

※請在答案卡內作答

一、單選題 1-20 (每題二分，答錯不倒扣，總共四十分)

二、多選題 21-50 (每題二分，答錯不倒扣，總共六十分)

1. Which of the following alkynes will produce a single product upon mercury(II)-catalyzed hydration?

- (A) 2-methyl-5-ethyl-3-heptyne
 (B) 3,3-dimethyl-1-heptyne
 (C) 3-hexyne
 (D) 2-hexyne
 (E) Both 3,3-dimethyl-1-heptyne and 3-hexyne

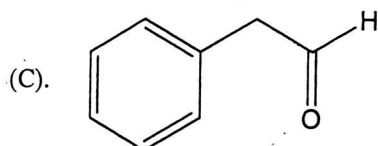
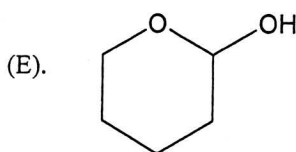
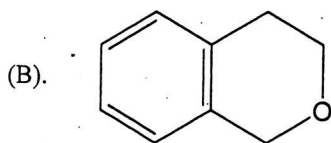
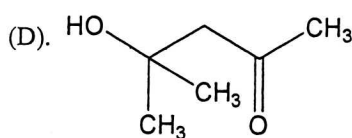
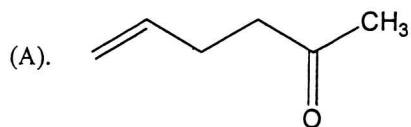
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2. Choose the *best* reagent or sequence of reagents from the list provided below for carrying out the following transformations. Place the letter of your response to the left of the reaction.

- | | | |
|-----------------------|------------------|------------------------------|
| (A). PBr ₃ | (D) | SOCl ₂ , pyridine |
| (B) HCl (gas), ether | (E) | HBr (gas), ether |
| (C). 1. | Mg, ether | |
| 2. | D ₂ O | |



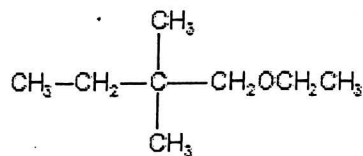
3. MATCH a structure from the list below to the following IR spectra.



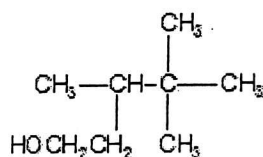
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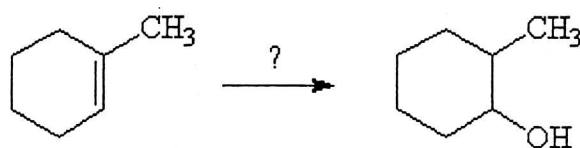
(D)



(E)



5. What reagents are needed to accomplish the following transformation?



- (A) $\text{H}_2\text{O}/\text{H}^+$
 (B) $\text{H}_2\text{O}/\text{Peroxide}$
 (C) OH^-
 (D) BH_3
 (E) 1. BH_3 / 2. HO^- , H_2O_2 , H_2O

6. In a Grignard reagent, the carbon bonded to the magnesium has a partial _____ charge, because carbon is _____ electronegative than magnesium.

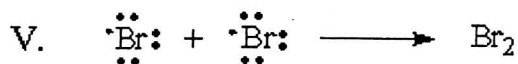
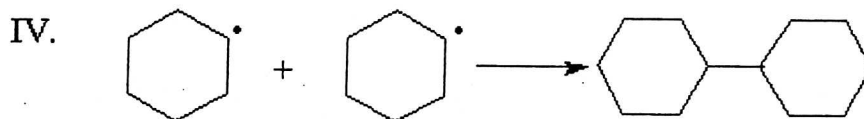
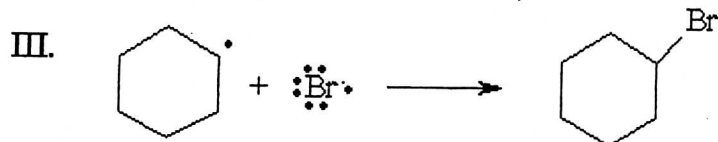
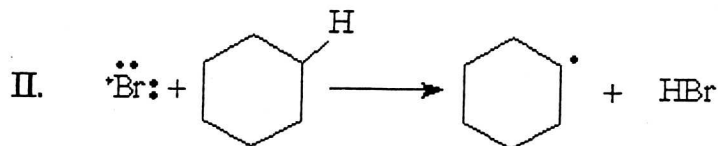
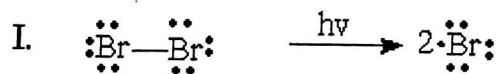
This makes this carbon of the Grignard _____.

- (A) negative, more, nucleophilic
 (B) negative, less, electrophilic
 (C) positive, more, electrophilic
 (D) positive, less, nucleophilic
 (E) positive, less, electrophilic

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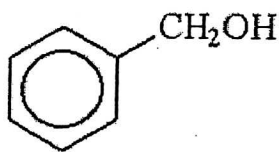
7. Which of the following is the rate-determining step for the monobromination of cyclohexane?

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

8. Which of the following m/z values is the base peak for benzyl alcohol?



- (A) 77
(B) 108
(C) 91
(D) 17
(E) 52

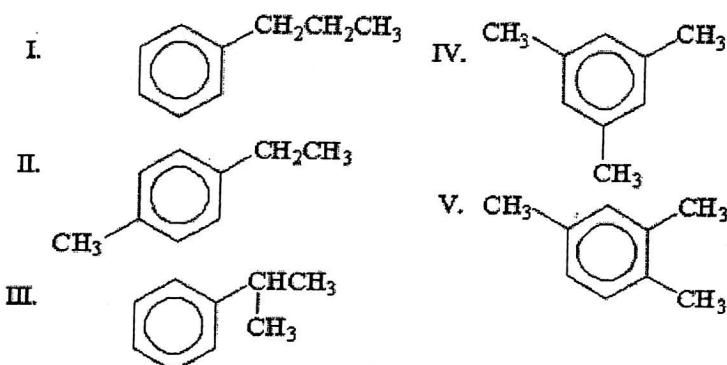
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9. An unknown compound, C_9H_{12} , gave the following NMR spectrum:

Triplet at 1.21 ppm (3H) Singlet at 2.30 ppm (3H) Quartet at 2.60 ppm (2H) Singlet at 7.04 ppm (4H)

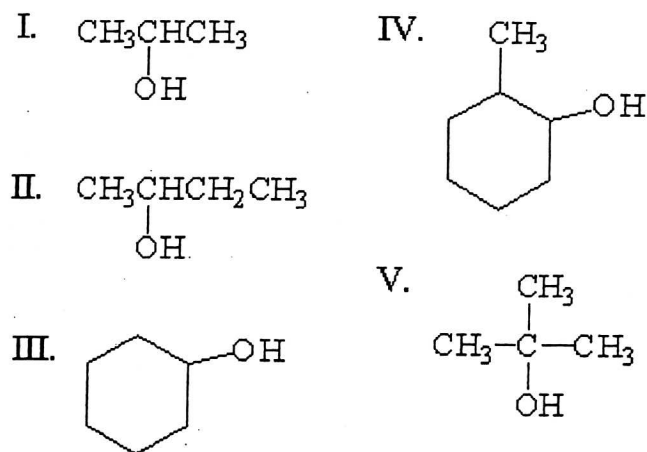
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What is the structure of the compound?



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

10. Which of the following alcohols gives a rearranged carbocation when dehydrated?



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

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11. What results when but-1-ene is subjected to the following reaction sequence:

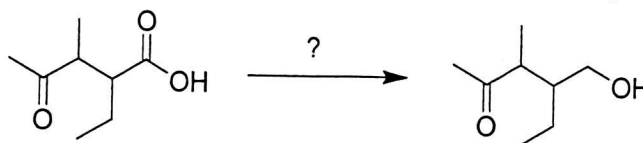
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- (1) Cl_2 , H_2O , (2) NaOH , (3) H_3O^+ ?
(A) a meso epoxide
(B) a 1:1 mixture of enantiomeric epoxides
(C) a meso diol
(D) a 1:1 mixture of enantiomeric diols
(E) butan-2-ol
12. What is the major organic product which results when cycloheptene is irradiated in the presence of *N*-bromosuccinimide?
(A) 1-bromocycloheptene
(B) 2-bromocycloheptene
(C) 1,2-dibromocycloheptane
(D) 3-bromocycloheptene
(E) 4-bromocycloheptene
13. Which of the following compounds absorbs the longest wavelength of UV-visible light?
(A) (*E*)-but-2-ene
(B) (*Z*)-but-2-ene
(C) hex-1-ene
(D) (*Z*)-1,3-hexadiene
(E) (*E*)-1,3,5-hexatriene
14. Which of the following compounds has the lowest boiling point?
(A) 1,2,3-trichlorobenzene
(B) 1,2,4-trichlorobenzene
(C) *p*-dichlorobenzene
(D) *m*-dichlorobenzene
(E) *o*-dichlorobenzene
15. Which of the following compounds has the most signals in the noise-decoupled ^{13}C NMR spectrum?
(A) *o*-dibromobenzene
(B) *m*-dibromobenzene
(C) *p*-dibromobenzene
(D) 1,3,5-tribromobenzene
(E) 1,2,3,4-tetrabromobenzene

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16. when 2,4-dinitrochlorobenzene is treated with sodium hydroxide at 100°C followed by protonation:
- (A) 2,4-dinitrophenol is formed via an addition-elimination nucleophilic aromatic substitution mechanism.
- (B) 2,4-dinitrophenol is formed via an elimination-addition nucleophilic aromatic substitution mechanism.
- (C) 3,5-dinitrophenol is formed via an elimination-addition nucleophilic aromatic substitution mechanism.
- (D) 3,5-dinitrophenol is formed via an electrophilic aromatic substitution mechanism.
- (E) 2,4-dinitrophenol is formed via an electrophilic aromatic substitution mechanism.
17. Consider the equilibrium of each of the carbonyl compounds with HCN to produce cyanohydrins. Which is the correct ranking of compounds in order of increasing K_{eq} for this equilibrium?
- (A) $H_2CO < \text{cyclohexanone} < CH_3CHO < 2\text{-methylcyclohexanone}$
- (B) $CH_3CHO < 2\text{-methylcyclohexanone} < \text{cyclohexanone} < H_2CO$
- (C) $\text{cyclohexanone} < 2\text{-methylcyclohexanone} < H_2CO < CH_3CHO$
- (D) $\text{cyclohexanone} < 2\text{-methylcyclohexanone} < CH_3CHO < H_2CO$
- (E) $2\text{-methylcyclohexanone} < \text{cyclohexanone} < CH_3CHO < H_2CO$
18. Pyridine typically undergoes electrophilic aromatic substitution _____ rapidly than benzene, and its preferred site of substitution is the _____ - position.
- (A) more, 2
- (B) more, 3
- (C) more, 4
- (D) less, 2
- (E) less, 3
19. Which of the reagents listed below would work best in the following reaction?



- (A) $NaBH_4$
- (B) $LiAlH_4$
- (C) BH_3 - THF
- (D) $LiAl[(OC(CH_3)_3)_3]H$

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(E) none of the above

20. Which of the following statements is true?

(A) two equivalents of Grignard reagent react with acid chlorides to yield tertiary alcohols after hydrolysis.

(B) LiAlH_4 reacts with acid chlorides to yield secondary alcohols after hydrolysis.

(C) $\text{LiAlH}[\text{OC}(\text{CH}_3)_3]_3$ reacts with acid chlorides to yield primary alcohols after hydrolysis.

(D) both A and B

(E) both B and C

21. Mass spectrometry and infrared spectroscopy are complementary techniques. Please indicate what are the WRONG statement below.

(A) Mass spectrometry provides information about the molar mass and formula while infrared spectroscopy helps identify the functional groups in the formula.

(B) Infrared spectroscopy provides information about the molar mass and formula while mass spectrometry helps identify the functional groups in the formula.

(C) Mass spectrometry provides information about the carbon-hydrogen framework while infrared spectroscopy helps identify the functional groups in the framework.

(D) Infrared spectroscopy provides information about the carbon-hydrogen framework while mass spectrometry helps identify the functional groups in the framework.

(E) Non of the above.

22. When (*R*)-2-butanol is treated with TsCl in pyridine, what are the WRONG statement for the product formed.

(A) an achiral compound

(B) a mixture of diastereomers

(C) a racemic mixture

(D) a single enantiomer

(E) none of the above

23. Which of the followings are likely to be found in the product mixture which results when 2,2-dimethyl-3-pentanol is heated in phosphoric acid?

(A) (*E*)-4, 4-dimethyl-2-pentene

(B) (*Z*)-4, 3-dimethyl-2-pentene

(C) 2, 3-dimethyl-2-pentene

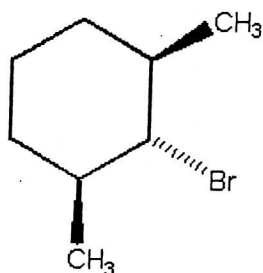
(D) 2, 3-dimethyl-1-pentene

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(E) 4, 4-dimethyl-1-pentene

24. The alkyl halide below is not capable of undergoing an E2 reaction upon treatment with sodium ethoxide. Please indicate the WRONG statement here.



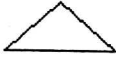
- (A) Br⁻ is too poor a leaving group.
 (B) The substrate is too hindered.
 (C) Too much angle strain would be present in the alkene product.
 (D) Sodium ethoxide is a poor base to use in E2 reactions.
 (E) The C-H and C-Br bonds which need to break cannot achieve an anti-periplanar orientation.
25. Which of the following statements concerning S_N2 reactions of alkyl halides is correct?
 (A) The rate of reaction depends on the concentration of the nucleophile.
 (B) The rate of reaction depends on the concentration of the alkyl halide.
 (C) The rate of reaction of a particular alkyl bromide depends on the steric accessibility of the carbon of the C-Br bond.
 (D) All alkyl iodides react more rapidly than all alkyl chlorides.
 (E) The rate of reaction does not depend on the relative nucleophilicity of the nucleophile.
26. Which of the following bromides reacts readily via an S_N2 reaction with NaN₃?
 (A) C₆H₅CH₂Br
 (B) CH₃CH₂CH=CHBr
 (C) (C₆H₅)₃CBr
 (D) (CH₃)₃CCH₂CH₂CH₂Br
 (E) 1-bromo-1-methylcyclohexane
27. Which of the following statements are appropriate about benzene?
 (A) All of the carbon atoms are sp hybridized.
 (B) It has delocalized electrons.

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- (C) The carbon-carbon bond lengths are not all the same.
 (D) The carbon-hydrogen bond lengths are not all the same.
 (E) All twelve atoms lie in the same plane.

28. Which of the following pairs are NOT resonance structures?

- I. $\text{CH}_2=\text{CHCH}_3$ and 
- II. $\begin{array}{c} \text{CH}_2=\text{C}-\text{H} \\ | \\ \text{:}\ddot{\text{O}}\text{:} \end{array}$ and $\begin{array}{c} \text{CH}_3-\text{C}-\text{H} \\ || \\ \text{:}\ddot{\text{O}}\text{:} \end{array}$
- III. $\begin{array}{c} \text{CH}_3-\text{C}-\text{H} \\ || \\ \text{:}\ddot{\text{O}}\text{:} \end{array}$ and $\begin{array}{c} \text{CH}_3-\overset{\oplus}{\text{C}}-\text{H} \\ | \\ \text{:}\ddot{\text{O}}\text{:}^- \end{array}$
- IV. $\begin{array}{c} \text{CH}_3-\text{C}-\text{H} \\ || \\ \text{O} \end{array}$ and $\begin{array}{c} \text{CH}_3-\overset{\ominus}{\text{C}}-\text{H} \\ | \\ \text{:}\ddot{\text{O}}\text{:}^+ \end{array}$
- V. $\text{CH}_3-\overset{\cdot\cdot}{\underset{\cdot\cdot}{\text{O}}}-\text{CH}_3$ and $\text{CH}_3\text{CH}_2\overset{\cdot\cdot}{\underset{\cdot\cdot}{\text{O}}}\text{H}$

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

29. The reagent needed to convert 2-butyne to *trans*-2-butene is _____.

- (A) H_2/Pt
 (B) $\text{H}_2/\text{Lindlar's catalyst}$
 (C) Li/NH_3
 (D) Na/NH_3
 (E) $\text{H}_2/\text{Pd-Carbon}$

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30. According to the Hammond Postulate, which of the followings are NOT correct?

- (A) The transition state of an endothermic reaction step will be more reactant-like than product-like.

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- (B) The intermediate of an endothermic reaction step will be more reactant-like than product-like.
 (C) The transition state of an exothermic reaction step will be more reactant-like than product-like.
 (D) All transition states are more product-like than reactant-like.
 (E) All transition states are more reactant-like than product-like.

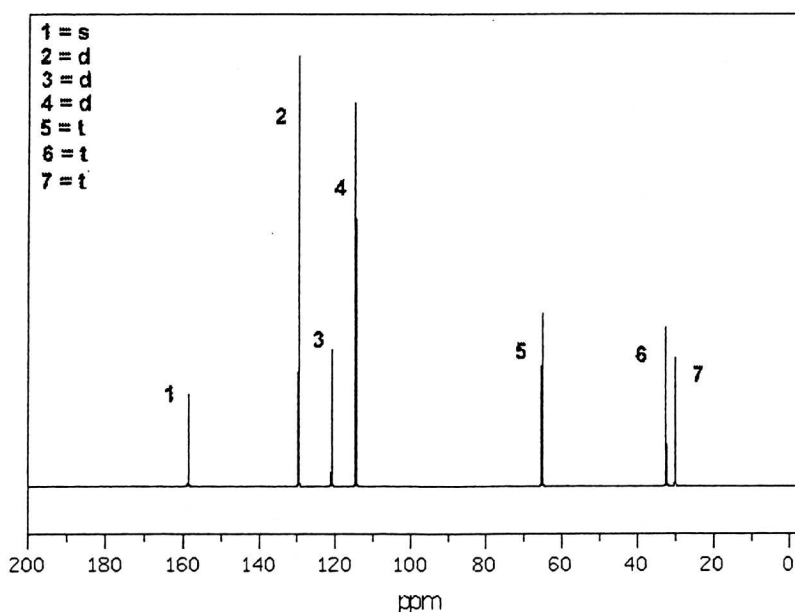
31. Which of the following statement are true for enantiomers?

- (A) They do not have the same melting point.
 (B) They do not have the same boiling point.
 (C) They have the same chemical reactivity with non-chiral reagents.
 (D) They have the same density.
 (E) They have the same specific rotation.

32. Which of the following compounds are not chiral?

- (A) *cis*-1-bromo-3-chlorocyclobutane
 (B) *trans*-1-bromo-3-chlorocyclobutane
 (C) *cis*-1,4-dimethylcyclohexane
 (D) *cis*-1,3-dimethylcyclohexane
 (E) *trans*-1,3-dimethylcyclohexane

33. Which of the structures shown below are NOT consistent with the C-13 NMR (off resonance splitting for each peak is shown as a table within the figure) and H-NMR spectra? (formula = $C_9H_{11}OBr$)

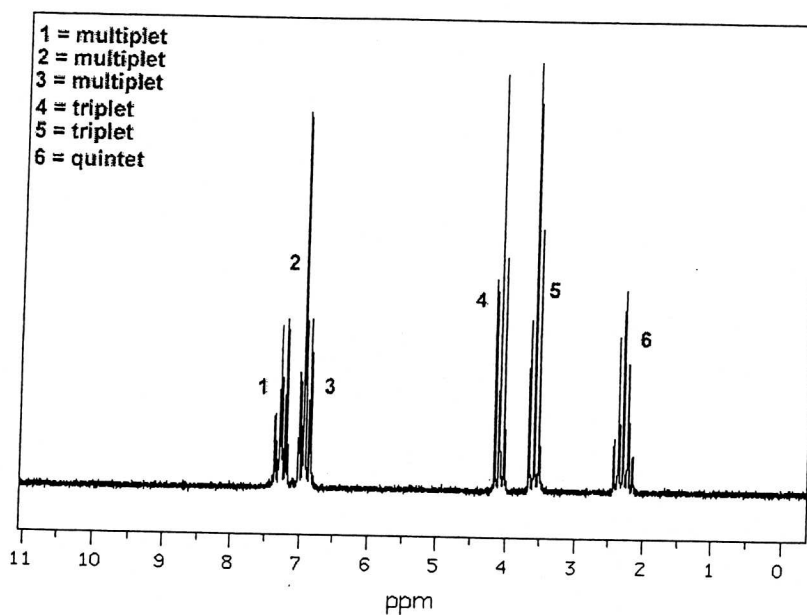


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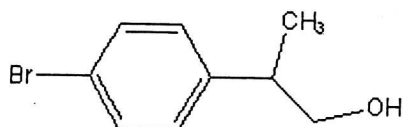
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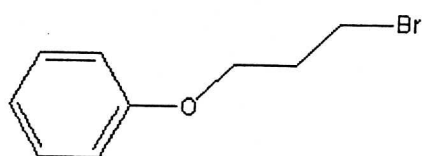
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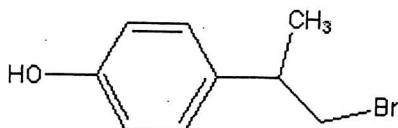
(A)



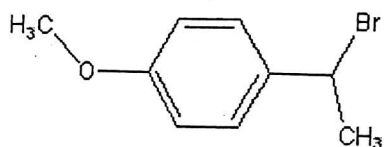
(B)



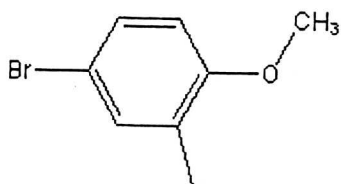
(C)



(D)



(E)



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34. Which of the following alkyl chlorides is likely to undergo rearrangement during a solvolysis reaction?
- (A) 2-chloro-4-methylpentane
(B) 2-chloro-3-methylpentane
(C) 2-chloro-2-methylpentane
(D) *cis*-1-chloro-2-ethylcyclohexane
(E) *trans*-1-chloro-2-ethylcyclohexane
35. Which of the following statements concerning the conformers of butane are not true?
- (A) Unlike ethane, all butane conformers are classified as eclipsed.
(B) The lowest energy conformer of butane is the gauche conformer.
(C) There is more torsional strain in the anti conformer than in the totally eclipsed conformer.
(D) The eclipsed and totally eclipsed conformers have the same amount of nonbonded strain.
(E) The gauche and anti-conformers differ primarily in the amount of nonbonded strain present.
36. Which of the following statements are true?
- (A) in the Michael reaction, addition to the α,β -unsaturated carbonyl occurs in a 1,2-fashion
(B) $\text{CH}_2=\text{CHCN}$ is a nucleophile that does conjugate additions
(C) $\text{PhCH}_2\text{CH}_2\text{CO}_2\text{H}$ results when malonic ester is treated with the following sequence of reagents:
1. $\text{NaOCH}_2\text{CH}_3$; 2. PhCH_2Br ; 3. H_3O^+ , Δ
(D) the approximate pK_a of diethyl malonate is 13
(E) the approximate pK_a of acetone is 10
37. Which of the following statements are true?
- (A) a protein bonded to a fat would be classified as a lipoprotein
(B) snake venom is an example of a protein
(C) a protein bonded to a sugar residue would be classified as a nucleoprotein
(D) dicyclohexylcarbodiimide (DCC), peptide coupling reagent, is most commonly used in solid phase peptide synthesis
(E) The solid-phase method of peptide synthesis was devised by Merrifield
38. Which of the following statements are wrong?
- (A) 5 CO_2 and 6 H_2O are needed to make a molecule of glucose in photosynthesis
(B) a diastereomer is called erythro if its Fischer projection shows similar groups on opposite sides of the molecule on adjacent carbons
(C) stereoisomeric aldohexoses that differ in configuration at only a single carbon are epimers

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- (D) D-erythrose and D-threose represents a pair of epimers
 (E) the structural relationship between D-gulose and L-gulose is enantiomer

39. Which of the following statements are wrong?

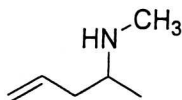
- (A) a nitrile can be made by dehydrating an amide. However, for this reaction to occur, the amide must be N-methylated
 (B) PhNHCHO can be made from benzene by a sequence of 1. HNO₃, H₂SO₄ 2. (HCO)₂O
 (C) pentanamide can be converted to 1-pentanamine by LiAlH₄
 (D) both acetyl chloride and acetic anhydride can react with aniline to yield acetanilide
 (E) CH₃CH₂CH(CH₃)CH₂CO₂CH₃ will be the major organic product in the reaction of 3-methylpentanoic acid with CH₂N₂

40. Which of the following statements are wrong?

- (A) NaOCl can be used to convert a carboxylic acid directly into its corresponding acid chloride derivative
 (B) esters and amides are most easily made by nucleophilic acyl substitution reactions on carboxylic acids
 (C) vinyl lithium would react with acetic acid to form 2-butanone
 (D) the conversion of butanoic acid to 2-pentanone is best accomplished with 1. thionyl chloride; 2. methanol
 (E) LiAl [OC(CH₃)₃]₃H will reduce an acid chloride to an aldehyde

41. Which of the following statements are correct?

- (A) the IUPAC name for the following amine is 2,N-dimethyl-1-penten-4-amine



- (B) N,N-dimethylaniline is a tertiary amine
 (C) in the mass spectrum of dipropylamine, the base peak appears at *m/z* 72
 (D) a three-carbon, nitrogen-containing compound exhibits three ¹³C NMR peaks (δ 11.2, 27.3, and 44.9 ppm). This compound can be CH₃CH₂CH₂NH₂
 (E) when pyridine is treated with a mixture of nitric and sulfuric acids, the major product is 3-nitropyridine

42. Which of the following statements are correct?

- (A) the following represents the correct ranking in terms of increasing boiling point: *n*-butane <

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2-butanone < diethyl ether < 1-butanol

(B) 2-pentanone would show only one triplet in its off resonance decoupled ^{13}C NMR spectrum

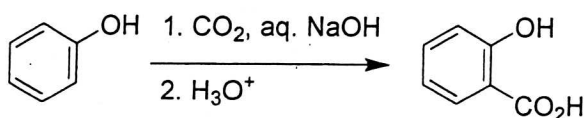
(C) n to π^* transitions is usually observed in the UV spectra of ketones

(D) 1. O_3 ; 2. $(\text{CH}_3)_2\text{S}$ can be used to convert 1-hexyne into 2-hexanone

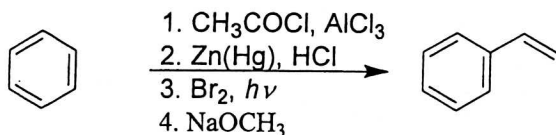
(E) both 2-pentanone and 2-phenylethanal may be made from 1,3-dithiane

43. Which of the following syntheses are correct?

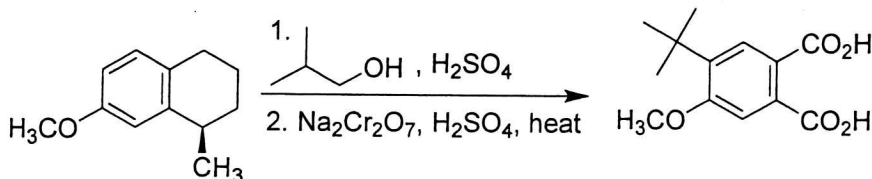
(A)



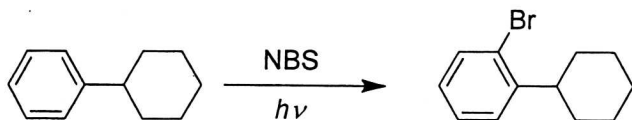
(B)



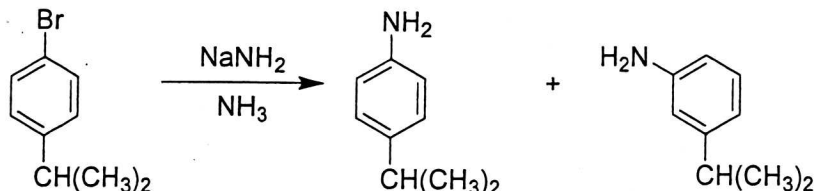
(C)



(D)



(E)



44. Which of the following statements are true?

(A) 2 peaks are in the proton spin decoupled ^{13}C NMR spectrum of 1,3,5-trinitrobenzene

(B) mesitylene is also an acceptable name for 1,3,5-trimethylbenzene

(C) three distinct isomers are possible for trichlorobenzene

(D) benzofuran is a fused-ring heterocycle


(E) pentalene is an aromatic molecule

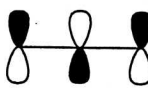
注意:背面有試題

※請在答案卡內作答

45. Which of the following statements are true?

- (A) in the allyl radical, the antibonding π molecular orbital is singly occupied
- (B) 2 electrons are present in the nonbonding π molecular orbital of the allyl cation
- (C) 3 electrons populate the π molecular orbitals of the allyl radical

(D) the HOMO of pentadienyl anion is 

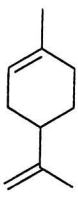
(E) the antibonding π molecular orbital of the allyl cation is 

46. Which of the following statements are true?

- (A) sodium (*S*)-2-butoxide + iodoethane would produce (*R*)-2-ethoxybutane
- (B) heating a mixture of ethanol and *t*-butanol in sulfuric acid is an acceptable way to synthesize *t*-butyl ethyl ether
- (C) the Williamson ether synthesis occurs by the S_N1 mechanistic pathway
- (D) when cyclohexene is subjected to mercuration in methanol and the resulting mixture is reduced with sodium borohydride, the major organic product is a meso ether
- (E) iodobenzene and methanol are the expected products of the reaction of PhOCH_3 with concentrated HI

47. Which of the following statements are true?

- (A) camphor is an example of a terpene
- (B) terpenes which contain two isoprene units are called monoterpenes
- (C) 2 isoprene units can be found in geranial
- (D) the C:H ratio present in most terpenes is 1:2

(E)  is a diterpene

48. Which of the following structural features are typically found in a prostaglandin?

- (A) a carboxyl group
- (B) a 5-membered ring
- (C) a hydroxyl group
- (D) a carbon-carbon double bond

類組：化學類 科目：有機化學(1002)共 17 頁 第 17 頁※請在答案卡內作答

(E) an amino group

49. Which of the following statements are true?

- (A) $(\text{PhCO}_2)_2$ is an initiator for a free-radical polymerization
- (B) water pipes are commonly manufactured from poly(vinyl chloride)
- (C) if the side groups of a polymer chain are generally on the same side of the polymer backbone, the polymer is called syndiotactic
- (D) sulfur is necessary to the vulcanization of rubber
- (E) the T_g of a polymer is its gum transition temperature

50. Which of the following syntheses can produce carboxylic acid?

- (A) oxidation of primary alcohols and aldehydes with chromic acid
- (B) cleavage of an terminal alkene with hot KMnO_4
- (C) cleavage of an alkyne with ozone or hot permanganate
- (D) oxidation of alkyl benzene by hot KMnO_4
- (E) reaction of Grignard reagent with water