

## CSIR NET - CHEMICAL SCIENCE

### MOCK TEST PAPER

- This paper contains 75 Multiple Choice Questions
- part A 15, part B 35 and part C 25
- Each question in Part 'A' carries two marks
- Part 'B' carries 2 marks
- Part 'C' carries 4 marks respectively.
- There will be negative marking @ 25% for each wrong answer.
- Pattern of questions : MCQs
- Total marks : 200
- Duration of test : 3 Hours

# VPM CLASSES

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## PARTA (1-15)

- The amino acids required for creatine formation
  - Glycine
  - Arginine
  - Methionine
  - All of these
- There are  $r$  copies each of  $n$  different books. The number of ways in which these may be managed in a shelf is:
  - $\frac{n!}{(n-r)!}$
  - $\frac{n!}{r!}$
  - $\frac{(n-r)!}{r!}$
  - $\frac{(nr)!}{(r!)^n}$
- The largest interval on which the function  $f(x) = \frac{-x}{(1+|x|)}$  is differentiable is:
  - $(-\infty, 0)$
  - $(0, \infty)$
  - $(-\infty, \infty)$
  - $(-\infty, 0) \cup (0, \infty)$
- Urea is known to denature proteins at high concentration due to
  - Its ability to disrupt water structure
  - Its ability to interfere with hydrogen bond between peptide groups in proteins
  - Both (1) and (2)
  - Its ability to disrupt electrostatic interactions

5. A live virus while multiplying inside a host cell also activates T-cytotoxic cells because—
- (1) The viral antigens present inside the cell are processed and presented on MHC-class I molecules to activate such cells
  - (2) The viral antigens are secreted out to activate antigen presenting cells which produce IL-12 to activate such cells
  - (3) the viral; antigens directly bind to T Cytotoxic cell and activate them
  - (4) In the presence of viral antigens the humoral response is suppressed which indirectly enhances the T cytotoxic response
6. A patient is suffering from untreated insulin dependent diabetes. Which one of the following metabolic actions is occurring in this patient?
- (1) Glucose is used by skeletal muscle for fuel
  - (2) Ketone bodies are released by the liver into the blood
  - (3) Glucose is used by the liver for fuel
  - (4) Fatty acids are transported from the liver to the adipose tissue
7. Which of the following statements is true about the Krebs (citric acid) cycle and the Calvin (light dependent) cycle?
- (1) They both result in a net production of ATP and NADH
  - (2) They both result in a release of oxygen
  - (3) They both are carried out by enzymes located within an organelle matrix
  - (4) They both take place within the cytoplasmic Matrix
8. The internal resistance of which of following instrument is highest:
- (1) ammeter
  - (2) galvanometer
  - (3) voltmeter
  - (4) Micrometer
9. When a force is applied it gives impulse. Impulse is equal to:
- (1) Force applied
  - (2) Momentum produced
  - (3) Change in momentum

(4) None of these

10. The linear magnification of an image is  $m$ . The magnification for area will be

- (1)  $\sqrt{m}$
- (2)  $m$
- (3)  $m^2$
- (4)  $m^4$

11. While using triode as an amplifier, we avoid making the grid positive, because

- (1) The mutual characteristic is not straight
- (2) It decreases the plate current
- (3) It affects the amplification factor
- (4) Of some other reason.

12. Which of the following is not an acid?

- (1)  $\text{HNO}_3$
- (2)  $\text{CH}_3\text{COOH}$
- (3)  $\text{H}_2\text{SO}_4$
- (4) All of these are acids

13. Acidic hydrogen is present in:

- (1) Ethyne
- (2) Ethylene
- (3) Benzene
- (4) Ethane

14. Oxidation No. of Mn in  $\text{MnO}_4^-$ :

- (1) +5
- (2) -5
- (3) +7
- (4) -7

15. Carbon tetrachloride has no net dipole moment because of

- (1) Its planar structure

- (2) Its regular tetrahedral structure
- (3) Similar sizes of carbon and chlorine atoms
- (4) Similar electron affinities of carbon and chlorine

**PART B (16-50)**

16. The Gibb's function  $G$  in thermodynamics is defined as  $G = H - TS$ . In an isothermal, isobaric, reversible process  $G$
- (1) Remains constant but not zero
  - (2) Varies linearly
  - (3) Varies non linearly
  - (4) Is zero
17. The reaction  $2\text{NO} + \text{Br}_2 \longrightarrow 2\text{NOBr}$  follows the mechanism given below.
- (i)  $\text{NO} + \text{Br}_2 \longrightarrow \text{NOBr}_2$  ...fast
  - (ii)  $\text{NOBr}_2 + \text{NO} \longrightarrow 2\text{NOBr}$  ...slow
- If concentration of both  $\text{NO}$  and  $\text{Br}_2$  are increased two times the rate of reaction would become
- (1) 4 times
  - (2) 6 times
  - (3) 16 times
  - (4) 8 times
18. Among the species  $\text{O}_2^+$ ,  $\text{O}_2$  and  $\text{O}_2^-$ , the order of first ionization energy is
- (1)  $\text{O}_2^+ < \text{O}_2 < \text{O}_2^-$
  - (2)  $\text{O}_2^- < \text{O}_2 < \text{O}_2^+$
  - (3)  $\text{O}_2^- < \text{O}_2^+ < \text{O}_2$
  - (4)  $\text{O}_2^+ < \text{O}_2^- < \text{O}_2$
19. Which of the following has the lowest melting point?
- (1)  $\text{LiCl}$
  - (2)  $\text{NaCl}$
  - (3)  $\text{KCl}$
  - (4)  $\text{RbCl}$

20. Among feldspar, muscovite mica and zeolite,
- (1) All are three dimensional silicates
  - (2) Feldspar and zedite are three dimensional, while muscovite mica is layered
  - (3) Feldspar is three dimensional, while zeolite and muscovite mica are layered
  - (4) All are layered silicates
21. Smoke detectors contain a small amount of americium-241. What is the final product nucleide if americium-241 radioactively decays by a total of eight alpha decays and four beta decays?
- (1) rhenium-209
  - (2) gdd-209
  - (3) bismuth-209
  - (4) plutonium-237
22. In the reaction shown below X and Y respectively are
- $$\text{Fe}_3(\text{CO})_{12} \xrightarrow{\text{Na}} \text{X} \xrightarrow{\text{CH}_3\text{COCl}} \text{Y}$$
- (1)  $[\text{Fe}(\text{CO})_4]^{2-}$ ;  $[\text{CH}_3\text{C}(\text{O})\text{Mn}(\text{CO})_5]^-$
  - (2)  $[\text{Fe}(\text{CO})_4]^{2-}$ ;  $[\text{CH}_3\text{COMn}(\text{CO})_4]^-$
  - (3)  $[\text{Fe}(\text{CO})_5]^-$ ;  $[\text{ClFe}(\text{CO})_5]$
  - (4)  $[\text{Fe}(\text{CO})_4]^{2-}$ ;  $[\text{ClMn}(\text{CO})_5]^-$
23. An example of a metal cluster with no bridging ligands is
- (1)  $\text{Fe}_2(\text{CO})_9$
  - (2)  $\text{Fe}_3(\text{CO})_{12}$
  - (3)  $\text{Mn}_2(\text{CO})_{10}$
  - (4)  $\text{Co}_2(\text{CO})_8$
24. The 'STYX' code for diborane is:
- (1) 2020
  - (2) 2200
  - (3) 2002
  - (4) 0220
25. Which of the following statements is correct for a strong electrolyte?
- (1)  $\Lambda_m$  increases linearly with  $C^{1/2}$ .

- (2)  $\Lambda_m$  decreases linearly with  $C^2$ .  
 (3)  $\Lambda_m$  decreases linearly with  $C^{1/2}$ .  
 (4)  $\Lambda_m$  increases linearly with  $C^2$ .

26. Match the compounds in **List-I** with the corresponding structure/property given in **List-II**

<b>List-I</b>	<b>List-II</b>
(a) $(\text{Ph}_3\text{P})_3\text{RhCl}$	(i) Spinel
(b) $\text{LiC}_6$	(ii) Intercalation
(c) $\text{PtF}_6$	(iii) Oxidising agent
(d) $\text{Ni}_3\text{S}_4$	(iv) Catalyst for alkene hydrogenation

- (1) a-iii, b-i, c-ii, d-iv  
 (2) a-iv, b-ii, c-iii, d-i  
 (3) a-iii, b-ii, c-i, d-iv  
 (4) a-iv, b-iii, c-ii, d-i

27. Which one of the following coordination compounds used as an anti-cancer drug for treatment of malignant tumors ?

- (1)  $\text{K}[\text{Pt}(\text{C}_2\text{H}_4)\text{Cl}_3]\text{H}_2\text{O}$   
 (2)  $\text{K}_2[\text{Pt}(\text{CN})_4]3\text{H}_2\text{O}$   
 (3)  $\text{trans}[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$   
 (4)  $\text{Cis}[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$

28. Consider the following compounds:-

- (1)  $\text{CH}_2\text{N}_2$   
 (2)  $\text{CH}_2 = \text{C} = \text{O}$   
 (3)  $\text{CH}_2\text{I}_2$

Those compounds which would generate a carbene on exposure to ultraviolet light include

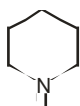
- (1) 1, 2 and 3  
 (2) 1 and 3

(3) 1 and 2

(4) 2 and 3

29. Among the given compounds, the one which is least basic is

(1)



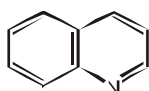
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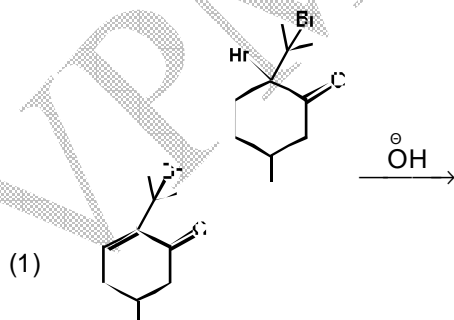
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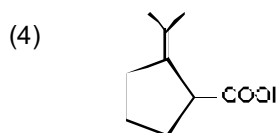
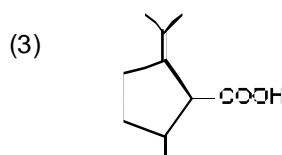
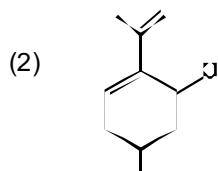
(4)



30. The major product formed in the following reaction.







31. In the reaction given below, the orientation of two bromine substituents in the product is

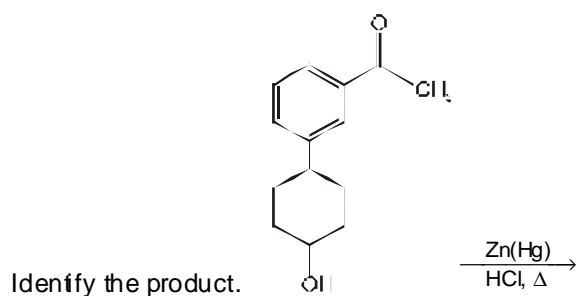


- (1) Equatorial at both C-1 and C-2
- (2) Equatorial at C-1 and axial at C-2
- (3) Axial at C-1 and equatorial at C-2
- (4) Axial at both C-1 and C-2

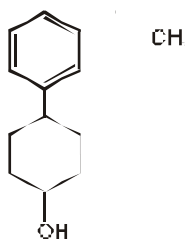
32. The number of valence electrons on the metal atom in  $[\text{Cr}(\eta^5\text{-Cp})(\text{CO})_2(\text{PPh}_3)]$  is

- (1)  $18e^-$
- (2)  $19e^-$
- (3)  $20e^-$
- (4)  $17e^-$

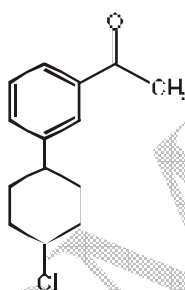
33.



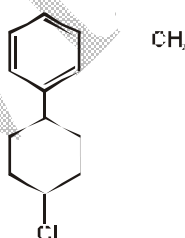
(1)



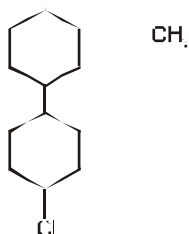
(2)



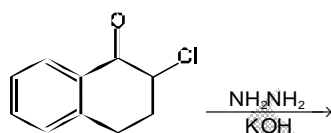
(3)

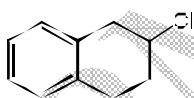
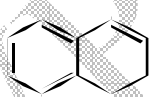
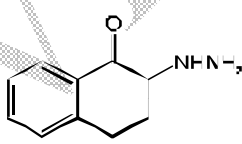


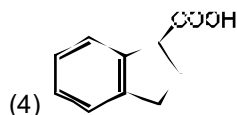
(4)



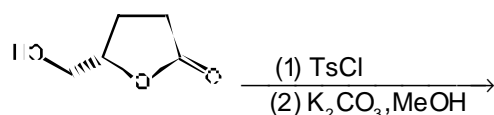
34. Cope rearrangement involves
- (1) [1,5]-sigmatropic rearrangement
  - (2) [4+2]-cycloaddition reaction
  - (3) [3,3]-sigmatropic rearrangement
  - (4)  $6\pi$ -electrocyclisation reaction
35. The major product formed in the reaction given below is



- (1) 
- (2) 
- (3) 



36. The major product formed in the reaction given below is

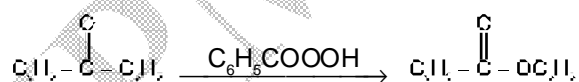


- (1)
- (2)
- (3)
- (4) None

37. Boric acid in aqueous solution in presence of glycerol behaves as a strong acid due to the formation of

- (1) An anionic metal-chelate  
 (2) Borate anion  
 (3) Glycerate ion  
 (4) A charge transfer complex

38. The intermediate involved in the reaction given below is



- (1) Carbene  
 (2) Free radical  
 (3) Carbanion  
 (4) Criegee intermediate

39. In the given reaction

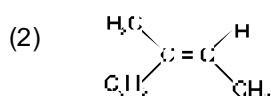
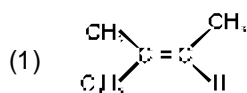
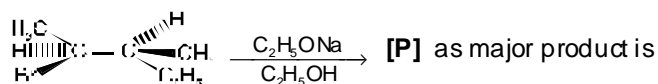
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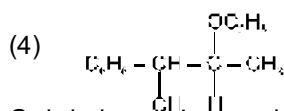
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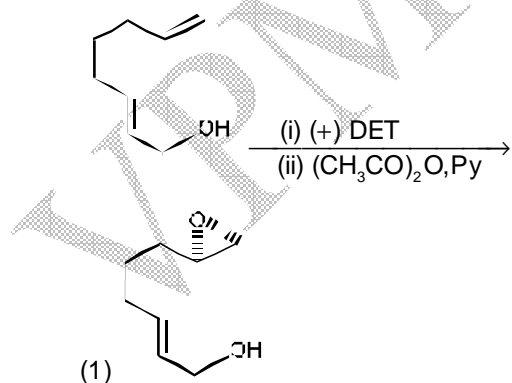
(3) Mixture of 1 and 2

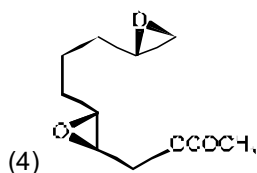
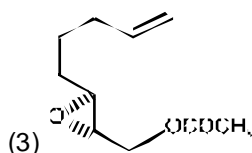
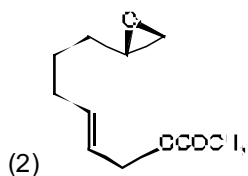


40. Gelatin is added during polarographic measurements to :

- (1) Reduce streaming motion of falling mercury drop
- (2) Increase  $I_d$
- (3) Increase  $E_{1/2}$
- (4) Eliminate residual current

41. The major product formed in the following reaction is





42. Addition of a positive catalyst to an exothermic reaction
- (1) increases exothermicity and activation barrier
  - (2) Decreases exothermicity, but increases barrier
  - (3) Increases exothermicity only
  - (4) Decreases activation barrier, but does not change the exothermicity.
43. If  $N_0$  is the initial number of nuclei, number of nuclei remaining undecayed at the end of  $n$ th half life is
- (1)  $2^{-n} N_0$
  - (2)  $2^n N_0$
  - (3)  $n^{-2} N_0$
  - (4)  $n^2 N_0$
44. The average value of  $p_x^2$  for the particle in a box of length  $L$  is
- (1)  $2mE$

- (2) mE  
(3) 3mE  
(4) 4mE
45. Among  $\text{XeO}_3\text{F}_2$ ,  $\text{ICl}_2^-$ ,  $\text{ClO}^-$  and  $\text{SO}_3^{2-}$  the number of species having three lone pair of electrons on the central atom according to VSEPR theory is —
- (1) 3  
(3) 0  
(3) 4  
(4) 2
46.  $\text{C}_6\text{H}_6$  molecule has point group
- (1)  $D_{4h}$   
(2)  $D_{2d}$   
(3)  $D_{6h}$   
(4)  $D_{3d}$
47. The total number of lines expected in  $^{31}\text{P}$ -NMR spectrum of phosphinic acid
- (1) Six  
(2) Three  
(3) Four  
(4) One
48. The INCORRECT statement about linear dimethylpolysiloxane,  $[(\text{CH}_3)_2\text{SiO}]_n$ , is
- (1) it is extremely hydrophilic  
(2) it is prepared by a KOH catalysed ring-opening reaction of  $[\text{Me}_2\text{SiO}]_4$   
(3) it has a very low glass transition temperature  
(4) it can be reinforced to give silicon elastomers
49. Only one signal is present in the PMR or NMR spectra of
- (1)  $\text{C}_3\text{H}_4$ ,  $\text{C}_3\text{H}_6$   
(2)  $\text{C}_4\text{H}_6$ ,  $\text{C}_5\text{H}_{12}$   
(3)  $\text{C}_3\text{H}_{18}$ ,  $\text{C}_2\text{H}_6\text{O}$

(4) All

50. Cubic close packing of  $n$  spheres generates the following number of interstitial sites

- (1)  $2n$  octahedral and  $n$  tetrahedral sites
- (2)  $n$  octahedral and  $n$  tetrahedral sites
- (3)  $2n$  octahedral and  $2n$  tetrahedral sites
- (4)  $n$  octahedral and  $2n$  tetrahedral sites

**Part-C (51-75)**

51. If the ratio of composition of oxidized and reduced species in electrochemical cell, is given as  $\frac{[O]}{[R]} =$

$e^3$  the correct potential difference will be

- (1)  $E - E^{0'} = \frac{RT}{nF}$
- (2)  $E - E^{0'} = \frac{3RT}{nF}$
- (3)  $E - E^{0'} = -\frac{3RT}{nF}$
- (4)  $E - E^{0'} = -\frac{RT}{nF}$

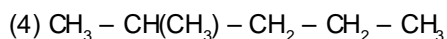
52. The ESR spectrum of  $[\text{NO}(\text{SO}_3)_2]^{2-}$  consist of:

- (1) Singlet
- (2) Triplet
- (3) Doublet
- (4) Septet

53. The  $^{13}\text{C}$  NMR spectrum of a compound shows 6 peaks and the  $^1\text{H}$  NMR spectrum shows 5 peaks. Which of the following is this compound?

- (1)  $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$
- (2)  $\text{CH}_3 - \text{C}(\text{CH}_3)_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$
- (3)  $\text{CH}_3 - \text{CH}(\text{CH}_3) - \text{CH}_2 - \text{CH}_2 - \text{C}(\text{CH}_3)_2 - \text{CH}_3$





54. Which one of the following pairs of electronic configurations of low spin transition metal ions (3d) in an octahedral field undergoes a strong Jahn Teller Distortion?
- (1)  $d^1, d^9$   
 (2)  $d^7, d^9$   
 (3)  $d^6, d^2$   
 (4)  $d^4, d^3$
55. Which one of the pairs of following statements about reduction of  $[\text{Co}(\text{EDTA})]^-$  by  $\text{Cr}(\text{II})(\text{aq})$  is correct
- (i) Reactant  $[\text{Co}(\text{EDTA})]^-$  has inert coordination sphere.  
 (ii) Reaction proceeds by outer-sphere mechanism.  
 (iii) Reactant  $[\text{Co}(\text{EDTA})]^-$  has Labile coordination sphere.  
 (iv) Reaction proceeds by inner-sphere mechanism.
- (1) (i) and (iv)  
 (2) (i) and (ii)  
 (3) (iii) and (ii)  
 (4) (iii) and (iv)
56. Which one of the following pairs consists of a good oxidizing and a good reducing agent respectively?
- (1)  $\text{Ce}(\text{III}), \text{In}(\text{III})$   
 (2)  $\text{Ce}(\text{IV}), \text{Eu}(\text{III})$   
 (3)  $\text{Ce}(\text{III}), \text{Eu}(\text{II})$   
 (4)  $\text{Ce}(\text{IV}), \text{Sm}(\text{II})$
57. Hemery thin contains —
- (1) Two Fe atoms and binds dioxygen in feric state  
 (2) One Fe atom and binds dioxygen in ferrous state  
 (3) Two Fe atoms and binds dioxygen in ferrous state  
 (4) One Fe atom and binds dioxygen in feric state
58. Hydroformylation using cobalt catalyst initiates with

- (1) Alkene addition to  $[\text{CoH}(\text{CO})_4]$
- (2) Alkene addition to  $[\text{Co}_2(\text{CO})_8]$
- (3) Alkene addition to  $[\text{CoH}(\text{CO})_3]$
- (4) CO addition to  $[\text{CoH}(\text{CO})_3]$

59. Which of the following is not true for siderophores?

- (1) They are polydentate ligands that have very high affinity for Fe (II).
- (2) They are bidentate ligands that have very high affinity for Co (III).
- (3) They are polydentate ligands that have very high affinity for Cu (II).
- (4) They are polydentate ligands that have high affinity for Fe (III).

60. The Number of bridging and terminal carbonyls present in  $\text{Rh}_4(\text{CO})_{12}$

- (1) 4 and 8
- (2) 0 and 12
- (3) 3 and 9
- (4) 2 and 10

61. Consider the following reaction and equilibrium constant,



Which of the following is the correct expression for the equilibrium constant at  $800^\circ\text{C}$  for?



(1)  $K_{c_2} = (0.72)^2$

(2)  $K_{c_2} = \frac{1}{0.72}$

(3)  $K_{c_2} = \left(\frac{1}{0.72}\right)^2$

(4)  $K_{c_2} = \left(\frac{1}{0.72}\right)^{\frac{1}{2}}$

62. The number of M – M bonds and total number of electrons in  $\mu - \text{CO} - [\eta^4\text{-C}_4\text{H}_4] \text{Fe}(\text{CO})_2$  are respectively :

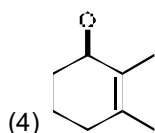
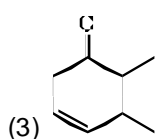
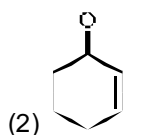
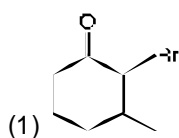
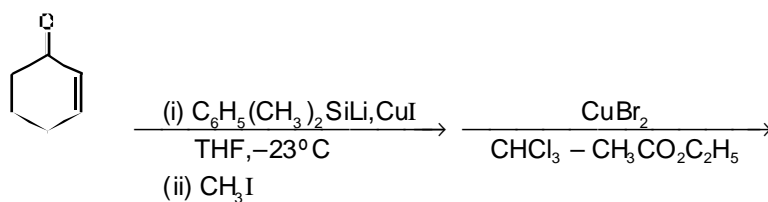
- (1) 2,  $30 e^\ominus$

(2) 6, 32 e<sup>⊖</sup>

(3) 3, 30 e<sup>⊖</sup>

(4) 4, 28 e<sup>⊖</sup>

63. The major product formed in the following transformation



64. The major product obtained by the reaction of BBr<sub>3</sub> with NH(CH<sub>3</sub>)<sub>2</sub>

(1) B(NH<sub>2</sub>)<sub>3</sub> & HBr

(2) B(N(CH<sub>3</sub>)<sub>2</sub>)<sub>3</sub> & B<sub>2</sub>(N(CH<sub>3</sub>)<sub>2</sub>)<sub>4</sub>

(3) B(N(CH<sub>3</sub>)<sub>2</sub>)<sub>3</sub> & 3[NH<sub>2</sub>(CH<sub>3</sub>)<sub>2</sub>]Br

(4) None

65. The number of Hyperfine Lines in the ESR spectrum of (SO<sub>3</sub>)<sub>2</sub>NO<sup>-</sup> anion are

(1) 8

(2) 3

(3) 2

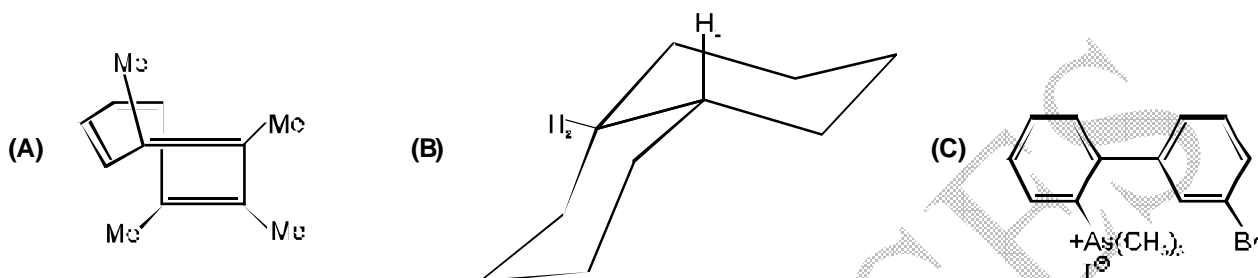
(4) 5

66. The Energy Levels of cyclobutadiene are  $\alpha + 2\beta$ ,  $\alpha$ ,  $\alpha$ ,  $\alpha - 2\beta$ . The delocalisation Energy in cyclobutadiene is
- (1)  $3\beta$
  - (2)  $\beta$
  - (3)  $2\beta$
  - (4) 0
67. The resultant pH when 200 ml of an aqueous solution of HCl (pH = 2) is mixed with 300 ml of an aqueous solution of NaOH (pH = 12) is
- (1) 12.4
  - (2) 8.7
  - (3) 11.3
  - (4) 13
68. Using the fundamental equation  $\partial H = TdS + VdP$  the maxwell relation is
- (1)  $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$
  - (2)  $\left(\frac{\partial T}{\partial V}\right)_S = \left(\frac{\partial P}{\partial S}\right)_T$
  - (3)  $\left(\frac{\partial S}{\partial V}\right)_P = \left(\frac{\partial P}{\partial T}\right)_V$
  - (4)  $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$
69. The relationship between mean ionic activity coefficient for  $K_2SO_4$  and its ion is given by
- (1)  $\gamma_{\pm} = \gamma_+^2 \gamma_-^1$
  - (2)  $\gamma_{\pm}^3 = \gamma_+^2 \gamma_-^1$
  - (3)  $\gamma_{\pm}^3 = \gamma_+ \gamma_-^2$
  - (4)  $\gamma_{\pm} = \gamma_+ \gamma_-^2$
70. What is the coordination number of  $Ca^{2+}$  ion and  $Ti^{4+}$  ion in perovskite?
- (1) 6, 12
  - (2) 6, 6

(3) 12, 6

(4) 6, 3

71. Amongst the following the correct statement for the compounds A, B and C is:



(1) A and B achiral and C is chiral.

(2) A is chiral and B and C are achiral.

(3) A and B chiral and C is achiral.

(4) All are chiral.

72. The rotational structure in the Raman spectrum of carbon dioxide,  $\text{CO}_2$ , is offset from the wave number of the incident radiation by  $2.3622 \text{ cm}^{-1}$ ,  $5.5118 \text{ cm}^{-1}$ ,  $8.6614 \text{ cm}^{-1}$ , ... . Determine the rotational constant of carbon dioxide.

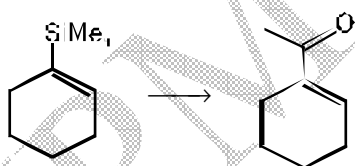
(1)  $0.3937 \text{ cm}^{-1}$

(2)  $1.1811 \text{ cm}^{-1}$

(3)  $0.5906 \text{ cm}^{-1}$

(4)  $2.3622 \text{ cm}^{-1}$

73. Reagents that can be used in the following conversion are:



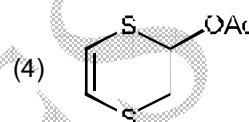
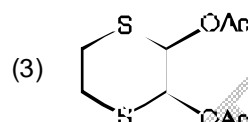
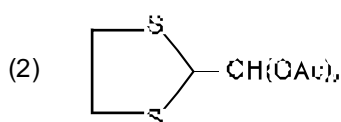
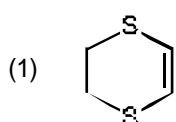
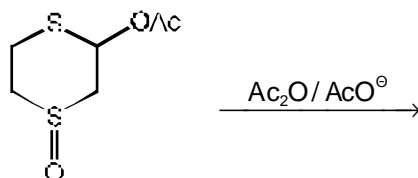
(1)  $\text{PhCHO} - \text{TiCl}_4/\Delta$

(2) (i)  $\text{EtMgI}$ , (ii)  $\text{KMnO}_4$

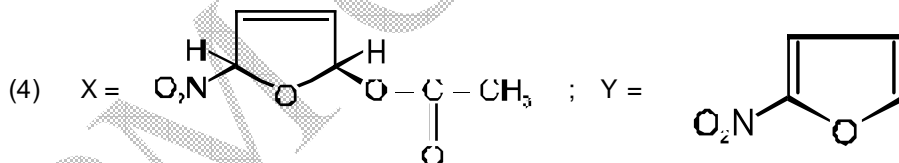
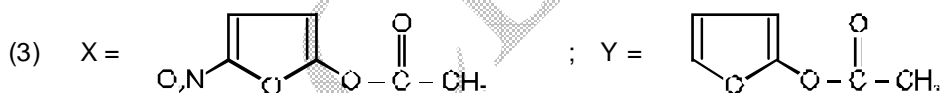
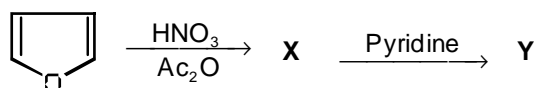
(3)  $\text{MeCOCl} - \text{AlCl}_3/\Delta$

(4)  $p\text{-TsOH-benzene}/80^\circ\text{C}$

74. Major product formed in the following reaction is:



75. Structure of X and Y in the reaction sequence of furan given below:



## Answer Key

Que.	Ans.	Que.	Ans.	Que.	Ans.	Que.	Ans.	Que.	Ans.
1	4	16	1	31	4	46	3	61	3
2	4	17	4	32	4	47	2	62	3
3	3	18	2	33	3	48	1	63	4

4	2	19	1	34	3	49	1	64	3
5	1	20	2	35	2	50	2	65	2
6	2	21	3	36	1	51	2	66	4
7	3	22	2	37	1	52	2	67	3
8	3	23	3	38	4	53	3	68	4
9	3	24	3	39	1	54	2	69	2
10	3	25	3	40	2	55	1	70	3
11	1	26	2	41	3	56	2	71	4
12	4	27	4	42	4	57	1	72	1
13	1	28	3	43	1	58	3	73	3
14	3	29	3	44	1	59	4	74	2
15	2	30	3	45	4	60	3	75	4

### PART A (1-15)

1. (4) For creatine synthesis three amino acids glycine, arginine, and methionine are required

2.(4) If there are r copies of n different books so there are nr books

and they can be arranged as  $\frac{(nr)!}{r! r! \dots n \text{ times}}$

$$= \frac{(nr)!}{(r!)^n}$$

3. (3) given function  $f(x) = \frac{-x}{(1+|x|)}$

Since f(x) is real valued function and

$$1+|x| \neq 0$$

$\Rightarrow f(x)$  exists for all  $x \in \mathbb{R}$

so it be differentiable at all  $x \in \mathbb{R}$

4.(2) Denaturation may be defined as the disruption of the secondary tertiary and quaternary structure of the native protein resulting in the alterations of physical, chemical and biological characteristics of the protein by a variety of agents. Urea interferes with the hydrogen bonds between peptide linkages.

- 5.(1) Endogenous antigens are synthesized inside a cell; typically they are derived from pathogens (eg viruses, bacteria and parasites). Class I MHC present peptide antigen derived from endogenous protein antigen. Tc cells recognize antigen with class I molecule on target cell.
6. (2) Patient suffering from untreated insulin dependent diabetes releases ketone bodies. Due to insulin lipolysis in adipose tissue increases blood level of free fatty acid. Accelerated, but incomplete, oxidation of fatty acids for energy, especially in liver results into the formation of ketone bodies. Since ketone bodies are acidic, their increased amount in blood causes acidosis.
- 7.(3) Both Krebs's cycle and Calvin cycle are carried out by enzymes located within an organelle matrix. Krebs's cycle is carried out by enzymes in mitochondrial matrix and calvin cycle in chloroplast matrix.
- 8.(3) The internal resistance of voltmeter is highest.

9.(3)  $\therefore \vec{F} = \frac{d\vec{P}}{dt}$  (Newton's 2 law of motion)

$$\vec{F} dt = d\vec{P}$$

integrating both sides

At  $t_1 = 0, P = \vec{P}_1$  and  $t_2 = t, P = \vec{P}_2$

So  $\int_0^t \vec{F} dt = \int_{\vec{P}_1}^{\vec{P}_2} d\vec{P}$

If  $F_{av}$  is the force during this time.

So,  $F_{av} [t]_0^t = \left[ \vec{P} \right]_{\vec{P}_1}^{\vec{P}_2}$

$$F_{av} \times t = \vec{P}_2 - \vec{P}_1$$

Impulse  $\vec{I} = \vec{F}_{av} \times t = \vec{P}_2 - \vec{P}_1$

So, impulse is equal to change in momentum.

- 10.(3) The linear magnification of an image is m. The magnification for area will be  $m^2$ .
- 11.(1) For amplification without distortions, we use the straight portion of the mutual characteristics.
- 12.(4)  $HNO_3, CH_3COOH, H_2SO_4$  All are acids



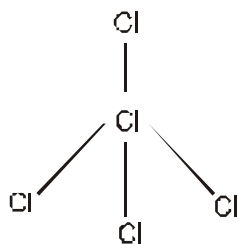
13.(1)  $\Delta$  Acidic hydrogen is present in ethyne [H – C  $\equiv$  C – H]

14.(3)  $\text{MnO}_4^-$

$$x - 8 = -1$$

$$x = 8 - 1 = +7$$

15.(2)



Carbon tetrachloride has no dipole moment because of its regular tetrahedral structure.

**PART B (16-50)**

16.(1)  $G = H - TdS$

$$dG = VdP - SdT$$

At const. P and const. T

$$dG = 0$$

$$G = \text{const.}$$

17.(4)  $r = k[\text{NOBr}_2][\text{NO}]$

$$[\text{NOBr}_2] = k'[\text{NO}][\text{Br}_2]$$

$$r = k k' [\text{NO}]^2 [\text{Br}_2] = k'' [\text{NO}]^2 [\text{Br}_2]$$

When con. of both NO and  $\text{Br}_2$  is doubled.

$$r = k [2\text{NO}]^2 [2\text{Br}_2] = 8k [\text{NO}]^2 [\text{Br}_2]$$

18.(2) Bond order  $\propto$  I.E.

The order of I.E.

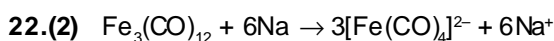
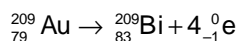
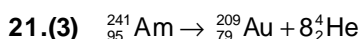
$$\text{O}_2^- < \text{O}_2 < \text{O}_2^+$$

so. Bond order is  $1.5 < 2 < 2.5$

19.(1) Melting point  $\propto \frac{1}{\text{covalent character}}$

LiCl has lowest melting point

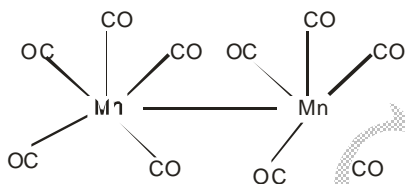
20.(2) Feldspar and Zeolite are three dimensional while muscovite mica is Layered



[X]

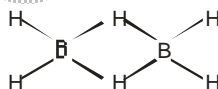


23.(3)



An example of a metal cluster with no bridging Ligands is  $\text{Mn}_2(\text{CO})_{10}$

24.(3) Diagram  $\text{B}_2\text{H}_6$



S – Number of B-H-B bonds = 2

T = Number of B-B-B bonds = 0

Y = Number of B-B bonds = 0

X = Number of  $\text{BH}_2$  group = 2

The STYX codes for diborane is 2002

25.(3)  $\Lambda_m = \Lambda_m^\circ - b\sqrt{c}$

$\Lambda_m$  decreases linearly with  $C^{1/2}$ .

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26.(2) (a)  $(\text{Ph}_3\text{P})_3\text{Rh Cl}$  (iv) Catalyst for alkene Hydrogenation

(b)  $\text{Li C}_6$  (ii) Intercalation

(c)  $\text{Pt F}_6$  (iii) Oxidising agent

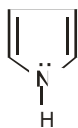
(d)  $\text{Ni}_3\text{S}_4$  (i) Spinel

27.(4)  $\text{Cis}[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$  compound is used as an anti cancer drug for treatment of malignant tumors

28.(3)  $\text{CH}_2\text{N}_2 \xrightarrow{h\nu} \dot{\text{C}}\text{H}_2 + \text{N}_2$

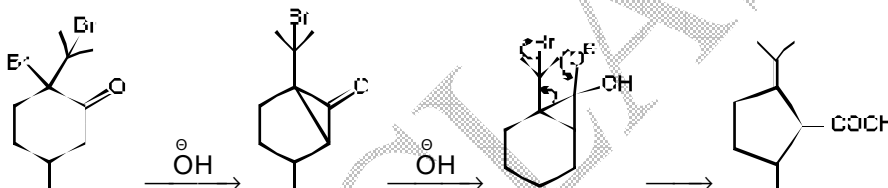
$\text{CH}_2 = \text{C} = \text{O} \xrightarrow{h\nu} \dot{\text{C}}\text{H}_2 + \text{CO}$

29.(3)



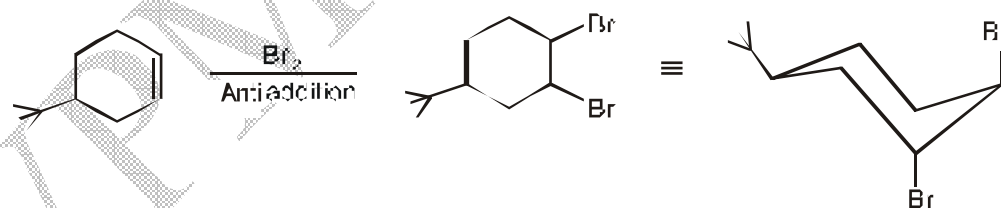
Pyrrole is least basic due to delocalization of lone pair in aromatic sextet.

30.(3)



Favorskii reaction, E2

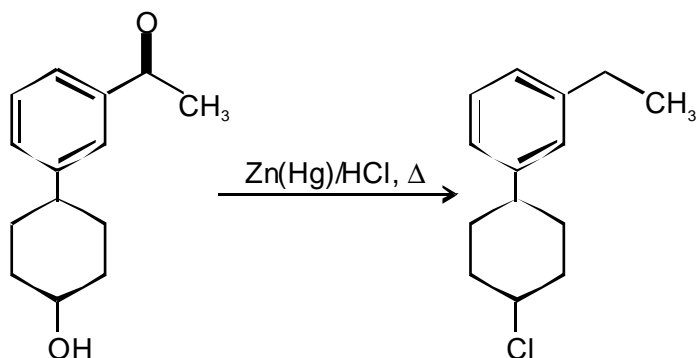
31.(4)



axial at both C-1 and C-2

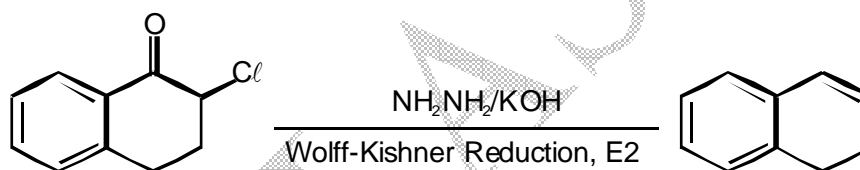
32.(4)  $[\text{Cr}(\eta^5\text{-Cp})(\text{CO})_2(\text{PPh}_3)] = 6 + 5 + 4 + 2 = 17e^-$

33.(3) Clemmensen Reduction and  $\text{S}_{\text{N}}1$  reaction of  $-\text{OH}$  group by  $\text{HCl}$ .

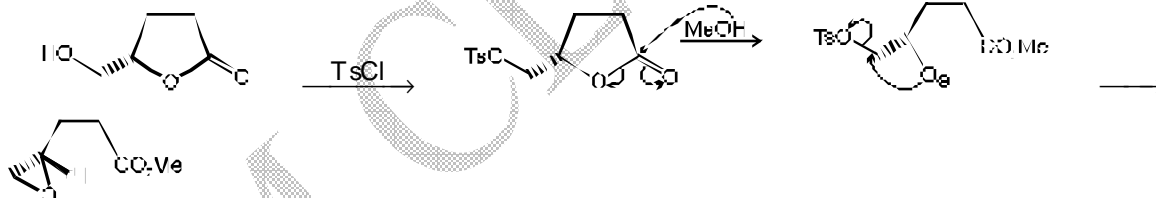


34.(3) Cope rearrangement involves [3, 3] sigmatropic rearrangement

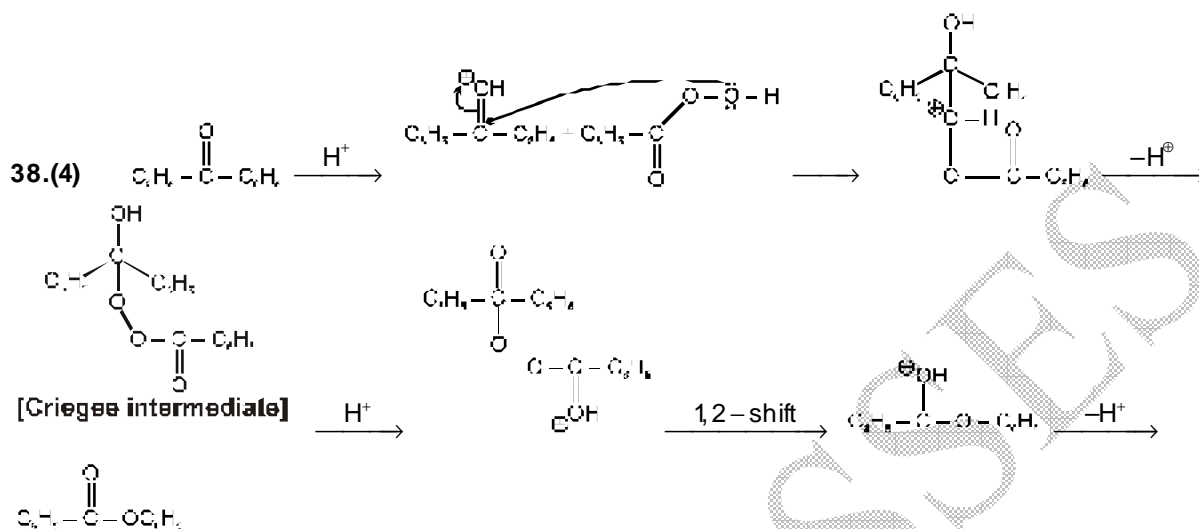
35.(2)



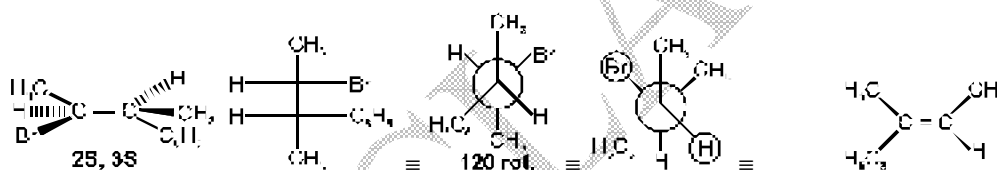
36.(1)



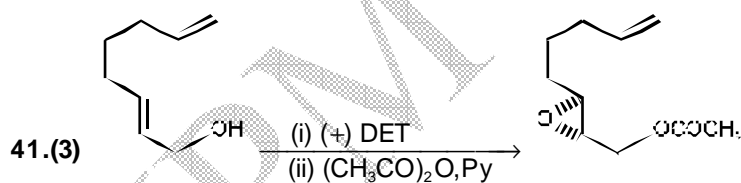
37.(1) Boric acid in aqueous solution in presence of glycerol behaves as a strong acid due to the formation of an anionic metal-chelate.



39.(1)



40. (2) **Gelatin** is added during polarographic measurement to increase diffusion current ( $I_d$ )



42.(4) Addition of a positive catalyst to an exothermic reaction decreases activation barrier, but does not change the exothermicity

43.(1)

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$$

$$N = N_0 2^{-n}$$

$$44.(1) \psi = \sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L} \quad 0 < x < L$$

$$\langle p_x^2 \rangle = \frac{2}{L} \int_0^L \left\{ \sin \frac{n\pi x}{L} \left[ -\frac{\hbar^2 d^2}{dx^2} \right] \sin \frac{n\pi x}{L} \right\} dx = \frac{2\hbar^2}{L} \left( \frac{n\pi}{L} \right)^2 \int_0^L \sin^2 \frac{n\pi x}{L} = \frac{n^2 \hbar^2}{4L^2} = 2mE$$

$$E = \frac{n^2 \hbar^2}{8mL^2}$$

45.(4)  $\text{XeO}_3\text{F}_2 \rightarrow$  no lone pair

$\text{ICl}_2^- \rightarrow$  3 lone pair

$\text{ClO}^- \rightarrow$  3 lone pair

$\text{SO}_3^{2-} \rightarrow$  one lone pair

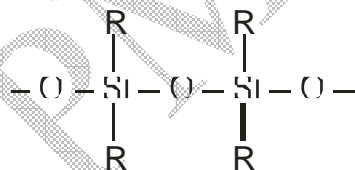
46.(3)  $\text{C}_6\text{H}_6$  molecules has point group  $D_{6h}$

47.(2) Hypo phosphorous acid



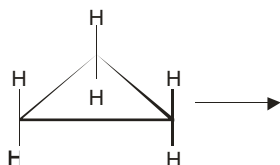
$$\text{No of lines} = (2nI + 1) = (2 \times 2 \times \frac{1}{2} + 1) = 3$$

48.(2) Silicones are very hydrophobic.



So statement A is incorrect.

49.(1)  $\text{H}_2\text{C}=\text{C}=\text{CH}_2$  — only one signal



only one signal

50.(2) Cubic close packing of  $n$  spheres generates  $n$  octahedral and  $2n$  tetrahedral interstitial sites

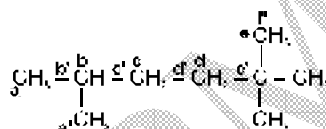
### Part-C (51-75)

$$51.(2) E = E^{\circ} - \frac{RT}{nF} \ln \frac{[R]}{[O]}$$

$$E - E^{\circ} = + \frac{RT}{nF} \ln \frac{[O]}{[R]} = \frac{RT}{nF} \ln e^3 = \frac{3RT}{nF}$$

52.(2) The ESR spectrum of  $[\text{NO}(\text{SO}_3)_2]^{2-}$  yields a triplet which arises from the interaction between the spin of the unpaired electron and the spin of a  $\text{N}^{14}$  confirming that this electron is localised on N-atom.

$$(2nI + 1) = 2 \times 1 \times 1 + 1 = 3 \text{ (triplet)}$$



53.(3)

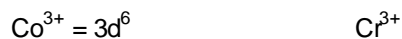
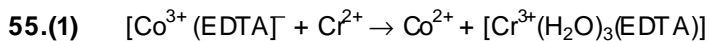
5 peaks [ $^1\text{H}$  NMR]      6 peaks [ $^{13}\text{C}$  NMR]

54.(2)  $d^7 = t_{2g}^6 e_g^1$  — strong John Teller distortions

(eg unsymmetrical)

$d^9 = t_{2g}^6 e_g^3$  — strong John teller distortion

(eg unsym.)



(Inert)

Reactant has inert coordination sphere reaction proceeds by inner sphere mechanism

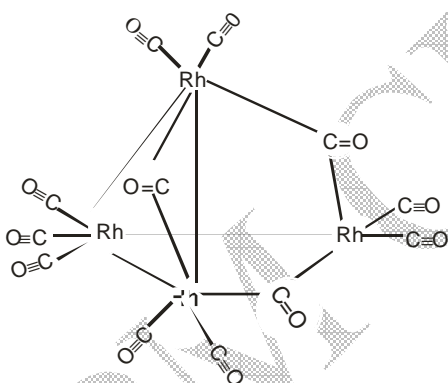
56.(2) Ce(IV) is good oxidizing and Sm(II) good reducing agent

57.(1) Hemerythrin contains two Fe atoms and binds dioxygen in ferric state

58.(3) Hydroformylation using cobalt catalyst initiates with Alkene addition to  $[\text{CoH}(\text{CO})_5]$

59.(4) Siderophores are polydentate ligands that have very high affinity for Fe(III)

60.(3)



3-Bridging carbonyl and 9 terminal carbonyl present in  $\text{Rh}_4(\text{CO})_{12}$

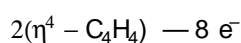
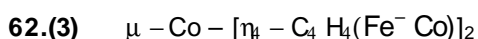
61.(3)  $K_o = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]}$

$K_{c_2} = \frac{[\text{CO}]^2[\text{H}_2\text{O}]^2}{[\text{CO}_2]^2[\text{H}_2]^2}$



$$\left[ \frac{1}{K_{c_1}} \right]^2 = K_{c_2}$$

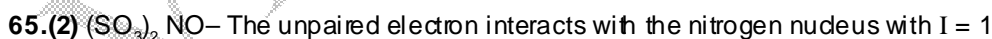
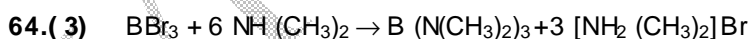
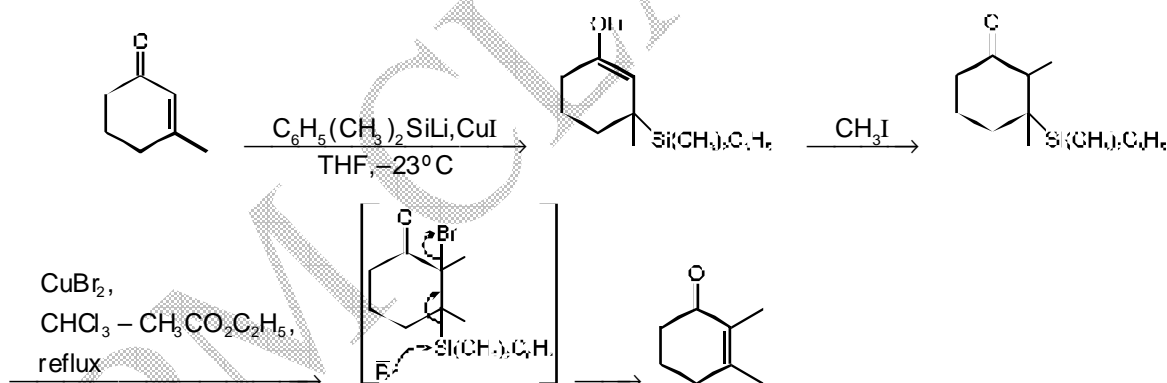
$$K_{c_2} = \left( \frac{1}{0.72} \right)^2$$



M - M bonds =  $\frac{\text{number of metals (n)} - \text{total no. } e^- \text{ in complex}}{2}$

=  $\frac{18 \times 2 - 30}{2} = 3 \text{ Fe - Fe bond}$

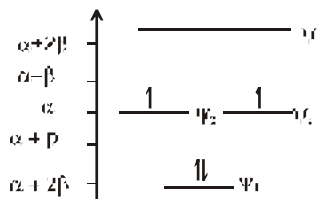
63.(4)



so the no. of lines =  $(2nI + 1) = (2 \times 1 \times 1 + 1)$

= 3

66.(4)



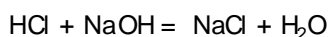
$$DE = 2(\alpha + 2\beta) + 2\alpha - 4(\alpha + \beta)$$

$$= 2\alpha + 4\beta + 2\alpha - 4\alpha - 4\beta = 0$$

67.(3) pH of HCl = 2

$$[\text{HCl}] = 10^{-2} \text{M}$$

pH of NaOH = 12



$$[\text{OH}^-] \text{ After reaction} = \frac{1}{500} = 2 \times 10^{-3} \text{M}$$

$$\text{pOH} = -\log[\text{OH}^-] = -\log 2 \times 10^{-3} = 2.7$$

$$\text{pH} = 14 - 2.7 = 11.3$$

68.(4)  $dH = T ds + Vdp$

If p is constant  $dP = 0$

$$\partial H = T ds$$

$$\left(\frac{\partial H}{\partial s}\right)_p = T \dots (i)$$

if S is constant  $dS = 0$

$$\partial H = V dp$$

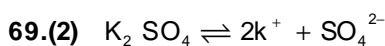
$$\left(\frac{\partial H}{\partial p}\right)_s = v \dots (ii)$$

Differentiating (i) with respect to p keeping S constant and differentiating Equ. (ii) With respect to S keeping p constant

$$\frac{\partial^2 H}{\partial s \partial p} = \left(\frac{\partial T}{\partial p}\right)_s \dots (iii)$$

$$\frac{\partial^2 H}{\partial s \partial p} = \left( \frac{\partial V}{\partial S} \right)_p \dots (iv)$$

$$\left( \frac{\partial T}{\partial P} \right)_s = \left( \frac{\partial V}{\partial S} \right)_p$$



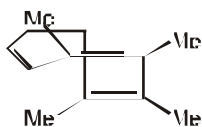
$$(\gamma_+)^{(x+y)} = (\gamma_+)^x (\gamma_-)^y$$

$$\gamma_{\pm}^{(2+1)} = (\gamma_+)^2 (\gamma_-)^1$$

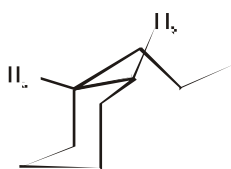
$$\gamma_{\pm}^3 = \gamma_+^2 \gamma_-$$

70.(3) the coordinate number of  $Ca^{2+}$  ion is 12 and  $Ti^{4+}$  is 6 in perovskite

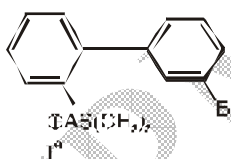
71.(4)



→ It has no plane of symmetry = chiral



→ dis-declin - chiral

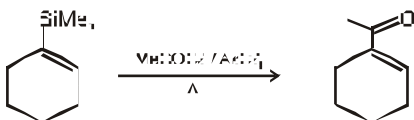


A single bulky group prevents rotation to make the compound chiral

72.(1)  $6B = 2.3622$

$$B = \frac{2.3622}{6} = 0.3937 \text{ cm}^{-1}$$

73.(3)



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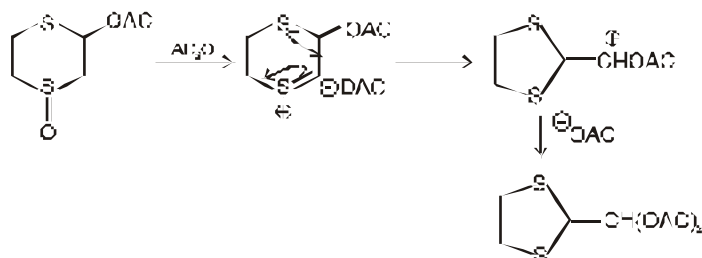
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74.(2)



75.(4)

