

國立清華大學 101 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、醫學生物科技學程

考試科目（代碼）：有機化學(0502、0706)

共__10__頁，第__1__頁

*請在【答案卷】作答

單選題：

(20%, 2% each)

- Which of the following species behaves as a nucleophile?
(A) CH_4 (B) H^+ (C) H_2O
(D) Fe^{3+} (E) Br^+
- What is the net charge of the peptide Arg-Phe-Gly-Lys-Glu at pH 7?
(A) +2 (B) +3 (C) -2
(D) +1 (E) -3
- Which of the following chromatography is suitable for separation of proteins with charges?
(A) exclusion (B) size (C) affinity
(D) ion exchange (E) gel filtration
- Which of the following terms is equal to the pH at the midpoint of an acid/base titration?
(A) The pK of the corresponding acid
(B) The pK of the corresponding base
(C) 14 minus the pK of the corresponding acid
(D) 14 plus the pK of the corresponding base
(E) None of the above
- Which of the following chromatography is suitable for separation of proteins with charges?
(A) exclusion (B) size (C) affinity
(D) ion exchange (E) gel

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6. 82 g of a compound was completely burned in the presence of oxygen. The products were 17.1 g of carbon dioxide and 10.5 g of water. What is the empirical formula for this compound?
- (A) C_nH_{2n-2} (B) C_nH_{2n} (C) C_nH_{2n+2}
(D) $C_nH_{2n}O$ (E) $C_nH_{2n+2}O$
7. If white light is passed through a solution containing a substance that absorbs very strongly but only within the band $4800 \pm 300 \text{ \AA}$, what color do you expect to perceive?
- (A) violet (B) green (C) orange
(D) yellow (E) red
8. What is the name of compound $CH_2=CH-CH_2-B(CH_3)_2$?
- (A) boroxine (B) borazine (C) allyldimethylborane
(D) 1,1-dimethylborane (E) dimethylaminodimethylborane
9. Which names of the following organosilicon compounds are correct?
- I. $(C_6H_5)_4Si$ tetraphenylsilane II. $(CH_3)_3SiOSiH_3$ siloxytrimethylsilane
III. $CH_3SiH_2NH_2$ methylsilazane IV. $(C_6H_5)_2Si(OH)_2$ diphenylsilanediol
(A) I, II (B) I, III (C) II, IV (D) I, III, IV (E) I, II, III, IV
10. Hydrolysis of neutral compound (X), $C_5H_{10}O_2$, gives an acid (Y) and an alcohol (Z). Z reacts with PCl_3 and is then treated with Mg. Addition of CO_2 followed by hydrolysis, yields an acid identical (Y). What is the structural formula of Y?
- (A) CH_3CH_2COOH (B) CH_3CH_2OH (C) $CH_3CH_2CH_2COOH$
(D) $CH_3CH_2CH_2OH$ (E) $CH_3CH_2CH_2CH_2COOH$

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共 10 頁，第 3 頁

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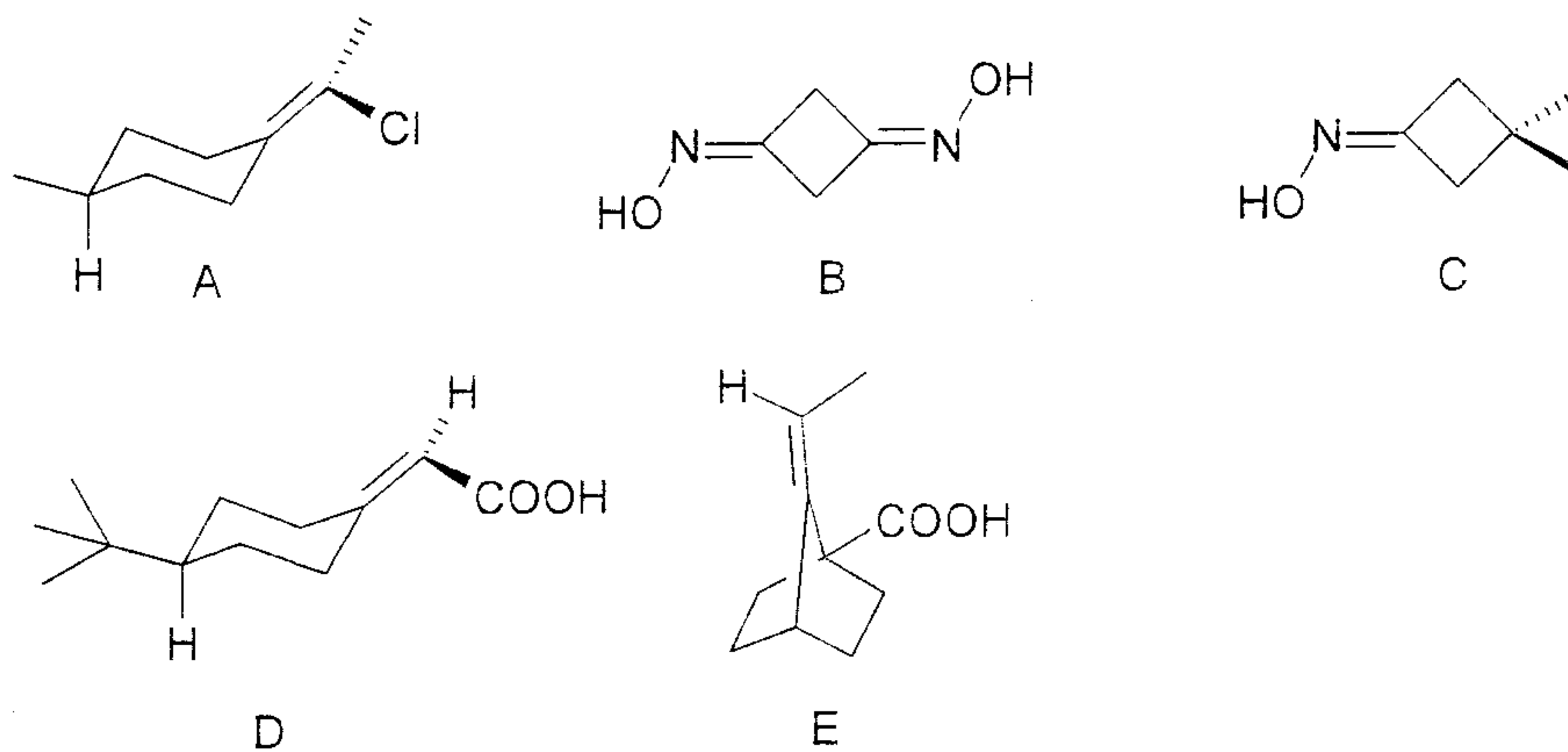
複選題：

(10%. 2% each)

1. Which of the following species is amphoteric?

- (A) H_2O (B) NH_2 (C) NH_4^+
(D) Cl^- (E) HF

2. Which of the following species is chiral?



3. Which of the following statements is correct?

- (A) There are two broad classes of stereoisomers.
(B) Achiral molecules cannot possess chiral centers.
(C) A reaction catalyzed by an enzyme always gives an optically active product.
(D) Racemization of an enantiomer must result in breaking of at least one bond to the chiral center.
(E) An attempted resolution can distinguish a racemate from a *meso* compound.

4. Which of the following statements is correct?

- (A) All substances with chiral atoms are optically active and resolvable.
(B) Enantiomers possible in molecules that do not have chiral carbon atoms.
(C) A prochiral carbon can be primary or tertiary.
(D) Conformational enantiomers can be resolved.
(E) All molecules with stereogenic centers are chiral.

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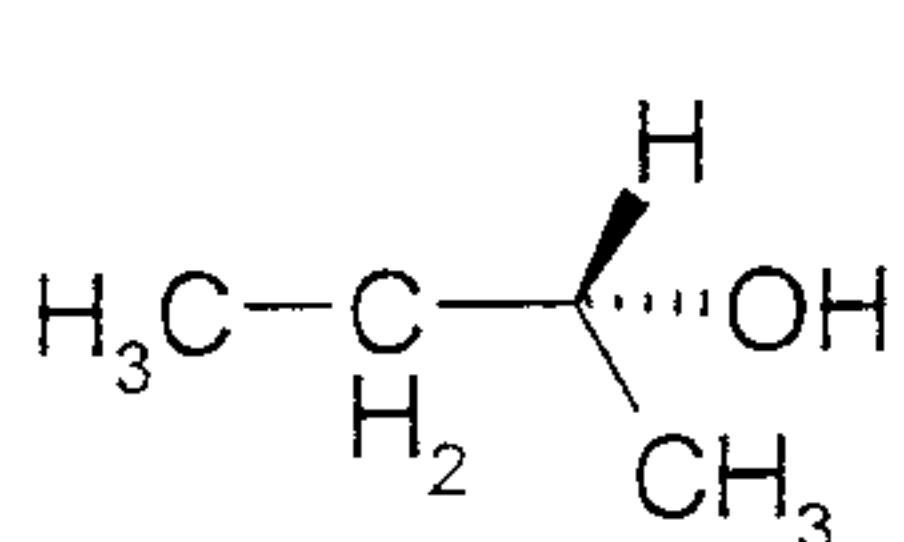
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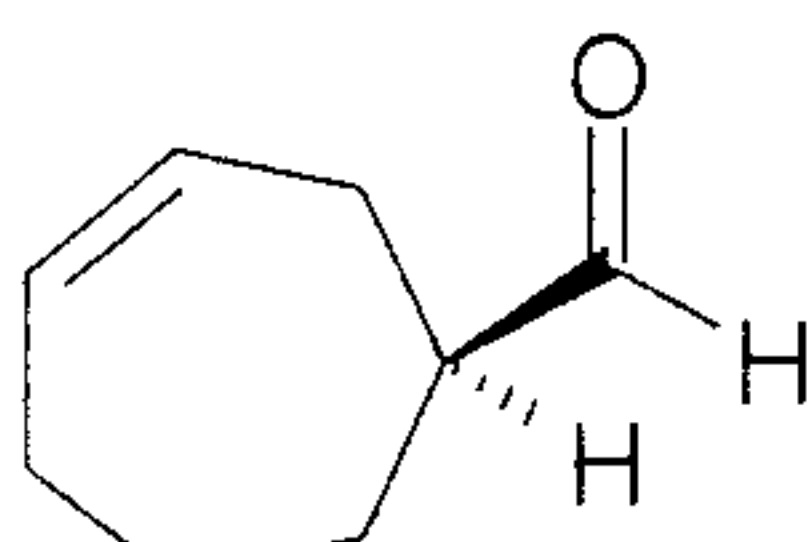
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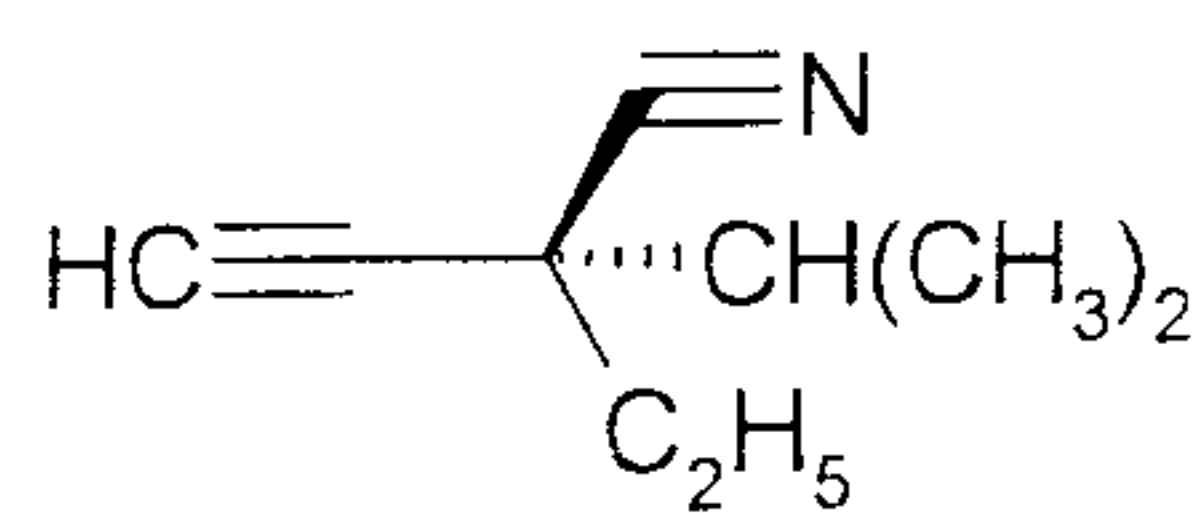
5. Which of the following compounds show *R* configuration?



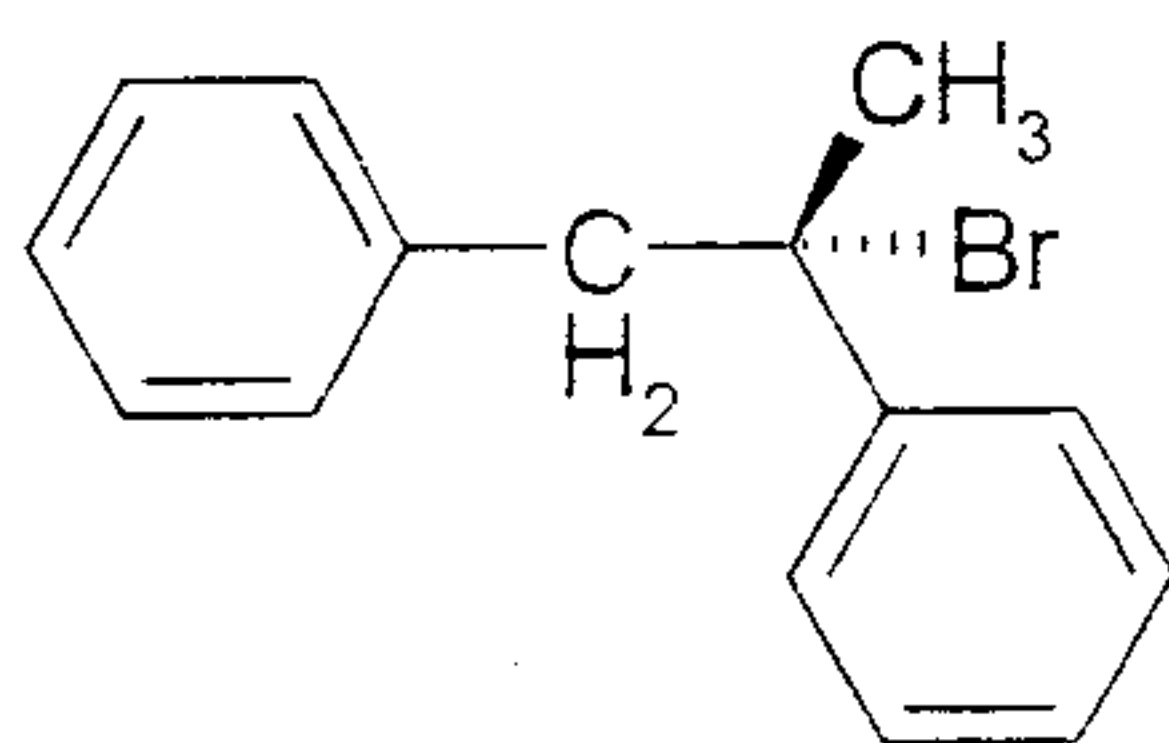
A



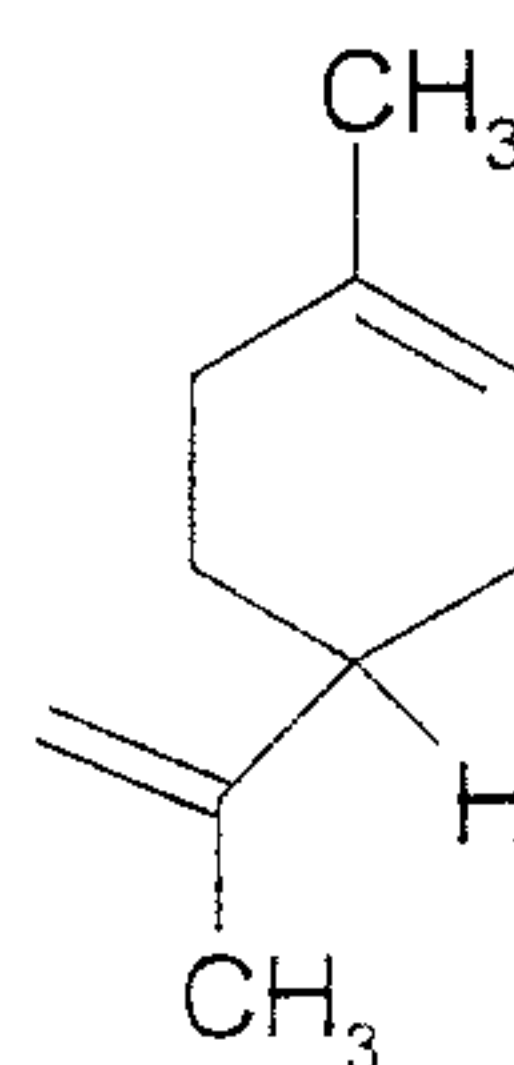
B



C



D



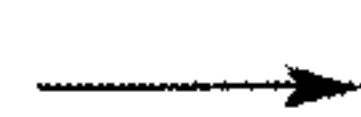
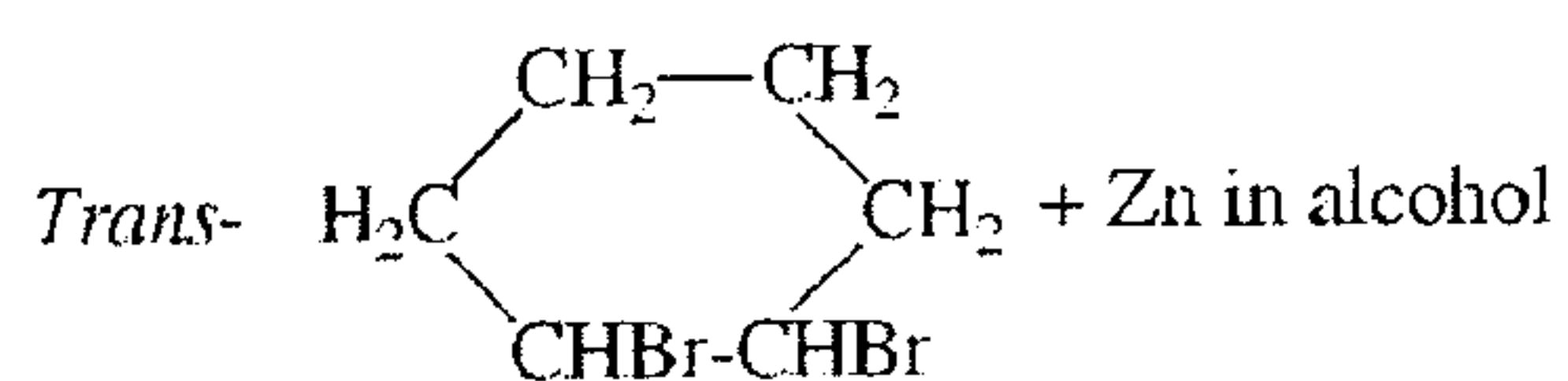
E

填充題

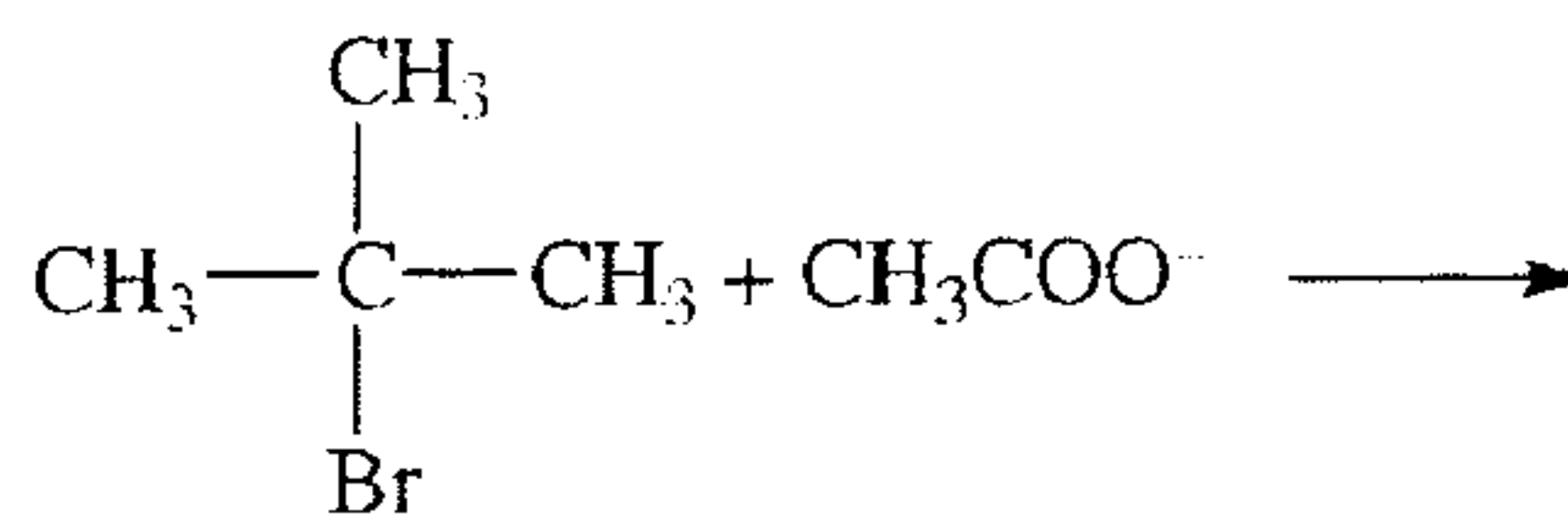
(36%, 2 each)

1. Please draw the structural formula of the principal organic compound formed in each of the following reactions.

(1)

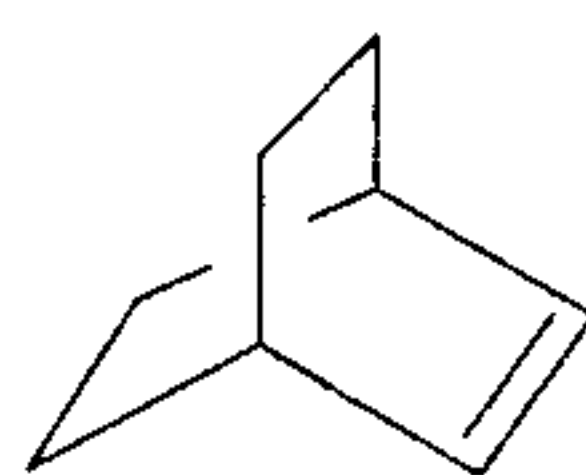


(2)



2. What are the major products of each reaction with following compound?

- Bromine in CCl_4
- OsO_4 , then NaHSO_3
- 3-chloroperbenzoic acid, then aqueous acid
- H_2/Pt



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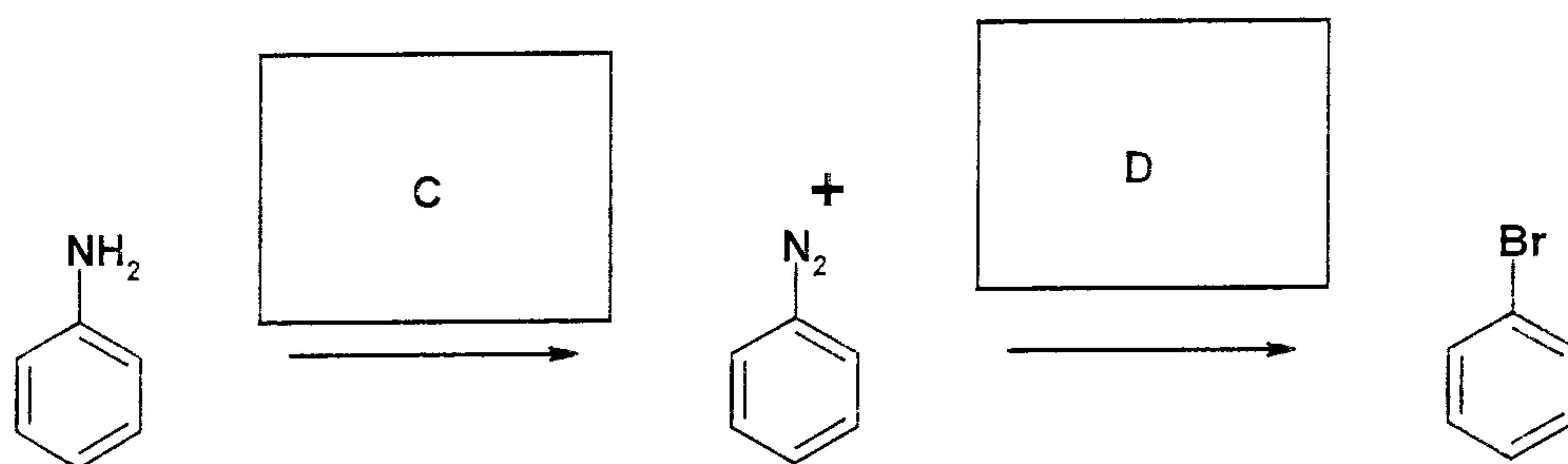
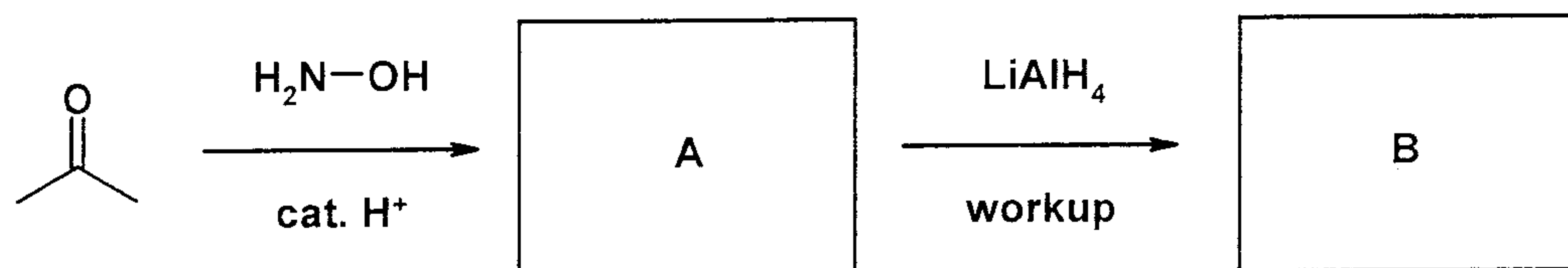
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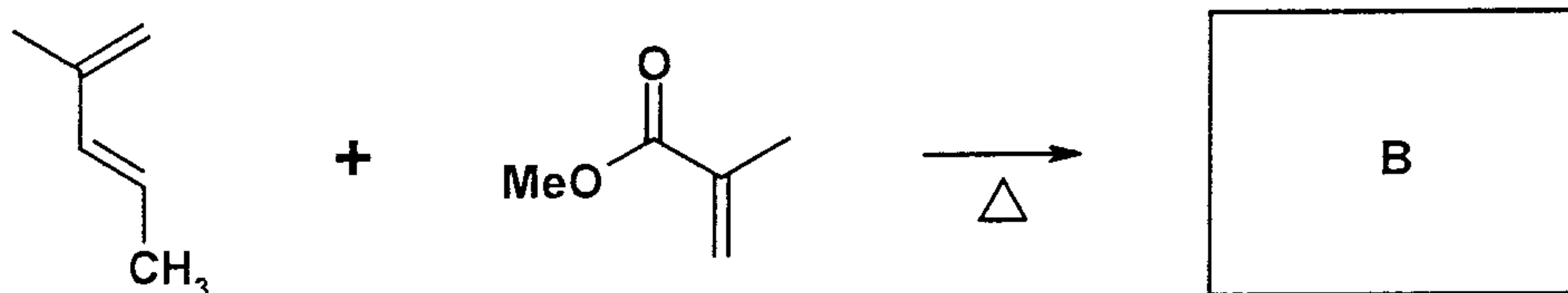
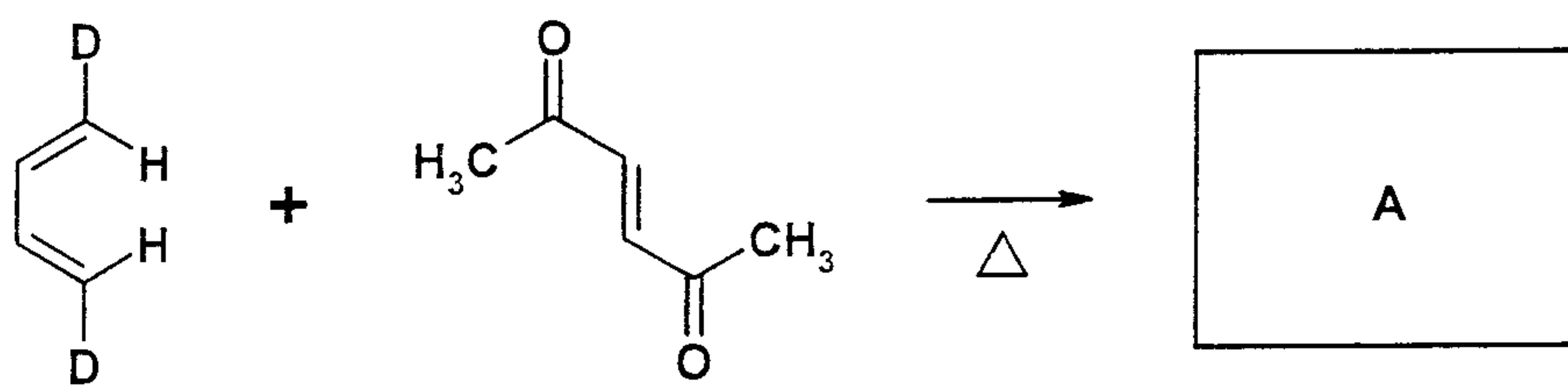
共 10 頁，第 5 頁 *請在【答案卷】作答

3. Please provide the requested products or reagents.

(1)



(2)



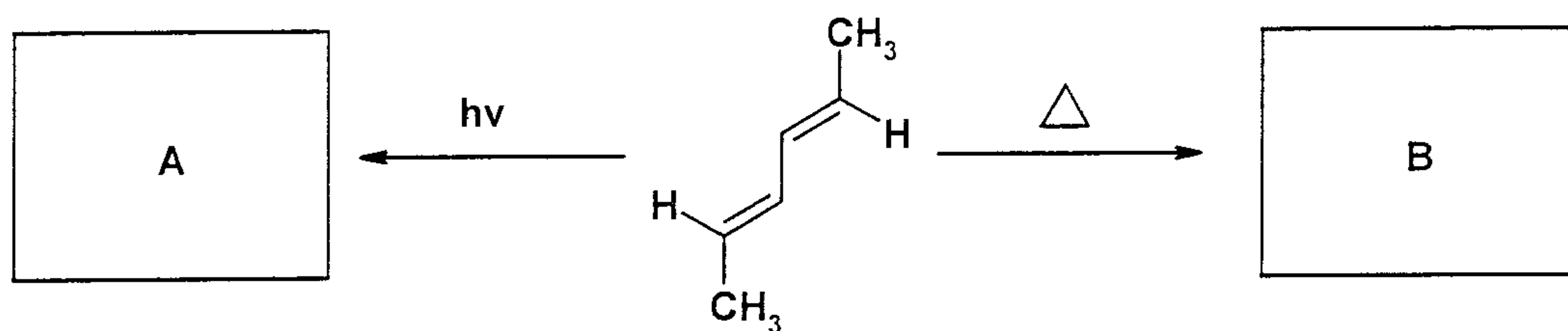
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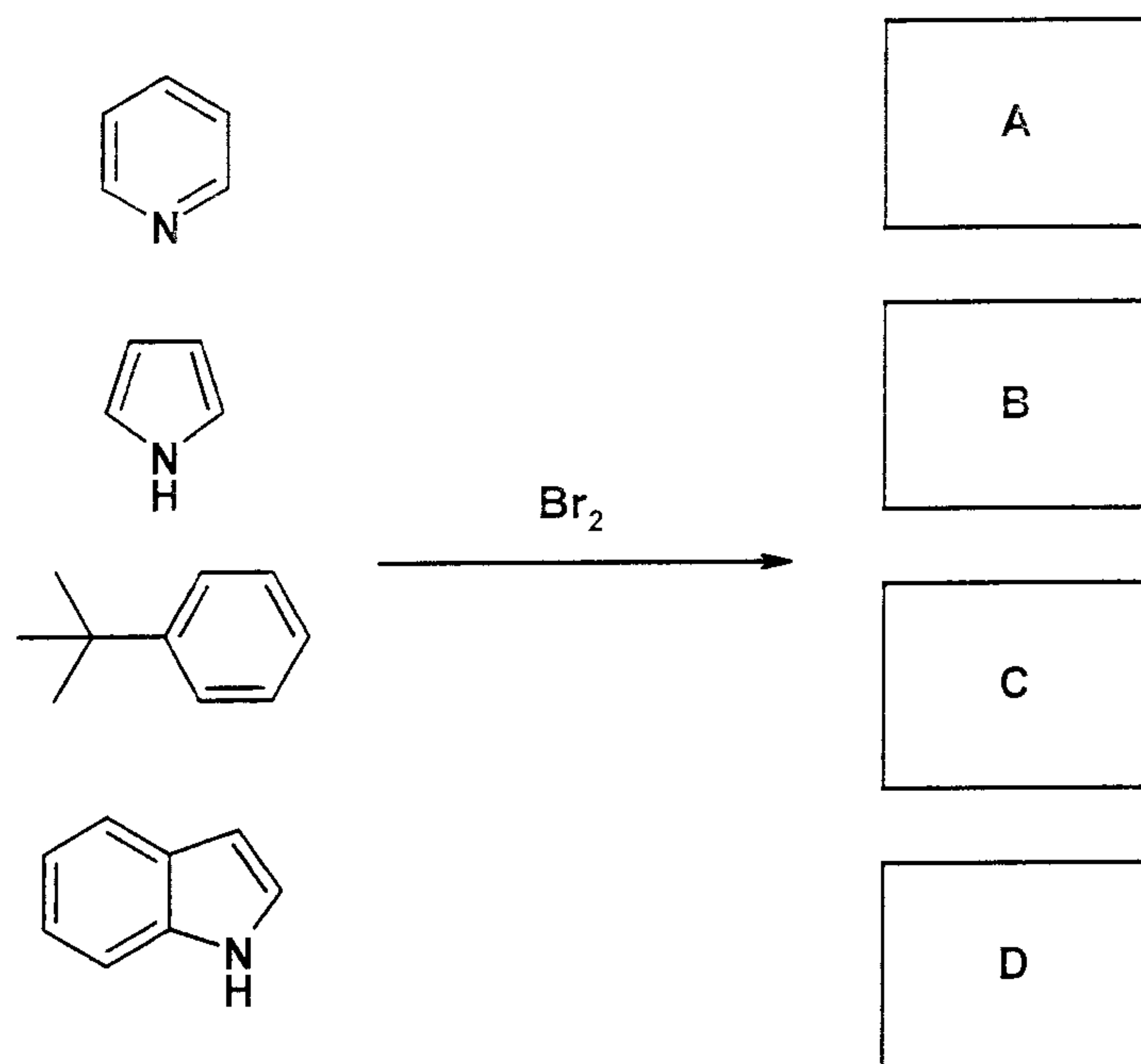
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(3)



(4)



簡答題

(20%, 5% each)

1. The pK_a values for side chain amino groups of Histidine, Lysine and Arginine are 6.0, 10.5 and 12.5 respectively.

- In physiological condition, which of them are protonated and which are not?
- Which one of the three are the most 'basic'?

<Show your calculation in detail>

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共__10__頁，第__7__頁 *請在【答案卷】作答

2. The frequency of absorption bands on IR spectrum is presented by wavenumbers

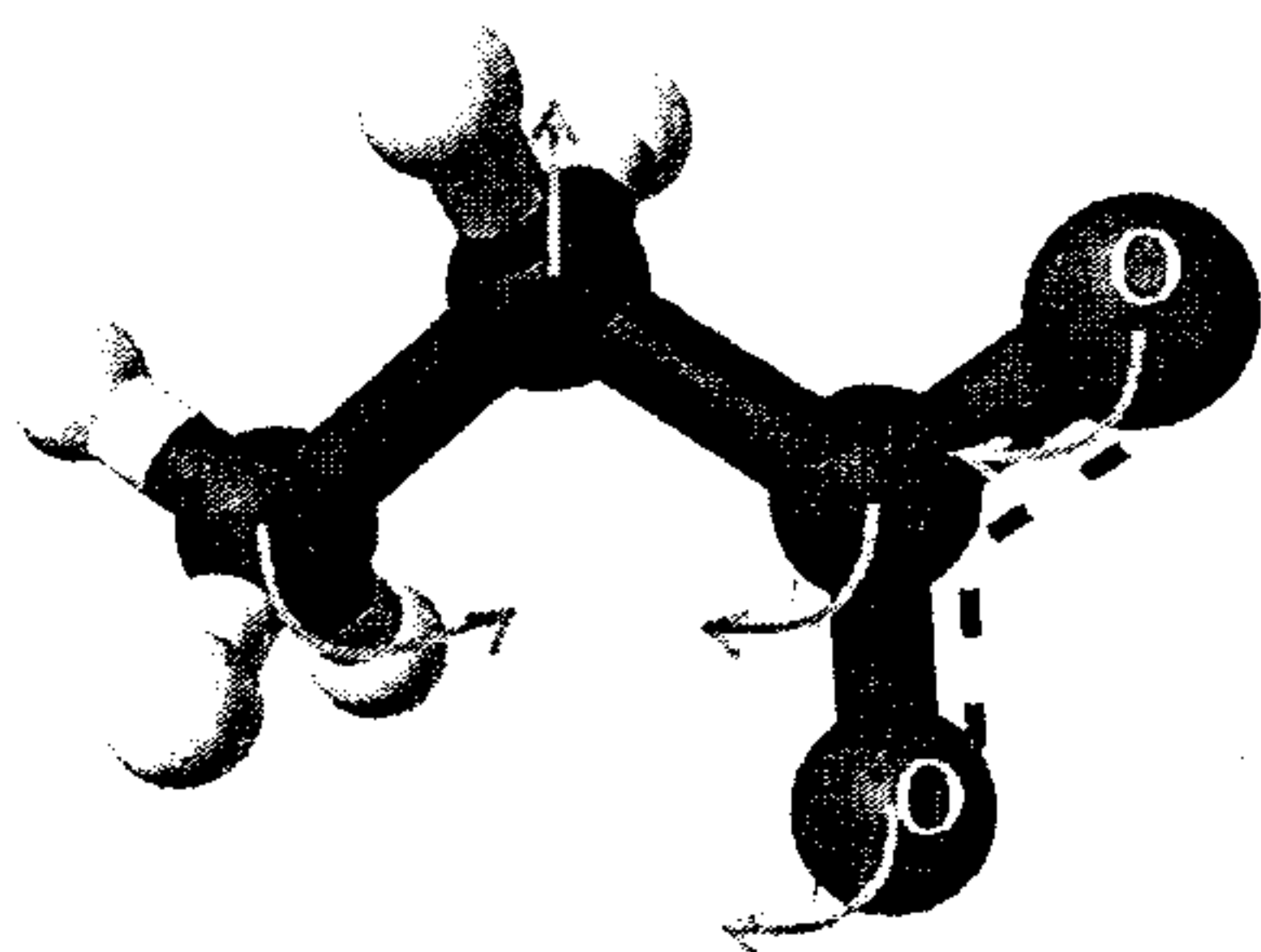
$$\tilde{\nu} = \frac{1}{2\pi c} \left(\frac{k}{\mu} \right) \text{ (cm}^{-1}\text{)}$$
 where c is the speed of light, k is the binding strength between

two atoms, and μ is the reduced mass. Here $\mu = m_1 m_2 / (m_1 + m_2)$ where m_1 and m_2 are the masses of the two atoms. The side chain of Serine has a function group $-\text{OH}$ and that of Cysteine has a function group $-\text{SH}$. Let's assume $-\text{OH}$ and $-\text{SH}$ have the same bond strength, which group has a higher wavenumber and explain why?

<Show your calculation in detail>

3. Nicotinamide adenine dinucleotide (NAD^+) is an important coenzyme for cell metabolism. It oxidizes metabolites according to particular cellular needs which result in a reduced form of NAD^+ , NADH . Now let us study NADH in absorption spectra. If 20.8% of the 340-nm radiation incident on a given solution of NADH is transmitted and if the extinction coefficient of NADH at 340 nm is $6.22 \times 10^6 \text{ cm}^2 \cdot \text{mol}^{-1}$, what is the concentration of NADH in the solution? (The path length is 1 cm.) **<Show your calculation in detail>**

4. What is the Total, Translational, Rotational and Vibrational degrees of freedom for the amino acid (a) glycine $\text{NH}_3\text{-CH}_2\text{-COO}^-$ and (b) valine? In one of the normal modes glycine atoms vibrate as shown below.



(c) Is this mode infrared-active?

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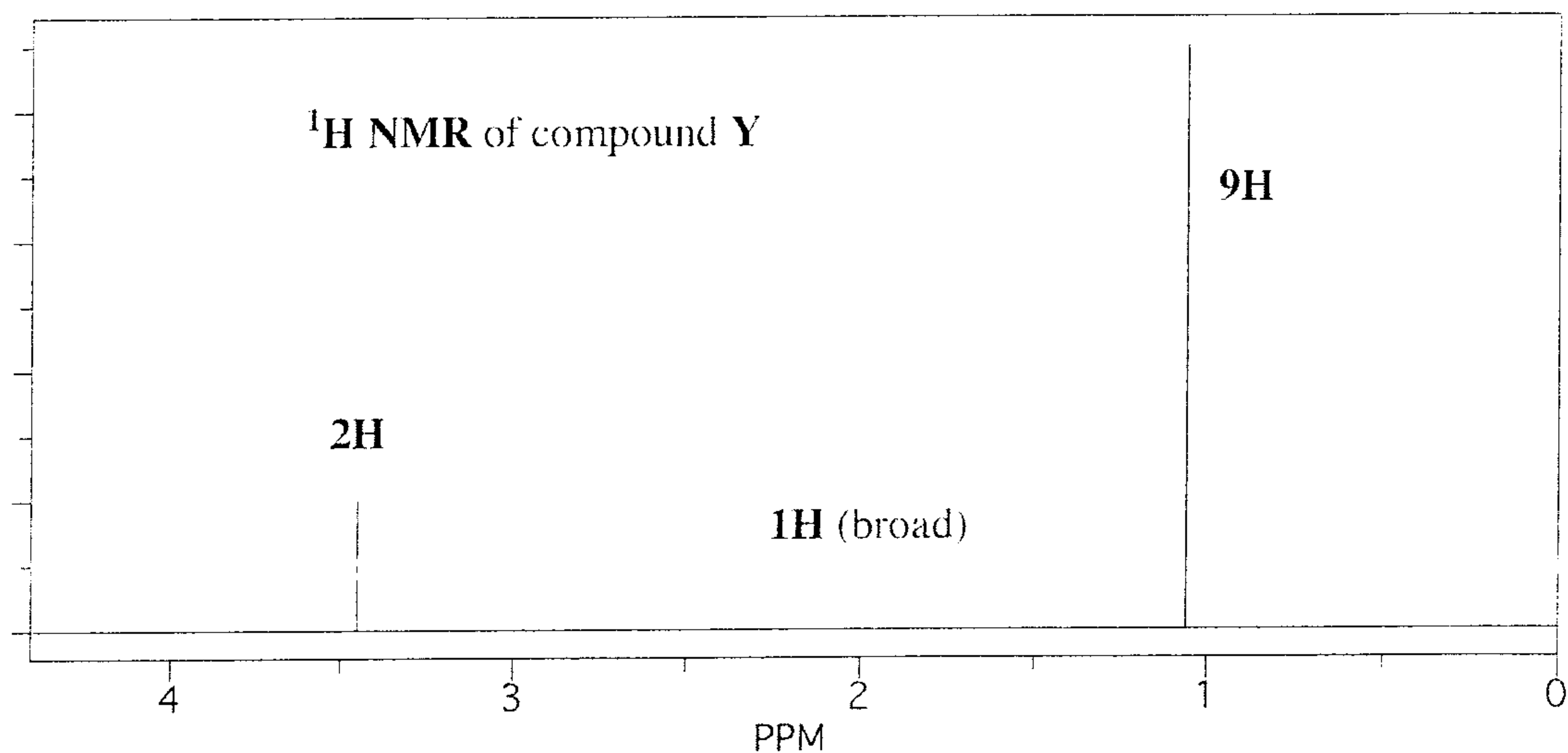
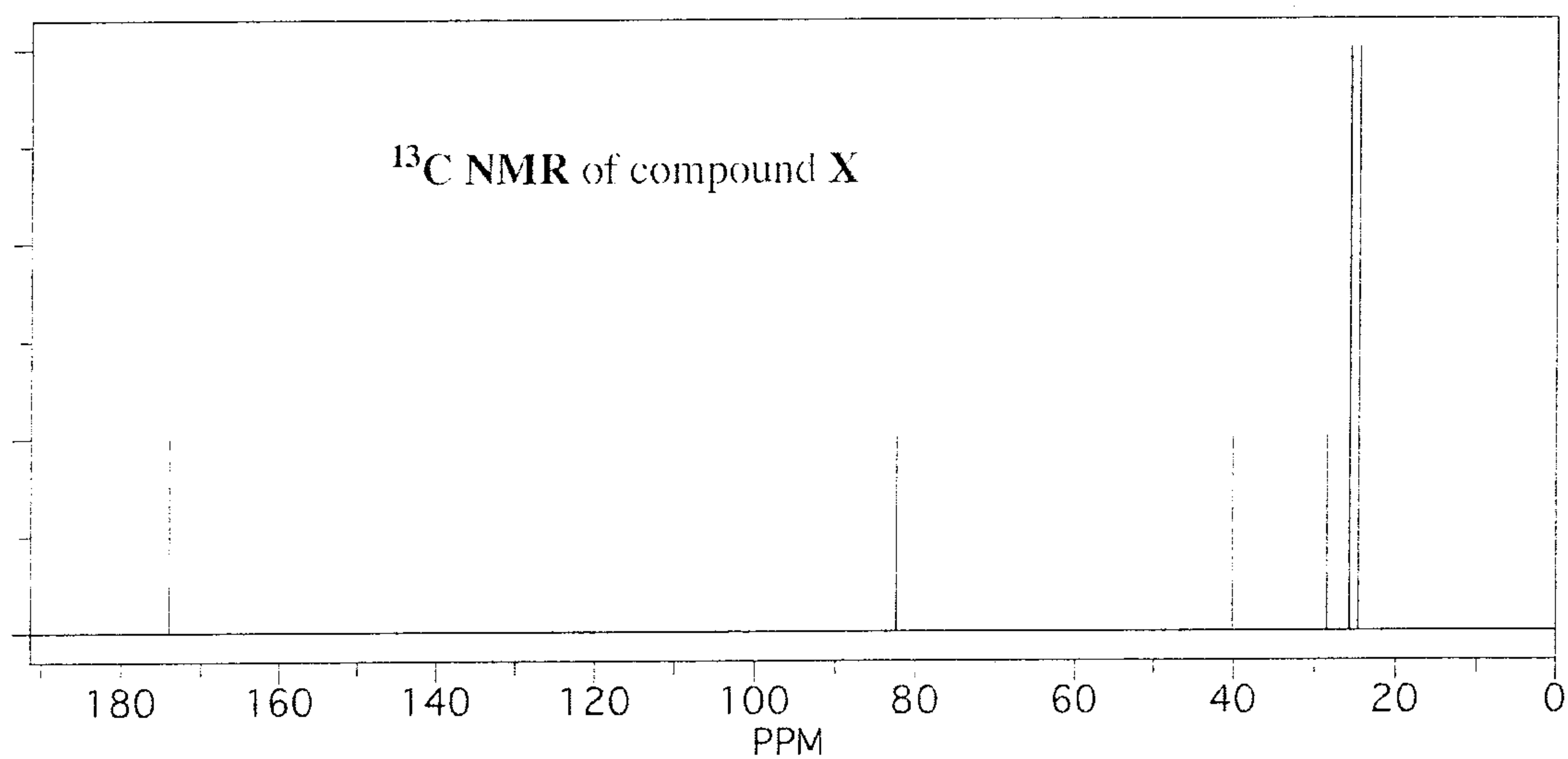
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光譜題 **Describe details in each structural determination step. (14%, 7% each)**

1. An unknown compound X (containing only carbon, hydrogen, and oxygen) has $m/z = 172$ (M^+) and 115, and its ^{13}C NMR spectrum below. When treated with lithium aluminum hydride in ether, a single compound Y is produced, and its ^1H NMR spectrum is given below. In the space below the NMR spectra at the bottom of the page, draw the structures of X and Y. Circle your final answers and clearly indicate which is compound X and which is compound Y.



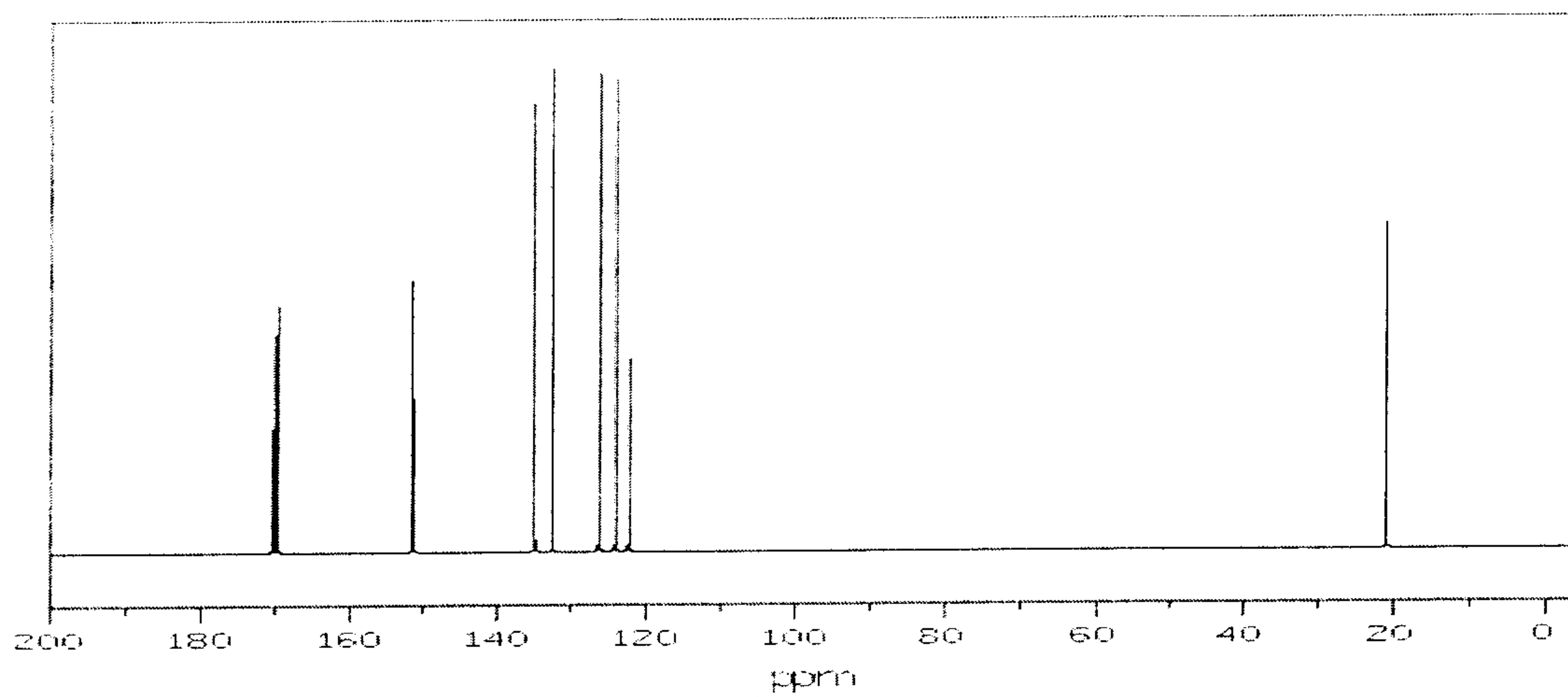
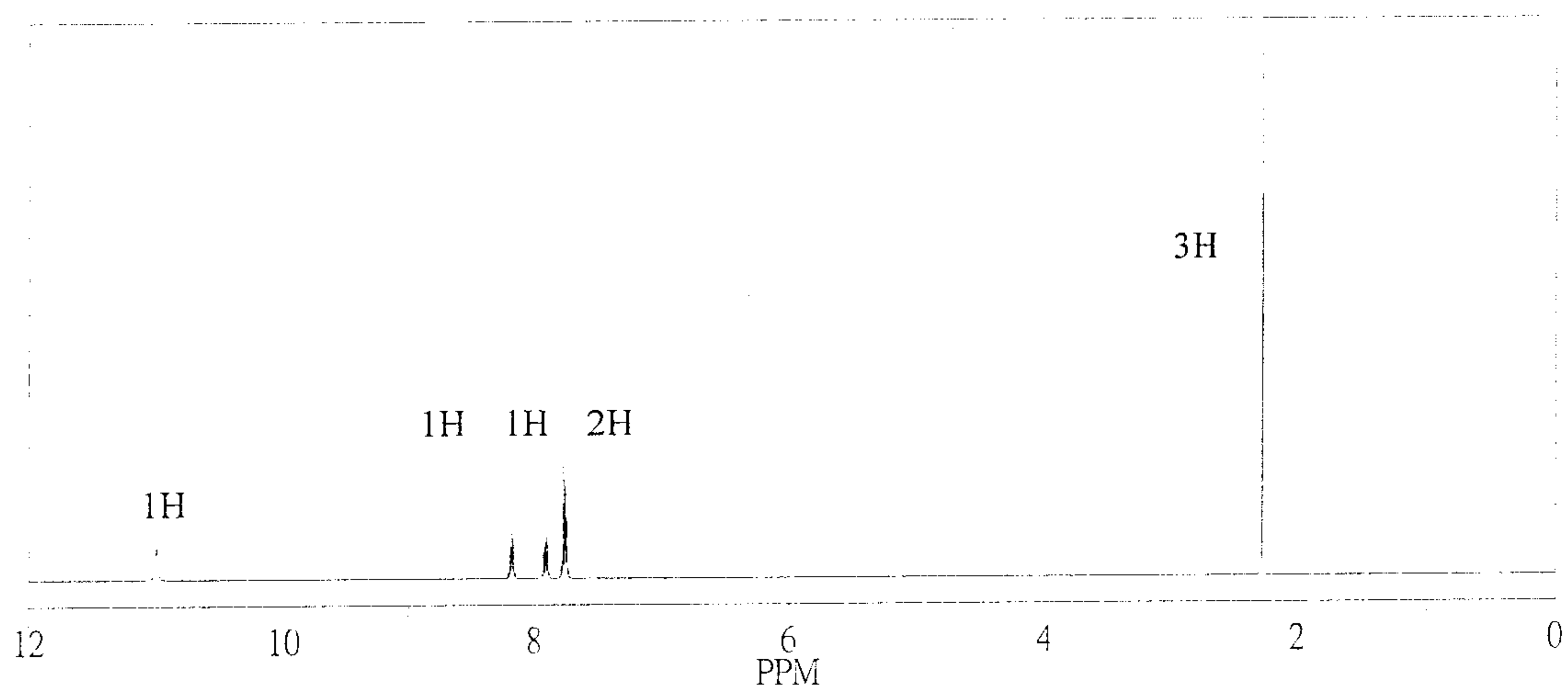
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2. A compound has molecular formula $C_9H_8O_4$. Deduce its molecular structure from the following infrared, proton NMR and carbon NMR spectra.



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