CHEM ACADEMY

FULL TEST - 2

IIT-JAM - 2017

Solution (04.02.17)

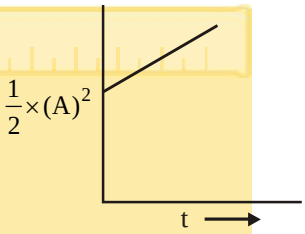
1. For n^{th} order reaction $A \rightarrow B$:

$$(A)^{1-n} = (A_0)^{1-n} + (n-1)kt \qquad n = 3$$

$$(A)^{-2} = (A_0)^{-2} + 2kt$$

$$\frac{1}{(A)^2} = \frac{1}{(A_0)^2} + 2kt$$

$$\frac{1}{2(A)^2} = \frac{1}{2(A_0)^2} + kt$$

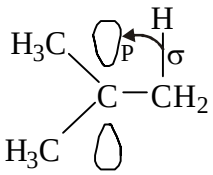


Y = C + MX

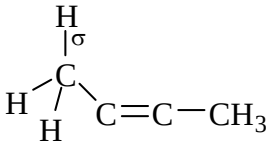
n = 3; x = 2

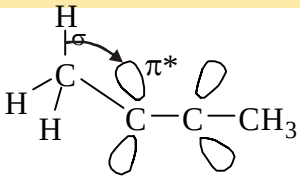
Ans: 3 + 2 = 5

Option A is correct

2. 

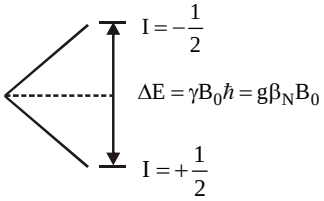
Overlapping between σ – P





overlapping between σ – π*

Correct option is (a)

3. 

$$\because \quad \Delta E = \gamma B_0 \hbar = \gamma B_0 \frac{h}{2\pi} = h\nu = gB_N B_0$$

4. At low temperature axial and equitorial protons of cyclohexane give two different signal but at high temperature only one signal arises.

5. $P(V - b) = RT$ $\quad a = 0$ & $b \neq 0$

According to the given gas equation attraction forces are absent hence only repulsive forces are present.

So potential energy becomes positive when molecules comes closer.

Hence only (c) is correct.

6. According to debroglie equation

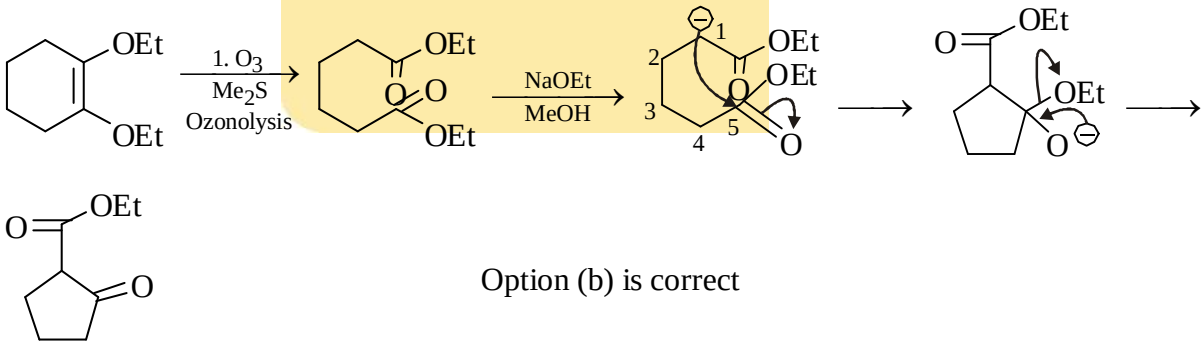
$$\lambda = \frac{h}{mv}$$

$$\frac{\lambda_{He}}{\lambda_{Ne}} = \frac{h/m_{He}v}{h/m_{Ne}v} = \frac{m_{Ne}}{m_{He}} \Rightarrow \frac{20}{4} = 5$$

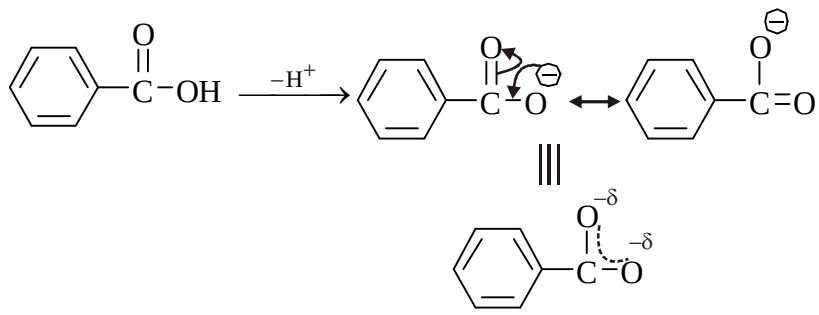
7. Ni
↓
Pd
↓
Pt

As we go down the group from 3d to 4d and 5d, effective nuclear charge increae also for 5d relativistic effect play important role.

$\therefore \quad r_{pd} \approx r_{Pt}$

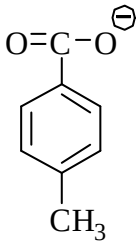
8. 

Option (b) is correct

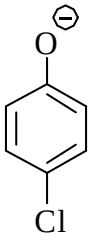
9. 

Carboxylate anion stablize by equivalent resonance

So it is more acidic than phenol.



$-CH_3$ group destablize anion by giving electron from hyperconjugation.

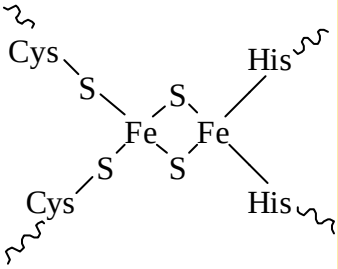


–Cl stablize anion by –I group

Correct order is III > IV > II > I

Correct option is (b)

10. Rieske Protein



Number of inorganic sulphur = 2 (labile)

11. Although, down the group Lewis acidic strength decreases, due to increase in size and decrease in charge intensity.

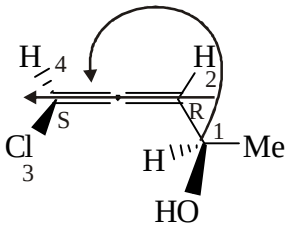
So, the order should be $GaX_3 < AlX_3 < BX_3$.

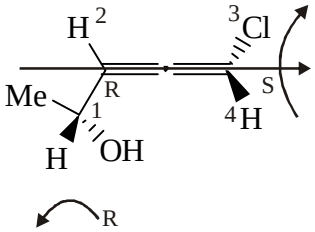
But in BX_3, back bonding occurs as a consequence of which lewis acidic character decreases.

Therefore, observed order: $GaX_3 < BX_3 < AlX_3$

Option (c) is correct.

12.





Both have same name SR, SR, so identical

13. Option (c) is correct.

14. $\underset{\text{Tetrahedral}}{NiCl_4^{2-}} \xleftarrow{HCl} Ni^{+2} \xrightarrow{KCN} \underset{\text{square planar}}{[Ni(CN)_4]^{2-}}$

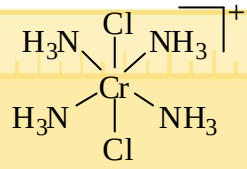
15. Molality is the number of moles of solute per kg of solvent.

i.e. 5.2 mole $\rightarrow$ 1000 kg H_2O i.e. 55.5 moles

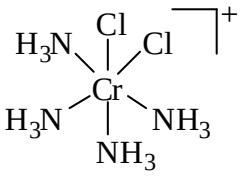
$$x_{CH_3OH} = \frac{5.2}{5.2+55.5} = 0.086$$

16. (a) $[Cr(NH_3)_4Cl_2]Cl$

$Cr^{+3} \Rightarrow d^3 \quad \therefore$ Paramagnetic & shows cis & trans isomerism



Trans



Cis

(b) $[Ti(H_2O)_5Cl](NO_3)_2$

$Ti^{+3} \Rightarrow d^1$ Paramagnetic & show ionization isomerism

$[Ti(H_2O)_5NO_3]Cl \cdot NO_3$

(c) $[Pt(en)(NH_3)Cl]NO_3$

$Pt^{+1} \rightarrow d^8 \rightarrow$ square planar $\quad \therefore$ diamagnetic & exhibit ionization isomerism

$[Pt(en)(NH_3)NO_3]Cl$

(d) $[Co(NH_3)_4(NO_3)_2]NO_3 \quad \because$ NH_3 act as SFL

$Co^{+3} \rightarrow d^6$ Diamagnetic & show cis-trans isomers.

17. $[P_x, x]$

$$\left(i\hbar\frac{\partial}{\partial x}, x\right)$$

$$i\hbar\left(\frac{\partial}{\partial x}, x\right)$$

$= -i\hbar$

$\neq 0 \quad \therefore$ Non-commute

18. $k_P = k_C(RT)^{\Delta ng}$

$$\frac{k_C}{k_P} = (RT)^{-\Delta ng}$$

For the given reaction $\Delta ng = -\frac{1}{2}$

$\therefore \quad \frac{k_P}{k_C} = (RT)^{\frac{1}{2}}$

19. $Ni^{+2} \xrightarrow{NH_3} [Ni(NH_3)_6]$ octahedral

$Pt^{+2} \xrightarrow{NH_3} [Pt(NH_3)_4]^{+2}$ square planar

$Zn^{+2} \xrightarrow{NH_3} Zn(NH_3)_4$ Tetrahedral

20. X – O – H

X should have lower ionization potential then only X^+, OH^- will be formed and act as base.

21. Correct answer is (b)

22. $[Mo(\eta'allyl)_3(\eta^3allyl)_2\, NO]$

Let say heptacity of NO is x.

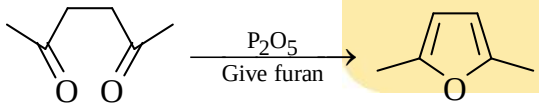
According to 18 electron rule

$18 = 6 + (1 \times 3) + (3 \times 2) + x$

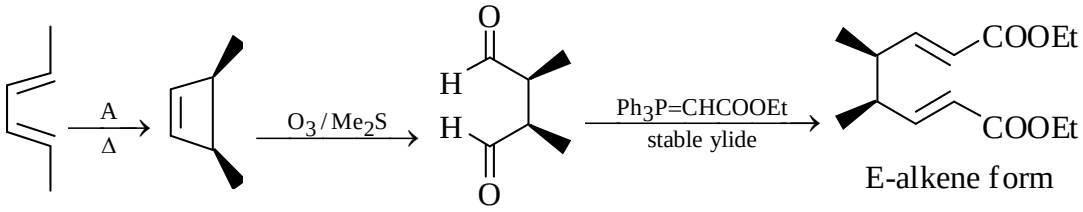
$x = 3$

23. On increasing the temperature, initially % yield increase because N_2 and H_2 bonds reqcures high energy but as the reaction is exothermic further increase in temperature results in decrease of temperature.

24. Less deviation is observed for dilute solutions.

25. 

Correct option is (a)

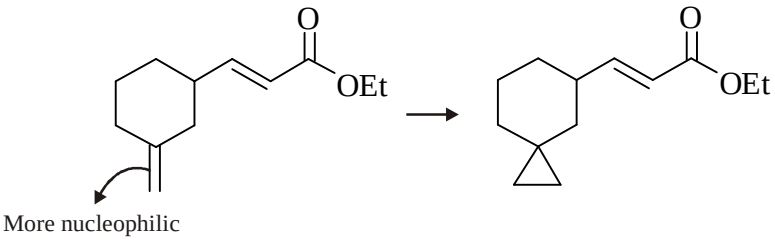
26. 

E-alkene form

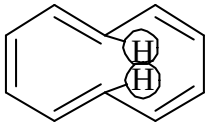
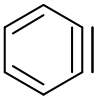
27. This is simmon Smith reaction

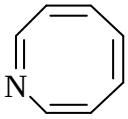
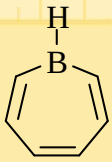
More nucleophilic alkene part react first

double bond which are conjugation with $-\overset{\overset{O}{\|}}{C}-$ become less nucleophilic not able to attack.



Correct option is (d)

28. (I)  Non aromatic (II)  Aromatic

(III)  Tub shape Non Aromatic (IV)  6π electron Aromatic

Correct option is (d)

29. $CH_4(g) + 2O_2 \rightarrow CO_2 + 2H_2O \qquad \Delta H^\circ = -802.8\ kJ$

$\Delta H^\circ = \Sigma$ bond energy of reactant $- \Delta H^\circ = \Sigma$ bond energy of product

$\Delta H^\circ = [4 \times \Delta H_{C-H} + 2\Delta H_{O=O}] - [2 \times \Delta H_{C=O} + 4 \times \Delta H_{O-H}]$

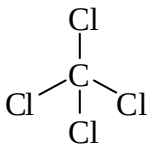
$-802.8\ kJ = [4 \times 416.2 + 2\ (493.7)] - [2 \times \Delta H_{C=O} + 4 \times 464.4]$

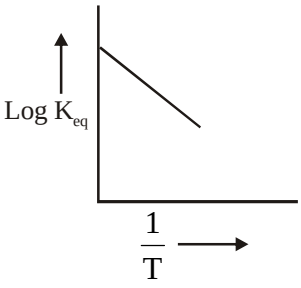
$\Rightarrow \qquad 2\Delta H_{C=O} = 1597.2$

$\Delta H_{C=O} = 798.7\ kJ\ mol^{-1}$

30. For spherical rotar molecule has Td, Oh, I_h point group.

CCl_4 is spherical rotar has Td point group.



31. 

slope = negative

Using: Vant Hoff equation

$$\log K_{eq} = \log A' - \frac{\Delta H}{2.303RT}$$

Slope = $-\frac{\Delta H}{2.303R}$ $\Rightarrow$ a negative value only when ΔH = positive.

$\therefore$ It is an endothermic reaction.

* Slope = $\frac{-\Delta H}{2.303R} = -50K$

$\Delta H = 50 \times 2.303 \times 8.314$

$= 957.36 \text{ J mol}^{-1}$

* For bimolecular reaction

According to ACT

$E_a = \Delta H + 2RT$

$= 957.36 + (2 \times 8.314 \times 298) = 5912 \text{ J mol}^{-1}$

$\sim 5.9 \text{ kJ mol}^{-1}$

* On increasing the temperature, rate constant increases ($E_a > 0$) and equilibrium constant also increases for an endothermic process, accorting to Le-chatlier principle.

Correct answer is b, c, d.

32. Deviation from Beer's law

(a) Very high conc. of analyte (b) Association & Dissociation of Analyte

(c) Polychromatic light

33. Statement a, b & c are correct

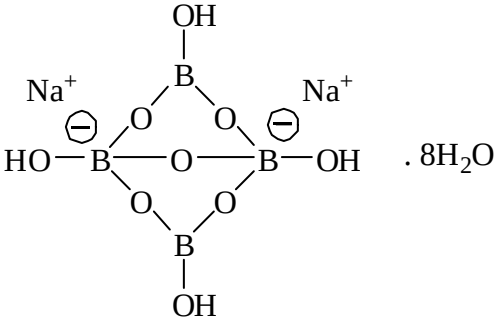
(d) is incorrect

$$\ln \tau = \ln \tau_0 + \frac{Ea}{RT}$$

$$\text{Slope} = +\frac{Ea}{R}$$

34. Borax

$Na_2B_4O_7 \cdot 10H_2O \quad \sim \quad [B_4O_5(OH)_4]^{2-} \cdot 8H_2O$



$\cdot 8H_2O$

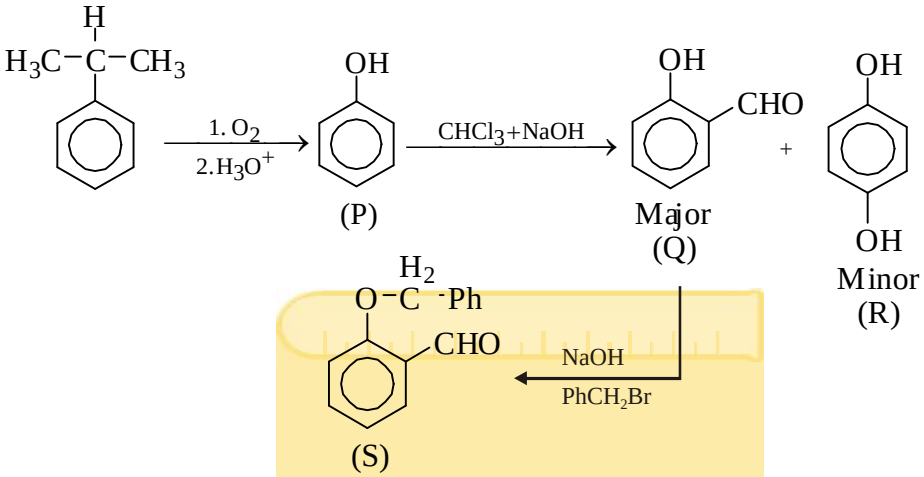
(a) 19 atom sp^3 hybridised.

(b) 8 molecules are hydrated.

(c) 34 lone pair of electrons

(d) 2 boron atoms are sp^2 hybridised.

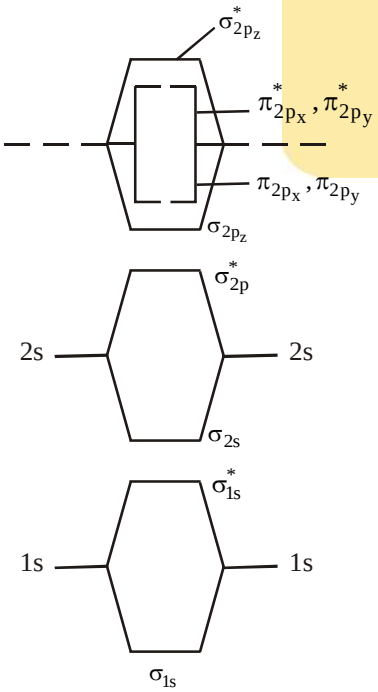
35.



$\because$ Q contains phenolic group hence it gives % aq. $FeCl_3$ test.

S gives ppt with 2,4-DNP because it contains aldehyde group

36.



If 2s-2p mixing is not operative means energy of $\sigma_{2p} < \pi_{2p}$

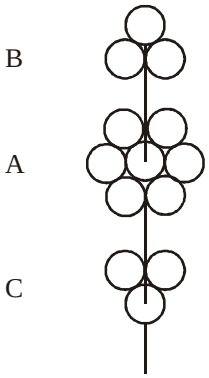
If hunds rule is not followed means pairing takes place easily.

* Be_2 has 8 electron $\therefore$ diamagnetic

* B_2 has 10 electron $\therefore$ diamagnetic

(c) C_2 has 12 electron $\therefore$ diamagnetic

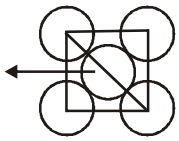
(d) N_2 has 14 electron $\therefore$ diamagnetic

37. 

ccp is ABCABC arrangement, but for the top most layer (Lets say A) each atom touches 6 in same layer & only 3 below the plane.

P.E. is 74%, hence Z = 4

Also atoms touches along the face centres.



$a\sqrt{2} = 4r$

$a = 2\sqrt{2}r$

38. (a) 

$$\text{Bond order} \propto \frac{1}{\text{Bond length order}}$$

More is back bonding, lower will be CO bond

$\therefore$ p donor increases bond length.

(b) $V(CO)_6$ is 17 e^- species

$\therefore$ accepts e^- readily to get stablize according to

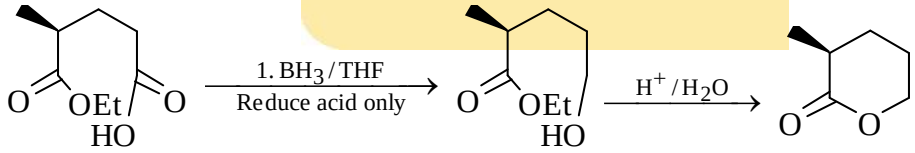
(c) $Os_5(CO)_{15}$

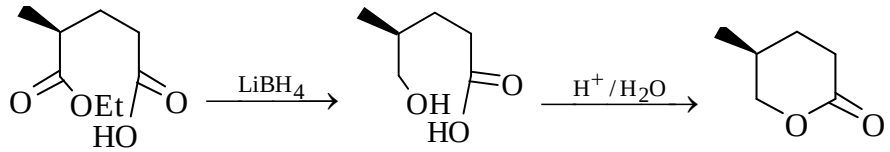
VSE = 8 × 5 + 4 + 2 × 15 = 74

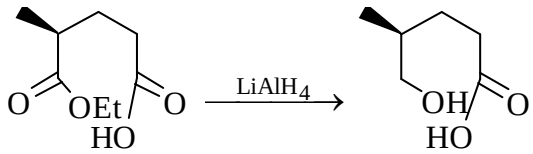
$$5 + x = \left|\frac{74 - 12 \times 5}{2}\right|$$

x = 2 Nido structure

39. Option a, b, c is correct

40. (a) 

(b) 

(c) 

(d) No reaction

Incorrect option is a, c and d.

41. For univalent metal ion

Mass deposited by passage of 6.02×10^{23} electrons corresponds to molar mass 'M'.

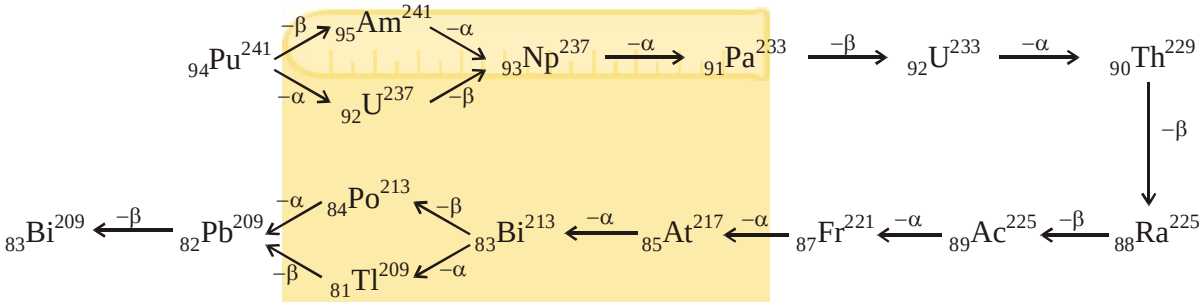
For divalent ion

$2 \times 6.02 \times 10^{23}$ electrons $\rightarrow$ molar mass 'M'

Now,

1.81×10^{22} electrons $\rightarrow$ 1 gram discharged

$$\therefore \quad 2 \times 6.02 \times 10^{23} \text{ electrons} \rightarrow \frac{1}{1.81 \times 10^{22}} \times 2 \times 6.02 \times 10^{23} = \frac{2 \times 60.2}{1.81} = 66.7 \text{ g.}$$

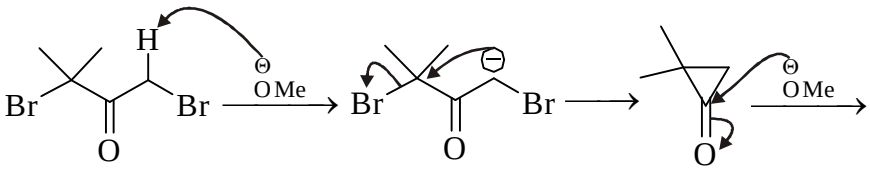
42. 

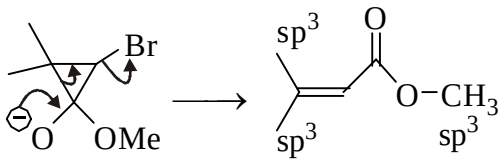
Parent Nucleus: $_{94}Pu^{241}$

Last Nucleus: $_{83}Bi^{209}$

No. of α 8

No. of β 5

43. 



Answer is 3.

44. Ligands which have third period or onward central atom is present with no π bond will accept in σ*

$\therefore$ R_3P, H_2S are s* acceptor. Also H_2 has lower energy σ_{1s}^{*} available.

45. $Br_2 + Na_2CO_3 \rightarrow NaBr + NaBrO_3 + CO_2$

(1) To balance the reaction first reverse the reaction.

$$\underset{n_F}{Na_2CO_3} + \underset{1}{NaBr^-} + \underset{5}{NaBrO_3^-} \rightarrow Br_2 + Na_2CO_3$$

(2) Cross multiply the n_f, Balance Br.

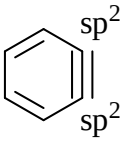
$$Na_2CO_3 + 5NaBr^- + NaBrO_3^- \rightarrow 3Br_2 + Na_2CO_3$$

(3) Balance other

$$5NaBr + NaBrO_3 + 3CO_2 \rightarrow 3Br_2 + 3Na_2CO_3$$

46. The incorrect statement about kinetic theory of gaseous is b.

47. Jahn Teller distortion is observed when t_{2g} and e_g are unsymmetrically filled. Therefore $[Mn(H_2O)_6]^{+3}$. Which is $t_{2g}^3\ e_g^1$. Shows JTD.

48. 

Total $6\pi\ e^-$

49. Heat of hydrogenation is inversely proportional to stability of alkene

Order of stability is I > IV > II > III

$\therefore$ Heat of hydrogenation III > II > IV > I

Answer is 3

50. For diatomic molecule

N = 2

Degree of freedom = 6

Translational = 3

Rotational = 2

Vibrational = 1

$$U = 5 \times \frac{1}{2}RT = \frac{5}{2}RT$$

$$C_v = \frac{5}{2}R$$

$$C_p = \frac{7}{2}R$$

$$C_p = \frac{7}{2} \times 2 \text{ cal } k^{-1} \text{ mol}^{-1}$$

$$C_p = 7 \text{ cal } k^{-1} \text{ mol}^{-1}$$

51. (I) $2A \underset{}{\overset{k_1}{\rightleftharpoons}} A_2$ (fast)

(II) $A + B \overset{k_2}{\rightleftharpoons} C$ (fast)

(III) $A_2 + C \xrightarrow{k_3} P + 2A$ (slow)

overall reaction: $A + B \rightarrow P$

Rate = $k_3[A_2][C]$

Applying equilibrium approximation on A_2 & C.

From (I): $k_1 = \frac{[A_2]}{[A]^2} \Rightarrow [A_2] = k_1.[A]^2$

From (II): $k_2 = \frac{[C]}{[A][B]} \Rightarrow [C] = k_2 . [A][B]$

$\therefore$ Rate = $k_3 \times k_1 . [A]^2 . k_2 . [A][B]$

$= k'[A]^3[B]'$

Overall order = 4.

52.

$$XeF_6 \xrightarrow[\text{hydrolysis}]{\text{complete}} (P)XeO_3 + \boxed{HF}$$

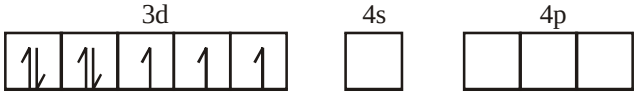
$$XeO_3 \xrightarrow{OH^-/H_2O} HXeO_4^{\Theta}\,(Q)$$

$$2HXeO_4^{\Theta} + 2OH^{\Theta} \rightarrow XeO_6^{4-} + Xe + \boxed{O_2} + 2H_2O$$

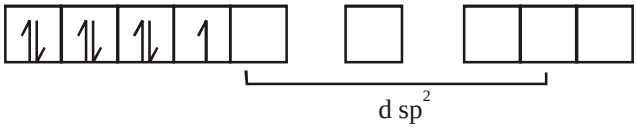
Total number of gases = 2

53. IV statement is incorrect because both are diastereomers

54. $Co^{+2}\ d^7$



For square planar, one 3d orbital is required to be empty.



1 unpaired electron is present

$\therefore \quad \mu_s = \sqrt{n(n+2)} \Rightarrow 1.73.$

55. When liberated I_2 is titrated with $Na_2S_2O_3$

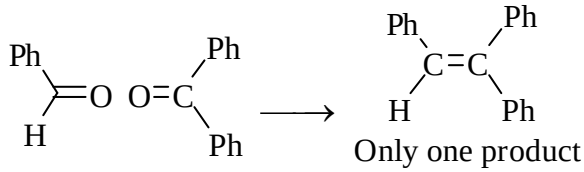
equivalent of I_2 = equivalent of $Na_2S_2O_3 \Rightarrow 48 \times 0.25$

$eq_{I_2} = 12$

Also $eq_{I_2} = 12 = eq_{bleach} \Rightarrow N \times V = 12$

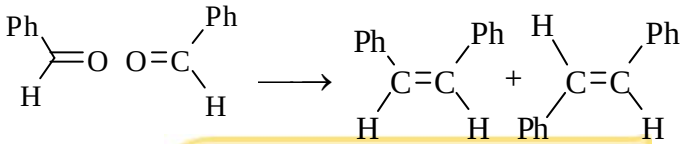
N = 0.48.

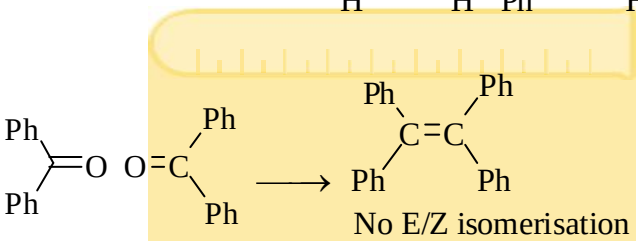
56. Mecmurry coupling reaction

Cross coupling 

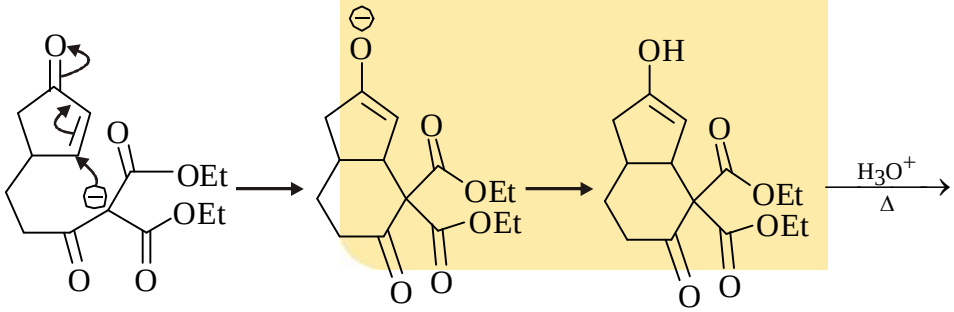
Only one product

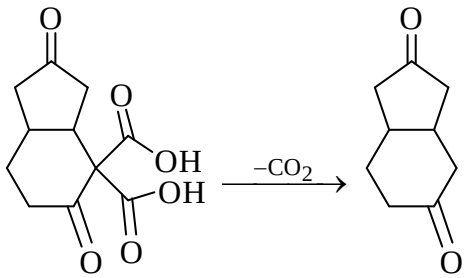
No E/Z isomerisation

Self coupling 



No E/Z isomerisation

57. 



Number of carbon atom is 9.

58. Isoelectronic point is a PH where overall charge an amino acid is zero.

$$\therefore \quad pI = \frac{4.5 + 3.5}{2} = 4$$

59. $\Delta G = -nRT \ln \frac{V_2}{V_1}$

$= 1 \times R \times 300 \ln \frac{4}{1}$

$= -300R \ln(2)^2$

$= -600 \ln 2 \times R$

$= -415.88\ R$

60. $J_{max} = \sqrt{\frac{K_B T}{2B\hbar c}} - \frac{1}{2}$

$J_{max} = \left(\frac{1.38 \times 10^{-23} \times 300}{2 \times 1.566 \times 6.67 \times 10^{-34} \times 3 \times 10^{10}} \right)^{1/2} - \frac{1}{2}$

$J_{max} = 7.7 = 8$