2CH_3$ (CH3 branch)

E) $CH_3CHCH_2CH_3$ (CH3 branch)

44. What compound(s) result(s) from the reaction of $CH_3CH_2CH_2MgBr$ with $CH_3CH_2CH_2CH_2CO_2H$?

A) $(CH_3CH_2CH_2)_2CCH_2CH_2CH_2CH_3$ (OH)

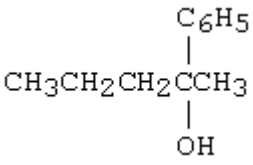
B) $CH_3CH_2CH_2CCH_2CH_2CH_2CH_3$ (O)

C) $CH_3CH_2CH_2CH_2COCH_2CH_2CH_3$ (O)

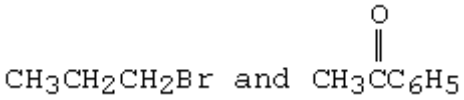
D) $CH_3CH_2CH_3$ + $CH_3CH_2CH_2CH_2CO_2MgBr$

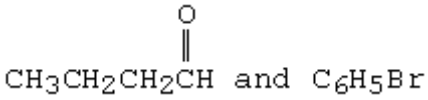
E) $CH_3CH_2COCCH_2CH_2CH_2CH_3$ (O O)

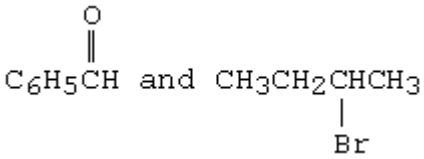
45. In the reaction of carbonyl compounds with $LiAlH_4$, the effective reducing species is:
    A) Li^+
    B) Al^{+3}
    C) AlH_4^-
    D) AlH_3
    E) H^-

46. 

    Your task is to synthesize through a Grignard synthesis. Which pairs of compounds listed below would you choose as starting materials?

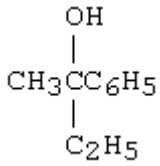
    A) 

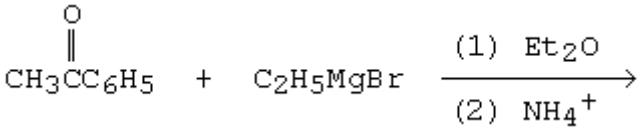
    B) 

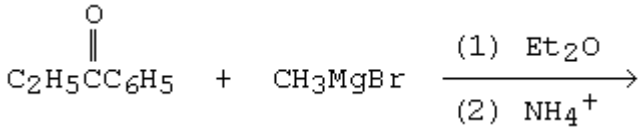
    C) 

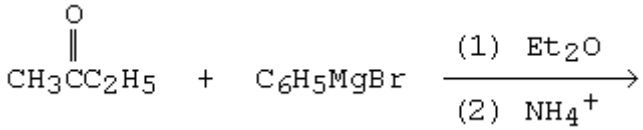
    D) More than one of these
    E) None of these

47. Which of the following reactions would serve as a reasonable synthesis of the following racemic alcohol?



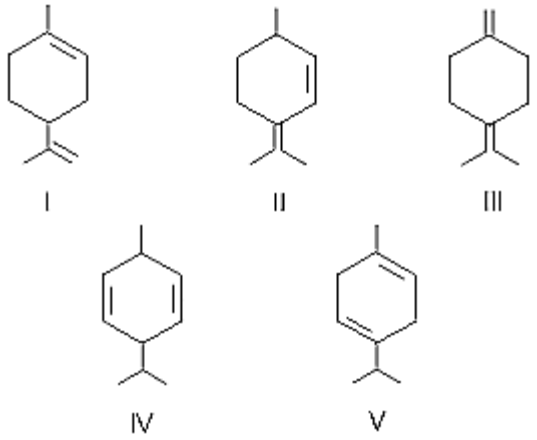
A) 

B) 

C) 

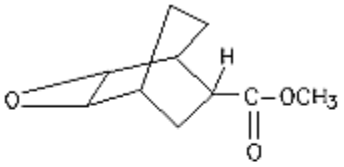
D) Answers A) and B) only
E) Answers A), B) and C)

48. Select the structure of the conjugated diene.



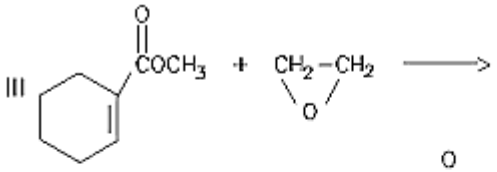
A) I
B) II
C) III
D) IV
E) V

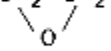
49. How would you synthesize:

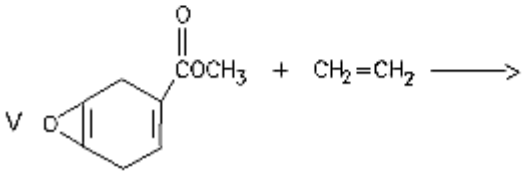


I 1,3–Cyclohexadiene + $CH_2=CHCOCH_3$, then RCOOH

II 1,3–Cyclohexadiene + RCOOH, then $CH_2=CHCOCH_3$

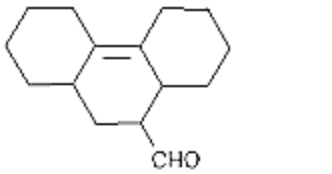
III 

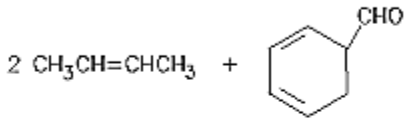
IV 1,4–Cyclohexadiene + $CH_2=CHCOCH_3$, then 

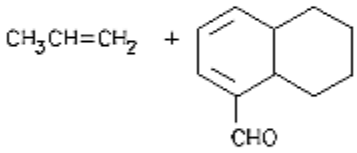
V 

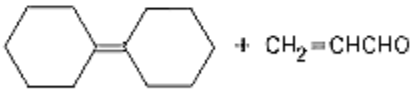
A) I
B) II
C) III
D) IV
E) V

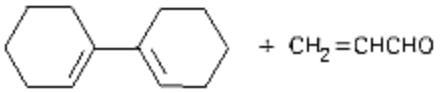
50. Which of the following would afford a synthesis of the following compound?



I 

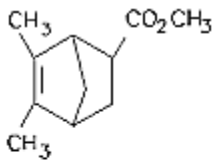
II 

III 

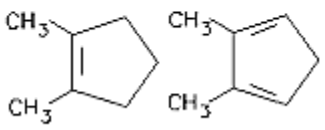
IV 

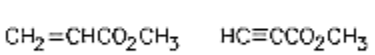
A) I
B) II
C) III
D) IV
E) None of these

51. Which compounds could be used in a Diels-Alder synthesis of



?





I II III IV

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

52. Treatment of 2-butene (cis or trans) with Cl_2 at 400°C would yield mainly:

A) $CH_2ClCHClCH_2CH_3$

B) $CH_3CHClCH_2CH_3$

C) $CH_3CH{=}CClCH_3$

D) $CH_3CH{=}CHCH_2Cl$ and $CH_3\underset{\displaystyle Cl}{\underset{|}{C}}HCH{=}CH_2$

E) $CH_3CHClCHClCH_3$

Answer Key

1. D
2. D
3. A
4. D
5. B
6. A
7. C
8. C
9. D
10. B
11. A
12. E
13. C
14. D
15. C
16. B
17. C
18. E
19. A
20. A
21. C
22. A
23. E
24. B
25. B
26. D
27. A
28. C
29. E
30. C
31. A
32. C
33. B
34. D
35. A
36. A
37. A
38. C
39. B
40. D
41. E
42. B
43. C
44. D

45. E
46. A
47. E
48. B
49. A
50. D
51. C
52. D