Test Booklet Code & Serial No.
प्रश्नपत्रिका कोड व क्रमांक

B

Paper-II
CHEMICAL SCIENCE

Signature and Name of Invigilator

1. (Signature) .....

(Name) .....

2. (Signature) .....

(Name) .....

Seat No. | | | | | | | |

(In figures as in Admit Card)

Seat No. .....

(In words)

OMR Sheet No. | | | | | | | |

(To be filled by the Candidate)

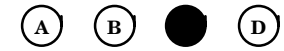
MAR - 33223

Time Allowed : 2 Hours] **[Maximum Marks : 200**

Number of Pages in this Booklet : **40** Number of Questions in this Booklet : **100**

Instructions for the Candidates

1. Write your Seat No. and OMR Sheet No. in the space provided on the top of this page.
2. This paper consists of **100** objective type questions. Each question will carry *two* marks. *All* questions of Paper II will be compulsory.
3. At the commencement of examination, the question booklet will be given to the student. In the first 5 minutes, you are requested to open the booklet and compulsorily examine it as follows :
   (*i*) To have access to the Question Booklet, tear off the paper seal on the edge of this cover page. Do not accept a booklet without sticker-seal or open booklet.
   (*ii*) Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Faulty booklets due to missing pages/questions or questions repeated or not in serial order or any other discrepancy should not be accepted and correct booklet should be obtained from the invigilator within the period of 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time will be given. The same may please be noted.
   (*iii*) After this verification is over, the OMR Sheet Number should be entered on this Test Booklet.
4. Each question has four alternative responses marked (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.
   Example : where (C) is the correct response.

5. Your responses to the items are to be indicated in the **OMR Sheet given inside the Booklet only.** If you mark at any place other than in the circle in the OMR Sheet, it will not be evaluated.
6. Read instructions given inside carefully.
7. Rough Work is to be done at the end of this booklet.
8. If you write your Name, Seat Number, Phone Number or put any mark on any part of the OMR Sheet, except for the space allotted for the relevant entries, which may disclose your identity, or use abusive language or employ any other unfair means, you will render yourself liable to disqualification.
9. You have to return original OMR Sheet to the invigilator at the end of the examination compulsorily and must not carry it with you outside the Examination Hall. You are, however, allowed to carry the Test Booklet and duplicate copy of OMR Sheet on conclusion of examination.
10. Use only Blue/Black Ball point pen.
11. Use of any calculator or log table, etc., is prohibited.
12. There is no negative marking for incorrect answers.

विद्यार्थ्यांसाठी महत्त्वाच्या सूचना

1. परीक्षार्थींनी आपला आसन क्रमांक या पृष्ठावरील वरच्या कोपऱ्यात लिहावा. तसेच आपणांस दिलेल्या उत्तरपत्रिकेचा क्रमांक त्याखाली लिहावा.
2. सदर प्रश्नपत्रिकेत 100 बहुपर्यायी प्रश्न आहेत. प्रत्येक प्रश्नास **दोन** गुण आहेत. या प्रश्नपत्रिकेतील **सर्व** प्रश्न सोडविणे अनिवार्य आहे.
3. परीक्षा सुरू झाल्यावर विद्यार्थ्याला प्रश्नपत्रिका दिली जाईल. सुरुवातीच्या 5 मिनिटांमध्ये आपण सदर प्रश्नपत्रिका उघडून खालील बाबी अवश्य तपासून पहाव्यात.
   (*i*) प्रश्नपत्रिका उघडण्यासाठी प्रश्नपत्रिकेवर लावलेले सील उघडावे. सील नसलेली किंवा सील उघडलेली प्रश्नपत्रिका स्वीकारू नये.
   (*ii*) पहिल्या पृष्ठावर नमूद केल्याप्रमाणे प्रश्नपत्रिकेची एकूण पृष्ठे तसेच प्रश्नपत्रिकेतील एकूण प्रश्नांची संख्या पडताळून पहावी. पृष्ठे कमी असलेली/कमी प्रश्न असलेली/प्रश्नांचा चुकीचा क्रम असलेली किंवा इतर त्रुटी असलेली सदोष प्रश्नपत्रिका सुरुवातीच्या 5 मिनिटातच पर्यवेक्षकाला परत देऊन दुसरी प्रश्नपत्रिका मागवून घ्यावी. त्यानंतर प्रश्नपत्रिका बदलून मिळणार नाही तसेच वेळही वाढवून मिळणार नाही याची कृपया विद्यार्थ्यांनी नोंद घ्यावी.
   (*iii*) वरीलप्रमाणे सर्व पडताळून पाहिल्यानंतरच प्रश्नपत्रिकेवर ओ.एम.आर. उत्तरपत्रिकेचा नंबर लिहावा.
4. प्रत्येक प्रश्नासाठी (A), (B), (C) आणि (D) अशी चार विकल्प उत्तरे दिली आहेत. त्यातील योग्य उत्तराचा रकाना खाली दर्शविल्याप्रमाणे ठळकपणे काळा/निळा करावा.
   उदा. : जर (C) हे योग्य उत्तर असेल तर.

5. या प्रश्नपत्रिकेतील प्रश्नांची उत्तरे **ओ.एम.आर. उत्तरपत्रिकेतच दर्शवावीत.** इतर ठिकाणी लिहिलेली उत्तरे तपासली जाणार नाहीत.
6. आत दिलेल्या सूचना काळजीपूर्वक वाचाव्यात.
7. प्रश्नपत्रिकेच्या शेवटी जोडलेल्या कोऱ्या पानावरच कच्चे काम करावे.
8. जर आपण ओ.एम.आर. वर नमूद केलेल्या ठिकाणाव्यतिरिक्त इतर कोठेही नाव, आसन क्रमांक, फोन नंबर किंवा ओळख पटेल अशी कोणतीही खूण केलेली आढळून आल्यास अथवा असभ्य भाषेचा वापर किंवा इतर गैरमार्गांचा अवलंब केल्यास विद्यार्थ्याला परीक्षेस अपात्र ठरविण्यात येईल.
9. परीक्षा संपल्यानंतर विद्यार्थ्याने मूळ ओ.एम.आर. उत्तरपत्रिका पर्यवेक्षकांकडे परत करणे आवश्यक आहे. तथापि, प्रश्नपत्रिका व ओ.एम.आर. उत्तरपत्रिकेची द्वितीय प्रत आपल्याबरोबर नेण्यास विद्यार्थ्यांना परवानगी आहे.
10. फक्त निळ्या किंवा काळ्या बॉल पेनचाच वापर करावा.
11. कॅलक्युलेटर किंवा लॉग टेबल वापरण्यास परवानगी नाही.
12. चुकीच्या उत्तरासाठी गुण कपात केली जाणार नाही.

Chemical Science

Paper II

Time Allowed : 120 Minutes] **[Maximum Marks : 200**

Note : This Paper contains **Hundred (100)** multiple choice questions. Each question carrying **Two (2)** marks. Attempt *All* questions.

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1. Biological nitrification is identified by :

   (A) $2[NO_3]^- + 12H^+ + 10e^- \rightarrow N_2 + 6H_2O$

   (B) $[NH_4]^+ + 2O_2 \rightarrow [NO_3]^- + H_2O + 2H^+$

   (C) $N_2 + 10H^+ + 8e^- \rightarrow 2[NH_4]^+ + H_2$

   (D) $N_2 + 3H_2 \rightarrow 2NH_3$

2. The Pairing Energy (P) contribution to the CFSE of a high spin d^7 ion in an octahedral geometry is :

   (A) O (B) P

   (C) 2P (D) 3P

3. The number of EPR lines observed in the *p*-dinitro benzene radical anion will be (I for ^{14}N = 1 and ^{16}O = 0) :

   (A) 5 (B) 25

   (C) 30 (D) 10

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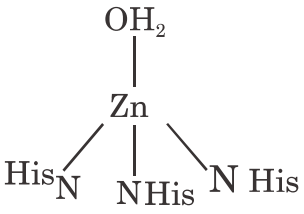
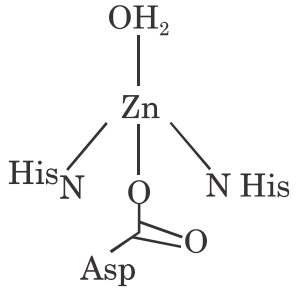
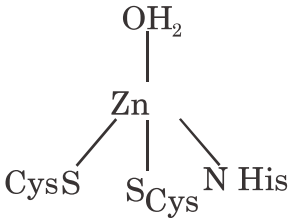
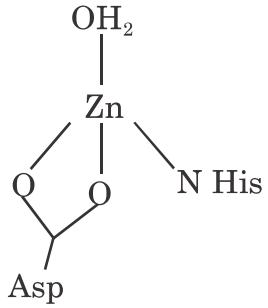
4. Zinc is present at the active site of many hydrolytic enzymes where at least one water molecule is coordinated to zinc. The activation of this zinc-bound water to form $[Zn\text{-}OH]^+$ depends on the ligand environment around zinc. In which of the following, the formation of $[Zn–OH]^+$ is more facile ?

(A) 

(B) 

(C) 

(D) 

5. Crystal field splitting parameter (Δ) decreases in the order :

(A) $[CoF_6]^{3-} > [CoF_6]^{4-} > [Co(H_2O)_6]^{2+}$

(B) $[Co(H_2O)_6]^{2+} > [CoF_6]^{4-} > [CoCl_6]^{4-}$

(C) $[CoCl_6]^{4-} > [CoCl_4]^{2-} > [CoF_6]^{3-}$

(D) $[CoF_6]^{3-} > [CoCl_6]^{4-} > [CoF_6]^{4-}$

6. R-S term symbol of Eu^{2+} (At. No. = 63) is :

(A) $^8S_{7/2}$ (B) $^7F_6$

(C) $^6H_{5/2}$ (D) $^7F_0$

7. The most widely used flame in Atomic Absorption Spectroscopy is :

(A) Air-coal gas (B) Air-acetylene

(C) Air-LPG (D) N_2-acetylene

8. When crystals of Al_2O_3 are grown from a solution containing a low concentration of V^{3+}, the vanadium ions occupy octahedral aluminum sites. The crystal has absorption bands at 17400, 25200 and 34500 cm^{-1}. The Δ_o of this complex is :

(A) 17400 (B) 25200

(C) 21750 (D) 14500

9. The monomeric complex, Fe (Pyridine)$_4$ Cl_2, is tetragonally distorted, trans-octahedral complex. The ^{57}Fe Mössbauer spectrum of this complex at 297 K shows doublet with isomer shift, δ=1.06 mm s^{-1}, and quadrupole splitting, Δ = 3.08 mm s^{-1}. The spin state of this complex is :

(A) High spin, s = 2

(B) Low spin, s = 0

(C) High spin, s = 5/2

(D) Low spin, s = $\frac{1}{2}$

10. SrF_2 solid adopts a fluorite structure. The coordination number of cation and anion in this structure is :

(A) 6, 6 (B) 6, 4

(C) 8, 4 (D) 4, 2

11. E factor is calculated by kg of waste producted per kg of product. The E factor for the following conversion is :

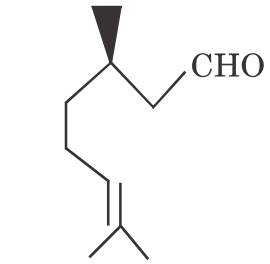
$$2\ C_6H_5I + Cu \rightarrow C_6H_5 - C_6H_5 + CuI_2$$

The reaction gave 100% conversion :

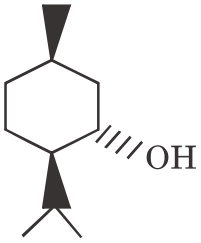
(A) 2.0 (B) 4.0

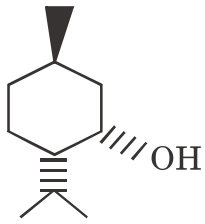
(C) 1.0 (D) 8.3

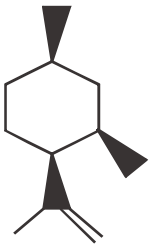
12. When (R)-Citronellal is treated with anhydrous $ZnBr_2$ the major product formed is :

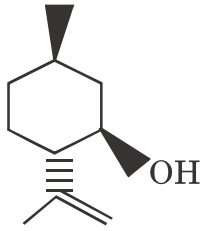


(R)-Citronellal

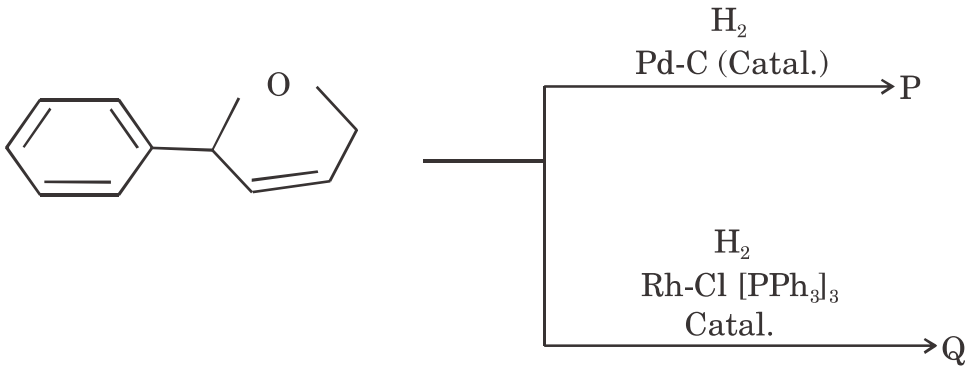
(A) 

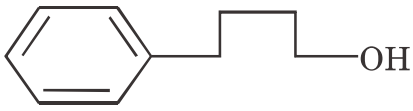
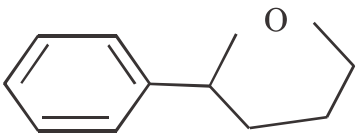
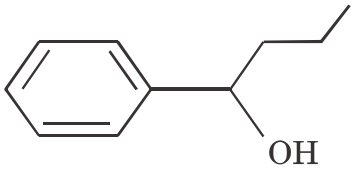
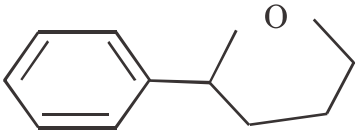
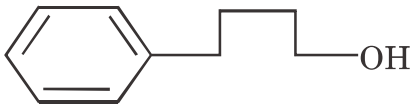
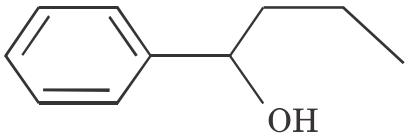
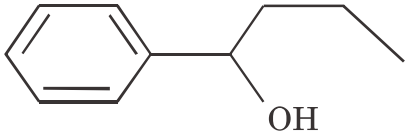
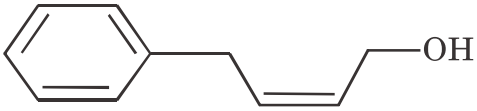
(B) 

(C) 

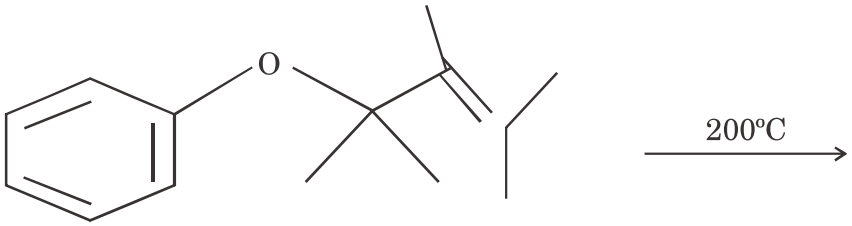
(D) 

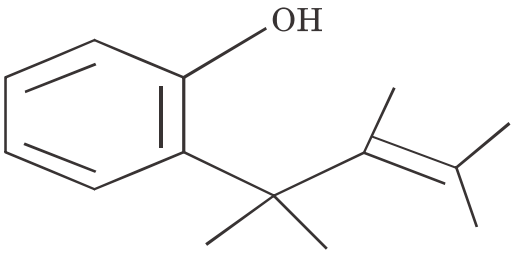
13. The major products (P & Q) of the following reactions are :

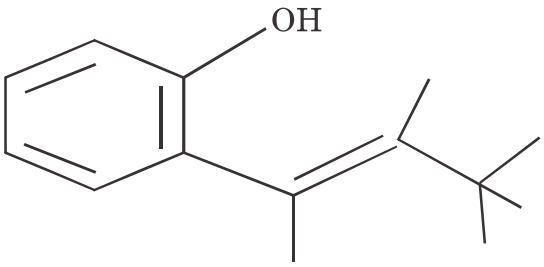


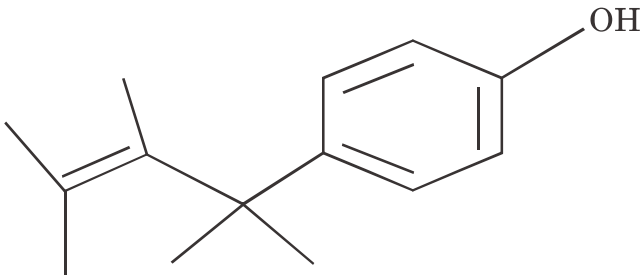
	P	Q
(A)		
(B)		
(C)		
(D)		

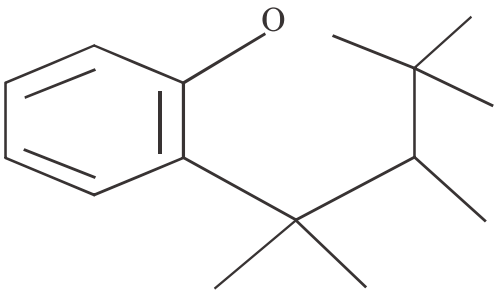
14. The major product of the following reaction is :



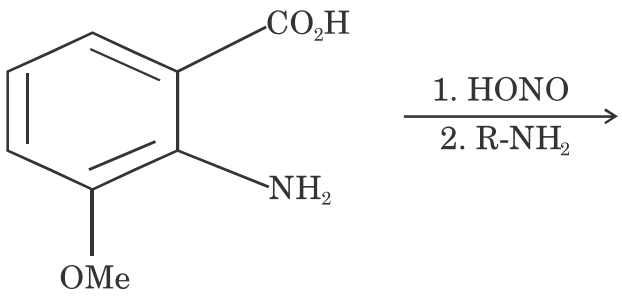
(A) 

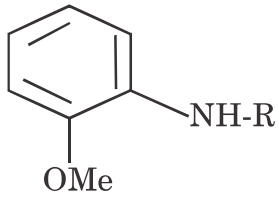
(B) 

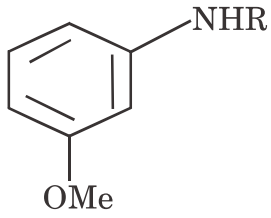
(C) 

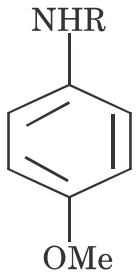
(D) 

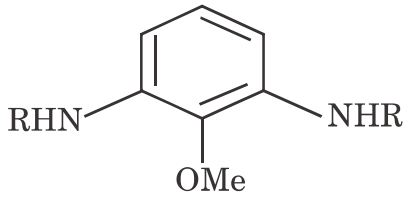
15. Predict the major product of the following reaction :



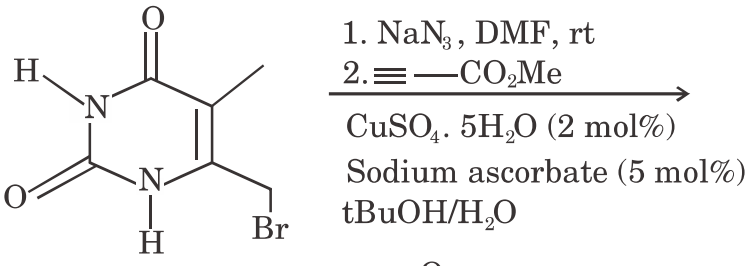
(A) 

(B) 

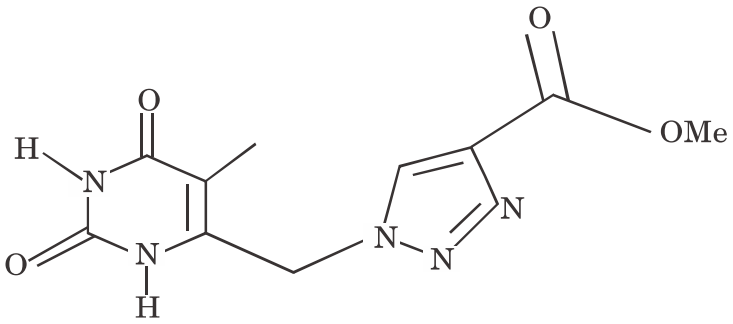
(C) 

(D) 

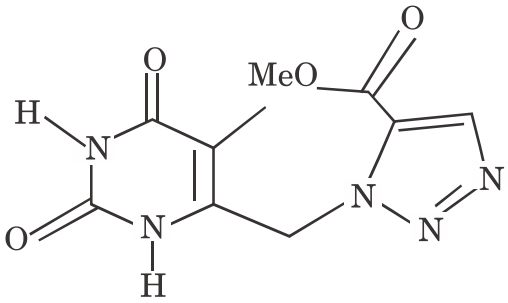
16. Predict the major product of the following reaction :



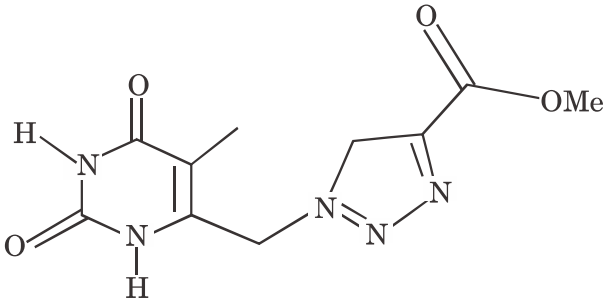
(A)



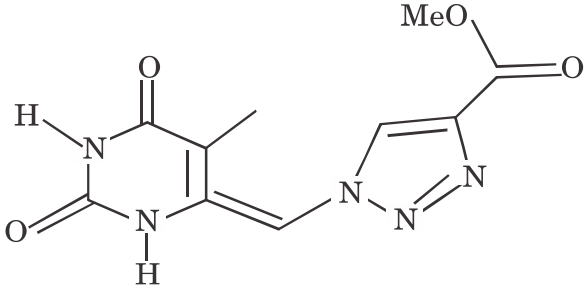
(B)



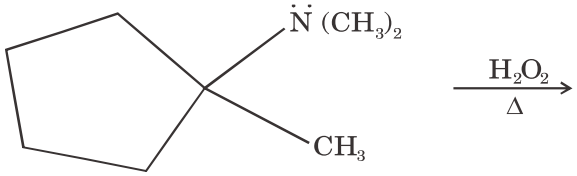
(C)

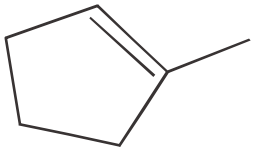


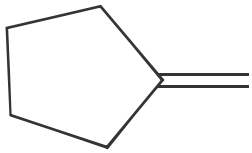
(D)

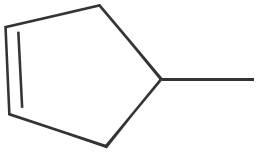


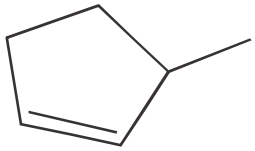
17. The major product of the following reaction is :



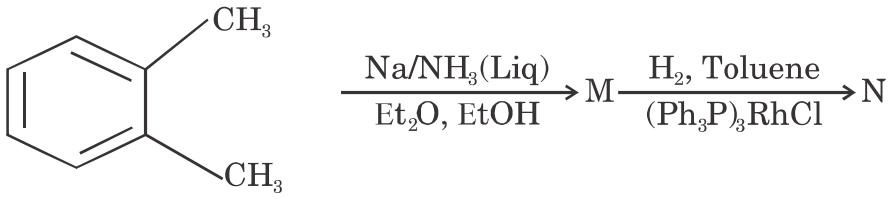
(A) 

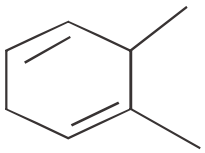
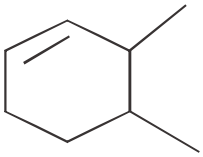
(B) 

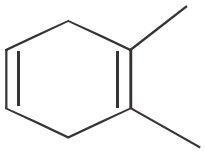
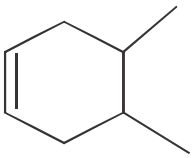
(C) 

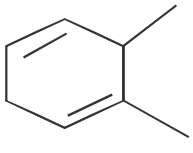
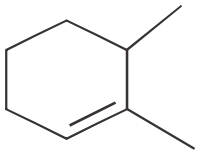
(D) 

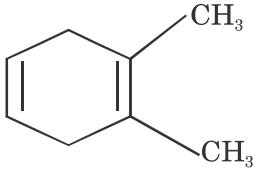
18. The major products formed in the following reaction is :

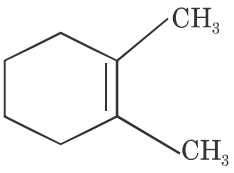


(A) M =  N = 

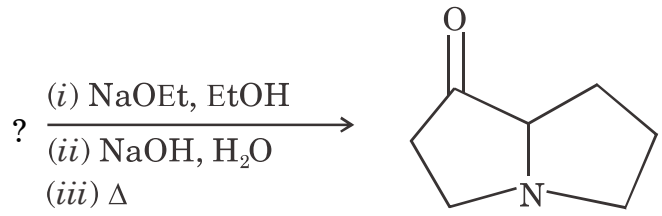
(B) M =  N = 

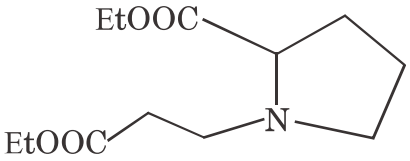
(C) M =  N = 

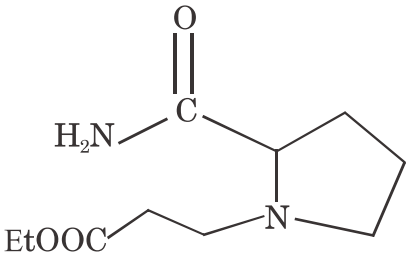
(D) M = 

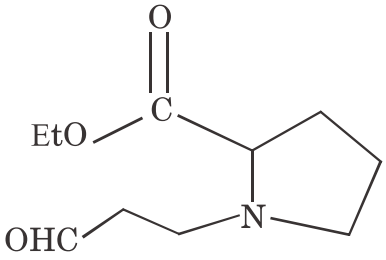
N = 

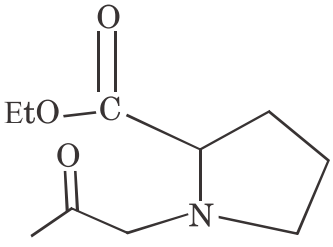
19. The correct starting compound for the following conversion is :



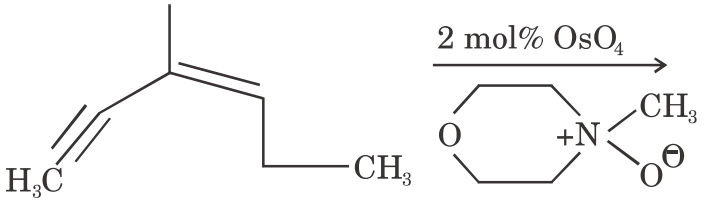
(A) 

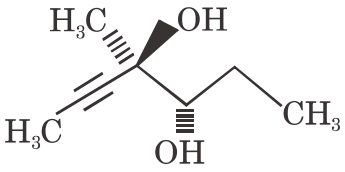
(B) 

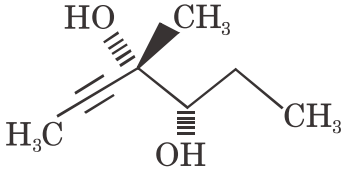
(C) 

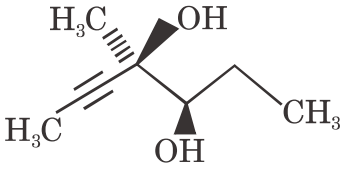
(D) 

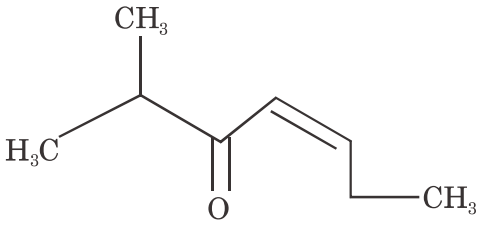
20. The major product of the following reaction is :



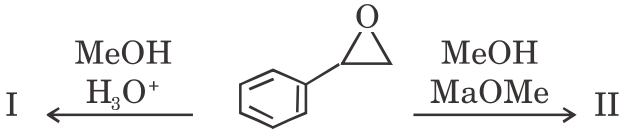
(A) 

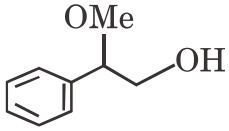
(B) 

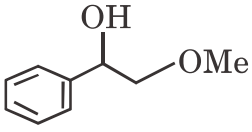
(C) 

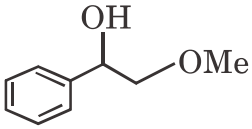
(D) 

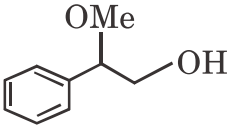
21. Predict the major product of the following reactions :

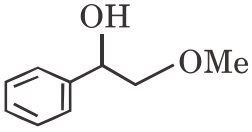


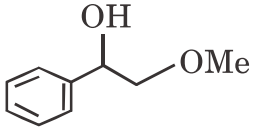
(A) I = 

II = 

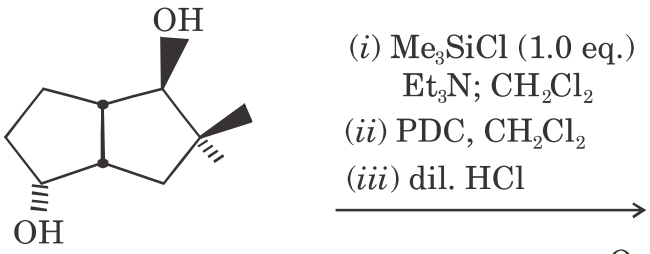
(B) I = 

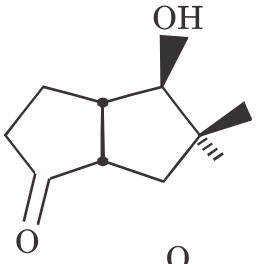
II = 

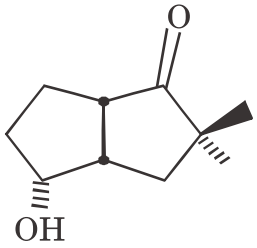
(C) I & II = 

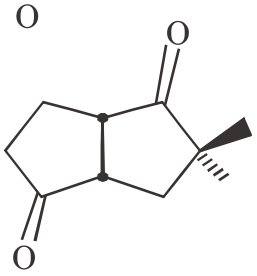
(D) I & II = 

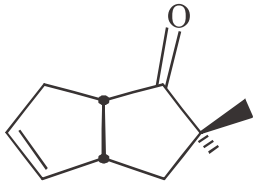
22. The major product of the following reaction is :



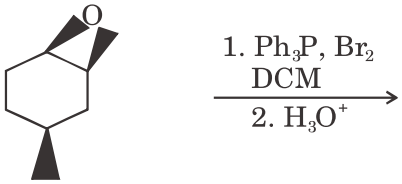
(A)


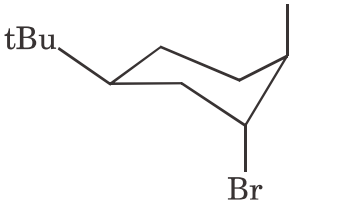
(B)


(C)


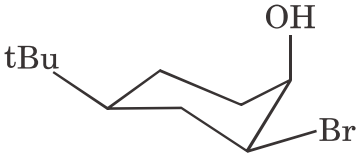
(D)


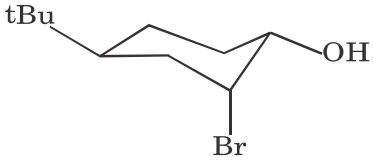
23. Predict the major product of the following reaction :



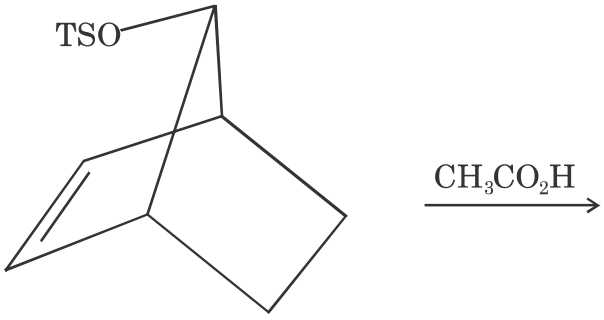
(A)


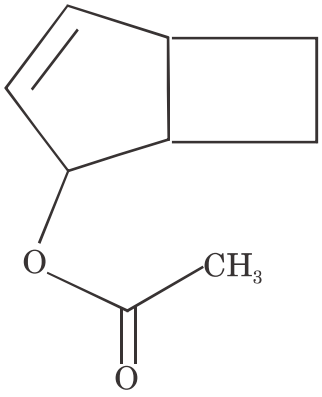
(B)

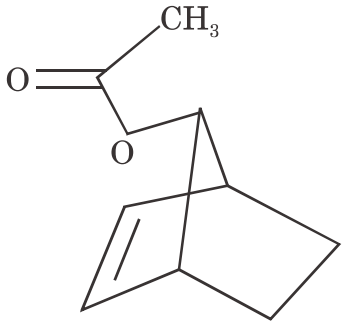

(C)


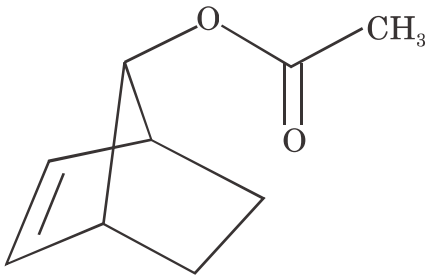
(D)


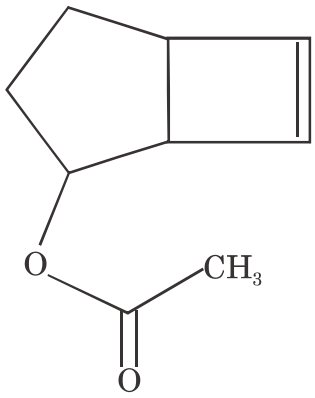
24. Predict the major product of the following reaction :



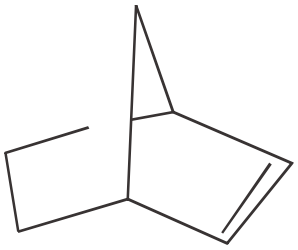
(A) 

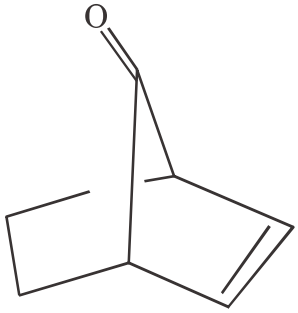
(B) 

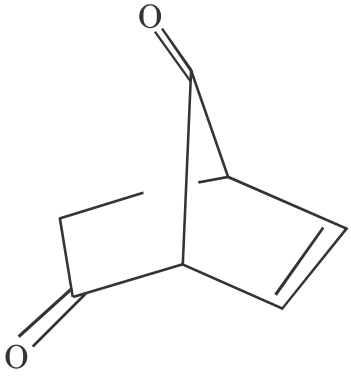
(C) 

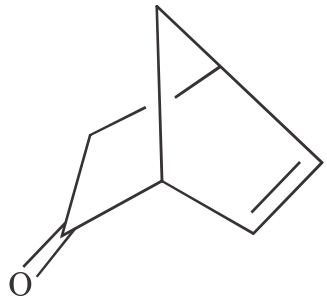
(D) 

25. Which of the following will produce chiral product on treatment with :
(*i*) O_3, MeOH; (*ii*) H_2O_2; (*iii*) Heat ($-CO_2$)

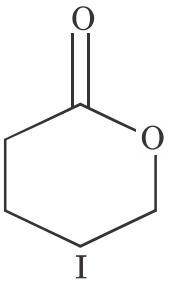
(A) 

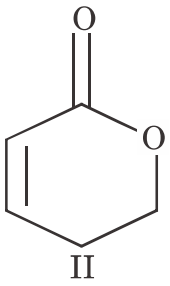
(B) 

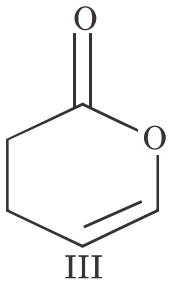
(C) 

(D) 

26. The *correct* order for carbonyl stretching frequencies in IR-spectra of the following compounds is :


I


II


III

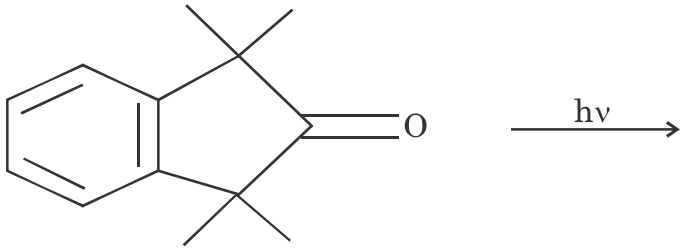
(A) III > I > II (B) I > II > III
(C) II > III > I (D) I > III > II

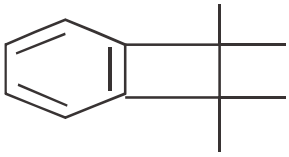
27. The *correct* match of compounds given in Column I with spectral data given in column II is :

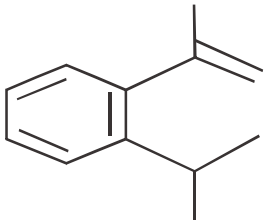
Column I	Column II
(*a*) 1, 2-Dichloroethane	(*i*) λ_{max} 220 nm
(*b*) 1, 4-Dibromobenzene	(*ii*) Only one singlet at 3.7 δ in ^1H – NMR spectrum
(*c*) 2-Methyl-1,3-butadiene	(*iii*) Peaks at 234, 236, 238 m/e with intensity (1 : 2 : 1) in MS-spectrum
(*d*) Cyclopropane	(*iv*) Absorption at 1815 cm^{-1} in IR spectrum

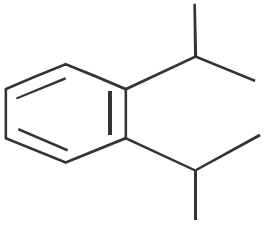
(A) (*a–iii*), (*b–ii*), (*c–i*), (*d–iv*)
(B) (*a–ii*), (*b–iii*), (*c–i*), (*d–iv*)
(C) (*a–iv*), (*b–i*), (*c–ii*), (*d–iii*)
(D) (*a–i*), (*b–iv*), (*c–iii*), (*d–ii*)

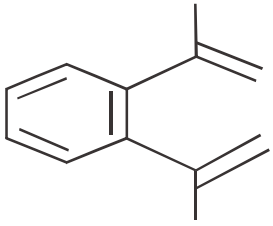
28. The major product of the following reaction is :



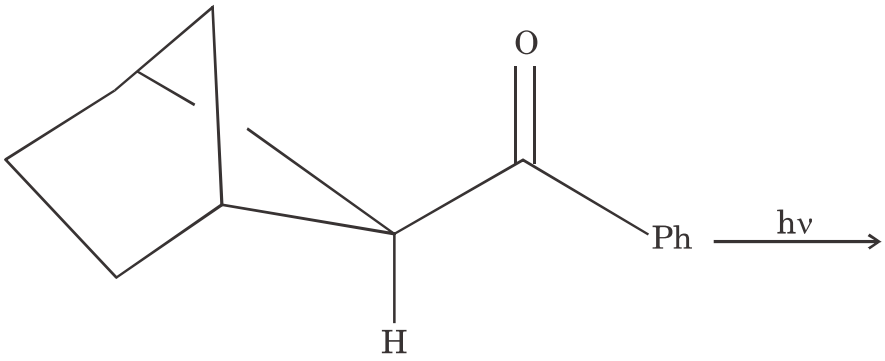
(A) 

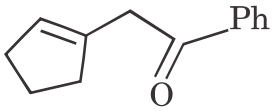
(B) 

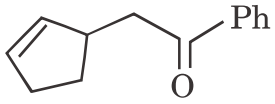
(C) 

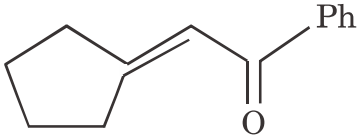
(D) 

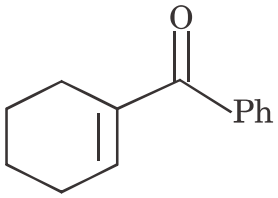
29. The major product of the following reaction is :



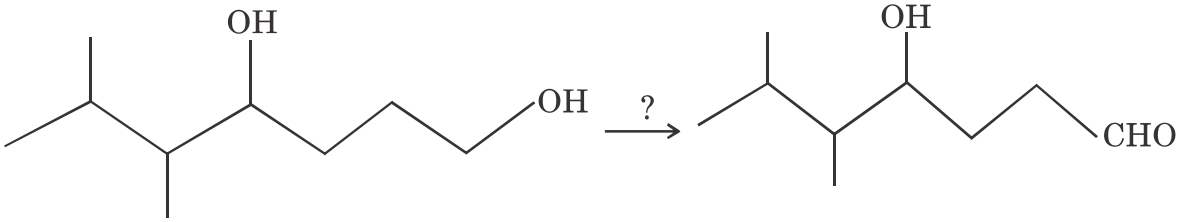
(A) 

(B) 

(C) 

(D) 

30. Suggest most suitable reagent/condition for the following conversion :



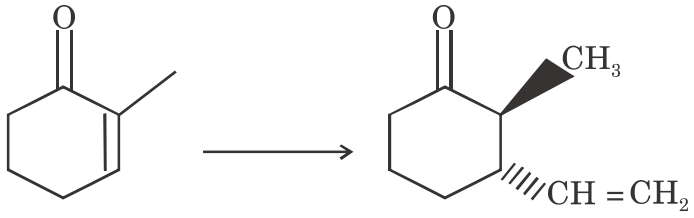
(A) MnO_2; CH_2Cl_2

(B) TEMPO (2.0%); NaOCl (1.25 eq), CH_2Cl_2

(C) Pyridinium dichromate (PDC); CH_2Cl_2

(D) Dimethyldioxirane (DMDO); CH_2Cl_2

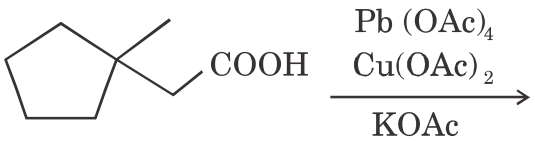
31. The *correct* reagents for the following conversion are :



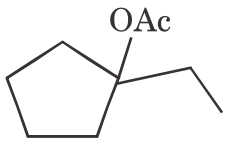
(A) Vinyllithium; CuI, THF; $H_3O^{\oplus}$ (B) Vinyllithium; $H_3O^{\oplus}$

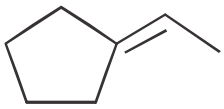
(C) Vinylmagnesium; $H_3O^{\oplus}$ (D) Vinylmagnesium; $CoCl_2$; $H_3O^{\oplus}$

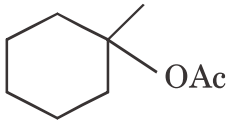
32. The major product of the following reaction is :



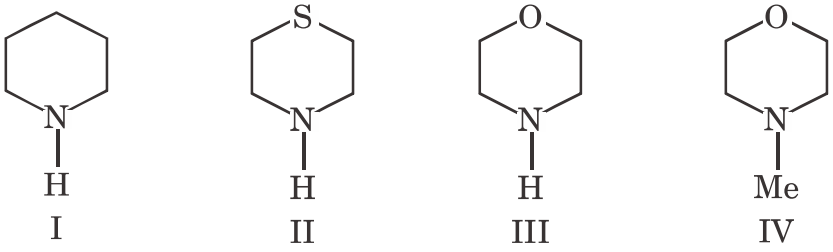
(A) 

(B) 

(C) 

(D) 

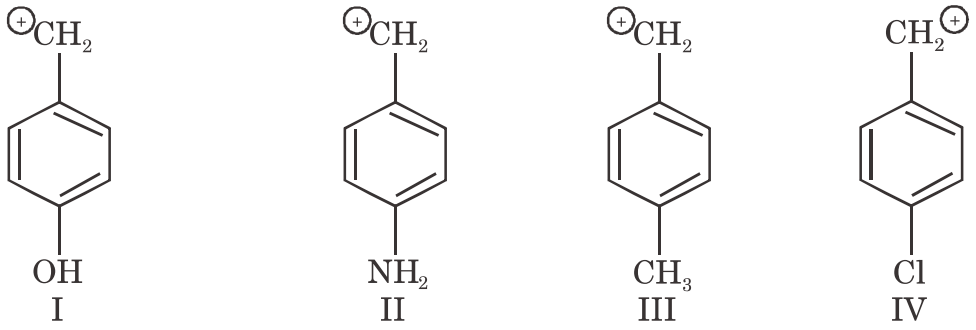
33. Rank the following molecules in decreasing order of basicity :



(A) I > II > III > IV (B) III > IV > II > I

(C) I > III > II > IV (D) III > II > IV > I

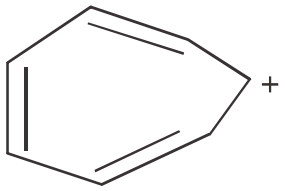
34. Arrange the following intermediates into increasing order of stability :

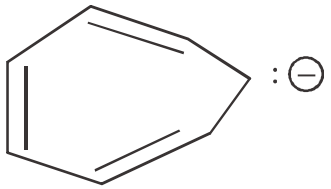


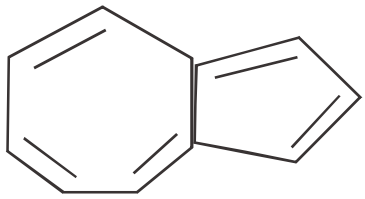
(A) IV < III < II < I (B) IV < III < I < II

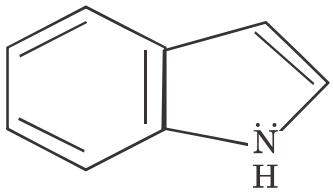
(C) III < IV < II < I (D) I < IV < III < II

35. Identify antiaromatic compound from the following :

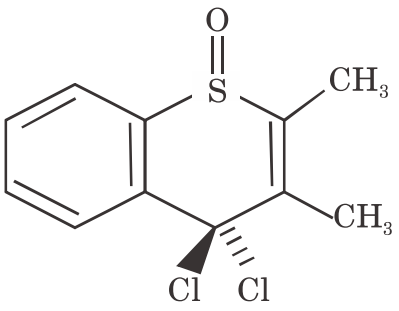
(A) 

(B) 

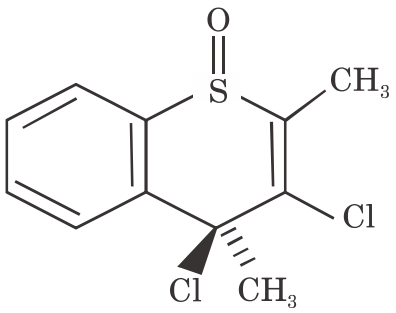
(C) 

(D) 

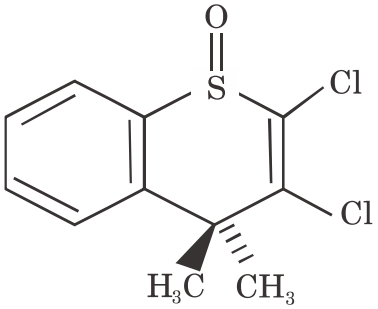
36. Which statement is *correct* for the following four molecules ?



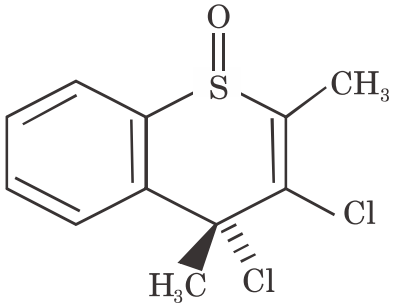
I



II



III



IV

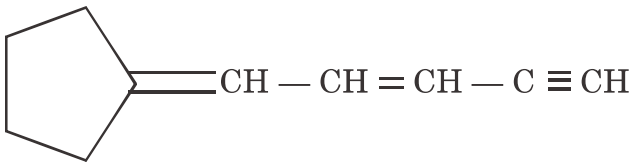
(A) I and II are chiral

(B) II and IV are chiral

(C) I, II, III and IV are chiral

(D) I and IV are chiral

37. How many geometrical isomers are possible for the following molecule :



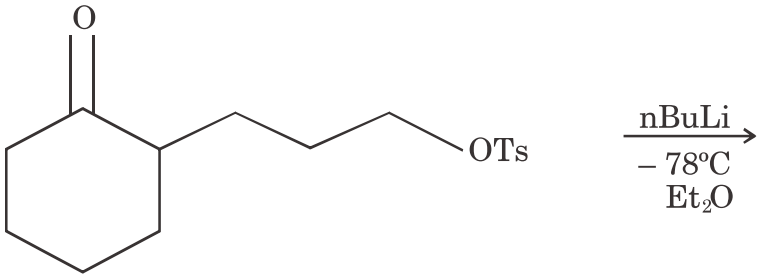
(A) 2

(B) 3

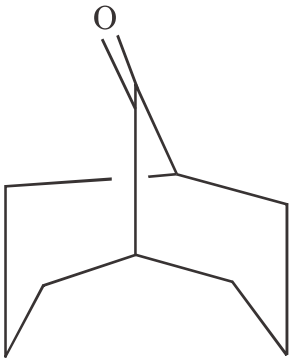
(C) 4

(D) 6

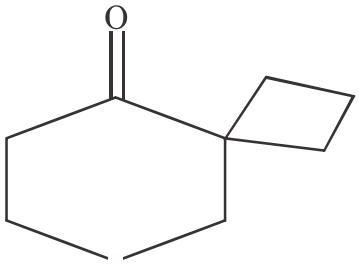
38. The major product of the following reaction is :



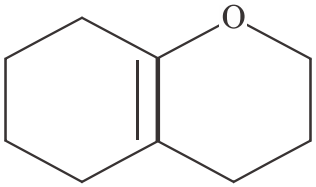
(A)



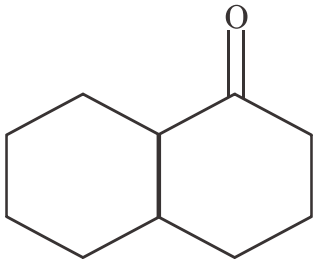
(B)



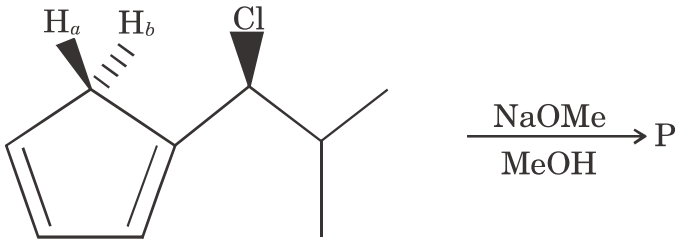
(C)



(D)



39. What is the relationship between H_a and H_b in the product P formed in the following reaction ?



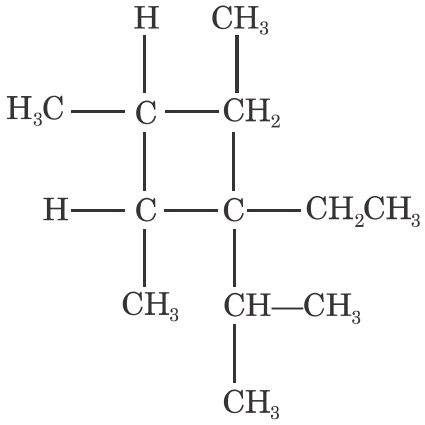
(A) Diastereotopic

(B) Enantiotopic

(C) Homotopic

(D) Vicinal

40. The IUPAC name of the following compound is :



(A) 3-Ethyl-2, 4, 5-trimethyl heptane

(B) 5-Ethyl-3, 4, 6-trimethyl heptane

(C) 3-isopropyl-4, 5-dimethyl heptane

(D) 5-isopropyl-3, 4-dimethyl heptane

41. Which one is the *correct* expression for zeroth order reaction ?

(A) $-\int_{[A]_0}^{[A]_t} d[A] = K_0 \int_{o}^{t} dt$

(B) $-\int_{[A]_o}^{[A]_t} d[A] = \int_{o}^{t} dt$

(C) $-\int_{[A]_o}^{[A]_t} d[A] = K_0$

(D) $-d[A] = K_0 \int_{o}^{t} dt$

42. Mechanism for ionic reaction in the light of activated complex theory is written as :

$$A^{Z_1} + B^{Z_2} \rightleftarrows (AB)^{\neq Z_1+Z_2} \rightarrow P$$

and corresponding rate law

$$\frac{d[P]}{dt} = \frac{\gamma_A \gamma_B}{\gamma^{\neq}} \times \frac{K_2 K_1}{K-1} [A] [B]$$

$\because \gamma \equiv$ Activity coefficients

If we hypothetically "Put-off" the charges on reactants, then the portion of equation,

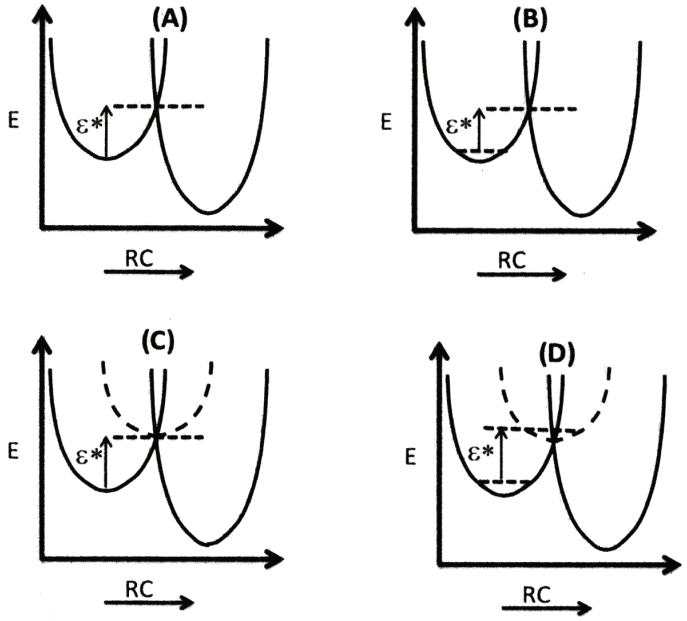
(A) $\frac{\gamma_A \cdot \gamma_B}{\gamma^{\neq}} \rightarrow 1$

(B) $\frac{\gamma_A \gamma_B}{\gamma^{\neq}} = 0$

(C) $\frac{K_2 K_1}{K-1} \rightarrow \infty$

(D) $\frac{K_2 K_1}{K-1} \rightarrow 0$

43. Which of the following energy surface (diagram) most appropriately represents gist of activated complex theory ?



(A) A

(B) A and C

(C) B

(D) D

44. Collision theory based bimolecular rate constant is given as :

$$K = N_A\sqrt{\frac{8k_BT}{\pi\mu}} \cdot \pi d^2 \, e^{-Ea/RT}$$

Applying this theory to the following gases state reaction,

(1) $2NOCl \xrightarrow{K_1} 2NO + 2Cl$

(2) $2ClO \xrightarrow{K_2} Cl_2 + O_2$

The rate constants, K_1 and K_2 should be in the order of :

(A) $K_1 > K_2$ (B) $K_2 < K_1$

(C) $K_1 \approx K_2$ (D) $K_1 \geq K_2$

45. Concept of electrochemical potential (EMF) is associated to :

(A) half cell

(B) Complete electrochemical cell

(C) Electrochemical reaction at equilibrium

(D) Potential difference of cell

46. Consider the cell

$$Cd(s)/Cd^{2+}\ (1.0M)\ ||\ Cu^{2+}\ (1.0M)\ |\ Cu(s)$$

Voltage of the cell can be raised by :

(A) Raising $[Cu^{2+}]$ or/and decreasing (Cd^{2+})

(B) Raising $[Cu^{2+}]$ and $[Cd^{2+}]$

(C) Raising $[Cd^{2+}]$

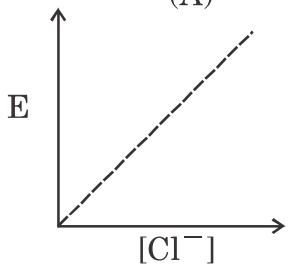
(D) Decreasing $[Cu^{2+}]$

47. For the calomel half cell,

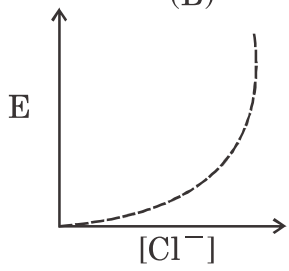
$$Hg(s)/Hg_2Cl_2\ (s)/Cl^-\ (aq.)$$

Change in electrode potential w.r.t. $[Cl^-]$ would look like :

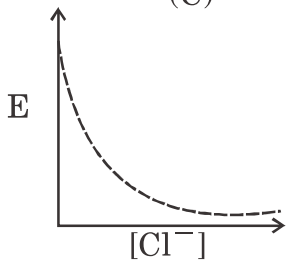
(A)



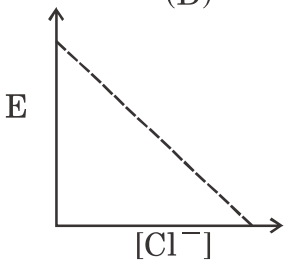
(B)



(C)



(D)



(A) = (A) (B) = (B)

(C) = (C) (D) = (D)

48. Average value of distance of an electron from nucleus in hydrogen atom in its lowest energy is expressed as :

(A) $\langle r \rangle = \frac{1}{\pi a^3} - \int_0^\infty r^3 e^{-2r/a_0}\, dr$

(B) $\langle r \rangle = \frac{1}{\pi a^3} \int_0^\infty r^3 e^{-r/a_0} \left(e^{-r/a_0}\right)^* dr$

(C) $\langle r \rangle = \frac{1}{\pi a^3} \left(\int_0^\infty r^3 e^{-2r/a_0}\, dr\right) * \left(\int_0^\pi \sin\theta\, d\theta\right) * \left(\int_0^{2\pi} d\phi\right)$

(D) $\langle r \rangle = \frac{5}{2} a_o$

49. $-\frac{\hbar^2}{2}\left(\frac{1}{me}+\frac{1}{mh}\right)\frac{d^2\psi}{dx^2} + \frac{z^2}{4\pi r}$. $\Psi = E\Psi$ could be a Schrödinger equation for :

(A) A particle in 1-D box problem

(B) Two particles in 2D box problem

(C) Simple harmonic motion between two particles

(D) Two charged particles in 1-D box problem

50. The following function is acceptable as state function over the range $(-\infty \text{ to } +\infty)$:

(A) e^{-x^2} (B) $\tan x$

(C) $\cot x$ (D) xe^{-x^2}

51. Apart from X-ray crystallography, the most important method to estimate protein structure with atomic resolution :

(A) 2-D NMR spectroscopy (B) LC-MS-MS

(C) Circular Dichroism (D) Fluorescence spectroscopy

52. 0.1 Mol of NaOH is added into 250 ml buffer solution. Change in pH is noted to be 0-2 units. The buffer capacity of buffer(s) is :

(A) = 1 (B) = 2

(C) = 3 (D) = 4

53. The drift speed of bovine serumalbumin under the electric field is measured at various pH :

pH	4.1	4.6	5.0	5.7	6.4	7.1
Speed μm/s	+0.50	+0.25	–0.25	–0.7	–0.9	–1.5

The isoelectric point of the protein should be, approximately in the range :

(A) 4.1 (B) 5.2

(C) 4.8 (D) 7.0

54. pH of 0.05 M $(NH_4)_2SO_4$ is (Given : $K_b(NH) = 10^{-5}$) :

(A) pH = 5 (B) pH = 4

(C) pH = 6 (D) pH = 3

55. Which of the following equations for the pressure of a gas is *correct* ?

(A) $dP = \frac{2RT}{(V-b)^2}\ dV + \frac{R}{(V-b)}dT$ (B) $dP = \frac{-RT}{(V-b)^2}\ dV + \frac{R}{(V-b)}dT$

(C) $dP = \frac{2RT}{(V-b)^2}dV + \frac{R}{(V-b)^2}dT$ (D) $dP = \frac{-RT}{(V-b)^2}dV + \frac{R}{(V-b)^2}dT$

56. Which of the following statements is *correct* regarding standard free energy change and the equilibrium constant for a mixture of ideal gases ?

(A) Standard free energy change and equilibrium constant are independent of total pressure and temperature

(B) Both properties depend on total pressure and temperature

(C) Both properties are independent of temperature but depend on total pressure

(D) Both properties depend on temperature but independent of total pressure

57. Consider an ideal solution of two liquids A and B. If partial vapour pressures of both liquids are same, then total pressure of the solution is :

(A) $\frac{P_A^o P_B^o}{P_A^o + P_B^o}$ (B) $\frac{2P_A^o P_B^o}{P_A^o + P_B^o}$

(C) $\frac{P_A^o}{P_A^o + P_B^o}$ (D) $\frac{2P_B^o}{P_A^o + P_B^o}$

58. For a non-linear triatomic gas, the molar heat capacity is :

(A) 5R (B) 7R

(C) 6R (D) $\frac{9}{2}R$

59. For a system with non-degenerate zero energy state and doubly degenerate upper state (with energy E), the partition function is :

(A) $2e^{-E/kT}$ (B) $2 + e^{-E/kT}$

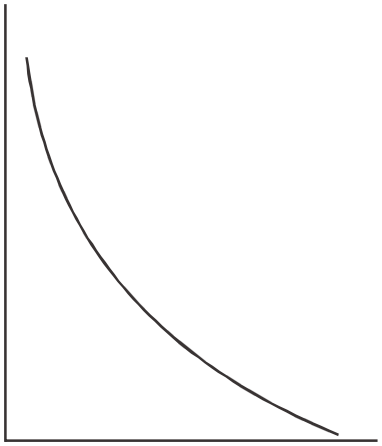
(C) $3e^{-E/kT}$ (D) $1 + 2e^{-E/kT}$

60. At low temperature, heat capacity of solids at constant volume is proportional to :

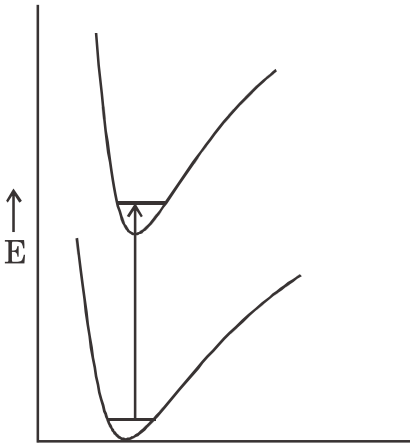
(A) T^3 (B) $\left(\frac{1}{T}\right)^3$

(C) $(RT)^2$ (D) $\left(\frac{R}{T}\right)^2$

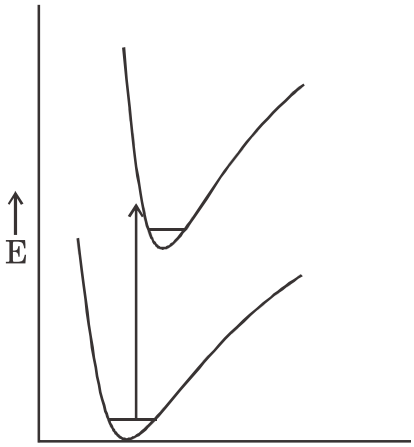
61. The variation of intensities of spectral lines shown in the figure corresponds to :



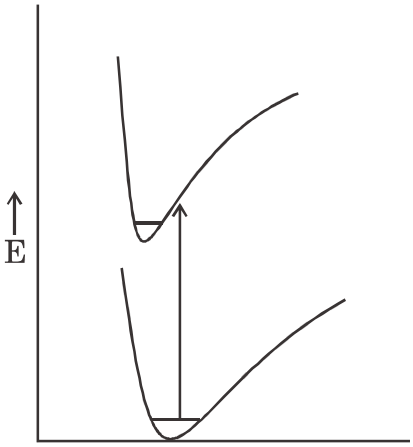
(A)



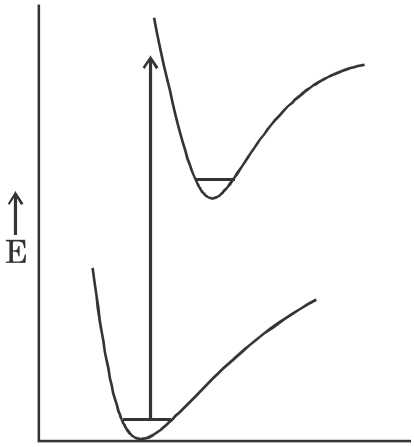
(B)



(C)



(D)



62. The selection rule for vibrational Raman spectra is :

(A) $\Delta v = \pm 1, \pm 2, \ldots\ldots\ldots\ldots$ (B) $\Delta v = 0, \pm 1, \pm 2, \ldots\ldots\ldots\ldots$

(C) $\Delta v = \pm 1, \pm 2, \ldots\ldots\ldots\ldots$ (D) $\Delta v = \pm 2$

63. In rotational fine structure of vibration-electronic transitions of a diatomic molecule, the band head will appear in R-branch if :

(A) $B' < B''$ (B) $B' = B''$

(C) $B' > B''$ (D) $B' = -B''$

64. In electronic spectra of molecules, the vibrational quantum number leading to convergence of vibrational spectral lines is given by :

(A) $\frac{1}{x_e} - 1$ (B) $\frac{1}{\bar{w}_e} - 1$

(C) $\frac{1}{2x_e} - 1$ (D) $\frac{1}{\bar{w}_e x_e} - 1$

65. The excess population of nuclear spins in lower state is given by :

(A) $\frac{n_{\text{lower}}}{n_{\text{lower}} + n_{\text{upper}}}$ (B) $\frac{n_{\text{lower}} + n_{\text{upper}}}{n_{\text{lower}} - n_{\text{upper}}}$

(C) $\frac{n_{\text{upper}} - n_{\text{lower}}}{n_{\text{upper}} + n_{\text{lower}}}$ (D) $\frac{n_{\text{lower}} - n_{\text{upper}}}{n_{\text{lower}} + n_{\text{upper}}}$

66. Calculate the wavelength of an electron accelerated through a potential of 16 V :

$$\left(\text{Given : } (2\ me)^{1/2} = 5.4 \times 10^{-25}\ \frac{\text{kg.m}}{\text{S.V}^{1/2}}\ \right)$$

(A) 0.307 nm (B) 0.123 nm

(C) 0.0123 nm (D) 3.07 nm

67. The first order correction term to the ground state energy of hydrogen like atom is :

(A) Positive
(B) Negative
(C) Zero
(D) Can be positive or negative

68. The slater determinant of helium atom is :

(A) $\Psi(1,2) = \frac{1}{\sqrt{2!}} \begin{vmatrix} 1S(2)\alpha(2) & 1S(1)\alpha(1) \\ 1S(2)\beta(2) & 1S(1)\beta(1) \end{vmatrix}$

(B) $\Psi(1,2) = \frac{1}{\sqrt{2!}} \begin{vmatrix} 1S(1)\alpha(1) & 1S(2)\alpha(2) \\ 1S(1)\beta(1) & 1S(2)\beta(2) \end{vmatrix}$

(C) $\Psi(1,2) = \frac{-1}{\sqrt{2!}} \begin{vmatrix} 1S(1)\alpha(1) & 1S(2)\alpha(2) \\ 1S(1)\beta(1) & 1S(2)\beta(2) \end{vmatrix}$

(D) $\Psi(1,2) = \frac{1}{2} \begin{vmatrix} 1S(1)\alpha(1) & 1S(2)\beta(1) \\ 1S(1)\alpha(2) & 1S(2)\beta(2) \end{vmatrix}$

69. In the study of solution of a polymer, the plot of $\frac{\pi}{C}$ versus 'C' results into the information of :

(A) $\overline{Mn}$ as reciprocal of intercept and polymer-solvent interaction constant as slope
(B) $\overline{Mn}$ as an intercept and concentration as slope
(C) $\overline{Mn}$ as the slope and polymer-solvent interaction constant as an intercept
(D) Only $\overline{Mn}$ as ratio intercept and slope

70. According to Langmuir model :

(I) All adsorption sites are equivalent
(II) Adsorption and desorption are cooperative processes
(III) Probability of adsorption is not affected by occupancy state of adsorption site
(IV) Only monolayer adsorption

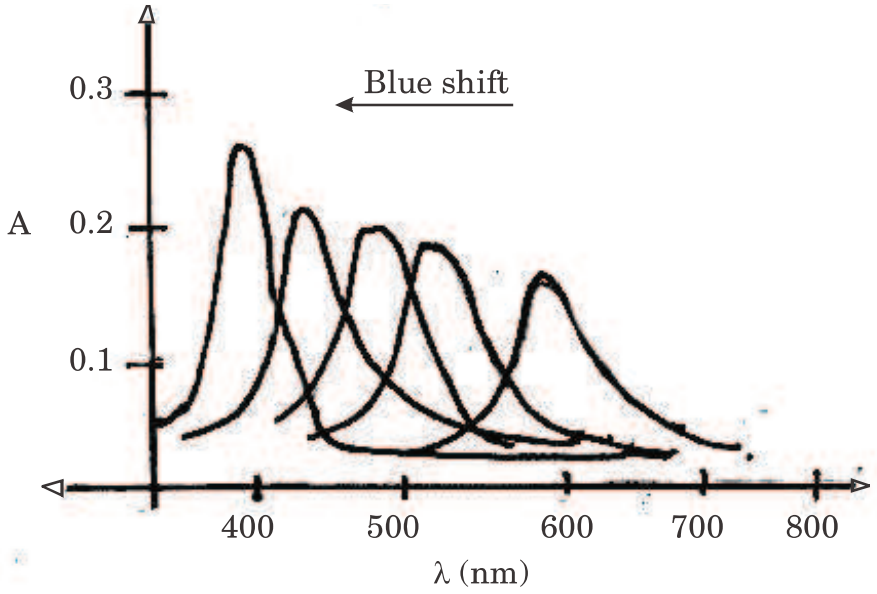
(A) (I), (II) and (III)
(B) (I) and (IV)
(C) (II) and (III)
(D) (II) and (IV)

71. Systematic change in λ_{max} with size in case of semiconductor nanoparticles is due to the phenomenon :

(A) Surface plasmon resonance (B) Size quantization effect

(C) Nano-effect (D) Band theory

72. The following UV-vis spectra recorded on various sizes of semiconductor nanoparticles :



The blue shift in the spectra is correlated to :

(A) decrease in size of nanoparticles (B) Increase in size of nanoparticles

(C) Surface plasmon resonance (D) Nothing to do with size

73. According to variation theorem, energy eigenvalue obtained from an approximate wave function is :

(A) Always equal to E_o (B) Upper bound to E_o

(C) Lower bound to E_o (D) Always positive

74. The adsorbent which has higher adsorptive power in column chromatography is :

(A) SiO_2 (B) MgO

(C) $CaCO_3$ (D) Al_2O_3

75. $[BrF_4]^-$ has :
(A) Shape similar to SF_4 (B) sp^3d hybridization
(C) sp^3 hybridization (D) sp^3d^2 hybridization

76. The number of significant figures in the answer of addition (0.6540 + 6.54 + 65.4 + 654) is :
(A) 725 (B) 3
(C) 4 (D) 8

77. The EPR lines predicted for $^{\bullet}CF_2H$ radical will be (^{12}C; I = O, F, H; I = ½)
(A) 6 (B) 0
(C) 3 (D) 2

78. Drug metabolism occurs mainly in :
(A) Liver (B) Brain
(C) Spleen (D) Kidney

79. Catalytic converters are used in reduction and oxidation on reactions to reduce harmful emissions. The oxidation of CO and hydrocarbons was carried out by catalyst consisting the following metals :
(A) Pt, Rh (B) Pt, Pd
(C) Co, Rh (D) Co, Ni

80. Which one of the following molecules is an anti-fungal agent ?
(A) Sulfa drug (B) Amphotericin-B
(C) Oseltamivir (Tamiflu) (D) Remdesivir

81. The complex $[FeF_6]^{3-}$ is colorless, whereas $[CoF_6]^{3-}$ is colored; this is because :

(A) Both are high spin complexes

(B) Spin forbidden transitions in $[FeF_6]^{3-}$ and spin allowed transitions in $[CoF_6]^{3-}$

(C) Spin-allowed transitions in $[FeF_6]^{3-}$ and spin-forbidden transitions in $[CoF_6]^{3-}$

(D) $[FeF_6]^{3-}$ is low spin complex, and $[CoF_6]^{3-}$ is high spin complex

82. The species with the lowest Valence Electron (VE) count is :

(A) $[V(CO)_6]^-$ (B) $[Cu(MA_3)_6]^{2+}$

(C) $[AuCl_4]^-$ (D) $[Zn(en)_3]^{2+}$

83. The Wade's rules can be applied to the naked clusters of *p*-block elements. According to Wade's rules, the number of skeletal electrons in $Pb_5^{7^{2-}}$ cluster is :

(A) 18 (B) 22

(C) 8 (D) 12

84. In an axially symmetric field, NQR transition/s expected for nuclear spin quantum number I = 7/2 is/are :

(A) 1 (B) 2

(C) 3 (D) 4

85. $^{31}P-\{^1H\}$ spectrum of diamagnetic complex mer–$RhCl_3$ $(PEt_3)_3$ would show (^{103}Rh, ^{31}P; I = $1/2$)

(A) a doublet

(B) a triplet

(C) doublet of doublet and doublet of triplet

(D) triplet of doublet and doublet of doublet

86. Based on Pauling's electronegativity scale hydrogen can oxidize :

(A) Boron (B) Carbon

(C) Nitrogen (D) Oxygen

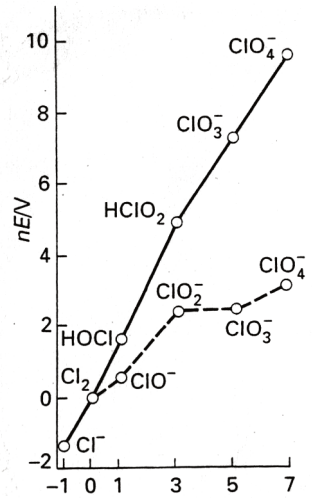
87. The following reaction

$$3CH_3Li + SbCl_3 \rightarrow (CH_3)_3Sb + 3LiCl$$

is an example of :

(A) Oxidative addition
(B) Reductive elimination
(C) Metal-halogen exchange
(D) Metathesis reaction

88. Consider the given Frost diagram for chlorine species in acidic (solid line) and basic (dashed line) media. The INCORRECT statement about their reactivities is :



(A) ClO_2^- is more susceptible to disproportionation in acidic than in basic medium
(B) All species disproportionate in acidic medium
(C) ClO_4^- is a stronger oxidizing agent in basic than in acidic medium
(D) Except Cl^-, other chlorine species are strongly oxidizing in acidic than in basic medium

89. The radionuclide ^{135}Te undergoes four successive β^- emission to give the stable isotope :

(A) ^{135}I
(B) ^{135}Xe
(C) ^{135}Cs
(D) ^{135}Ba

90. The molecule which does not have Td symmetry :

(A) SiF_4 (B) CH_4

(C) P_4 (D) XeF_4

91. Historically, oxygen was prepared by the decomposition of metal oxides. The *correct* set of oxides that give dioxygen on heating is :

(A) HgO, CaO, BaO (B) KO_2, BaO_2, Na_2O

(C) Na_2O, CaO, BaO (D) HgO, KO_2, BaO_2

92. The ${}_PK_a$ of coordinated water is lowest for :

(A) $[Fe(H_2O)_6]\ Cl_2$ (B) $[Fe(H_2O)_6]\ Cl_3$

(C) $[Zn(H_2O)_6]\ Cl_2$ (D) $[Ru(H_2O)_6]\ Cl_3$

93. The results of a copper analysis are found to give 42.50% of metal as compared to true value of 42.92%. The relative error of analysis is :

(A) –0.97% (B) +0.97%

(C) –0.42% (D) +0.42%

94. The set of compounds that show autoionization is :

(A) Cl_2O_6, $POCl_3$, HF

(B) IF_3, HF, $POCl_3$

(C) HF, IF_3, Cl_2O_6

(D) $POCl_3$, IF_3, Cl_2O_6

95. The radionuclide ${}^{22}_{11}Na$ decays by a positron emission. The ratio of the atomic mass and atomic number of the resulting nuclide is given by :

(A) $\frac{22}{10}$ (B) $\frac{22}{11}$

(C) $\frac{21}{10}$ (D) $\frac{21}{11}$

96. R-S terms possible for a first-row transition metal complex in a weak field of ligands are ^2H, ^2G, ^4F, ^2F, ^2D, ^2D and ^2P. The ground term of this complex is/are :

(A) ^2H (B) ^4P

(C) ^4P and ^4F (D) ^4F

97. Lanthanides and actinides are not known to form neutral carbonyl complexes because :

(A) They lack electrons in *d* orbitals

(B) Their *d* orbitals do not overlap with π orbitals of CO

(C) They tend to hydrate CO under ambient conditions

(D) Their large metal atoms cannot interact with smaller diatomic ligands

98. Concurrent bond formation between metal and the entering group and bond cleavage between metal and the leaving group is observed in a/an :

(A) Associative reaction (B) Dissociative reaction

(C) Interchange reaction (D) Reductive elimination reaction

99. Hemocyanin is an oxygen transport protein in arthropodes. The mode of oxygen binding to copper in hemocyanin is :

(A) $\mu - \eta^1 : \eta^1 - O_2^{2-}$ (B) $\mu - \eta^2 : \eta^2 - O_2^{2-}$

(C) $\mu - \eta^1 : \eta^1 - O_2^{-}$ (D) $\mu - \eta^2 : \eta^2 - O_2^{-}$

100. The observed magnetic moment for the complex $Cs_2[CoCl_4]$ is 4.59 B.M. The magnetic moment can be best explained by :

(A) The spin only value

(B) Spin-orbit coupling

(C) Orbital contribution to the magnetic moment

(D) Temperature independent paramagnetism

ROUGH WORK

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