# CHEMISTRY
# SECTION-I
# INTEGER TYPE QUESTIONS

**Q.21 to Q.28 are "Integer Type" questions. (The answer to each of the questions are upto 1 digit (0 to 9))**

21. Three moles of $B_2H_6$ are completely reacted with methanol. The number of moles of boron containing product formed is -
तीन मोल (moles) $B_2H_6$ की मेथेनाल के साथ सम्पूर्ण अभिक्रिया होती है। बने हुये बोरान अन्तर्विष्ट उत्पाद के मोलों की संख्या है।

**Ans.** 6

**Sol.** $B_2H_6 + 6CH_3OH \longrightarrow 2B(OCH_3)_3 + 6H_2$
For 3 moles of $B_2H_6$ mole of B containing product formed = 6

**22.** The molar conductivity of a solution of a weak acid HX (0.01 M) is 10 times smaller than the molar conductivity of a solution of a weak acid HY (0.1 M). If $\lambda^0_{X^-} \approx \lambda^0_{Y^-}$, the difference in their $pK_a$ values, $pK_a$ (HX) – $pK_a$ (HY), is (consider degree of ionization of both acids to be <<1).
एक दुर्बल अम्ल HX (0.01 M) के विलयन की मोलर चालकता (molar conductivity) एक दूसरे दुर्बल अम्ल HY (0.1 M) के विलयन की मोलर चालकता से 10 गुना कम है। यदि $\lambda^0_{X^-} \approx \lambda^0_{Y^-}$, तब इनके $pK_a$ का अन्तर, $pK_a$ (HX) – $pK_a$ (HY), है (दोनों अम्लों के आयनीकरण की मात्रा (degree of ionization) <<1)

**Ans.** 3

**Sol.** $\lambda^\circ_{X^-} \approx \lambda^\circ_{Y^-}$

$\Rightarrow \lambda^\circ_{H^+} + \lambda^\circ_{X^-} \approx \lambda^\circ_{H^+} + \lambda^\circ_{Y^-} \quad \Rightarrow \lambda^\circ_{HX} \approx \lambda^\circ_{HY} \qquad (1)$

Also $\frac{\lambda_m}{\lambda^\circ_m} = \alpha$, So, $\lambda_m(HX) = \lambda^\circ_m \alpha_1$ and $\lambda_m(HY) = \lambda^\circ_m \alpha_2$

(Where $\alpha_1$ and $\alpha_2$ are degrees of dissociation of HX and HY respectively.)

Now, Given that

$\lambda_m(HY) = 10\lambda_m(HX)$

$\Rightarrow \lambda^\circ_m \alpha_2 = 10 \times \lambda^\circ_m \alpha_1$

$\alpha_2 = 10\ \alpha_1 \qquad (2)$

$K_a = \frac{C\alpha^2}{1-\alpha}$, but $\alpha << 1$, therefore $K_a = C\alpha^2$

$\Rightarrow \frac{K_a(HX)}{K_a(HY)} = \frac{0.01\alpha_1^2}{0.1\alpha_2^2} = \frac{0.01}{0.1} \times \left(\frac{1}{10}\right)^2 = \frac{1}{1000}$

$\Rightarrow \log(K_a(HX)) - \log(K_a(HY)) = -3$

$\Rightarrow pK_a(HX) - pK_a(HY) = 3$

**23.** A closed vessel with rigid walls contains 1 mol of $^{238}_{92}U$ and 1 mol of air at 298 K. Considering complete decay of $^{238}_{92}U$ to $^{206}_{82}Pb$, the ratio of the final pressure to the initial pressure of the system at 298 K is.

एक दृढ दीवारों वाले बंद पात्र में 298 K पर 1 मोल $^{238}_{92}U$ तथा 1 मोल वायु अंतर्विष्ट हैं। यदि $^{238}_{92}U$ का $^{206}_{82}Pb$ में पूर्ण क्षय हो, तब 298 K पर निकाय के अन्तिम दाब तथा प्रांरम्भिक दाब का अनुपात है।

**Ans.** 9

**Sol.** Initial moles of gases = 1

$$^{238}_{92}U \longrightarrow ^{206}_{82}Pb + 8^4_2He + 6_{-1}e^o$$

| | |
|---|---|
| Inital moles | 1 moles |
| Moles after decompostion | 8 moles |

Total gaseous moles after decompostion = 8 + 1 = 9 moles

Ratio of pressures $\frac{P_f}{P_i} = \frac{n_f}{n_i} = 9$

**24.** In dilute aqueous $H_2SO_4$, the complex diaquadioxalatoferrate (II) is oxidized by $MnO_4^-$. For this reaction, the ratio of the rate of change of $\left[H^{\oplus}\right]$ to the rate of change of $[MnO_4^-]$ is :

तनु जलीय $H_2SO_4$ में संकुल डाइऐक्वाडाइऑक्सैलेटोफेरेट (II) (diaquadioxalatoferrate(II)) $MnO_4^-$ द्वारा ऑक्सीकृत होता है। इस अभिक्रिया में $\left[H^{\oplus}\right]$ के परिवर्तन की दर तथा $[MnO_4^-]$ के परिवर्तन की दर का अनुपात है।

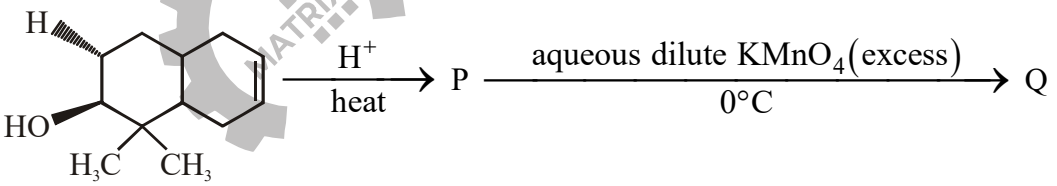
Ans. 8

**Sol.** $$8H^{\oplus} + MnO_4^- + [Fe(H_2O)_2(OX)_2]^{2-} \longrightarrow Mn^{2+} + Fe^{3+} + 4CO_2 + 6H_2O$$

$$\frac{\text{rate of change of } [H^+]}{\text{rate of change of } [MnO_4^-]} = 8$$

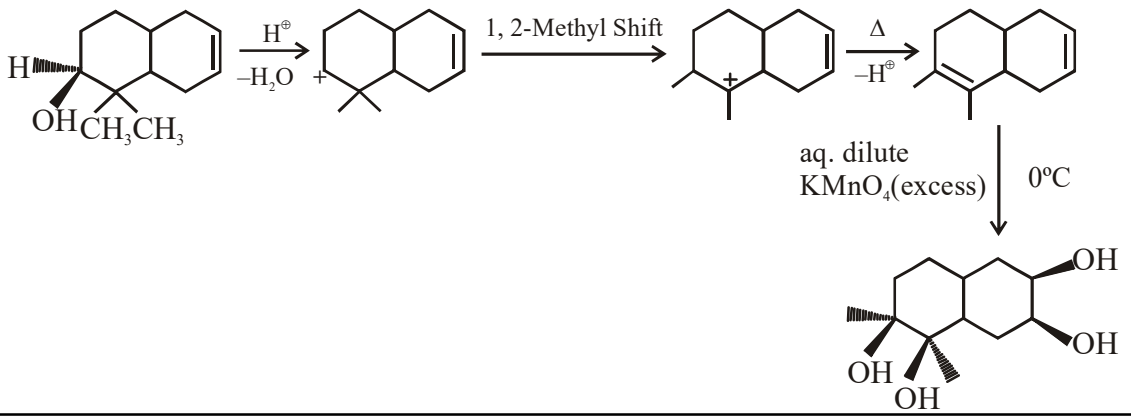
**25.** The number of hydroxyl group (s) in Q is

उत्पाद (product) Q में हाइड्राक्सिल समूह /समूहों (hydroxyl group (s)) की संख्या है।

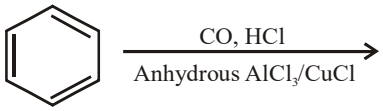


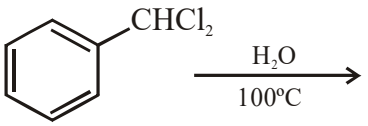

**Ans.** 4

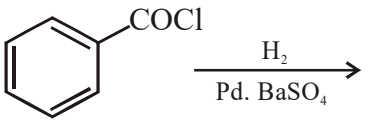
**Sol.**

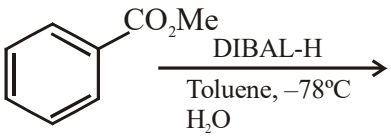


**26.** Among the following the number of reaction (s) that produce(s) benzaldehyde is :
निम्नलिखित में बेन्जाल्डीहाइड (benzaldehyde) का उत्पाद करने वाली अभिक्रिया (अभिक्रियाओं) की संख्या है :

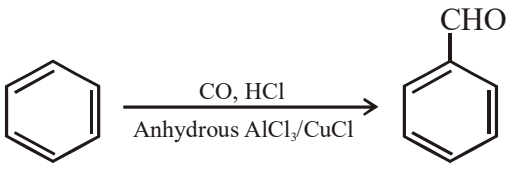
I. 


II. 

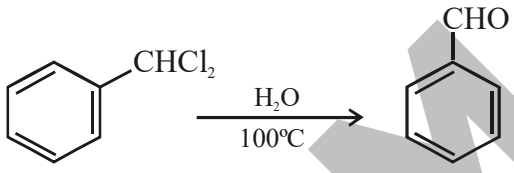

III. 

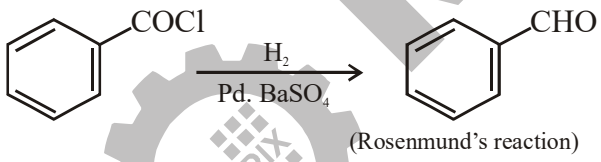

IV. 


**Ans.** 4

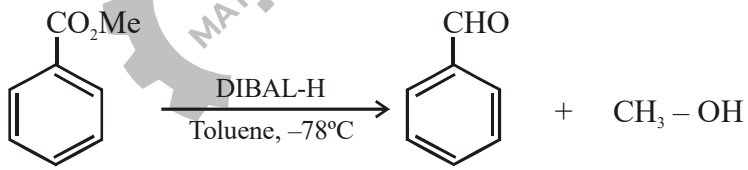
**Sol.** (I) 

(Gattermann Koch reaction)

(II) 


(III) 

(Rosenmund's reaction)

(IV) 

(Partial reduction)

**27.** In the complex acetylbromidodicarbonylbis(triethylphosphine)iron(II), the number of Fe–C bond (s) is :
संकुल (acetylbromidodicarbonylbis(triethylphosphine)iron(II) में Fe–C बंध (बंधों) की संख्या है :

**Ans.** 3

**Sol.** $[Fe(CH_3CO)Br(CO)_2\{P(C_2H_5)_3\}_2]$

$CH_3-\overset{\overset{O}{\|}}{C}^{\ominus}$ Ligand $\longrightarrow$ One Fe–C bond

Co Ligand $\longrightarrow$ two Fe–C bond

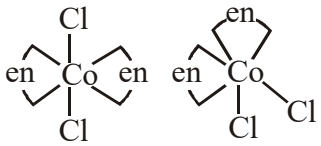
**28.** Among the complex ions, $[Co(NH_2–CH_2–CH_2–NH_2)_2Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$, $[Fe(H_2O)_4(OH)_2]^+$, $[Fe(NH_3)_2(CN)_4]^-$, $[Co(NH_2–CH_2–CH_2–NH_2)_2Cl_2]^{2+}$ and $[Co(NH_3)_4(H_2O)Cl]^{2+}$, the number of complex ions(s) that show (s) *cis-trans* isomerism is :

दिये गये संकुल आयनों, $[Co(NH_2–CH_2–CH_2–NH_2)_2Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$, $[Fe(H_2O)_4(OH)_2]^+$, $[Fe(NH_3)_2(CN)_4]^-$, $[Co(NH_2–CH_2–CH_2–NH_2)_2Cl_2]^{2+}$ तथा $[Co(NH_3)_4(H_2O)Cl]^{2+}$, में संकुल आयन (आयनों) की संख्या जो समपक्ष–विपक्ष *(cis-trans)* समावयवता दर्शाते है (हैं) :

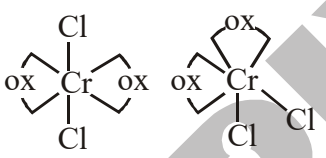
Ans. 6

Sol. All the complexes given show cis-trans isomerism

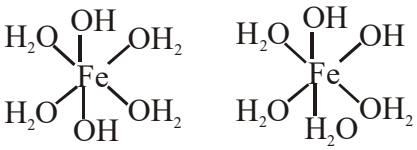
$[Co(NH_2–CH_2–CH_2–NH_2)Cl_2]^+$



$[(CrCl_2(C_2O_4)_2]^{3-}$

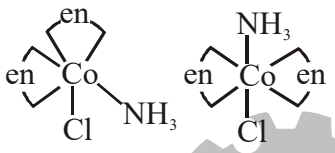


$[Fe(H_2O)_4(OH)_2]^+$

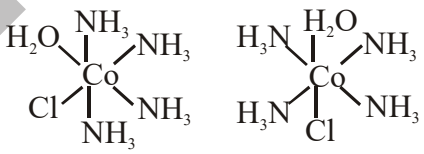


$[Fe(NH_3)_2(CN)_4]^-$

$[Co(NH_2–CH_2–CH_2–NH_2)_2(NH_3)Cl]^{2+}$



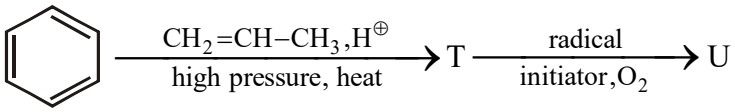
$(CO(NH_3)_4(H_2O)Cl]^{2+}$

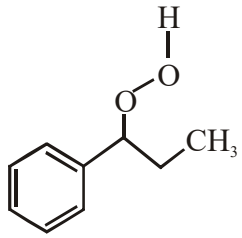


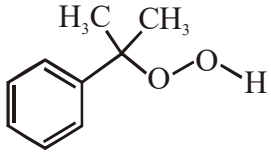
## SECTION-II
## MULTIPLE CORRECT CHOICE TYPE

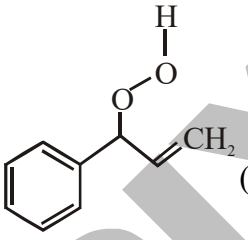
**Q.29 to Q.36 has four choices (A), (B), (C), (D) out of which ONE OR MORE may be correct.**

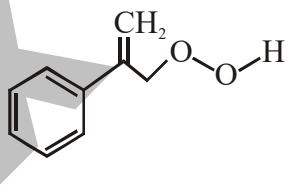
**29.** The major product U in the following reactions is :
निम्नलिखित अभिक्रियाओं में मुख्य उत्पाद U है :

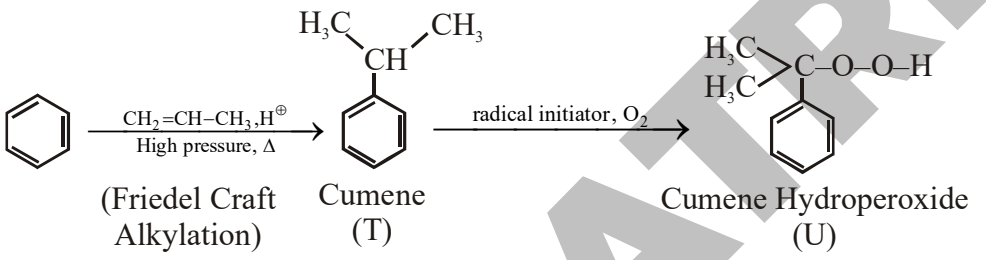



(A) 

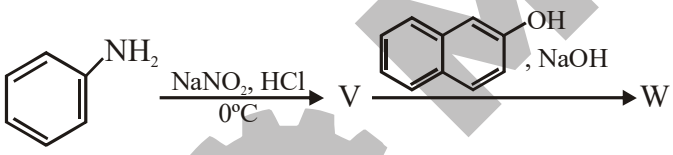
(B*) 

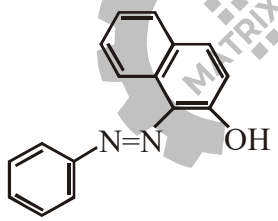
(C) 

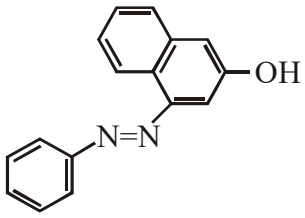
(D) 

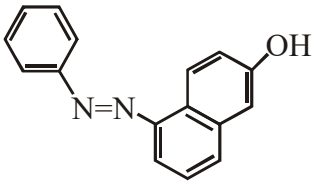
**Sol.** 

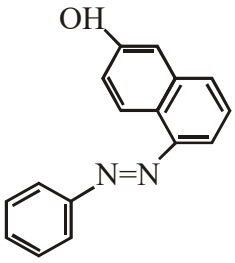

**30.** In the following reactions, the major product W is :
निम्नलिखित अभिक्रियाओं में मुख्य उत्पाद W है :



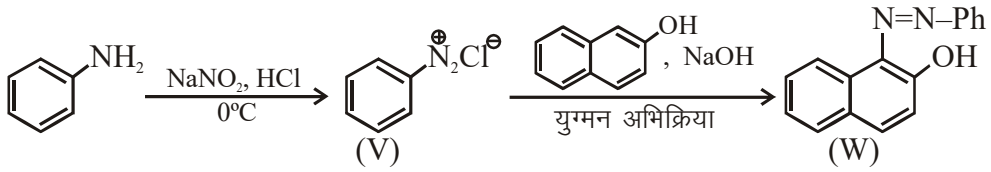

(A*) 

(B) 

(C) 

(D) 

**Sol.**




**31.** The correct statement (s) regarding, (i) HClO, (ii) $HClO_2$, (iii) $HClO_3$ and (iv) $HClO_4$, is(are) :

(A) The number of Cl = O bonds in (ii) and (iii) together is two

(B*) The number of lone pairs of electrons on Cl in (ii) and (iii) together is three

(C*) The hybridization of Cl in (iv) is $sp^3$

(D) Amongst (i) to (iv), the strongest acid is (i)

(i) HClO, (ii) $HClO_2$, (iii) $HClO_3$ तथा (iv) $HClO_4$ के संदर्भ में सही विकल्प/विकल्पों है (हैं) :

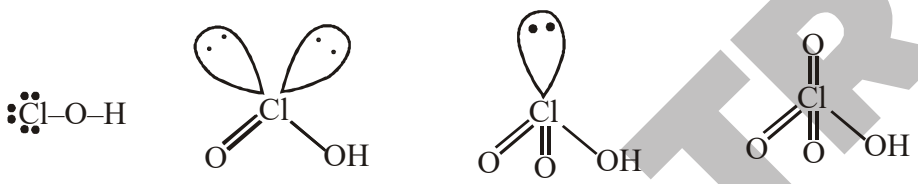
(A) (ii) तथा (iii) में Cl = O बंधों की संख्या जोड़कर दो है।

(B*) (ii) तथा (iii) में Cl पर एकाकी युग्म इलेक्ट्रॉनों (lone pairs of electrons) की संख्या जोडकर तीन है।

(C*) (iv) में Cl का संकरण $sp^3$ है।

(D) (i) से (iv) में सबसे प्रबल अम्ल (i) है।

**Sol.**




(i) (ii) (iii) (iv)

* Number of lone pairs on Cl in (ii) & (iii) together is 3

* Hybridisation of Cl in (iv) is $sp^3$

* Strongest acid is $HClO_4$ (iv)

**32.** The pair (s) of ions where BOTH the ions are precipitated upon passing $H_2S$ gas in presence of dilute HCl, is(are) :

आयन युग्म, जहाँ दोनों आयन तनु HCl की उपस्थिति में $H_2S$ गैस प्रवाहित करने पर अवक्षेपित (precipitate) होते हैं, है (हैं) :

(A) $Ba^{2+}$, $Zn^{2+}$ (B) $Bi^{3+}$, $Fe^{3+}$ (C*) $Cu^{2+}$, $Pb^{2+}$ (D*) $Hg^{2+}$, $Bi^{3+}$

**Sol.** Precipitate is formed on passing $H_2S$ in acidic medium i.e. ion must be of group II.

$Cu^{2+}$, $Pb^{2+}$, $Hg^{2+}$, $Bi^{3+}$

**33.** Under hydrolytic conditions, the compounds used for preparation of linear polymer and for chain termination, respectively, are :

(A) $CH_3SiCl_3$ and $Si(CH_3)_4$ (B*) $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$

(C) $(CH_3)_2SiCl_2$ and $CH_3SiCl_3$ (D) $SiCl_4$ and $(CH_3)_3SiCl$

जल–अपघटनीय अवस्था में, श्रृंखला बहुलक के विरचन (preparation) तथा श्रृंखला समापन के लिए जिन यौगिकों का उपयोग होता है, वह क्रमानुसार, हैं :

(A) $CH_3SiCl_3$ तथा $Si(CH_3)_4$ (B*) $(CH_3)_2SiCl_2$ तथा $(CH_3)_3SiCl$

(C) $(CH_3)_2SiCl_2$ तथा $CH_3SiCl_3$ (D) $SiCl_4$ तथा $(CH_3)_3SiCl$

**Sol.** For linear polymer, we need $R_2SiCl_2$ and for termination, we need $R_3SiCl$.

**34.** When $O_2$ is adsorbed on a metallic surface, electron transfer occurs from the metal to $O_2$. The TRUE. statement (s) regarding this adsorption is (are)

(A) $O_2$ is physisorbed (B*) heat is released

(C*) occupancy of of $\pi^*_{2p}$ of $O_2$ is increased (D*) bond length of $O_2$ is increased

एक धातु पृष्ठ पर $O_2$ का अधिशोषण (adsorption) होने पर धातु से $O_2$ को इलेक्ट्रॉन स्थानान्तरण (electron transfer) होता है। इस अधिशोषण के बारे में सही विकल्प/विकल्पों है (हैं) :

(A) $O_2$ का भौतिक अधिशोषण होता है। (B*) ऊष्मा निकलती है।

(C*) $O_2$ में $\pi^*_{2p}$ का अध्यावास (occupancy) बढता है। (D*) $O_2$ की आबन्ध लम्बाई (bond length) बढ़ती है।

**Sol.** (A) Incorrect : Because electronic transfer takes place and it is chemisorbtion

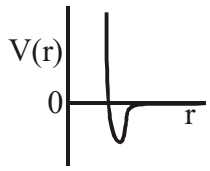
(B) Correct : Adsorbtion is always exothermic

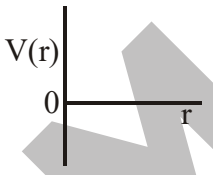
(C) Correct : $O_2$ will accept the electron from metal into its $\pi^*_{2p}$ orbital

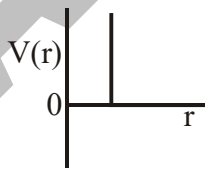
(D) Correct : Since the electron enters into $\pi^*$ orbital bond order decreases and bond length increases

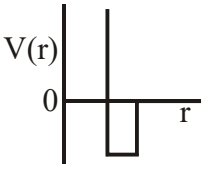
**35.** One mole of a monoatomic real gas satisfied the equation $p(V-b)=RT$ where b is a constant. The relationship of interatomic potential V(r) and interatomic distance r for the gas is given by :

एक मोल एकपरमाणुक वास्तविक गैस समीकरण $p(V-b)=RT$ को सन्तुष्ट करती है, जहाँ b एक नियतांक है। इस गैस के अंतरापरमाणुक (interatomic) विभव (potential) V(r) तथा अन्तरापरमाणुक दूरी r के बीच का सम्बन्ध है :

(A) 

(B) 

(C*) 

(D) 


**Sol.** $P(V-b)=RT$

$\Rightarrow PV-Pb=RT \quad \Rightarrow \quad \frac{PV}{RT}=\frac{Pb}{RT}+1$

$\Rightarrow Z=1+\frac{Pb}{RT}$

Hence $Z>1$ at all pressures.

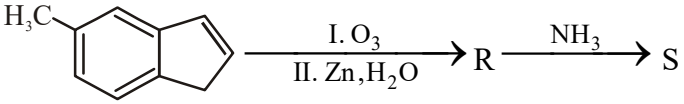
This means , repulsive tendencies will be dominant when interatomic distance are small.

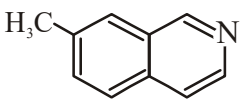
This means, interatomic potential is never negative but becomes positive at small interatomic distances.

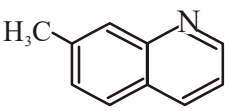
Hence answer is (C)

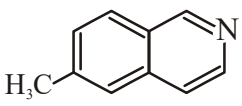
**36.** In the following reactions, the product S is :

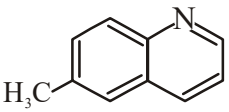
निम्नलिखित अभिक्रियाओं में उत्पाद S है :



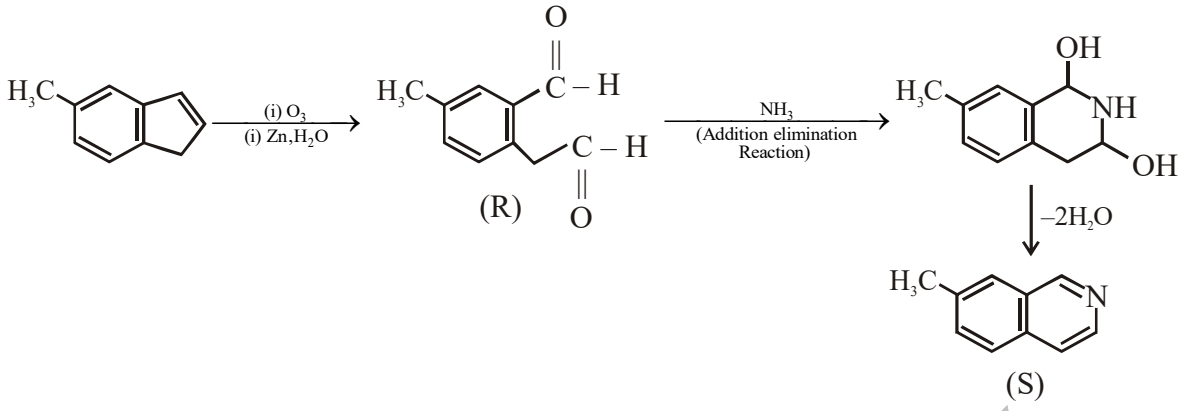

(A*) 

(B) 

(C) 

(D) 

**Sol.**




## SECTION-III
## PARAGRAPH TYPE QUESTIONS

**Q.37 to Q.40 has four choices (A), (B), (C), (D) out of which ONLY ONE is correct.**

## PARAGRAPH-I [37-38]

When 100 mL of 1.0 M HCl was mixed with 100 mL of 1.0 M NaOH in an insulated beaker at constant pressure, a temperature increase of 5.7°C was measured for the beaker and its contents. (**Expt - 1**). Because the enthalpy of neutralisation of a strong acid with a strong base is a constant (–57.0 kJ $mol^{-1}$), this experiment could be used to measure the calorimeter constant. In a second experiment (**Expt-2**), 100 mL of 2.0 M acetic acid ($K_a = 2.0\times10^{-5}$) was mixed with 100 mL of 1.0 M NaOH (under identical conditions to (Expt - 1)) where a temperature rise of 5.6°C was measured.

(Consider heat capacity of all solutions as 4.2 $Jg^{-1} K^{-1}$ and density of all solutions as 1.0 g $mL^{-1}$)

स्थिर दाब पर एक ऊष्मारोधी बीकर (insulated beaker) में 100 mL HCl (1.0 M) को 100 mL NaOH (1.0 M) के साथ मिश्रित करने पर बीकर तथा उसकी अन्तर्वस्तुओं का तापमान 5.7 ºC बढ़ जाता है (प्रयोग 1) । प्रबल अम्ल के साथ प्रबल क्षारक की उदासीनीकरण (neutralization) ऐन्थैल्पी एक नियतांक (–57.0 kJ $mol^{-1}$) होने के कारण इस प्रयोग का उपयोग कैलोरीमीटर स्थिरांक (calorimeter constant) को मापने में किया जा सकता है। एक दूसरे प्रयोग **(प्रयोग 2)** में 100 mL ऐसीटिक अम्ल (2.0 M, $K_a = 2.0\times10^{-5}$) को 100 mL NaOH (1.0 M) के साथ मिश्रित करने पर (प्रयोग 1 की समरूप अवस्था में) 5.6°C तापमान वृद्धि मापित की गयी।

(सभी विलयनों की ऊष्मा धारिता 4.2 $Jg^{-1} K^{-1}$ तथा सभी विलयनों का घनत्व 1.0 g $mL^{-1}$ है)

**37.** Enthalpy of dissociation (in kJ $mol^{-1}$) of acetic acid obtained from the **Expt-2** is :

प्रयोग 2 से प्राप्त ऐसीटिक अम्ल की वियोजन ऐन्थैल्पी (dissociation enthalpy) (in kJ $mol^{-1}$ में) है :

(A*) 1.0 (B) 10.0 (C) 24.5 (D) 51.4

**Sol.** Let the heat capacity of insulated beaker be C.

Mass of aqueous content in expt. 1 = (100 + 100) × 1

= 200 g

$\Rightarrow$ Total heat capacity = (C + 200 × 4.2) J/K

Moles of acid, base neutralised in expt. 1 = 0.1 × 1 = 0.1

$\Rightarrow$ Heat released in expt. 1 = 0.1 × 57 = 5.7 KJ

$\Rightarrow$ 5.7 × 1000 = (C + 200 × 4.2) × $\Delta$T.

5.7 × 1000 = (C + 200 + 4.2) × 5.7

$\Rightarrow (C + 200 \times 4.2) = 1000$

In second experiment,

$n_{CH_3COOH} = 0.2,\ n_{NaOH} = 0.1$

Total mass of aqueous content = 200 g

$\Rightarrow$ Total heat capacity = $(C + 200 \times 4.2) = 1000$

$\Rightarrow$ Heat released = $1000 \times 5.6 = 5600$ J.

Overall, only 0.1 mol of $CH_3COOH$ undergo neutralization.

$$\Rightarrow \Delta H_{neutralization} \text{ of } CH_3COOH = \frac{-5600}{0.1} = -56000 \text{ J/mol} = -56 \text{ KJ/mol}$$

$$\Rightarrow \Delta H_{Ionization} \text{ of } CH_3COOH = 57 - 56 = 1 \text{ KJ/mol}$$

**38.** The pH of the solution after **Expt-2**

प्रयोग 2 के पश्चात विलयन का pH है –

(A) 2.8 (B*) 4.7 (C) 5.0 (D) 7.0

Sol. Final solution contain 0.1 mole of $CH_3COOH$ and $CH_3COONa$ each.

Hence it is a buffer solution.

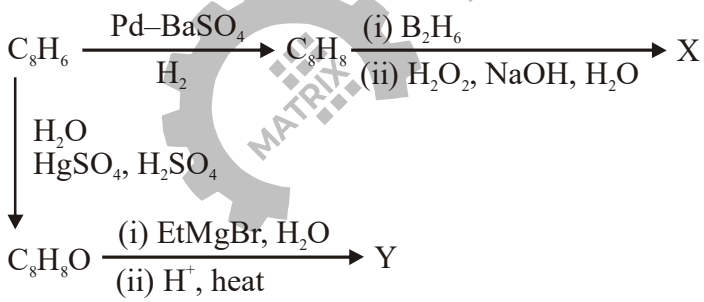
$$pH = pK_a + \log\frac{[CH_3COO^-]}{[CH_3COOH]}$$

$$= 5 - \log 2 + \log\frac{0.1}{0.1} = 4.7$$

## PARAGRAPH-II [39-40]

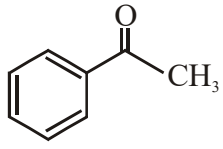
In the following reaction:

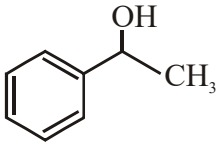
निम्नलिखित अभिक्रियाओं में

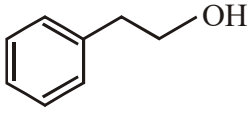


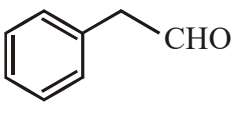

**39.** Compound X is

यौगिक X है :

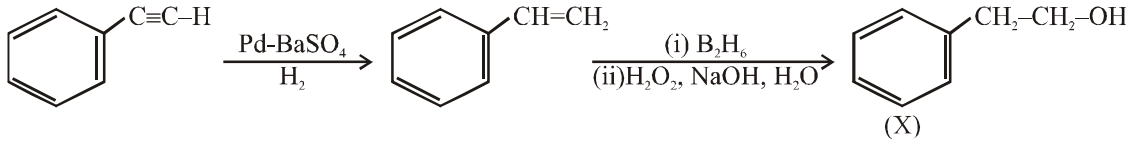
(A) 

(B) 

(C*) 

(D) 

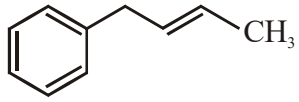
**Sol.**

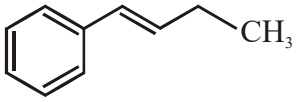


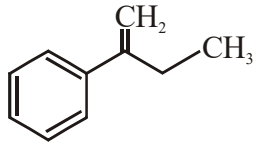

(X)

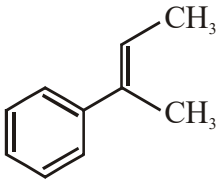
**40.** The major compound Y is :

मुख्य यौगिक Y है :

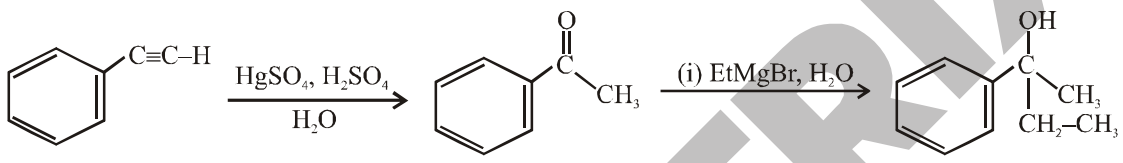
(A) 

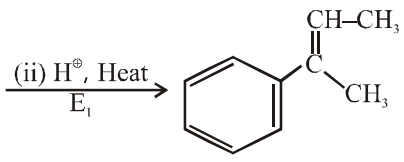

(B) 


(C) 


(D*) 


**Sol.**




(Y)