2014 – CY

Booklet No. **301782**

A

Test Paper Code : CY

QUESTION BOOKLET CODE **A**

Reg. No.

Time : 3 Hours

Name :

Maximum Marks : 100

SEAL

SEAL

GENERAL INSTRUCTIONS

1. This Question-cum-Answer Booklet has **20** pages consisting of Part-I and Part-II.

2. An **ORS** (Optical Response Sheet) is inserted inside the Question-cum-Answer Booklet for filling in the answers of Part-I. Verify that the CODE and NUMBER Printed on the ORS matches with the CODE and NUMBER Printed on the **Question-cum-Answer Booklet.**

3. Based on the performance of Part-I, a certain number of candidates will be shortlisted. Part-II will be evaluated only for those shortlisted candidates.

4. The merit list of the qualified candidates will depend on the performance in both the parts.

5. Write your **Registration Number and Name** on the top right corner of this page as well as on the right hand side of the **ORS**. Also fill the appropriate bubbles for your registration number in the **ORS**.

6. The Question Booklet contains blank spaces for your rough work. No additional sheets will be provided for rough work.

7. **Non-Programmable Calculator is <u>ALLOWED</u>. But clip board, log tables, slide rule, cellular phone and other electronic gadgets are <u>NOT ALLOWED</u>.**

8. The Question-cum-Answer Booklet and the ORS must be returned in its entirety to the Invigilator before leaving the examination hall. **Do not remove any page from this Booklet.**

9. Refer to special instructions/useful data on the reverse of this page.

Instructions for Part-I

10. Part-I consists of **35** objective type questions. The first 10 questions carry **ONE** mark each and the rest 25 questions carry **TWO** marks each.

11. Each question has 4 choices for its answer: (A), (B), (C) and (D). Only **ONE** of the four choices is correct.

12. Fill the correct answer on the left hand side of the included **ORS** by darkening the appropriate bubble with a black ink ball point pen as per the instructions given therein.

13. There will be **negative marks for wrong answers**. For each 1 mark question the negative mark will be 1/3 and for each 2 mark question it will be 2/3.

Instructions for Part-II

14. Part-II has **8** subjective type questions. Answers to this part must be written in blue/black/blue-black ink only. The use of sketch pen, pencil or ink of any other color is not permitted.

15. Do not write more than one answer for the same question. In case you attempt a descriptive question more than once, please cancel the answer(s) you consider wrong. Otherwise, the answer appearing last only will be evaluated.

Special Instructions / Useful Data

Velocity of light = 3×10^8 ms^{-1}

1 atmosphere = 101325 Pa

R = 8.314 J mol^{-1} K^{-1}

PART-I: Objective Questions

Q.1 – Q. 10 carry one mark each:

Q.1   For square matrices M and N, if $MN = M$ and $NM = N$, then:

(A) $M^2 = M$ and $N^2 = N$ (B) $N^2 \neq N$ and $M^2 = M$

(C) $M^2 \neq M$ and $N^2 \neq N$ (D) $M^2 \neq M$ and $N^2 = N$

Q.2   The energy of an electron in a hydrogenic atom with nuclear charge Z varies as:

(A) Z (B) Z^2 (C) $1/Z$ (D) $1/Z^2$

Q.3   The carbonyl stretching frequency ($\nu_{C=O}$) is highest for:

Q.4   The homolytic breaking of the C_a–C_b bond is easiest in:

CY-1/20

Q.5 Tollen's test will be negative for:

(A) Glucose   (B) Mannose   (C) Sucrose   (D) Galactose

Q.6 Which one among the following is a sesquiterpene?

(A)

(B)

(C)

(D)

Q.7 The predicted geometry of TeF_4 by **VSEPR theory** is:

(A) Octahedral   (B) Square planar
(C) Tetrahedral   (D) Trigonal bipyramidal

Q.8 Among the following, the isoelectronic pair is:

(A) NO and CO   (B) O_2^- (superoxide anion) and NO^-
(C) NO^+ and CO   (D) O_2^- (superoxide anion) and NO^+

Q.9 The metal ion of an enzyme involved in hydration of CO_2 is:

(A) Cu (II)   (B) Fe (II)   (C) Mg (II)   (D) Zn (II)

Q.10 Among the following, the element having maximum inert pair effect is:
[Given: Atomic number of Ge = 30, Pb = 82, Si = 14 and Sn = 50]
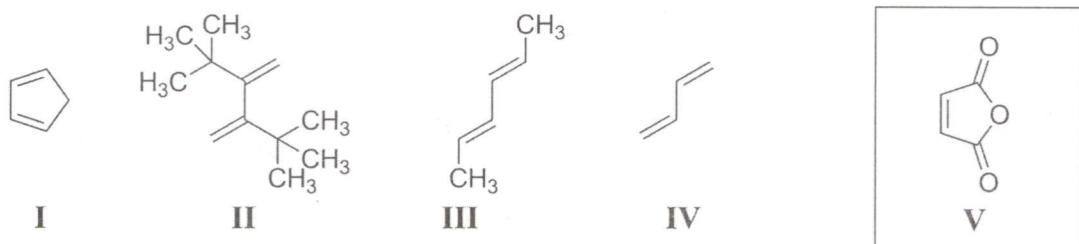
(A) Ge   (B) Pb   (C) Si   (D) Sn
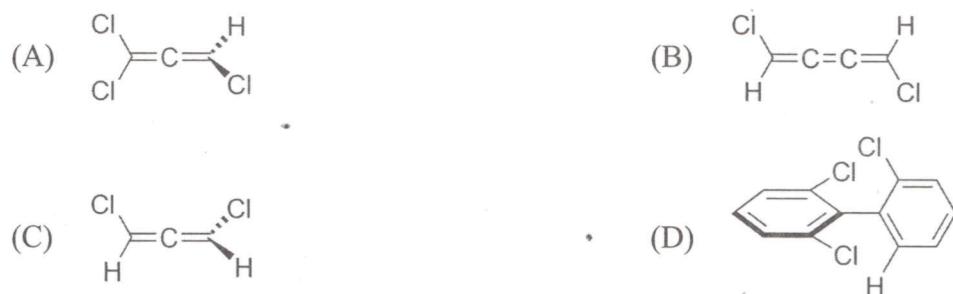
Q. 11 – Q. 35 carry two marks each:
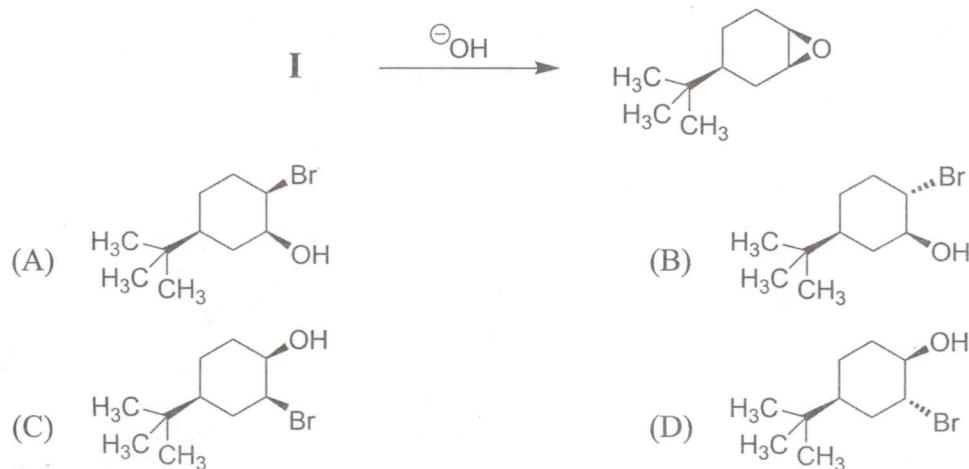
Q.11   The reactivity of compounds **I-IV** with maleic anhydride (**V**) follows the order:

(A)   **I < II < III < IV**

(B)   **II < IV < III < I**

(C)   **II < I < III < IV**

(D)   **II < I < IV < III**

Q.12   Which one among the following molecules is chiral?
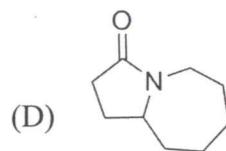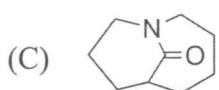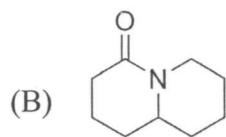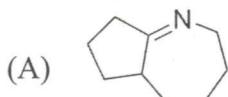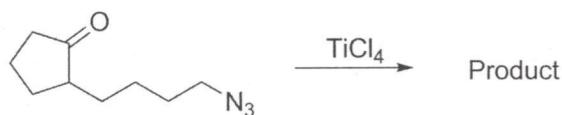
Q.13   Identify the starting material **I** in the given reaction.
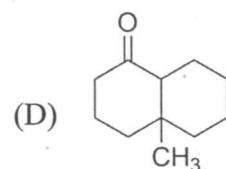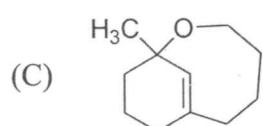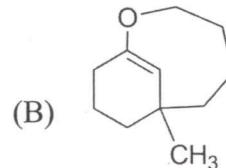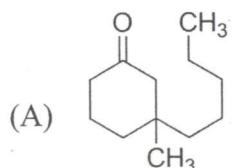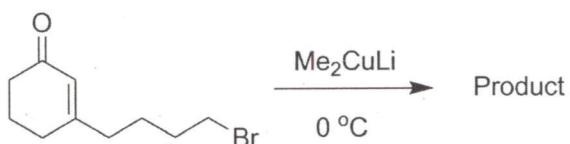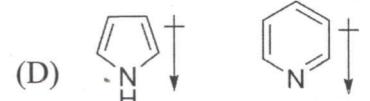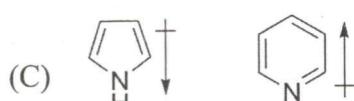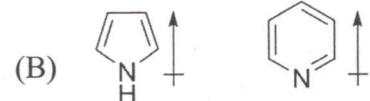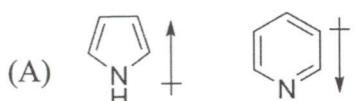
Q.14 The major product for the following reaction is:

$$\xrightarrow{\text{TiCl}_4} \text{Product}$$

(A)

(B)

(C)

(D)

Q.15 The structure of the major product in the following reaction is:

$$\xrightarrow[\text{0 °C}]{\text{Me}_2\text{CuLi}} \text{Product}$$

(A)

(B)

(C)

(D)
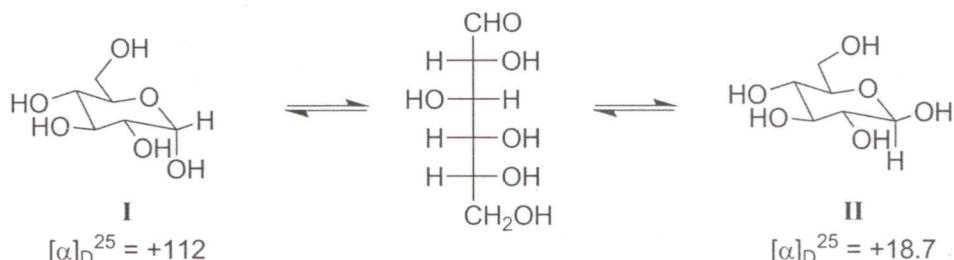
Q.16 The correct orientation of dipoles in pyrrole and pyridine is:

(A)

(B)

(C)

(D)
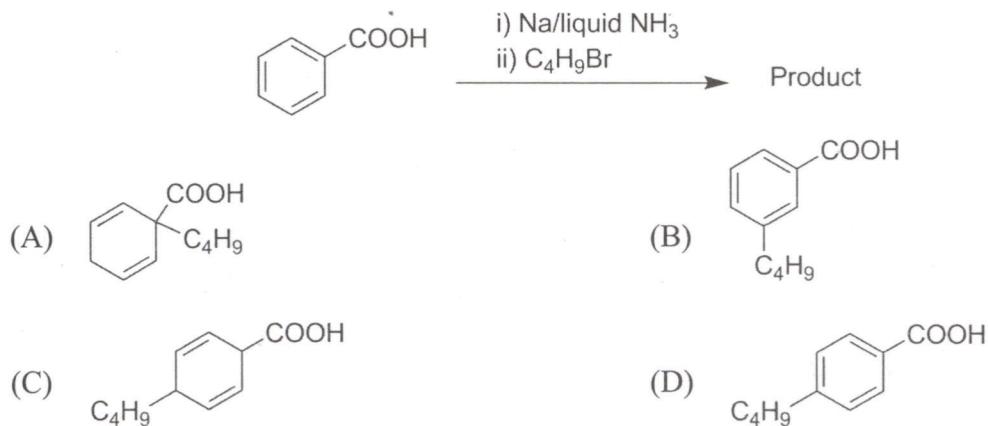
Q.17 Specific rotations of freshly prepared aqueous solutions of **I** and **II** are +112 and +18.7, respectively. On standing, the optical rotation of aqueous solution of **I** slowly decreases to give a final value of +52.7 due to equilibration with **II**. Under this state of equilibrium, what is the ratio **II:I** ?


I

$[\alpha]_D^{25} = +112$

CHO
H——OH
HO——H
H——OH
H——OH
CH$_2$OH

II

$[\alpha]_D^{25} = +18.7$

(A) 0.57   (B) 1.00   (C) 1.75   (D) 5.9
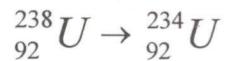
Q.18 The major product formed in the following reaction is:

i) Na/liquid NH$_3$
ii) C$_4$H$_9$Br

Product

(A)   (B)

(C)   (D)

Q.19 In boron neutron capture therapy, the initial boron isotope used and the particle generated after neutron capture respectively are:

(A) ^{11}B and α particle   (B) ^{10}B and α particle

(C) ^{11}B and β particle   (D) ^{10}B and β particle

Q.20 The number of α and β particle(s), generated in the following radioactive decay process, are:

$$^{238}_{92}U \rightarrow\ ^{234}_{92}U$$

(A) one α and two β particles   (B) two α and one β particles

(C) one α and four β particles   (D) no α and four β particles

Q.21 In the measurement of hardness of water by complexometric titration, identify **P** and **Q** in the following equation.

$$[\mathbf{P}]^- + [H_2Y]^{2-} \rightarrow [\mathbf{Q}]^{2-} + [HIn]^{2-} + H^+$$

red   colourless   colourless   blue

(A) **P** = MgY ; **Q** = MgIn

(B) **P** = MgY$_2$; **Q** = MgIn$_2$

(C) **P** = MgIn$_2$; **Q** = MgY$_2$

(D) **P** = MgIn ; **Q** = MgY

Q.22 An aqueous solution of hemoglobin has a molar absorptivity value of $18,600$ L mol^{-1}cm^{-1} for an absorbance value of 0.1 at 540 nm (Given: cell thickness $= 1$ cm). The concentration (in µM) of the hemoglobin solution is:

(A) 0.537   (B) 5.37   (C) 53.7   (D) 537.0

Q.23 The electronic transitions responsible for the colour of K$_2$Cr$_2$O$_7$ and porphine in their solid state respectively are:

(A) d$\rightarrow$d ; $\pi\rightarrow\pi^*$

(B) M$\rightarrow$L charge transfer ; $\pi\rightarrow\pi^*$

(C) L$\rightarrow$M charge transfer ; $\pi\rightarrow\pi^*$

(D) L$\rightarrow$M charge transfer ; d$\rightarrow$d
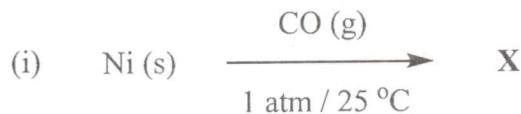
Q.24 The correct order of M–C (M = Ti, V, Cr and Mn) bond stretching frequency is:

(Given: Atomic number of Ti = 22, V = 23, Cr = 24 and Mn = 25)

(A) $[V(CO)_6]^- < Cr(CO)_6 < [Mn(CO)_6]^+ < [Ti(CO)_6]^{2-}$

(B) $[Ti(CO)_6]^{2-} < [V(CO)_6]^- < Cr(CO)_6 < [Mn(CO)_6]^+$

(C) $[Mn(CO)_6]^+ < Cr(CO)_6 < [V(CO)_6]^- < [Ti(CO)_6]^{2-}$

(D) $[Mn(CO)_6]^+ < [V(CO)_6]^- < Cr(CO)_6 < [Ti(CO)_6]^{2-}$

Q.25 For the following reactions, the metal complexes **X** and **Y** are:

(i) Ni (s) $\xrightarrow[\text{1 atm / 25 }^\circ\text{C}]{\text{CO (g)}}$ **X**

(ii) FeCl$_2$ $\xrightarrow{\text{2 NaC}_5\text{H}_5}$ **Y**

(A) **X** = Ni(CO)$_4$; **Y** = Fe(η^5-C$_5$H$_5$)$_2$

(B) **X** = Ni(CO)$_4$; **Y** = Fe(η^1-C$_5$H$_5$)$_2$

(C) **X** = Ni(CO)$_5$; **Y** = Fe(η^5-C$_5$H$_5$)$_2$

(D) **X** = Ni(CO)$_6$; **Y** = Fe(η^1-C$_5$H$_5$)$_2$

Q.26 The correct order of crystal field strength is:

(Given: en = ethylenediamine)

(A) Cl$^-$ < H$_2$O < en < (η^5-C$_5$H$_5$)$^-$

(B) H$_2$O < Cl$^-$ < (η^5-C$_5$H$_5$)$^-$ < en

(C) H$_2$O < (η^5-C$_5$H$_5$)$^-$ < en < Cl$^-$

(D) en < Cl$^-$ < H$_2$O < (η^5-C$_5$H$_5$)$^-$

Q.27 The carbon–oxygen bond in an organic compound absorbs electromagnetic radiation of frequency 6×10^{13} Hz. This frequency corresponds to the region:

(A) Infrared   (B) Microwave   (C) Ultraviolet   (D) Visible

Q.28 According to the equipartition principle of energy, the molar heat capacity at constant volume for CO$_2$ (g), SO$_2$ (g) and H$_2$O (g) follows the trend:

(A) CO$_2$ = SO$_2$ = H$_2$O

(B) CO$_2$ > SO$_2$ = H$_2$O

(C) H$_2$O > SO$_2$ = CO$_2$

(D) CO$_2$ = SO$_2$ > H$_2$O

Q.29 $\left[\dfrac{-h^2}{(8\pi^2 m)}\dfrac{d^2}{dx^2} + \dfrac{h^2\alpha^2 x^2}{(2\pi^2 m)} \right] \exp\left(-\alpha x^2\right) = C\dfrac{h^2}{(4\pi^2)}\exp\left(-\alpha x^2\right)$, where h, π, m and α are constants. Then C is:

(A) $2\alpha/m$ (B) $\alpha/2m$ (C) α/m (D) α^2/m

Q.30 Among Ar, NH$_4$Cl, HF and HCl, the strength of interatomic/intermolecular forces follows the order:

(A) NH$_4$Cl > HF > HCl > Ar

(B) HF > HCl > Ar > NH$_4$Cl

(C) HCl > Ar > NH$_4$Cl > HF

(D) Ar > NH$_4$Cl > HF > HCl

Q.31 The number of degrees of freedom in the homogeneous liquid region of a two component system with a eutectic point, at one atmosphere pressure, is:

(A) 0   (B) 1   (C) 2   (D) 3

Q.32 The ionic strength of 0.1 M aqueous solution of $Fe_2(SO_4)_3$ is:

(A) 0.1 M   (B) 0.65 M   (C) 1.3 M   (D) 1.5 M

Q.33 If the transport number of Na^+ is 0.463 (dilute solution of NaCl in methanol), the transport number of H^+ (dilute solution of HCl in methanol) is:

(Given, Λ^∞ (NaCl in methanol) = 96.9 $ohm^{-1}\,cm^2\,mol^{-1}$ and

Λ^∞ (HCl in methanol) = 192 $ohm^{-1}\,cm^2\,mol^{-1}$).

(A) 0.27   (B) 0.46   (C) 0.54   (D) 0.73

Q.34 Charcoal (1 gram) of surface area 100 m^2 per gram, absorbs 60 mg of acetic acid from an aqueous solution at 25 °C and 1 atmosphere pressure. The number of moles of acetic acid adsorbed per cm^2 of charcoal surface is:

(A) 10^{-2} (B) 10^{-6} (C) 10^{-5} (D) 10^{-9}

Q.35 The change in entropy for the following transformations is respectively:

(+ indicates increase, – indicates decrease and 0 indicates no change)

(i) SO_2Cl_2 (g) $\xrightarrow{\Delta}$ SO_2 (g) + Cl_2 (g)

(ii)   n $CH_2{=}CH_2$ (g) $\xrightarrow{Catalyst}$ $-\left[CH_2{-}CH_2\right]_n$ (s)

(iii) I_2 (s) $\xrightarrow[\text{1 atmosphere}]{\Delta}$ I_2 (v)

(iv)   Adiabatic reversible expansion of an ideal gas

(A) +, –, 0, +   (B) +, –, 0, 0   (C) –, +, +, 0   (D) +, –, +, 0

**PART-II: Descriptive Questions**

Q. 36 – Q. 43 carry five marks each.

Q.36   Using crystal field theory (CFT), for the $[Co(NH_3)_6]^{3+}$ ion

    (a)   draw the d-orbital splitting including their orbital labels (designations) and show their electron occupancy.

    (b)   calculate the crystal field stabilization energy (ignore pairing energy) and spin-only magnetic moment values.

    (Given: atomic number of Co = 27)

Q.37 (a) Write the correct order of lattice energy for LiX, X = F, Cl, Br and I.

(b) A first order reflection from (111) plane is observed for LiX with $2\theta = 24.6°$ (X-ray of wavelength 1.54 Å). Assuming LiX to be a cubic crystal system, calculate the length of the side of the unit cell in Å.

Q.38 For the reaction:

$$2\,NO \;+\; 2\,H_2 \;\xrightarrow{\;700\,^{\circ}C\;}\; N_2 \;+\; 2\,H_2O$$

(i) Write the expression for the rate of the reaction in terms of the change in concentrations of NO and H_2O.

(ii) Given the following data for the above reaction, find the order of the reaction with respect to (a) NO and (b) H_2 and the rate constant of the reaction along with the proper unit.
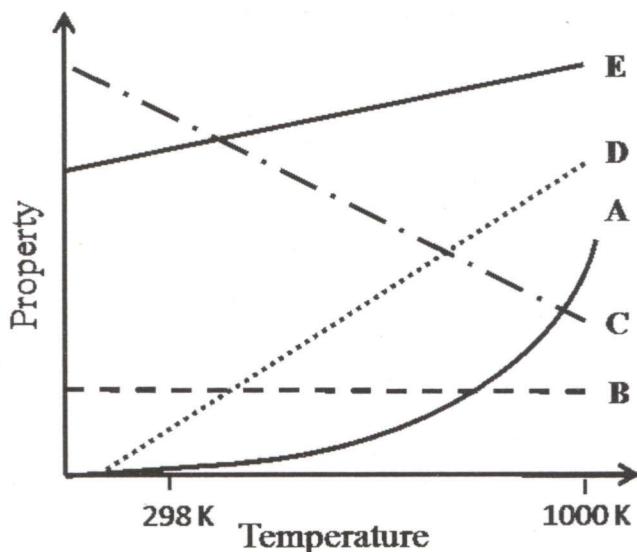
	$[NO]_{t=0}$ (mol dm^{-3})	$[H_2]_{t=0}$ (mol dm^{-3})	Initial rate (mol dm^{-3} s^{-1})
Experiment 1	0.025	0.01	2.4×10^{-6}
Experiment 2	0.025	0.005	1.2×10^{-6}
Experiment 3	0.0125	0.01	0.6×10^{-6}

Q.39 The vapour pressure of benzene is 5333 Pa at 7.6 °C and 53330 Pa at 60.6 °C. Calculate the heat of vapourization of benzene and the normal boiling point of benzene.

Q.40 The following graph represents the dependence of certain properties **I to V** (given below) as a function of temperature.

Property

I   The enthalpy change of a gas phase reaction in which the sum of the number of moles of products is greater than the sum of the number of moles of reactants

II   The osmotic pressure of an ideal solution at a given concentration

III   The standard Gibbs free energy of formation of metal oxides

IV   The molar heat capacity at constant volume for a an ideal gas, as predicted by the equipartition of energy

V   The rate constant of a reaction with $E_a = 100$ kJ mol^{-1}
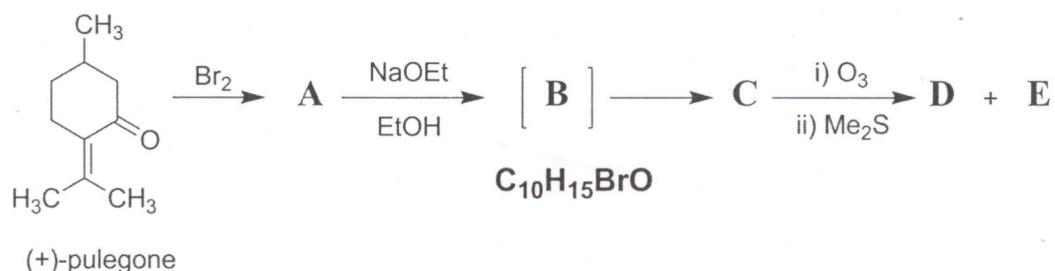
The lines/curves **A, B, C, D** and **E** corresponding to the appropriate property are:

Answer:

| Property	Line/Curve
I	
II	
III	
IV	
V	
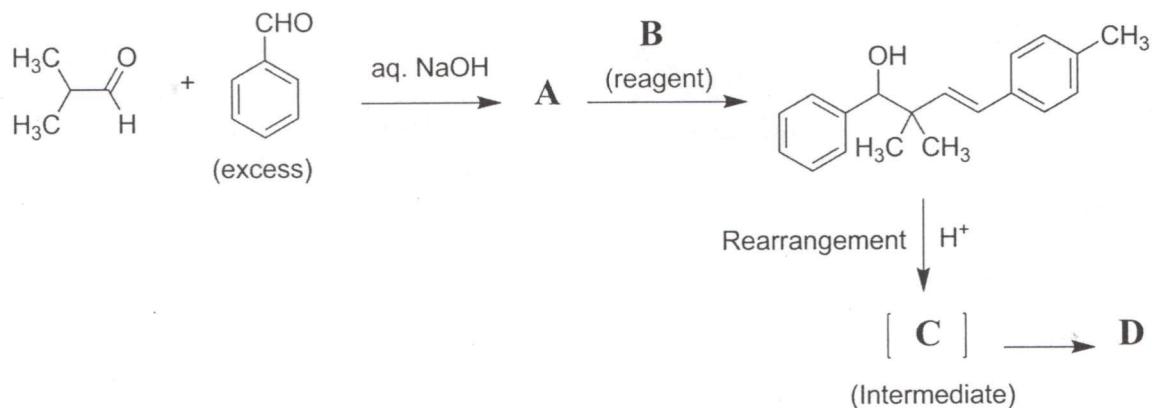
Q.41 Draw the structures **A-E** for the given transformation.
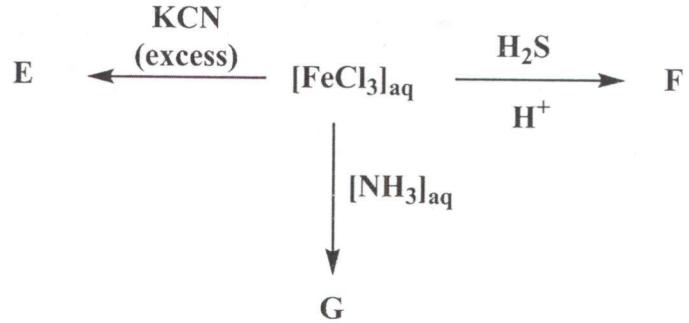
Q.42 In the reaction sequence given below, draw the structures of **A**, **C**, **D** and reagent **B**.

Q.43 (a) How many ^{1}H NMR signals are expected for 2-chlorobut-2-ene? (ignore spin-spin coupling)

(b) Write down the iron containing chemical species, **E**, **F** and **G** in the following reactions.

$$\mathbf{E} \xleftarrow[\text{(excess)}]{\text{KCN}} [\text{FeCl}_3]_{aq} \xrightarrow[\text{H}^+]{\text{H}_2\text{S}} \mathbf{F}$$

$$[\text{FeCl}_3]_{aq} \xrightarrow{\;[\text{NH}_3]_{aq}\;} \mathbf{G}$$

Space for rough work

Space for rough work

Space for rough work

Space for rough work

Question Number	Marks	
36		
37		
38		
39		
40		
41		
42		
43		
Total Marks in the Subjective Part		

Total Marks (in words)	:	
Signature of Examiner(s)	:	
Signature of Head Examiner(s)	:	
Signature of Scrutinizer	:	
Signature of Chief Scrutinizer	:	
Signature of Coordinating Head Examiner	:	

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