5b) methylcation - sp^2 — trigonal planar
methylanion - sp^3 — pyramidal shape.
methyl radical - sp^2. — trigonal planar

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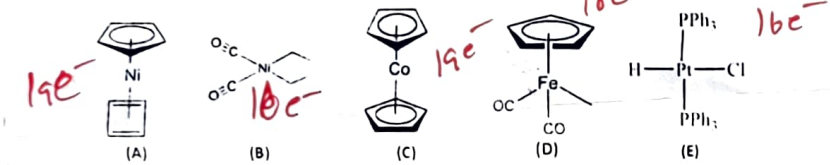
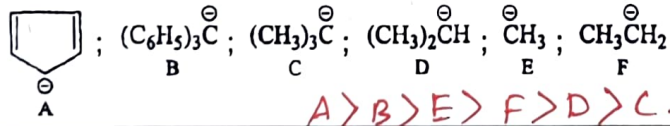
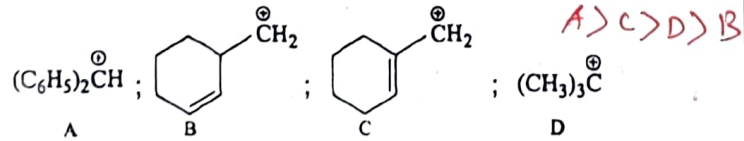
SCHOOL OF ADVANCED SCIENCES
Department of Chemistry
Fall Semester 2023-24
Continuous Assessment Test – I

Course Code: BCHY101L **Duration** : 90 Minutes **Slot:** D2+TD2
Course Name: Engineering Chemistry **Max. Marks** : 50
Class Numbers:
VL2023240106213/6215/6217/6219/6239/6243/6247/6251/6255/6264/6275/6279/6283/6287/6291
Faculty Names: Manish Kumar Mishra/ Sheela A/Buvaneswari G/Satish Kumar G/Sriraghavan K/Karpagam S/ Arunprasad M/Ravikanth K/Sai Saraswathi V/Namrata Deka/Barnali Maiti/Chandan Maity/Madhumitha G./ Buvaneswari G. /Veera Venkata Ramesh E.

QN	Answer ALL the questions (5 x 10 = 50 Marks)	Marks	CO	BL
1	What are the assumptions of Crystal Field Theory (CFT)? Draw the differences in the orbital occupancy for high and low spin complexes of d^4, d^5, d^6, and d^7 metal ions based on CFT. Also, explain the magnetic properties of the same complexes.	10	CO1	L1
2	Comment on the stability of the following organometallic complexes according to 18 electron rule. Justify your answer.  (A) (B) (C) (D) (E)	10	CO1	L5
3	(a) How many categories of organometallic complexes are possible based on the bonding nature of metal-carbon bonds? Discuss the categories with examples. (b) Draw the structure of chlorophyll? Why does the photosynthesis process can't happen without Mg^{2+} attached to chlorophyll?	(5 + 5)	CO1	L2
4	(a) How does the hybridization of $[Fe(CN)_6]^{3-}$ different from $[FeI_6]^{3-}$? Also, explain the magnetic properties of both complexes. (b) Discuss the stability of carbanions and arrange them in the decreasing order:  A > B > E > F > D > C.	(5 + 5)	CO1	L4
5	(a) Discuss the stability of carbocations and arrange them in the decreasing order:  A > C > D > B (b) Discuss the hybridization and geometry of methyl cation, methyl anion, and methyl radical through molecular orbital structures.	(5 + 5)	CO1	L3

$(FeCCN)_6)^{3-}$ = Octahedral, d^2sp^3, ~~Diamagnetic~~. Paramagnetic
$(Fe(I)_6)^{3-}$ = octahedral, sp^3d^2, Paramagnetic.

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Answer Key

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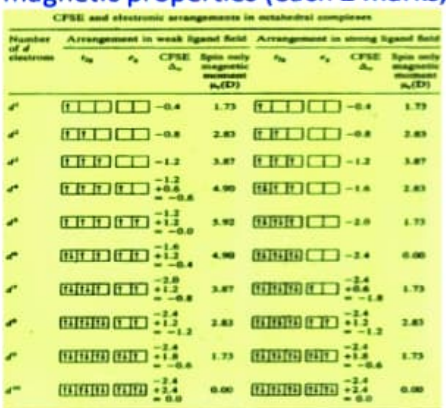
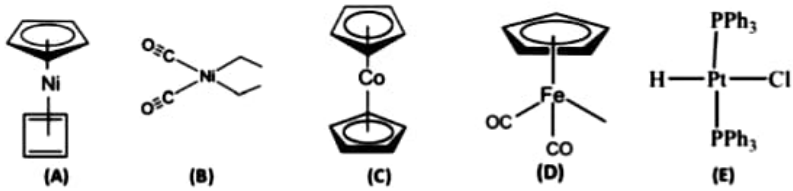
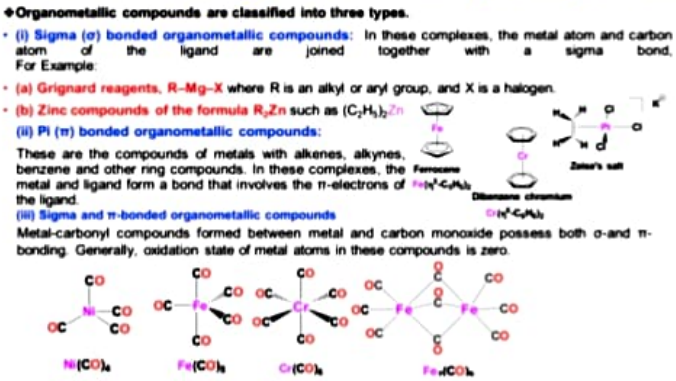
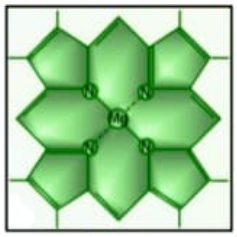
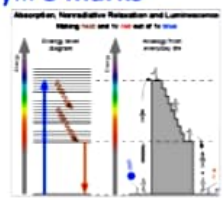
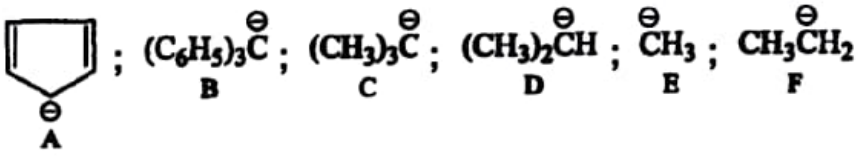
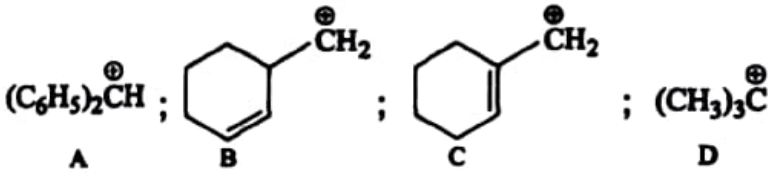
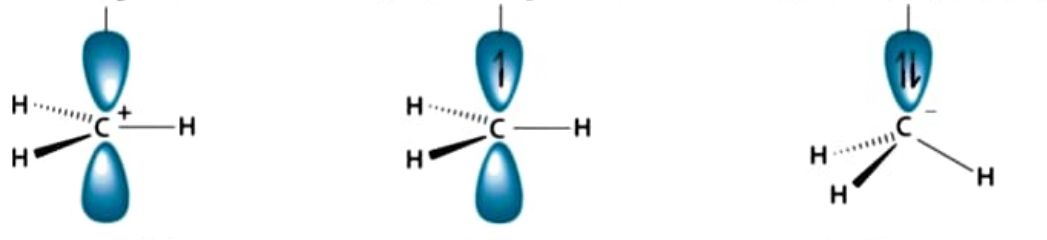
Q. No.	Answer ALL the questions (5 x 10 = 50 Marks)	Marks	CO	BL
1	What are the assumptions of Crystal Field Theory (CFT)? Draw the differences in the orbital occupancy for high and low spin complexes of d^4, d^5, d^6, and d^7 metal ions based on CFT. Also, explain the magnetic properties of the same complexes. Assumption of CFT: **2 marks** ➢ Interaction between the metal ion and the ligands are purely electrostatic (ionic) ➢ Ligands are considered as point charges ➢ Ion-ion interaction, if the ligand is negatively charged and ion-dipole interaction, if the ligand is neutral ➢ Electrons on the metal are under repulsive from those on the ligands ➢ Electrons on metal occupy those d-orbitals farthest away from the direction of approach of ligands. High and low spin complexes of d^4, d^5, d^6, and d^7 metal ions based on CFT with magnetic properties (each 2 marks; total **8 marks**) 	**10**	CO1	BL 1
2	Comment on the stability of the following organometallic complexes. Justify your	**10**	CO1	BL

	answer.  (A) (B) (C) (D) (E) Each example 2 marks (2 x 5 = **10 marks**) A= 19 e- (Not stable) B= 16 e- (Not stable) C= 19 e- (Not stable) D= 18 e- (Stable) E= 16 e- (Not stable)			5
3	**(a)** How many categories of organometallic complexes are possible based on the bonding nature of metal-carbon bonds? Discuss the categories with examples. There are three categories of OM complexes (see the slide below)  **(b)** Draw the structure of chlorophyll? Why does the photosynthesis process can't happen without Mg^{2+} attached to chlorophyll? Basic Structure of chlorophyll: **2 marks**  Role of Mg2+ in chlorophyll: **3 marks** 	**(5 + 5)**	CO1	BL 1

Role of Mg in chlorophyll

- Without Mg^{2+} the chlorin ring is fluorescent – i.e. the absorbed light energy is emitted back immediately
- With Mg^{2+} chlorophyll becomes phosphorescent
- In the case of fluorescence, the absorbed light energy is lost immediately – will not be used for chemical reaction
- In the case of phosphorescence, there will be excited state of finite life time and the energy can be used for chemical reactions
- The Mg^{2+} coordination increase the rigidity of the planar chlorin ring. The energy loss as heat due to vibration of the ring during light absorption is prevented

4	**(a)** How does the hybridization of $[Fe(CN)_6]^{3-}$ different from $[FeI_6]^{3-}$? Also, explain the magnetic properties of both complexes. **$[Fe(CN)_6]^{3-}$ = Octahedral d^2sp^3 Geometry, Diamagnetic (example taken from slide)** **$[FeI_6]^{3-}$ = Octahedral sp^3d^2 Geometry, Paramagnetic** **(b)** Discuss the stability of carbanions and arrange them in the decreasing order:  A ; $(C_6H_5)_3\overset{\ominus}{C}$ B ; $(CH_3)_3\overset{\ominus}{C}$ C ; $(CH_3)_2\overset{\ominus}{C}H$ D ; $\overset{\ominus}{C}H_3$ E ; $CH_3\overset{\ominus}{C}H_2$ F Stability order is **A > B > E > F > D > C**	**(5 + 5)**	CO1	BL 2
5	**(a)** Discuss the stability of carbocations and arrange them in the decreasing order:  $(C_6H_5)_2\overset{\oplus}{C}H$ A ; B ; C ; $(CH_3)_3\overset{\oplus}{C}$ D Stability order is **A > C > D > B** **(b)** Discuss the hybridization and geometry of methyl cation, methyl anion, and methyl radical through molecular orbital structures. Methyl cation: sp2, trigonal planar (empty pz orbital) Methyl anion: sp3, **pyramidal shape** Methyl radical: sp2, trigonal planar (half-filled pz orbital) Vacant $2p_z$ orbital — Half-filled $2p_z$ orbital — Filled sp^3 hybrid orbital  **(a) Methyl cation** **(b) Methyl radical** **(c) Methyl anion**	**(5 + 5)**	CO1	BL 3