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CHEMISTRY
ORGANIC CHEMISTRY

Level & Board	CIE (A-LEVEL)
TOPIC:	HYDROCARBONS
PAPER TYPE:	SOLUTION - 1
TOTAL QUESTIONS	10
TOTAL MARKS	87

Hydrocarbons - 1

1)

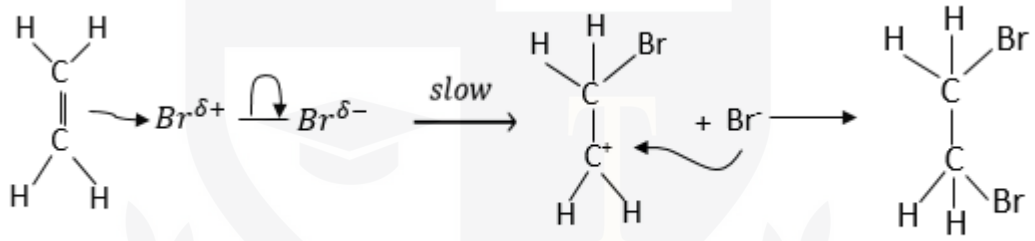
(a) (i) Cracking is a process whereby a large molecule is broken down into smaller molecules.

(ii) Heal and/or with a catalyst.

(iii) $C_{10}H_{22} \longrightarrow C_5H_{10} + C_5H_{12}$

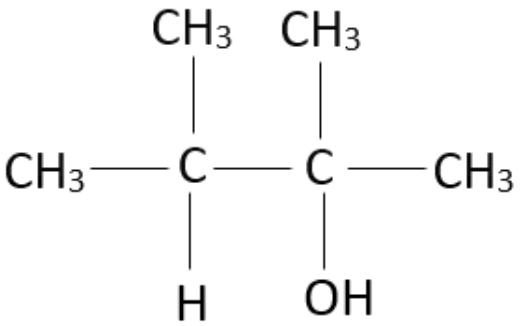
(iv) It allows the formation of useful smaller molecules from the larger but less useful molecules.

(b) Electrophillic addition



The electron rich double polarizes the Br2 molecule. The Br – Br bond undergoes heterolytic cleavage and a bromonium ion is formed. The Br- then attacks the bromonium ion to form 1,2 – dibromoethane.

(c) (i)



(ii) $HOOC - (CH_2)_4 - COOH$

2)

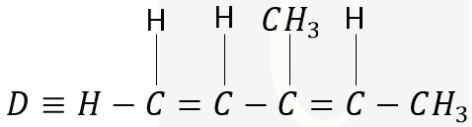
(a) (i) uv light.

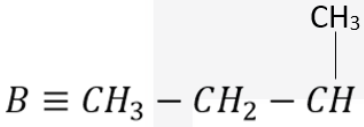
(ii) The reaction goes via a free – radical pathway, and the overall reaction is a substitution (where a H in C_2H_6 is replaced by a Br).

(iii) The reaction is catalysed by the uv light and both C2H6 and Br2 are both in the gaseous phase (hence homogeneous).

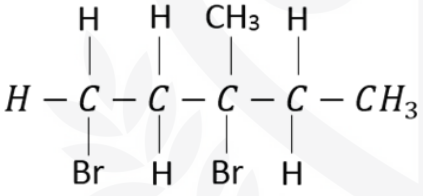
(b) (i) NaOH, ethanol solvent, heat.

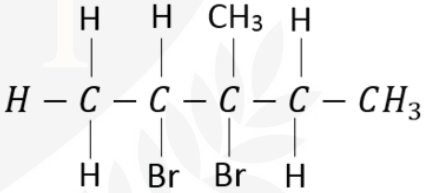
(ii)





(iii)





(iv) 2

Only the C = C bond at C – 2 and C – 3 can show cis – trans isomerism since 2 different groups are bonded to each of these 2 carbon atoms.

3)

(a) **I**: Limited Cl_2. uv light

II: Limited Cl_2, $FeCl_3$ catalyst

III: $KMnO_4$, dilute H_2SO_4, heat

IV: PCl_5

(b) Ease of hydrolysis: **K** > **H** > **J**

J is difficult to be hydrolysed because there is partial double bond character between C and Cl. The Cl p – orbital can overlap with the π – orbitals of benzene ring.

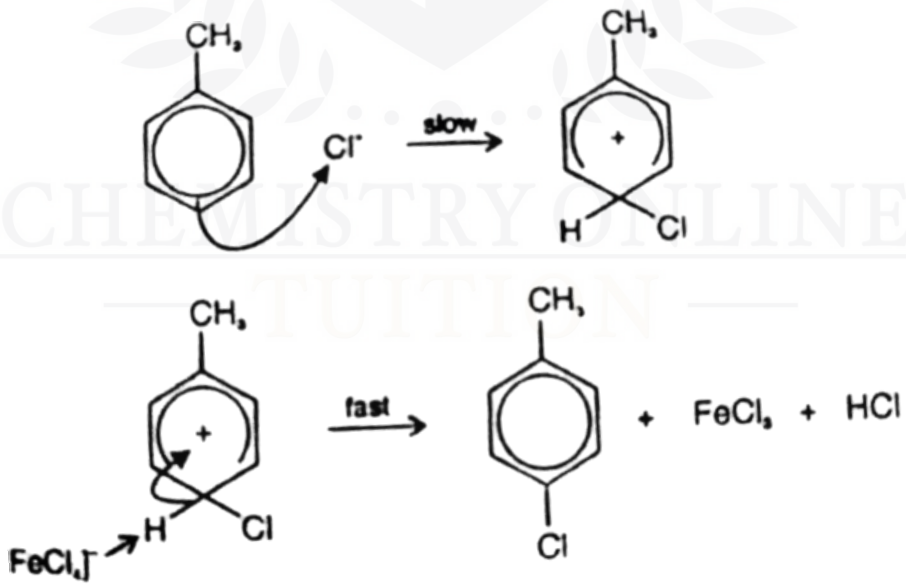
K is hydrolysed readily because the presence of 2 highly electronegative O and Cl makes the carbon atom in – COCl highly electron deficient, and hence radily attacked by water nucleopile.

(c) (i) An electrophile is an electron deficient species that readily accepts an electron pair.

(ii) $FeCl_3 + Cl_2 \longrightarrow [FeCl4]^- + Cl^-$

$FeCl_3$ is a lewis acid and it readily accepts an electron pair form Cl_2. Cl_2 undergoes heterolytic fission, thus generating a Cl^+.

(iii)



4)

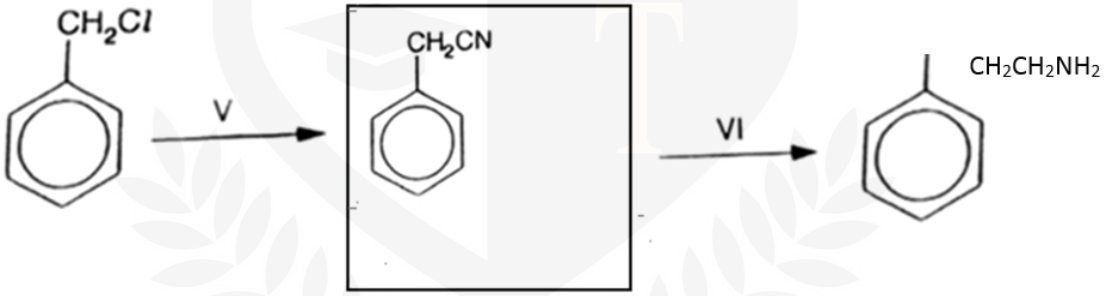
(a)

	Reagents	Conditions
I.	Cl_2 / $AlCl_3$	heat
II.	Cl_2	UV
III.	$KMnO_4$	H^+(dil. Acid)
IV	$SOCl_2$	room temperature

(b) reaction I: electrophilic substitution

reaction III: oxidation

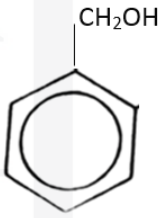
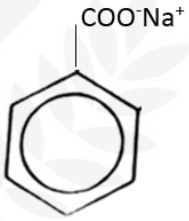
(c)



Reagents and conditions for step V: KCN / ethanol heat

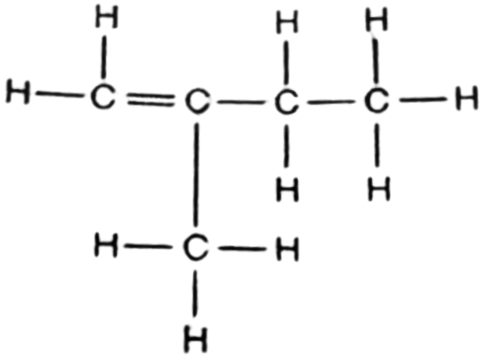
reagents and conditions for step VI: $LiAlH_4$ dry ether

(d)

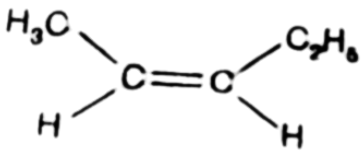
compound	reagent	
	cold water	hot NaOH(aq)
E	no reaction	no reaction
F	no reaction	
G		

5)

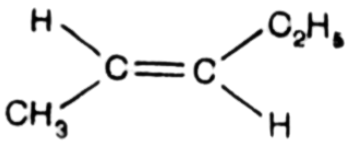
(a)



(b)

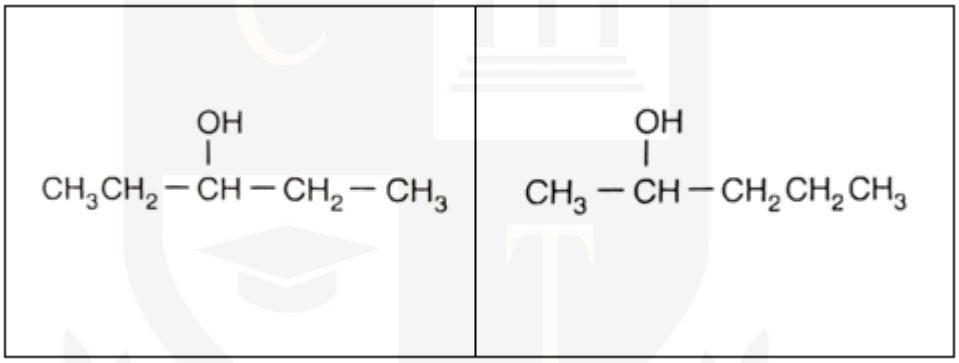


cis

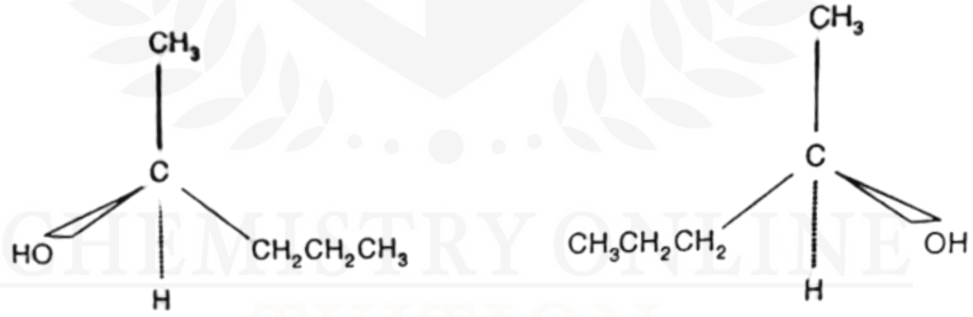


trans

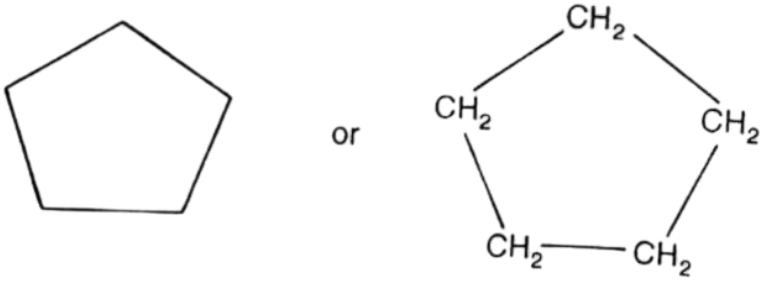
(c)



(d)

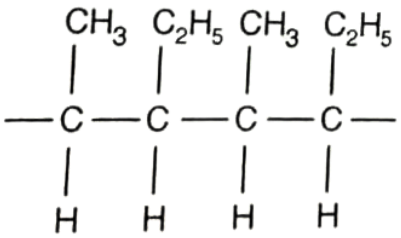


(e)



or

(f)

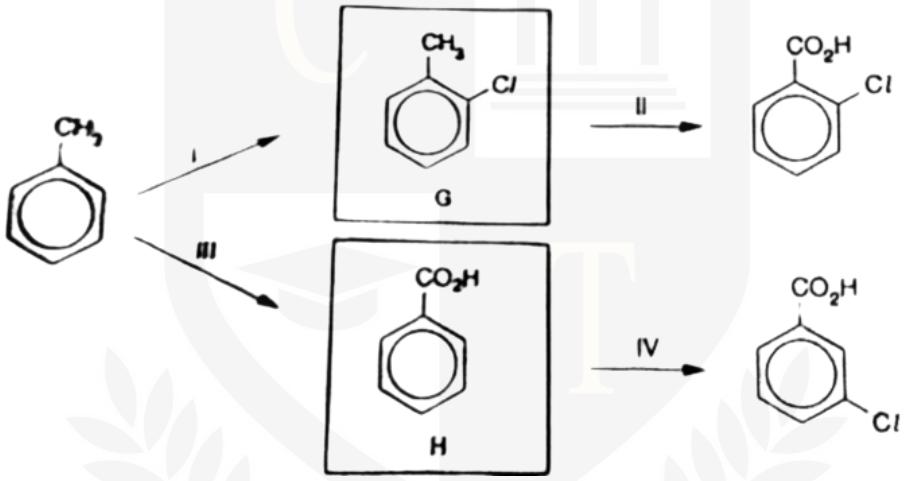


6)

(a) Conc HNO_3 + Conc H_2SO_4 at 50 – 60^0C

(b) $2H_2SO_4 + HNO_3 \rightarrow 2HSO_4^- + H_3O^+ + NO_2^+$

(c)

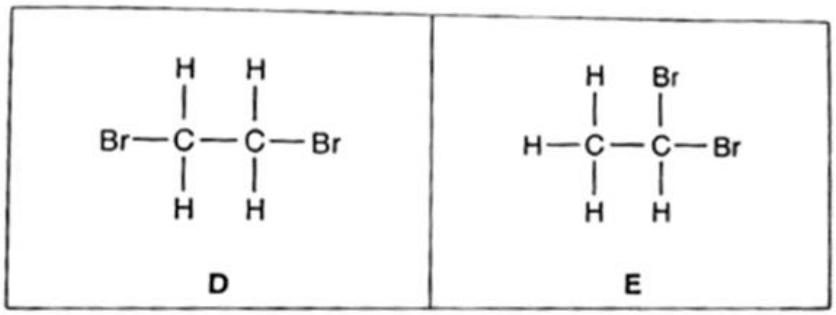


Reaction I: Cl_2 & $AlCl_3$ reaction II: $KMnO_4$;H^+

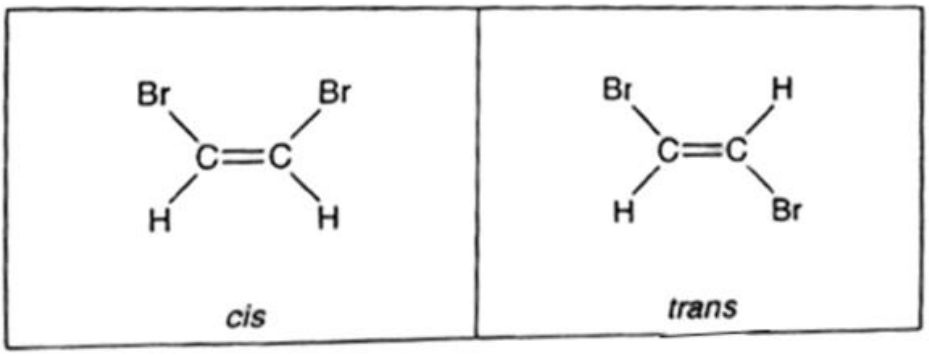
Reaction III: $KMnO_4$ / H^+ reaction IV: Cl_2 & Cl_2 & $AlCl_3$

7)

(a) (i)



(ii)



(b) (i) Hydrogen

Nickel catalyst.

(ii) Isomer formed is: 1 > 2 dibromoethane (D) above.

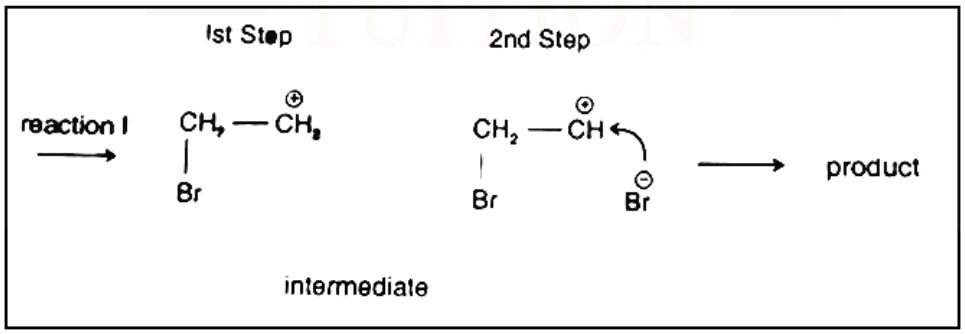
reason: Cis isomer has one Br atom on each carbon atom on the same side of the double bond.

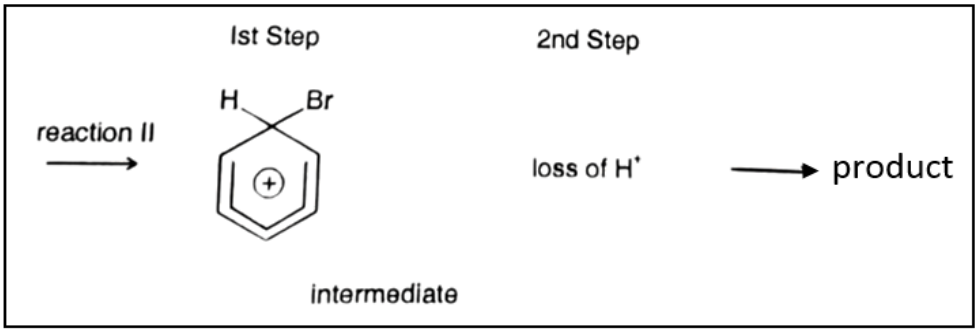
8)

(a) reaction I: Electrophillic addition.

reaction II: Electrophillic substitution.

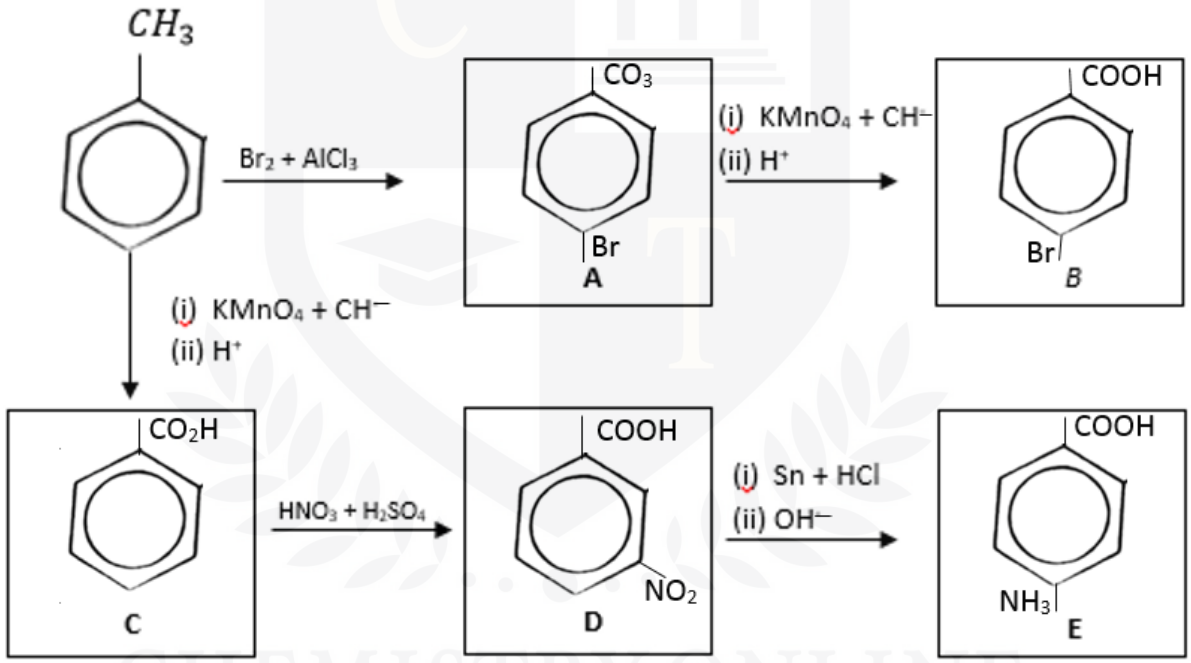
(b)





(c) Delocalised ring of electrons (in benzene) is stable so reformed in the 2nd step.

9)



10)

(a) (i)

$^{79}Br^+$	$^{81}Br^+$	($^{79}Br^-$ $^{79}Br^+$)	($^{81}Br^-$ $^{79}Br^-$)	($^{81}Br^-$ $^{81}Br^-$)
79	81	158	160	162

(ii)

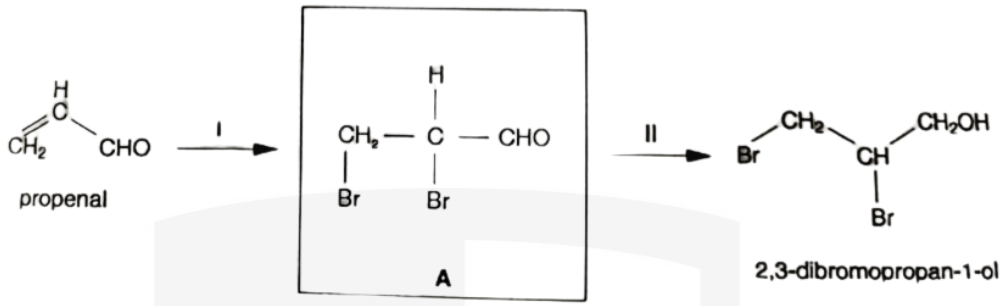
- 158, 160, 162

1 : 2 : 1

- 79 : 81

  1 : 1

(b) (i)



(ii)

- Reaction I: Br_2 in CCl_4
- Reaction II: UA/H_4 / Ether or ($NaBH_4$)

(c) (i) 218, 220, 216

(ii)

mass number	molecular formula
31	CH_3O^+
106	$C_2H_3{}^{79}Br^+$
108	$C_2H_3Br81^+$
185	$C_2H_3{}^{79}Br_2{}^+$
187	$C_2H_3{}^{79}Br^{81}Br^+$
189	$C_2H_3Br^{81}Br^{81+}$

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