

**Topic 10.3 : Structural Elucidation in Organic Chemistry**

1. **HCI/2009/P3/Q3e**

**A** undergoes tri-iodomethane reaction  $\Rightarrow$  **A** contains  $\text{CH}_3\text{CH}(\text{OH})-$  or  $\text{CH}_3\text{CO}-$  group.

From the given molecular formula, **A** is  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CO}_2\text{H}$ .

**A** undergoes halogenation (nucleophilic substitution) with  $\text{PCl}_5$  to form **B**. **A** contains  $-\text{OH}$  and/or  $-\text{CO}_2\text{H}$  groups.

**B** is  $\text{CH}_3\text{CHClCH}_2\text{COCl}$ .

The  $-\text{COCl}$  group in **B** undergoes hydrolysis with water to give **C**.

**C** is  $\text{CH}_3\text{CHClCH}_2\text{CO}_2\text{H}$ .

**C** undergoes nucleophilic substitution with  $\text{KCN}$ , followed by acid hydrolysis to **D**.

**D** is  $\text{CH}_3\text{CH}(\text{CO}_2\text{H})\text{CH}_2\text{CO}_2\text{H}$ .

**C** undergoes nucleophilic substitution with  $\text{NH}_3$  to form **E**.

**E** is  $\text{CH}_3\text{CH}(\text{NH}_3^+)\text{CH}_2\text{CO}_2^-$  (reject the molecular form)

2. **DHS/2009/P3/Q2b**

The **carbon to hydrogen ratio** of **P** is **1 : 2**.

**P** does not contain benzene ring, but could contain **alkene** group.

**P** undergoes **electrophilic addition** with hydrogen chloride gas to form **Q** and **R** in unequal proportion.

**P** is an **unsymmetrical alkene**. **Q** and **R** are **halogenoalkanes**.

**Q** and **R** undergo **nucleophilic substitution** with sodium hydroxide to form **S** and **T** respectively.

**S** and **T** are **alcohols**.

**S** is **not oxidized** by acidified potassium manganate (VII).

**S** is a **tertiary alcohol**.

**T** is **oxidized** by acidified potassium manganate (VII) to form **U**.

**T** is a **primary or secondary alcohol**. **U** could be **carboxylic acid or ketone**.

**U** undergoes **neutralisation** / **acid – base reaction** with sodium carbonate to liberate carbon dioxide gas.

**U** is a **carboxylic acid**, hence **T** is a **primary alcohol**.

**P** undergoes **(strong) oxidation** with acidified potassium manganate (VII) to form **V**,  $C_5H_{10}O$ , **which has only one oxygen atom**, and carbon dioxide.

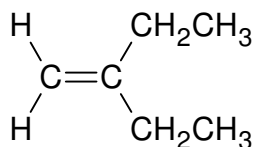
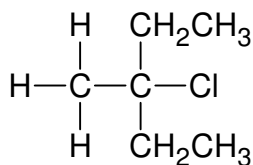
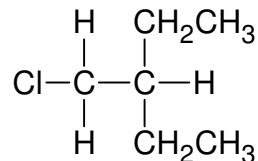
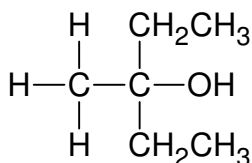
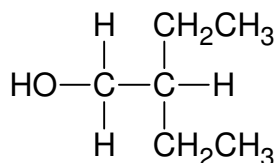
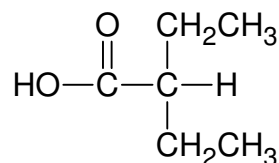
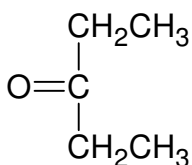
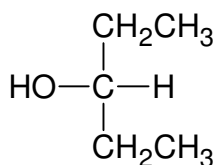
**P** has a **terminal alkene** group. **V** is a **ketone**.

**V** undergoes **condensation** with 2,4-dinitrophenylhydrazine to form an orange precipitate.

**V** is a **ketone / carbonyl compound**.

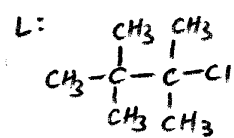
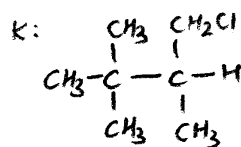
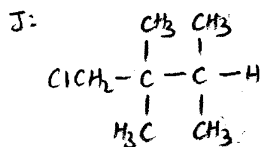
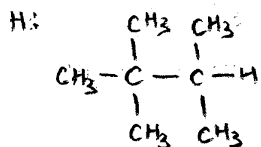
**V** undergoes **reduction** with lithium aluminium hydride to form **W**, which does not exhibit optical activity.

**W** is a **secondary alcohol** and is a **symmetrical** molecule.

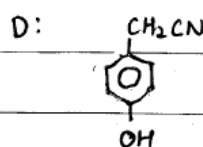
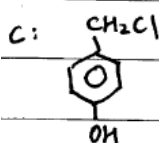
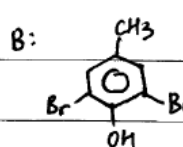
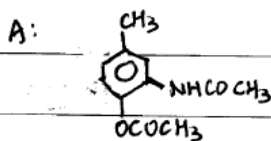
**P****Q****R****S****T****U****V****W**

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3. IJC/2009/P3/Q1f

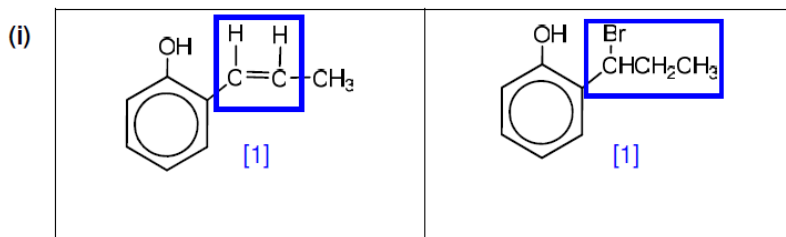


4. ACJC/2009/P2/Q4b



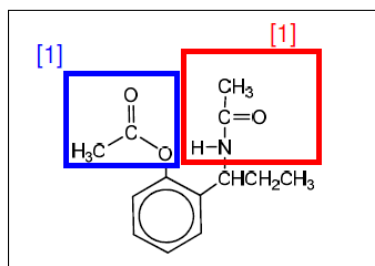
Step	Reagents	Conditions
1	Sn + conc HCl, followed by NaOH(aq)	reflux
2	dilute HNO <sub>3</sub>	20°C
3	KMnO <sub>4</sub> in H <sub>2</sub> SO <sub>4</sub> (aq)	reflux
4	KCN in ethanol	reflux
5	KOH (aq)	reflux

5. JJC/2009/P2/Q6c



B

C

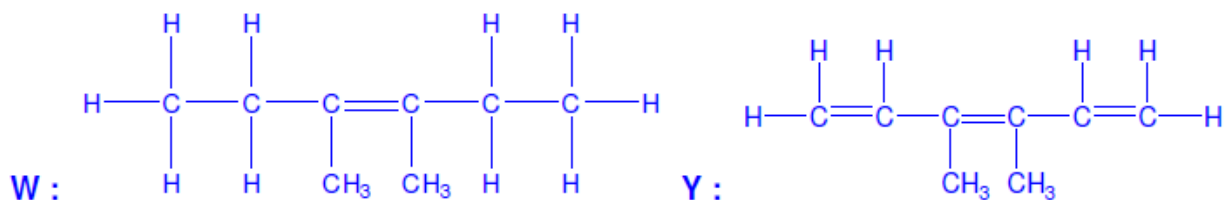
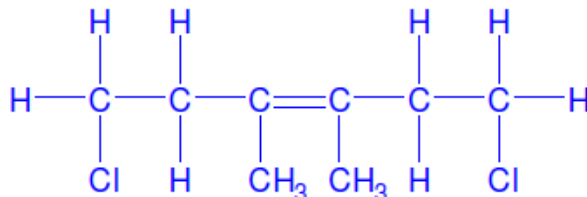


E

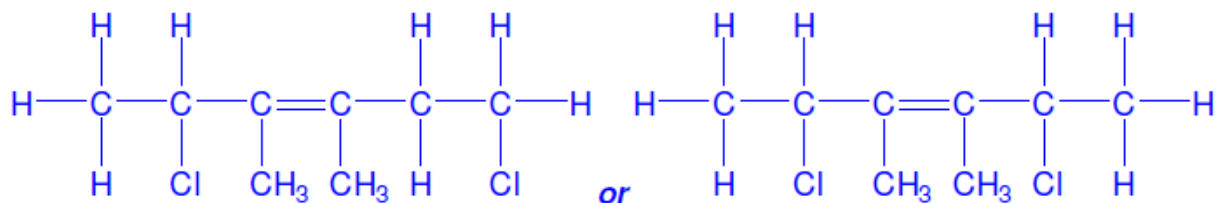
(ii) **Excess NH<sub>3</sub>, heat under reflux in ethanol**

6. **MJC/2009/P3/Q4c**

(ci) X can be : (accept other logical answers)



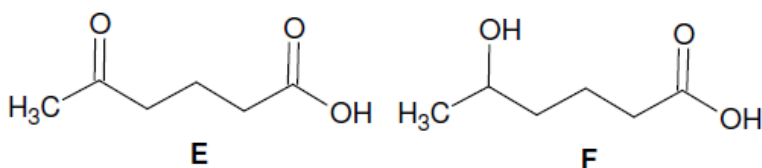
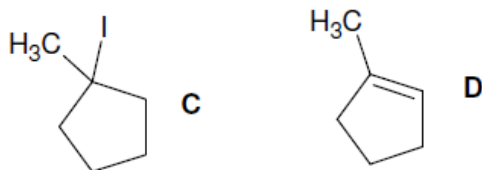
(cii)



(ciii) There is 1 alkene double bond that is capable of exhibiting cis-trans isomerism as there are 2 different groups attached to each C atom; no of stereoisomers = 2.

7. **NJC/2009/P3/Q2e**

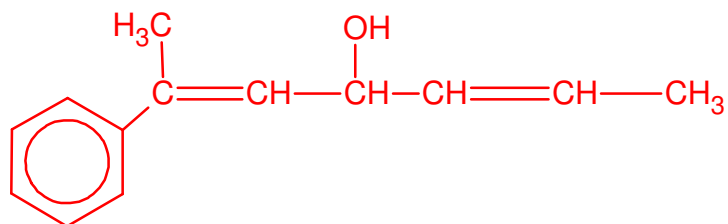
(e)



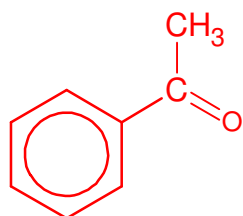
8. NYJC/2009/P3/Q5c

**STRUCTURES**

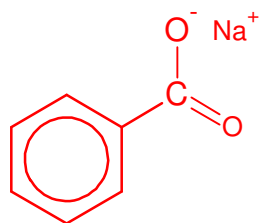
[1] M is



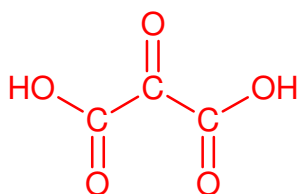
[1] N is



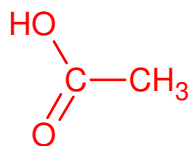
[1] R is



[1] P is



[1] Q is



**EXPLANATION OF THE REACTIONS DESCRIBED**

[1] M decolourises aqueous bromine due to **electrophilic addition** across the **alkene (C=C)** functional group.

[1] M produces white fumes (of HCl) with  $\text{PCl}_5$  due to a **substitution** reaction of the (secondary) **alcohol** functional group.

[1] M produced 3 compounds, N, P and Q with hot acidified potassium manganate (VII) due to **oxidative cleavage** of the (2) **alkene** functional groups present.

[1] N does not undergo **mild oxidation** with Fehling's reagent as it is **not an aldehyde**.

[1] N gives a yellow ppt (of  $\text{CHI}_3$ ) and salt R with aq alkaline iodine due to the (mild) **oxidation** (and cleavage) of the  **$\text{CH}_3\text{COR}$**  group.

[1] P gives an effervescence (of  $\text{CO}_2$ ) with  $\text{Na}_2\text{CO}_3(\text{s})$  due to a **neutralization** reaction with the **carboxylic acid** functional group.

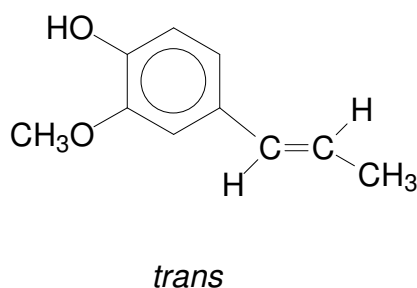
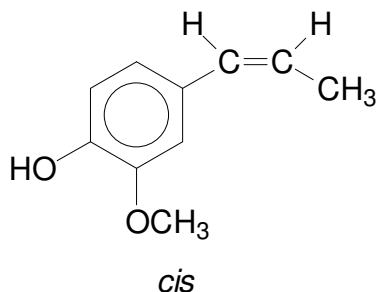
[1] P gives an orange precipitate with 2,4-DNPH due to **condensation** with the **ketone** functional group.

[1] Q gives an effervescence (of  $\text{CO}_2$ ) with  $\text{Na}_2\text{CO}_3(\text{s})$  due to a **neutralization** reaction with the **carboxylic acid** functional group.

[1] Q does not give an orange precipitate with 2,4-DNPH due to the **absence of a carbonyl** functional group for **condensation**.

9. **RJC/2009/P2/Q4(a),(b)**

- (a) Structural/positional isomerism  
 (b) Geometric isomerism



10. **SAJC/2009/P3/Q4c**

Information	Deduction
Stereoisomer A	- contains either an alkene with non-identical groups on the same carbon or chiral carbon
A reacts with hot acidified potassium manganate(VII) solution	- A undergoes oxidation - A contains $\text{C}=\text{C}$

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<b>B</b> forms a yellow precipitate with hot alkaline iodine solution.	- <b>B</b> contains $\text{CH}_3\text{CO-}$ (do not accept $\text{CH}_3\text{CHOH-}$ )
Cold alkaline hydrogen cyanide was added to <b>B</b> and the mixture was reduced to form compound <b>C</b>	- <b>B</b> is a ketone which undergoes nucleophilic addition with HCN - <b>C</b> contains an amine functional group
Compound <b>D</b> formed white precipitate with ethanolic silver nitrate solution.	- <b>D</b> contains chloroalkane which forms AgCl
Compound <b>D</b> was reacted with phosphorous pentachloride to form compound <b>E</b> .	- <b>D</b> is an alcohol or carboxylic acid (do not accept <b>D</b> contains $-\text{OH}$ group) which undergoes nucleophilic substitution / displacement reaction to form <b>E</b> which is a an acid chloride.
Compounds <b>C</b> and <b>E</b> were then reacted to form two compounds <b>F</b> and <b>G</b> , with identical molecular formula $\text{C}_7\text{H}_{14}\text{O}_2\text{NCl}$ .	- condensation reaction took place
Compound <b>F</b> is neutral.	- <b>F</b> is an amide or <b>F</b> does not contain phenol/carboxylic acid/amine.

Compound	Structure	Compound	Structure
<b>A</b>	$\begin{array}{c} \text{CH}_2\text{Cl} \quad \text{CH}_2\text{CH}_3 \\ \quad \quad \quad \diagdown \quad \diagup \\ \quad \quad \quad \text{C}=\text{C} \\ \quad \quad \quad \diagup \quad \diagdown \\ \text{H} \quad \quad \quad \text{CH}_3 \end{array}$	<b>D</b>	$\begin{array}{c} \text{CH}_2\text{Cl} \\ \quad \quad \quad \diagdown \\ \quad \quad \quad \text{C}=\text{O} \\ \quad \quad \quad \diagup \\ \text{HO} \end{array}$
<b>B</b>	$\begin{array}{c} \quad \quad \quad \text{CH}_2\text{CH}_3 \\ \quad \quad \quad \diagdown \\ \text{O}=\text{C} \\ \quad \quad \quad \diagup \\ \quad \quad \quad \text{CH}_3 \end{array}$	<b>E</b>	$\begin{array}{c} \text{CH}_2\text{Cl} \\ \quad \quad \quad \diagdown \\ \quad \quad \quad \text{C}=\text{O} \\ \quad \quad \quad \diagup \\ \text{C} \end{array}$

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<b>C</b>	$\begin{array}{c} \text{CH}_2\text{CH}_3 \\   \\ \text{HO}-\text{C}-\text{CH}_2\text{NH}_2 \\   \\ \text{CH}_3 \end{array}$	<b>F</b>	$\begin{array}{c} \text{CH}_2\text{CH}_3 \\   \\ \text{HO}-\text{C}-\text{CH}_2\text{NHCOCH}_2\text{Cl} \\   \\ \text{CH}_3 \end{array}$
		<b>G</b>	$\begin{array}{c} \text{CH}_2\text{CH}_3 \\   \\ \text{CH}_2\text{C}/\text{COO}-\text{C}-\text{CH}_2\text{NH}_2 \\   \\ \text{CH}_3 \end{array}$

## 11. SAJC/2009/P3/Q5c

Information	Deduction
Both <b>A</b> and <b>B</b> do not react with $\text{Na}_2\text{CO}_3$	- <b>A</b> and <b>B</b> do not have $-\text{COOH}$
<b>A</b> and <b>B</b> do not give positive test	<b>A</b> and <b>B</b> do not contain any methyl ketone $\text{CH}_3\text{CO}-$ or $\text{CH}_3\text{CHOH}-$ group
0.370 g of <b>A</b> reacts with sodium to form a flammable gas that takes up $125.8 \text{ cm}^3$ of space at $32.5 \text{ }^\circ\text{C}$ and 101 kPa.	Flammable gas – $\text{H}_2$ No of moles of <b>A</b> = $0.370/74 = 0.005 \text{ mol}$ $101000 \times 125.8 \times 10^{-6} = n \times 8.31 \times (273+32.5)$ No of moles of $\text{H}_2 = 0.005 \text{ mol}$ - mole ratio of <b>A</b> : $\text{H}_2 = 1 : 1$ - <b>A</b> contains 2 alcohol groups
<b>B</b> does not react with Na	- <b>B</b> does not contain $-\text{OH}$ group.

\* Alternatively, students can give equations to illustrate the reactions undergone by **A** and **B**

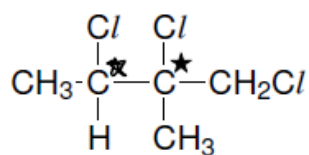
	Structure		Structure
<b>A</b>		<b>B</b>	$\begin{array}{c} \text{H} \quad \quad \text{O} \quad \quad \text{H} \\   \quad \quad    \quad \quad   \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{C}-\text{H} \\   \quad \quad \quad \quad   \\ \text{H} \quad \quad \quad \quad \text{H} \end{array}$



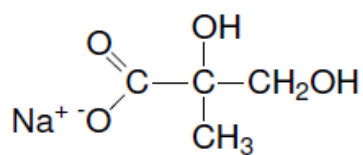
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$  \begin{array}{c}  \text{H} \\    \\  \text{H}-\text{C}-\text{C}=\text{C}-\text{O}-\text{H} \\    \quad   \quad   \\  \text{H} \quad \text{O} \quad \text{H} \\    \\  \text{H}  \end{array}  $ <p>or any structure with two OH groups (not CH<sub>3</sub>CHOH-) and C=C.</p> <p>*</p> $  \begin{array}{c}  \text{H} \\    \\  \text{H}-\text{O}-\text{C}-\text{C}=\text{C}-\text{H} \\    \quad   \quad   \\  \text{H} \quad \text{H} \quad \text{H}  \end{array}  $ <p>*[not stable]</p>	<p>or</p> $  \begin{array}{c}  \text{O} \quad \text{H} \quad \text{H} \\     \quad   \quad   \\  \text{H}-\text{C}-\text{O}-\text{C}-\text{C}-\text{H} \\  \quad \quad   \quad   \\  \quad \quad \text{H} \quad \text{H}  \end{array}  $
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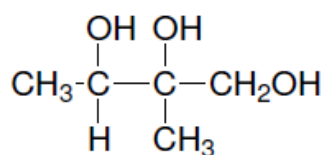
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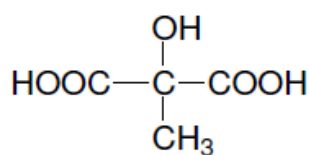
A



D



B



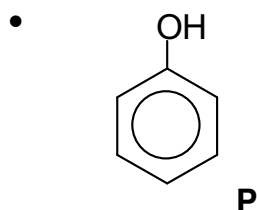
E



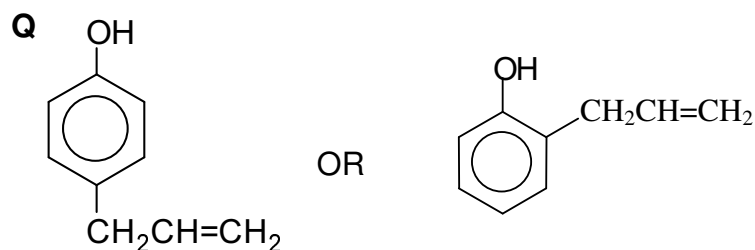
C

13. TJC/2009/P3/Q1b

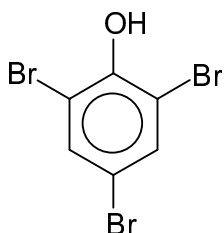
- High C:H ratio infers that P is an aromatic compound.



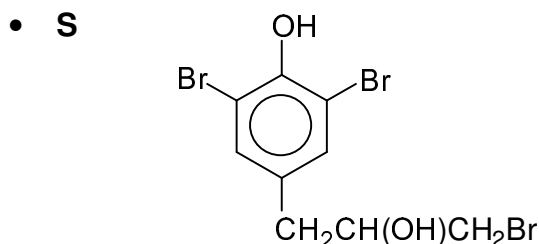
- With anhydrous aluminium chloride P undergoes electrophilic substitution reaction to form Q. As the -OH is an activating group, the substituent will be directed to the ortho or para position.



- P undergoes electrophilic substitution as it decolourises aqueous bromine to form white ppt R. R is 2,4,6-tribromophenol as -OH is a highly activating group.

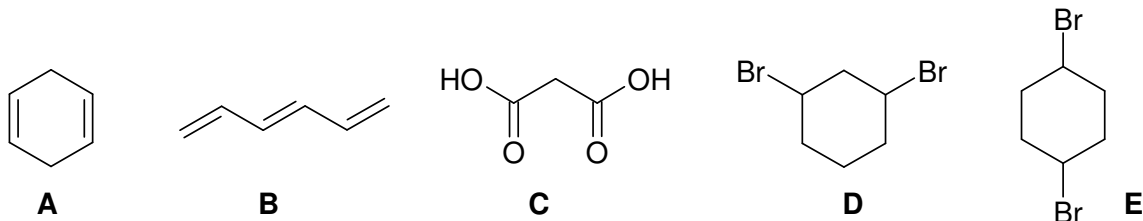


- Q react with aqueous bromine to form white ppt S, with the same no of bromine atoms per molecule of R. As Q has a C-C double bond, electrophilic addition takes place as well. This implies that 1 Br will be attached to one of the carbons of the C-C double bonds. Thus, only 2 Br will be attached directly to the benzene.



**S** is optically active because of its chiral carbon. The mirror image of **S** is non-superimposable.

14. TPJC/2009/P3/Q1d



(i)

**A** undergoes electrophilic addition with HBr to form **D** and **E**.

**A** undergoes vigorous oxidation / oxidative cleavage with hot acidified  $\text{KMnO}_4$  to form **C**.

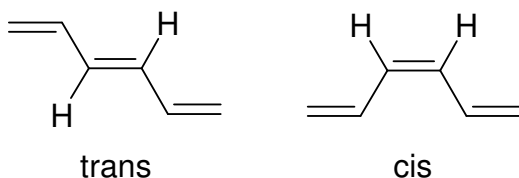
**C** can undergo neutralization or acid-base reaction with aqueous  $\text{Na}_2\text{CO}_3$  to liberate  $\text{CO}_2$  gas.

**B** undergoes vigorous oxidation / oxidative cleavage with hot acidified  $\text{KMnO}_4$  to form  $\text{CO}_2$

**B** undergoes electrophilic addition with HBr followed by nucleophilic substitution with aqueous NaOH to form hexan-2,3,5-triol.

(ii) **A** cannot form cis-trans isomers as it is a cyclic alkene and the trans isomer will result in bond angle strain.

**B** can form a pair of cis-trans isomers as it has an  $\text{C}=\text{C}$  bond with each carbon bonded to two different groups of atoms.

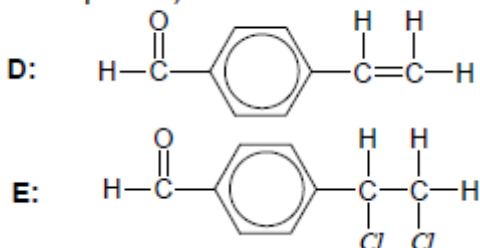


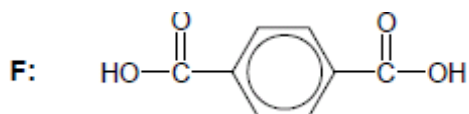
hexan-2,3,5-triol has 3 chiral carbons, hence no. of optical isomers =  $2^3 = 8$

YJC/2009/P3/Q5c

15.

(c) Structures: (relative positions of the 2 functional groups on the benzene ring is not important)

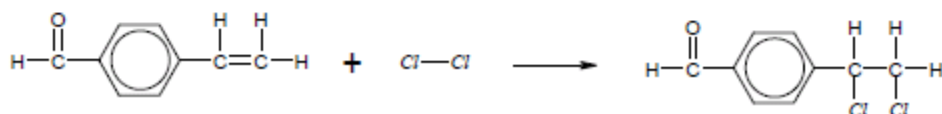




Any 3 out of the following explanations:

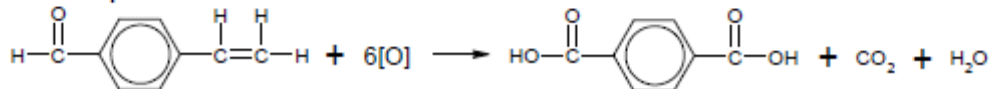
- **D** has a large hydrophobic group (the benzene ring),  $\therefore$  does not dissolve in water
- **D** does not contain phenol and COOH group,  $\therefore$  does not dissolve in NaOH or **F** contains COOH group,  $\therefore$  can dissolve in NaOH
- **D** contains a C=C double bond, as it undergoes electrophilic addition with chlorine gas to form **E**.

or equation:



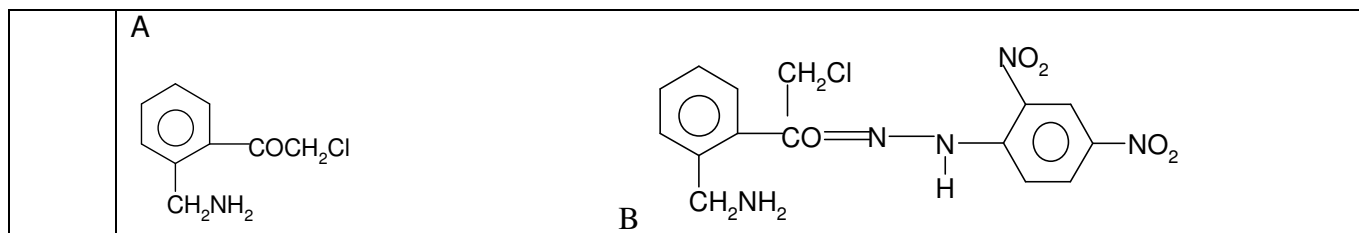
- **D** contains a benzaldehyde group,  $\therefore$  does not react with Fehling's solution but reacts with Tollen's reagent
- The benzaldehyde group on **D** is oxidised to COOH group; **and** the alkene group undergoes oxidative cleavage to form a COOH group with hot acidified  $\text{KMnO}_4$  to give **F**.

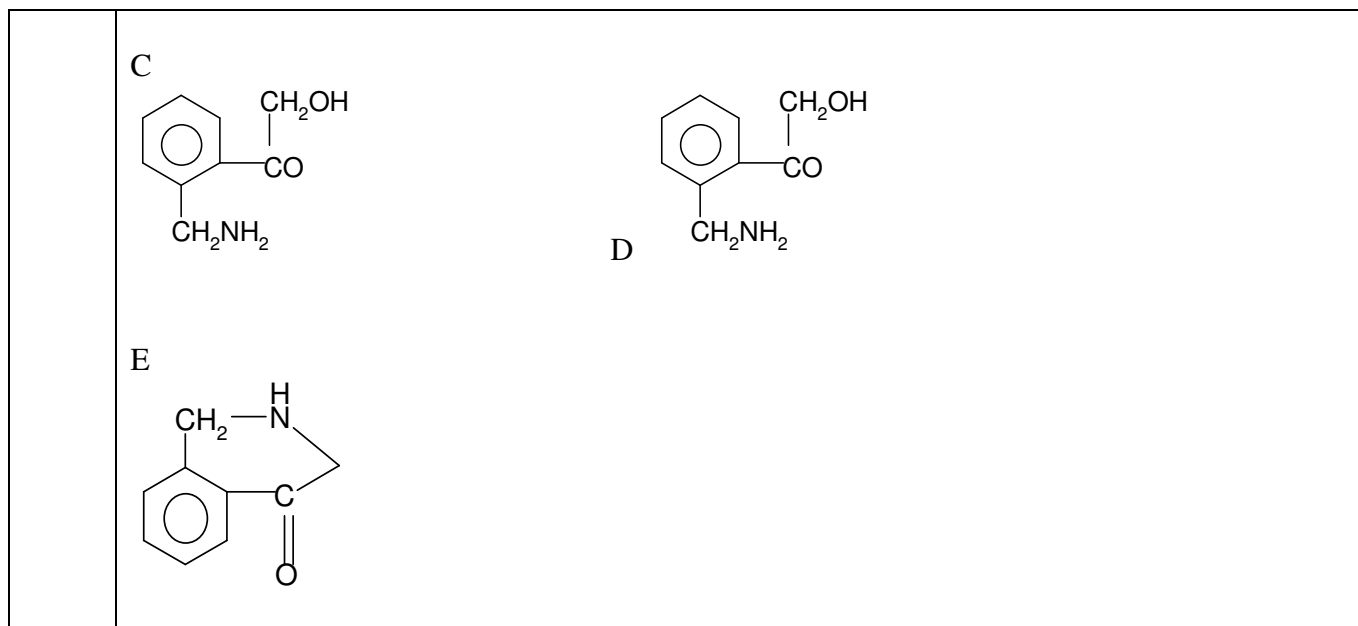
or equation:



**ACJC/2009/P3/Q4b**

16. A has amine group being basic. No reaction with aq  $\text{Br}_2$  shows absence of phenylamine. A is a ketone.  $\therefore$  A has a benzene ring, and is 2,4 directing. A undergoes nucleophilic substitution with aq  $\text{OH}^-$  forming C. C has a primary alcohol forming  $\text{COOH}$  confirming by reaction with carbonate. A undergoes elimination.

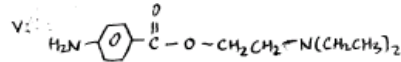
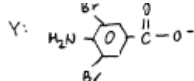
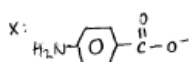



**IJC/2009/P3/Q3a**

17.

(i)

(i)



The ester group in V undergoes hydrolysis when heated with NaOH(aq) to yield compounds W and X.

Compound X undergoes electrophilic substitution with Br<sub>2</sub>(aq) to yield compound Y.

(ii)

 (ii) Add I<sub>2</sub>(aq) in NaOH(aq). Warm

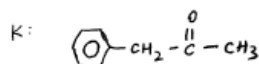
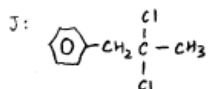
Compound W gives no observable reaction.

Compound Z gives a yellow precipitate.

**IJC/2009/P3/Q5d**

18.

(ii)



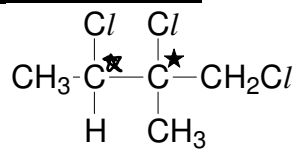
K is a ketone and hence, it can undergo condensation reaction with 2,4-DNPH to give an orange precipitate.

K has the structure  $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{R}$  and hence, it gives a yellow precipitate when heated with aqueous alkaline I<sub>2</sub>.

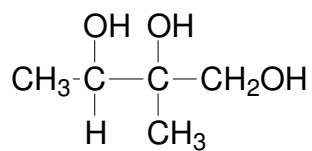
Both J and K are oxidised to  $\text{C}_6\text{H}_5-\text{CO}_2\text{H}$  when treated with hot acidified  $\text{KMnO}_4$ .

**SRJC/2009/P3/Q3e**

19.



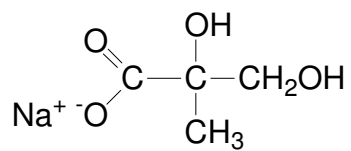
**A**



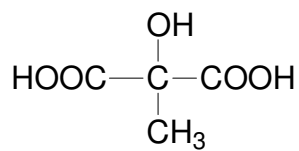
**B**

**CHI<sub>3</sub>**

**C**



**D**

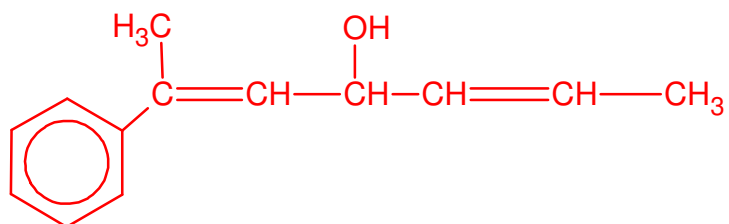


**E**

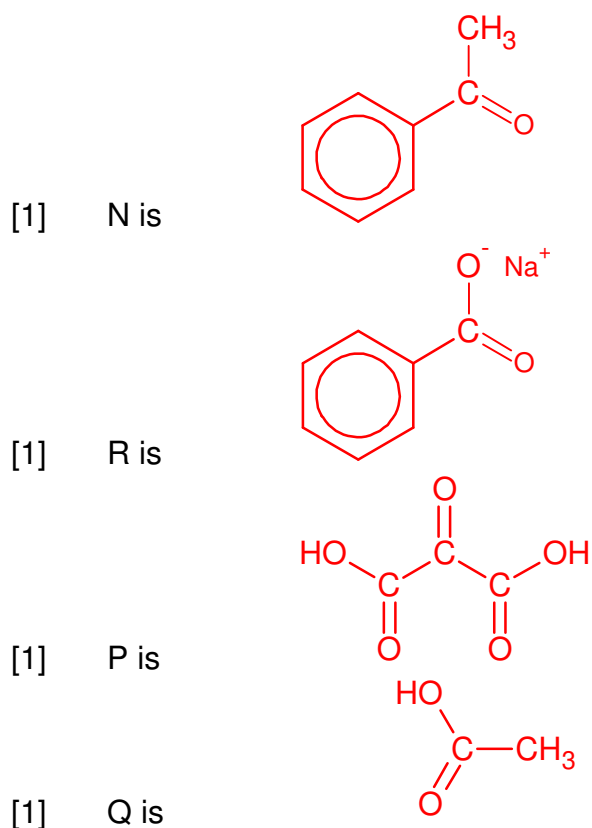
**NYJC/2009/P3/Q5c**

20.

STRUCTURES



[1] M is



#### EXPLANATION OF THE REACTIONS DESCRIBED

[1] M decolourises aqueous bromine due to electrophilic addition across the alkene (C=C) functional group.

[1] M produces white fumes (of HCl) with  $\text{PCl}_5$  due to a substitution reaction of the (secondary) alcohol functional group.

[1] M produced 3 compounds, N, P and Q with hot acidified potassium manganate (VII) due to oxidative cleavage of the (2) alkene functional groups present.

[1] N does not undergo mild oxidation with Fehling's reagent as it is not an aldehyde.

[1] N gives a yellow ppt (of  $\text{CHI}_3$ ) and salt R with aq alkaline iodine due to the (mild) oxidation (and cleavage) of the  $\text{CH}_3\text{COR}$  group.

[1] P gives an effervescence (of  $\text{CO}_2$ ) with  $\text{Na}_2\text{CO}_3(\text{s})$  due to a neutralization reaction with the carboxylic acid functional group.

[1] P gives an orange precipitate with 2,4-DNPH due to condensation with the ketone functional group.

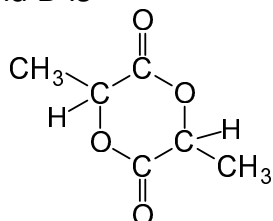
[1] Q gives an effervescence (of  $\text{CO}_2$ ) with  $\text{Na}_2\text{CO}_3(\text{s})$  due to a neutralization reaction with the carboxylic acid functional group.

[1]Q does not give an orange precipitate with 2,4-DNPH due to the absence of a carbonyl functional group for condensation.

**RI/2009/P3/Q1c-e**

21.

(c) Compound D is

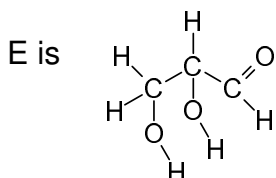


D does not contain  $\text{-OH}$  nor  $\text{-COOH}$  since it does not react with sodium. It is a diester formed when  $\text{-OH}$  and  $\text{-COOH}$  groups of one lactic acid molecule reacts with the  $\text{-COOH}$  and  $\text{-OH}$  groups respectively of another lactic acid molecule.

(d)(i) E has a chiral centre as it rotates plane-polarised light. E is an aldehyde since it reacts with Fehling's solution to give a reddish brown precipitate.

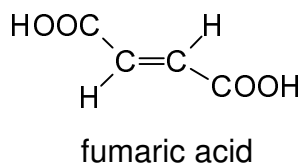
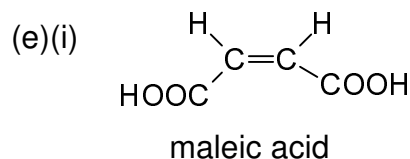
$$\text{Amount of hydrogen evolved with sodium per mol of E} = \frac{0.24}{24} \div 0.01 = 1 \text{ mol}$$

Hence two displaceable H are present  $\Rightarrow$  there are two  $\text{-OH}$  group.

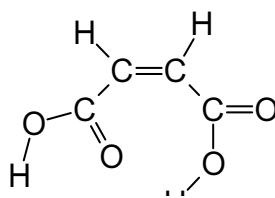


(ii) E is an alcohol. The stability of its anion is lower than the stability of the anion of lactic acid as the anion is destabilised by the electron-donating  $\text{-CH}_2\text{CH(OH)CHO}$  group.

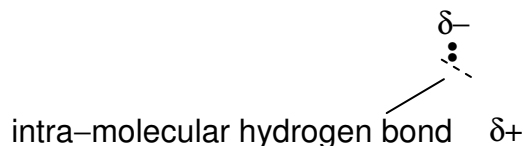
Lactic acid is a much stronger acid as its anion forms two equivalent resonance structures with the negative charge on O delocalised over two electronegative O atoms.



(ii) Intramolecular hydrogen-bonding occurs in maleic acid and thus it has lower melting point as there are less sites for inter-molecular hydrogen bonding.





**RI/2009/P3/Q5b**

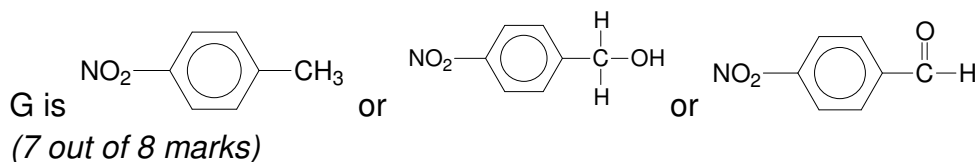
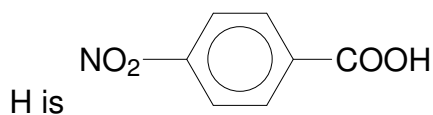
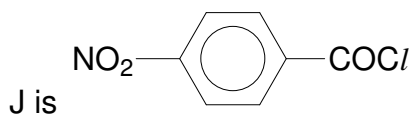
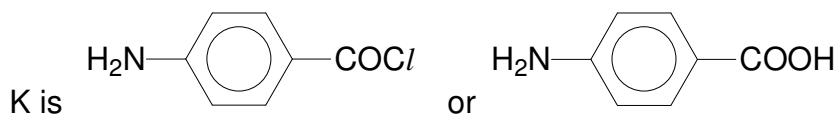
22.

(b) Information	Deduction of structure
Formula of G = C <sub>8</sub> H <sub>11</sub> O <sub>3</sub> N	Index of unsaturation = $\frac{1}{2}(2 \times 8 + 2 - 11 + 1) = 4$ (or high C to H ratio) ⇒ G is likely to contain a benzene ring/ aromatic.
G rotates plane-polarised light.	G is likely to contain at least one chiral carbon.
G gives a violet colouration with neutral FeCl <sub>3</sub> solution	G is a phenol with violet colouration formed by complex formation.
G reacts with 2 mol of aq NaOH	There are 2 phenolic-OH group in G, reacting with OH <sup>-</sup> via acid-base reaction.
G is insoluble in water but dissolves in dil H <sub>2</sub> SO <sub>4</sub> .	G is likely to contain an amine group, with -NH <sub>2</sub> being protonated by H <sup>+</sup> .
G is oxidised by K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> to form a product which reacts with 2,4-DNPH to give an orange ppt.	G is a secondary alcohol and is oxidised to a ketone by K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .
H is formed by reaction of G with Al <sub>2</sub> O <sub>3</sub>	H is formed from G by dehydration, it is likely an alkene.
H reacts with aq Br <sub>2</sub> to form C <sub>8</sub> H <sub>7</sub> O <sub>3</sub> NBr <sub>4</sub> .	The product is likely to be a bromohydrin formed by electrophilic addition and electrophilic substitution into activated benzene ring.
G reacts with ClCO-COCl to	The phenol, secondary alcohol and amine reacts

form J which has 3 hexagonal rings.	with $\text{ClCO-COCl}$ via nucleophilic substitution. 3 hexagonal ring $\Rightarrow$ cyclic esters and amides formed with the phenolic $-\text{OHs}$ and alcoholic $-\text{OH}$ and amine on adjacent carbon atoms.
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**SRJC/2009/P3/Q5a**

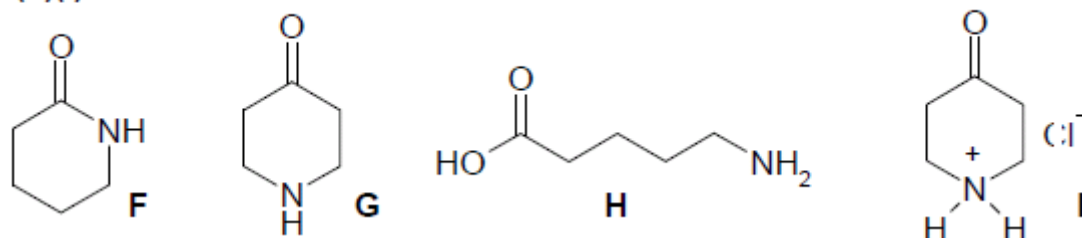
23. (a)
- G undergoes oxidation with acidified  $\text{KMnO}_4$ .
  - H undergoes nucleophilic substitution with  $\text{PCl}_5$ .
    - H is an alcohol or carboxylic acid
    - J is a halogenoalkane or acyl chloride
  - J undergoes reduction with tin in concentrated hydrochloric acid.
    - J contains nitrobenzene
    - K contains phenylamine
  - K reacts with  $(\text{C}_2\text{H}_5)_2\text{NCH}_2\text{CH}_2\text{OH}$  through esterification/nucleophilic substitution/acylation
    - J must contain acyl chloride
    - H is a carboxylic acid



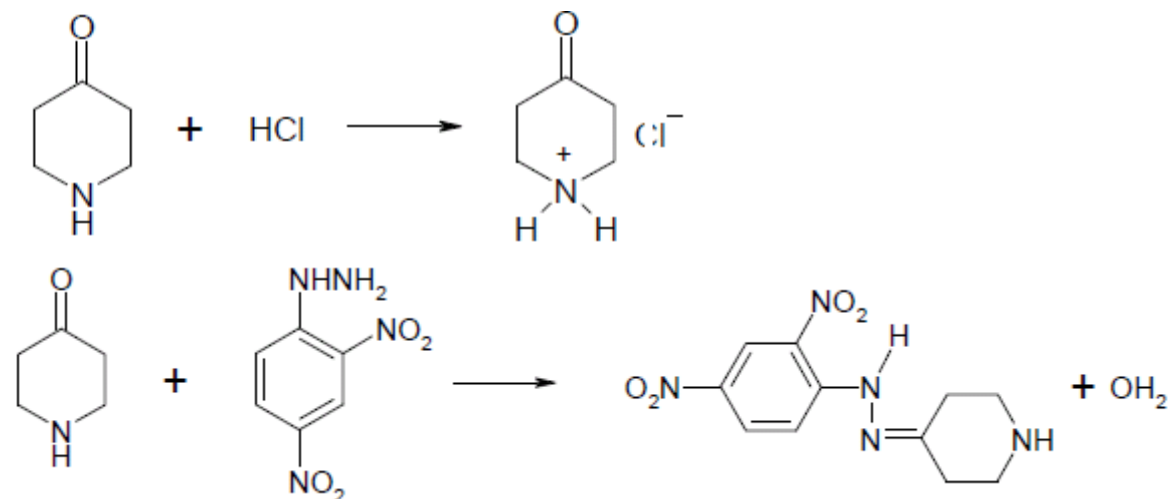
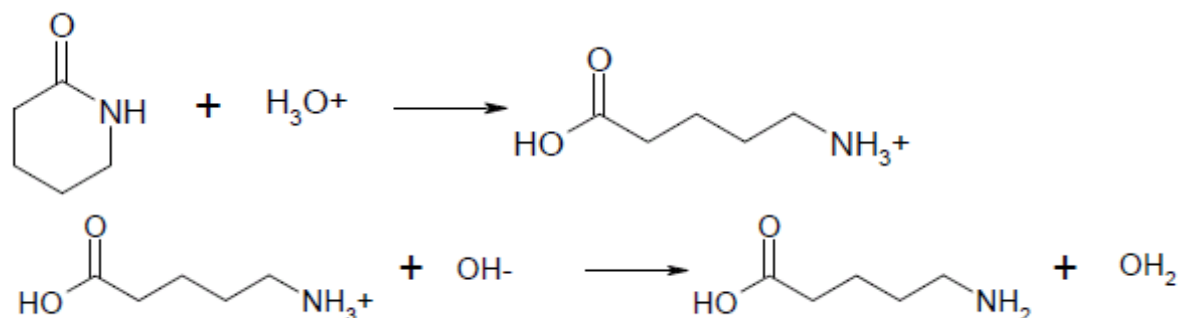
**TPJC/2009/P3/Q4b**

24.

4(b)(i)



A number of other structures are acceptable for F & G. As long as the structure has the correct functional group, and meets the given molecular formula (ie has a ring), the structure can be accepted. No marks are deducted for highly unstable ring structures such as 3 or 4 member rings.



(ii) F is a [primary/secondary] amide the lone pair of electrons on the N atom are drawn toward the electronegative oxygen atom and are not available for donation.

G is a [primary/secondary] amine and has a lone pair of electrons on the N atom available for donation

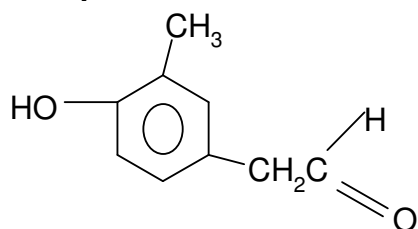
**TPJC/2009/P3/Q5c**

25.

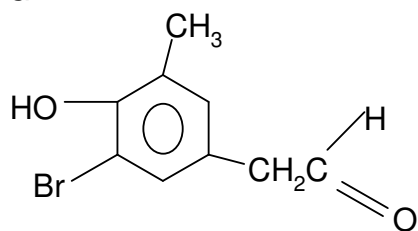
## Structural Elucidation in Organic Chemistry

- compound F has high C:H ratio/C:H almost 1, hence likely to be benzene derivatives.
- compound F is insoluble in water but dissolves in NaOH → F is acidic.
- (F undergoes CONDENSATION rx with 2,4-DNPH → F is carbonyl compound.)
- F reacts with Fehling's soln → F is an aliphatic aldehyde.
- F undergoes electrophilic substitution readily with bromine water to form G, which (only has one H of F substituted with Br) → F is a disubstituted phenol.
- F undergoes side chain alkyl gp oxidation with hot H<sup>+</sup>/KMnO<sub>4</sub> to give an acid, H.
- (H, C<sub>8</sub>H<sub>6</sub>O<sub>5</sub> has one carbon less than F → F has an ethyl side chain)
- H reacts with Na<sub>2</sub>CO<sub>3</sub> in 1:1 ratio → H is dibasic acid

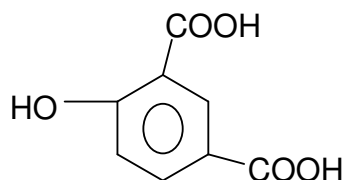
F



G



H



Structural Elucidation in Organic Chemistry

