CAREER ENDEAVOUR
Best Institute for IIT-JAM, NET & GATE

CSIR-UGC-NET/JRF | GATE CHEMISTRY

TEST : ORGANOMETALLIC COMPOUNDS

Time : 00: 45 Hour **Date : 06-10-2018**
M.M. : 60

INSTRUCTION :

1. **There are Two Parts. Part-A contains 10 objective type questions, each question carry 2 marks and Part-B contains 10 objective type questions, each question carry 4 marks.**
2. **There is negative marking, @ 25% will be deducted for each wrong answer.**
3. **Attempt all the questions, use of calculator is not allowed.**

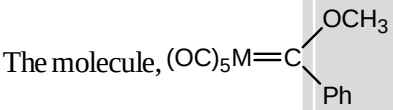
PART - A

1. Find out the metal in complex (X), assume ligand in maximum hetacity and complex (X) follow 18 electron rule.

$$(C_6H_6)\underset{(X)}{M}(C_4H_4)$$

(a) Os (b) Rh (c) Pt (d) Re

2. Which of the following statement is/are not true?
(I) 18 electron rule is only applicable for transition metal organometallic complexes
(II) 18 electron rule is not applicable for main group as well as lanthanide and actinide
(III) 18 electron rule is applicable to main group but not for lanthanide and actinide.
(IV) Square planar complexes generally not follow 16 electron rule.
(a) I and II (b) II and III (c) I and III (d) II, III and IV

3. The molecule, 

Obey 18 electron rule. The two metal satisfying the condition are

(a) Mo, V (b) Cr, Re^+ (c) Cr, Mo^+ (d) Cr, V

4. Following 18 electron rule as a guide, determine x in $\left[\eta^5Cp(CO)_2\underset{(I)}{Fe}(PhC\equiv CH)\right]^x$ and

$\left[\left(\eta^6C_6H_6\right)\underset{(II)}{Mn}(CO)_2(CH_3)\right]^x$

(a) (I) $+3$; (II) $+1$ (b) (I) 0; (II) $+1$ (c) (I) -1; (II) 0 (d) (I) $+1$; (II) 0

5. Which among the following alkene will bind most strongly to a metal?
(a) Cyclohexene (b) Norbornene (c) COD (d) Ethylene

6. The compound which obey 18 electrons rule is
(a) $[Mo(NCCH_3)_2(CO)_2(PPh_2)_3]$ (b) $[HRh(CO)(PPh_3)_3]^+$
(c) $[IrBr_2(CO)(PPh_3)_2(CH_3)]^-$ (d) $[Cr(I)(CHR)(CO)_4(CH_3)]$

7. In the complex $Me_4Al_2(\mu\text{-}Me)_2$, the two alkyl acts as a bridging ligands. This seems to happens by 2e, three centre bond involving between metal and alkyl carbon. The hapticity of terminal and bridging alkyl groups are respectively.
(a) η^1, η^2 (b) η^2, η^1 (c) η^3, η^1 (d) η^1, η^1

8. $Cr(CO)_6 + NO \xrightarrow{h\nu} P\left[Cr(NO)_x\right]$

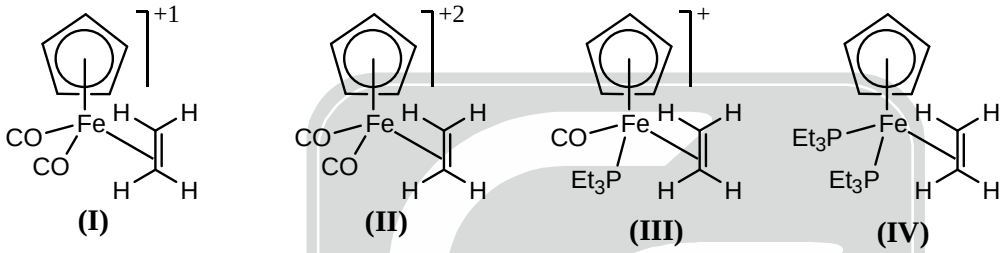
The complex 'P' is homoleptic complex and follows 18 electron the value of '*x*' will be
(a) 3 (b) 4 (c) 0 (d) 5

9. Consider the metal carbonyl complex (A), $\left[M(CO)_6\right]^q$ where q = –2, –1, 0, +1

The strongest ν_{C-O} band in IR spectrum can be observed when the value of q will be
(a) –2 (b) –1 (c) 0 (d) +1

10. The complex $[M(\eta^6-C_6H_6)(CO)_2]_2$ obeys the 18 electron rule and has one metal-metal double bond. Predict M
(a) Cr, Fe, W (b) Fe, Ru, Os (c) W, Mo, Cr (d) Co, Rh, Ir

PART -B

11. 

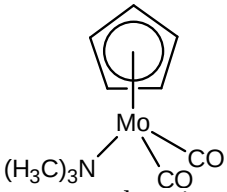
Arrange the given compounds in the increasing order of ethylene C–C bond length
(a) I < II < III < IV (b) II < I < III < IV (c) III < II < I < IV (d) IV < II < I < III

12. $Rh(CO)Cl(PPh_3)_2$ $Rh(CO)Cl(PEt_3)_2$ $Rh(CO)Cl[P(C_6F_5)_3]_2$
(I) **(II)** **(III)**

Arrange the given compound in decreasing order of Rh–C bond length
(a) III > II > I (b) I > II > III (c) III > I > II (d) II > III > I

13. Consider the statement:
N_2 and CO are isoelectronic molecule but M–N_2 complexes are much weaker compared to M–CO complexes
The correct explanation is
(a) CO is better σ -donor than N_2
(b) The HOMO of CO is slightly anti-bonding where as it is bonding in N_2.
(c) N_2 is poor π acceptor
(d) All of these

14. For the molecule (A),



Consider the following statement about its room temperature spectral data.
(I) ^{1}H NMR has singlet at 5.48 and 3.18 ppm
(II) ^{1}H NMR has multiplet at 5.48 and singlet at 3.18 ppm
(III) IR has CO stretching bands at 1950 and 1860 cm^{-1}
(IV) IR has CO stretching band at 1950 cm^{-1}.
(a) I and III (b) II and IV (c) II and III (d) I and IV

15. Match complexes in ***Column-I*** with their appropriate CO streching frequency (V_{CO}) in ***Column-II***.

Column-I	***Column-II***
(I) $Mn_2(CO)_{10}$	(A) 2057 cm^{-1}
(II) $Co_2(CO)_8$	(B) 1976 cm^{-1}
(III) $Ni(CO)_4$	(C) 2000 cm^{-1}
(IV) $V(CO)_6$	(D) 2013 cm^{-1}
(V) $Cr(CO)_6$	(E) 2023 cm^{-1}
(VI) $Fe(CO)_5$	(F) 2044 cm^{-1}

(a) I-A, II-B, III-D, IV-C, V-F, VI-E (b) 1-F, II-E, III-D, IV-C, V-B, VI-A
(c) 1-D, II-F, III-A, IV-B, V-C, VI-E (d) 1-D, II-F, III-B, IV-A, V-C, VI-E

16. A compound **A** having the composition $FeC_9H_8O_3$ shows one signal at 2.5 ppm and another one around 5.0 ppm in its ^1H NMR spectrum. The IR spectrum of this compound shows two bands around 1900 and 1680 cm^{-1}. The compound follows the 18 electron rule of the following statements for A, the correct one is/are

(A) It has $\eta^5 - Cp$ group. (B) It has a terminal CO ligand.
(C) It has a CH_3 ligand (D) It has Fe–H bond.
(a) (A) and (B) only (b) (C) only (c) (A) and (C) only (d) (B) and (D) only.

17. Chromium is known to form complexes with carbonyl and nitroryl ligands for complexes of the type $Cr(CO)_n(NO)_m$, determine the values of *m* and *n*. The complex should obey $18e^-$ rule and which have only linear nitrosyl ligands

(a) Two and four (b) Four and two
(c) Two and three (d) Three and two

18. Find the best possible combination of metal ligand and charge. So, that the complex (X) follows 18 electron rule.

$$\left[M(L)_x\right]^{z-}$$

(a) $M = Co, L = CO, x = 4, z = 3$ (b) $M = Fe, L = CN, x = 4, z = 2$
(c) $M = Fe, L = CO, x = 4, z = 2$ (d) $M = Mn, L = PPh_3, x = 5, z = 2$

19. Carbonyl stretching frequency of the given compound follows the order

(i) Fac-$Mo(CO)_3(PF_3)_3$ (ii) Fac-$Mo(CO)_3(PClPh_2)_3$
(iii) Fac-$Mo(CO)_3(PCl_3)_3$ (iv) Fac-$Mo(CO)_3(PMe_3)_3$
(a) (i) > (ii) > (iii) > (iv) (b) (iv) > (iii) > (ii) > (i)
(c) (i) > (ii) > (iv) > (iii) (d) (ii) > (i) > (iii) > (iv)

20. $\left[\eta^5 CpFe(CO)\right]_4$ (A) is a dark green solid compound. The IR spectrum shows a single CO stretching band at 1640 cm^{-1}. The ^1H NMR spectrum shows a single line even at low temperature. Which of the following statement is not true on the basis of gien data about the structure of $\left[\eta^5 CpFe(CO)\right]_4$

(a) The complex (A) follows the 18 electron rule.
(b) The total number of M–M bonds in complex are six.
(c) All CO's are present μ^3-mode.
(d) Two CO's are present in μ^2-mode where as another two CO's are present at μ^3 modes.

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[ANSWERS]

PART-A

1. (a)	**2. (d)**	**3. (b)**	**4. (d)**	**5. (b)**	**6. (d)**	**7. (d)**
8. (b)	**9. (d)**	**10. (c)**				

PART-B

11. (b)	**12. (a)**	**13. (d)**	**14. (d)**	**15. (c)**	**16. (a)**	**17. (d)**
18. (c)	**19. (a)**	**20. (d)**				