PRACTICE PAPER

CHEMISTRY

26. Major product obtained in the given reaction

 + $\xrightarrow{H_2SO_4}$ is

(2 Moles)

(a)

(b)

(c)

(d)
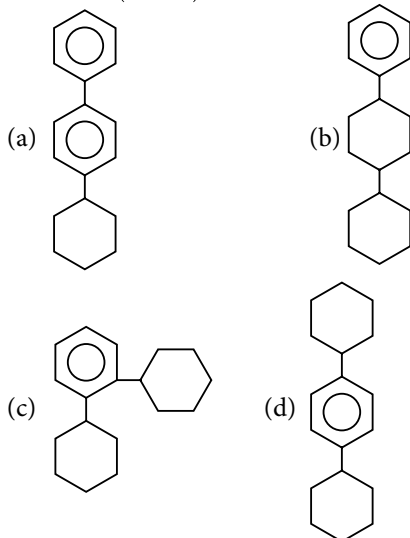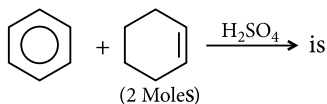
27. Which of the following is a wrong order with respect to the property mentioned against each?

(a) $O_2^{2-} > O_2 > O_2^{2+}$ (Paramagnetic moment)
(b) $NO^- > NO > NO^+$ (bond length)
(c) $H_2 > H_2^+ > He_2^+$ (bond energy)
(d) $NO_2^+ > NO_2 > NO_2^-$ (bond angle)

28. Which is not correctly matched?
(1) Basic strength of oxides :
$Cs_2O < Rb_2O < K_2O < Na_2O < Li_2O$
(2) Stability of peroxides :
$Na_2O_2 < K_2O_2 < Rb_2O_2 < Cs_2O_2$
(3) Stability of bicarbonates :
$LiHCO_3 < NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3$
(4) Melting point : $NaF < NaCl < NaBr < NaI$
(a) 1 and 4   (b) 1 and 3
(c) 1 and 2   (d) 2 and 3

29. The bond enthalpy of $H_{2(g)}$ is 436 kJ mol^{-1} and that of $N_{2(g)}$ is 941.3 kJ mol^{-1}. Calculate the average bond enthalpy of an N—H bond in ammonia if $\Delta H_f^\circ (NH_3)$ = – 46.0 kJ mol^{-1}.
(a) 443.67 kJ mol^{-1} (b) 474.33 kJ mol^{-1}
(c) 390.2 kJ mol^{-1} (d) 244.88 kJ mol^{-1}

30. Terpineol and chloroxylenol are the compounds of which of the following classes?
(a) Disinfectant   (b) Chemosterilant
(c) Tranquilisers   (d) None of these

31. A cell contains two hydrogen electrodes. The negative electrode is in contact with a solution of 10^{-6} M hydrogen ions. The EMF of the cell is 0.118 V at 25°C. Calculate the concentration of hydrogen ions at the positive electrode.
(a) 10 M   (b) 10^{-2} M
(c) 0.1 M   (d) 10^{-4} M

32. Identify the correct sequence of increasing number of π-bonds in structures of the following molecules :
I. $H_2S_2O_6$ II. H_2SO_3
III. $H_2S_2O_5$
(a) I < II < III   (b) II < III < I
(c) II < I < III   (d) I < III < II

33. $-CH_2CH{=}CH_2$ $\xrightarrow{NBS}$ X
$\xrightarrow{Br_2/Fe}$ Y
$\xrightarrow{Br_2/water}$ Z
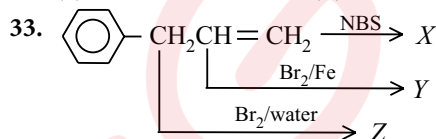
X, Y and Z respectively are

(a) X:

Y:

Z:

(b) X:

Y:

Z:

(c) $X = Y = Z =$

(d) $X = Y = Z =$

34. Which of the following statements are incorrect?
I.   Zinc can be extracted by self-reduction.
II. A depressant prevents certain type of particles to come to the froth.
III. Copper matte contains ZnS and Cu_2S.
IV. The solidified copper obtained from reverberatory furnace has blistered appearance due to evolution of SO_2 during the extraction.
(a) I and II   (b) II and III
(c) I and III   (d) II and IV

35. What are *A*, *B* and *C* in the following sequence of reaction?

(a) $A = B = C =$

(b) $A = B = C =$

(c) $A = B = C =$

(d) A :

, B :

,

C :
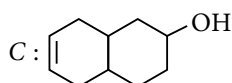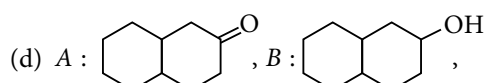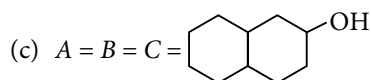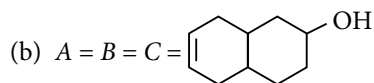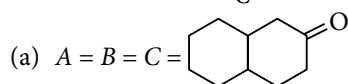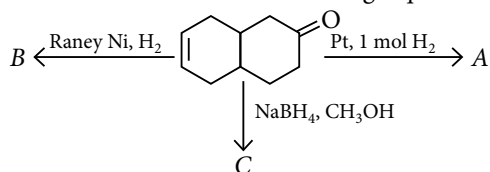
**36.** In context with the transition elements, which of the following statements is incorrect?
  (a) In addition to the normal oxidation states, the zero oxidation state is also shown by these elements in complexes.
  (b) In the highest oxidation states, the transition metals show basic character and form cationic complexes.
  (c) In the highest oxidation states of the first five transition elements (Sc to Mn), all the 4*s* and 3*d* electrons are used for bonding.
  (d) Once the d^5 configuration is exceeded, the tendency to involve all the 3*d* electrons in bonding decreases.

37. pH of a mixture of 1M benzoic acid (pK_a = 4.20) and 1 M C_6H_5COONa is 4.5. In 300 mL buffer, benzoic acid is [log 2 = 0.3]
  (a) 200 mL   (b) 150 mL
  (c) 100 mL   (d) 50 mL.

38. 200 g sample of hard water is passed through a cation exchanger in which H^+ ions are exchanged by Ca^{2+} ions. The water coming out of cation exchanger needed 75 mL of 0.1 N NaOH for complete neutralisation. The hardness of water due to Ca^{2+} ion is
  (a) 250 ppm   (b) 500 ppm
  (c) 750 ppm   (d) 1000 ppm.

39. The degree of dissociation of $Ca(NO_3)_2$ in a dilute solution containing 14 g of the salt per 200 g of water at 100°C is 70%. If the vapour pressure of water is 760 mm, calculate the vapour pressure of solution.
  (a) 750.50 mm   (b) 745.98 mm
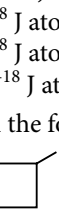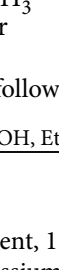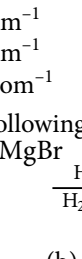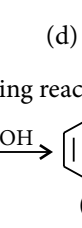 (c) 200.50 mm   (d) 14.02 mm
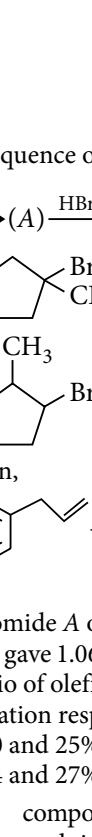
40. $BCl_{3(excess)} \xrightarrow[\text{ether}]{LiAlH_4} (A) \xrightarrow[\text{(ii) High temperature}]{\text{(i) Excess of } NH_3} (B)_{(liquid)},$
  (*B*) is

  (a) Borazole,
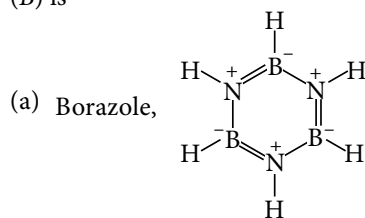
  (b) Boron nitride, $(BN)_x$

  (c)

  (d)
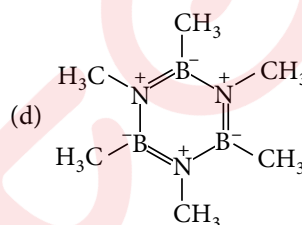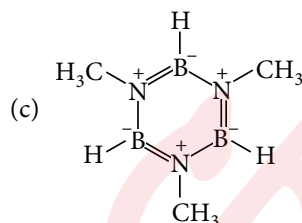
41. Calculate the energy of first stationary state of Li^{2+}, if ionization energy of He^+ is 19.6×10^{-18} J atom^{-1}.
  (a) 176.4×10^{-18} J atom^{-1}
  (b) 4.9×10^{-18} J atom^{-1}
  (c) 8.7×10^{-18} J atom^{-1}
  (d) 44.1×10^{-18} J atom^{-1}

42. Identify (*B*) in the following sequence of reaction,

  (a)

          (b)

  (c)

          (d)

43. Consider the following reaction,

  In an experiment, 1.99 g of bromide *A* on reaction with ethanolic potassium hydroxide gave 1.062 g of a mixture of the olefin *B* and *C*. If the ratio of olefins *B* : *C* formed is 2 : 1, the yield for their formation respectively are
  (a) 60 and 30%   (b) 50 and 25%
  (c) 66 and 33%   (d) 54 and 27%

44. Aqueous solutions of two compounds M–O–H and M'–O–H have been prepared in two different

beakers. If the electronegativity of $M = 3.5$, $M' = 1.72$, $O = 3.0$ and $H = 2.1$, then the solutions respectively are
(a) acidic, acidic
(b) acidic, basic
(c) basic, basic
(d) basic, acidic.

45.

$$CH_3 - \overset{(3)}{N} \quad \overset{O}{\underset{(2)}{\overset{\|}{C}}} - NH_2$$

$$\underset{(4)}{Ph - NH} \quad \overset{(1)}{NH} \quad O = \overset{|}{C} - CH_3$$
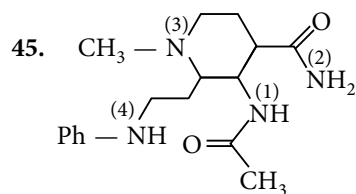
Correct order of basicity is
(a) $3 > 1 > 2 > 4$
(b) $3 < 1 < 2 < 4$
(c) $3 < 4 < 1 < 2$
(d) $3 > 4 > 1 > 2$

Numerical Value Type

46. An aromatic hydrocarbon (A) $C_{16}H_{16}$ shows following reactions :
(i) It decolourises both Br_2 in CCl_4 and cold aq. $KMnO_4$.
(ii) It adds an equimolar amount of H_2.
(iii) Oxidation with $KMnO_4$ gives a dicarboxylic acid (B) $C_6H_4(COOH)_2$ which gives only one monobromo substitution product.
The number of stereoisomers of the compound (A) is_____.

47. The graph of compressibility factor (Z) *vs* P for one mole of a real gas is shown below. The graph is plotted at constant temperature 273 K. If the slope of graph at very high pressure $\left(\dfrac{dZ}{dP}\right)$ is $\left(\dfrac{1}{2.8}\right)$ atm^{-1}, then the volume of one mole of real gas molecules (in L/mol) is_____.
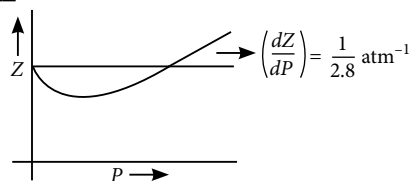
48. A complex of Fe^{2+} has magnetic moment value of 4.89 B.M. The number of electrons in the t_{2g} level of Fe^{2+} is_____.

49. Number of chiral centre in compound A is _____.

$\xrightarrow[H_2O]{Br_2}$ Compound (A)
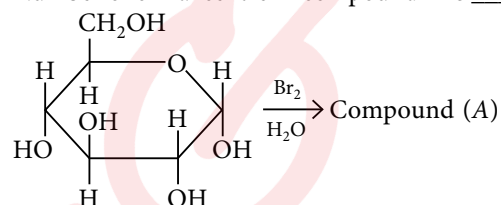
50. A flask contains a mixture of compounds A and B. Both compounds decompose by first-order kinetics. The half-lives are 54.0 min for A and 18.0 min for B. If the concentrations of A and B are equal initially, the time taken (in min) for the concentration of A to be four times that of B will be _____ .

HINTS & EXPLANATIONS

CHEMISTRY

26. (d) :

27. (a) :

	NO^-	$>$	NO	$>$	NO^+	(bond length)
Bond order	2.0		2.5		3	

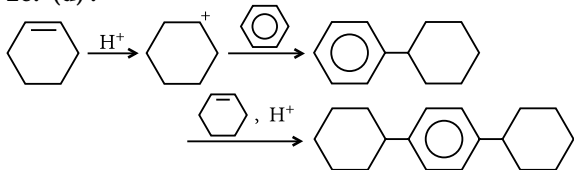|	H_2	$>$	H_2^+	$>$	He_2^+	(bond energy)
Bond order	1		0.5		0.5	

(In He_2^+ more electron in antibonding MO's)

	NO_2^+	$>$	NO_2	$>$	NO_2^-	
Bond angle	180°		133°		115°	

	O_2^{2-}	$<$	O_2^+	$<$	O_2	(paramagnetic moment)
No. of e^- unpaired	0		1		2	

28. (a) : Basic strength of the oxides increases in the order : $Li_2O < Na_2O < K_2O < Rb_2O < Cs_2O$. The increase in basic strength is due to the decrease in *I.E.* and increase in electropositive character.

The melting points of the halides decrease in the order $NaF > NaCl > NaBr > NaI$, as the size of the halide ion increases. The decrease in melting point is due to increase in the covalent character with increase in the size of anion according to Fajan's rule.

29. (c) : Given :

$N_{2(g)} \rightarrow 2N_{(g)}$; $\Delta H° = 941.3$ kJ mol^{-1} ....(i)

$H_{2(g)} \rightarrow 2H_{(g)}$; $\Delta H° = 436.0$ kJ mol^{-1} ....(ii)

$\frac{1}{2} N_{2(g)} + \frac{3}{2} H_{2(g)} \rightarrow NH_{3(g)}$; $\Delta_f H° = -46.0$ kJ mol^{-1} ....(iii)

Multiplying eqn. (i) by 1/2 and (ii) by 3/2 and then adding, we get

$\frac{1}{2} N_{2(g)} + \frac{3}{2} H_{2(g)} \rightarrow N_{(g)} + 3H_{(g)}$; ....(iv)

$\Delta H° = 941.3 \times \frac{1}{2} + 436.0 \times \frac{3}{2}$

$= 470.65 + 654 = 1124.65$ kJ mol^{-1}

On subtracting eqn. (iii) from eqn. (iv), we get

$NH_3 \rightarrow N_{(g)} + 3H_{(g)}$; ....(v)

$\Delta H° = 1124.65 - (-46.0)$ kJ mol^{-1} $= 1170.65$ kJ mol^{-1}

Since there are three N—H bonds in NH_3, the average bond enthalpy is obtained by dividing the value of $\Delta H°$ of eqn. (v) by 3.

Hence, $\Delta H_{N-H} = \frac{1170.65}{3} = 390.2$ kJ mol^{-1}

30. (a) : Terpineol and chloroxylenol are the compounds of disinfectant class that inactivate or destroy microorganisms.

31. (d) : Negative electrode signifies the anode on which oxidation takes place. Thus, cell may be represented as

$H_2 \mid H^+ (10^{-6}M) \mid\mid H^+_{(C)} \mid H_2$ with $n = 1$

Half-cell reactions are

$\frac{1}{2} H_2$ d $H^+(10^{-6}$ M$) + e^-$ (Oxidation half-reaction)

$H^+_{(C)} + e^- \rightarrow \frac{1}{2} H_2$ (Reduction half-reaction)

Overall reaction : $H^+_{(C)} \rightarrow H^+(10^{-6}$ M$)$

Hence, it is a concentration cell for which

$E_{cell} = \frac{0.0591}{n} \log \frac{C_1}{C_2}$

$0.118 = \frac{0.0591}{1} \log \frac{C}{10^{-6}} = 0.0591(\log C + 6)$

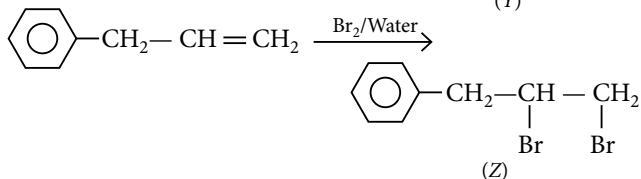$\log C = \frac{0.118 - 0.3546}{0.0591} = -4$ ∴ $C = 10^{-4}$ M

32. (b) : $H_2S_2O_6$, $HO-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-OH \Rightarrow 4\pi$-bonds

H_2SO_3, $HO-\underset{\underset{O}{\|}}{S}-OH \Rightarrow$ one π-bond

$H_2S_2O_5$, $HO-\underset{\underset{O}{\|}}{S}-S-OH \Rightarrow 3\pi$-bonds

Therefore, the correct order is II < III < I.

33. (b) :
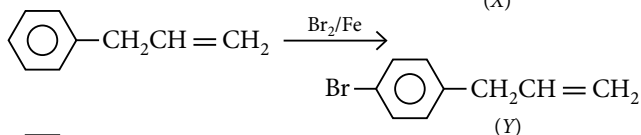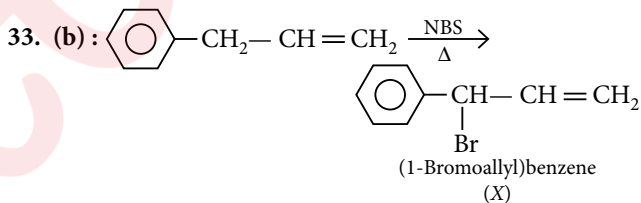
34. (c) : Copper matte consists of Cu_2S and FeS. I and III are incorrect.

35. (d) :
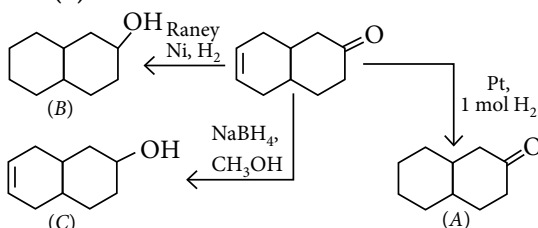
36. (b) : When the transition metals are in their highest oxidation state, they no longer have tendency to give away electrons, they are not basic but show acidic character and form anionic complexes.

37. (c) : $pH = pK_a + \log \dfrac{[\text{Salt}]}{[\text{Acid}]}$

$\therefore \ 4.5 = 4.2 + \log \dfrac{[\text{Salt}]}{[\text{Acid}]} \Rightarrow \log \dfrac{[\text{Salt}]}{[\text{Acid}]} = 0.3$

$\therefore \ \dfrac{[\text{Salt}]}{[\text{Acid}]} = 2$ ...(i)

Let V mL 1 M C_6H_5COOH solution and $(300 - V)$
1 M C_6H_5COONa solution be mixed together,

$[\text{Acid}] = \dfrac{V \times 1}{1000} \times \dfrac{1000}{300}; \ [\text{Salt}] = \dfrac{(300-V)}{1000} \times \dfrac{1000}{300}$

$[\text{Acid}] = \dfrac{V}{300}; \ [\text{Salt}] = \dfrac{300-V}{300}$

$\therefore \ \dfrac{300 - V/300}{V/300} = 2$ (from equation (i))

$\Rightarrow \ 300 - V = 2\,V \ \Rightarrow \ V = 100$ mL

38. (c) : Millimoles of H^+ ion present in 200 g of water coming out of exchanger $= 75 \times 0.1 = 7.5$ $[N_1V_1 = N_2V_2]$

$\therefore$ Millimoles of Ca^{2+} ion present in hard water $= \dfrac{7.5}{2}$

[1 Ca^{2+} is replaced by 2H^+ ions.]

Hence, mg of Ca^{2+} ion $= \dfrac{7.5}{2} \times 40 = 150$ mg

$\therefore$ Amount of Ca^{2+} ion present in 200 g of hard water $= 150$ mg

Amount of Ca^{2+} ion present in 10^6 g of hard water

$= \dfrac{150}{200} \times 10^6 \times 10^{-3} = 750$ ppm

39. (b) : $\Delta p_{\text{theor.}} = $ Lowering in vapour pressure, when there is no dissociation.

$\Delta p_{\text{theor.}} = p° \times \dfrac{w_2 M_1}{w_1 M_2}$ (Given, $p° = 760$ mm, $w_2 = 14$ g,

$w_1 = 200$ g, $M_1 = 18$, $M_2 = 164$)

$= \dfrac{760 \times 14 \times 18}{200 \times 164} = 5.84$ mm
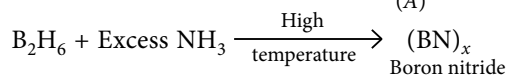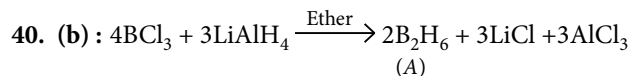
Degree of dissociation $= \dfrac{70}{100} = 0.7$

$\dfrac{\Delta T_{\text{obs.}}}{\Delta T_{\text{theor.}}} = \dfrac{\text{No. of particles after dissociation.}}{\text{No. of particles when there is}}$
$\hspace{5cm}\text{no dissociation.}$

$= \dfrac{1 + (n-1)\alpha}{1} = \dfrac{1 + (3-1) \times 0.7}{1} = 2.4$

So, $\Delta p_{\text{obs.}} = 2.4 \times \Delta p_{\text{theor.}} = 2.4 \times 5.84 = 14.02$ mm

$p° - p_s = \Delta p_{\text{obs.}} = 14.02$
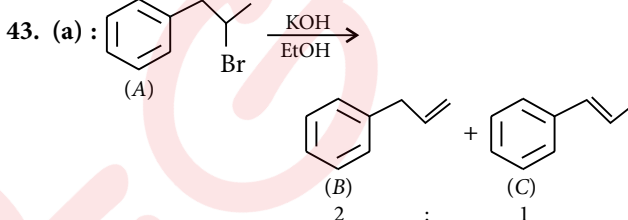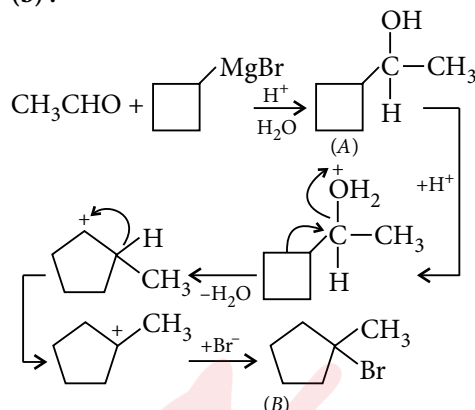
$p_s = p° - 14.02 = 760 - 14.02 = 745.98$ mm

40. (b) : $4BCl_3 + 3LiAlH_4 \xrightarrow{\text{Ether}} \underset{(A)}{2B_2H_6} + 3LiCl + 3AlCl_3$

$B_2H_6 + \text{Excess } NH_3 \xrightarrow[\text{temperature}]{\text{High}} \underset{\text{Boron nitride}}{(BN)_x}$

41. (d) : E_1 i.e., I.E. of $He^+ = $ I.E. of H i.e., E_1 of H $\times 2^2$

E_1 i.e., I.E. of $Li^{2+} = E_1$ of H $\times 3^2$

$\dfrac{E_1 \text{ of } Li^{2+}}{E_1 \text{ of } He^+} = \dfrac{9}{4}$

E_1 of $Li^{2+} = \dfrac{9}{4} \times 19.6 \times 10^{-18} = 44.1 \times 10^{-18}$ J atom^{-1}

42. (b) :

43. (a) :

M.wt. of A = 199 g mol^{-1}
M.wt. of B or C = 118 g mol^{-1}
According to balanced chemical equation 199 g of A give product mixture = 118 g

$\therefore$ 1.99 g of A will give products $= \dfrac{118 \times 1.99}{199} = 1.18$ g
But yield = 1.062 g

So, percentage yield $= \dfrac{1.062}{1.18} \times 100 = 90\%$

Since, ratio of B and C is 2 : 1
$\therefore$ Yield of B = 60% and yield C = 30%

44. (b) : In the compound $M - O - H$, if I.E. or E.N. of M is low, the compound will act as a base and if the I.E. or E.N. of M is high, the compound will behave as an acid. Therefore, $M - O - H$ will act as an acid as E.N. of M is high (3.5) and $M' - O - H$ will act as a base as E.N. of M' is low (1.72).

45. (d) : All, Nitrogens have same hybridisation but N–3 is not stabilised by lone-pair delocalization and due to +I effect of $-CH_3$, it is most basic.

In case of amides, the lone pair is destabilized by the electron withdrawing $>C=O$ which is stronger electron withdrawing group than phenyl group. So, lone pair of N is unavailable for proton so it is less basic than aniline.

46. (2) : (i) Aromatic hydrocarbon (A) decolourises Br_2 in CCl_4 and cold aq. $KMnO_4$ and thus (A) must have unsaturated aliphatic $C=C$ bond in the chain.
(ii) Addition of one mole of H_2 also confirms one $C=C$ bond in the chain.
(iii) Oxidation of (A) by hot $KMnO_4$ gives (B),

$C_6H_4 \begin{smallmatrix} \diagup COOH \\ \diagdown COOH \end{smallmatrix}$ which gives only one monobromo

substitution product, i.e., it should be p-isomer.

Thus, (*B*) is

$$\text{HOOC}-\langle\bigcirc\rangle-\text{COOH}$$

(shown as benzene ring with COOH at top and COOH at bottom)
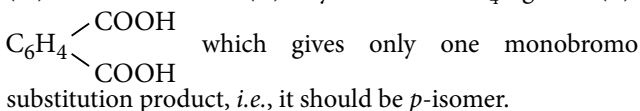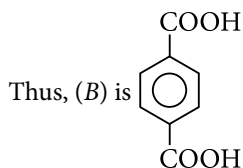
keeping in view above facts, (*A*) is

$$\text{CH}_3-\langle\bigcirc\rangle-\text{CH}=\text{CH}-\langle\bigcirc\rangle-\text{CH}_3$$

(*A*) shows geometrical isomerism,

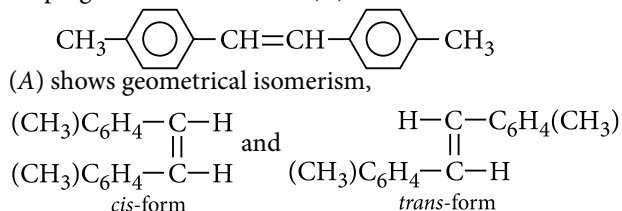$$\begin{matrix} (\text{CH}_3)\text{C}_6\text{H}_4-\overset{\displaystyle\|}{\text{C}}-\text{H} \\ (\text{CH}_3)\text{C}_6\text{H}_4-\text{C}-\text{H} \\ \textit{cis}\text{-form} \end{matrix} \quad \text{and} \quad \begin{matrix} \text{H}-\overset{\displaystyle\|}{\text{C}}-\text{C}_6\text{H}_4(\text{CH}_3) \\ (\text{CH}_3)\text{C}_6\text{H}_4-\text{C}-\text{H} \\ \textit{trans}\text{-form} \end{matrix}$$

47. (2) : $Z = 1 + \dfrac{Pb}{RT}$ (at high pressure)

$$\frac{dZ}{dP} = \frac{b}{RT} = \frac{1}{2.8}$$

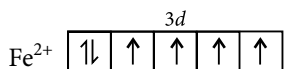$$b = \frac{RT}{2.8} = \frac{0.082 \times 273}{2.8} = 8$$

Now, $b = 4\,V$

$$\left[\left(\because V = N_A \times \frac{4}{3}\pi r^3\right) = \text{volume of 1 mole gas}\right]$$

$$V = \frac{b}{4} = \frac{8}{4} = 2$$

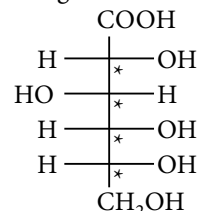**48. (4) :** $\mu = 4.89 = \sqrt{n(n+2)} \Rightarrow n = 4$

Since, Fe^{2+} has four unpaired electrons so, its configuration will be

$$Fe^{2+} \quad \overset{3d}{\boxed{\uparrow\downarrow\,|\,\uparrow\,|\,\uparrow\,|\,\uparrow\,|\,\uparrow}}$$

Hence, it is a weak field complex.

In weak field complexes, first the t_{2g} and e_g levels are singly occupied and then the pairing of electrons in t_{2g} level takes place. Thus, there are 4 electrons in t_{2g} level.

49. (4) : After ring opening oxidation of α - *D* - glucose leads to the formation of gluconic acid.

$$\begin{matrix} \text{COOH} \\ \text{H}—\overset{*}{\rule{0pt}{8pt}}—\text{OH} \\ \text{HO}—\overset{*}{\rule{0pt}{8pt}}—\text{H} \\ \text{H}—\overset{*}{\rule{0pt}{8pt}}—\text{OH} \\ \text{H}—\overset{*}{\rule{0pt}{8pt}}—\text{OH} \\ \text{CH}_2\text{OH} \end{matrix}$$

50. (54) : Total time $T = n \times t_{1/2}$

or $n = \dfrac{T}{t_{1/2}}$ $\therefore n_A = \dfrac{T}{54}$; $n_B = \dfrac{T}{18}$

Now for reactant *A* : $N_A = N_0\left(\dfrac{1}{2}\right)^{T/54}$

and for reactant *B* : $N_B = N_0\left(\dfrac{1}{2}\right)^{T/18}$

$$\therefore \frac{N_B}{N_A} = \left(\frac{1}{2}\right)^{\frac{T}{18}-\frac{T}{54}} = \left(\frac{1}{2}\right)^{T(54-18)/54\times18} = \left(\frac{1}{2}\right)^{2T/54}$$

But $N_A = 4N_B$

$$\therefore \frac{N_B}{4N_B} = \left(\frac{1}{2}\right)^{2T/54} ; \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{2T/54}$$

$\therefore 2T/54 = 2$, $T = 54$ min.