JEE Main 2017 Chemistry Paper With Solutions (April 2)

Question 1: Given $C_{(graphite)} + O_2 (g) \rightarrow CO_2 (g)$;
$\Delta_r H^o = -393.5$ kJ mol^{-1}
$H_2 (g) + [1 / 2] O_2 (g) \rightarrow H_2O (l)$;
$\Delta_r H^o = -285.8$ kJ mol^{-1}
$CO_2 (g) + 2H_2O(l) \rightarrow CH_4 (g) + 2O_2 (g)$;
$\Delta_r H^o = +890.3$ kJ mol^{-1}
Based on the above thermochemical equations, the value of $\Delta_r H^o$ at 298 K for the reaction $C_{(graphite)} + 2H_2 (g) \rightarrow CH_4 (g)$ will be :

(1) -74.8 kJ mol^{-1}
(2) -144.0 kJ mol^{-1}
(3) $+74.8$ kJ mol^{-1}
(4) $+144.0$ kJ mol^{-1}

Solution: (1)
$C_{(graphite)} + O_2 (g) \rightarrow CO_2 (g)$;
$\Delta_r H^o = -393.5$ kJ mol^{-1} ...(i)
$H_2 (g) + [1 / 2] O_2 (g) \rightarrow H_2O (l)$;
$\Delta_r H^o = -285.8$ kJ mol^{-1} …. (ii)
$CO_2 (g) + 2H_2O(l) \rightarrow CH_4 (g) + 2O_2 (g)$;
$\Delta_r H^o = +890.3$ kJ mol^{-1} … (iii)
By applying the operation (i) + 2 × (ii) + (iii), we get
$C_{(graphite)} + 2H_2(g) \rightarrow CH_4(g)$;
$\Delta_r H^o = -393.5 - 285.8 \times 2 + 890.3$
$= -74.8$ kJ mol^{-1}

Question 2: 1 gram of a carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 moles of CO_2. The molar mass of M_2CO_3 in g mol^{-1} is :

(1) 118.6
(2) 11.86
(3) 1186
(4) 84.3

Solution: (4)

$M_2CO_3 + 2HCl \rightarrow 2MCl + H_2O + CO_2$

$$n_{M_2CO_3} = n_{CO_2}$$

$$\frac{1}{M_{M_2CO_3}} = 0.01186$$

$$M_{M_2CO_3} = \frac{1}{0.01186}$$

= 84.3 g/mol

Question 3: ΔU is equal to :

(1) Adiabatic work
(2) Isothermal work
(3) Isochoric work
(4) Isobaric work

Solution: (1)

For adiabatic process, q = 0
As per 1st law of thermodynamics, $\Delta U = W$.

Question 4: The Tyndall effect is observed only when the following conditions are satisfied :

(a) The diameter of the dispersed particles is much smaller than the wavelength of the light used.
(b) The diameter of the dispersed particle is not much smaller than the wavelength of the light used.
(c) The refractive indices of the dispersed phase and dispersion medium are almost similar in magnitude.
(d) The refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude.

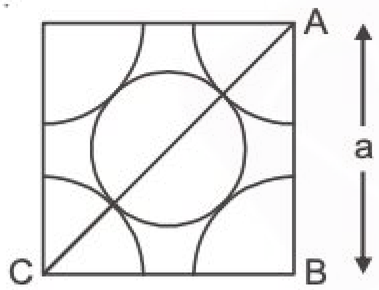
(1) (a) and (c)
(2) (b) and (c)
(3) (a) and (d)
(4) (b) and (d)

Solution: For Tyndall effect refractive index of dispersion phase and dispersion medium must differ significantly. Secondly, the size of the dispersed phase should not differ much from the wavelength used.

Question 5: A metal crystallises in a face centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be :

(1) $\sqrt{2}$ a
(2) a/$\sqrt{2}$
(3) 2a
(4) 2$\sqrt{2}$ a

Solution: (2)
In FCC, one of the faces is like



By △ABC,
$2a^2 = 16r^2$
$r^2 = (1 / 8) a^2$
$r = 1 / 2\sqrt{2}$ a
Distance of closest approach = 2r = a / $\sqrt{2}$

Question 6: Given

$E^\circ_{Cl_2/Cl^-} = 1.36\ V,\ E^\circ_{Cr^{3+}/Cr} = -0.74\ V$

$E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\ V,\ E^\circ_{MnO_4^-/Mn^{2+}} = 1.51\ V$.

Among the following, the strongest reducing agent is:

(1) Cr^{3+}
(2) Cl^-
(3) Cr
(4) Mn^{2+}

Solution: (3)

For Cr^{3+}, $E^\circ_{Cr^{3+}/Cr_2O_7^{2-}} = -1.33\ V$

For Cl^-, $E^\circ_{Cl^-/Cl_2} = -1.36\ V$

For Cr, $E^\circ_{Cr/Cr^{3+}} = 0.74\ V$

For Mn^{2+}, $E^\circ_{Mn^{2+}/MnO_4^-} = -1.51\ V$

Positive E° is for Cr, hence it is the strongest reducing agent.

Question 7: The freezing point of benzene decreases by 0.45°C when 0.2 g of acetic acid is added to 20 g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be : (K_f for benzene = 5.12 K kg mol^{-1})

(1) 74.6%
(2) 94.6%
(3) 64.6%
(4) 80.4%

Solution: (2)

0.45 = i (5.12) [(0.2 / 60) / 20] * 1000
i = 0.527

$2CH_3\,COOH \rightleftharpoons [CH_3\,COOH]_2$

$(1 - \alpha) \qquad\qquad \alpha / 2$

$i = (1 - \alpha) / 2$

$0.527 = 1 - (\alpha / 2)$

$\alpha / 2 = 0.473$

$\alpha = 0.946$

% association = 94.6%

Question 8: The radius of the second Bohr orbit for the hydrogen atom is : (Planck's Constant. $h = 6.6262 \times 10^{-34}$ Js; the mass of electron = 9.1091×10^{-31} kg; charge of electron $e = 1.60210 \times 10^{-19}$ C; permittivity of vacuum $\varepsilon_0 = 8.854185 \times 10^{-12}\ kg^{-1}m^{-3}A^2$)

(1) 0.529 Å

(2) 2.12 Å

(3) 1.65 Å

(4) 4.76 Å

Solution: (2)

$r = a_0\,(n^2 / Z)$

$= 0.529 \times 4$

$= 2.12$ Å

Question 9: Two reactions R_1 and R_2 have identical pre-exponential factors. The activation energy of R_1 exceeds that of R_2 by 10 kJ mol^{-1}. If k_1 and k_2 are rate constants for reactions R_1 and R_2 respectively at 300 K, then $\ln (k_2/k_1)$ is equal to ($R = 8.314$ J $mol^{-1}K^{-1}$)

(1) 6

(2) 4

(3) 8

(4) 12

Solution: (2)

$$k_1 = Ae^{-E_{a_1}/RT}$$

$$k_2 = Ae^{-E_{a_2}/RT}$$

$$\frac{k_2}{k_1} = e^{\frac{1}{RT}(E_{a_1} - E_{a_2})}$$

$$\ln\frac{k_2}{k_1} = \frac{E_{a_1} - E_{a_2}}{RT}$$

$$= \frac{10 \times 10^3}{8.314 \times 300} \approx 4$$

Question 10: pK_a of a weak acid (HA) and pK_b of a weak base (BOH) are 3.2 and 3.4, respectively. The pH of their salt (AB) solution is :

(1) 7.0
(2) 1.0
(3) 7.2
(4) 6.9

Solution: (4)
$pH = 7 + [(1 / 2) (pK_a - pK_b)]$
$= 7 + (1 / 2) [3.2 - 3.4]$
$= 6.9$

Question 11: Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect, is :

(1) both form nitrides
(2) nitrates of both Li and Mg yield NO_2 and O_2 on heating
(3) both form basic carbonates

(4) both form soluble bicarbonates

Solution: (3)
Mg forms basic carbonate $3MgCO_3 \cdot Mg(OH)_2 \cdot 3H_2O$ but no such basic carbonate is formed by Li.

Question 12: Which of the following species is not paramagnetic?

(1) O_2
(2) B_2
(3) NO
(4) CO

Solution: (4)
CO has 14 electrons (even) $\therefore$ it is diamagnetic.
NO has $15e^-$ (odd) $\therefore$ it is paramagnetic and has 1 unpaired electron in $\pi * 2p$ molecular orbital.
B_2 has $10e^-$ (even) but still paramagnetic and has two unpaired electrons in $\pi * 2p_x$ and $\pi * 2p_y$ (s-p mixing).
O_2 has 16 e^- (even) but still paramagnetic and has two unpaired electrons in $\pi * 2p_x$ and $\pi * 2p_y$ molecular orbitals.

Question 13: Which of the following reactions is an example of a redox reaction?

(1) $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$
(2) $XeF_6 + 2H_2O \rightarrow XeO_2 F_2 + 4HF$
(3) $XeF_4 + O_2 F_2 \rightarrow XeF_6 + O_2$
(4) $XeF_2 + PF_5 \rightarrow [XeF]^+ PF6^-$

Solution: (3)
Xe is oxidised from +4 (in XeF_4) to +6 (in XeF_6)
Oxygen is reduced from +1 (in O_2F_2) to zero (in O_2)

Question 14: A water sample has ppm level concentration of following anions
$F^- = 10$; $SO^{2-}{}_4 = 100$; $NO_3^- = 50$

The anion/anions that make/makes the water sample unsuitable for drinking is/ are :

(1) only F^-
(2) only $SO^{2-}{}_4$
(3) only NO_3^-
(4) both $SO^{2-}{}_4$ and NO_3^-

Solution: (1)
The permissible limit of F^- in drinking water is up to 1 ppm.
Excess concentration of $F^- > 10$ ppm causes decay of bones.

Question 15: The group having isoelectronic species is :

(1) $O2^-$, F^-, Na, Mg^{2+}
(2) O^-, F^-, Na^+, Mg^{2+}
(3) O^{2-}, F^-, Na^+, Mg^{2+}
(4) O^-, F^-, Na, Mg^+

Solution: (3)
Mg^{2+}, Na^+, O^{2-} and F^- all have 10 electrons each.

Question 16: The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are :

(1) Cl^- and ClO^-
(2) Cl^- and ClO_2^-
(3) ClO^- and ClO_3^-
(4) ClO_2^- and ClO_3

Solution: (1)

$$Cl_2 + \underset{\text{Cold \& dilute}}{2NaOH} \longrightarrow NaCl + \underset{\text{Sodium hypochlorite}}{NaOCl} + H_2O$$

Question 17: In the following reactions, ZnO is respectively acting as a/an :
(a) $ZnO + Na_2O \rightarrow Na_2ZnO_2$
(b) $ZnO + CO_2 \rightarrow ZnCO_3$

(1) acid and acid
(2) acid and base
(3) base and acid
(4) base and base

Solution: (2)
In (a), ZnO acts as acidic oxide as Na_2O is a basic oxide.
In (b), ZnO acts as basic oxide as CO_2 is an acidic oxide.

Question 18: Sodium salt of an organic acid 'X' produces effervescence with conc. H_2SO_4. 'X' reacts with the acidified aqueous $CaCl_2$ solution to give a white precipitate which decolourises the acidic solution of $KMnO_4$. 'X' is :

(1) CH_3COONa
(2) $Na_2C_2O_4$
(3) C_6H_5COONa
(4) HCOONa

Solution: (2)

$$\underset{(X)}{Na_2C_2O_4} + \underset{Conc.}{H_2SO_4} \longrightarrow Na_2SO_4 + \underset{\text{oxalic acid}}{H_2C_2O_4}$$

$$H_2C_2O_4 \xrightarrow[\Delta,\ -H_2O]{\text{Conc. } H_2SO_4} \underbrace{CO\uparrow + CO_2\uparrow}_{\text{(effervescence)}}$$

$$\underset{(X)}{Na_2C_2O_4} + CaCl_2 \longrightarrow \underset{\text{white ppt.}}{CaC_2O_4\downarrow} + 2NaCl$$

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

Question 19: The most abundant elements by mass in the body of a healthy human adult are: Oxygen (61.4%); Carbon (22.9%), Hydrogen (10.0%); and Nitrogen (2.6%). The weight which a 75 kg person would gain if all ^1H atoms are replaced by ^2H atoms is :

(1) 7.5 kg
(2) 10 kg
(3) 15 kg
(4) 37.5 kg

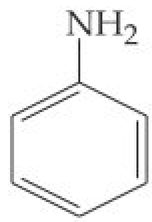
Solution: (1)
Mass of hydrogen = (10/100) * 75 = 7.5 kg
Replacing ^1H by ^2H would replace 7.5 kg with 15 kg.
Net gain = 7.5 kg

Question 20: On treatment of 100 mL of 0.1 M solution of $CoCl_3.6H_2O$ with excess $AgNO_3$; 1.2×10^{22} ions are precipitated. The complex is :

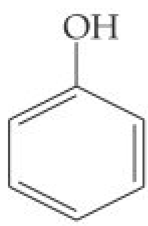
(1) $[Co(H_2O)_6]Cl_3$
(2) $[Co(H_2O)_5Cl]Cl_2.H_2O$
(3) $[Co(H_2O)_4Cl_2]Cl.2H_2O$
(4) $[Co(H_2O)_3Cl_3].3H_2O$

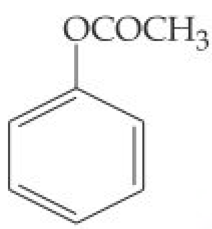
Solution: (2)
Millimoles of $AgNO_3 = [(1.2 \text{ x } 10^{22}) / (6 * 10^{23})] * 1000 = 20$
Millimoles of $CoCl_3.6H_2O = 0.1 \times 100 = 10$
Each mole of $CoCl_3.6H_2O$ gives two chloride ions.
$[Co(H_2O)_5Cl]Cl_2.H_2O$

Question 21: Which of the following compounds will form a significant amount of *meta* product during the mono-nitration reaction?

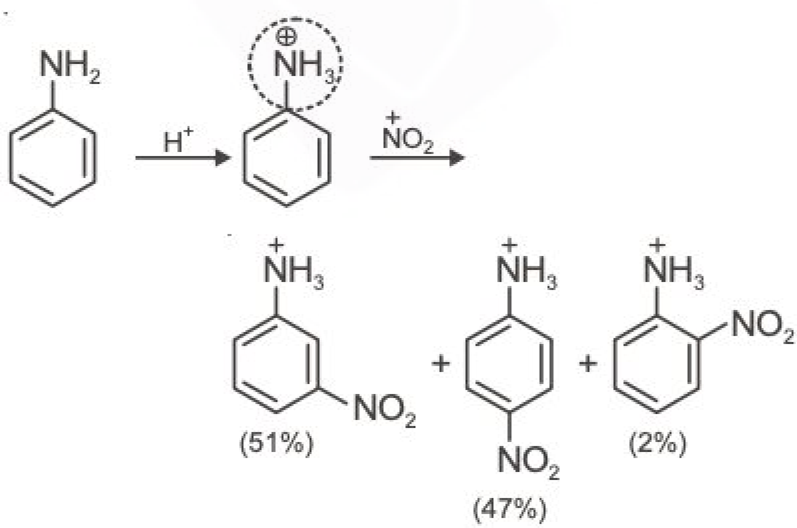
(1) 

(2) 

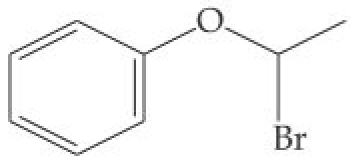
(3) 

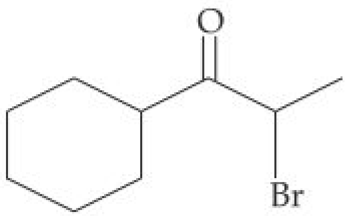
(4) 

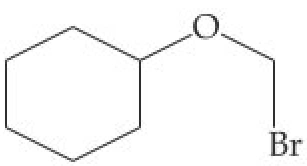
Solution: (1)

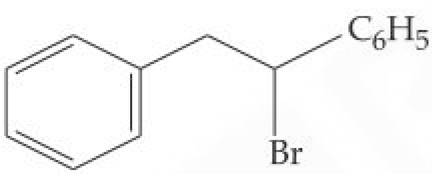


Question 22: Which of the following, upon treatment with *tert*-BuONa followed by addition of bromine water, fails to decolourize the colour of bromine?

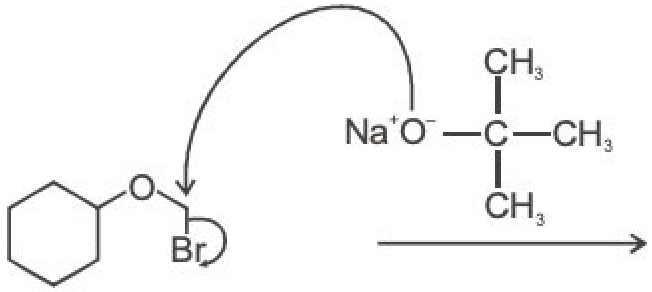
(1) 

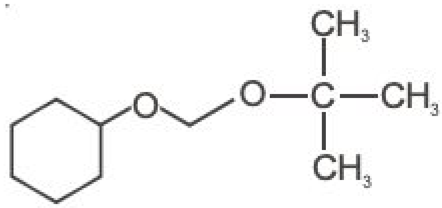
(2) 

(3) 

(4) 

Solution: (3)



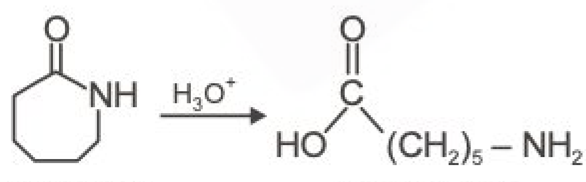


(Product)

Question 23: The formation of which of the following polymers involves hydrolysis reaction?

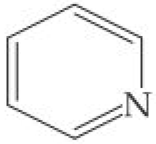
(1) Nylon 6, 6
(2) Terylene
(3) Nylon 6
(4) Bakelite

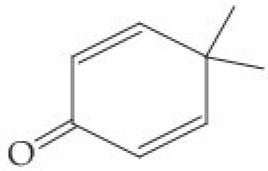
Solution: (3)
Caprolactam is hydrolysed to produce caproic acid which undergoes condensation to produce Nylon-6.

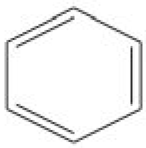


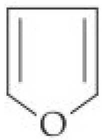
(Caprolactam) (Caproic acid)

Question 24: Which of the following molecules is the least resonance stabilized?

(1) 

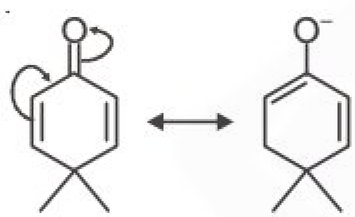
(2) 

(3) 

(4) 

Solution: (2)

However, all molecules given in options are stabilised by resonance but compound given in option (2) is least resonance stabilised (other three are aromatic)



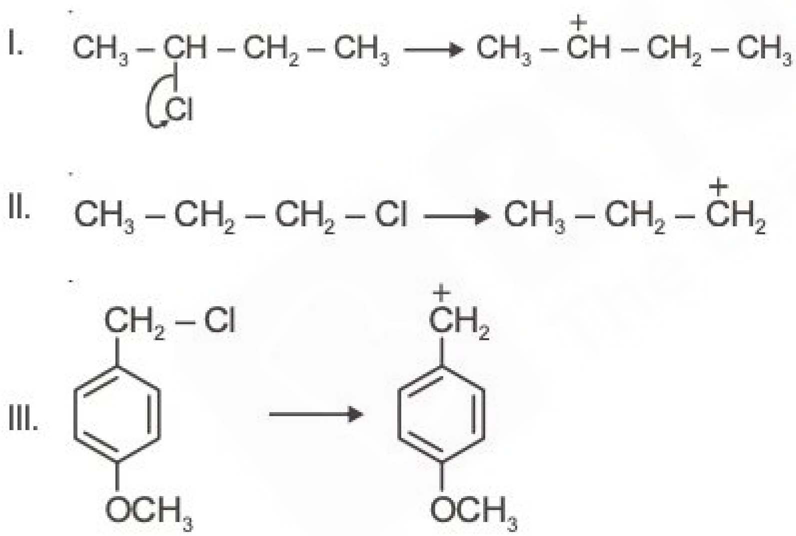
Question 25: The increasing order of the reactivity of the following halides for the S_N1 reaction is :

$CH_3CHClCH_2CH_3$ (I) $CH_3CH_2CH_2Cl$ (II)

$p-H_3CO-C_6H_4-CH_2Cl$ (III)

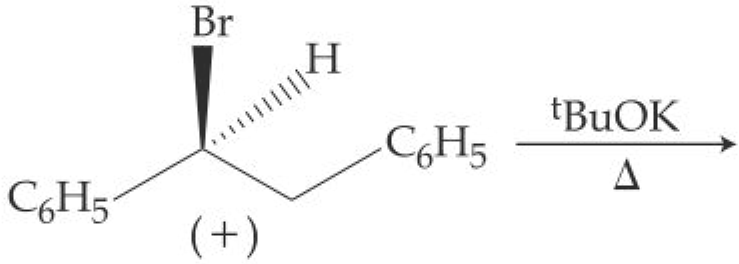
(1) (I) < (III) < (II)
(2) (II) < (III) < (I)
(3) (III) < (II) < (I)
(4) (II) < (I) < (III)

Solution: (4)
Rate of S_N1 reaction ∝ stability of carbocation



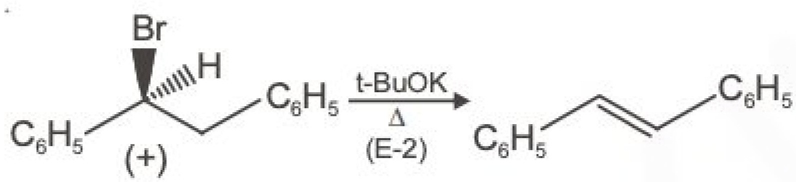
So, II < I < III
Increase in the stability of carbocation and hence increase the reactivity of halides.

Question 26: The major product obtained in the following reaction is:



(1) (+) $C_6H_5CH(O^tBu)CH_2C_6H_5$
(2) (−) $C_6H_5CH(O^tBu)CH_2C_6H_5$
(3) (±) $C_6H_5CH(O^tBu)CH_2C_6H_5$
(4) $C_6H_5CH = CHC_6H_5$

Solution: (4)



Question 27: Which of the following compounds will behave as reducing sugar in an aqueous KOH solution?

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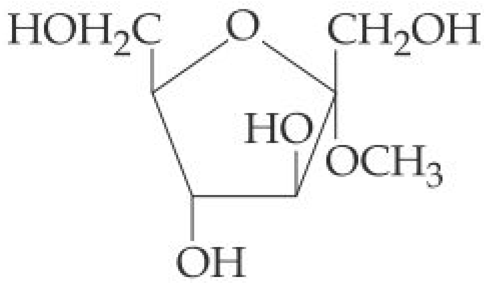
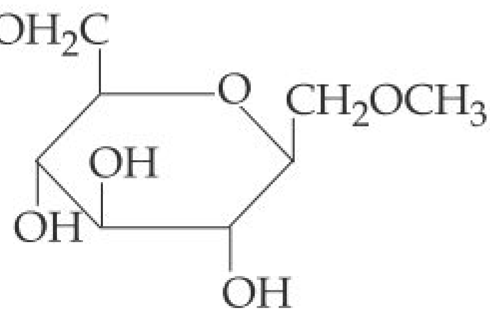
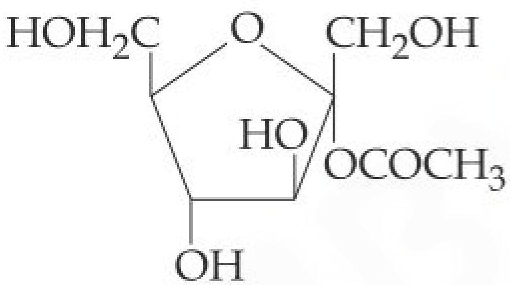
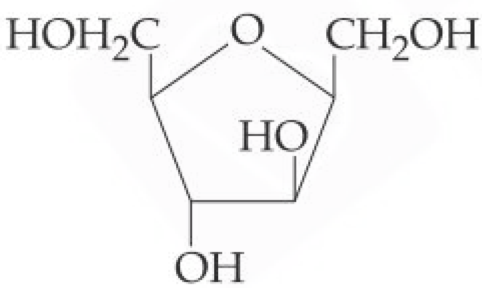


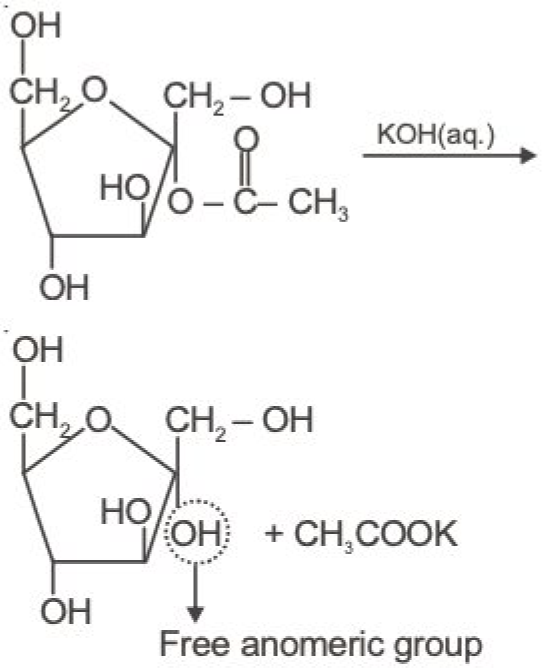
(2)


(3)


(4)


Solution: (3)

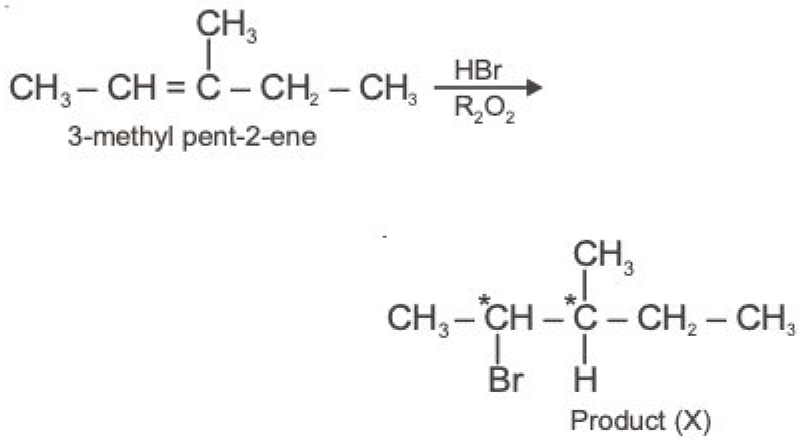
Sugars in which there is free anomeric –OH group are reducing sugars.



Question 28: 3-Methyl-pent-2-ene on reaction with HBr in presence of peroxide forms an addition product. The number of possible stereoisomers for the product is :

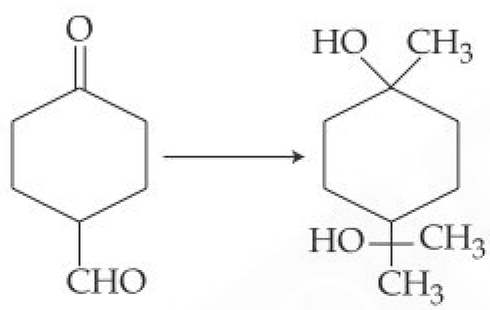
(1) Two
(2) Four
(3) Six
(4) Zero

Solution: (2)



Since the product (X) contains two chiral centres and it is unsymmetrical.
So, its total stereoisomers = $2^2 = 4$.

Question 29: The correct sequence of reagents for the following conversion will be :



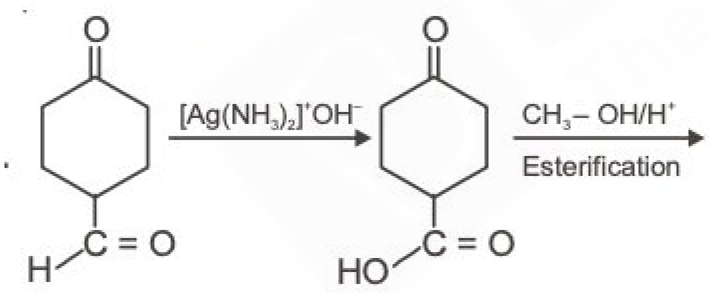
(1) CH_3MgBr, $[Ag(NH_3)_2]^+OH^-$, H^+/CH_3OH

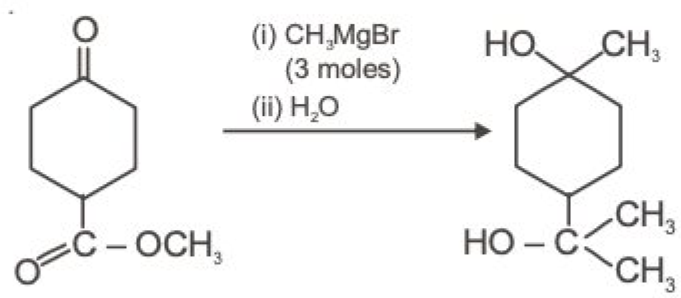
(2) $[Ag(NH_3)_2]^+OH^-$, CH_3MgBr, H^+/CH_3OH

(3) $[Ag(NH_3)_2]^+OH^-$, H^+/CH_3OH, CH_3MgBr

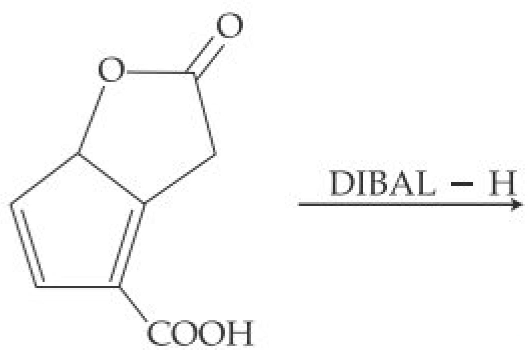
(4) CH_3MgBr, H^+/CH_3OH, $[Ag(NH_3)_2]^+OH^-$

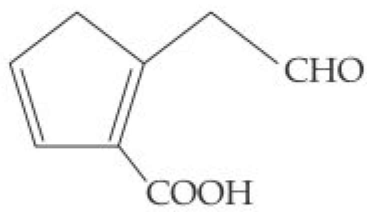
Solution: (3)

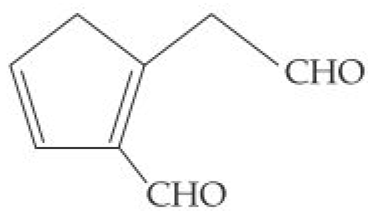


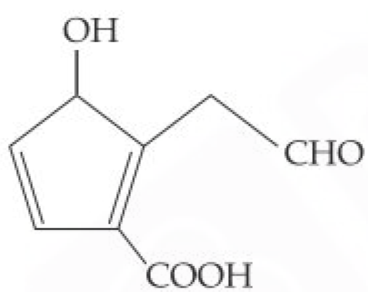


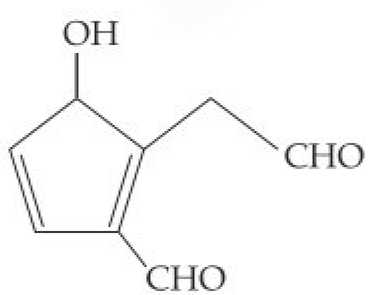
Question 30: The major product obtained in the following reaction is :



(1) 

(2) 

(3) 

(4) 

Solution: (4)

DIBAL — H reduces esters and carboxylic acids into aldehydes