《化學》

I. Choose one correct answer for the following questions

【單選題】每題 1 分，共計 60 分，答錯一題倒扣 0.25 分，倒扣至本大題零分爲止，未作答，不給分不扣分。

(D)1.

If the equilibrium constant for A + B $\rightleftharpoons$ C is 0.123, then the equilibrium constant for 2C $\rightleftharpoons$ 2A + 2B is _____.

(A) 1.00-2(0.123) (B) 8.13 (C) 0.123

(D) 66.1 (E) 16.3

(E)2. Consider the following rate law: Rate = k $[A]^n[B]^m$.

How are the exponents *n* and *m* determined?

(A) By using the balanced chemical equation

(B) By using the subscripts for the chemical formulas

(C) By using the coefficients of the chemical formulas

(D) By educated guess

(E) By experiment

(D)3. How many oxygen atoms are there in one formula unit of $Ca_3(PO_4)_2$?

(A) 2 (B) 4 (C) 6

(D) 8 (E) none of these

(B)4. An unknown substance dissolves readily in water but not in benzene (a nonpolar solvent). Molecules of what type are present in the substance?

(A) neither polar nor nonpolar (B) polar (C) either polar or nonpolar

(D) nonpolar (E) none of these

(A)5. Which of the species below, when dissolved in H_2O, will not produce a basic solution?

(A) SO_2 (B) NH_3 (C) BaO

(D) $Ba(OH)_2$ (E) none of these

(B)6. $CaCl_2(s)+2H_2O(g) \rightleftharpoons CaCl_2 \cdot 2H_2O(s)$

Consider the reaction:
The equilibrium constant for the reaction as written is _____.
(A) $K=[CaCl_2 \cdot 2H_2]/([CaCl_2][H_2O]^2)$ (B) $K=1/[H_2O]^2$ (C) $K=1/2[H_2O]$
(D) $K=[H_2O]^2$ (E) $K=[CaCl_2 \cdot 2H_2O]/[H_2O]^2$

(D)7. Which of the following concentration measures will change in value as the temperature of a solution changes?
(A) mass percent (B) mole fraction (C) molality
(D) molarity (E) all of these

(A)8. A solution containing 296.6g of $Mg(NO_3)_2$ per liter has a density of 1.114 g/mL. The molarity of the solution is:
($Mg(NO_3)_2$:148.3 g/mol).
(A) 2.000 M (B) 2.446 M (C) 6.001 M
(D) 1.805 M (E) none of these

(D)9. Calculate the molality of C_2H_5OH in a water solution that is prepared by mixing 50.0 mL of C_2H_5OH with 100.0 mL of H_2O at 20℃. The density of the C_2H_5OH is 0.789 g/mL at 20℃. (C_2H_5OH: 46.07 g/mol. Density of H_2O is 1 g/cm^3).
(A) 0.086 m (B) 0.094 m (C) 1.24 m
(D) 8.56 m (E) none of these

(B)10. Which statement about N_2 is false?
(A) It is a gas at room temperature.
(B) The oxidation state is +3 on one N and -3 on the other.
(C) It has one sigma and two pi bonds between the two atoms.
(D) It can combine with H_2 to form NH_3.
(E) It has two pairs of nonbonding electrons.

(C)11. Which of these statements about benzene is true?
(A) All carbon atoms in benzene are sp^3 hybridized.
(B) Benzene contains only π bonds between C atoms.
(C) The bond order of each C—C bond in benzene is 1.5.
(D) Benzene is an example of a molecule that displays ionic bonding.
(E) All of these statements are false.

(D)12. When electrons in a molecule are not found between a pair of atoms but move throughout the molecule, this is called _____.
(A) ionic bonding
(B) covalent bonding
(C) polar covalent bonding

(D) delocalization of the electrons

(E) a dipole moment

(B)13. Which one of the following descriptions for microelectrodes is incorrect?

(A) The dimensions of such electrodes are usually smaller than about 20 μm.

(B) The IR (current × resistance) drop of microelectrodes is higher than traditional electrodes.

(C) Such electrodes can be used for the study of chemical processes in single cells.

(D) They are also called ultramicroelectrodes or microscopic electrodes.

(E) By using such electrodes, three electrodes system is not necessary.

(A)14. Which one of the following descriptions about GC (gas chromatography) is correct?

(A) In GC, the stationary phase is liquid or solid, the mobile phase is gas.

(B) It can only be applied for gaseous samples.

(C) In order to obtain a complete separation, different gaseous mixtures are purged into the column successively.

(D) GC is not an efficient separation technique.

(E) All of these are correct.

(D)15. Which one of the following detectors is not used for HPLC (high-performance liquid chromatography)?

(A) Absorbance detectors

(B) Fluorescence detectors

(C) Electrochemical detectors

(D) Flame ionization detectors

(E) Mass spectrometers

(B)16. Which one of the following descriptions about CE (capillary electrophoresis) is incorrect?

(A) Electrophoresis is a separation technique based on the different migration rates of charged species.

(B) It cannot be used to separate proteins and nucleic acids.

(C) Its particular strength is the unique ability to separate charged macromolecules.

(D) Until the appearance of CE, electrophoretic separations were not carried out in columns.

(E) Most of the detectors used for HPLC can be employed for CE.

(B)17. The pH meter is widely used for measuring the H^+ concentrations in the solutions. Which one of the following descriptions for a pH is incorrect?

(A) The sensing material is a special thin glass membrane at the tip of the electrode.

(B) No reference electrode is required for a pH meter.

(C) The real signal obtained from the pH meter is voltage (or difference of potentials).

(D) In basic solutions, the indicator electrode also responds to alkali metal ions.

(E) pH meters can be used to determine the equivalence point of the acid-base titration.

(D)18. Atomic spectrometer is widely applied for the analysis of various elements. Which one of the following is not an atomization method used for most atomic spectrometer?
(A) Flame
(B) Inductively coupled plasma
(C) Electrothermal oven
(D) Laser
(E) Electric spark

(B)19. A method of separation that employs a system with two phases of matter, a mobile phase and a stationary phase, is
called _____.
(A) filtration (B) chromatography (C) distillation
(D) vaporization (E) homogenization

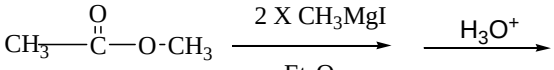
(A)20. A solution is also called a _____.
(A) homogeneous mixture (B) heterogeneous mixture
(C) pure mixture (D) compound (E) distilled mixture

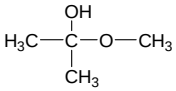
(C)21. Which one of the following descriptions for the Beer's law is incorrect?
(A) Beer's law is ordinarily represented as $A = \varepsilon bs$.
(B) For a mixture, the total absorbance at a λ =the sum of individual absorbance if there is no intermolecular interaction.
(C) Beer's law is more suitable for concentrated solutions.
(D) Negative deviations are always observed if polychromic radiations are used.
(E) The b term in the equation of item (a) means the optical length.

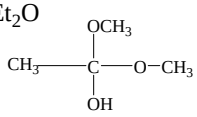
(D)22. Buffer solutions are very important for many analytical applications. Which one of the following descriptions about buffer solutions is incorrect?
(A) Buffer solutions are generally from conjugate acid/base pairs.
(B) Buffer solutions can resist to changes of pH when the solutions are diluted or added with strong acids or bases.
(C) The buffer capacity is the measurement of ability that resists to pH changes.
(D) The buffer capacity of a solution is determined by the strength of the conjugate acid/base pair.
(E) The pH of a buffer solution can be determined by $pH=pK_a + \log([base]/[acid])$.

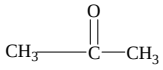
(D)23. Which one of the following apparatuses is not used for measurement of volume?
(A) Volumetric (B) Pipet (C) Buret
(D) Test tube (E) All of these are used for measurement of volume.

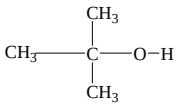
(D)24. What is the major product of the following reaction?



(A) 

(B) 

(C) 

(D) 

(E) None of the above

(B)25. Which one of the following molecular formulae can represent a pair of mirror image isomers?

(A) H_2NCH_2COOH

(B) $H_2NCH(CH_3)COOH$

(C) $H_2NCH_2CH_2COOH$

(D) $H_2NCH_2COOCH_3$

(E) $(CH_3)_2CHCOOH$

(E)26. A chain reaction is one that :

(A) involves a series of steps

(B) involves two steps with similar energies of activation

(C) is initiated by heat

(D) requires the addition of an external terminating agent

(E) involves a reaction in which the propagation steps also produce the product and initiator necessary for another propagation cycle

(D)27. Which statement best describes 1,3-butadiene?

(A) 1,3-butadiene is less stable than 1,4-pentadiene due to steric crowding.

(B) 1,3-butadiene is more stable than 1,4-pentadiene because of less steric crowding.

(C) 1,3-butadiene is less stable than two molecules of 1-butene.

(D) 1,3-butadiene is more stable than 1,4-pentadiene due to resonance energy.

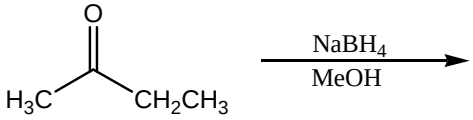
(E) 1,3-butadiene's carbon atoms are sp^3 hybridized.

(C)28. Which is the general formula for cyclic hydrocarbons with one double covalent bond between adjacent atoms?

(A) C_nH_{2n+2} (B) C_nH_{2n} (C) C_nH_{2n-2}

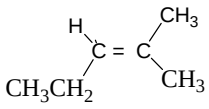
(D) C_nH_{2n-4} (E) C_nH_{2n-6}

(C)29. What is the major product of the following reaction?



(A) (S) 2-butanol (B) (R)2-butanol (C) racemic mixture of 2-butanol
(D) e.e of (S)-butanol (E) diastereomeric mixture of 2-butanol

(D)30. How many absorptions will the following compound have in its carbon NMR spectrum?

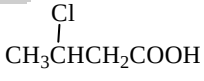


(A) 3 (B) 4 (C) 5
(D) 6 (E) 7

(B)31. The pinacol rearrangement proceeds via _____ intermediate.
(A) carbanion (B) carbocation (C) radical
(D) lone pair (E) neutral

(E)32. Rank the following compounds with respect to increasing acidity (least acidic to most acidic).

1



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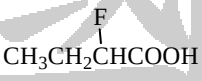

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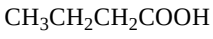

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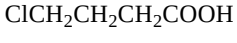
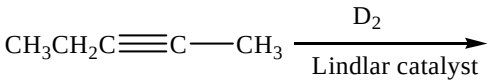
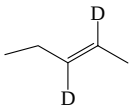
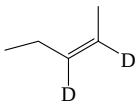
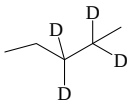


5

(A) 3<1<2<5<5 (B) 4<3<1<2<5 (C) 4<3<1<2<5
(D) 5<2<1<3<4 (E) 4<5<2<1<3

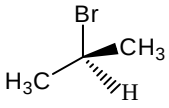
(B)33. What is the product of the following reaction:



(A)  (B)  (C) 

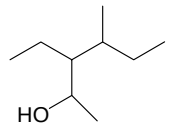
(D) All of the above (E) Pentane

(C)34. What is the stereochemistry of the following compound:



(A) R-form (B) S-form (C) not chiral
(D) meso compound (E) racemic mixture

(A)35. What is the name of the compound whose line drawing is shown below?



(A) 3-ethyl-4-methyl-2-hexanol
(B) 4-ethyl-3-methyl-5-hexanol
(C) 3,4-diethyl-2-pentanol
(D) 2,3-diethyl-4-pentanol
(E) 3-iso-buty1-2-pentanol

(B)36. Which of the following statements is **correct**?
(A) Alkenes have only sp^2 hybridised carbon atoms.
(B) Alkenes will react with ozone to give carbonyl compounds.
(C) Amines can react with carboxylic acids to give esters.
(D) Tertiary alcohols will oxidise to ketones.
(E) Bromobenzene will undergo an SN_2 substitution reaction

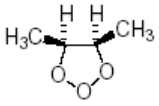
(B)37. Which of the following alkyl bromides will undergo the SN_2 reaction the fastest?
(A) Bromobenzene (B) Butyl bromide
(C) *tert*-Butyl bromide (D) *iso*-butyl bromide
(E) 1-Bromo-4-nitrobenzene

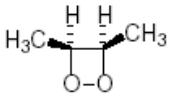
(C)38. What is the normality of a solution containing 49g of of H_3PO_4 in 2,000 mL, of solution?
(A) 0.25 N (B) 0.50 N (C) 0.75 N
(D) 1.00 N (E) 1.50 N

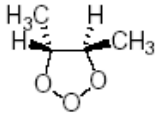
(D)39. The K_a values for HSO_4^- and $H_2PO_4^-$ are 1.2×10^{-2} and 6.3×10^{-8} respectively. Therefore it follows the HSO_4^- is a _____ acid than $H_2PO_4^-$ and SO_4^{2-} is a _____ base than HPO_4^{2-}.
(A) weaker, weaker (B) stronger, stronger
(C) weaker, stronger (D) stronger, weaker
(E) cannot be predicted

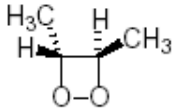
(E)40. Determine the empirical formula of polystyrene which is 92.3% C and 7.7% H. (Atomic weights: C = 12.01, H = 1.008).
(A) CH_3 (B) CH_2 (C) C_2H
(D) C_2H_3 (E) CH

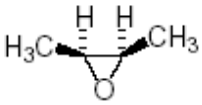
(C)41. Give the intermediate that is formed in the ozonolysis reaction of (*E*)-2-butene.

(A) 

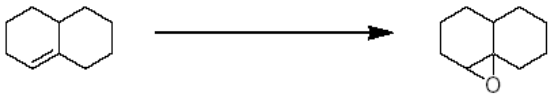
(B) 

(C) 

(D) 

(E) 

(C)42. Give the reagent(s) that would best accomplish the following transformation.



(A) CH_3COOH (B) MnO_2 (C) mCPBA

(D) NBS (E) AIBN

(B)43. The acid present in vinegar is _____.

(A) Ethanol (B) Ethanoic acid (C) Formic acid

(D) Benzoic acid (E) Hydrochloric acid

(E)44. Which of the following dissolved in water to form acid rain?

(A) H_2SO_4 (B) HCl(g) (C) NO_2(g)

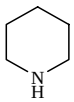
(D) Cl_2 (g) (E) SO_3 (g)

(C)45. The compound, 2-methy1-2-propanol, is an isomer of _____.

(A) butane (B) propane (C) butanol

(D) propanol (E) methanol

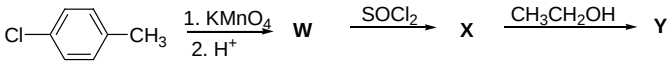
(C)46. What is the name of the following amine?

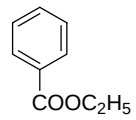


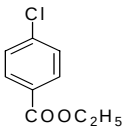
(A) Pyridine (B) Pyrrole (C) Piperidine

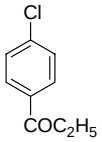
(D) Pyrimidine (E) Pyrrolidine

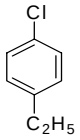
(B)47. Which structure best fits compound Y produced by the following series of reactions starting with p-chlorotoluene?

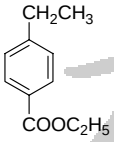


(A) 

(B) 

(C) 

(D) 

(E) 

(B)48. Choose the statement that is true concerning nitrobenzene and electrophilic aromatic substitution.

(A) Activate the benzene ring at meta-position

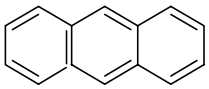
(B) Deactivate the benzene ring at the ortho and para-positions

(C) meta-Position of benzene ring most deactivated

(D) Activate the ortho-position only

(E) Activate the para-position only

(B)49. Which of the following are antiaromatic?

(A) 

(B) 

(C) 

(D) 

(E) None of the above

(A)50. In the experiment, which of the following would have been removed by washing the solution with sodium carbonate?

(A) Phthalic acid (B) Methylbenzoate

(C) Aniline (D) Nitrobenzene

(E) N-Phenylphthalimide

(A)51. For Diels-Alder cycloaddition reactions to take place most rapidly and in highest yield the dienophile must:

(A) be substituted with electron-withdrawing groups

(B) be able to adopt and s-trans conformation

(C) be substituted with electron-donating groups

(D) be able to adopt an s-cis consformation

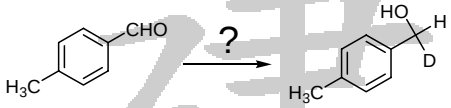
(E) none of the above

(D)52. 2-Chloro-1, 3-butadiene is polymerized to yield an excellent, expensive synthetic rubber with good weather resistance called:

(A) Chloroprene (B) Isoprene (C) Polystyrene

(D) Neoprene (E) none of the above

(B)53. Which of the following reagents is best used for conversion show below?



(A) 1. $NaBH_4$, 2. D_3O^+ (B) 1. $NaBD_4$, 2. H_3O^+

(C) 1. $LiAlH_4$, 2. D_3O^+ (D) 1. $LiAlH_4$, 2. H_3O^+

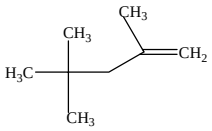
(E) 1. $NaBH_4$, 2. H_3O^+

(E)54. The mass spectra of alcohols often fail to exhibit detectable M peaks but instead show relatively large _____ peaks.

(A) M+1 (B) M+2 (C) M-15

(D) M-16 (E) M-18

(D)55. The following compound is used as an additive in gasoline to improve its octane value:



Which of the following is a correct IUPAC name for this compound:

(A) 2,2,4-trimethyl-1-pentene

(B) 2,2,4-trimethyl-2-pentene

(C) 2,2,4-trimethyl-5-pentene

(D) 2,4,4-trimethyl-1-pentene

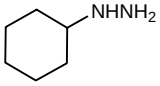
(E) 2,4,4-trimethyl-2-pentene

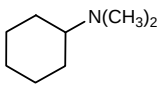
(E)56. Which of the following amines will react with cyclopentanone to form an enamine?

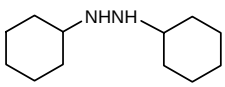
(A) $CH_3(CH_2)_3NH_2$ (B) $(CH_3)_3N$ (C) pyridine

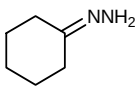
(D) $(CH_3)_3CNH_2$ (E) none of the above

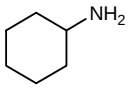
(D)57. Which of the following compounds is a hydrazone?

(A) 

(B) 

(C) 

(D) 

(E) 

(A)58. Which of the following statements describes the first step in the mechanism of the aldol condensation?

(A) An alpha hydrogen is abstracted by the base to from an enolate anion.

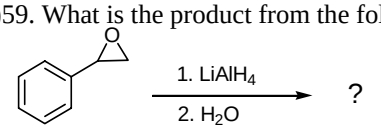
(B) A nucleophilic base attacks the carbony1 carbon atom.

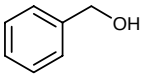
(C) The carbonyl oxygen is protonated by the base ion.

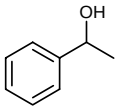
(D) An alpha hydrogen is abstracted by an acid to the enolate anion.

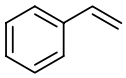
(E) none of above.

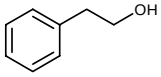
(B)59. What is the product from the following reaction?



(A) 

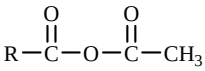
(B) 

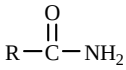
(C) 

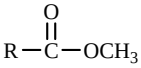
(D) 

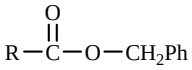
(E) none of the above

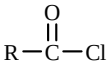
(B)60. Which of the following compounds is hydrolyzed most slowly in aqueous NaOH?

(A) 

(B) 

(C) 

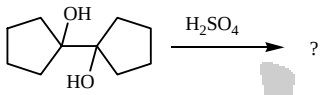
(D) 

(E) 

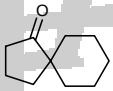
II. Choose one correct answer for the following questions

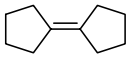
【單選題】每題 2 分，共計 40 分，答錯一題倒扣 0.5 分，倒扣至本大題零分爲止，未作答，不給分不扣分。

(A)61. What is the major product of the following reaction?



(A) 

(B) 

(C) 

(D) 

(E) none of the above.

(B)62. Which of the following is the best method for preparing N-benzylpyrrolidine from benzoic acid?

(A) I). Pyrrolidine; II) $SOCl_2$; III). 1. LAH; 2. H_2O

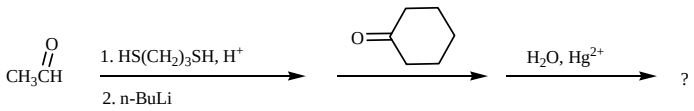
(B) I). $SOCl_2$; II). Pyrrolidine; III). 1. LAH; 2. H_2O

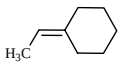
(C) I). 1. LAH; 2. H_2O; II). $SOCl_2$; III). Pyrrolidine

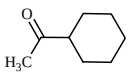
(D) I). $SOCl_2$; II). 1. LAH; 2. H_2O; III). 1. Pyrrolidine

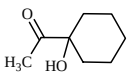
(E) None of the above

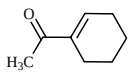
(C)63. What is the major product of the following conversions?

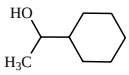


(A) 

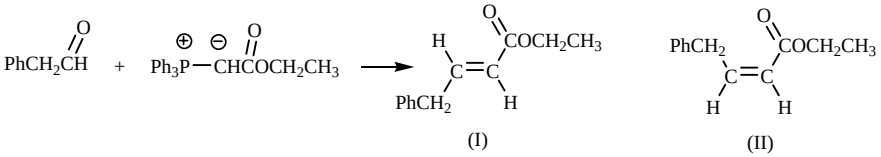
(B) 

(C) 

(D) 

(E) 

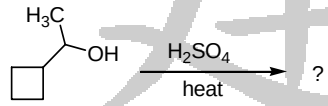
(A)64. What is the major product of the following reaction?



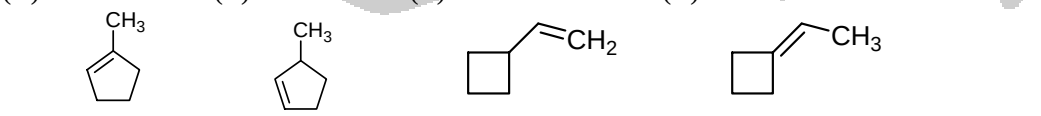
(I) (II)

(A) Only (I) is formed
(B) Only (II) is formed
(C) (I) is major product
(D) (II) is major product
(E) (I):(II) = 50:50

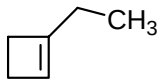
(A)65. What is the product of the following reaction?



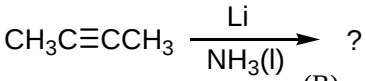
(A) (B) (C) (D)



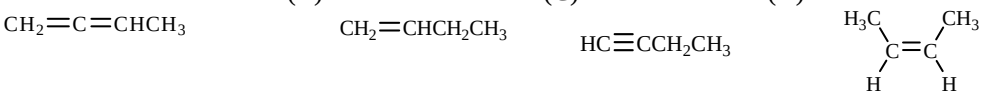
(E)



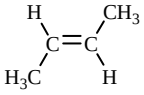
(E)66. What is the major product from this reaction?



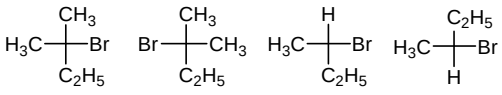
(A) (B) (C) (D)



(E)



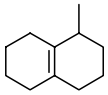
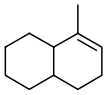
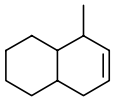
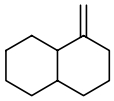
(D)67. Which Fischer projections represent pair of enantiomers?

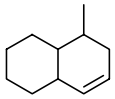


(I) (II) (III) (IV)

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

(A)68. Which constitutional isomer has the lowest heat of hydrogenation?

(A)  (B)  (C)  (D) 

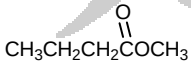
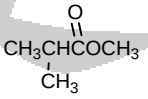
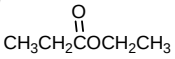
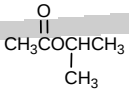
(E) 

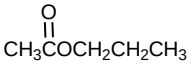
(D)69. Which compound would provide the following 1H-NMR spectrum?

Multiplet at 5.01 ppm (1H)

Singlet at 2.04 ppm (3H)

Doublet at 1.25 ppm (6H)

(A)  (B)  (C)  (D) 

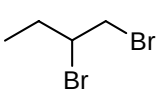
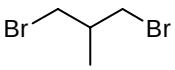
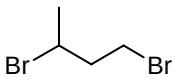
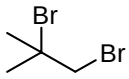
(E) 

(D)70. An unknown compound, $C_4H_8Br_2$, gave the following NMR spectrum:

Singlet at 1.97 ppm (6H)

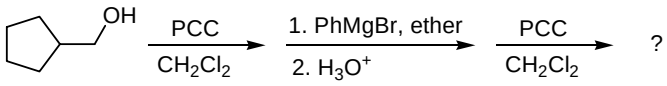
Singlet at 3.89 ppm (2H)

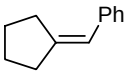
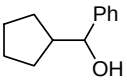
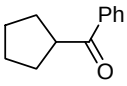
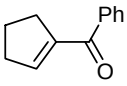
What is the structure of the compound?

(A)  (B)  (C)  (D) 

(E) none of the above

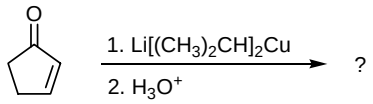
(C)71. What is the major product of the following conversions?

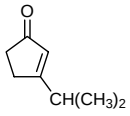


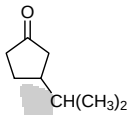
(A)  (B)  (C)  (D) 

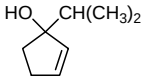
(E) none of the above

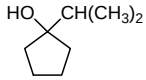
(B)72. What is the major organic product of the following reaction?



(A) 

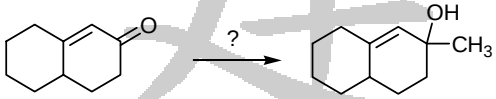
(B) 

(C) 

(D) 

(E) none of the above

(B)73. What reagent(s) would you use to accomplish the following conversion?



(A) CH_3Br, H_3O^+

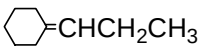
(B) CH_3MgBr, H_3O^+

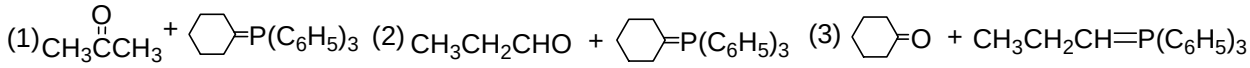
(C) $(CH_3)_2CuLi$, H_3O^+

(D) CH_3Br, $LiAlH_4$, H_3O^+

(E) CH_3MgBr, $LiAlH_4$, H_3O^+

(D)74. What carbonyl compound and what phosphonium ylide are required for the synthesis of the following alkene?

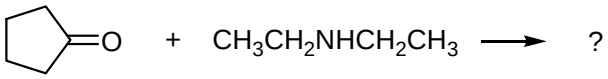


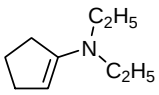


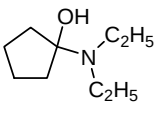
(A) only (1) (B) only (2) (C) only (3)

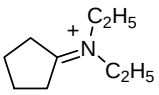
(D) (2) and (3) (E) (1),(2),and (3).

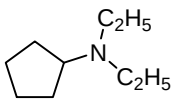
(A)75. What is the major organic product of the following reaction?

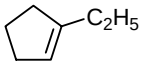


(A) 

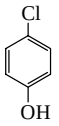
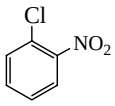
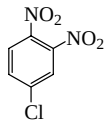
(B) 

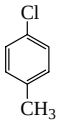
(C) 

(D) 

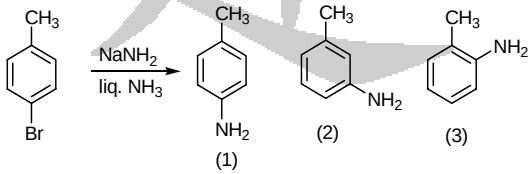
(E) 

(D)76. Which of the following is most reactive toward nucleophilic aromatic substitution?

(A)  (B)  (C)  (D) 

(E) 

(D)77. What are the products of the following reaction?



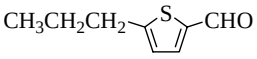
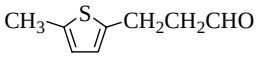
(A) only (1) (B) only (2) (C) only (3)

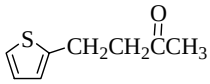
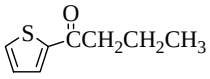
(D) (1) and (2) (E) (2) and (3)

(D)78. An unknown compound has the formula $C_8H_{10}OS$, and is known to contain a thiophene ring. The proton NMR spectrum of this compound is:

0.98, triplet, 3H; 1.74, multiplet, 2H; 2.80, triplet, 2H; 7.40, multiplet, 1H; 7.55, multiplet, 2H.

What is the structure of this compound?

(A)  (B) 

(C)  (D) 

(E) none of the above.

(A)79. Deduce the identity of the compound from the data provide.

$C_5H_8O_4$:

IR (cm^{-1}): 2800-3300 (broad), 2950, 1740

^{13}C NMR (δ, splitting): 17.3 (quartet), 44.3 (singlet), 210.5 (singlet).

(A) $HO_2CC(CH_3)_2CO_2H$.

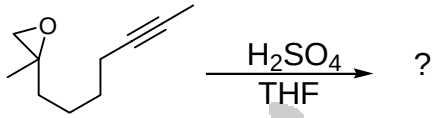
(B) $CH_3O_2CCH_2CO_2CH_3$.

(C) $HO_2CCCH_2CH_2CH_2CO_2H$.

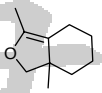
(D) $CH_3O_2CCH_2CH_2CO_2H$.

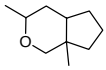
(E) $CH_3O_2CCO_2CH_2CH_3$.

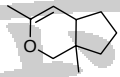
(B)80. What is the major organic product of the following reaction?



(A) 

(B) 

(C) 

(D) 

(E) none of the above