Test Booklet Code & No.
प्रश्नपत्रिका कोड व क्र. **B**

Paper-III
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)

MAY - 33316

Time Allowed : 2½ Hours] **[Maximum Marks : 150**

Number of Pages in this Booklet : **32** Number of Questions in this Booklet : **75**

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 **75** objective type questions. Each question will carry *two* marks. *All* questions of Paper-III will be compulsory, covering entire syllabus (including all electives, without options).
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.

   (A) (B) ● (D)

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. परिक्षार्थींनी आपला आसन क्रमांक या पृष्ठावरील वरच्या कोपऱ्यात लिहावा. तसेच आपणांस दिलेल्या उत्तरपत्रिकेचा क्रमांक त्याखाली लिहावा.
2. सदर प्रश्नपत्रिकेत **75** बहुपर्यायी प्रश्न आहेत. प्रत्येक प्रश्नास **दोन** गुण आहेत. या प्रश्नपत्रिकेतील **सर्व** प्रश्न सोडविणे अनिवार्य आहे. सदरचे प्रश्न हे या विषयाच्या संपूर्ण अभ्यासक्रमावर आधारित आहेत.
3. परीक्षा सुरू झाल्यावर विद्यार्थ्याला प्रश्नपत्रिका दिली जाईल. सुरुवातीच्या 5 मिनीटांमध्ये आपण सदर प्रश्नपत्रिका उघडून खालील बाबी अवश्य तपासून पहाव्यात.
   (*i*) प्रश्नपत्रिका उघडण्यासाठी प्रश्नपत्रिकेवर लावलेले सील उघडावे. सील नसलेली किंवा सील उघडलेली प्रश्नपत्रिका स्विकारू नये.
   (*ii*) **पहिल्या पृष्ठावर नमूद केल्याप्रमाणे प्रश्नपत्रिकेची एकूण पृष्ठे तसेच प्रश्नपत्रिकेतील एकूण प्रश्नांची संख्या पडताळून पहावी. पृष्ठे कमी असलेली/कमी प्रश्न असलेली/प्रश्नांचा चूकीचा 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 पहिल्यानंतरच 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.

   (A) (B) ● (D)

5. या प्रश्नपत्रिकेतील प्रश्नांची उत्तरे **ओ.एम.आर. उत्तरपत्रिकेतच दर्शवावीत.** इतर ठिकाणी लिहीलेली 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 ठिकाणा व्यतिरीक्त इतर कोठेही नाव, आसन क्रमांक, फोन नंबर किंवा ओळख पटेल अशी कोणतीही खूण केलेली आढळून आल्यास अथवा असभ्य भाषेचा वापर किंवा इतर गैरमार्गाचा अवलंब केल्यास विद्यार्थ्याला परीक्षेस अपात्र ठरविण्यात येईल.
9. परीक्षा संपल्यानंतर विद्यार्थ्याने मूळ ओ.एम.आर. उत्तरपत्रिका पर्यवेक्षकांकडे परत करणे आवश्यक आहे. तथापी, 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 III

Time Allowed : 2½ Hours] **[Maximum Marks : 150**

Note : This paper contains **Seventy Five (75)** multiple choice questions, each question carrying **Two (2)** marks. Attempt *All* questions.

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1. Which of the following statements is *not correct* about the quantum mechanical harmonic oscillator ?

   (A) The amplitude of a quantum mechanical harmonic oscillator in its ground state will not exceed its classical value in lower energy states.

   (B) The average values of $<x>$ and $<p>$ are zero.

   (C) In highly excited states the quantum mechanical oscillator behaves as a classical oscillator

   (D) The wave function for quantum mechanical harmonic oscillator is always either odd or even.

2. The free energy of mixing for the ideal solution is given by :

$$\Delta G_{mix} = RT(x_A \ln x_A + x_B \ln x_B)$$

   $\because$ x_A and x_B are respective mole fractions from the expression one can deduce that :

   (A) The mixing is not spontaneous and ΔG = +ve

   (B) The mixing is spontaneous and ΔG is negative and maximum at X = 1/2

   (C) The mixing is exothermic

   (D) The mixing is endothermic

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3. The term symbol not possible for the nd^2 electronic configuration is :

(A) ^3F (B) ^1D

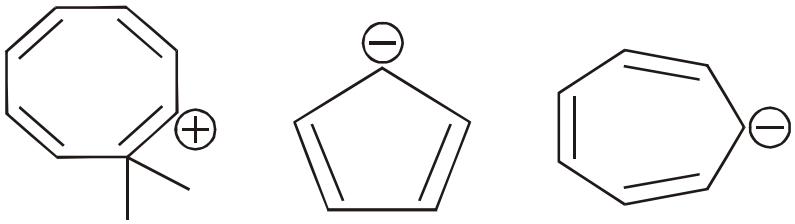
(C) ^1G (D) ^1F

4. Log of mean activity coefficient ($\gamma_{\pm}$) for 0.005 mol kg^{-1} KCl solution at 25°C is :

(A) –0.920 (B) 0.0360

(C) 0.920 (D) –0.0360

5.



[A] [B] [C]

Among the ions [A], [B] and [C], given :

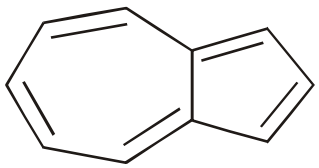
(A) A is aromatic, B is homoaromatic and C is antiaromatic

(B) A is homoaromatic, B is aromatic and C is antiaromatic

(C) A is aromatic, B is antiaromatic and C is homoaromatic

(D) A is homoaromatic, B is antiaromatic and C is aromatic

6.



[X]

The most *correct* statement about compound [X] is :

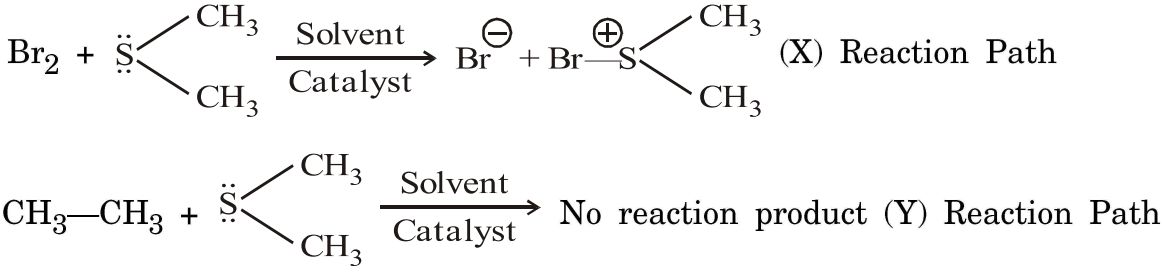
(A) It is aromatic

(B) It is aromatic and has high dipole moment than expected

(C) It is aromatic but has no dipole moment

(D) It is antiaromatic

7. Justify the answer given in the statement below for reaction (X) and reaction (Y) pathways :



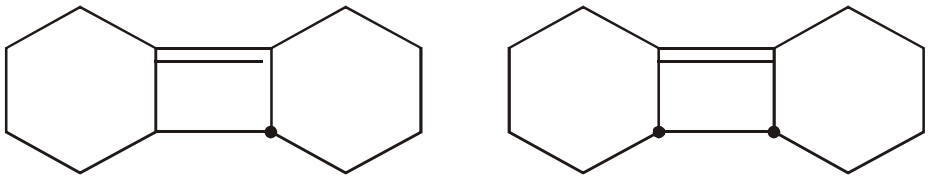
(A) Lone pair of electrons are donated from S-atom to Br—Br to form new S-Br band, in (X) path but not possible to break C—C bond in (Y) path

(B) Lone pair of electrons are donated from Br—Br to S-atom in path (X), but not possible to donate CH_3—CH_3 σ-bond to S-atom in path (Y)

(C) Lone pair of electrons are restricted by S-atom to donate in both (X) path and (Y) path, but catalytic reagent may do this in path (X) only

(D) Lone pair of electrons are blocked by S-atom in path (Y) but bromine procure electron pair from solvent in path (X)

8.



X Y

Both X and Y are subjected to thermal ring opening. It will be observed that :

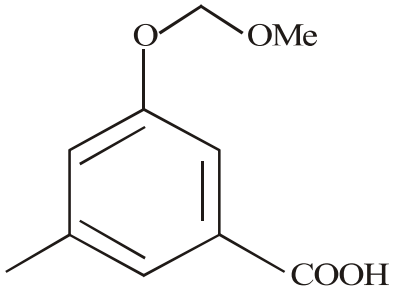
(A) X undergoes ring opening, more readily compared to Y

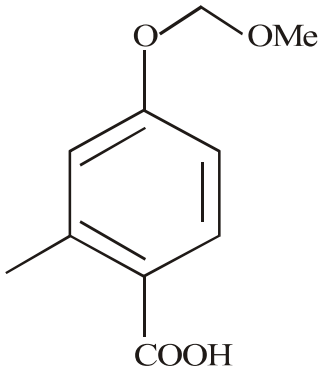
(B) Y undergoes ring opening, more readily compared to X

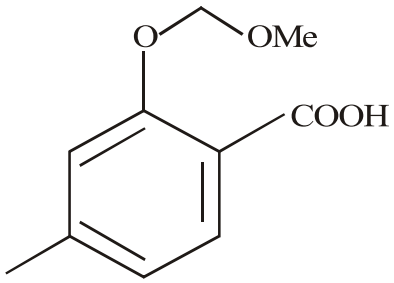
(C) The rate of ring opening reaction is same for both molecules X and Y

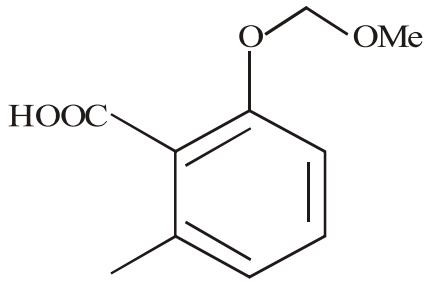
(D) Y does not undergo ring opening even at high temperature

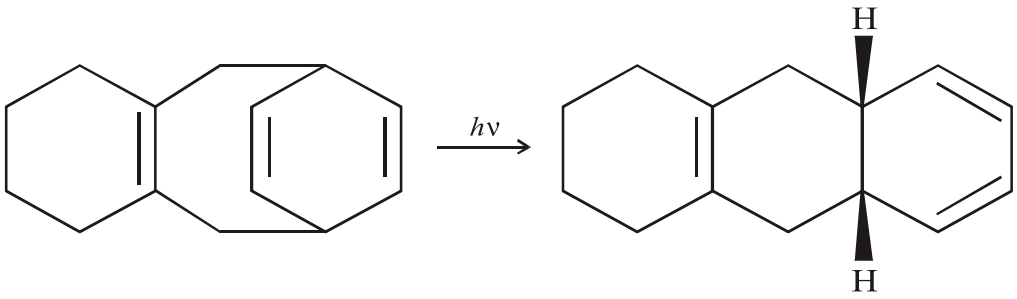
9. Methoxymethyl ether of *m*-cresol is reacted with *t*-BuLi in dry ether and the product is reacted with dry ice followed by acidic work-up. The major product (X) formed has structure :

(A) 

(B) 

(C) 

(D) 

10. 

The above reaction involves :

(A) [1, 3] sigmatropic carbon migration with inversion at migrating center

(B) [1, 3] sigmatropic carbon migration with retention at migrating center

(C) [1, 3] sigmatropic hydrogen migration

(D) [1, 5] sigmatropic carbon migration with retention at migrating center

11. Pericyclic disrotatory ring opening of 1, 3-cyclo hexadiene to 1, 3, 5- hexatriene could be considered as :

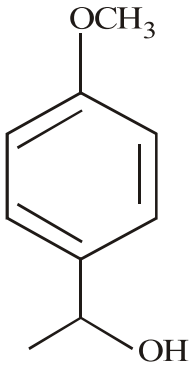
(A) $[\pi^2 s + \sigma^2 a]$ cycloaddition (B) $[\pi^2 a + \sigma^2 a]$ cycloaddition

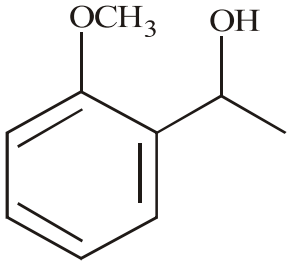
(C) $[\pi^4 s + \sigma^2 s]$ cycloaddition (D) $[\pi^4 a + \sigma^2 a]$ cycloaddition

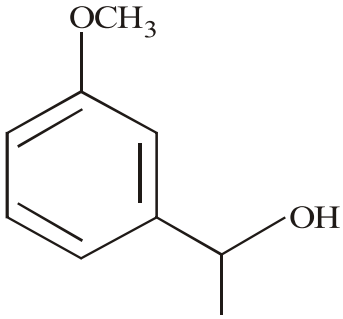
12. An aromatic ether (C_7H_8O) is reacted with *n*-butyl lithium and the ether derivative obtained is reacted with an aliphatic aldehyde to form Y($C_9H_{12}O_2$). Y on oxidation forms compound Z($C_9H_{10}O_2$). Compound Z has the following PMR data :

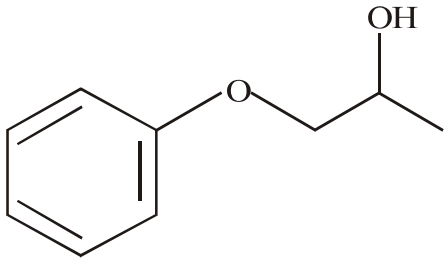
δ 3.83, *s*, 3H; 2.3, *s*, 3H; 7.1-7.5, *m*, 4H.

The structure of compound [Y] is :

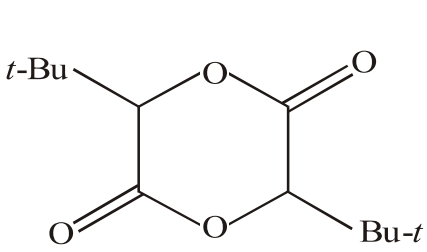
(A) 

(B) 

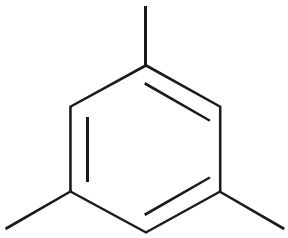
(C) 

(D) 

13.



(X)



(Y)

Compounds (X) and (Y) exhibit two singlets each in their ^{1}H NMR spectrum.

The expected chemical shifts in δ units are :

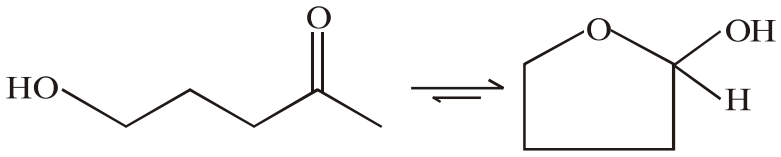
(A) 2.3 and 7.2 for X; 0.95 and 4.8 for Y

(B) 0.95 and 4.8 for X; 2.3 and 7.2 for Y

(C) 0.95 and 7.2 for X; 2.3 and 4.8 for Y

(D) 2.3 and 4.8 for X; 0.95 and 7.2 for Y

14. Identify the name of product (X) in the following transformation :



(X)

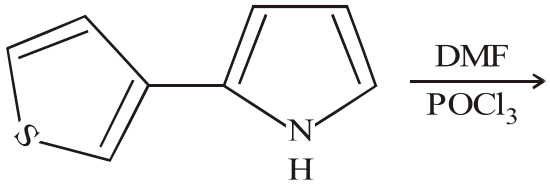
(A) X = Ketal

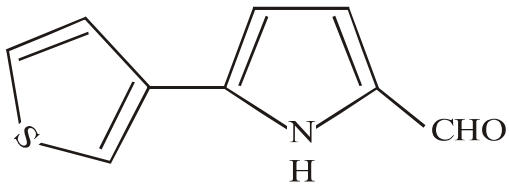
(B) X = Lactal

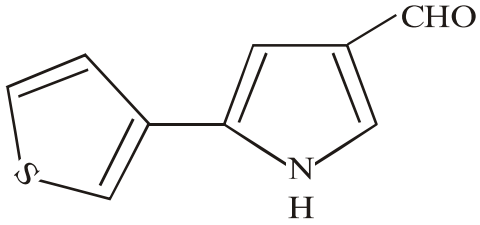
(C) X = Acetal

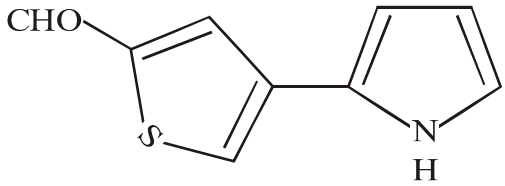
(D) X = Hemiketal

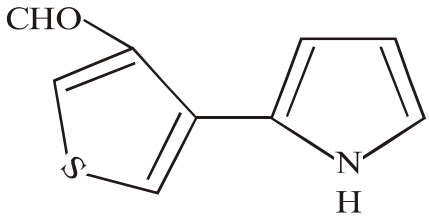
15. The major product (X) in the following reaction is :



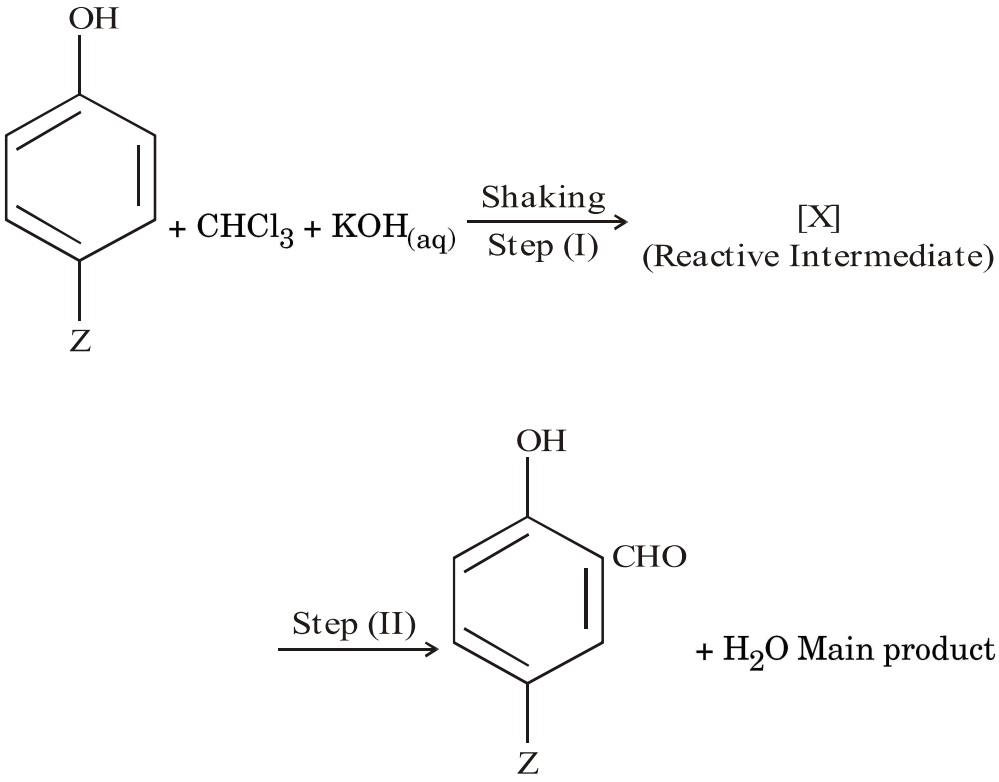
(A) 

(B) 

(C) 

(D) 

16. In the following reaction, first step involved deprotonation of chloroform by strong base (usually KOH) to form the reactive intermediate (X) as :

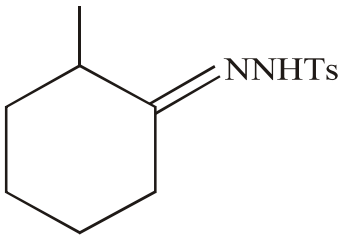


(A) X = Dichlorocarbanion ion

(B) X = Trichlorocarbanion ion

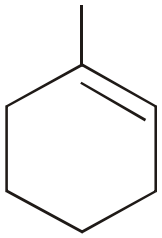
(C) X = Dichlorocarbene species

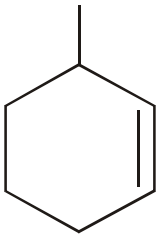
(D) X = Chlorohydrin species

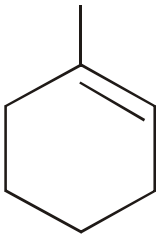
17. 

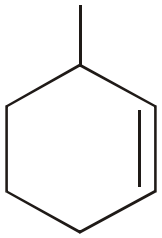
$\xrightarrow[Et_2O]{MeLi,}$ [X] (Major) + [Y] (Minor)

The above reaction is an example of ..... reaction and structure of [X] is :

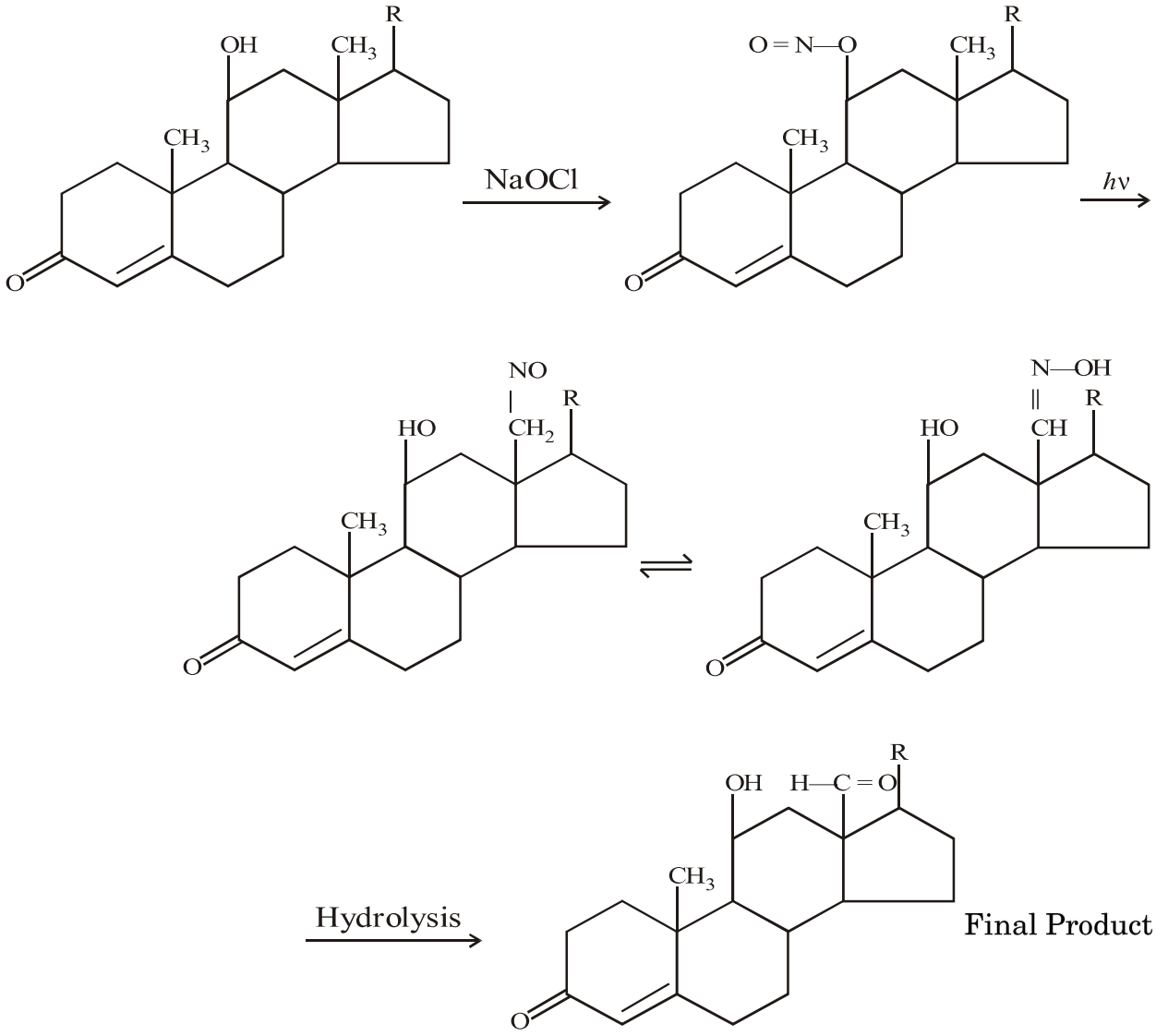
(A) Stevens rearrangement, X = 

(B) Shapiro reaction, X = 

(C) Shapiro reaction, X = 

(D) Stevens rearrangement, X = 

18. Identify the following conversion :



(A) Ene Reaction

(B) Hofmann Loffler Reaction

(C) Barton Reaction

(D) Shapiro Reaction

19. Thymine is a pyrimidine base present in DNA, its carbohydrate substitution in 2-deoxyribofuranose is attached to :

(A) N-3 of Thymine

(B) N-1 of Thymine

(C) Both N-1 and N-3 of Thymine

(D) Neither N-1 nor N-3 of Thymine

20. Match the following combinations and choose suitable pairs :

(L)	β-Carotene	(1)	Protein
(M)	Morphine	(2)	Alkaloid
(N)	Alanin	(3)	Steroid
(O)	Estrogene	(4)	Terpene

(A)	(L)—(3)	(M)—(1)	(N)—(4)	(O)—(2)
(B)	(L)—(1)	(M)—(3)	(N)—(2)	(O)—(4)
(C)	(L)—(4)	(M)—(2)	(N)—(1)	(O)—(3)
(D)	(L)—(2)	(M)—(4)	(N)—(3)	(O)—(1)

21. One of the statement is *true* in case of Nucleotides :

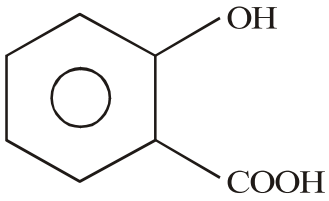
(A) They are phosphoric acid esters of Pyrimidines

(B) They are phosphoric acid esters of Sugars

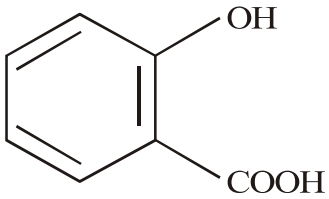
(C) They are phosphoric acid esters of Purines

(D) They are phosphoric acid esters of Nucleosides

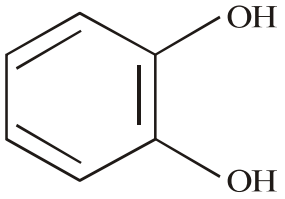
22. The oil of winter green (X) is formed in one of the following reactions :

(A) 

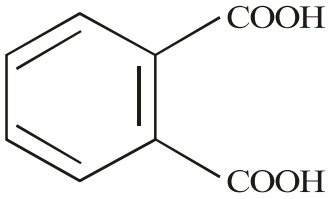
$+ \underset{\text{(glacial)}}{CH_3COOH} \xrightarrow[\text{Refluxed}]{H_2SO_4} (X)$

(B) 

$+ \underset{\text{solution}}{HCOOH} \xrightarrow[\text{Refluxed}]{H_2SO_4} (X)$

(C) 

$+ CH_3COOH \xrightarrow[\text{Refluxed}]{H_2SO_4} (X)$

(D) 

$+ CH_3OH \xrightarrow[\text{Refluxed}]{H_2SO_4} (X)$

23. The carbonyl compounds exhibits electrophilic functionality because they have :

(A) A Low Energy LUMO σ^* orbital

(B) A Low Energy HOMO π^* orbital

(C) A Low Energy LUMO π^* orbital

(D) A Low Energy HOMO σ^* orbital

24. In emulsion polymerization method, the initiator used is :

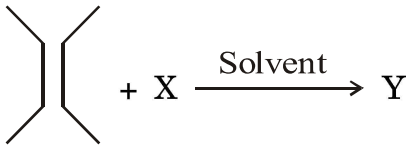
(A) Soluble in monomer

(B) Soluble in water

(C) Soluble in both water and monomer

(D) Insoluble in both water and monomer

25. Simple following alkene is a weak nucleophile and reacts with X = electrophile given below, identify the best suitable electrophile and Y = product :



Alkene Product

(A) X = Br_2 and Y = Dibromoalkane

(B) X = NO and Y = Nitrosoalkane

(C) X = NO_2 and Y = Nitroalkane

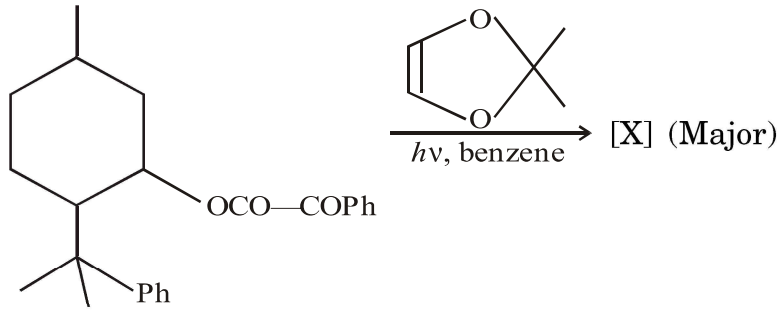
(D) X = CO and Y = Carboxylalkane

26. $^{\Theta}BH_4$ can have electrons from B-H bond available for donation, although $^{\Theta}BH_4$ devoid lone pair of electrons of π orbital electron it act as :

(A) poor nucleophile (B) good nucleophile

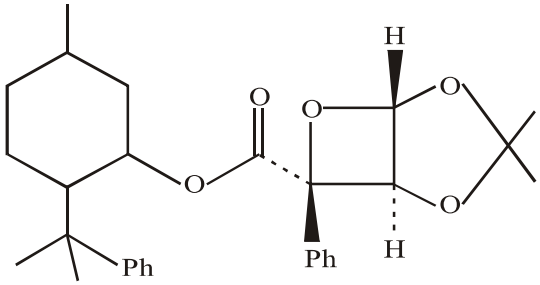
(C) good electrophile (D) neutral species

Linked problems, Q. No. **27** and Q. No. **28** :

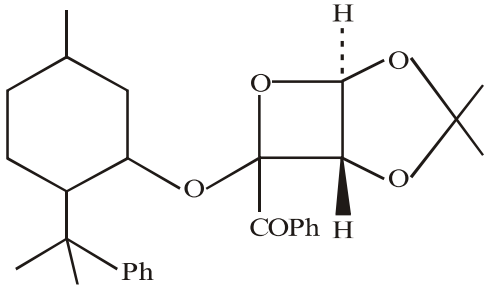


27. The structure of [X] is :

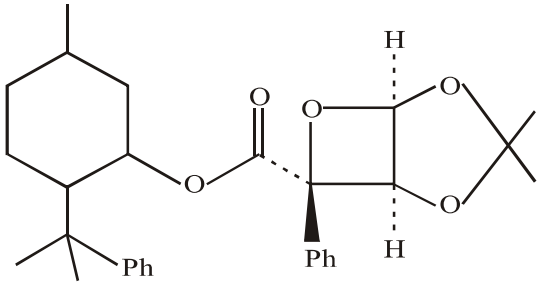
(A)



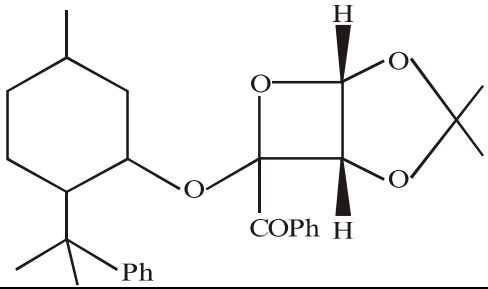
(B)



(C)



(D)



28. The name of the above reaction is :

(A) Paterno-Buchi reaction (B) Barton reaction

(C) Michael addition (D) Ene reaction

29. When gamma-ray photon with sufficiently high energy interacts with matter, pair production can occur. In this process, the photon is totally absorbed in creating :

(A) a positron (B) an electron

(C) a positron and an electron (D) a neutron

30. Two 10.0 ml aliquots of sea water were taken for neutron activation analysis. Exactly 1.0 ml of a standard solution containing 1.0 μg Al^{3+} was added to one aliquot and 1.0 ml of distilled water was added to other aliquot. The two samples were then irradiated simultaneously in a homogeneous neutron flux. After a brief cooling period, the gamma radiation from the decay of ^{28}Al was counted for each sample. The solution diluted with distilled water gave a counting rate of 2200 cpm whereas the solution containing the added Al^{3+} gave 4200 cpm. What is the mass of Al in the 10 ml aliquot ?

(A) 2.2 μg (B) 1.1 μg

(C) 2.4 μg (D) 1.2 μg

31. Which one of the following is an example of β-decay ?

(A) $^{48}_{24}Cr + {}^{0}_{1}e \rightarrow {}^{48}_{23}V$ + X-rays

(B) $^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

(C) $^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{1}_{0}n + 5.7MeV$

(D) $^{23}_{11}Na + {}^{1}_{0}n \rightarrow {}^{24}_{11}Na$ + gamma rays

32. Edge dislocations result when :

(A) atoms in one layer do not match up precisely with those of the next

(B) atoms in one layer do match up with those of the next

(C) cations migrate to the surface

(D) anions migrate to the surface

33. Frenkel defect is caused when :

(A) Anions are missing from its lattice sites

(B) Cations are migrated to nearby interstitial sites

(C) Cations and equal number of anions migrate from its lattice sites to the surface of crystal

(D) Cations are migrating from its lattice sites to the surface of crystal

34. For transition metal (M) spinels, M(II) $[M'III]_2O_4$ is considered a normal spinel, while M′(III) [M(II) M′(III)]O_4 is considered an inverse spinel. Based on these consideration which one of the following is *true* ?

(A) Fe_3O_4 is a normal spinel

(B) Ni(II)Fe_2O_4 is a normal spinel

(C) Co_3O_4 is an inverse spinel

(D) Mn_3O_4 is a normal spinel

35. The correct STYX number for B_5H_9 (nido-pentaborane) is :

(A) 2002 (B) 4120

(C) 3003 (D) 4012

36. The magnetic properties of the actinides are quite complex because :

(A) spin-orbital coupling of 5*f* electrons is negligible

(B) the 5*f* electrons do not interact with ligands

(C) the 5*f* electrons interact much lesser with ligands

(D) the spin-orbital coupling and ligand field effects are of comparable magnitude

37. The absorption bands in electronic spectra of lanthanide cations are :

(A) broad and low intensity

(B) broad and high intensity

(C) sharp and line-like

(D) Broad and appear at lower wavelength

38. Which of the following metal ions should form a more stable octahedral complex with pyridine ?

(A) Fe^{2+} (B) Fe^{3+}

(C) Ru^{3+} (D) V^{3+}

39. Which of the following complexes has zero orbital moment ?

(A) $[Mn(CN)_6]^{4-}$ (B) $[Mn(CN)_6]^{3-}$

(C) $[Mn(H_2O)_6]^{5+}$ (D) $[FeF_6]^{3-}$

40. The number of valence electrons in $Ni(\eta^3\text{-allyl})_2$ and $Mn(\eta^5\text{-}C_5H_5)\ (CO)_3$ is, respectively :

(A) 18 and 17 (B) 16 and 18

(C) 14 and 19 (D) 16 and 17

41. How many M-M bonds should form in complex $[Mo(\eta^5\text{-}C_5H_5)\ (CO)_2]_2$ in order to obey 18 electron rule ? [Given : At. no. of Mo = 42]

(A) 1 (B) 2

(C) 3 (D) 4

42. Which of the following is a stable 18 electron species ?

(A) $Ni(\eta^3\text{-allyl})_2$

(B) $Ru(\eta^5\text{-}C_7H_7)\ (\eta^1\text{-}C_6H_5)CO$

(C) $Mo(\eta^5\text{-}C_5H_5)\ (\eta^1\text{-}C_5H_5)\ (CO)_2$

(D) $Rh(PPh_3)_2COCl$

43. The π-acidic ligands stabilize the metal ions in lower oxidation states because of :

(A) L → M π-interaction

(B) Stronger L → M σ-interaction

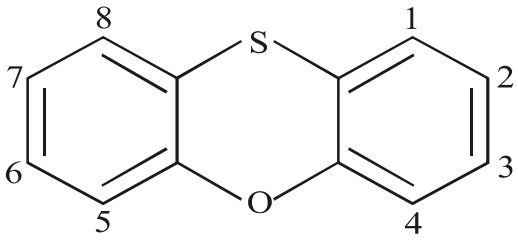
(C) Synergic effect

(D) Neutralization of the positive charge over the metal ion.

44. Which of the following will undergo the easiest hydrogenation ?

(A) $Cr(\eta^6\text{-}C_6H_6)_2$ (B) $Fe(\eta^5\text{-}C_5H_5)_2$

(C) $Mo(\eta^5\text{-}C_5H_5)_2$ (D) $Co(\eta^5\text{-}C_5H_5)_2$

45. 

Yields a monolithiated product on lithiation with Li(s) in an inert solvent. Which C atom is expected to exchange H with Li ?

(A) 1 (B) 2

(C) 3 (D) 4

46. During a ligand substitution reaction, if an intermediate with higher coordination is formed, the possible mechanism of the reaction is :

(A) A (B) I_a

(C) D (D) I_d

47. Which of the following is expected to undergo the fastest inner sphere reduction by $[Cr(H_2O)_6]^{2+}$?

(A) $[Co(PY)_6]^{3+}$ (B) $[Co(PY)_5\ (ampy)]^{3+}$

(C) $[Fe(PY)_5\ (dampy)]^{3+}$ (D) $[Co(PY)_5\ (dampy)]^{3+}$

[PY = pyridine

ampy = 4-aminopyridine

dampy = 3, 5-diaminopyridine]

48. The reaction :

$$\left[Pt(en)_2Cl_2\right]^{2+}_{(aq)} + \left[Pt\left(NH_3\right)_4\right]^{2+}_{(aq)} \underset{Cl^-}{\overset{Cl^-}{\rightleftharpoons}} \left[Pt(en)_2\right]^{2+}_{(aq)} + \left[Pt\left(NH_3\right)_4 Cl_2\right]^{2+}_{(aq)}$$

is an example of :

(A) Isomerization reaction (B) Ligand substitution reaction

(C) Electron transfer process (D) Reproportionation reaction

49. A 4Fe-3S protein has :

(A) 4 sulphides and 3Fe bound to cysteine residues

(B) 3 sulphides and 4Fe bound to cysteine residues

(C) 4 Fe and 3 cysteine residues

(D) 4 sulphides out of which 3 are bridging between the Fe ions

50. The MET-APO form of the active site in hemocyanin has :

(A) One Cu^+ (B) One Cu^{2+}

(C) One Cu^{1+} and one Cu^{2+} (D) Two Cu^{2+}

51. Which of the following has the lowest nephelauxetic ratio ?

(A) $[RuCl_6]^{3-}$ (B) $[Fe(PY)_4Cl_2]$

(C) $[Ru(NH_3)_6]^{2+}$ (D) $[Ru(bipy)_3]^{2+}$

[bipy = 2, 2′-bipyridine]

[PY = pyridine]

52. On the basis of cluster valence electron count, the structure of the metallic framework in $Co_4(CO)_{12}$ and $Ru_4(CO)_{16}$ can be predicted to be respectively :

(A) Tetrahedral and square planar

(B) Square planar and butterfly

(C) Butterfly and tetrahedral

(D) Square planar and tetrahedral

53. A solution containing 10.0 ppm $KMnO_4$ had a transmittance of 0.1 in a 2.0 cm cell at 520 nm. The absorptivity of $KMnO_4$ solution is :

(A) 5.0×10^2 Lg^{-1} cm^{-1} (B) 5.0×10^3 Lg^{-1} cm^{-1}

(C) 2.5×10^2 Lg^{-1} cm^{-1} (D) 2.5×10^3 Lg^{-1} cm^{-1}

54. An acid HB has a distribution coefficient of 8.8 between an organic solvent and water. At pH 6.0, exactly half of the material is extracted into the organic solvent from an equal volume of the aqueous phase. The dissociation constant of acid HB is :

(A) 8.8×10^{-6} (B) 7.8×10^{-6}

(C) 9.8×10^{-6} (D) 6.8×10^{-6}

55. Which of the following is used as sources of radiation in uv-visible spectrophotometer ?

(A) Tungsten lamp

(B) Deuterium lamp

(C) Tungsten and deuterium lamp

(D) Xenon arc lamp

56. If the vivrational frequency of H_2 molecule is 4400 cm^{-1}, what will be the frequency of vibration of HD ?

(A) 2200 cm^{-1} (B) 4400 cm^{-1}

(C) 3300 cm^{-1} (D) 3833 cm^{-1}

57. The electrochemical cells are connected as shown below :

$$\begin{array}{l} Zn(s)|\ Zn^{2+}(1.0M)\,||\,Cu^{2+}(0.1M)|\ Cu(s)\ \text{cell I} \\ \quad\ \ | \qquad\qquad\qquad\qquad\qquad\quad\ \ | \\ Zn(s)|\ Zn^{2+}(0.1M)\,||\,Cu^{2+}(1.0M)|\ Cu(s)\ \text{cell II} \end{array}$$

Which statement is *correct* ?

(A) Flow of electrons from zinc electrode of cell (II) to the zinc electrode of cell (I)

(B) No current will flow

(C) Flow of electron from zinc electrode of cell (I) to the zinc electrode of cell (II)

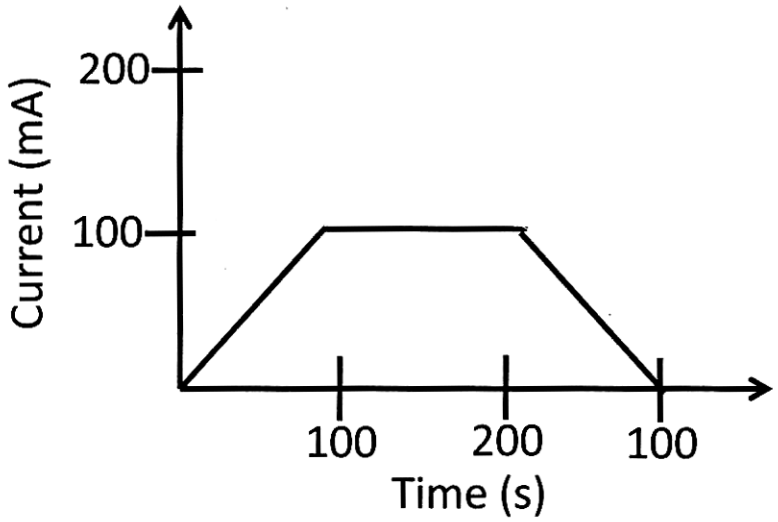
(D) $E_{cell} = E^0_{Cell}$

58. The free energy change of 1 mole of an ideal gas compressed isothermally from 1 atm to 2 atm is :

(A) –2 RT (B) RT ln 2

(C) –RT ln 2 (D) 2 RT

59. The following graph represents current-time curve for the deposition of Cu. Based on this graph, the amount of Cu deposited would be (Given : Atomic weight of Cu = 63) :



(A) 6.3 g (B) 63 g

(C) 6.3×10^{-3} g (D) 6.3×10^{-4} g

60. Which of the following shows maximum osmotic pressure in water ?

(A) 1 M NaCl (B) 1 M $MgCl_2$

(C) 1 M $(NH_3)_3\ PO_4$ (D) 1 M $Na_2S_2O_4$

61. Which of the following reactions is involved in the fuel cell ?

(A) $Cd + 2Ni(OH)_3 \rightarrow CdO + 2Ni(OH)_2 + H_2O$

(B) $Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$

(C) $2H_2 + O_2 \rightarrow 2H_2O$

(D) $2Fe + O_2 + 4H^+ \rightarrow 2Fe^{2+} + 2H_2O$

62. The trial function for the particle in 1D box (with $0 \leq x \leq a$) leading to the best possible ground state energy employing the variational method should be :

(A) $x^{\alpha}(a - x)^{\beta}$ (B) $\sin\left(\frac{\pi x}{a}\right)$

(C) $x(a - x)$ (D) $x^2(a - x)^2$

63. 24 J is consumed to blow a soap bubble of the radius 1 cm. The surface tension at air-water interface would be around :

(Hint : W = $\gamma \times$ A)

(A) 100 Jm^{-2} (B) 10 Jm^{-2}

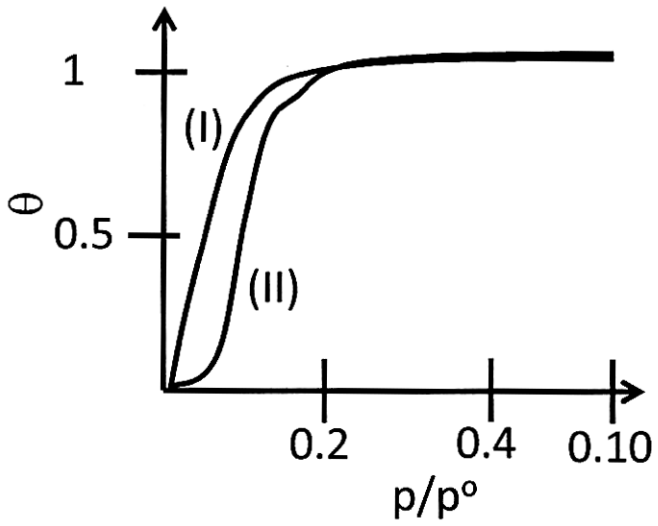
(C) 1 Jm^{-2} (D) 1000 Jm^{-2}

64. Out of the following which of the point group can a molecule have a dipole moment ?

(A) C_{2v} (B) D_{2d}

(C) D_{2h} (D) $C_{\infty h}$

65. Which statement is appropriate for the following two adsorption isotherms ?



(A) Plot (I) is a classic case of lateral interaction i.e. Frumkin-Fowler-Guggenheim (FFG) adsorption isotherm

(B) Plot (II) is classic case of Langmuir adsorption isotherm

(C) Plot (II) is a case of FFG adsorption isotherm

(D) Practically there is no difference between (I) and (II)

66. Which of the following relations is *not correct* for an ideal gas ?

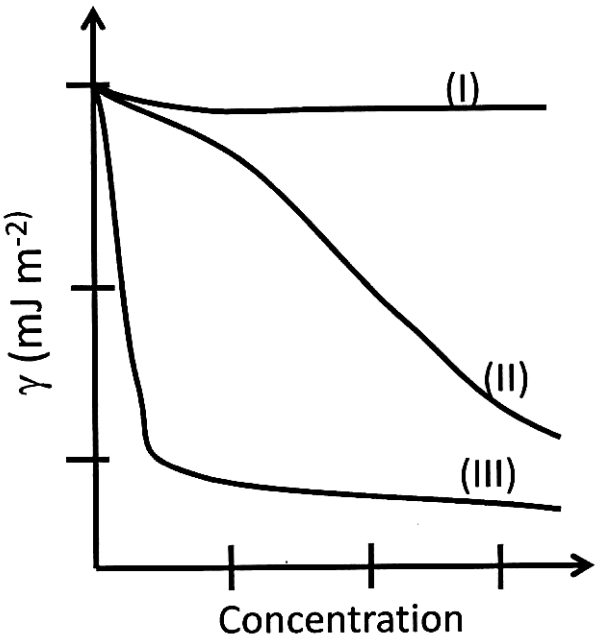
(A) $\left(\frac{\partial H}{\partial T}\right)_p - R = \left(\frac{\partial H}{\partial T}\right)_v$

(B) $\left(\frac{\partial H}{\partial T}\right)_p > \left(\frac{\partial H}{\partial T}\right)_v$

(C) $\left(\frac{\partial U}{\partial V}\right)_T = 0$

(D) $\left(\frac{\partial H}{\partial T}\right)_p + R = \left(\frac{\partial H}{\partial T}\right)_v$

67. Consider the following three plots for the surface tensions noted for three different solutes. Based on this which statement is most appropriate ?



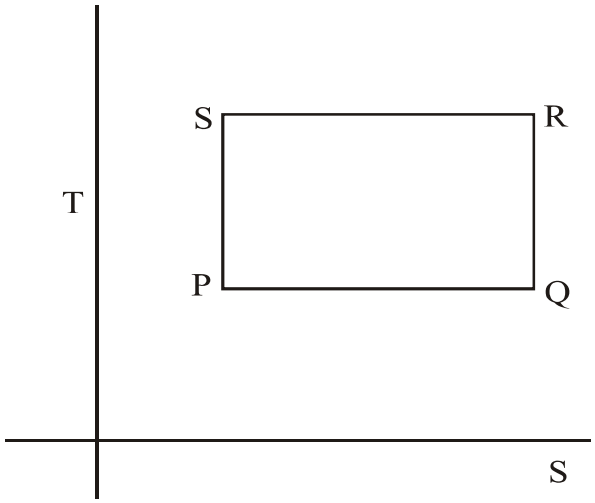
(A) All three plots are for surface active agents.

(B) From these plots, the critical micelles concentrations can be estimated.

(C) Among these, plot (III) is for a surfactant and plot (I) is possibly for an electrolyte.

(D) Among (II) and (III), plot II is for more active surface active agent.

68. If the Carnot cycle in enthalpy-temperature diagram shows :



then the system rejects heat to the surroundings in going from :

(A) R → S (B) P → Q

(C) Q → P (D) S → R

69. In the Michaelis-Menten mechanism for the enzymolysis :

$$E + P \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} X \xrightarrow{K_2} E + P$$

The steady-state approximation leads to a concentration of an intermediate :

$$[X] = \frac{K_1 E_0 S_0}{K_1 S_0 + K_{-1} + K_2}$$

Then the initial rate of reaction is given as :

(A) $\nu_0 = \dfrac{K_2 S_0}{1 + \left(\dfrac{K_{-1} + K_2}{K_1}\right)\dfrac{1}{E_0}}$ (B) $\nu_0 = \dfrac{V_m}{1 + \dfrac{K_m}{E_0 S_0}}$

(C) $\nu_0 = \dfrac{K_2 E_0}{1 + \left(\dfrac{K_{-1} + K_2}{K_1}\right)\dfrac{1}{S_0}}$ (D) $\nu_0 = \dfrac{V_m}{1 + \dfrac{K_m}{E_0}}$

70. What is the de Broglie wavelength associated with a particle in 1D box ($0 \leq x \leq a$) with the width of 5 Å in its first excited state (the PE inside the box is zero and that outside being infinity) :

(A) 10 Å (B) 5 Å

(C) 2.5 Å (D) 1 Å

71. Laughing gas N_2O, can be prepared from H_2 and NO :

$$H_2(g) + 2NO(g) \rightarrow N_2O(g) + H_2O(g),$$

A study of initial concentration verses initial rates at certain tempeature yield the following data :

Set	$[H_2]$, M	[NO], M	R_0 Ms^{-1}
1	0.1	0.5	2.560×10^{-6}
2	0.2	0.3	1.843×10^{-6}
3	0.1	0.3	9.216×10^{-7}
4	0.2	0.6	7.373×10^{-6}

Which of the following is the *correct* rate law ?

(A) $R = K[H_2]\,[NO]^2$ (B) $R = K[NO]^2$

(C) $R = K[H_2]\,[NO]$ (D) $R = K[H_2]^2$

72. The commutator $\left[\hat{x}, \hat{p}_x\right]$ is equal to :

(A) $-i\hbar$ (B) 0

(C) $\hat{p}_z$ (D) 1

73. In the Lindemann mechanism for the unimolecular reaction :

$$A(g) + M(g) \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} A^*(g) + M(g)$$

$$A^*(g) \xrightarrow{K_2} P$$

The apparent rate constant is given by :

$$K_{obs} = \frac{K_1 K_2 [M]}{K_2 + K_{-1}[M]}$$

(A) At high pressure the reaction becomes zeroth order w.r.t. A

(B) At high pressure the reaction becomes first order w.r.t. M

(C) At high pressure the reaction becomes first order w.r.t. A

(D) Pressure has no effect on the order of reaction

74. The average separation of $2p_z$ electron of the H atom from the nucleus will be (a_0 Bohr radius) :

(A) $3a_0/2$ (B) $5a_0$

(C) $4a_0$ (D) a_0

75. Upon increasing temperature of the solution, Debye-Huckel reciprocal length (x^{-1}) will :

(A) Increase

(B) Decrease

(C) No change

(D) Initially increase, passes through maxima and then decrease

ROUGH WORK