D

2007 – CH

Test Paper Code : CH

Time : 3 Hours Maximum Marks : 300

INSTRUCTIONS

1. The question-cum-answer book has **48** pages and has **44** questions. Please ensure that the copy of the question-cum-answer book you have received contains all the questions.
2. Write your **Roll 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. **13**. 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 objective question, you will be awarded **3 (three)** marks if you have written only the correct answer.
   (b) In case you have not written any answer for a question, you will be awarded **0 (zero)** mark for that question.
   (c) In all other cases, you will be awarded **–1 (minus one)** mark for the question.
   (d) 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 later 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. **Logarithmic Tables / Calculator of any kind / cellular phone / pager / electronic gadgets are not allowed.**
11. The question-cum-answer book must be returned in its entirety to the Invigilator before leaving the examination hall. Do not remove any page from this book.
12. Refer to Useful data on the reverse.

D

2007 – CH

READ THE INSTRUCTIONS ON THE LEFT SIDE OF THIS PAGE CAREFULLY

ROLL NUMBER						

Name :

Test Centre :

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

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 Invigi

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Useful Data

Atomic number: Sc (21), Ti (22), V (23), Cr (24), Mn (25), Fe (26), Co (27), Ni (28), Cu (29), Zn (30).

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

$2.303\ RT/nF = 0.059\ V$ at 298 K

$\ln 2 = 0.69$

$F = 96500\ C.\ mol^{-1}$

$c = 3 \times 10^{8}\ m.s^{-1}$

$h = 6.6 \times 10^{-34}\ J.s$

$m_e = 9 \times 10^{-31}\ kg$

DO NOT WRITE ON THIS PAGE

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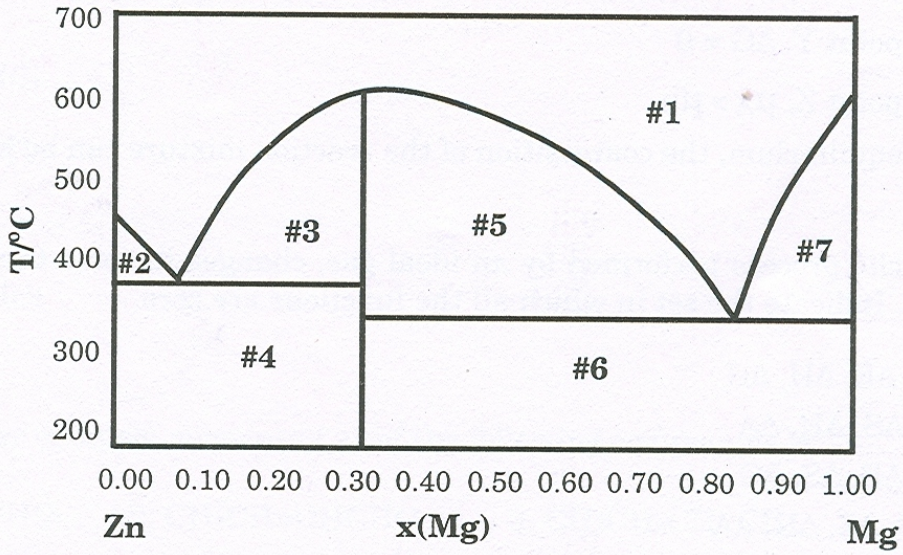
IMPORTANT NOTES FOR CANDIDATES

- **Attempt ALL the 44 questions.**
- **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 13 only.**

1. In the extraction of metals from their ores, which one of the following reduction methods can bring about a non-spontaneous reduction?
   (A) electrolytic reduction
   (B) reduction by carbon
   (C) reduction by another metal
   (D) reduction by hydrogen

2. The solid-liquid phase diagram for the Mg-Zn system is shown in the figure below where the vertical line at x(Mg) = 0.33 represents the formation of a congruent melting compound $MgZn_2$. The figure is divided into seven regions depending upon the physical state of the system. The composition of the region **#6** represents



   (A) single phase of a solution of Mg and Zn
   (B) two phase region between the solid Zn and solid $MgZn_2$
   (C) two phase region between the liquid and solid $MgZn_2$
   (D) two phase region between solid Mg and solid $MgZn_2$

3. Which one of the following species is the conjugate base of HO^-?
   (A) H_2O
   (B) O^{2-}
   (C) O_2^-
   (D) O_2^{2-}

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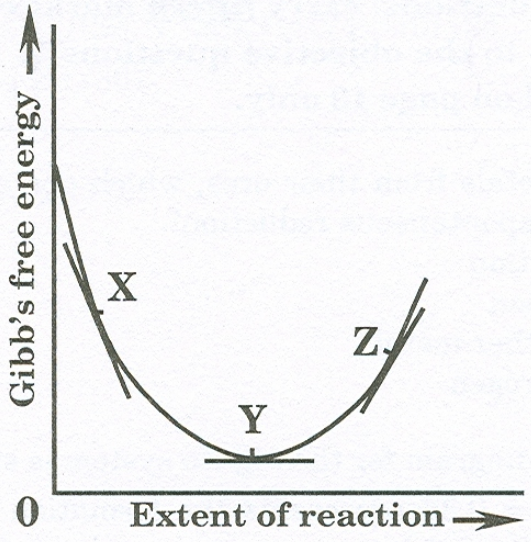
4. The plot of Gibb's free energy G and the extent of a reaction ξ is given below for the reaction A $\rightleftharpoons$ B. If μ_A and μ_B are the chemical potentials of A and B respectively, the **INCORRECT** statement is



(A) at point X, $\mu_A > \mu_B$

(B) at point Y, $\Delta G = 0$

(C) at point Z, $\mu_A > \mu_B$

(D) at equilibrium, the composition of the reaction mixture can be identified

5. For a cyclic process performed by an ideal gas, changes in some thermodynamic functions are zero. Indicate the set in which all the functions are zero.

(A) w, ΔE, ΔH, ΔG

(B) q, ΔS, ΔH, ΔA

(C) q, ΔE, ΔS, ΔG

(D) ΔE, ΔS, ΔH, ΔA

6. For a reaction with rate equation $-dC/dt = kC^2$, C_0 and C are the concentrations of the reactant at time 0 and t respectively. If 10 minutes were required for C_0 to become $C_0/2$, the time required for C_0 to become $C_0/4$ is

(A) 10 min

(B) 20 min

(C) 30 min

(D) 40 min

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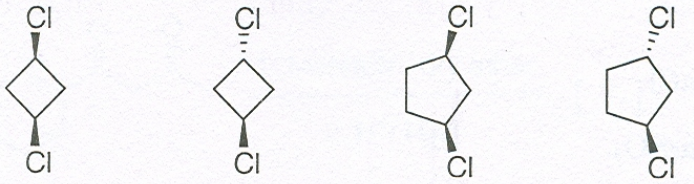
7. Which one of the following compounds is optically active?



(1) (2) (3) (4)

(A) 1

(B) 2

(C) 3

(D) 4

8. Which one of the following compounds gives positive test for both nitrogen and halogen with its Lassaigne's extract?

(A) $CH_3NH_2.HCl$

(B) $NH_2OH.HCl$

(C) NH_4Cl

(D) $H_2NNH_2.HCl$

9. The correct order of dipole moments (μ) of the following compounds is

1. $CH_3CH_2CH_2CHO$ 2. $CH_3CH=CHCHO$ 3. $CH_3CH_2CH=CH_2$

(A) $\mu_1 > \mu_2 > \mu_3$

(B) $\mu_2 > \mu_3 > \mu_1$

(C) $\mu_3 > \mu_1 > \mu_2$

(D) $\mu_2 > \mu_1 > \mu_3$

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10. An aqueous solution containing 0.01 M $FeCl_3$ and 0.06 M $HClO_4$ has the same ionic strength as a solution of

(A) 0.09 M NaCl

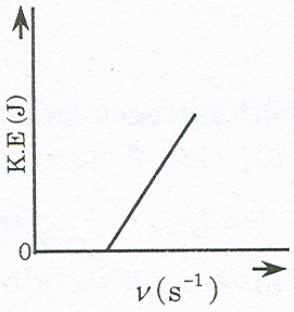
(B) 0.04 M Na_2SO_4

(C) 0.06 M $CuSO_4$

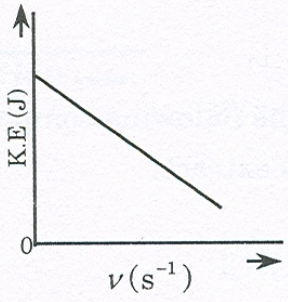
(D) 0.03 M H_3PO_4

11. Which one of the following figures, showing kinetic energy of the ejected electron *versus* the frequency (ν) of the incident photon, represents the Einstein's photoelectric effect?

(A)



(B)



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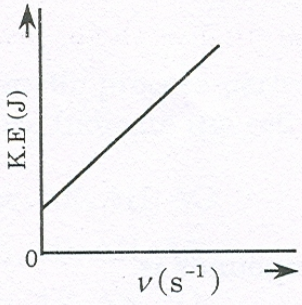
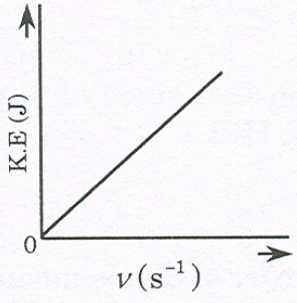


(D)



12. The standard potential of a Daniel cell is + 1.10 V and the equilibrium constant for the cell reaction is 1.5×10^{37}. It can be concluded that

(A) zinc oxidises copper

(B) displacement of copper by zinc goes to near completion

(C) copper oxidises zinc

(D) displacement of zinc by copper goes to completion

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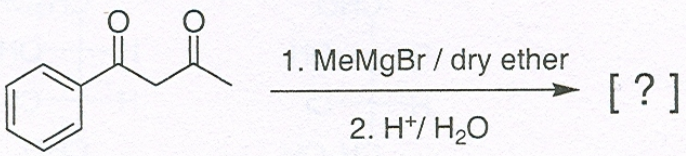
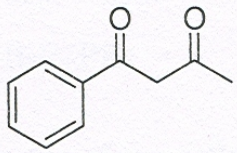
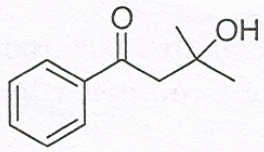
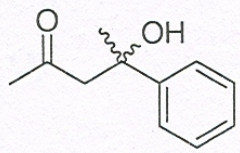
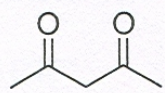
13. The main product obtained in the following reaction is



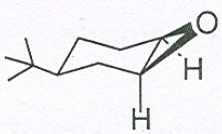
(A) 

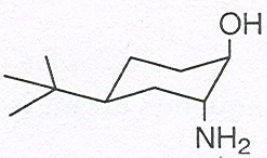
(B) 

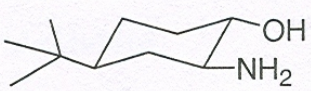
(C) 

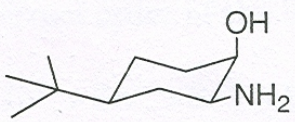
(D) 

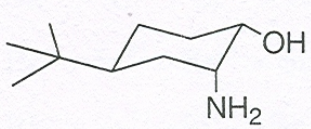
14. Which one of the following compounds reacts with nitrous acid to give the product **[P]**?

[P] = 

(A) 

(B) 

(C) 

(D) 

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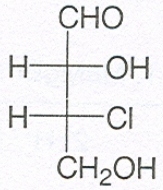
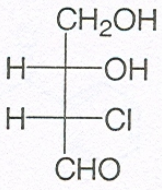
15.



1



2

The given compounds **1** and **2** are

(A) identical

(B) diastereomeric

(C) enantiomeric

(D) constitutionally isomeric

16. The compound, which

(i) reacts rapidly with acetyl chloride,

(ii) does not react with 2,4-dinitrophenylhydrazine **and**

(iii) does not form a yellow precipitate with excess of iodine in aqueous alkali is

(A) acetone

(B) diethyl ether

(C) 2-methyl-2-propanol

(D) ethanol

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17. During Wittig reaction, a phosphorus ylide gets converted to

(A) R_3P

(B) $R_3P{=}O$

(C) $R_3P^+HOH^-$

(D) $R_2P{-}PR_2$

18. Which one of the following species is **NOT** isoelectronic with CO ?

(A) N_2

(B) CN^-

(C) NO^+

(D) O_2^+

19. The ligand with only sigma (σ) bonding character is

(A) CN^-

(B) CH_3^-

(C) CO

(D) NO

20. The correct valence shell electronic configuration of the element with atomic number 22 is

(A) $[Ar]4s^23d^2$

(B) $[Ar]3d^4$

(C) $[Ar]3d^24s^2$

(D) $[Ar]4s^24p^2$

21. The correct order of the ionic radii is

(A) $In^{3+} > Sn^{4+} > Sr^{2+} > Rb^+$

(B) $Sn^{4+} > In^{3+} > Sr^{2+} > Rb^+$

(C) $Rb^+ > In^{3+} > Sr^{2+} > Sn^{4+}$

(D) $Rb^+ > Sr^{2+} > In^{3+} > Sn^{4+}$

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22. The normalisation constant 'A' for the wavefunction $\psi(\phi)=Ae^{(im\phi)}$ where $0 \leq \phi \leq 2\pi$ is

(A) $1/\sqrt{2\pi}$

(B) $\sqrt{2\pi}$

(C) 2π

(D) $1/\sqrt{2}$

23. The pH of a 1.0×10^{-3} M solution of a weak acid HA is 4.0. The acid dissociation constant K_a is

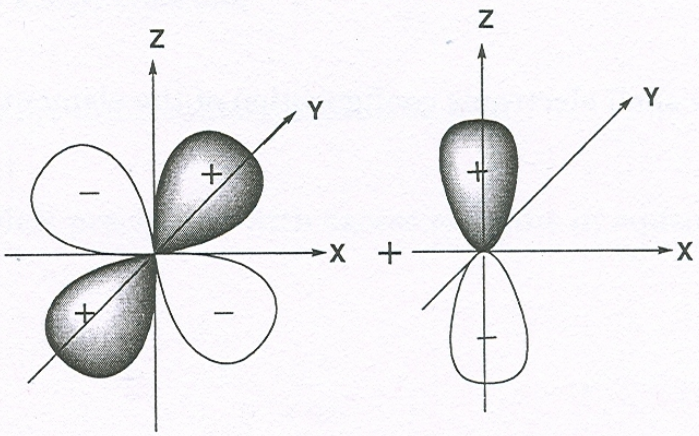
(A) 1.0×10^{-3}

(B) 1.0×10^{-4}

(C) 1.0×10^{-5}

(D) 2.0×10^{-5}

24. The overlap between the atomic orbitals sketched below is



(A) positive

(B) negative

(C) zero

(D) no overlap

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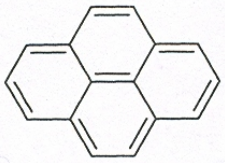
25. The value of 'n' for the following molecule according to Hückel's rule is



(A) 16

(B) 4

(C) 3

(D) 14

26. The shape of CH_3^- ion is

(A) trigonal planar

(B) tetrahedral

(C) trigonal pyramidal

(D) linear

27. The complementary strand of DNA for the following single stranded DNA sequence, 5′-A-T-C-A-T-G-C-3′ is

(A) 5′-A-T-C-A-T-G-C-3′

(B) 5′-T-A-G-T-A-C-G-3′

(C) 5′-G-C-A-T-G-A-T-3′

(D) 5′-C-G-T-A-C-T-A-3′

28. The ionic radii of Ca^{2+} and F^- are 100 pm and 133 pm respectively. The coordination number of Ca^{2+} in the ionic solid will be

(A) 8

(B) 6

(C) 4

(D) 2

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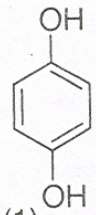
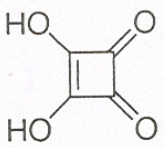
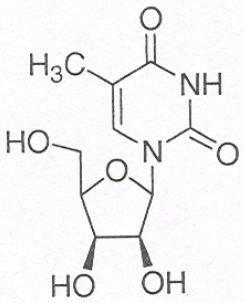
29. The compounds that react with aqueous $NaHCO_3$ to release CO_2 are



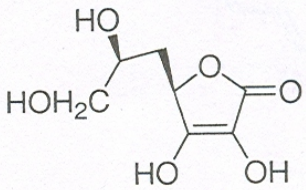
(1)



(2)



(3)



(4)

(A) 1 and 3

(B) 2 and 4

(C) 2 and 3

(D) 1 and 4

30. Which of the following reactions does **NOT** give H_3PO_4?

(A) $Ca_3(PO_4)_2 + H_2SO_4 \longrightarrow$

(B) $P_4O_6 + H_2O \longrightarrow$

(C) $PCl_5 + H_2O \longrightarrow$

(D) $P_4S_{10} + H_2O \longrightarrow$

Space for rough work

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QUESTION-CUM-ANSWER BOOK CODE **D**

Answer Table for Objective Questions

Write the Code of your chosen answer only in the 'Answer' column against each Question No. Do not write anything else on this page.

Question No.	Answer	Do not write in this column	Question No.	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		

FOR EVALUATION ONLY

No. of Correct Answers		Marks	(+)
No. of Incorrect Answers		Marks	(–)
Total Marks in Question Nos. 1-30			( )

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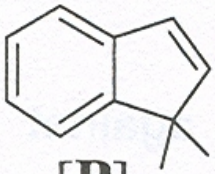
D

31.

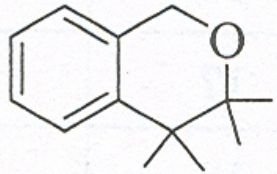


[P]

$\xrightarrow[2.\ NaIO_4]{1.\ KMnO_4}$ **[Q]** $C_{11}H_{12}O_2$ $\xrightarrow[2.\ H^+]{1.\ NaOH}$ **[R]** $C_{11}H_{12}O_2$

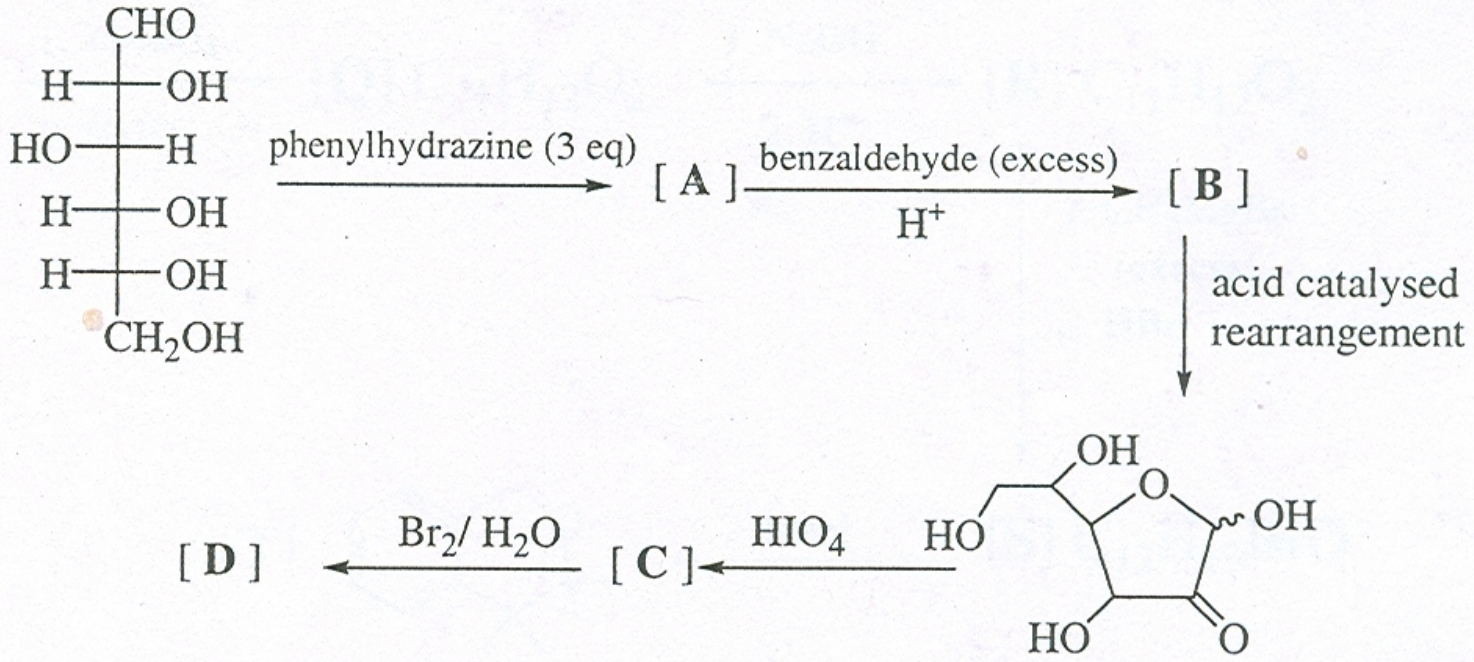
$\downarrow$ 1. CH_3MgBr (excess) 2. HBr

[S] $C_{13}H_{19}BrO$ $\xrightarrow{NaH}$ **[T]**



Identify the structures of the intermediate compoucollegedunia India's largest Student Review Platformd **S**. Show the transformation for each step. (15)

32. (a) For the following scheme of transformations, draw the structures of **A**, **B**, **C** and **D**.



(9)

(b) Complete hydrolysis of a pentapeptide with 6 N HCl at 110 °C in a sealed tube gave 2 equivalents of glycine, one equivalent each of tyrosine, leucine and phenylalanine. Reaction of the pentapeptide with Sanger's reagent (2,4-dinitrofluorobenzene, DNFB) and subsequent hydrolysis gave the DNFB derivative of tyrosine. Chymotrypsin cleavage of this peptide yielded tyrosine, leucine and a tripeptide. Deduce the sequence of the pentapeptide. (6)

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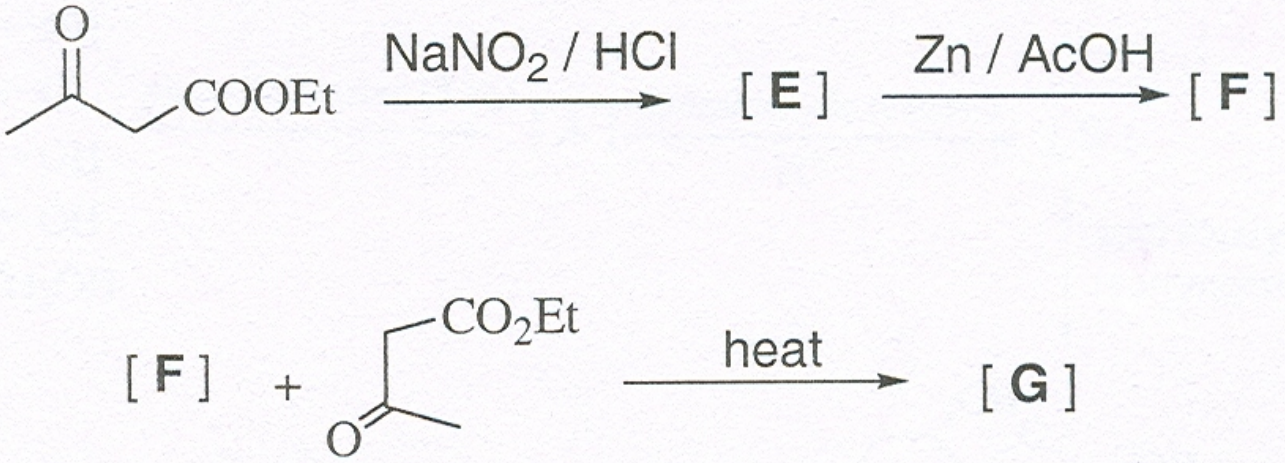
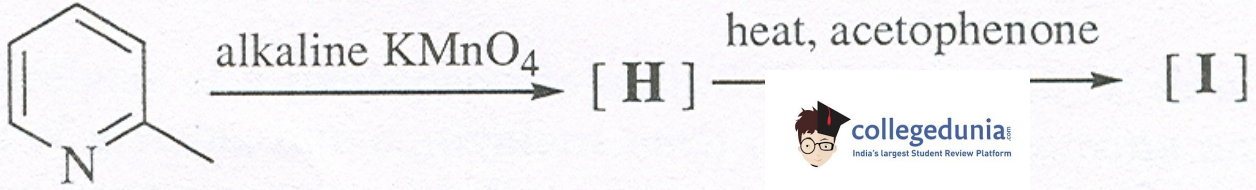
33. Complete the following reactions with appropriate structures for **E**, **F**, **G**, **H** and **I**.

(a)



(9)

(b)



(6)

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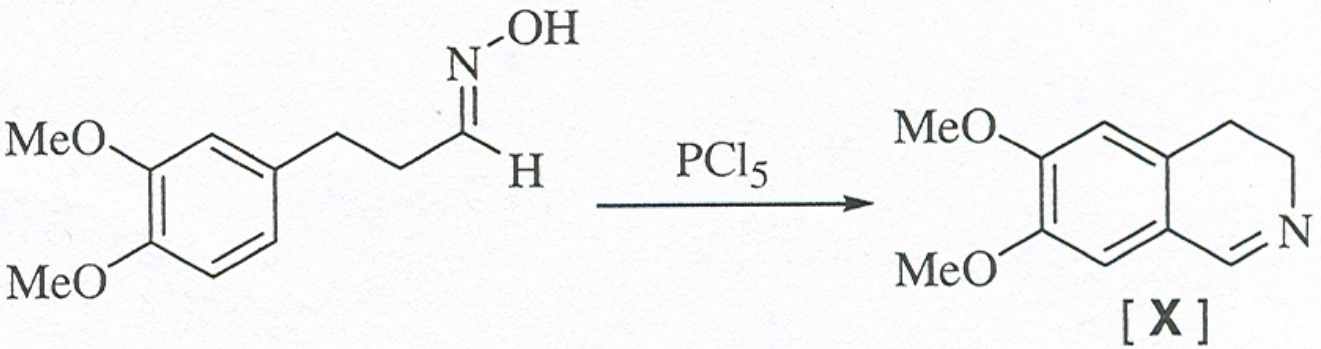
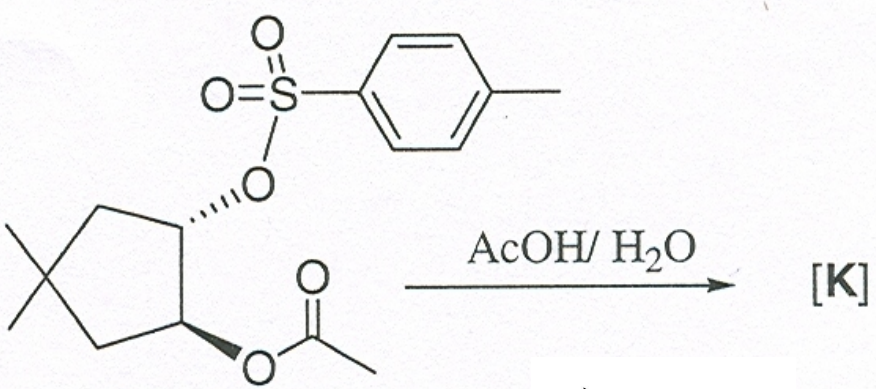
34. (a) Account for the following transformation with an appropriate mechanism. Give the structure of the Hofmann exhaustive methylation product of 1,2-dihydro derivative of [**X**].



[**X**]

(9)

(b) The optically pure ester [**J**] is hydrolysed in aqueous acetic acid to form a racemic mixture of *cis*-4,4-dimethyl-2-acetoxycyclopentanol [**K**]. Give a mechanistic explanation to account for the formation of [**K**] and the observed change in the optical activity.



[**J**]

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(6)

35. (a) **M** is a first row transition metal. MCl_2 on treatment with aqueous ammonia gives a blue colored solution of complex **N**. A solution of MCl_2 also gives a bright red precipitate of complex **O** with ethanolic dimethylglyoxime.

(i) Identify **M** and draw the structure of **O**.

(ii) Determine the hybridisation of **M** in complex **N**.

(iii) Identify the paramagnetic complex. (9)

(b) $[Cr(H_2O)_6]^{3+}$ gave an absorption at 208 kJ/mo[illegible]esponds to Δ_o. Calculate the crystal field stabilisation energy of this comple[illegible] (6)

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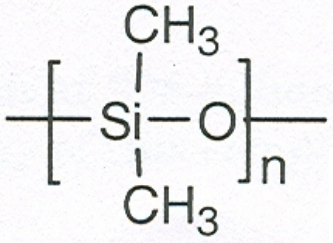
36. (a) Consider the ethers $H_3SiOSiH_3$ and H_3COCH_3.

(i) Which ether has more Lewis base character?

(ii) Which angle [Si-O-Si and C-O-C] is greater?

Justify your answer. (9)

(b) Starting from SiO_2, show how the following polymer is prepared industrially?



(6)

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37. (a) A solution of metal ion (M^{2+}) when treated with H_2S gas gives a black precipitate **A**. Precipitate **A** dissolves in hot concentrated nitric acid to give **B** along with elemental sulfur. The metal ion solution also gives a white precipitate **C** with an excess of KI. Write the chemical formulae of **A**, **B** and **C**. (9)

(b) Why are potassium permanganate solutions unstable in the presence of Mn^{2+} ions? In the quantitative estimation of iron present in iron ores dissolved in dilute HCl, titrations with dichromate are preferred over titrations with permanganate. Rationalise. (6)

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38. (a) Al_2Cl_6 and Al_2Me_6 are dimeric in gas phase. Draw their structures. Which compound has more Lewis acid character? Explain. (9)

(b) Arrange the halides $SnCl_2$, $PbCl_2$, $SiCl_2$ in i[illegible]rder of their stability. Give reasons for your answer. (6)

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39. (a) Acidification of an aqueous solution of yellow sodium chromate gives an orange colored compound **A**. A saturated solution of **A** on treatment with concentrated H_2SO_4 gives a bright orange solid **B**. Compound **A** in the presence of concentrated H_2SO_4 reacts with anion **C** to give a deep red colored liquid. Identify **A**, **B** and **C**. (9)

(b) $^{215}_{84}Po$ undergoes an α emission to give element **X** followed by a β emission to give element **Y**.

(i) Write the valence shell electronic config [illegible] .

(ii) Indicate the groups of the periodic table [illegible] and **Y** belong. (6)

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40. (a) When an ideal monoatomic gas is expanded from 1.5 bar, 24.8 L and 298 K into an evacuated container, the final volume becomes 49.6 L. Calculate ΔH, ΔS and ΔG for the process. (9)

(b) The Maxwell distribution function for the distribution of speeds of molecules in gaseous systems is given as,

$$f(c)=4\pi\left(m/2\pi kT\right)^{3/2}c^2\exp\left(-mc^2/2kT\right)$$

Show that the most probable speed, $c_{mps}=\left(2kT/m\right)^{1/2}$ (6)

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41. (a) At 600 K and 200 bar, a 1:3 (molar ratio) mixture of A_2 and B_2 react to form an equilibrium mixture containing $x_{AB_3} = 0.60$. Assuming ideal gas behaviour, calculate K_p for the reaction

$$A_2(g) + 3B_2(g) \rightleftharpoons 2AB_3(g)$$

(9)

(b) A 50 mL 0.05 M solution of Fe(II) is titrated with 0.05 M solution of Ce(IV) in the presence of dilute H_2SO_4 at 25 °C. Calculate the equivalence point potential and the equilibrium constant K in terms of log K.

$[E^0_{(Fe^{3+}/Fe^{2+})} = +0.75\ V,\ E^0_{(Ce^{4+}/Ce^{3+})} = +1.45\ V]$ (6)

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42. (a) The vapour pressure of D_2O at 20 °C is 745 mm Hg. When 15 g of a non-volatile compound is dissolved in 200 g of D_2O, the pressure changes to 730 mm Hg. Assuming the applicability of Raoult's law, calculate the molecular weight of the compound. (9)

(b) An enzyme following Michaelis-Menten kinetics was found to have highest activity at 37 °C and pH 7.0. If the maximum velocity v_{max} for th as 2.4×10^{-4} mol $L^{-1}s^{-1}$ with an initial enzyme concentration $[E]_o = 2.4$ nM, ne turnover frequency. (6)

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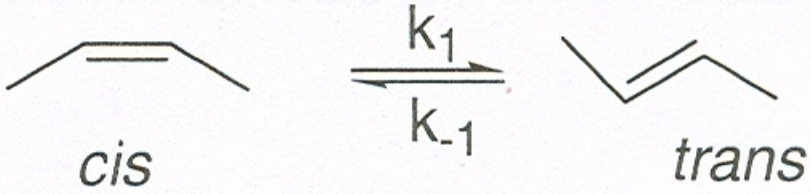
43. (a) Consider the 4π electrons in cyclobutadiene to be free particles in a 2-dimensional square box of length 2 Å. Calculate the wavelength of the electronic transition from the highest occupied molecular orbital (HOMO) to the lowest unoccupied molecular orbital (LUMO). Also write down the normalised wavefunctions for the occupied degenerate states. (9)

(b) The reaction



is first order in both directions. At 25°C, the equilibrium constant (K) of this reaction is 0.40. If 0.115 mol. dm^{-3} of *cis*-isomer to equilibrate, calculate the equilibrium concentration of each isomer. (6)

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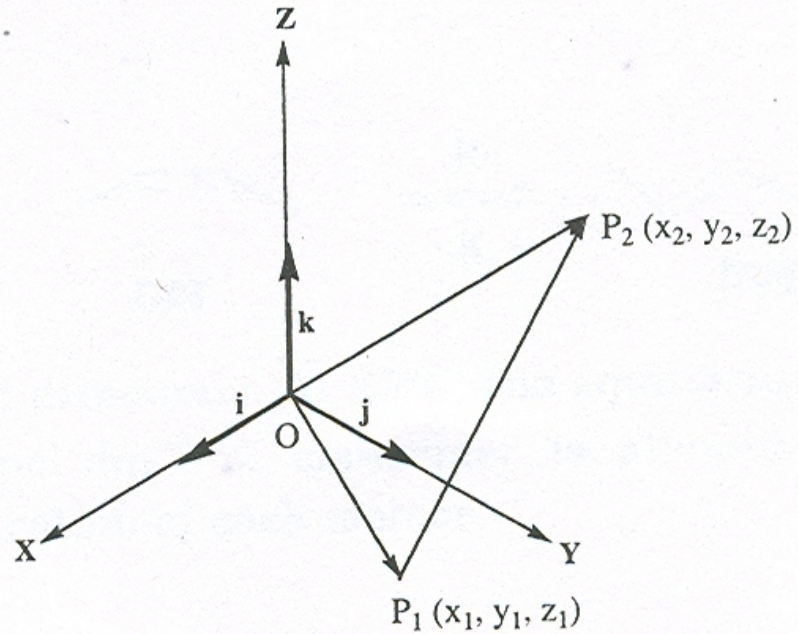
44. (a) With i, j and k as the unit vectors along X, Y and Z axes, express the vector $\overrightarrow{P_1P_2}$ in the given figure in terms of the coordinates of P_1 and P_2. Also determine the dot products of the unit vectors i, j, k.



(9)

(b) Deduce whether the matrices A and B commute or not.

$$A = \begin{pmatrix} 2 & 1 \\ 0 & 1 \end{pmatrix} \quad B = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$$

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2007 – CH Objective Part (Q. Nos. 1 – 30)	
Total Marks	Signature

Subjective Part					
Q. No.	Marks	Signature	Q. No.	Marks	Signature
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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