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2011 CY

Test Paper Code: CY

Time: 3 Hours **Maximum Marks: 300**

INSTRUCTIONS

1. This question-cum-answer booklet has **38** pages and has **44** questions. Please ensure that the copy of the question-cum-answer booklet you have received contains all the questions.
2. Write your **Registration Number, Name and the name of the Test Centre** in the appropriate space provided on the right side.
3. Write the answers to the objective questions against each Question No. in the **Answer Table for Objective Questions**, provided on Page No. **7**. Do not write anything else on this page.
4. Each objective question has **4 choices** for its answer: (A), (B), (C) and (D). Only **ONE** of them is the correct answer. There will be **negative marking** for wrong answers to objective questions. The following marking scheme for objective questions shall be used:
   (a) For each correct answer, you will be awarded **3 (Three)** marks.
   (b) For each wrong answer, you will be awarded **-1 (Negative one)** mark.
   (c) Multiple answers to a question will be treated as a wrong answer.
   (d) For each un-attempted question, you will be awarded **0 (Zero)** mark.
   (e) Negative marks for objective part will be carried over to total marks.
5. Answer the subjective question only in the space provided after each question.
6. Do not write more than one answer for the same question. In case you attempt a subjective question more than once, please cancel the answer(s) you consider wrong. Otherwise, the answer appearing last only will be evaluated.
7. All answers must be written in blue/black/blue-black ink only. Sketch pen, pencil or ink of any other colour should not be used.
8. All rough work should be done in the space provided and scored out finally.
9. No supplementary sheets will be provided to the candidates.
10. **Clip board, log tables, slide rule, calculator, cellular phone and electronic gadgets in any form are NOT allowed.**
11. The question-cum-answer booklet must be returned in its entirety to the Invigilator before leaving the examination hall. Do not remove any page from this booklet.
12. Refer to special instructions/useful data on the reverse.

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2011 CY

READ INSTRUCTIONS ON THE LEFT SIDE OF THIS PAGE CAREFULLY

REGISTRATION NUMBER						

Name:

Test Centre:

Do not write your Registration Number or Name anywhere else in this question-cum-answer booklet.

I have read all the instructions and shall abide by them.

……..
Signature of the Candidate

I have verified the information filled by the Candidate above.

……..
Signature of the Invigilator

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IMPORTANT NOTE FOR CANDIDATES

- **Questions 1-30 (objective questions) carry *three* marks each and questions 31-44 (subjective questions) carry *fifteen* marks each.**
- **Write the answers to the objective questions in the *Answer Table for Objective Questions* provided on page 7 only.**

Q.1 The pair of semimetals in the following is

(A) Al, Si (B) Ge, As (C) Sb, Te (D) Ca, B

Q.2 The most probable oxidation states for both Cr and Mo are

(A) +2, +3, +4 (B) +2, +3, +5 (C) +2, +3, +6 (D) +3, +4, +5

Q.3 The correct order of acidic character is

(A) $Al_2O_3 > MgO > SiO_2 > P_4O_{10}$ (B) $P_4O_{10} > Al_2O_3 > MgO > SiO_2$

(C) $P_4O_{10} > SiO_2 > Al_2O_3 > MgO$ (D) $SiO_2 > P_4O_{10} > Al_2O_3 > MgO$

Q.4 The pair of amphoteric oxides is

(A) VO, Cr_2O_3 (B) V_2O_3, Cr_2O_3 (C) VO_2, Cr_2O_3 (D) V_2O_5, CrO_3

Q.5 In the structure of $B_4O_5(OH)_4^{2-}$

(A) all four B atoms are trigonal planar

(B) one B atom is tetrahedral and the other three are trigonal planar

(C) three B atoms are tetrahedral and one is trigonal planar

(D) two B atoms are tetrahedral and the other two are trigonal planar

Q.6 The pH of an aqueous solution of Al^{3+} is likely to be

(A) neutral (B) acidic (C) slightly basic (D) highly basic

Q.7 Hydrolysis of $(CH_3)_2SiCl_2$ and CH_3SiCl_3 leads to

(A) linear chain and cross-linked silicones, respectively
(B) cross-linked and linear chain silicones, respectively
(C) linear chain silicones only
(D) cross-linked silicones only

Q.8 The oxide that has the inverse spinel structure is

(A) $FeCr_2O_4$ (B) $MnCr_2O_4$ (C) $CoAl_2O_4$ (D) Fe_2CoO_4

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Q.9 The transition metal monoxide that shows metallic conductivity is

(A) NiO (B) MnO
(C) TiO (D) CoO

Q.10 The metal that is extracted by the reduction method is

(A) Al (B) Au (C) Hg (D) Mg

Q.11 The most viscous liquid is

(A) water (B) methanol (C) ethylene glycol (D) glycerol

Q.12 In ammonical buffer, oxine (8-hydroxyquinoline) forms yellow precipitate with

(A) Mg(II) (B) Ca(II) (C) Ba(II) (D) Sr(II)

Q.13 Addition of an aqueous solution of Fe(II) to potassium hexacyanochromate(III) produces a brick-red colored complex, which turns dark green at 100 ºC. The dark green complex is

(A) $Fe_4[Cr(CN)_6]_3$ (B) $KFe[Cr(CN)_6]$ (C) $KCr[Fe(CN)_6]$ (D) $Fe[Cr(CN)_6]$

Q.14 In the following equation **X** is

$$^{241}_{95}\mathrm{Am} + \alpha \rightarrow {}^{243}_{97}\mathrm{Bk} + \mathbf{X}$$

(A) $2\ {}^{1}_{0}\mathrm{n}$ (B) ${}^{1}_{0}\mathrm{n}$ (C) $2\ {}^{1}_{1}\mathrm{H}$ (D) ${}^{4}_{2}\mathrm{He}$

Q.15 Based on the principle of equipartition of energy, the molar heat capacity of CO_2 at constant volume $C_{v,m}$ is

(A) 3.5R (B) 6R (C) 6.5R (D) 9R

Q.16 One mole of a van der Waals gas undergoes reversible isothermal transformation from an initial volume V_1 to a final volume V_2. The expression for the work done is

(A) $RT\ln\frac{V_2}{V_1} + a(V_2 - V_1)$ (B) $-RT\ln\frac{V_2 - b}{V_1 - b} + a\left(\frac{1}{V_1} - \frac{1}{V_2}\right)$

(C) $RT\ln\frac{P_2}{P_1}$ (D) $RT\ln\frac{V_2 - b}{V_1 - b} - a\left(\frac{1}{V_1} - \frac{1}{V_2}\right)$

Q.17 The scalar product of two vectors **u** and **v**, where $\mathbf{u} = 2\mathbf{i} + 3\mathbf{j} - 5\mathbf{k}$ and $\mathbf{v} = \mathbf{i} + \mathbf{j} + 3\mathbf{k}$, is

(A) -10 (B) $2\mathbf{i} + 3\mathbf{j} - 15\mathbf{k}$ (C) $3\mathbf{i} + 4\mathbf{j} - 2\mathbf{k}$ (D) 10

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Q.18 The minimum concentration of silver ions that is required to start the precipitation of Ag_2S ($K_{sp} = 1 \times 10^{-51}$) in a 0.1 M solution of S^{2-} is

(A) 1×10^{-49} M (B) 1×10^{-50} M (C) 1×10^{-26} M (D) 1×10^{-25} M

Q.19 Identify the correct statement regarding Einstein's photoelectric effect

(A) The number of electrons ejected depends on the wavelength of incident radiation.

(B) Electron ejection can occur at any wavelength of incident radiation.

(C) The number of electrons ejected at a given incident wavelength depends on the intensity of the radiation.

(D) The kinetic energy of the ejected electrons is independent of the wavelength of incident radiation.

Q.20 The hydrolysis constant (K_h) of NH_4Cl is 5.6×10^{-10}. The concentration of H_3O^+ in a 0.1 M solution of NH_4Cl at equilibrium is

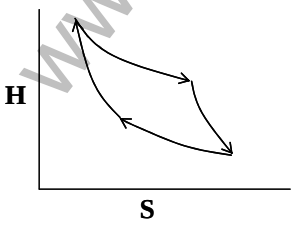
(A) $\sqrt{5.6 \times 10^{-11}}$ (B) $\sqrt{5.6 \times 10^{-10}}$
(C) 5.6×10^{-10} (D) 2.8×10^{-5}

Q.21 The acid dissociation constant (K_a) for HCOOH, CH_3COOH, $CH_2ClCOOH$ and HCN at 25 °C are 1.8×10^{-4}, 1.8×10^{-5}, 1.4×10^{-3} and 4.8×10^{-10}, respectively. The acid that gives highest pH at the equivalence point when 0.2 M solution of each acid is titrated with a 0.2 M solution of sodium hydroxide is

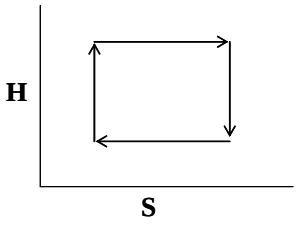
(A) HCOOH (B) CH_3COOH
(C) $CH_2ClCOOH$ (D) HCN

Q.22 For an ideal gas undergoing reversible Carnot Cycle, the plot of enthalpy (H) versus entropy (S) is

(A)



(B)



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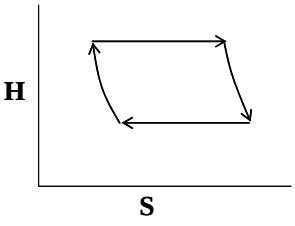

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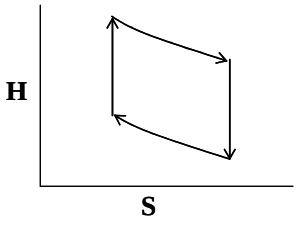

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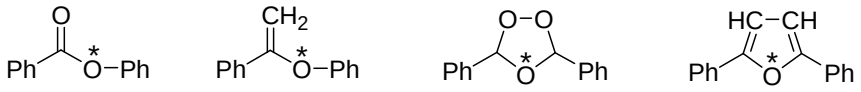
Q.23 Hybridizations of the atoms indicated with the asterisk (*) in the following compounds sequentially are



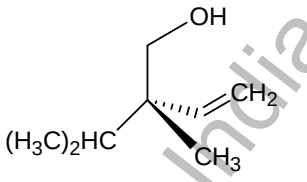
(A) sp^2, sp^2, sp^3, sp^2

(B) sp^2, sp^3, sp^3, sp^2

(C) sp^3, sp^3, sp^3, sp^2

(D) sp^2, sp^2, sp^3, sp^3

Q.24 The Cahn-Ingold-Prelog (CIP) priorities of the groups and the absolute configuration (R/S) of the following compound are



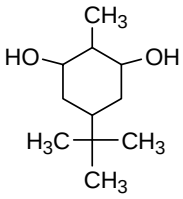
(A) $CH_2OH > CH(CH_3)_2 > CH{=}CH_2 > CH_3$ and S

(B) $CH_2OH > CH{=}CH_2 > CH(CH_3)_2 > CH_3$ and S

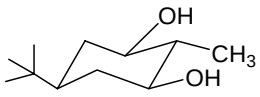
(C) $CH_2OH > CH{=}CH_2 > CH(CH_3)_2 > CH_3$ and R

(D) $CH_2OH > CH(CH_3)_2 > CH{=}CH_2 > CH_3$ and R

Q.25 The optically active stereoisomer of the following compound is



(A)



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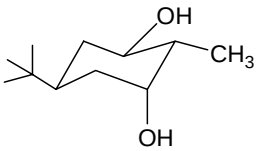

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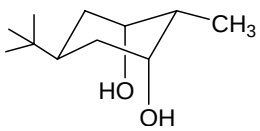

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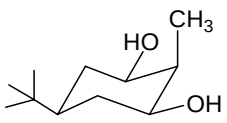

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Q.26 The correct relationship within each pair of the natural products is

(A) camphor–terpene; insulin–protein; nicotine–alkaloids; streptomycin–carbohydrate

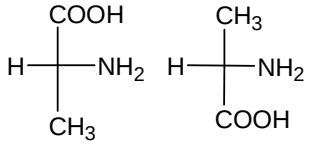
(B) camphor–terpene; insulin–carbohydrate; nicotine–alkaloid; streptomycin–lipid

(C) camphor–alkaloid; insulin–protein; nicotine–terpene; streptomycin–carbohydrate

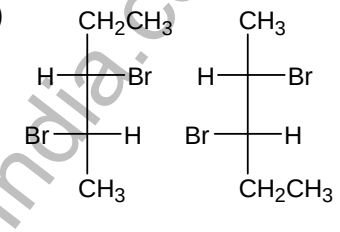
(D) camphor–carbohydrate; insulin–protein; nicotine–alkaloid; streptomycin–terpene

Q.27 The correct sequence of relationships between the compounds of the following pairs **i-iv** is

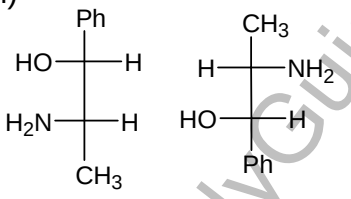
(i)



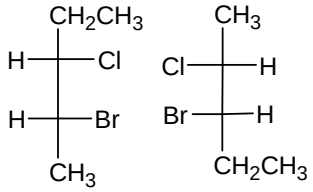
(ii)



(iii)



(iv)



(A) identical, enantiomers, diastereomers and structural isomers

(B) enantiomers, identical, structural isomers and diastereomers

(C) enantiomers, identical, diastereomers and structural isomers

(D) identical, identical, diastereomers and structural isomers

Q.28 The **INCORRECT** statement in the following is

(A) the nucleobase pairs are aligned perpendicular to the helical axis in DNA

(B) RNA contains uracil and thymine, but DNA contains only thymine

(C) all naturally occurring amino acids with the exception of glycine are chiral

(D) all enzymes are proteins, but all proteins are not necessarily enzymes

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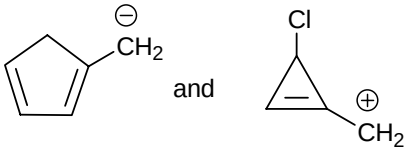
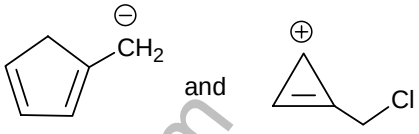
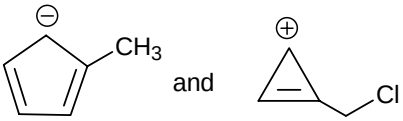
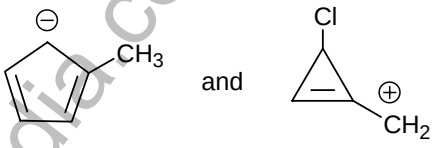
Q.29 The products **P** and **Q** in the following reactions, respectively, are

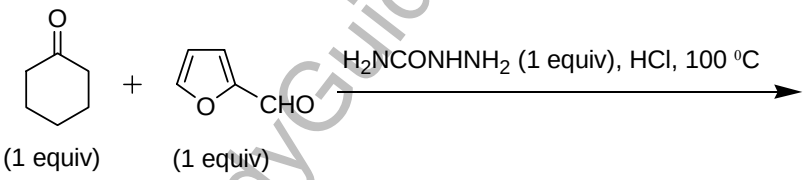
(A) 

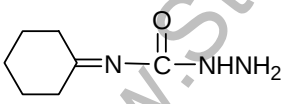
(B) 

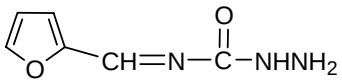
(C) 

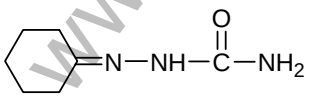
(D) 

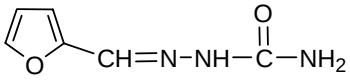
Q.30 The major product in the following reaction is



(A) 

(B) 

(C) 

(D) 

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Answer Table for Objective Questions

Write the Code of your chosen answer only in the 'Answer' column against each Question Number. Do not write anything else on this page.

Question Number	Answer	Do not write in this column	Question Number	Answer	Do not write in this column
01			16		
02			17		
03			18		
04			19		
05			20		
06			21		
07			22		
08			23		
09			24		
10			25		
11			26		
12			27		
13			28		
14			29		
15			30		

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FOR EVALUATION ONLY

Number of Correct Answers		Marks	(+)
Number of Incorrect Answers		Marks	(–)
Total Marks in Question 1-30			( )

Q.31 (a) In the following reactions, identify **X**, **Y** and **Z**.

$$Na_2SO_3 + S \xrightarrow{\text{boiling water}} \mathbf{X} \text{ (colorless solid)}$$

$$AgBr \xrightarrow{\text{excess } \mathbf{X}} \mathbf{Y} \text{ (soluble complex)}$$

$$\mathbf{X} + Cl_2 + H_2O \xrightarrow{\text{boiling water}} \mathbf{Z} + HCl$$

(9)

(b) Draw the structures of $S_4N_4H_4$ and $N_4S_4F_4$. (6)

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Q.32 (a) The magnetic moment of $[Fe(phen)_2(NCS)_2]$ varies with temperature. The magnetic moments at 200 K and 50 K are 4.9 BM and 0 BM, respectively. Write the *d*-electron configurations of Fe at both temperatures and give reason for the observed change in the magnetic moment.

(phen = 1,10-phenanthroline)

(6)

(b) PCl_5 exists as a discrete covalent molecule in the gaseous state, but is ionic in the solid state. Draw the structures of PCl_5 in gaseous and solid states.

(9)

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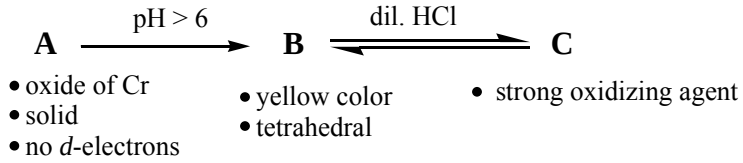
Q.33 In the following equilibrium and reactions, identify species **B** to **E**.

Write the balanced chemical equation for the conversion of **C** to **E**.



B + diphenylcarbazide ⟶ **D** (violet color)

C + HCl ⟶ **E** (greenish yellow gas)

(15)

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Q.34 (a) Identify species **A** and **C** in the following.
Write the balanced chemical equation for the conversion of **A** to $\mathbf{A^{3+}}$.

A + aquaregia ⟶ $\mathbf{A^{3+}}$ + NO

$\mathbf{A^{3+}} + I^-$ ⟶ **B** (black precipitate)

B + I^-(excess) ⇌ **C** (orange color)

Hint: **C** on dilution with water gives **B**

(9)

(b) Draw the structures of **X** and **Y** in the following reactions

(i) Borazine + HCl ⟶ **X**

(ii) Borazine + Br_2 ⟶ **Y**

(6)

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Q.35 (a) The molar conductances at infinite dilution for $BaCl_2$, KCl, K_2SO_4 and Cl^- are 280, 150, 300 and 76 Ω^{-1} m^2 mol^{-1}, respectively. Calculate the transport number of Ba^{2+} in $BaSO_4$ solution at infinite dilution. (9)

(b) If 4 moles of a $\mathbf{MX_2}$ salt in 1 kg of water raises the boiling point of water by 3.2 K, calculate the degree of dissociation of $\mathbf{MX_2}$ in the solution.
(For water, K_b = 0.5 K kg mol^{-1}) (6)

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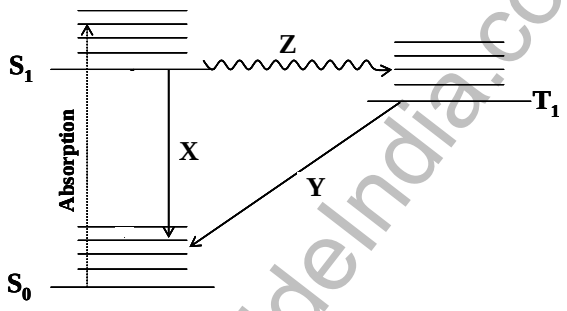
Q.36 (a) For the reaction **R** → **P**, the plot of ln[**R**] versus time (t) gives a straight line with a negative slope. The half life for the reaction is 3 minutes.
(ln 2 = 0.693, ln 0.1 = –2.303)

(i) Derive the expression for $t_{1/2}$.
(ii) Calculate the slope of the straight line.
(iii) Calculate the time required for the concentration of **R** to decrease to 10% of its initial value. (9)

(b) Shown below is the Jablonski diagram that describes various photophysical processes. The solid arrows represent radiative transitions and the wavy arrow represents a non-radiative transition.



(i) Name the photophysical pathways **X**, **Y** and **Z**.
(ii) Which of the radiative decays is faster? (6)

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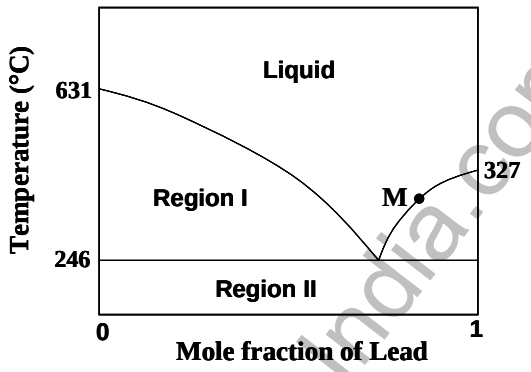
Q.37 (a) (i) Given that $\Delta G = -nFE$, derive the expression for the temperature dependence of the cell potential (E) in terms of the change in entropy (ΔS).

(ii) For a cell reaction, E (at 25 °C) = 1.26 V, $n = 2$ and $\Delta S = -96.5$ J K^{-1} mol^{-1}. Calculate E at 85 °C by assuming ΔS to be independent of temperature. ($F = 96500$ C mol^{-1}) (9)

(b) The phase diagram for the lead-antimony system at a certain pressure is given below.



(i) Identify the phases and components in region I and region II.
(ii) Calculate the number of degrees of freedom (variance) at point **M**. (6)

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Q.38 (a) One mole of an ideal gas initially at 300 K and at a pressure of 10 atm undergoes adiabatic expansion

(i) reversibly and
(ii) irreversibly against a constant external pressure of 2 atm until the final pressure becomes equal to the external pressure.

Calculate ΔS_{system} for (i) and (ii). For (ii), express the final answer in terms of R.

Given: Molar heat capacity at constant volume $C_{v,m} = 3R/2$ (9)

(b) For the following equilibrium at 300 °C,

$$\mathbf{N_2O_4\,(g) \rightleftharpoons 2NO_2\,(g)}$$

Calculate K_p when N_2O_4 is 30% dissociated and the total pressure is 2 bar. (6)

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Q.39 (a) The Maxwell probability distribution of molecular speeds for a gas is

$$F(v)dv = 4\pi v^2\left(\frac{m}{2\pi kT}\right)^{3/2}\exp\left(-\frac{mv^2}{2kT}\right)dv$$

where v is the speed, m the mass of a gas molecule and k the Boltzmann constant.

(i) Use $F(v)$ to show that the most probable speed v_{mp} is given by the expression

$$v_{mp} = \left(\frac{2RT}{M}\right)^{1/2}$$

(ii) Use R = 8 J K^{-1} mol^{-1} in the above expression to calculate the v_{mp} for $CH_4(g)$ at 127 °C. (9)

(b) The wavefunction of a quantum state of hydrogen atom with principal quantum number n = 2 is

$$\psi_{2lm}(r,\theta,\phi) = \frac{1}{\sqrt{32\pi}}\left(\frac{1}{a_0}\right)^{3/2}\left(2-\frac{r}{a_0}\right)\exp\left(-r/2a_0\right)$$

(i) Identify the values of quantum numbers l and m and hence the atomic orbital.
(ii) Find where the radial node of the wavefunction occurs. (6)

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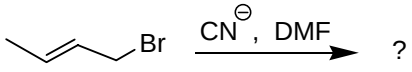
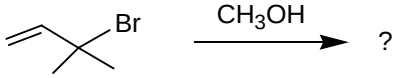
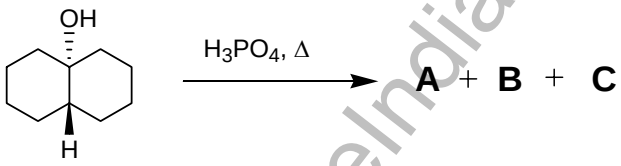
Q.40 (a) Write the possible substitution products in the following reactions.
Indicate the type/s of mechanism/s ($S_N1/S_N2/S_N2'$) that is/are operative in each reaction.

i) 

ii) 

(9)

(b) Write the elimination products **A** to **C** in the following reaction.
Identify the major product.



(6)

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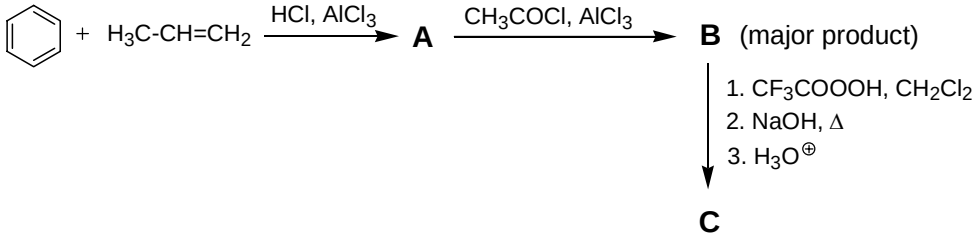
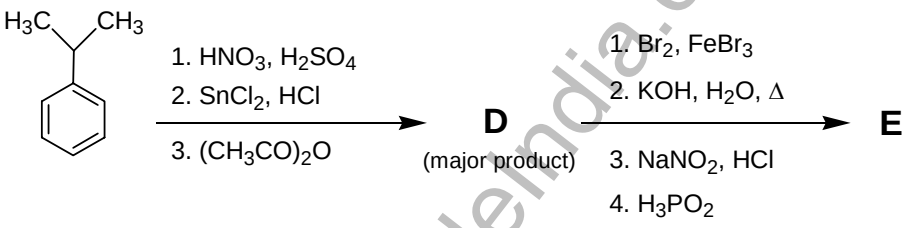
Q.41 (a) Write the structures of **A** to **C** in the following reaction sequence.



(9)

(b) Write the structures of **D** and **E** in the reactions given below.



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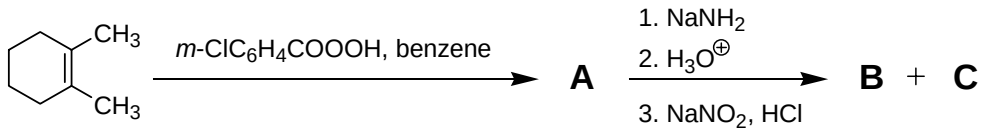
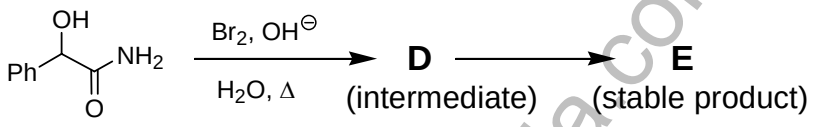
Q.42 (a) Write the structures of **A** to **C** in the following reaction sequence.



(9)

(b) Write the structures of **D** and **E** in the following reaction.



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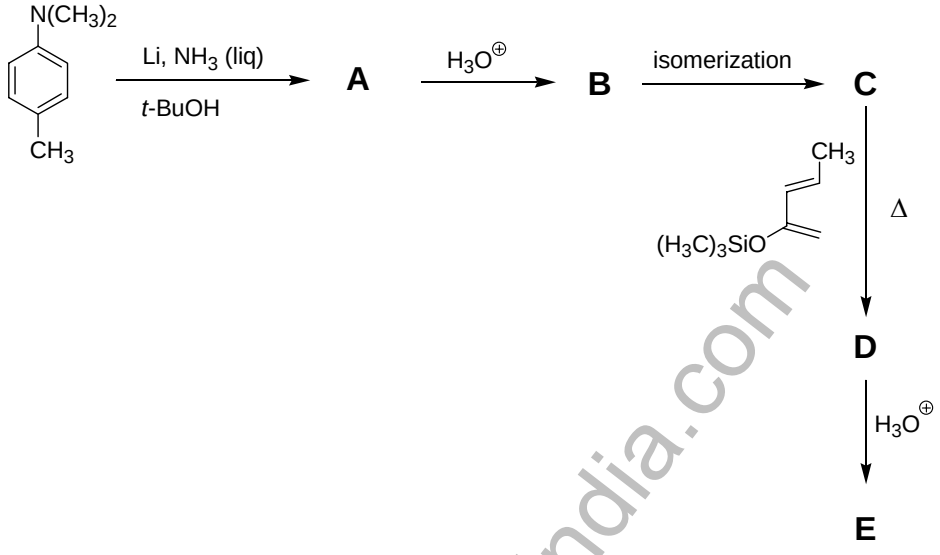
Q.43 Write the structures of the products **A** to **E** in the following reaction sequence.



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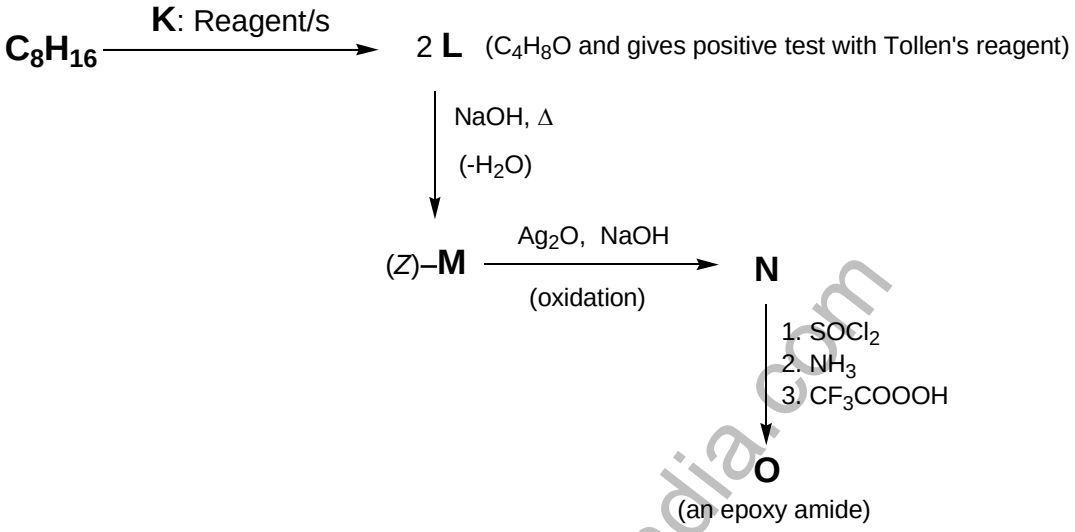
Q.44 Oxanamide **O**, a tranquilizer, is synthesized according to the following reaction Scheme. Write the missing structures and reagent/s **K** to **O**.



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2011 CY Objective Part (Question Number 1 – 30)	
Total Marks	**Signature**

Subjective Part					
Question Number	**Marks**		**Question Number**	**Marks**	
31			**38**		
32			**39**		
33			**40**		
34			**41**		
35			**42**		
36			**43**		
37			**44**		
Total Marks in Subjective Part					

Total (Objective Part) :	
Total (Subjective Part) :	
Grand Total :	
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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