PRACTICE PAPERS 2020

www.mtg.in | May 2020 | Pages 64 | ₹40

NEET | JEE ADVANCED | BITSAT

CHEMISTRY today

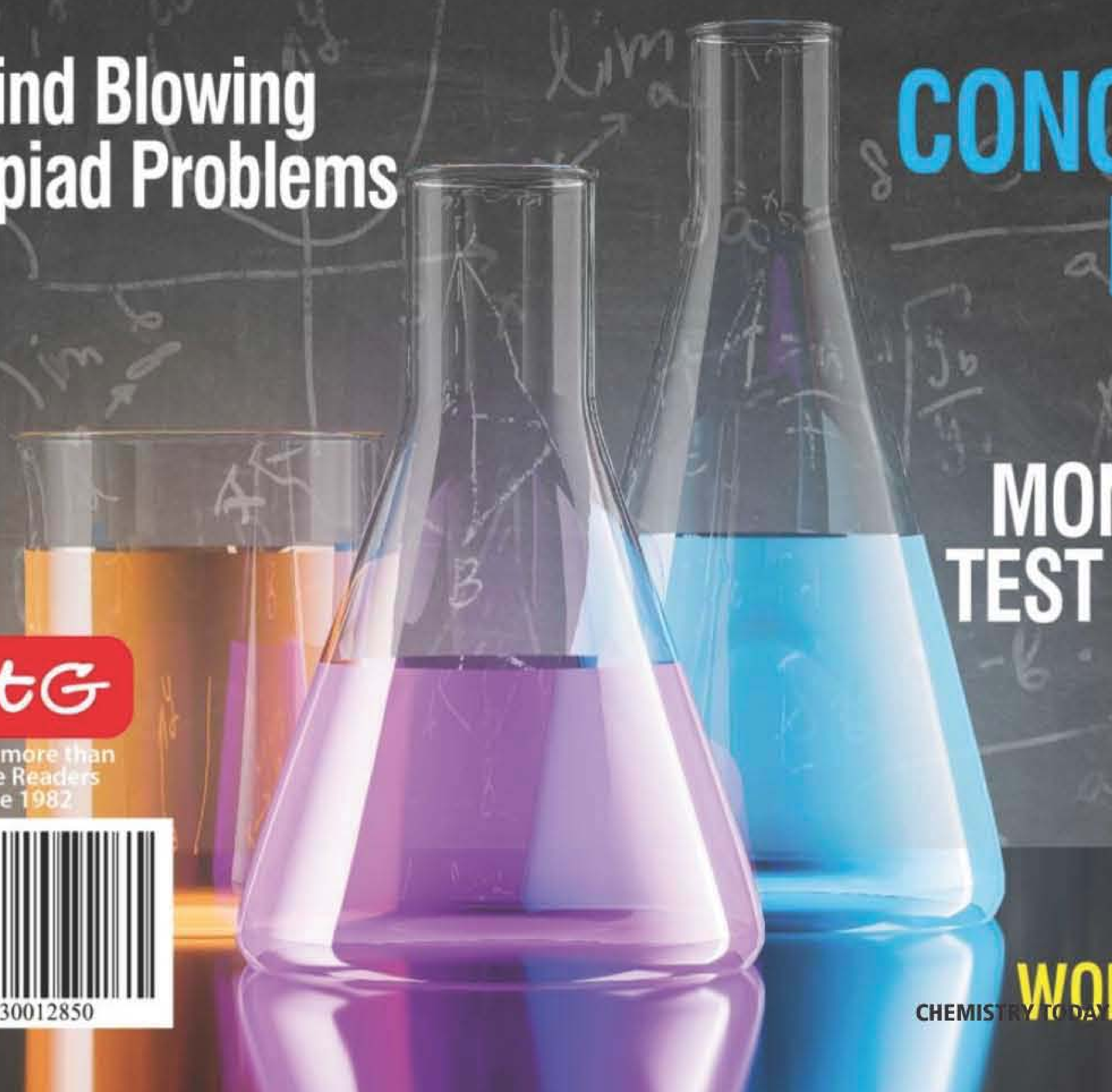
India's #1 CHEMISTRY MONTHLY FOR JEE (Main & Advanced) & NEET

Get Set Go for NEET | JEE

GEAR UP FOR JEE MAIN

10 Mind Blowing Olympiad Problems

CONCEPT MAP



MONTHLY TEST DRIVE CLASS XI-XII

mtG

Trust of more than 1 Crore Readers Since 1982

2020030012850

JEE WORKOUTS

CHEMISTRY today

Volume 29 No. 5 May 2020

Managing Editor
Mahabir Singh
Editor
Anil Ahlawat

Corporate Office:
Plot 99, Sector 44 Institutional area, Gurugram -122 003 (HR).
Tel : 0124-6601200 e-mail : info@mtg.in website : www.mtg.in
Regd. Office:
406, Taj Apartment, Near Safdarjung Hospital, New Delhi - 110029.

CONTENTS

Competition Edge

Printed and Published by Mahabir Singh on behalf of MTG Learning Media Pvt. Ltd. Printed at HT Media Ltd., B-2, Sector-63, Noida, UP-201307 and published at 406, Taj Apartment, Ring Road, Near Safdarjung Hospital, New Delhi - 110029.
Editor : Anil Ahlawat

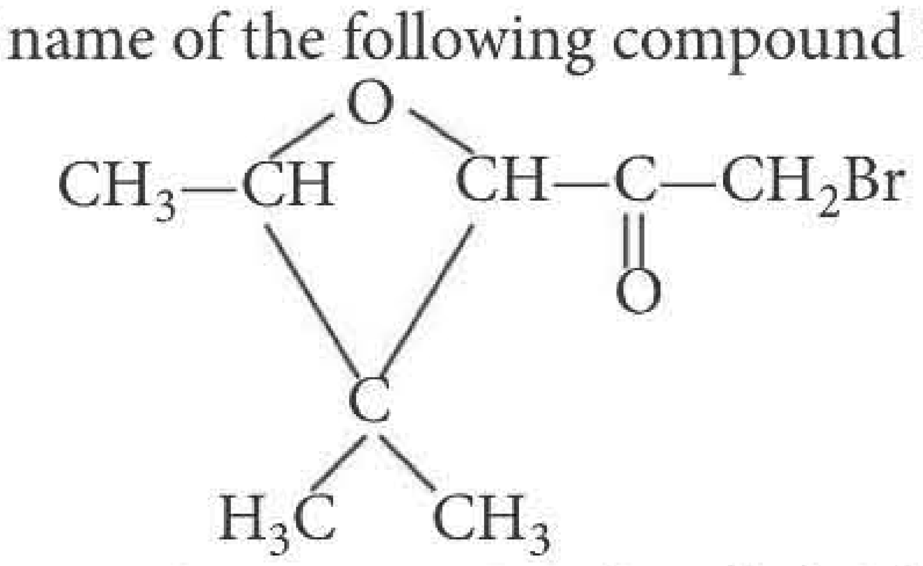
GET SET GO *for* NEET

with exclusive and brain storming MCQs

Practicing these MCQs help to strengthen your concepts and give you extra edge in your NEET preparation

1. *A* is binary compound of an univalent metal. 1.422 g of *A* reacts completely with 0.321 g of sulphur in an evacuated and sealed tube to give 1.743 g of a white crystalline solid (*B*) that formed a hydrated double salt (*C*) with $Al_2(SO_4)_3$. *A* and *B* are respectively
(a) KO_2, K_2SO_4 (b) NaO_2, Na_2SO_4
(c) K_2O, K_2SO_4 (d) Na_2O, Na_2SO_4

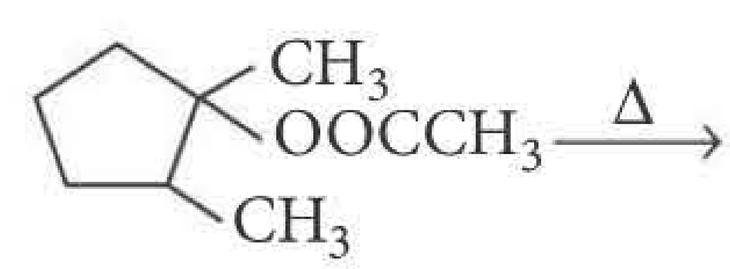
2. IUPAC name of the following compound is

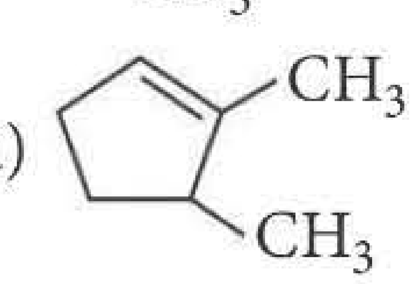
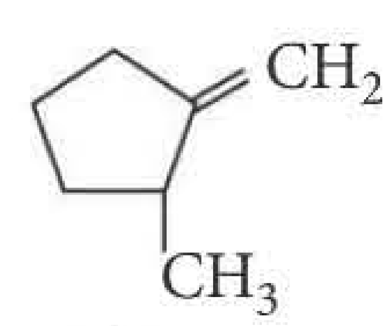
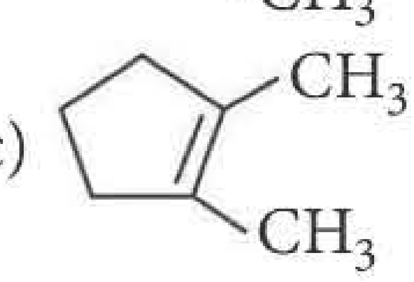
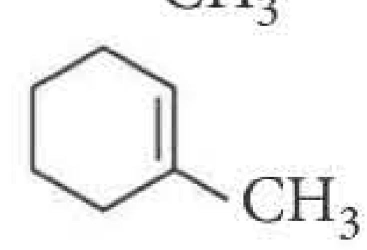


(a) 1-bromo-3, 5-epoxy-4, 4-dimethyl-2-hexanone
(b) 1-bromo-3, 3-dimethyl-2-oxo-2-hexanone
(c) 1-bromo-3, 3-dimethyl acetone
(d) 1-bromo-4, 4-dimethyl-5-oxo-hexanone.

3. For the equilibrium, $2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$, the partial pressures of SO_3, SO_2 and O_2 gases at 650 K are respectively 0.3 bar, 0.6 bar and 0.4 bar. If the moles of both the oxides of sulphur are so adjusted as equal, what will be the partial pressure of O_2 ?
(a) 0.4 (b) 1.0 (c) 1.3 (d) 1.6

4. Which of the following is the product for the given reaction?



(a) 
(b) 
(c) 
(d) 

5. Amphoteric oxide (X) + 3C + $Cl_2 \longrightarrow$ Poisonous gas + anhydrous chloride (Y)
Hydrated chloride $\xrightarrow{\Delta} Z$
Element present in (Y) other than 'Cl' reacts with concentrated HCl but leads to passivation with conc. HNO_3. Select the correct option.
(a) $X = Z$ and Y on reacting with LiH forms strong oxidising agent.
(b) $X = Z$ and Y on reacting with LiH forms strong reducing agent.
(c) $X \neq Z$ and Y is used as a catalyst in Friedel—Crafts reaction.
(d) $X \neq Z$ and Y on reacting with LiH forms strong oxidising agent.

6. $N_2 + 3H_2 \longrightarrow 2NH_3$
Molecular weights of NH_3 and N_2 are x_1 and x_2, their equivalent weights are y_1 and y_2 respectively. Then $(y_1 - y_2)$ is
(a) $\left(\frac{2x_1 - x_2}{6}\right)$ (b) $(x_1 - x_2)$
(c) $(3x_1 - x_2)$ (d) $(x_1 - 3x_2)$

7. By what method the quantity of organic pollutants in water can be determined?
(a) By measuring BOD
(b) By pH measurement
(c) By transparency measurement
(d) By measuring the change of colour

8. From the observations given below, suggest the relation between X, Y and Z.

Experiment	Heat supplied	Work done	ΔE
I	100 J supplied to the system	200 J work done by the system	X Joules
II	200 J supplied to the system	200 J work done on the system	Y Joules
III	400 J lost to the system	100 J work done by the system	Z Joules

(a) $X = Y = Z$ (b) $Y > X > Z$
(c) $Y > Z > X$ (d) $X > Z > Y$

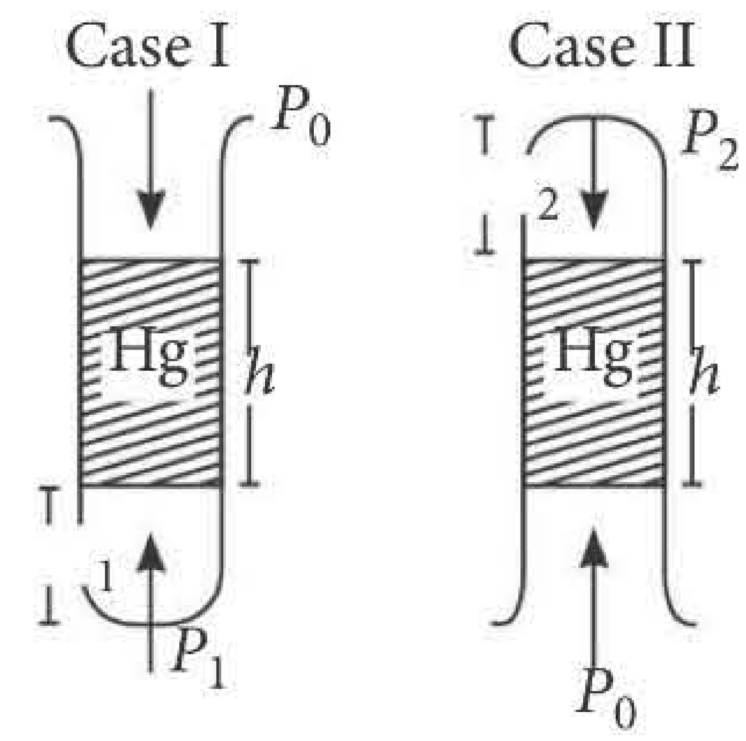
9. $C_3H_{8(g)} + A \longrightarrow \text{syn gas} \xrightarrow[Fe_2O_3/Cr_2O_3]{X}$

$$Y + Z \xrightarrow[\text{High } P]{\text{Cold water}} Z_{(g)} + \text{a soln. of } Y.$$

Z has low chemical reactivity at room temperature but under vigorous suitable conditions it reacts with other elements to form very useful compounds.
Z is also being looked upon as prospective source of energy for future. Which two substances are same ?
(a) X, Z (b) A, X (c) A, Y (d) A, Z

10. Which of the following statements is incorrect?
(a) Among O_2^+, O_2 and O_2^- the stability decreases as $O_2^+ > O_2 > O_2^-$.
(b) He_2 molecule does not exist as the effect of bonding and anti-bonding molecular orbitals cancel each other.
(c) C_2, O_2^{2-} and Li_2 are diamagnetic.
(d) In F_2 molecule, the energy of $\sigma 2p_z$ is more than π_{2px} and π_{2py}.

11. A gas column is trapped between closed end of a tube and a mercury column of length (h) when this tube is placed with its open end upwards the length of gas column is (ℓ_1), the length of gas column becomes (ℓ_2) when open end of tube is held downwards. Find atmospheric pressure in terms of height of Hg column.



(a) $\frac{h(\ell_1 - \ell_2)}{(\ell_1 + \ell_2)}$ (b) $\frac{h(\ell_1 + \ell_2)}{\ell_2 - \ell_1}$
(c) $h\left(\frac{(\ell_1 \times \ell_2)}{\ell_2 - \ell_1}\right)$ (d) None of these

12. For the element X, student Riya measured its radius as 102 nm, student Rajat as 203 nm. and Aman as 100 nm, using same apparatus. Their teacher explained that measurements were correct by saying that recorded values by three students were
(a) crystal, van der Waal and covalent radii
(b) covalent, crystal and van der Waal radii
(c) van der Waal, ionic and covalent radii
(d) none is correct.

13. The molar composition of polluted air is as follows :

Gas	At. wt.	Mole percentage
Oxygen	16	16%
Nitrogen	14	80%
Carbon dioxide	—	03%
Sulphur dioxide	—	01%

What is the average molecular weight of the given polluted air? (Given, atomic weights of C and S are 12 and 32 respectively.)
(a) 28.51 (b) 50.08 (c) 29.48 (d) 45.12

14. 0.395 g of an organic compound by Carius method for the estimation of sulphur gave 0.582 g of $BaSO_4$. The percentage of sulphur in the compound is
(a) 20.24 (b) 35 (c) 40 (d) 45

15. An electron in a hydrogen like atom makes transition from a state in which its de-Broglie wavelength is λ_1 to a state where its de-Broglie wavelength is λ_2 then wavelength of photon (λ) generated will be

(a) $\lambda = \lambda_1 - \lambda_2$ (b) $\lambda = \frac{4mc}{h}\left\{\frac{\lambda_1^2\lambda_2^2}{\lambda_1^2 - \lambda_2^2}\right\}$

(c) $\lambda = \sqrt{\frac{\lambda_1^2\lambda_2^2}{\lambda_1^2 - \lambda_2^2}}$ (d) $\lambda = \frac{2mc}{h}\left\{\frac{\lambda_1^2\lambda_2^2}{\lambda_1^2 - \lambda_2^2}\right\}$

SOLUTIONS

1. **(a) :** B forms double salt with $Al_2(SO_4)_3$ and thus, may be K_2SO_4. $(A) + S \longrightarrow (B)\ K_2SO_4$

1.743 g K_2SO_4 is obtained by 1.422 g of A

$\therefore$ 174 g K_2SO_4 is obtained by $\frac{1.422 \times 174}{1.743} = 142$ g of A

$\therefore$ 174 g K_2SO_4 requires 32 g of S

$\therefore$ 1.743 g K_2SO_4 requires $\frac{32 \times 1.743}{174} = 0.32$ g of S

Thus, given data confirms that (B) is K_2SO_4.

Now, $\underset{(A)\text{ potassium salt}}{2(A)} + S \longrightarrow K_2SO_4$

M. wt. of $(A) \times 2 = 142$ $\therefore$ M. wt. of $(A) = 71$

Since (A) is potassium salt

$\therefore$ Molecular weight of left component $= 71 - 39 = 32$

Thus, salt is KO_2.

2. **(a)**

3. **(d) :** The equilibrium given as,

$2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$

$\therefore K_p = \frac{p_{SO_2}^2 p_{O_2}}{p_{SO_3}^2} = \frac{0.6 \times 0.6 \times 0.4}{0.3 \times 0.3} = 1.6$ bar

Upon adjustment, K_p does not change,

$\therefore$ 1.6 bar $= K_p = \frac{x^2 p_{O_2}}{x^2}$

Partial pressure of oxygen = 1.6 bar

4. **(b)**

5. **(b) :** $\underset{X}{Al_2O_3} + 3C + Cl_2 \longrightarrow \underset{Y}{2AlCl_3} + 3CO$

Hydrated chloride on heating gives

$2Al(H_2O)_6Cl_3 \xrightarrow[\sim 400°C]{\text{strong heating}} ZAl_2O_3 + 9H_2O + 6HCl$

Al and Cl present in $AlCl_3$. Thus,

$2Al_{(s)} + 6HCl_{(aq)} \longrightarrow 2Al^{3+}_{(aq)} + 6Cl^-_{(aq)} + 3H_{2(g)}$

$2Al + 6HNO_{3(conc.)} \longrightarrow Al_2O_3 + 6NO_2 + 3H_2O$

Thin protective layer of Al_2O_3 on the surface of metal causes passivation.

$AlCl_3 + 4LiH \longrightarrow LiAlH_4 + 3LiCl$

6. **(a) :** For the given reaction, $N_2 + 3H_2 \longrightarrow 2NH_3$

Equivalent weight of $N_2(y_2) = x_2/6$

Equivalent weight of $NH_3(y_1) = x_1/3$

$y_1 - y_2 = \frac{x_1}{3} - \frac{x_2}{6} = \frac{2x_1 - x_2}{6}$

7. **(a)**

8. **(b) :** According to first two of thermodynamics,

$\Delta E = q + w$

For experiment I $q = +100$ J $w = -200$ J

$\Delta E = 100 - 200 = -100$ J $= X$

For experiment II $q = +200$ J $w = +200$ J

$\Delta E = 200 + 200 = 400$ J $= Y$

For experiment III $q = -400$ J $w = -100$ J

$\Delta E = -400 - 100 = -500$ J $= Z$

Thus, $Y > X > Z$.

9. **(b) :** $\underset{(A)}{C_3H_{8(g)}} + 3H_2O_{(g)} \rightarrow \underbrace{3CO_{(g)} + 7H_{2(g)}}_{\text{Syn gas}}$

$\underset{(X)}{CO_{(g)}} + H_2O_{(g)} \xrightarrow{Fe_2O_3/Cr_2O_3} \underset{(Y)}{CO_{2(g)}} + \underset{(Z)}{H_{2(g)}}$

10. **(d)**

11. **(b) :** For gas $P_1 = (P_0 + h)$ $P_2 = (P_0 - h)$

$V_1 = \pi r^2 \ell_1$ $V_2 = \pi r^2 \ell_2$

at const. T and moles.

$P_1V_1 = P_2V_2$; $(P_0 + h)\pi r^2 \ell_1 = (P_0 - h)\pi r^2 \ell_2$

$P_0\ell_1 + h\ell_1 = P_0\ell_2 - h\ell_2$; $P_0\ell_2 - P_0\ell_1 = h\ell_1 + h\ell_2$

$P_0 = \left(\frac{h(\ell_1 + \ell_2)}{(\ell_2 - \ell_1)}\right)$ cm of Hg column

12. **(a)**

13. **(c) :** $M_{avg} = \frac{\sum_{j=1}^{j=n} n_j M_j}{\sum_{j=1}^{j=n} n_j}$ Here $\sum_{j=1}^{j=n} n_j = 100$

$M_{avg} = \frac{16 \times 32 + 80 \times 28 + 44 \times 3 + 64 \times 1}{100} = 29.48$

14. **(a) :** Mass of $BaSO_4 = 0.582$ g

We know, $\underset{233}{BaSO_4} = \underset{32}{S}$

233 g of $BaSO_4$ contains sulphur = 32 g

0.582 g of $BaSO_4$ contains sulphur $= \frac{32}{233} \times 0.582$

Percentage of sulphur $= \frac{\text{wt. of sulphur}}{\text{wt. of compound}} \times 100$

$= \frac{32 \times 0.582}{233 \times 0.395} \times 100 = 20.24\%$

15. **(d) :** $hc/\lambda = E_2 - E_1 = KE_2 - KE_1$

$\therefore \lambda = \frac{h}{mV}$, $(mV)^2 = \left(\frac{h}{\lambda}\right)^2$, $\frac{1}{2}\frac{m^2V^2}{m} = \frac{1}{2m}\frac{h^2}{\lambda^2}$

$\therefore \frac{hc}{\lambda} = \frac{h^2}{2m\lambda_2^2} - \frac{h^2}{2m\lambda_1^2}$ $\therefore \lambda = \frac{2mc}{h}\left\{\frac{\lambda_1^2\lambda_2^2}{\lambda_1^2 - \lambda_2^2}\right\}$

◆◆

BOOST your NEET score

Practice Paper 2020

1. Compressibility factor (Z) for N_2 at $-50\ °C$ and 800 atm pressure is 1.95. Calculate the number of moles of N_2 gas required to fill a gas cylinder of 100 mL capacity under the given conditions.
(a) 2.24 (b) 1.12
(c) 6.10 (d) 2.90

2. Benzaldehyde reacts with ammonia to form
(a) hydrobenzamide (b) benzamide
(c) aniline (d) phenyl cyanide.

3. Which of the following is not a property of hydrophilic sols?
(a) High concentration of dispersed phase can be easily attained.
(b) Coagulation is reversible.
(c) Viscosity and surface tension are nearly same as that of water.
(d) The charge of the particle depends on the pH value of the medium; it may be positive, negative or even zero.

4. Which of the following alcohols is most reactive with HCl in the presence of $ZnCl_2$?

(a) $CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-OH$ (b) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2OH$

(c) $CH_3-\underset{\underset{CH_3}{|}}{CH}-OH$ (d) CH_3OH

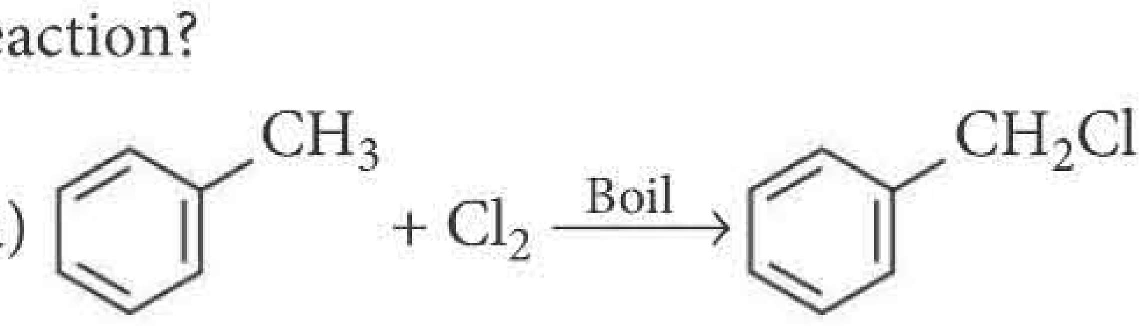
5. A ball of mass 200 g is moving with a velocity of 10 m sec^{-1}. If the error in measurement of velocity is 0.1%, the uncertainty in its position is
(a) 3.32×10^{-31} m
(b) 3.34×10^{-27} m
(c) 5.32×10^{-25} m
(d) 2.64×10^{-32} m

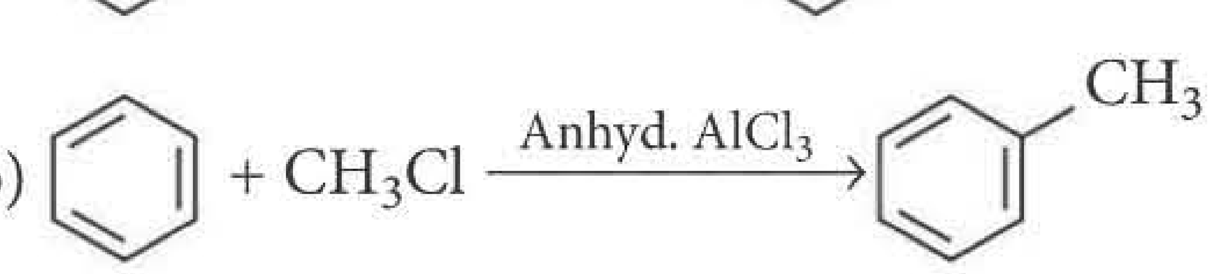
6. When neopentyl bromide is subjected to Wurtz reaction, the product formed is
(a) 2, 2, 4, 4-tetramethylhexane
(b) 2, 2, 4, 4-tetramethylpentane
(c) 2, 2, 5, 5-tetramethylhexane
(d) 2, 2, 3, 3-tetramethylhexane.

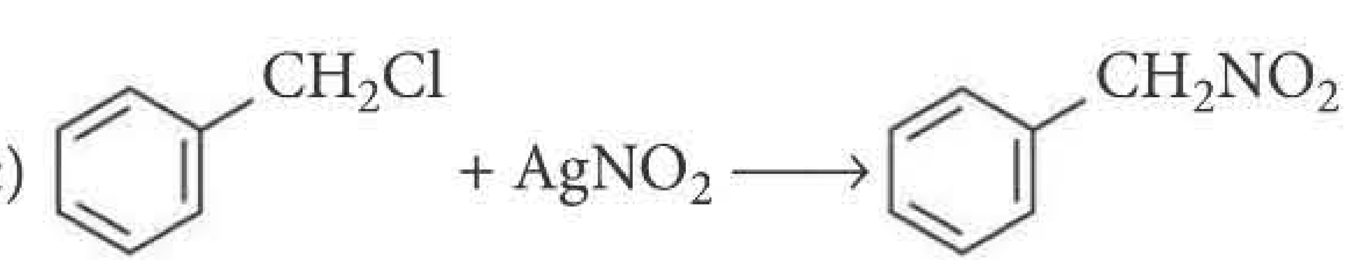
7. Which of the following statements about primary amines is false?
(a) Aryl amines react with nitrous acid to produce nitrophenols.
(b) Alkyl amines are stronger bases than ammonia.
(c) Alkyl amines are stronger bases than aryl amines.
(d) Alkyl amines react with nitrous acid to produce alcohols.

8. $NaNO_3$ when decomposes above 800 °C does not give
(a) N_2 (b) O_2 (c) NO_2 (d) Na_2O

9. Which of the following is a free radical substitution reaction?

(a) 

(b) 

(c) 

(d) $CH_3CHO + HCN \longrightarrow CH_3CH(OH)CN$

10. The density of sodium borohydride is 1.074 g/cm^3. 3.91 g of sodium borohydride contains 2.50×10^{23} atoms of H. The number of moles of H atoms present in 28.0 cm^3 of sodium borohydride is
(a) 3.192 (b) 2.03
(c) 1.67 (d) 1.92

11. The resistance of 0.5 N solution of an electrolyte in a conductivity cell was found to be 25 ohm. Calculate the equivalent conductivity of the solution if the electrodes in the cell are 1.6 cm apart and have an area of 3.2 cm^2.
(a) 10 S cm^2 equiv (b) 15 S cm^2 equiv
(c) 20 S cm^2 equiv (d) 40 S cm^2 equiv

12. The volume strength of 1.5 N H_2O_2 solution is
(a) 4.8 (b) 8.4 (c) 3.0 (d) 8.0

13. Aluminium crystallizes in a cubic close packed structure. Its metallic radius is 125 pm. What is the length of the side of unit cell?
(a) 145 pm (b) 353.5 pm
(c) 125 pm (d) 250 pm

14. The gases that give rise to photochemical smog are
(a) oxides of sulphur (b) oxides of nitrogen
(c) oxides of carbon (d) oxygen.

15. Identify the final product (Z) in the following sequence of reactions :
$(CH_3)_2CO + HCN \longrightarrow X \xrightarrow{H_3O^+} Y \xrightarrow[\text{Heat}]{H_2SO_4} Z$
(a) $(CH_3)_2C(OH)COOH$
(b) $CH_2{=}C(CH_3)COOH$
(c) $HOCH_2CH(CH_3)COOH$
(d) $CH_3CH{=}CHCOOH$

16. Calculate the longest wavelength (in Å) which can remove the electron from first Bohr's orbit. (Given : E_1 = 13.6 eV)
(a) 303.81 (b) 912.24 (c) 1095.12 (d) 1215.67

17. The product of acid catalysed hydration of 2-phenyl propene is
(a) 3-phenyl-2-propanol (b) 1-phenyl-2-propanol
(c) 2-phenyl-2-propanol (d) 2-phenyl-1-propanol.

18. Which of the following statements is not true about glucose?
(a) It is an aldohexose.
(b) On heating with HI it forms n-hexane.
(c) It is present in furanose form.
(d) It does not give 2,4-DNP test.

19. In a system : $A_{(s)} \rightleftharpoons 2B_{(g)} + 3C_{(g)}$, if the concentration of C at equilibrium is increased by a factor 2, it will cause the equilibrium concentration of B to change by
(a) two times of its original value
(b) one half of its original value
(c) $2\sqrt{2}$ times of its original value
(d) $\dfrac{1}{2\sqrt{2}}$ time of its original value.

20. Which of the following statements is not true?
(a) The Ellingham diagram shows the plots of ΔG vs T.
(b) In froth floatation process, depressants are added to enhance the formation of froth.
(c) Extraction of zinc oxide is done by coke.
(d) CO is more effective reducing agent below 983 K.

21. In a mixture of A and B, components show –ve deviations as
(a) ΔV_{mix} is +ve
(b) A–B interactions are weaker than A–A and B–B interactions
(c) ΔH_{mix} is +ve
(d) A–B interactions are stronger than A–A and B–B interactions.

22. Out of vanadium (V), chromium (Cr), manganese (Mn) and iron (Fe), which one is expected to have the highest second ionisation enthalpy?
(a) V (b) Cr (c) Mn (d) Fe

23. In a first order reaction, the initial amount of a substance becomes 1/3 in 100 seconds. How much time will be taken to reduce the concentration to 1/9 of the initial concentration?
(a) 200 sec (b) 100 sec (c) 50 sec (d) 400 sec

24. Among the following halides :
1. BCl_3 2. $AlCl_3$ 3. $GaCl_3$ 4. $InCl_3$
the order of decreasing Lewis acid character is
(a) 1, 2, 3, 4 (b) 4, 3, 2, 1
(c) 3, 4, 2, 1 (d) 2, 3, 4, 1.

25. Which of the following statements is not true about low density polythene?
(a) Obtained through free radical addition
(b) Chemically inert and tough
(c) Good conductor of electricity
(d) Highly branched structure

26. Identify a reagent from the following which can easily distinguish between but-1-yne and but-2-yne.
(a) Bromine, CCl_4
(b) H_2, Lindlar's catalyst
(c) Dilute H_2SO_4, $HgSO_4$
(d) Ammoniacal Cu_2Cl_2 solution

27. Which of the following is paramagnetic in nature?
(a) $[Cr(CO)_6]$ (b) $[Fe(CO)_5]$
(c) $[Fe(CN)_6]^{4-}$ (d) $[Cr(NH_3)_6]^{3+}$

28. Which of the following contains maximum number of lone pairs of electrons on the central atom?
(a) ClO_3^- (b) XeF_4
(c) SF_4 (d) I_3^-

29. Match List I with List II and select the correct option.

List I	List II
(I) Iodoform	(A) Anaesthetic
(II) Methyl salicylate	(B) Antiseptic
(III) Diethyl ether	(C) Insecticide
(IV) Hexachlorocyclohexane	(D) Detergent
	(E) Pain balm

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

30. In group 14, the inert-pair effect is more prominent in
(a) tin and lead (b) carbon and silicon
(c) carbon and lead (d) none of these.

31. Which is the most suitable reagent for the following conversion?

$$CH_3-CH=CH-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 \longrightarrow CH_3-CH=CH-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-OH$$

(a) Tollens' reagent
(b) Benzoyl peroxide
(c) I_2 and NaOH solution
(d) $LiAlH_4/C_2H_5OH$

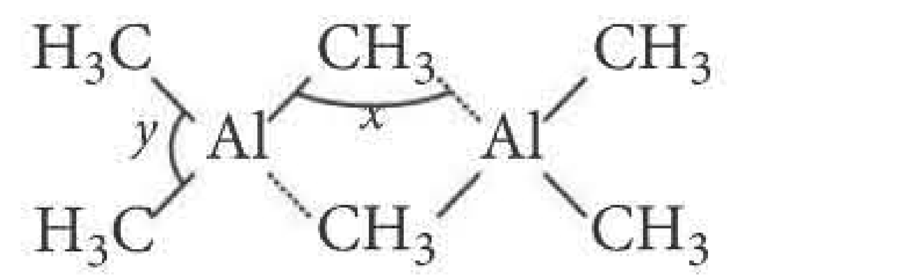
32. The values of T_c for few gases are given below : $H_2 : 33.2$ K, $O_2 : 154.3$ K, He : 5.3 K and $CO_2 : 304.10$ K. What is the correct increasing order of liquefaction of the above gases?
(a) $He < O_2 < H_2 < CO_2$
(b) $He < H_2 < O_2 < CO_2$
(c) $CO_2 < O_2 < H_2 < He$
(d) $O_2 < CO_2 < H_2 < He$

33. The basic character of the transition metal monoxides follows the order
(a) CrO > VO > FeO > TiO
(b) TiO > FeO > VO > CrO
(c) TiO > VO > CrO > FeO
(d) VO > CrO > TiO > FeO

34. 0.316 g of an organic compound, after heating with fuming nitric acid and barium nitrate crystals in a sealed tube gave 0.466 g of the precipitate of barium sulphate. The percentage of sulphur in the compound is
(a) 1.125 (b) 20.25
(c) 15.85 (d) 30.15

35. Nitrogen oxide that does not contain N—N bond is
(a) N_2O (b) N_2O_3 (c) N_2O_4 (d) N_2O_5

36. Compare x and y bond angles for the given molecule :



(a) $x > y$ (b) $y > x$
(c) $x = y$ (d) $x \geq y$

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

38. Enantiomers have
(a) identical m.pt./b.pt. but different refractive indices
(b) identical m.pt./b.pt. and refractive indices but rotate plane polarised light in opposite directions but to the same extent
(c) different refractive indices and rotate plane polarised light in the same direction but to different extent
(d) different m.pt./b.pt. but rotate plane polarised light in different directions but to the same extent.

39. A unit cell of sodium chloride has four formula units. The edge length of the unit cell is 0.564 nm. Density of sodium chloride is
(a) 1.08 g cm^{-3} (b) 2.16 g cm^{-3}
(c) 3.24 g cm^{-3} (d) none of these.

40. Some properties of the two species, NO_3^- and H_3O^+ are described below. Which one of them is correct?
(a) Dissimilar in hybridisation for the central atom with different structures.
(b) Isostructural with same hybridisation for the central atom.
(c) Isostructural with different hybridisation for the central atom.

(d) Similar in hybridisation for the central atom with different structures.

41. The plot of $\log_{10}K$ vs $1/T$ leads to a straight line having intercept equal to

(a) ΔG° (b) $\dfrac{\Delta G^\circ}{2.303R}$

(c) $\dfrac{\Delta S^\circ}{2.303R}$ (d) $\dfrac{\Delta H^\circ}{2.303R}$

42. Which of the following complexes has magnetic moment of 2.83 B.M.?

(a) $[Ni(NH_3)_6]^{2+}$ (b) $[Ni(CN)_4]^{2-}$

(c) $TiCl_4$ (d) $[CoCl_6]^{3-}$

43. The final product of the following sequence of reactions

$CaO + C \xrightarrow{\text{Heat}} A \xrightarrow{H_2O} B$, is

(a) ethanol

(b) ethyl hydrogen sulphate

(c) acetylene (d) ethylene glycol.

44. The same quantity of electricity that liberated 2.158 g of Ag was passed through a gold salt, and 1.314 g of gold was deposited. The equivalent mass of Ag is 107.9. Calculate oxidation state of Au in the salt. (At. mass of Au = 197)

(a) +2 (b) +3 (c) +1 (d) 0

45. If $E^\circ_{M^+/M} = -1.2$ V, $E^\circ_{X_2/X^-} = 1.1$ V and $E^\circ_{O_2/H_2O} = 1.23$ V, then on electrolysis of aqueous solution of salt MX, the products obtained are

(a) M, X_2 (b) H_2, X_2 (c) H_2, O_2 (d) M, O_2

SOLUTIONS

1. (a) : We have, $Z = \dfrac{PV}{nRT}$

$\therefore$ Mole of $N_2(n) = \dfrac{PV}{ZRT} = \dfrac{800 \times 100}{1.95 \times 0.0821 \times 223 \times 1000}$

$= 2.24$

2. (a) :

$$\begin{array}{l} C_6H_5-CH{=}\boxed{O + H_2}\,\boxed{N\,H} \\ C_6H_5-CH{=}\boxed{O + H_2}\,\boxed{N\,H} \end{array} + \boxed{O}{=}CHC_6H_5$$

$$\longrightarrow \begin{array}{l} C_6H_5CH{=}N \\ C_6H_5CH{=}N \end{array}\!\!>CHC_6H_5 + 3H_2O$$

Hydrobenzamide

3. (c) : Hydrophilic sols have lower surface tension and higher viscosity than that of water.

4. (a) : Order of reactivity of alcohols towards Lucas reagent : 3° > 2° > 1°

5. (d) : $\Delta v = \dfrac{0.1}{100} \times 10 = 10^{-2}$ m sec^{-1};

Now, $\Delta v \cdot \Delta x = \dfrac{h}{4\pi m}$

$\Delta x = \dfrac{6.625 \times 10^{-34}}{4 \times 10^{-2} \times 3.14 \times 200 \times 10^{-3}} = 2.64 \times 10^{-32}$ m

6. (c) : $2CH_3-C(CH_3)_2-CH_2Br + 2Na \xrightarrow{\text{Dry ether}}$

Neopentyl bromide

$CH_3-C(CH_3)_2-CH_2-CH_2-C(CH_3)_2-CH_3$

2,2,5,5-Tetramethylhexane

7. (a)

8. (c) : $NaNO_3 \xrightarrow{500\ °C} NaNO_2 + \frac{1}{2}O_2$

$2NaNO_3 \xrightarrow{> 800\ °C} Na_2O + N_2 + \frac{5}{2}O_2$

9. (a) : Side chain chlorination takes place in the presence of heat or light by free radical substitution mechanism.

10. (a) : Weight of sodium borohydride in 28.0 cm^3
$= 28 \times 1.074 = 30.072$ g

$\because$ 3.91 g of sodium borohydride has moles of H atoms
$= \dfrac{2.50 \times 10^{23}}{6.023 \times 10^{23}}$

$\therefore$ 30.072 g of sodium borohydride has moles of H atoms $= \dfrac{2.50 \times 10^{23}}{6.023 \times 10^{23}} \times \dfrac{30.072}{3.91}$

$= 3.192$ moles of H atoms

11. (d) : $\rho = R \cdot \dfrac{a}{l} = \dfrac{25 \times 3.2}{1.6} = 50$

$\kappa = \dfrac{1}{\rho} = \dfrac{1}{50} = 0.02$

$\Lambda_{eq} = \kappa \times V = \kappa \times \dfrac{1000}{\text{Normality}} = \dfrac{0.02 \times 1000}{0.5}$

$= 40$ S cm^2 equiv.

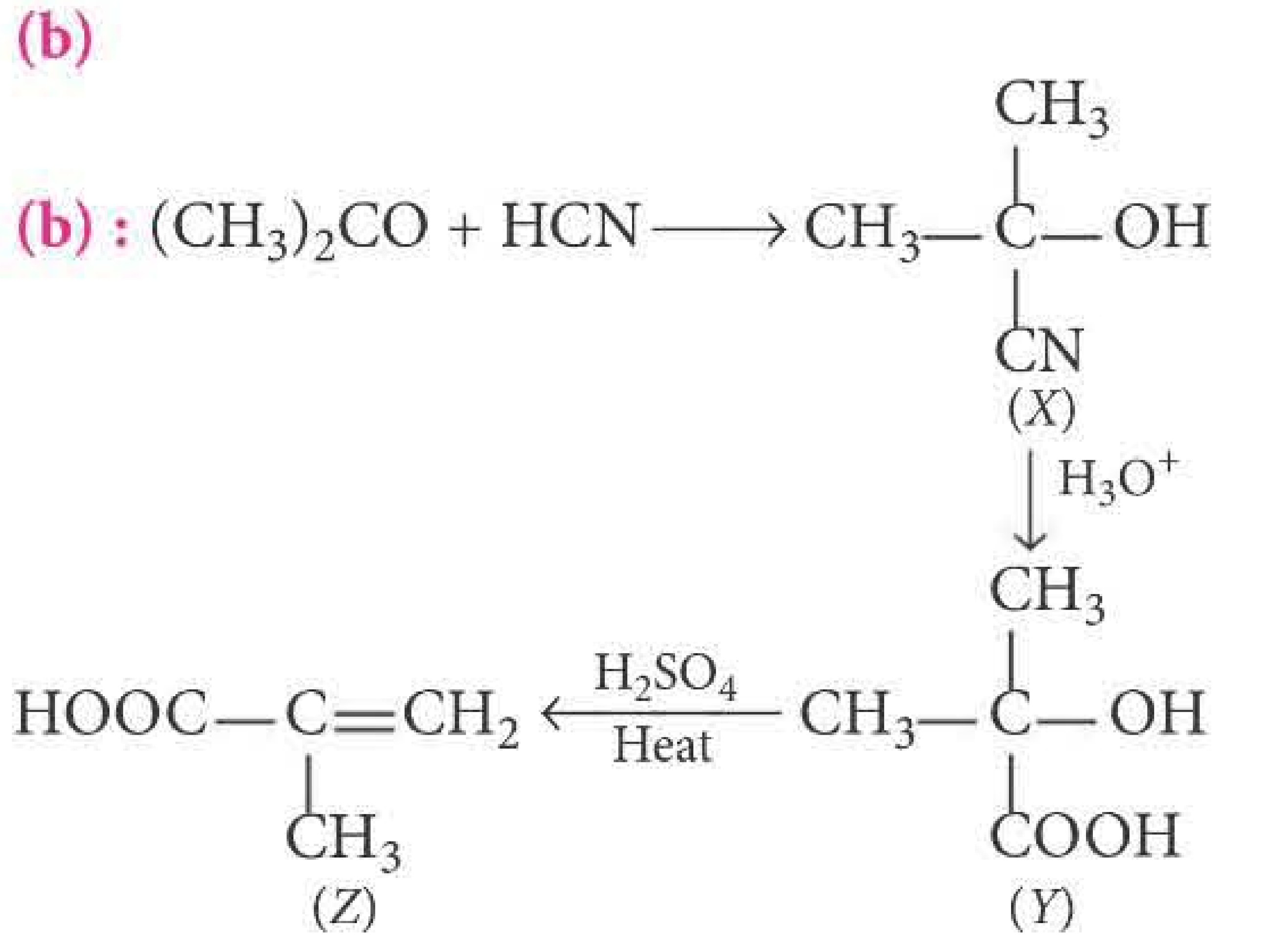
12. (b) : Volume strength = 5.6 × Normality
= 5.6 × 1.5 = 8.4

13. (b) : For a cubic close packed structure, length of the side of unit cell is related to radius as,

$r = \dfrac{a}{2\sqrt{2}}$

$a = r \times 2\sqrt{2} = 125 \times 2 \times 1.414$ pm $= 353.5$ pm

14. (b)

15. (b) : 

16. (b) : The photon capable of removing electron from first Bohr's orbit must possess energy

$= 13.6\ eV = 13.6 \times 1.602 \times 10^{-19}\ J$

$= 21.787 \times 10^{-19}\ J$

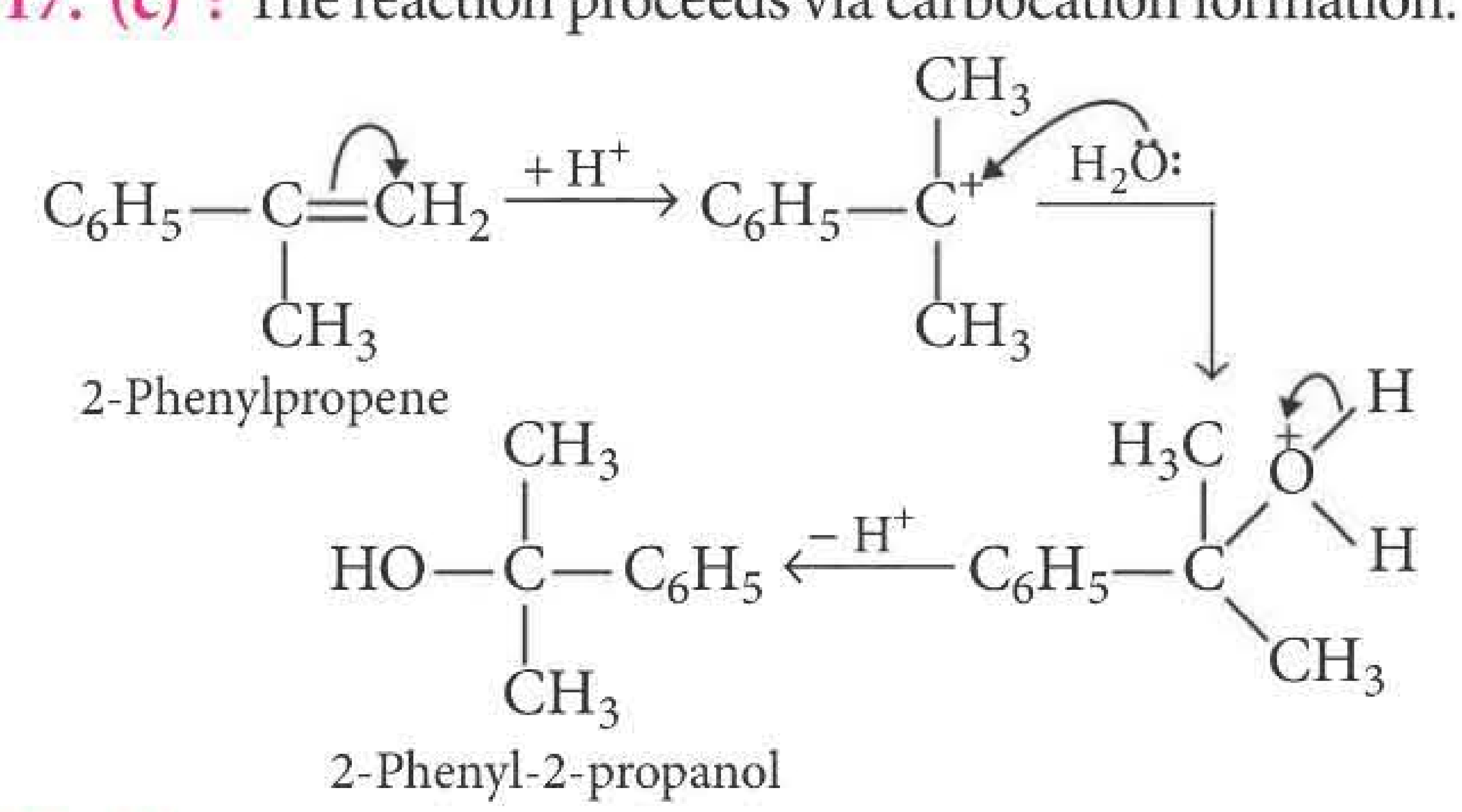
$\because\ E = \dfrac{hc}{\lambda}$

$21.787 \times 10^{-19} = \dfrac{6.625\times10^{-34}\times3.0\times10^{8}}{\lambda}$

$\therefore\ \lambda = 912.24 \times 10^{-10}\ m = 912.24\ Å$

This is longest λ because a photon having λ higher than this will possess energy lesser than required, as $E \propto \dfrac{1}{\lambda}$.

17. (c) : The reaction proceeds via carbocation formation.



18. (c) : Glucose is present in pyranose form.

19. (d) : $A_{(s)} \rightleftharpoons 2B_{(g)} + 3C_{(g)}$

$\therefore\ K_c = [C]^3[B]^2$;

If $[C]$ becomes twice, let conc. of B becomes B', then

$K_c = [2C]^3[B']^2$ or $[C]^3[B]^2 = [2C]^3[B']^2$

$\therefore\ \dfrac{[B']}{[B]} = \sqrt{\dfrac{1}{8}} = \dfrac{1}{2\sqrt{2}}$

20. (b)

21. (d) : Option (d) is a required condition for negative deviation along with $\Delta V_{mix} = -ve$ and $\Delta H_{mix} = -ve$.

22. (b) : The electronic configurations of these elements are

V ($Z = 23$) : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$

Cr ($Z = 24$): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

Mn ($Z = 25$): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$

Fe ($Z = 26$): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$

In the case of chromium, the second electron has to be removed from the half-filled d-shell which is more stable.

23. (a) : For the first order reaction,

$k = \dfrac{2.303}{t}\log_{10}\dfrac{a}{(a-x)}$

Let the initial amount is a mol L^{-1}, then

after $t = 100$ seconds, $(a - x) = \dfrac{a}{3}$ mol L^{-1}

$\therefore\ k = \dfrac{2.303}{100}\log_{10}\dfrac{a}{a/3} = \dfrac{2.303}{100}\log_{10} 3$

$= 10.988 \times 10^{-3}\ sec^{-1}$

Let the time required to reduce the concentration to $a/9$ is t_1, then

$t_1 = \dfrac{2.303}{10.988\times10^{-3}}\log_{10}\dfrac{a}{a/9} = 200$ sec

24. (a)

25. (c) : It is not a good conductor of electricity.

26. (d) : 1-Alkynes react with ammoniacal solution of Cu_2Cl_2 to form red precipitate of the corresponding copper alkynides.

But-1-yne reacts with ammoniacal Cu_2Cl_2 as follows :

$CH_3—CH_2—C\equiv CH + Cu(NH_3)_2Cl$

$\longrightarrow CH_3—CH_2—C\equiv C^-Cu^+$
red precipitate

But, but-2-yne does not react with this reagent.

27. (d) : CO and CN^- are strong field ligands which force the electrons to pair up and thus, complex is generally diamagnetic. NH_3 is a weak field ligand so that electrons remain unpaired and complex is generally paramagnetic.

28. (d) : ClO_3^- : 1 lone pair

XeF_4 : 2 lone pairs

SF_4 : 1 lone pair

I_3^- : 3 lone pairs

29. (c) : Iodoform - Antiseptic

Methyl salicylate - Pain balm

Diethyl ether - Anaesthetic

Hexachlorocyclohexane - Insecticide

30. (a) : Inert pair effect increases as we move down the group.

31. (c)

32. (b) : Higher the value of T_c, more easily the gas can be liquified.

33. (c) : The size of given metals decreases whereas ionization enthalpy increases from Ti to Fe. Hence, the metallic character of the metals decreases and therefore, basicity of oxides decreases from Ti to Fe.

34. (b) : Mass of substance taken = 0.316 g

Mass of $BaSO_4$ formed = 0.466 g

From stoichiometry, $\underset{233}{BaSO_4} \equiv \underset{32}{S}$

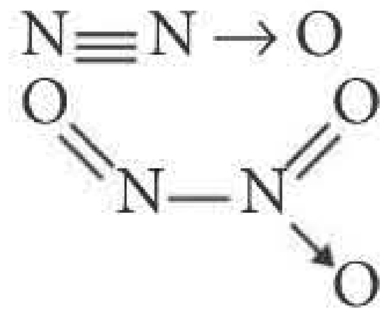
($\because$ molecular mass of $BaSO_4 = 137 + 32 + 64 = 233\ \text{g mol}^{-1}$)

Then, mass of S in 0.466 g of $BaSO_4 = \frac{0.466 \times 32}{233}$ g

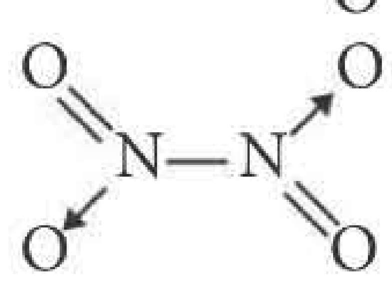
$$\text{Percentage of S in the compound} = \frac{0.466 \times 32}{233} \times \frac{100}{0.316} = 20.25\ \%$$

35. (d) : N_2O $\quad N \equiv N \rightarrow O$

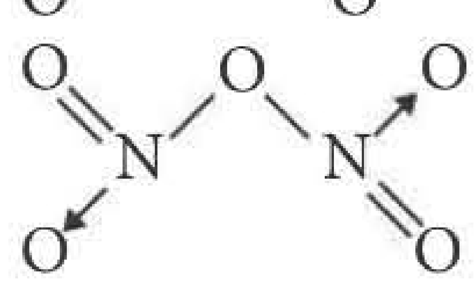
N_2O_3



N_2O_4



N_2O_5



36. (b)

37. (b) : In highest oxidation states, transition metals cannot form cationic complexes. Also, they show acidic character because in highest oxidation state, they can only accept the electrons and form anionic complexes.

38. (b)

39. (b) : $\rho_{NaCl} = \frac{Z \times M}{a^3 \times N_A}$

$\because$ $Z = 4$, formula mass $(M) = 58.5$, $a = 5.64 \times 10^{-8}$ cm

$$\therefore \quad \rho = \frac{4 \times 58.5}{6.023 \times 10^{23} \times (5.64 \times 10^{-8})^3} = 2.16\ \text{g cm}^{-3}$$

40. (a) : No. of electron pairs at the central atom = no. of atoms bonded to it + 1/2[group number of central atom – valency of the central atom ± no. of electrons]

No. of electron pairs at the central atom

in $NO_3^- = 3 + \frac{1}{2}[5 - 6 + 1] = 3$ $\quad$ (sp^2 hybridisation).

No. of electron pairs at the central atom in

in $H_3O^+ = 3 + \frac{1}{2}[6 - 3 - 1] = 4$ $\quad$ (sp^3 hybridisation).

41. (c) : $\Delta G^\circ = -2.303\ RT \log_{10} K$

$$\log_{10} K = -\frac{\Delta G^\circ}{2.303RT} = -\frac{(\Delta H^\circ - T\Delta S^\circ)}{2.303RT}$$

$$= -\frac{\Delta H^\circ}{2.303RT} + \frac{\Delta S^\circ}{2.303R}$$

Comparing it with straight line equation,

$y = mx + c$

we get, slope $(m) = \frac{-\Delta H^\circ}{2.303\ R}$

and intercept $(c) = \frac{\Delta S^\circ}{2.303\ R}$

42. (a) : 2.83 B.M. implies two unpaired electrons according to the expression, $\mu = \sqrt{n(n+2)}$ B.M. The species Ni^{2+}, Ni^{2+}, Ti^{4+} and Co^{3+} in the given complexes have $3d^8$, $3d^8$, $3d^0$, and $3d^6$ electronic configurations, respectively. CN being a strong field ligand causes pairing of electrons thus, $[Ni(CN)_4]^{2-}$ has zero unpaired electrons with dsp^2 hybridisation, while NH_3 being a weak field ligand, does not cause pairing of electrons thus, $[Ni(NH_3)_6]^{2+}$ has two unpaired electrons and 2.83 B.M. magnetic moment.

43. (c) : $CaO + 2C \xrightarrow{\text{Heat}} \underset{(A)}{CaC_2} \xrightarrow{H_2O} \underset{(B)}{CH \equiv CH}$

44. (b) : Number of equivalents of gold deposited = number of equivalents of silver deposited

i.e., $\frac{W_{gold}}{E_{gold}} = \frac{W_{silver}}{E_{silver}}$

$$E_{gold} = \frac{E_{silver} \times W_{gold}}{W_{silver}} = \frac{107.9 \times 1.314}{2.158} = 65.7$$

$$\text{Equivalent mass} = \frac{\text{Atomic mass}}{\text{Oxidation no. of Au in salt}}$$

$$\text{Thus, ox. no. of Au} = \frac{\text{Atomic mass}}{E_{gold}} = \frac{197}{65.7} = 3$$

45. (b) : $MX \longrightarrow M^+ + X^-$

$H_2O \longrightarrow H^+ + OH^-$

At cathode : H^+ ions will get reduced as the standard reduction potential of M^+ ions is negative (less than that of H^+).

$2H^+ + 2e^- \longrightarrow H_2$

At anode : The species having low value of standard reduction potential are oxidised. Hence, the reaction at anode is

$2X^- \longrightarrow X_2 + 2e^-$

$\therefore$ The products obtained are H_2 at cathode and X_2 at anode.

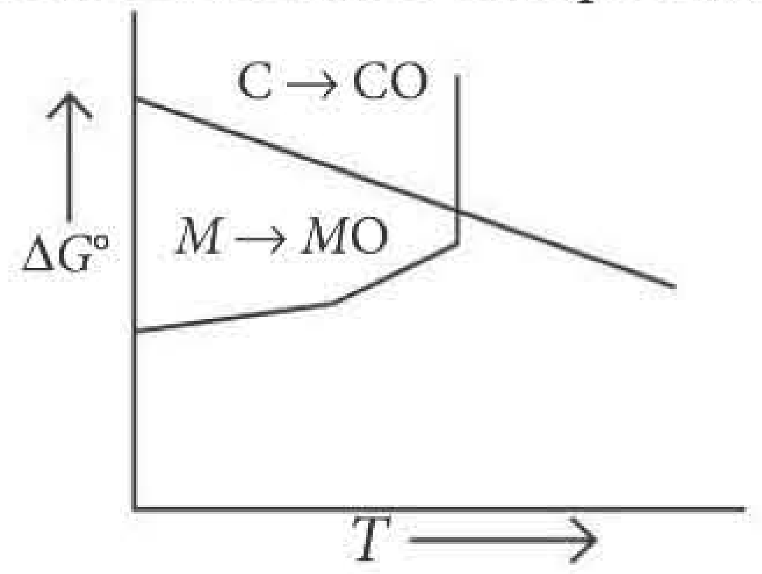
GET SET GO *for* JEE

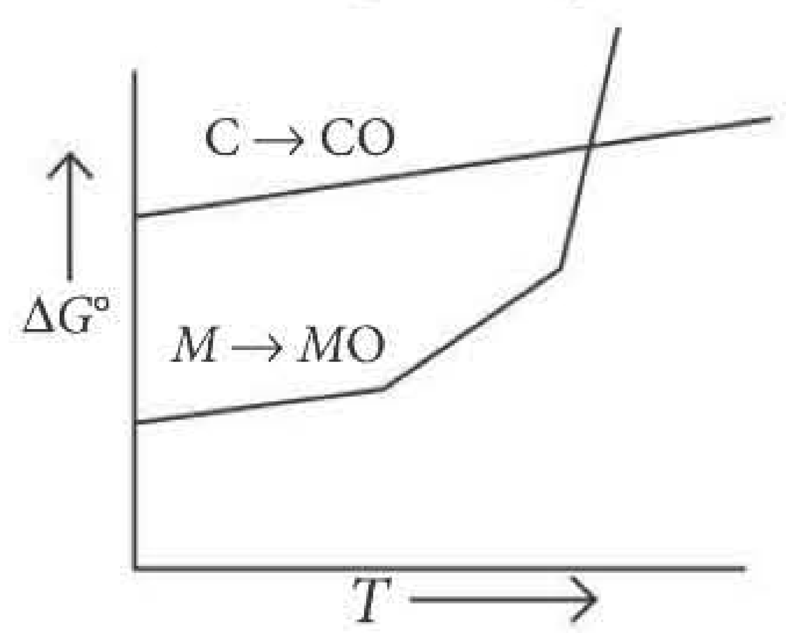
with exclusive and brain storming MCQs

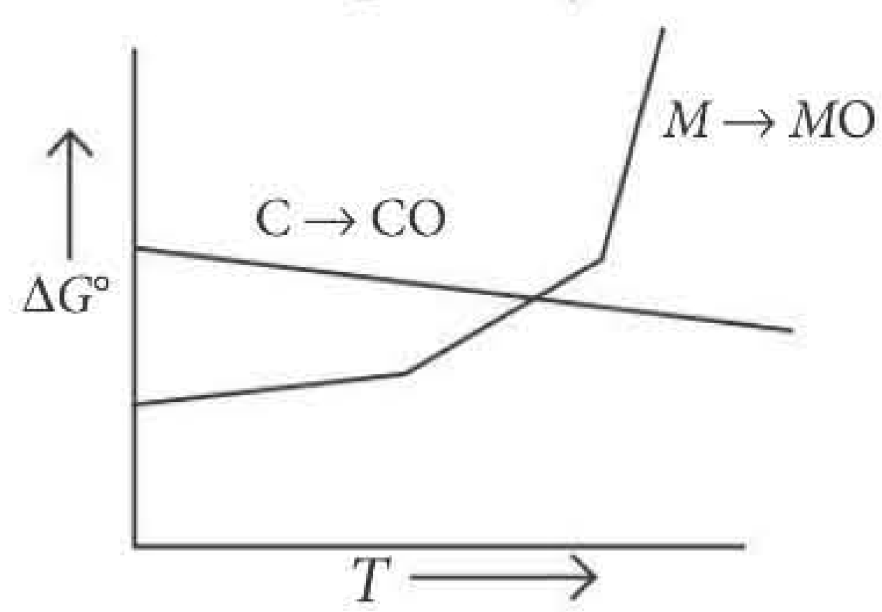
Practicing these MCQs help to strengthen your concepts and give you extra edge in your JEE preparation

SINGLE CORRECT OPTION

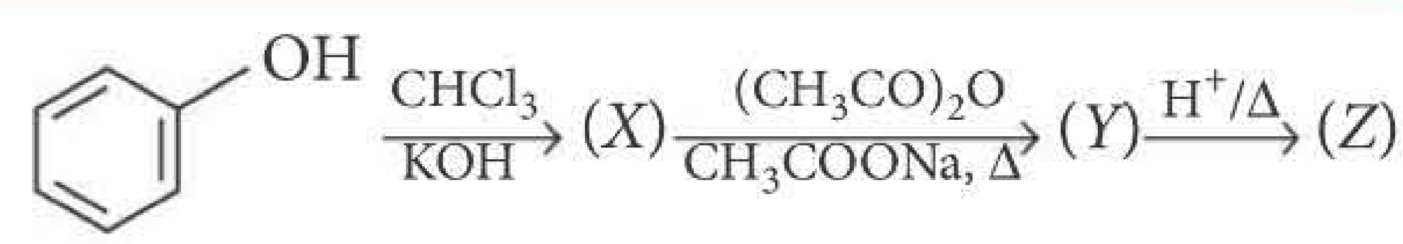
1. In which of the following cases metal obtained by carbon reduction is in liquid state?

(a) 

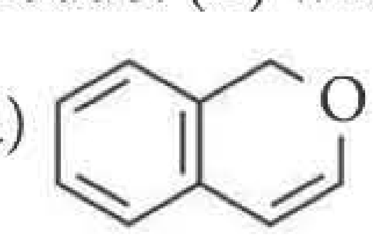
(b) 

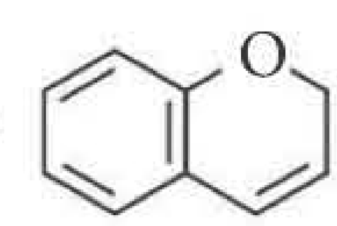
(c) 

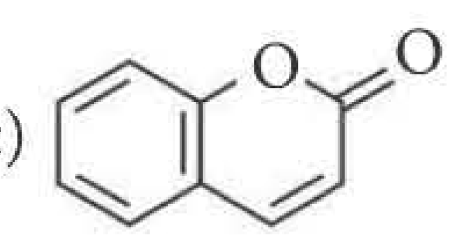
(d) None of these

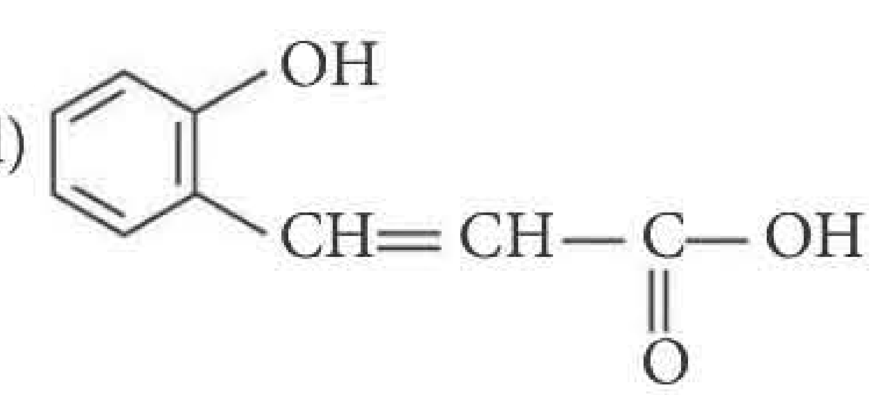
2. 

Product (Z) will be

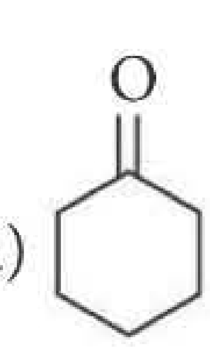
(a) 

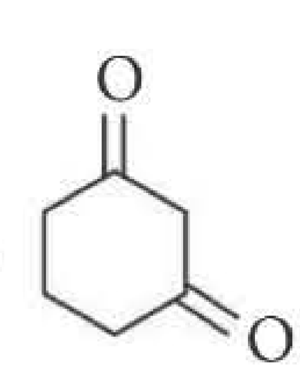
(b) 

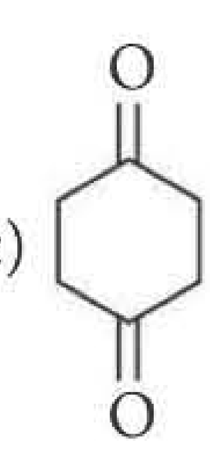
(c) 

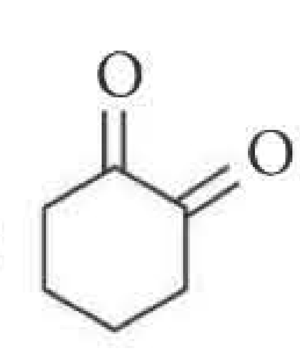
(d) 

3. Which of the following has the largest value of dissociation constant K_a?

(a) 

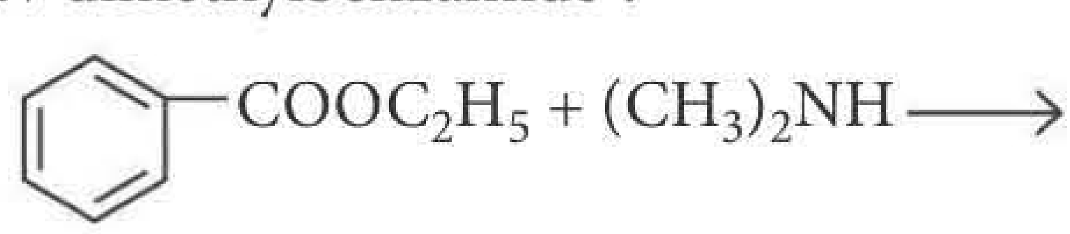
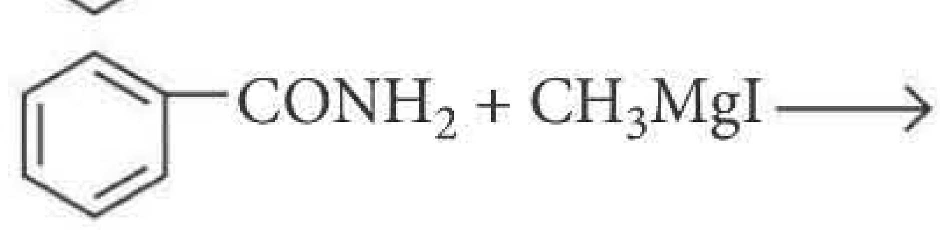
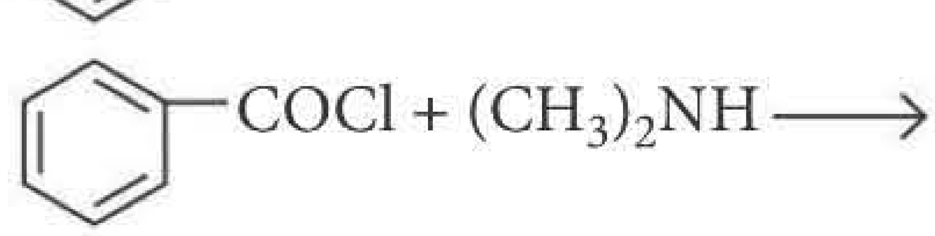
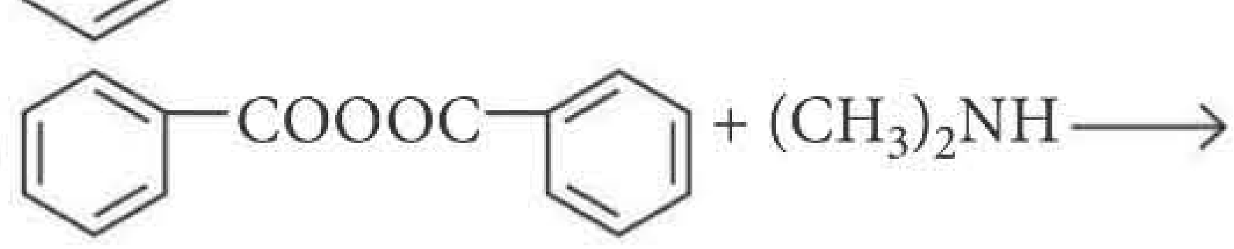
(b) 

(c) 

(d) 

4. Given the following limiting molar conductivities at 25 °C, HCl: 426 $\Omega^{-1}cm^2mol^{-1}$; NaCl: 126 $\Omega^{-1}cm^2mol^{-1}$; Na*C* (sodium crotonate): 83 Ω^{-1} cm^2mol^{-1}. What is the ionization constant of crotonic acid if the conductivity of a 0.001 M crotonic acid (H*C*) solution is 3.83×10^{-5} $\Omega^{-1}cm^{-1}$?
(a) 1.11×10^{-5} (b) 1.11×10^{-3}
(c) 1.11×10^{-7} (d) 1.11×10^{-2}

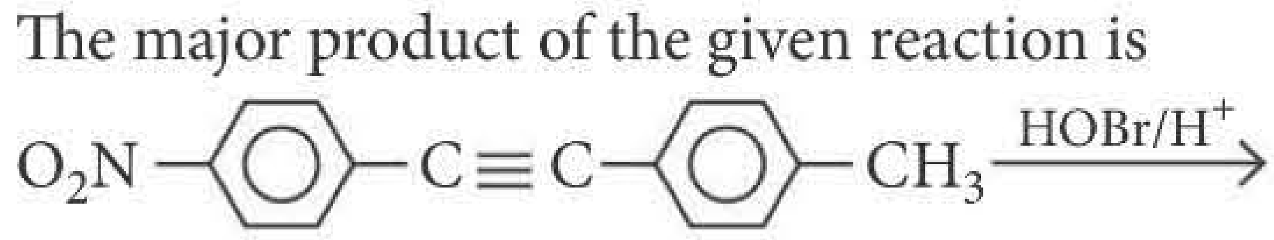
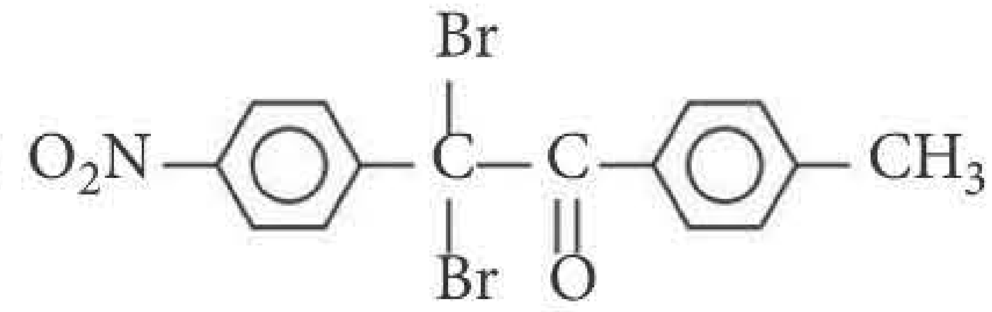
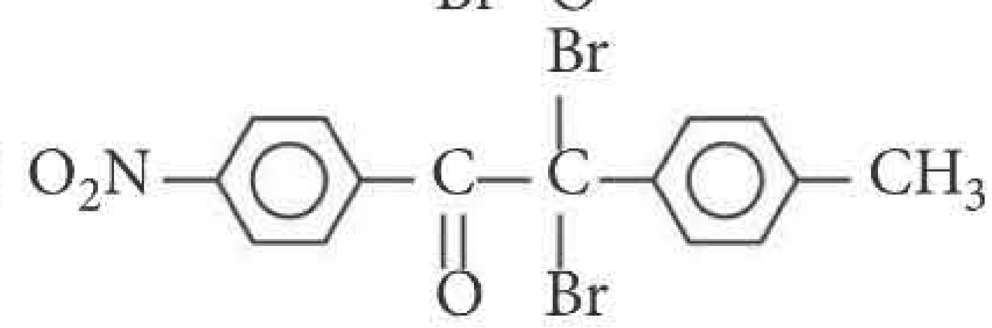
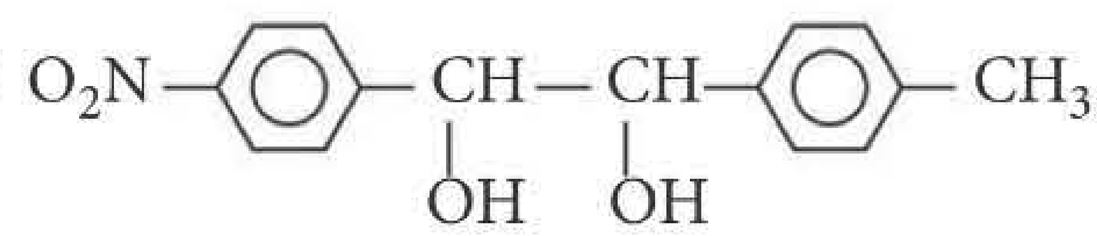
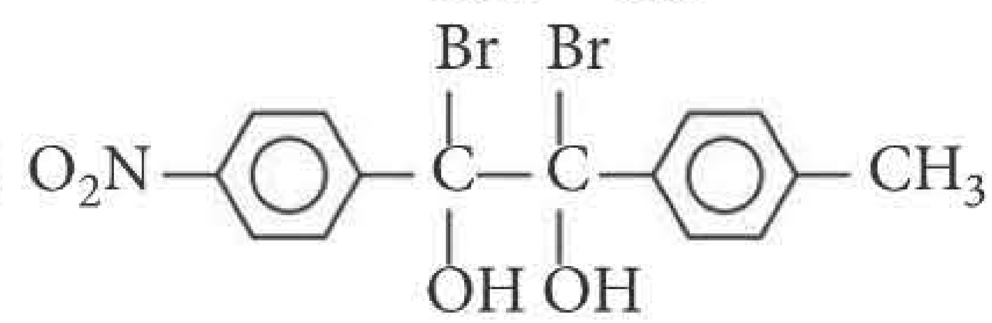
5. Identify the incorrect statement among the following.
(a) $CuSO_4$ reacts with KCl in aqueous solution to give Cu_2Cl_2.
(b) $CuSO_4$ reacts with KI in aqueous solution to give Cu_2I_2.
(c) $CuSO_4$ reacts with NaOH and glucose in aqueous medium to give Cu_2O.
(d) $CuSO_4$ on strong heating gives CuO.

6. Which of the following reactions will not give *N*, *N*-dimethylbenzamide ?
(a) 
(b) 
(c) 
(d) 

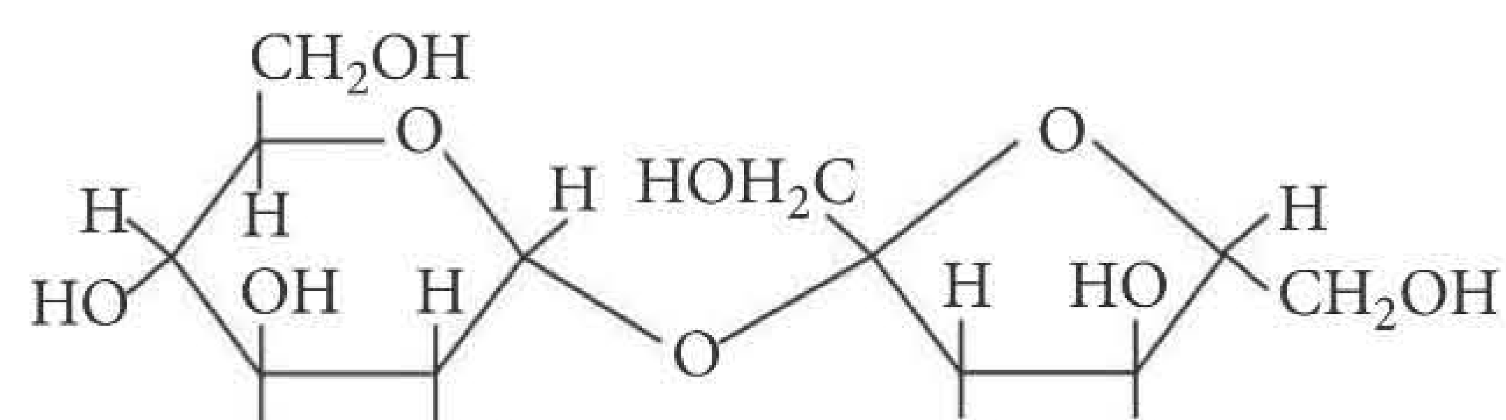
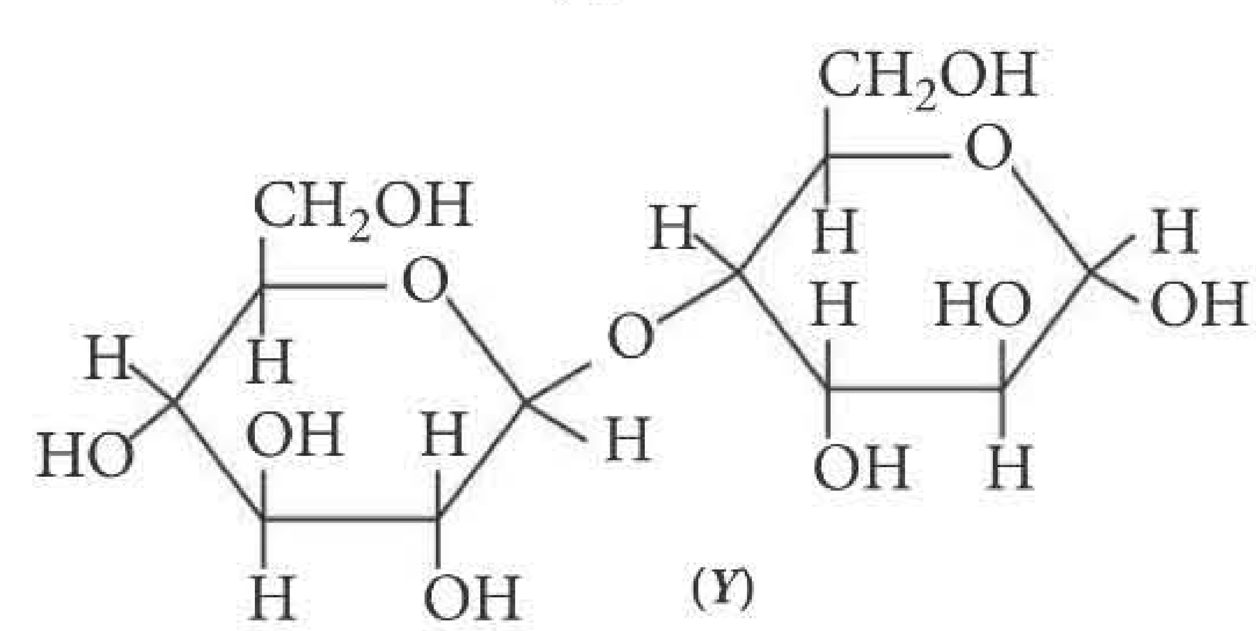
7. The spin magnetic moment of cobalt in $Hg[Co(SCN)_4]$ is
(a) 1.73 (b) 2.83 (c) 3.87 (d) 4.89

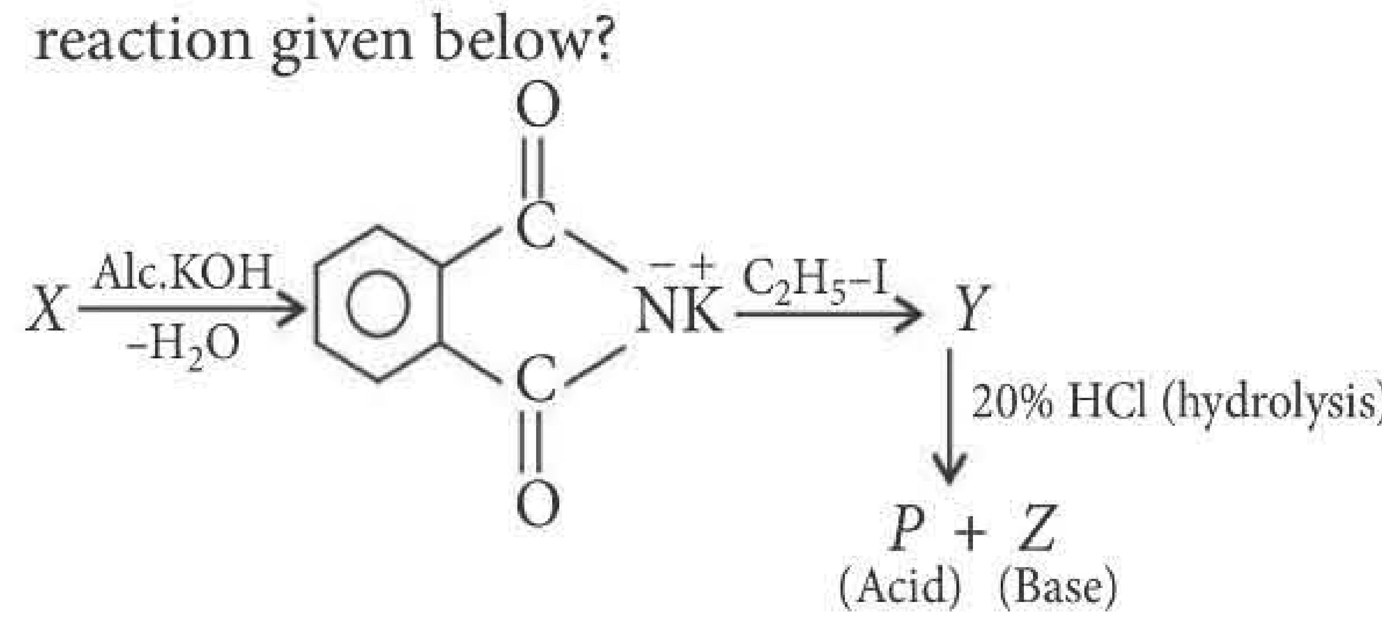
8. Which of the following gas molecules have maximum value of enthalpy of physisorption?
(a) C_2H_4 (b) Ne (c) H_2O (d) H_2

9. An organic compound forms a yellow crystalline solid with phenylhydrazine and gives a mixture of sorbitol and mannitol when reduced with sodium. Which among the following could be the compound?
(a) Fructose (b) Glucose
(c) Mannose (d) Sucrose

10. The major product of the given reaction is

(a) 
(b) 
(c) 
(d) 

MORE THAN ONE CORRECT OPTION

11. The correct statement(s) about the following sugars *X* and *Y* is (are)

(*X*)

(*Y*)
(a) *X* is a reducing sugar and *Y* is a non-reducing sugar.
(b) *X* is non-reducing sugar and *Y* is reducing sugar.
(c) The glucosidic linkages in *X* and *Y* are α and β, respectively.
(d) The glucosidic linkages in *X* and *Y* are β and α, respectively.

12. Which statement(s) is/are correct regarding the reaction given below?


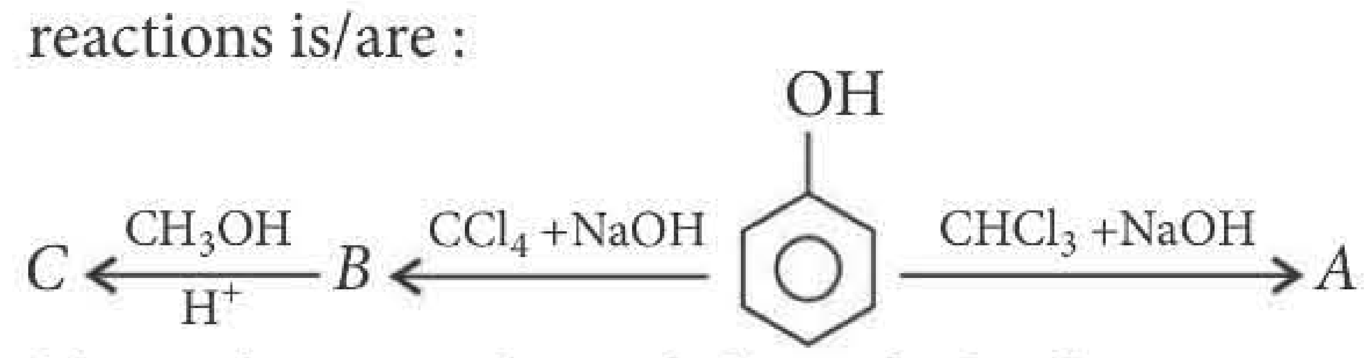
(a) Compound Y is N,N-diethylphthalimide.
(b) Compound X can be obtained by reacting P with ammonia.
(c) Compound Z is a primary amine.
(d) Compound Y is obtained by $E2$-mechanism.

13. For the given aqueous reactions, which of the statement(s) is (are) true?

$KI + K_3[Fe(CN)_6]$ (Excess) $\xrightarrow{\text{dilute } H_2SO_4}$ brownish-yellow solution $\xrightarrow{ZnSO_4}$ white precipitate + $\underbrace{\text{brownish-yellow filtrate}}$ $\xrightarrow{Na_2S_2O_3}$ Colourless solution

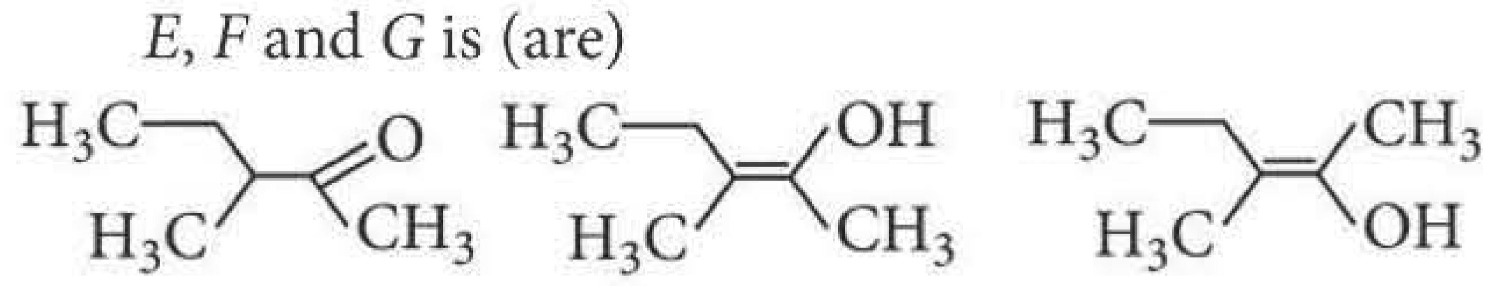
(a) The first reaction is a redox reaction.
(b) White precipitate is $Zn_3[Fe(CN)_6]_2$.
(c) Addition of filtrate to starch solution gives blue colour.
(d) White precipitate is soluble in NaOH solution.

14. Correct statement(s) regarding the following reactions is/are :



(a) product A is formed through the formation of dichlorocarbene
(b) product A is cinnamic acid
(c) product B is salicylic acid
(d) product C is oil of wintergreen.

15. The correct statement(s) concerning the structures E, F and G is (are)



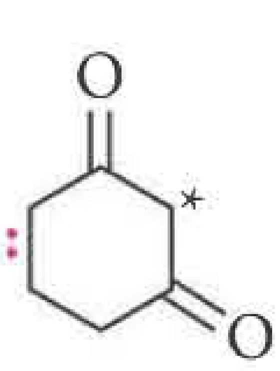
(E) (F) (G)

(a) E, F and G are resonance structures
(b) E, F and E, G are tautomers
(c) F and G are geometrical isomers
(d) F and G are diastereomers.

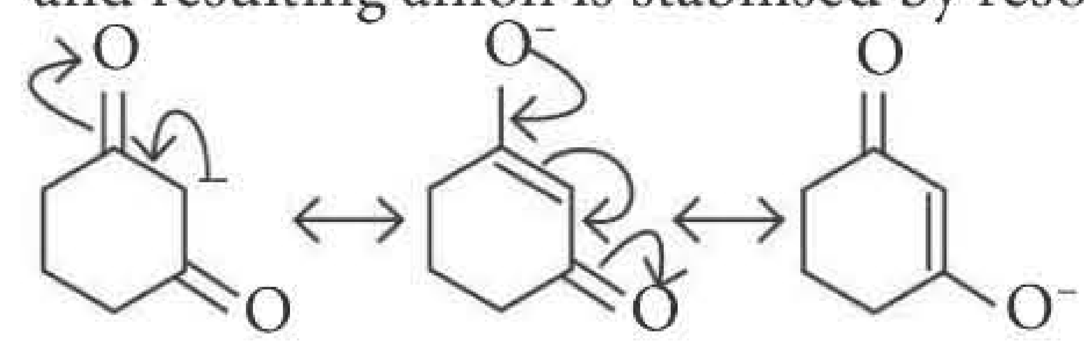
SOLUTIONS

1. **(c) :** When state of reduced metal changes from solid to liquid and then gas, there is steep increase in value of $\Delta G°$. In case of (1), (2) metal obtained is in gaseous state. In case of (3) it is in liquid state.

2. **(c)**

3. **(b) :** 

It contains the most reactive methylene group (*) and resulting anion is stabilised by resonance.



4. **(a) :** $\Lambda^\infty_m(HC) = \Lambda_m(HCl) + \Lambda_m(NaC) - \Lambda_m(NaCl)$
$= (426 + 83 - 126)\ \Omega^{-1}cm^2mol^{-1} = 383\ \Omega^{-1}cm^2mol^{-1}$
The molar conductivity of HC,

$$\Lambda_m(HC) = \frac{1000\times\kappa}{C} = \frac{3.83\times10^{-5}}{0.001}\times1000 = 38.3\ \Omega^{-1}cm^2mol^{-1}$$

The degree of dissociation,

$$\alpha = \frac{\Lambda_m(HC)}{\Lambda^\infty_m(HC)} = \frac{(38.3\ \Omega^{-1}cm^2mol^{-1})}{(383\ \Omega^{-1}cm^2mol^{-1})} = 0.1$$

$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{(10^{-3})(0.1)^2}{1-0.1} = 1.11\times10^{-5}$$

5. **(a) :** $2CuSO_4 + 4KI \rightarrow Cu_2I_2 + 2K_2SO_4 + I_2$ (not given by KCl)

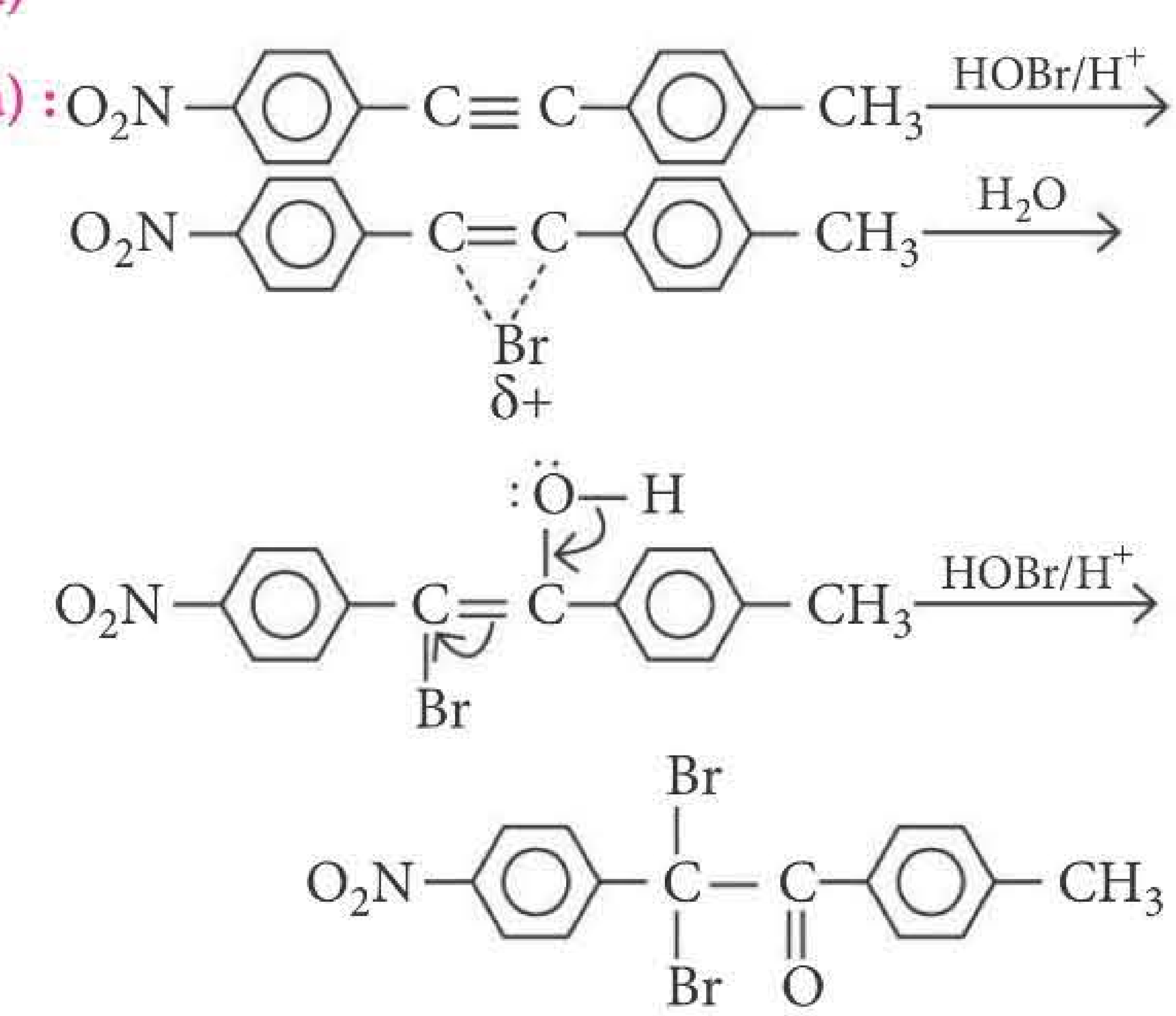
6. **(b) :** $C_6H_5CONH_2 + CH_3MgI \rightarrow C_6H_5CONHMgI + CH_4$

7. **(c) :** $Hg[Co(SCN)_4] \longrightarrow Hg^{2+} + [Co(SCN)_4]^{2-}$
Let oxidation state of cobalt be x.
$x + 4 \times (-1) = -2 \Rightarrow x = +2$
As SCN is a weak field ligand, hence no. of unpaired electrons in Co^{2+} (d^7 electronic configuration) is 3.
So, $\mu_s = \sqrt{3(3+2)} = 3.87$ B.M.

8. **(c) :** The more the liquefiable nature of a gas, the more is the enthalpy of adsorption. Water is more liquefiable.

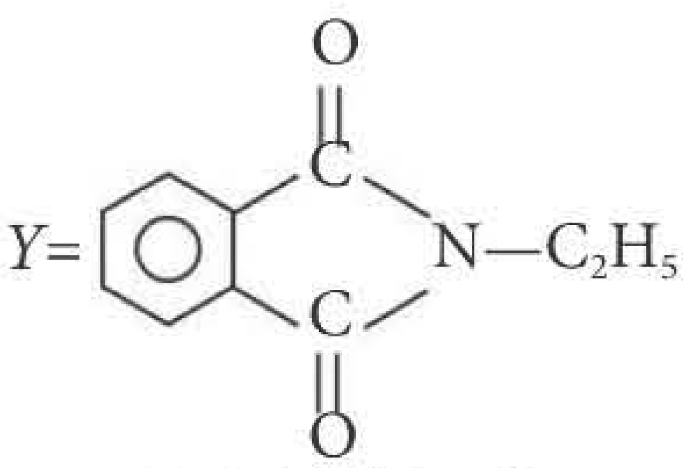
9. **(a)**

10. **(a) :**



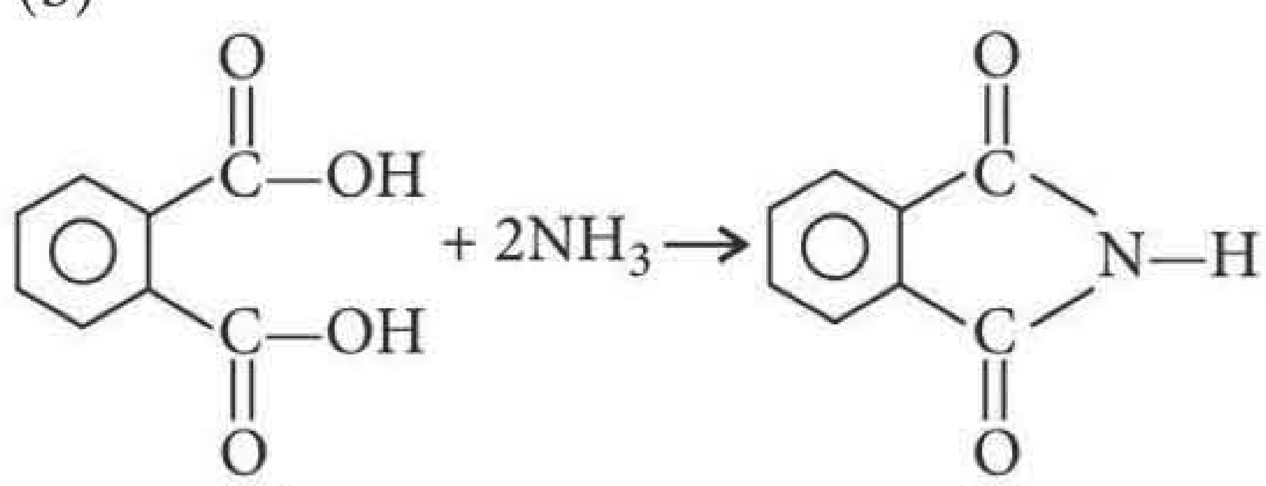
11. (b,c)

12. (b,c) : (a) $Y=$



N-ethylphthalimide

(b)



(*P*) (*X*)

(c) $Z = C_2H_5—NH_2$ (primary amine)

(d) The phthalimide anion is a strong nucleophile and it reacts with ethyl iodide by an S_N2 mechanism to give an *N*-ethylphthalimide.

13. (a,c,d) : $\underset{\text{Excess}}{KI_{(aq)}} + K_3[Fe(CN)_6]_{(aq)} \xrightarrow{\text{dil.}H_2SO_4}$

$\underset{\text{Brownish-yellow}}{KI_{3(aq)}} + K_4[Fe(CN)_6]_{(aq)} \xrightarrow{ZnSO_{4(aq)}}$

$\underset{\text{White ppt.}}{K_2Zn_3[Fe(CN)_6]_2}$ or $\underset{\text{White ppt.}}{[K_2Zn\{Fe(CN)_6\}]\downarrow} + KI_{3(aq)}$

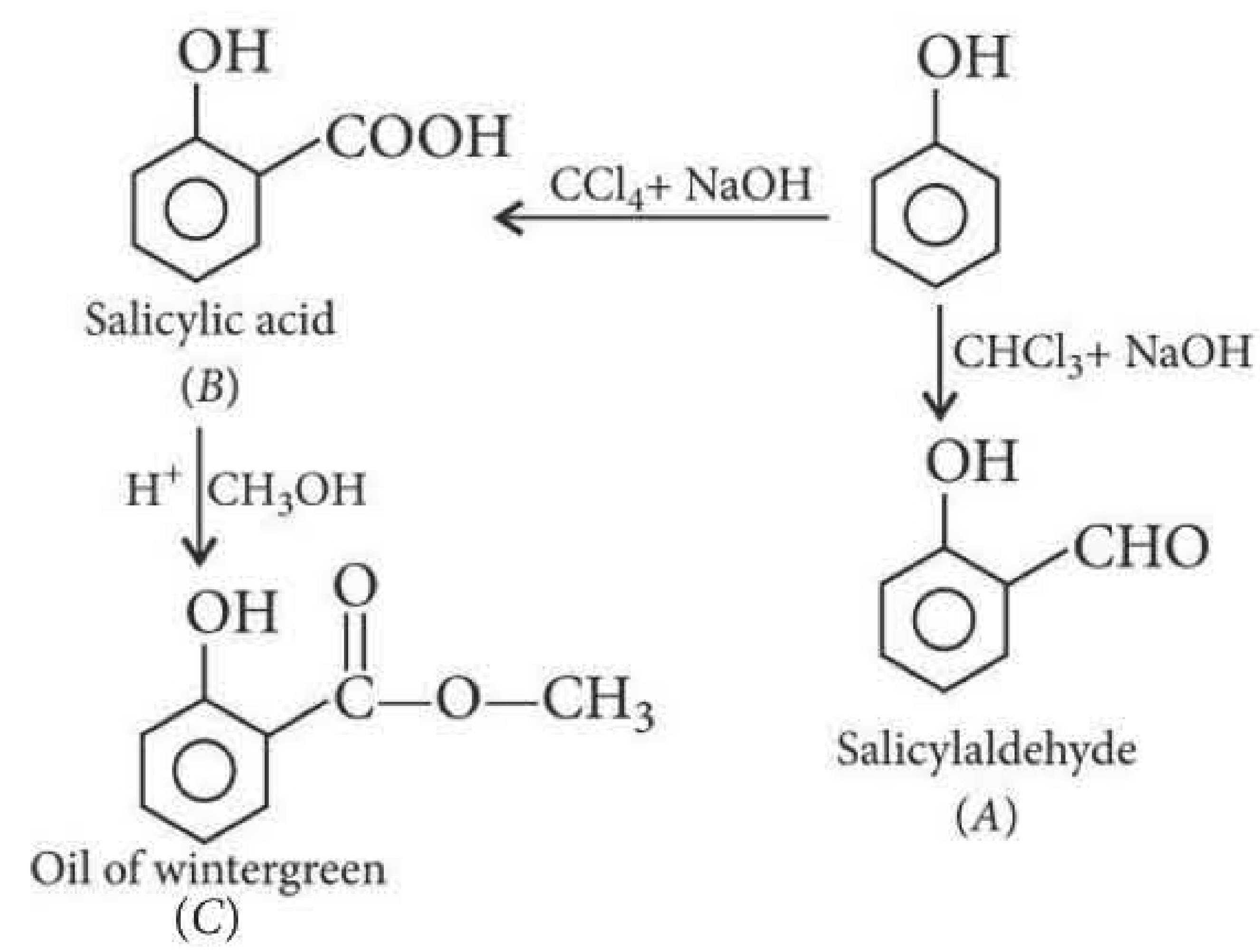
$KI_{3(aq)} + Na_2S_2O_3 \longrightarrow I^-_{(aq)} + \underset{\text{Colourless}}{S_4O^{2-}_{6(aq)}}$

$\underset{\text{White ppt.}}{K_2Zn_3[Fe(CN)_6]_2} + 12NaOH \longrightarrow 3[Zn(OH)_4]^{2-}_{(aq)} + 2[Fe(CN)_6]^{4-}_{(aq)} + 2K^+$

$KI_3 \rightleftharpoons KI + I_2$

$I_2 \xrightarrow[\text{Solution}]{\text{Starch}}$ Blue coloured complex

14. (a,c,d) :



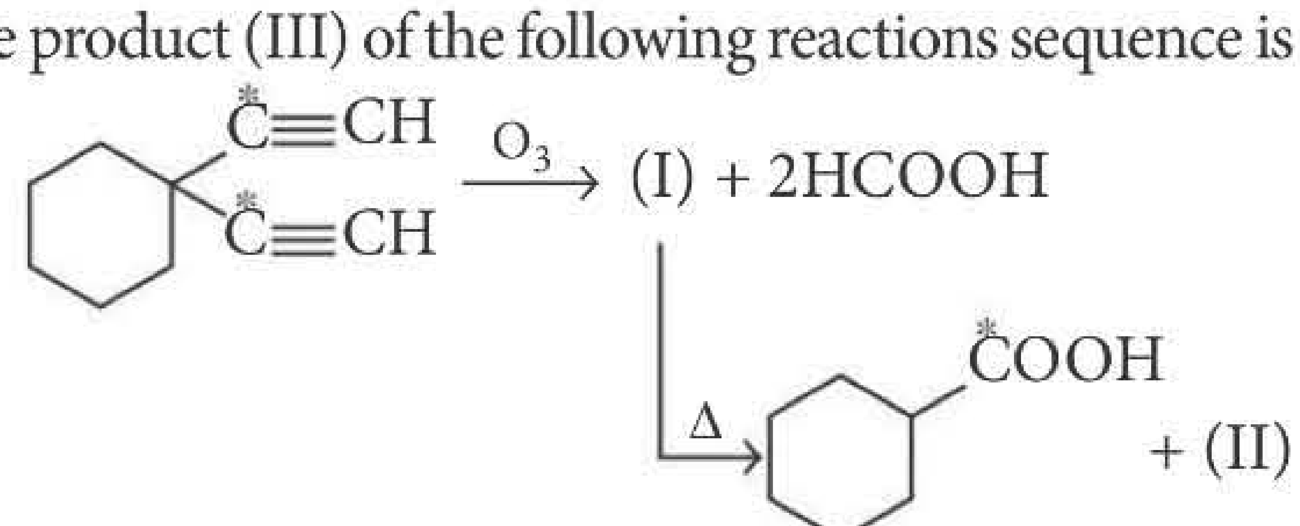
15. (b,c,d) : *E* and *F* as well as *E* and *G* differ in position of H atom, so these are tautomers not resonating structures. *F* and *G* are geometrical isomers and geometrical isomer are diastereomers.

GEAR UP FOR JEE MAIN 2020

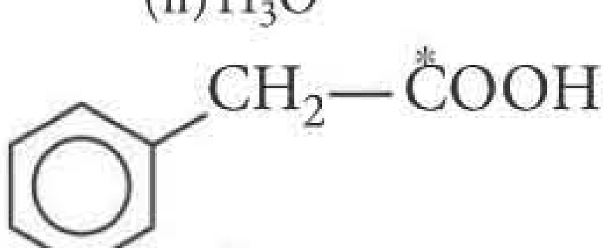
with Numerical Value Type Questions

1. Which of the following thermodynamic conditions at constant pressure and temperature is necessary for the spontaneity of a process?
   (a) $d(U - TS + PV) > 0$
   (b) $d(U - TS + PV) < 0$
   (c) $d(U - TS + PV) = 0$
   (d) $d(U + TS + PV) < 0$

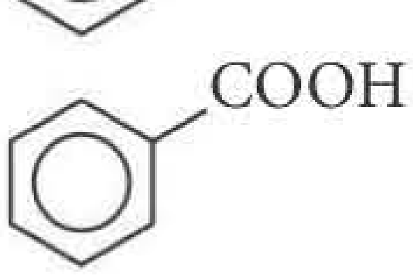
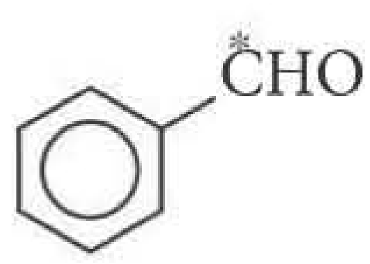
2. The product (III) of the following reactions sequence is

   (i) 

   (ii) (II) $\xrightarrow[\text{(ii) } H_3O^+]{\text{(i) PhMgBr}}$ (III)

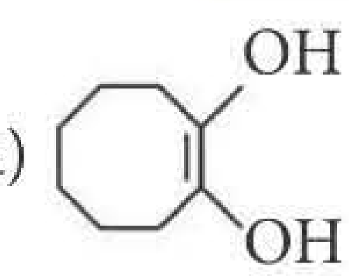
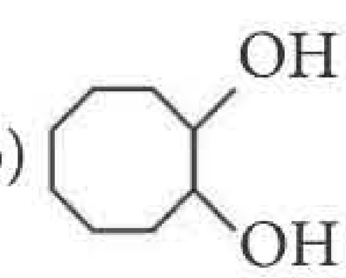
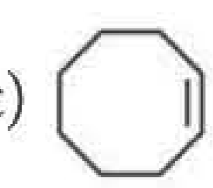
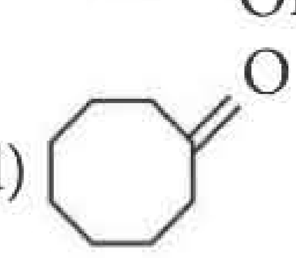
   (a) 

   (b) 

   (c)  (d) 

3. In the manufacture of H_2SO_4, the nitrated acid from the Gay-Lussac's tower is chemically
   (a) $NO_2 \cdot H_2SO_4$ (b) $NO \cdot H_2SO_4$
   (c) $NO \cdot 2H_2SO_4$ (d) $NO \cdot HSO_4$

4. Find the equilibrium constant for the reaction,
   $Cu^{2+} + In^{2+} \rightleftharpoons Cu^+ + In^{3+}$
   Given that, $E^\circ_{Cu^{2+}|Cu^+} = 0.15$ V, $E^\circ_{In^{2+}|In^+} = -0.4$ V, $E^\circ_{In^{3+}|In^+} = -0.42$ V
   (a) 10^{10} (b) 10^{15}
   (c) 10^{20} (d) 10^{18}

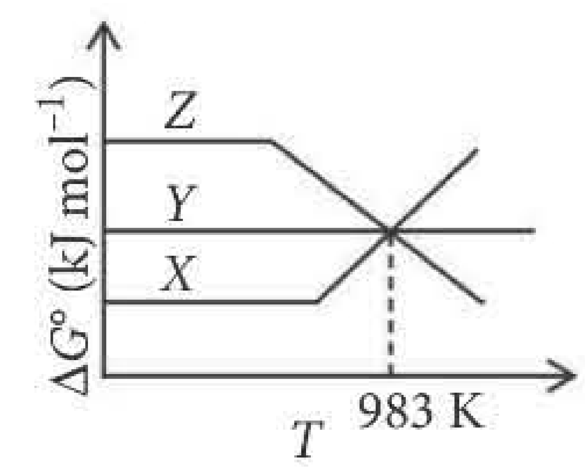
5. The reaction of cyclooctyne with $HgSO_4$ in the presence of aqueous H_2SO_4 gives
   (a)  (b) 
   (c)  (d) 

6. For the two gaseous reactions, following data is given :
   $A \rightarrow B;\ k_1 = 10^{10}\ e^{-20000/T}$
   $C \rightarrow D;\ k_2 = 10^{12}\ e^{-24606/T}$
   the temperature at which k_1 becomes equal to k_2 is
   (a) 400 K (b) 1000 K
   (c) 800 K (d) 1500 K

7. The number of hexagonal faces present in a truncated octahedron is
   (a) 6 (b) 8
   (c) 4 (d) 16

8. Identify the product for the given reaction.
   $$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-OC_2H_5 \xrightarrow[H_2O]{Na\overset{*}{O}H} \text{Product}$$
   (a) $CH_3-CH_2-\overset{\overset{O}{\|}}{C}-\overset{*}{O}^-$
   (b) $CH_3-CH_2-\overset{\overset{\overset{*}{O}}{\|}}{C}-O^-$
   (c) $CH_3CH_2-\overset{*}{O}-H$
   (d) Both (a) and (b)

9. In the given Ellingham diagram, X, Y and Z represent graph for metal oxides. At temperature below 983 K

   (a) Y will reduce oxide Z
   (b) Y will reduce oxide X
   (c) Z will reduce oxide X
   (d) Z will reduce oxide Y.

10. Which one of the following represents the correct increasing order of bond angles in the given molecules?

(a) $H_2O < OF_2 < OCl_2 < ClO_2$
(b) $OCl_2 < ClO_2 < H_2O < OF_2$
(c) $OF_2 < H_2O < OCl_2 < ClO_2$
(d) $ClO_2 < OF_2 < OCl_2 < H_2O$

11. Predict the order of Δ_o for the following compounds :

I. $[Fe(H_2O)_6]^{2+}$
II. $[Fe(CN)_2(H_2O)_4]$
III. $[Fe(CN)_4(H_2O)_2]^{2-}$

(a) (I) < (II) < (III)
(b) (II) < (I) < (III)
(c) (III) < (II) < (I)
(d) (II) < (III) < (I)

12. Reaction of cyclohexanone with dimethylamine in the presence of catalytic amount of an acid forms a compound if water during the reaction is continuously removed. The compound formed is generally known as

(a) an enamine (b) a Schiff's base
(c) an amine (d) an imine.

13. Which of the following is aromatic?

(a) [10]-Annulene (b) [14]-Annulene
(c) [16]-Annulene (d) [18] -Annulene

14. The electronegativities of H and Cl are 2.1 and 3.0 respectively. The correct statement about the nature of HCl is

(a) 17% ionic (b) 83% ionic
(c) 50% ionic (d) 100% ionic.

15. Identify I, II and III for the given reactions sequence.

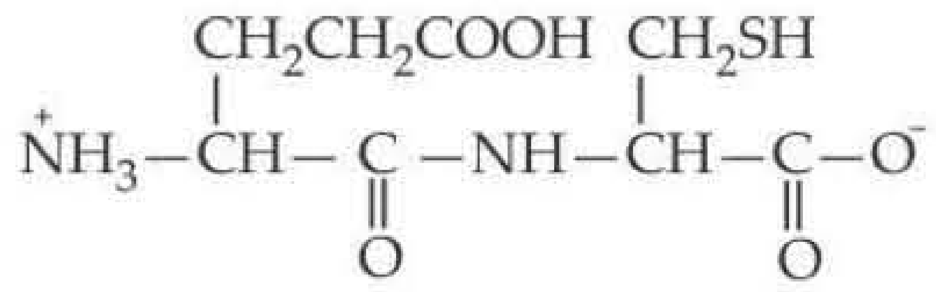
$$FeCr_2O_4 \xrightarrow{\text{I}} Na_2CrO_4 \xrightarrow{\text{II}} Na_2Cr_2O_7 \xrightarrow{\text{III}} Na_2Cr_2O_4$$

	I	II	III
(a)	Na_2CO_3/air, Δ	H_2SO_4	C
(b)	NaOH/air, Δ	C, Δ	C, Δ
(c)	Na_2CO_3/air, Δ	C, Δ	C, Δ
(d)	NaOH/air, Δ	Al, Δ	C, Δ

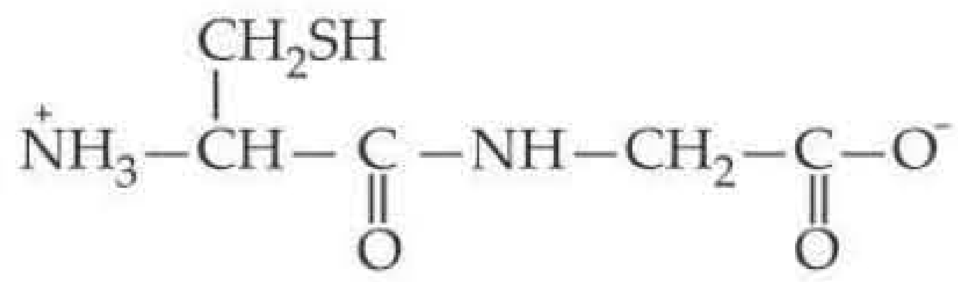
16. 1.325 g sample of fertilizer is heated with H_2SO_4 and then treated with alkali. The gas evolved is passed into 50.0 mL of 0.2030 N H_2SO_4. 25.32 mL of 0.1980 N NaOH are required for the titration of unused acid. The percentage of nitrogen in the fertilizer is

(a) 5.30% (b) 5.43%
(c) 4.99% (d) 6.01%

17. A tripeptide (*X*) on partial hydrolysis gave two dipeptides *Cys-Gly* and *Glu-Cys*, *i.e.*,



Glu-Cys

and 

Cys-Gly

Identify the tripeptide.

(a) *Glu-Cys-Gly* (b) *Gly-Glu-Cys*
(c) *Cys-Gly-Glu* (d) *Cys-Glu-Gly*

18. Which is not correct?

(a) $Ge(OH)_2$ is amphoteric.
(b) $GeCl_2$ is more stable than $GeCl_4$.
(c) GeO_2 is weakly acidic.
(d) $GeCl_4$ in HCl forms $[GeCl_6]^{2-}$ ion.

19. The enthalpy change involved in the oxidation of glucose is -2880 kJ mol^{-1}. 25% of this energy is available for muscular work. If 100 kJ of muscular work is needed to walk one km, what is the maximum distance that a person will be able to walk after eating 120 g of glucose?

(a) 4.80 km (b) 5.25 km
(c) 3.80 km (d) 5.75 km

20. Elastol is a polymer used to cleanup oil spill. It is a non-toxic, non-dispersant chemical. One gallon can remove 150 gallons of heavy oil. The monomer of elastol is

(a) $CH_2{=}CH{-}CN$ (b) $CH_2{=}\underset{\underset{CH_3}{|}}{C}{-}CH_3$

(c) $CH_2{=}\underset{\underset{CH_3}{|}}{C}{-}COOCH_3$

(d) $CH_2{=}CH{-}Ph$

NUMERICAL VALUE TYPE

21. 29.5 mg of an organic compound containing nitrogen was digested according to Kjeldahl's method and the evolved ammonia was absorbed in 20 mL of 0.1 M HCl solution. The excess of the acid required 15 mL of 0.1 M NaOH solution for complete neutralisation. The percentage of nitrogen in the compound is________.

22. A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g. The total number of C and H atoms in the molecular formula of gas is________.

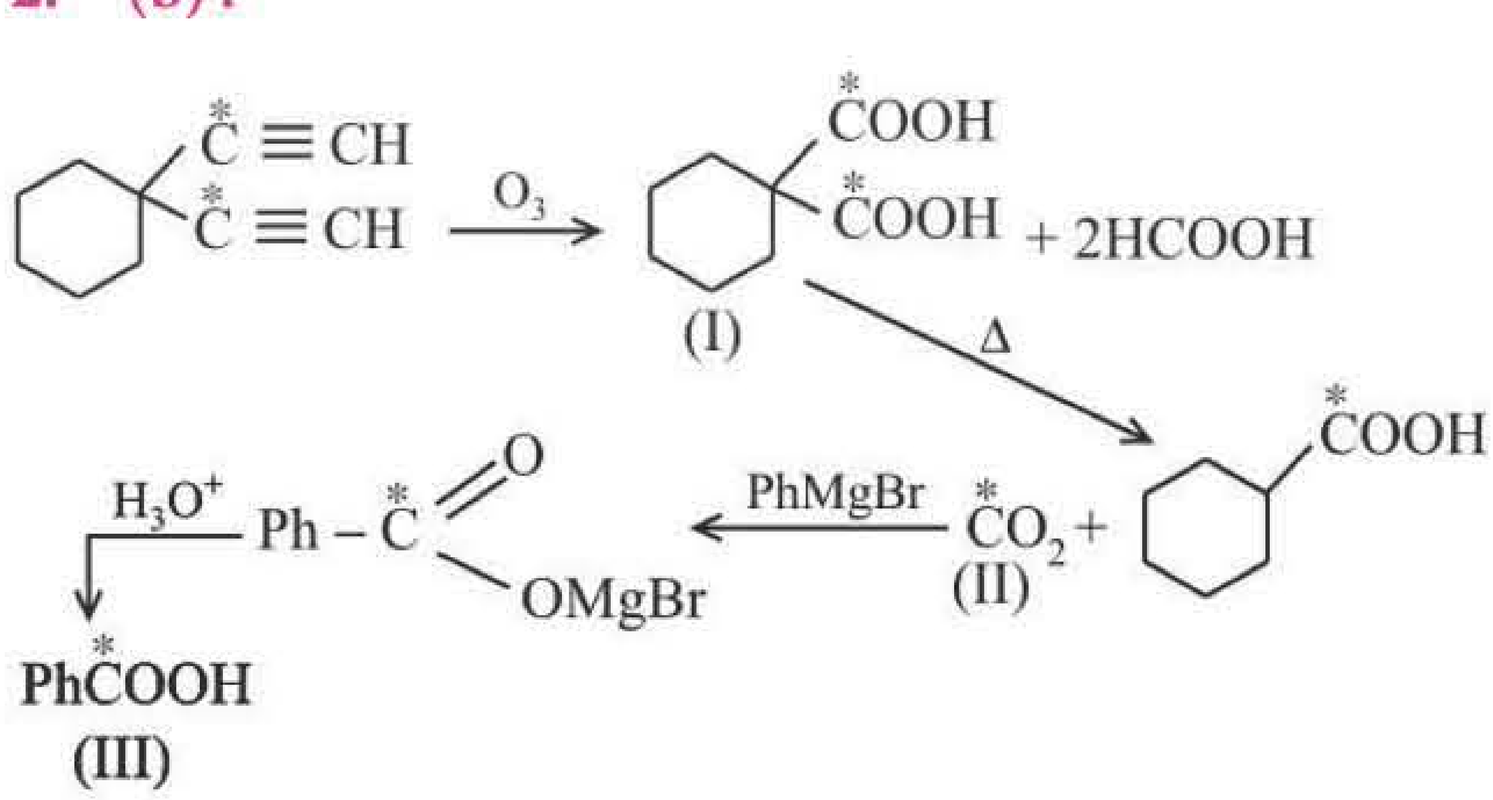
23. 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water. The vapour pressure of water (in torr) for this aqueous solution at 100°C is_____.

24. Bromine monochloride, BrCl decomposes into bromine and chlorine and reaches the equilibrium : $2BrCl_{(g)} \rightleftharpoons Br_{2(g)} + Cl_{2(g)}$ for which $K_c = 32$ at 500 K. If initially pure BrCl is present at a concentration of 3.3×10^{-3} mol L^{-1}, then its molar concentration in the mixture at equilibrium is $x \times 10^{-4}$ mol L^{-1}. The value of x is ______.

25. x mL of 0.5 M H_2SO_4 is needed to dissolve 0.5 g of copper (II) carbonate. The value of x is______.

SOLUTIONS

1. **(b)**
2. **(b) :**



3. **(d) :** $2H_2SO_4 + NO + NO_2 \longrightarrow 2NO{\cdot}HSO_4 + H_2O$

4. **(a) :** $Cu^{2+} + e^- \rightarrow Cu^+; \qquad \Delta G_1^\circ = -0.15\ F$

$In^{2+} + e^- \rightarrow In^+; \qquad \Delta G_2^\circ = +0.40\ F$

$In^+ \rightarrow In^{3+} + 2e^-; \qquad \Delta G_3^\circ = -0.84\ F$

$\therefore \quad Cu^{2+} + In^{2+} \rightarrow Cu^+ + In^{3+}; \qquad \Delta G^\circ = -0.59\ F$

$\Delta G^\circ = -nFE^\circ = -0.59\ F$

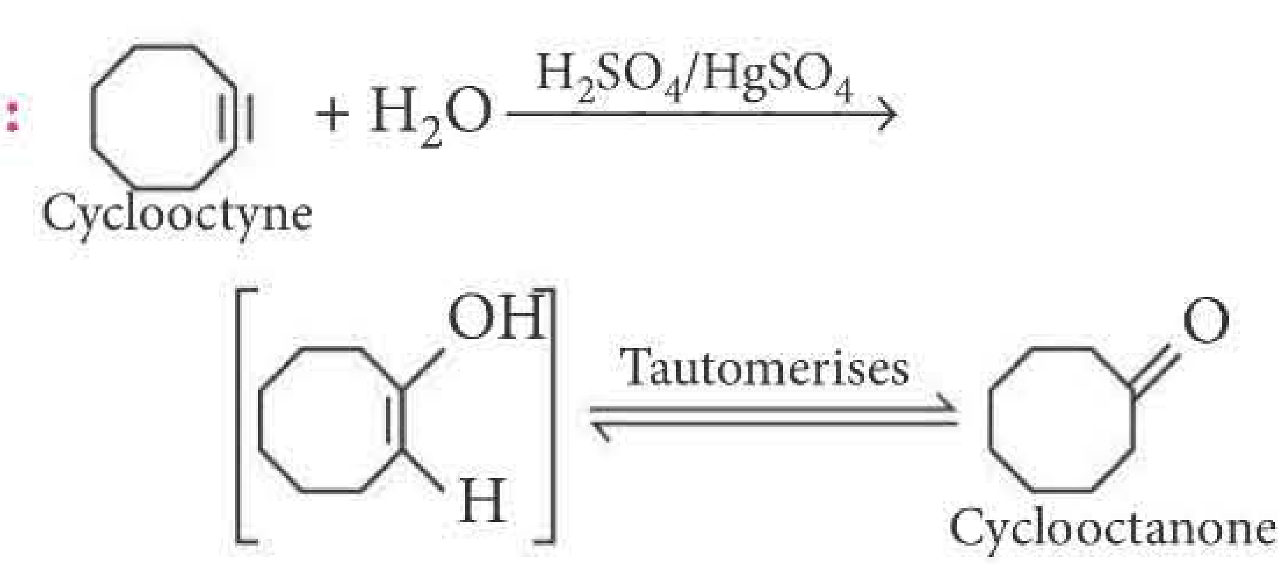
or $\quad -1 \times E^\circ_{cell}\, F = -0.59\ F \quad \therefore \quad E^\circ_{cell} = 0.59\ V$

At equilibrium, $E^\circ_{cell} = \dfrac{0.0591}{n} \log K_c$

$\therefore\ 0.59 = \dfrac{0.0591}{1} \log K_c$

Hence, $K_c = \text{antilog}\left(\dfrac{0.59}{0.0591}\right) = 10^{10}$

5. **(d) :**



6. **(b) :** $A \rightarrow B;\ k_1 = 10^{10} e^{-20000/T}$

$C \rightarrow D;\ k_2 = 10^{12} e^{-24606/T}$

When, $k_1 = k_2$

$10^{10} e^{-20000/T} = 10^{12} e^{-24606/T}$

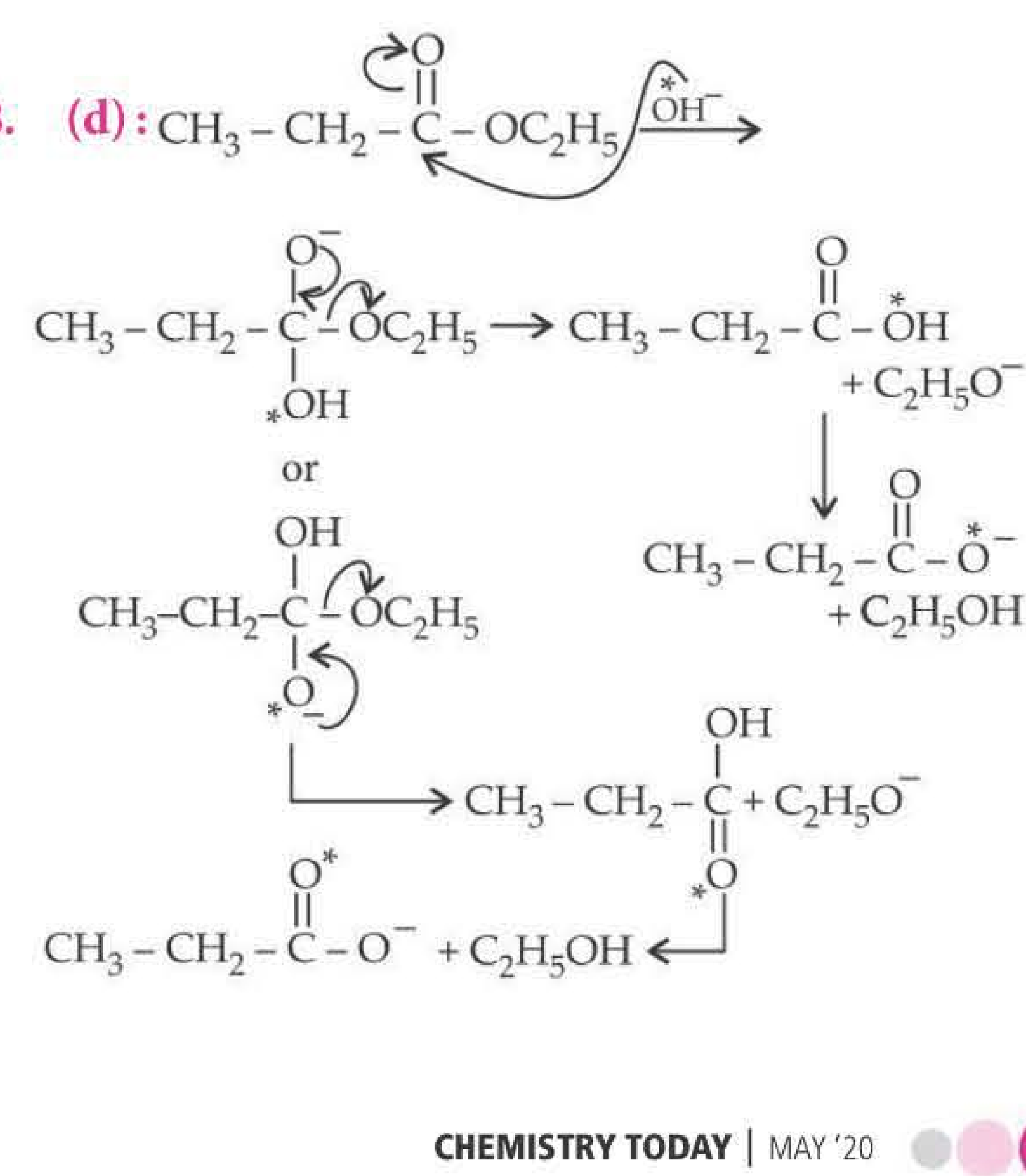
$e^{4606/T} = 100$

$\dfrac{4606}{T} = 2.303 \log 100 = 2.303 \times 2$

$\therefore \quad T = \dfrac{4606}{2.303 \times 2} = 1000\ K$

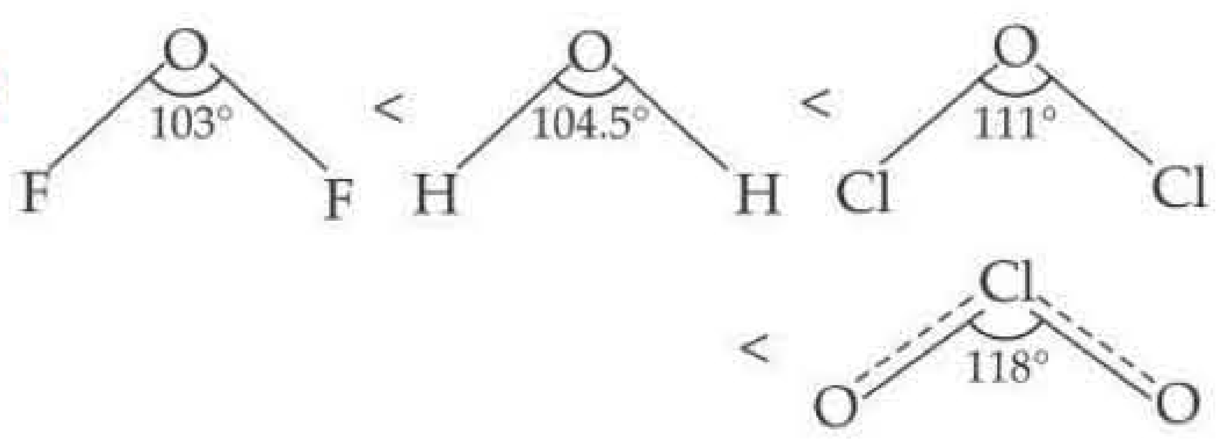
7. **(b) :** Truncated octahedron has 14 faces, 8 regular hexagonals and 6 squares.

8. **(d) :**



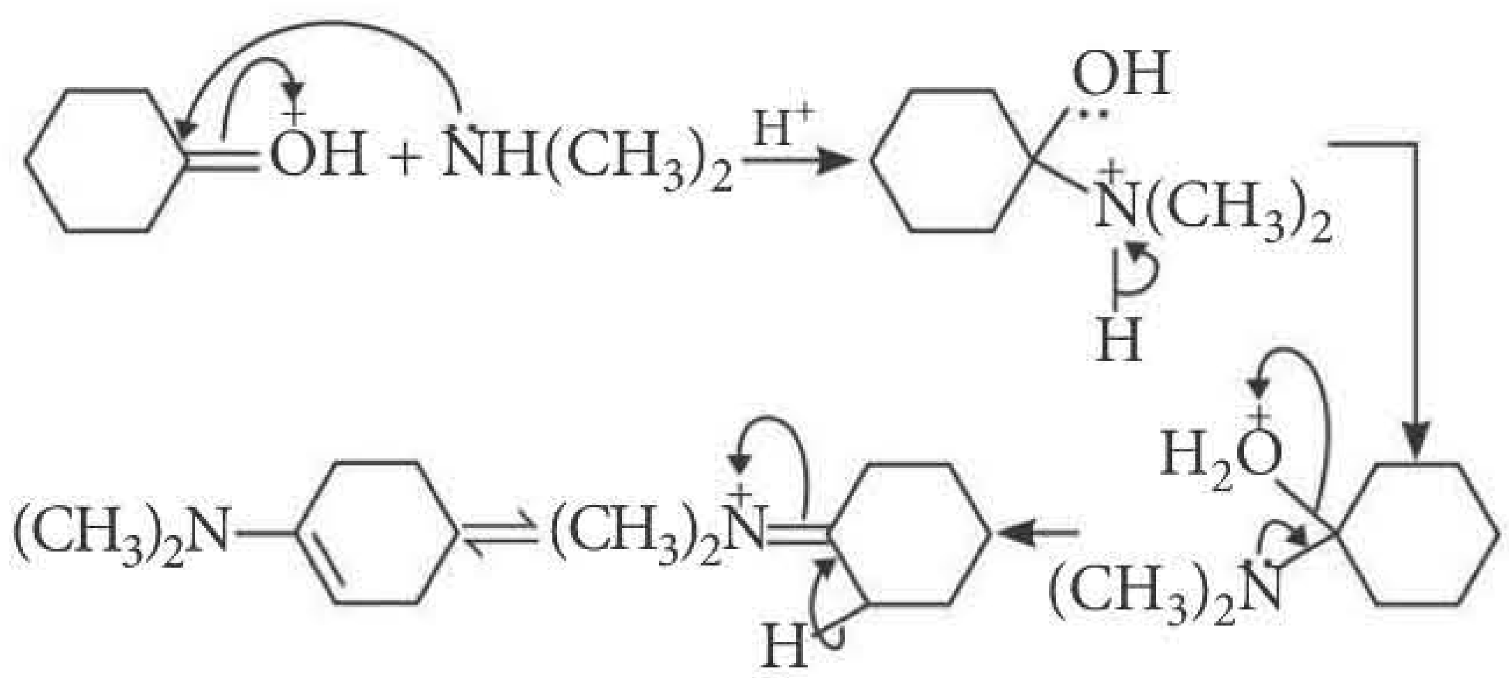
9. **(a) :** ΔG° of Y is less than Z and hence, it will reduce oxide of Z.

10. **(c) :**



11. **(a) :** The value of Δ_o for mixed ligands depends on the additive contributions of the ligand strengths. Since, CN^- has greater ligand strength than H_2O, the strength increases as the number of CN^- ions increases. Hence, the correct order of Δ_o is III > II > I.

12. **(a) :**



13. **(d):** [18]-Annulene is aromatic since it is planar and contains $(4n + 2)$ π-electrons. Although annulenes [10] and [14] also contain $(4n + 2)$ π-electrons but the crowding of hydrogens inside the ring prevents planarity and hence are not aromatic.

14. **(a) :** % ionic character $= 16(\chi_A - \chi_B) + 3.5(\chi_A - \chi_B)^2$

$= 16(3.0 - 2.1) + 3.5(3.0 - 2.1)^2$

$= 14.4 + 2.835 = 17.235 \approx 17\%$

15. **(a) :**

$$\underbrace{4FeCr_2O_4 + 8Na_2CO_3 + 7O_2}_{\text{(I)}} \xrightarrow{\Delta} 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$

$$2Na_2CrO_4 \xrightarrow{H_2SO_4(II)} Na_2Cr_2O_7 + Na_2SO_4 + H_2O$$

$$3CO + Na_2Cr_2O_4 \xleftarrow{3C(III)} Na_2Cr_2O_7$$

16. **(b):** Weight of sample $(W) = 1.325$ g

Volume of acid (H_2SO_4) used $(V_1) = 50$ mL

Normality of acid $(N_1) = 0.2030$ N

Volume of alkali required $(V_2) = 25.32$ mL

Normality of alkali $(N_2) = 0.1980$ N

Milliequivalents of H_2SO_4 left after reaction with NH_3 = Milliequivalents of alkali used for neutralisation of rest $H_2SO_4 = N_2V_2 = 0.1980 \times 25.32 = 5.013$

Milliequivalents of H_2SO_4 taken to absorb NH_3

$= N_1V_1$

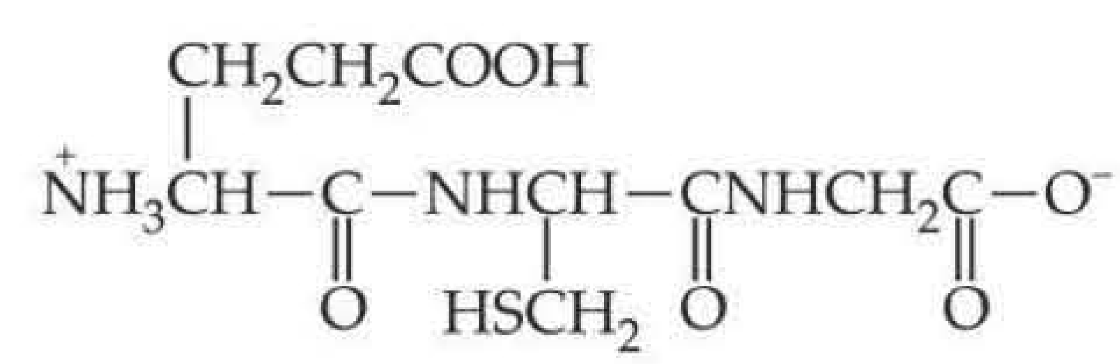
$= 0.2030 \times 50 = 10.15$

$\therefore$ Milliequivalents of H_2SO_4 which has reacted with $NH_3(x)$ = Milliequivalents of acid taken − Milliequivalents of acid left

$= 10.15 - 5.013 = 5.137$

Now, % N $= \dfrac{1.4x}{W} = \dfrac{1.4 \times 5.137}{1.325} = 5.43\%$

17. **(a) :** Since the tripeptide on hydrolysis gave two dipeptides *Glu-Cys* and *Cys-Gly*. Hence, cystine must be in between glutamic acid and glycine.



Glu-Cys-Gly

18. **(b) :** Ge^{4+} is more stable than Ge^{2+}, thus $GeCl_4$ is more stable than $GeCl_2$.

19. **(a) :** Molar mass of glucose $(C_6H_{12}O_6) = 180$ g mol^{-1}

Combustion reaction of glucose can be written as

$C_6H_{12}O_{6(s)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$;

$\Delta H = -2880$ kJ mol^{-1}

Number of moles of 120 g of glucose

$= \dfrac{120 \text{ g}}{180 \text{ g mol}^{-1}} = \dfrac{2}{3}$ mol

Enthalpy available from 120 g of glucose

$= \dfrac{2}{3} \times 2880 = 1920$ kJ

Enthalpy available for muscular work $= 1920 \times \dfrac{25}{100}$

$= 480$ kJ

Distance to which a person can move

$= \left(\dfrac{1 \text{ km}}{100 \text{ kJ}}\right) \times 480 \text{ kJ} = 4.80$ km

20. **(b) :** Elastol is a polymer of 2-methylpropene.

21. **(23.7) :**

The % of N according to Kjeldahl's method

$= \dfrac{1.4 \times N_1 \times V}{w}$

N_1 = Normality of the standard acid = 0.1 N

w = Mass of the organic compound taken

$= 29.5 \text{ mg} = 29.5 \times 10^{-3}$ g

V = Volume of N_1 acid neutralised by ammonia

$= (20 - 15) = 5$ mL

$\Rightarrow \quad \%N = \dfrac{1.4 \times 0.1 \times 5}{29.5 \times 10^{-3}} = 23.7$

22. (4) : Number of moles of CO_2

$= \dfrac{3.38}{44} = 0.0768$

No. of moles of C = 0.0768

No. of moles of $H_2O = \dfrac{0.690}{18} = 0.0383$

$\therefore$ No. of moles of H = 2 × 0.0383 = 0.0766

(i) The ratio of moles of C to H is 0.0768 : 0.0766 or 1 : 1

Therefore, empirical formula = CH

(ii) 10.0 L of fuel gas at STP weighs

$= \dfrac{11.6 \times 22.4}{10} = 25.98$ g

$\therefore$ Molar mass of gas = 25.98 g ≈ 26 g mol^{-1}

(iii) $n = \dfrac{\text{molar mass}}{\text{empirical formula mass}} = \dfrac{26}{13} = 2$

$\therefore$ Molecular formula = (empirical formula)$_n$

$= (CH)_2 = C_2H_2$

The total no. of C and H atoms in C_2H_2 = 4

23. (752.4) : $\dfrac{p^\circ - p_s}{p_s} = \dfrac{n}{N}$

$\dfrac{760 - p_s}{p_s} = \dfrac{18/180}{178.2/18} = \dfrac{1/10}{9.9}$

$\Rightarrow \quad 760 - p_s = \dfrac{1}{99} p_s \Rightarrow 760 \times 99 - 99 p_s = p_s$

$\Rightarrow 100 p_s = 760 \times 99$

$\Rightarrow \quad p_s = \dfrac{760 \times 99}{100} = 752.4$ torr

24. (3) : $2BrCl_{(g)} \rightleftharpoons Br_{2(g)} + Cl_{2(g)}$

	$2BrCl_{(g)}$	$Br_{2(g)}$	$Cl_{2(g)}$
Initial	3.30×10^{-3} mol L^{-1}	0	0
At eq.	$(3.30 \times 10^{-3} - x)$	$\frac{x}{2}$	$\frac{x}{2}$

$K_c = \dfrac{(x/2)(x/2)}{(3.30 \times 10^{-3} - x)^2} = 32$ (Given)

or $\dfrac{x}{2(3.30 \times 10^{-3} - x)} = \sqrt{32} = 5.66$

or $x = 11.32(3.30 \times 10^{-3} - x)$

or $12.32x = 11.32 \times 3.30 \times 10^{-3}$

or $x = 3.0 \times 10^{-3}$

$\therefore$ At eq., [BrCl] = $(3.30 \times 10^{-3} - 3.0 \times 10^{-3})$

$= 0.30 \times 10^{-3} = 3.0 \times 10^{-4}$ mol L^{-1}

25. (8.09) :

Applying Dilution law,

$M_1V_1 = M_2V_2$

meq. of H_2SO_4 = meq. of $CuCO_3$

Eq. wt. $= \dfrac{\text{Mol. wt.}}{\text{Valency}}$

Equivalent weight of $CuCO_3 = \dfrac{M}{2} = \dfrac{123.5}{2}$

$2 \times 0.5 \times V_1 = \dfrac{0.5 \times 2 \times 1000}{123.5}$

$\Rightarrow V_1 = 8.09$ mL

◈◈

Monthly Test Drive CLASS XII ANSWER KEY

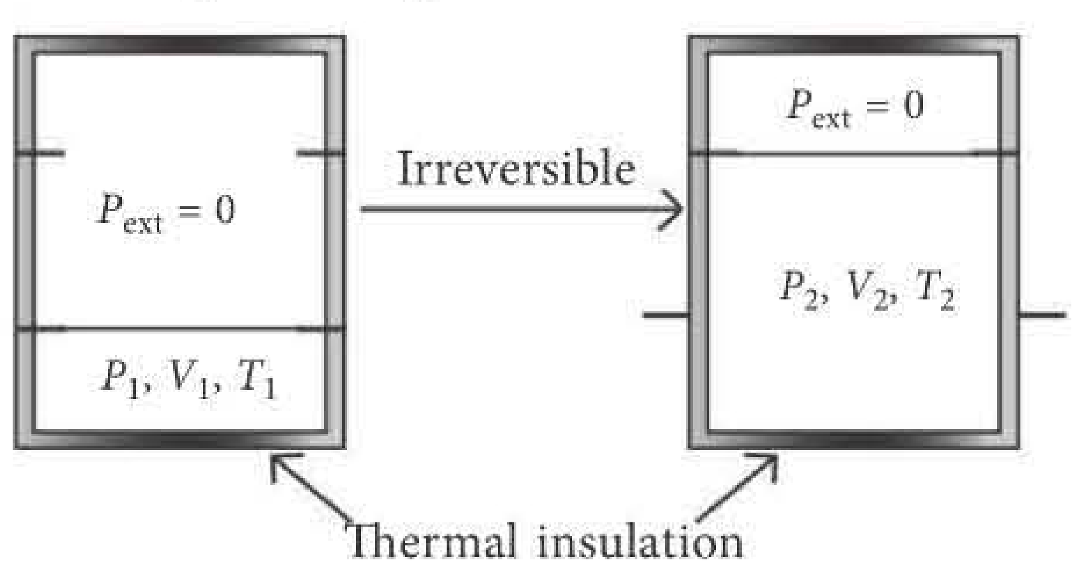
1. (b)	2. (c)	3. (d)	4. (a)	5. (c)
6. (a)	7. (b)	8. (a)	9. (d)	10. (b)
11. (b)	12. (c)	13. (d)	14. (b)	15. (b)
16. (b)	17. (a)	18. (a)	19. (c)	20. (b, c,d)
21. (b, d)	22. (a,b,c,d)		23. (a,b,d)	24. (4)
25. (0)	26. (1)	27. (a)	28. (c)	29. (d)
30. (b)				

JEE Advanced

PRACTICE PAPER 2020

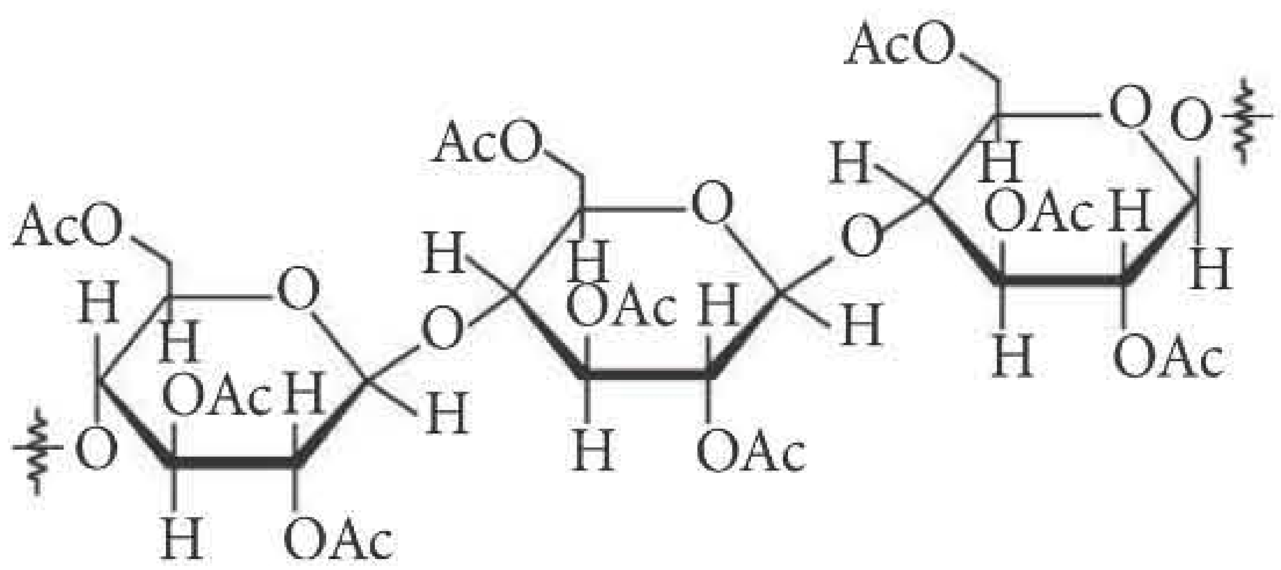
1. Two weak acid solutions HA_1 and HA_2, each with the same concentration and having pK_a values 3 and 5, are placed in contact with hydrogen electrode (1 atm, 25 °C) and are interconnected through a salt bridge. The emf of the cell is
   (a) 0.21 V (b) 0.059 V
   (c) 0.018 V (d) 0.021 V

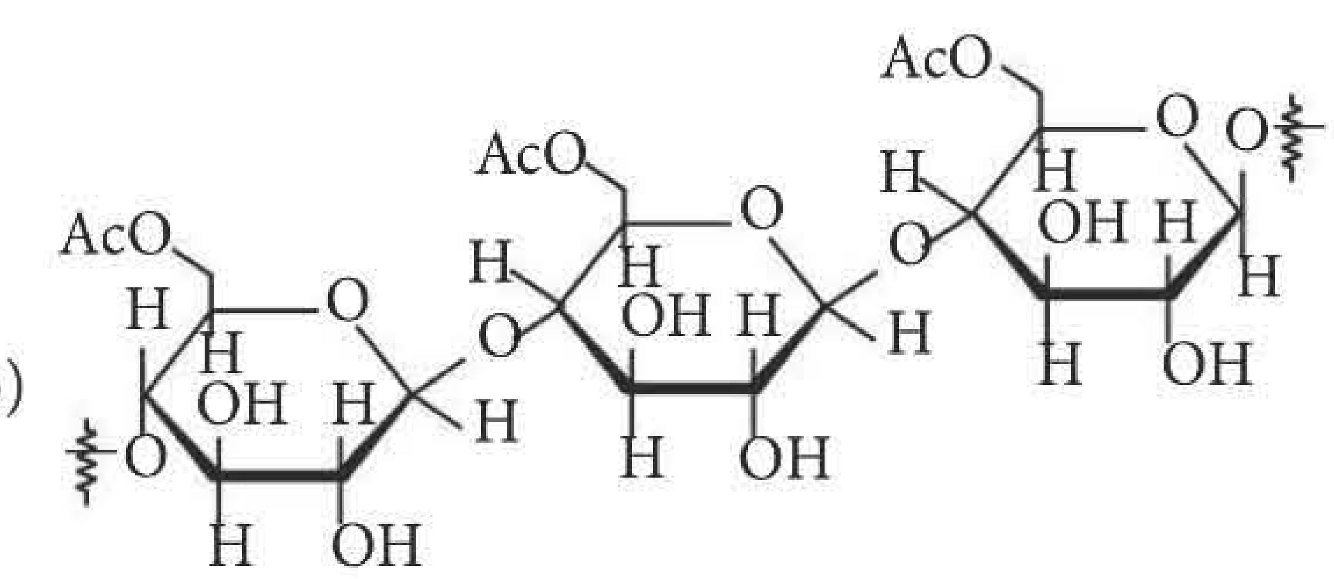
2. An ideal gas in a thermally insulated vessel at internal pressure = P_1, volume = V_1 and absolute temperature = T_1 expands irreversibly against zero external pressure, as shown in the diagram. The final internal pressure, volume and absolute temperature of gas are P_2, V_2 and T_2, respectively. For this expression, which is incorrect?

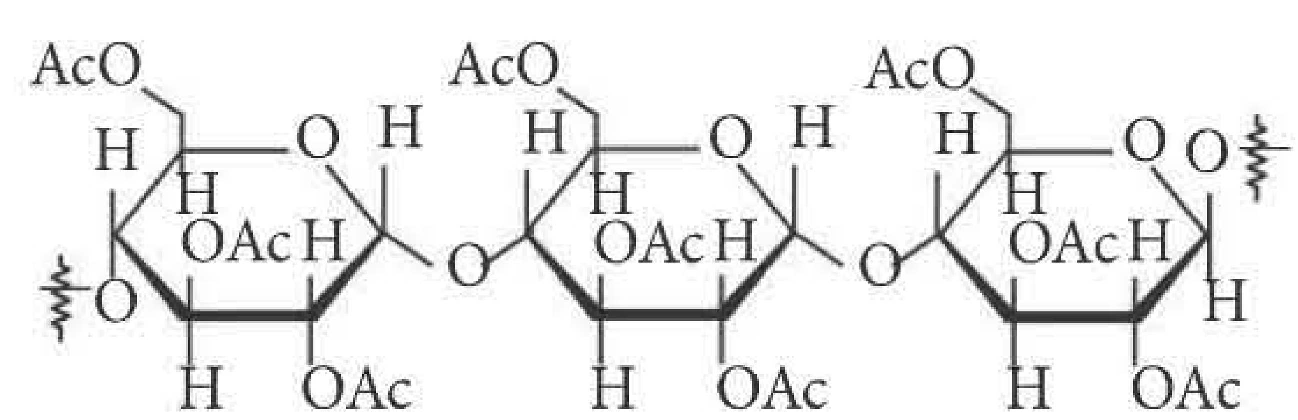


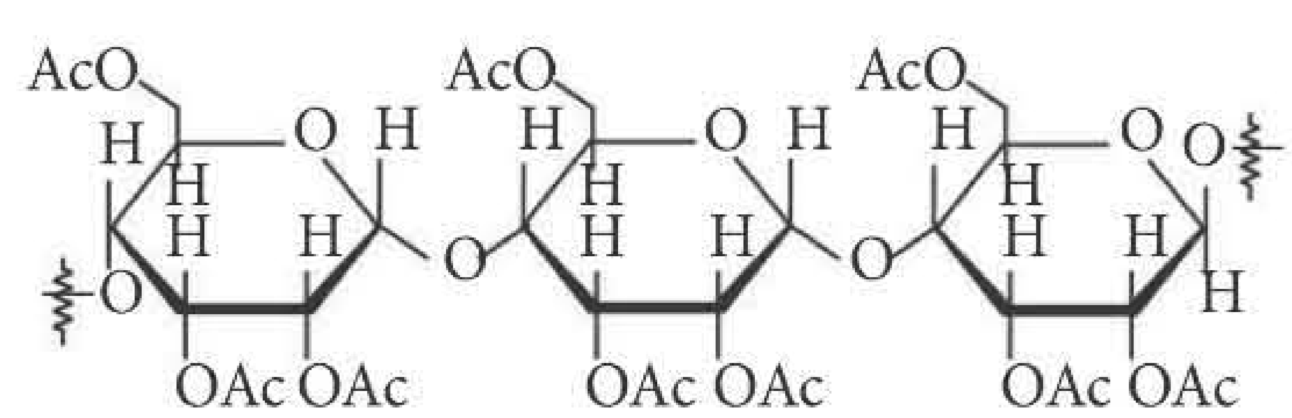
   (a) $q = 0$ (b) $T_2 = T_1$
   (c) $P_2V_2 = P_1V_1$ (d) $P_2V_2^{\gamma} = P_1V_1^{\gamma}$

3. Cellulose upon acetylation with excess acetic anhydride/H_2SO_4(catalytic) gives cellulose triacetate whose structure is

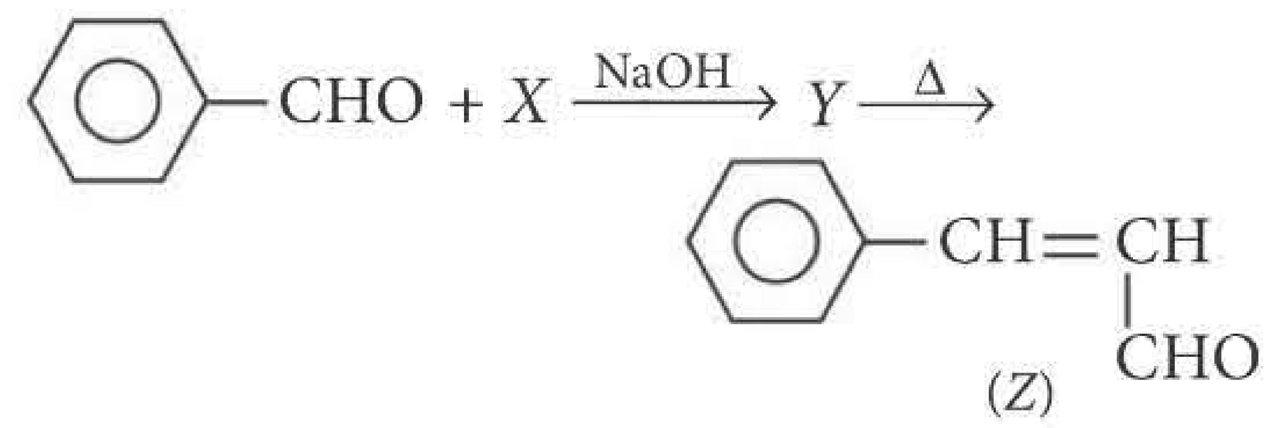
(a) 

(b) 

(c) 

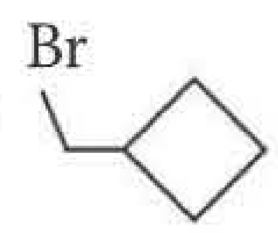
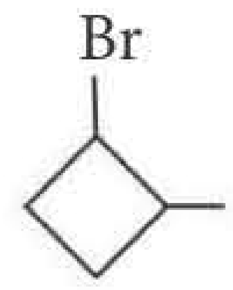
(d) 

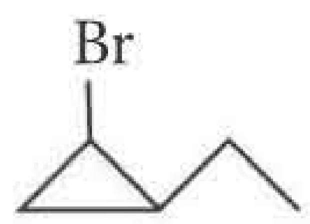
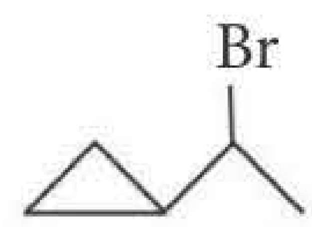
4. Which of the following statement(s) is/are correct for the reaction given below?



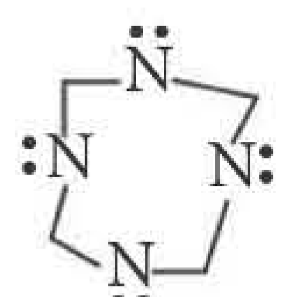
   (a) It is an example of aldol condensation.
   (b) X = HCHO, Y = Acetal
   (c) X = CH_3CHO,
   Y = 3-Hydroxy-3-phenyl propanaldehyde
   (d) It is Claisen-Schmidt condensation.

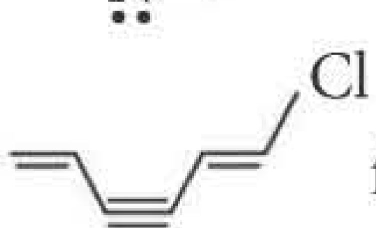
5. Compound X,(C_5H_9Br) does not add Br_2/CCl_4. On treatment with alcoholic KOH gives Y(C_5H_8), which adds to Br_2/CCl_4. (Y) on ozonolysis gives Z, ($C_5H_8O_2$). (X) could be

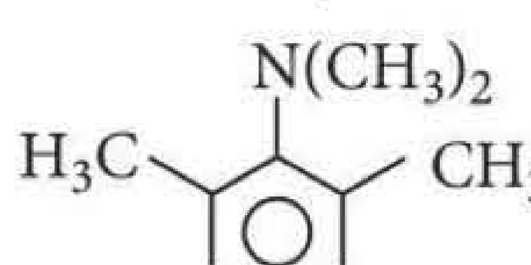
(a)  (b) 

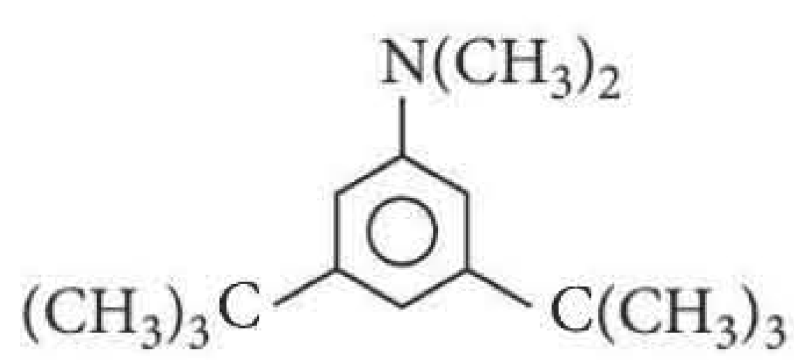
(c)  (d) 

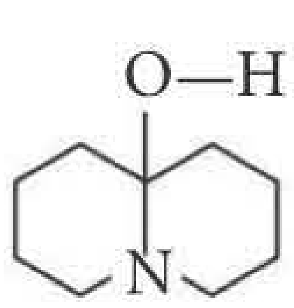
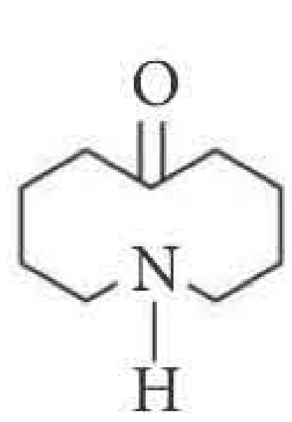
6. Which of the following statements are incorrect?

(a)  is more basic than $(CH_3)_3N$:.

(b)  forms white precipitate with $Ag^+_{(aq)}$ most readily.

(c)  is more basic than



(d)  and  are resonating structures to each other.

7. 4, 4′-Dinitrodiphenyl is obtained when

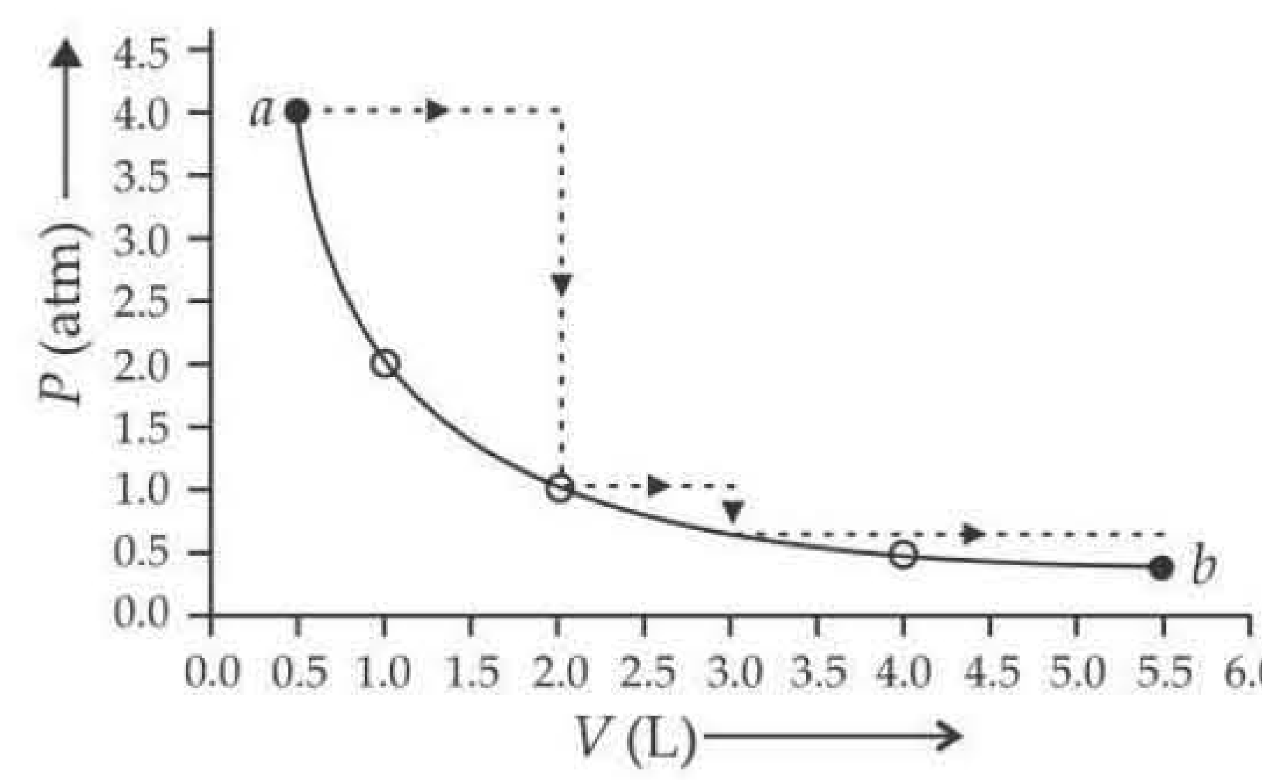
(a) 4-nitrochlorobenzene is heated with Na/ether

(b) 4-nitroiodobenzene is heated with copper powder in a sealed tube

(c) diphenyl is heated with a mixture of conc. HNO_3 + conc. H_2SO_4

(d) nitrobenzene is treated with 4-nitro-chlorobenzene in presence of anhyd. $AlCl_3$.

8. One mole of an ideal gas is taken from a to b along two paths denoted by the solid and the dashed lines as shown in the graph below. If the work done along the solid line path is w_s and that along the dotted line path is w_d, then the integer closest to the ratio $\frac{w_d}{w_s}$ is

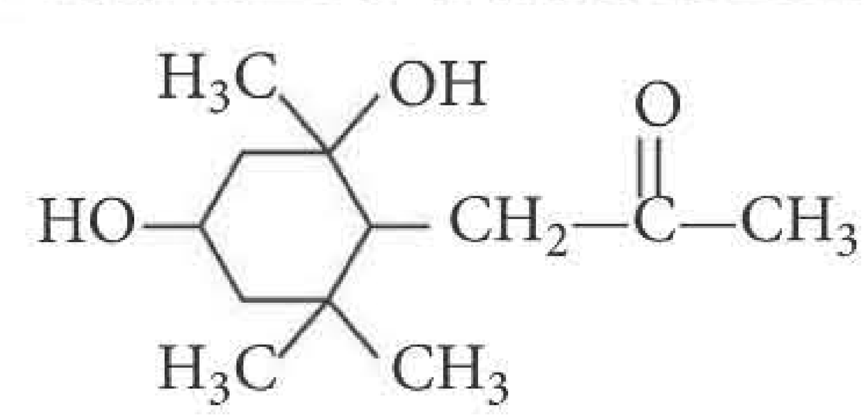


9. The weight of a cubic crystal of NaCl which contains 2.57×10^{21} unit cells is given : NaCl crystallises in *fcc* structure

10. Total net hydrogen atoms which are available for hydrogen bonding from 1°, 2° and 3° amines in an aqueous solution is

11. To 8.4 mL H_2O_2, excess of acidified solution of KI was added. The iodine liberated, required 20 mL of 0.3 N $Na_2S_2O_3$ solution. Volume strength of H_2O_2 solution is

12. Total number of stereoisomers for the compound

 is

Answer Q. 13 to 15 by appropriately matching the information given in the three columns of the following table :

Columns 1, 2 and 3 contain reactants, gaseous products and the yield of gaseous products respectively.

Column 1	Column 2	Column 3
(I) $\underset{1\,g}{H_2} + \underset{1\,g}{O_2} \rightarrow$	(i) CH_4	(P) 0.44 g
(II) $\underset{1\,g}{C} + \underset{1\,g}{O_2} \rightarrow$	(ii) CO_2	(Q) 1.125 g
(III) $\underset{1\,g}{CaCO_3} \rightarrow$	(iii) NH_3	(R) 1.2 g
(IV) $\underset{1\,g}{N_2} + \underset{1\,g}{H_2} \rightarrow$	(iv) H_2O	(S) 1.375 g

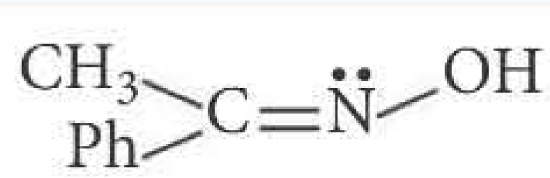
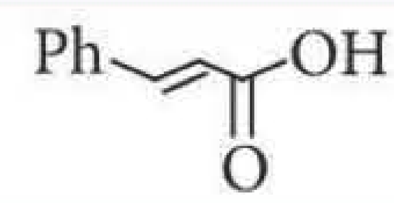
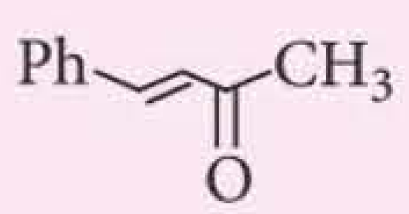
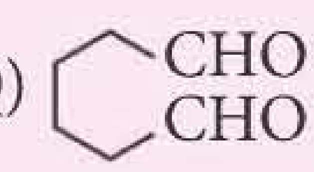
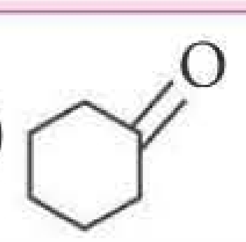
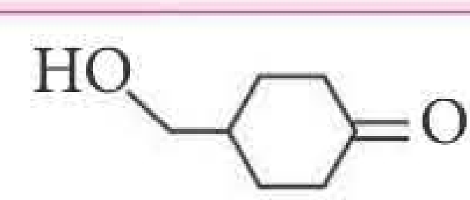
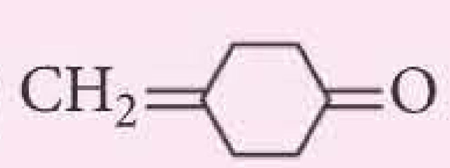
13. Which of the following combinations represents thermal decomposition reaction?

(a) (III)–(iv)–(P) (b) (I)–(i)–(Q)
(c) (II)–(ii)–(S) (d) (III)–(ii)–(P)

14. Which of the following combinations produces highest number of gaseous molecules?
(a) (I)–(iv)–(Q) (b) (II)–(ii)–(S)
(c) (III)–(ii)–(P) (d) (IV)–(iii)–(R)

15. In which of the following combinations product contains maximum number of atoms?
(a) (II)–(ii)–(S) (b) (IV)–(iii)–(R)
(c) (I)–(iv)–(Q) (d) (III)–(ii)–(P)

Answer Q. 16 to 18 by appropriately matching the information given in the three columns of the following table :
Columns 1, 2 and 3 contain reactants, reaction conditions and products respectively.

Column 1	Column 2	Column 3
(I) 	(i) $\xrightarrow[\text{(iii) Reductive ozonolysis}]{\text{(i) LAH (ii) Conc. } H_2SO_4/\Delta}$	(P) 
(II) 	(ii) $\xrightarrow[\text{(ii) } H_2O]{\text{(i) } H^+}$	(Q) 
(III) 	(iii) $\xrightarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } BH_3/THF}$	(R) 
(IV) 	(iv) $\xrightarrow{ClO^- + H_3O^+}$	(S) $CH_3COOH + PhNH_2$

16. Which combination is correct?
(a) (I)–(i)–(R) (b) (II)–(iv)–(Q)
(c) (III)–(i)–(Q) (d) (IV)–(ii)–(R)

17. Which combination will follow Beckmann rearrangement?
(a) (I)–(ii)–(R) (b) (I)–(ii)–(S)
(c) (IV)–(iii)–(S) (d) (II)–(ii)–(P)

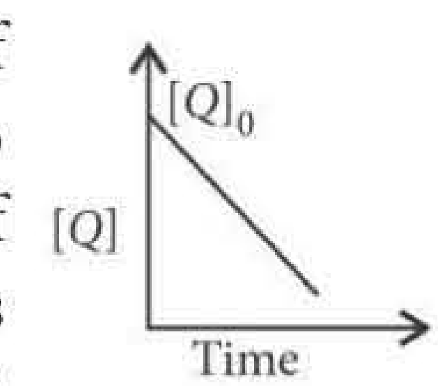
18. Which of the following combinations will lead to the product containing minimum number of α-hydrogen?
(a) (II)–(iv)–(P) (b) (IV)–(iii)–(P)
(c) (I)–(ii)–(S) (d) (III)–(i)–(Q)

19. The radii of two of the first four Bohr's orbits of the hydrogen atom are in the ratio 1 : 4. The energy difference between them may be
(a) either 12.09 eV or 10.2 eV
(b) either 2.55 eV or 10.2 eV
(c) either 13.6 eV or 3.4 eV
(d) either 3.4 eV or 0.85 eV.

20. In the given reaction,

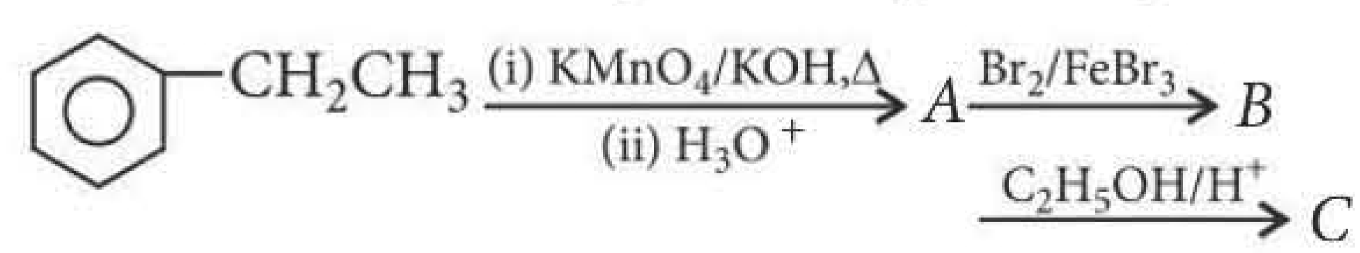
$$P + Q \longrightarrow R + S$$

the time taken for 75% reaction of P is twice the time taken for 50% reaction of P. The concentration of Q varies with reaction time as shown in given figure. The overall order of the reaction is

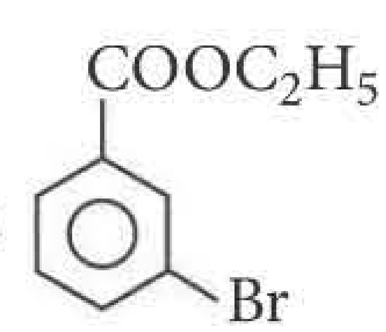


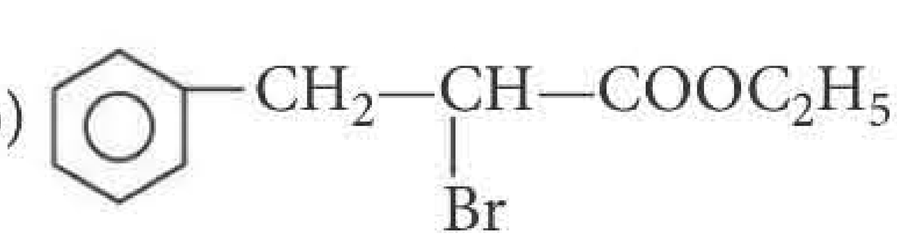
(a) 2 (b) 3
(c) 0 (d) 1

21. In a set of reactions, ethyl benzene yielded a product D.



'C' should be

(a) 

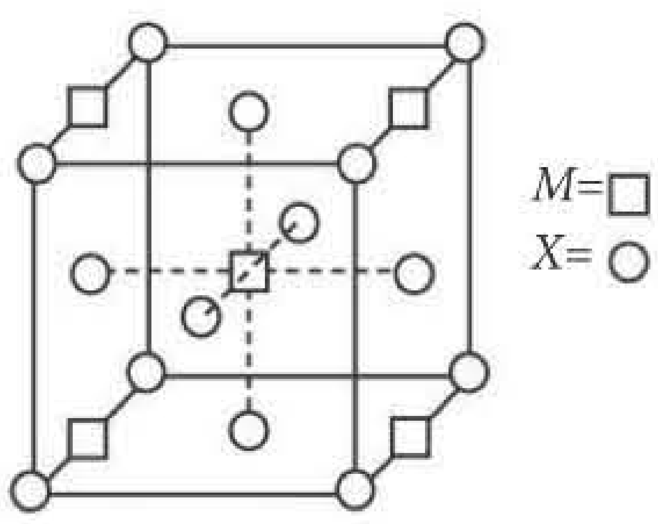
(b) 

22. Enthalpy is equal to

(a) $T^2\left[\dfrac{\partial(G/T)}{\partial T}\right]_P$ (b) $-T^2\left[\dfrac{\partial(G/T)}{\partial T}\right]_P$

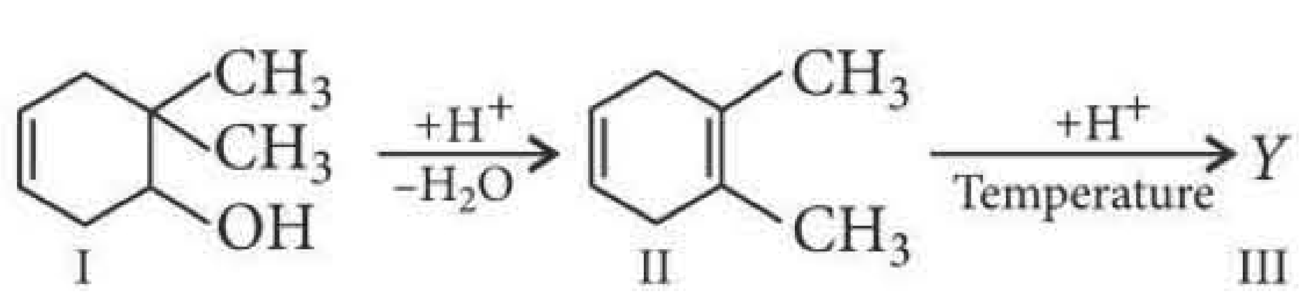
(c) $T^2\left[\dfrac{\partial(G/T)}{\partial T}\right]_V$ (d) $-T^2\left[\dfrac{\partial(G/T)}{\partial T}\right]_V$

23. A compound M_pX_q has cubic close packing (*ccp*) arrangement of X. Its unit cell structure is shown in the given figure. The empirical formula of the compound is



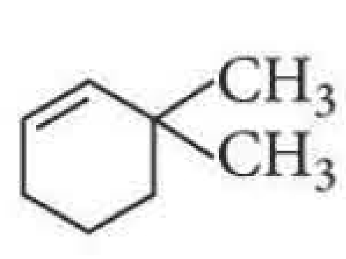
(a) MX (b) MX_2
(c) M_2X (d) M_5X_{14}

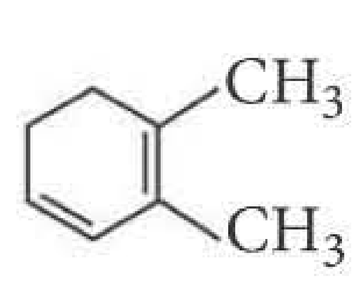
Read the following passage and answer Q. 24 and 25:
A hydrocarbon whose molecules contain two double bonds is simply called diene. Conjugated dienes are thermodynamically more stable than isolated dienes. Following reaction sequence is the synthesis of a diene.

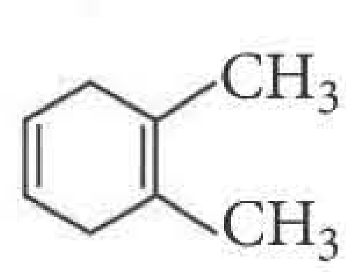


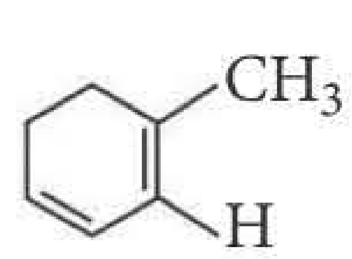
24. The number of carbocation(s) formed in the conversion I to II is
(a) 1 (b) 4 (c) 2 (d) 3

25. Compound Y is

(a) 

(b) 

(c) 

(d) 

SOLUTIONS

1. (b): $Pt|H_2(1\text{ atm})|HA_2||HA_1|H_2(1\text{ atm})|Pt$
At anode : $E_{(H^+/H_2)_2} = E^\circ_{(H^+/H_2)_2} + 0.059\ (pH)_2$
At cathode : $E_{(H^+/H_2)_1} = E^\circ_{(H^+/H_2)_1} + 0.059\ (pH)_1$
We know, $[H^+] = C\alpha = \sqrt{K_aC}$, $(pH = -\log[H^+])$

$pH_1 = \frac{1}{2}pK_{a_1} - \frac{1}{2}\log C$

$pH_2 = \frac{1}{2}pK_{a_2} - \frac{1}{2}\log C$

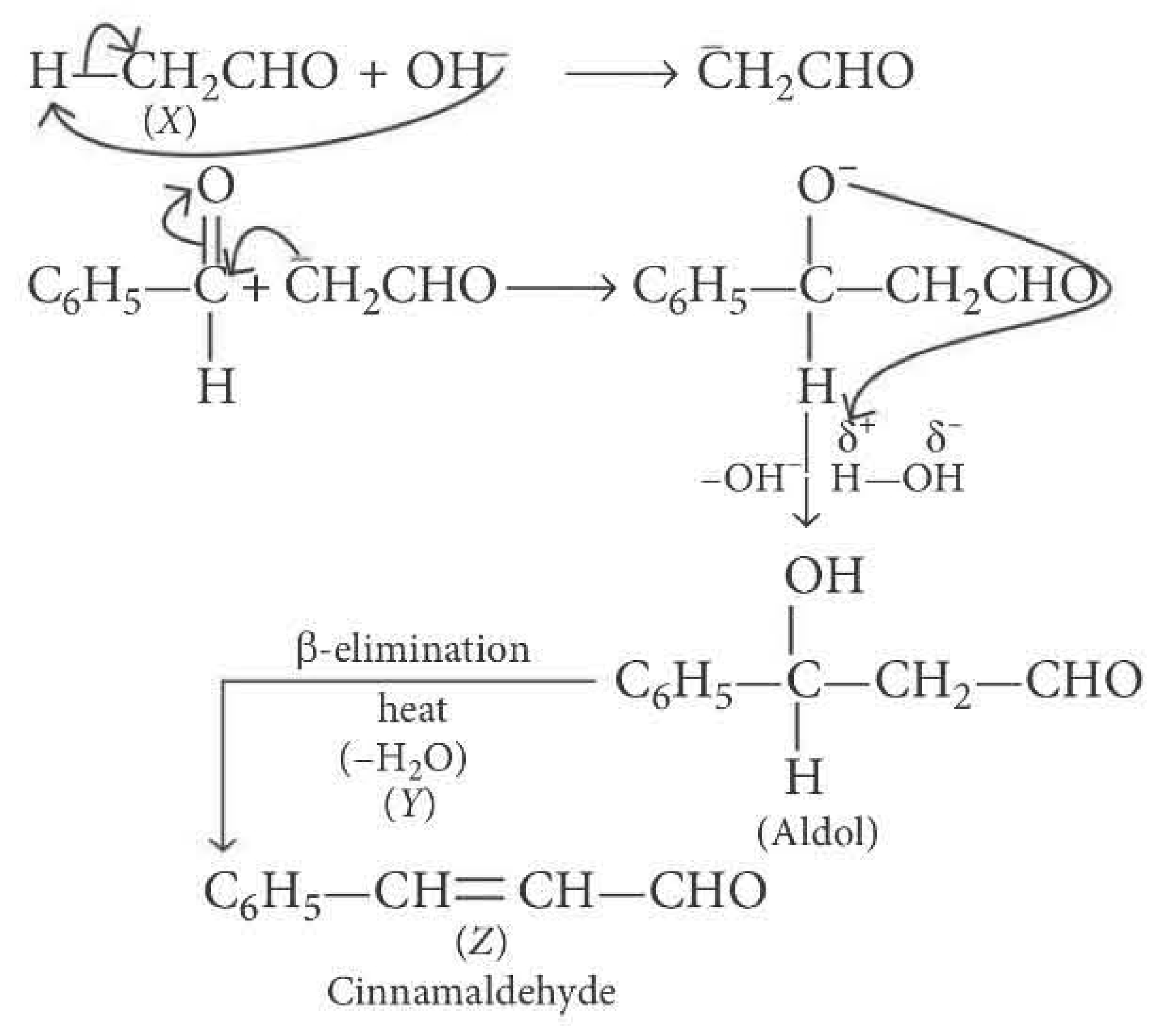
$E_{cell} = E_{(H^+/H_2)_1} - E_{(H^+/H_2)_2}$

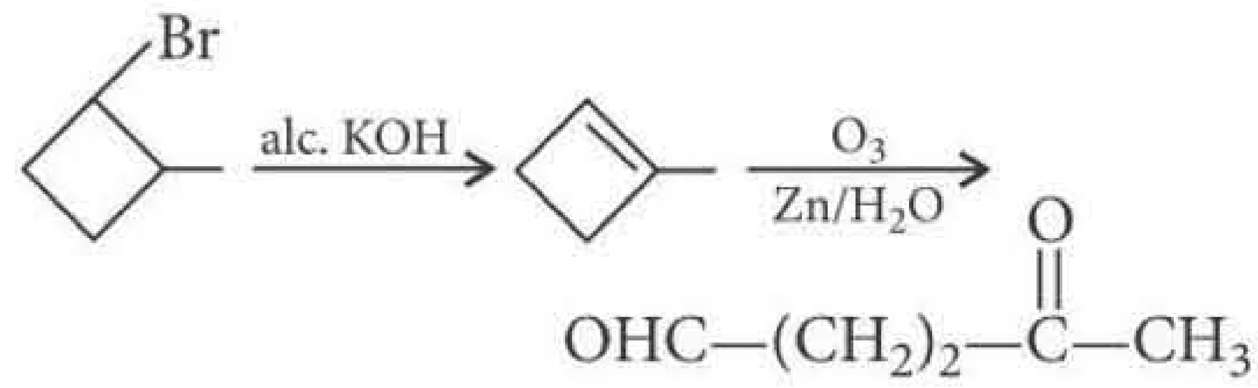
$= 0.059\left[\frac{1}{2}pK_{a_2} - \frac{1}{2}pK_{a_1}\right] = \frac{0.059}{2}(5-3) = 0.059\text{ V}$

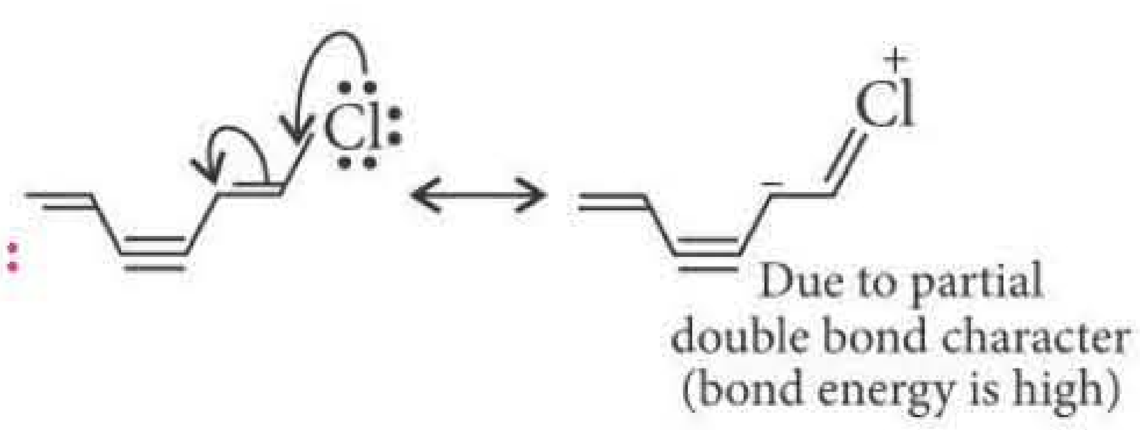
2. (d) : Since vessel is thermally insulated, *i.e.*, the process is adiabatic hence, $q = 0$.
Also, $P_{ext} = 0$, hence $w = 0$
From 1st law of thermodynamics, $\Delta E = q + w$
$\therefore\ \Delta E = 0$
$\therefore\ \Delta T = 0$ or $T_2 = T_1$
[$\because$ Internal energy of an ideal gas is a function of temperature.]
Applying ideal gas equation, $PV = nRT$
where n, R and T are constant.
then $P_1V_1 = P_2V_2$
Equation, PV^γ = constant, is applicable only for ideal gas in reversible adiabatic process.
Hence, $P_2V_2^\gamma = P_1V_1^\gamma$ equation is not applicable.

3. (a): Cellulose is a linear-chain polysaccharide of *D*-glucose which is joined by β-glycosidic linkage between C-1 of one glucose and C-4 of the next glucose. In one unit, only three —OH groups are free to undergo acetylation to form cellulose triacetates.

4. (a, c) : $NaOH_{(aq.)} \rightleftharpoons Na^+ + OH^-$



5. **(b):** 

6. **(b, d) :** 

Moreover, resonance involves the delocalisation of only charge or electrons but not the atoms.

7. **(a,b,c) :** Due to the presence of double bond character in *p*-nitrochlorobenzene and high bond dissociation enthalpy, it does not show coupling reaction like all three.

8. **(2):** The solid line represents an isotherm as the product of PV is constant throughout. The product of PV is (4 atm) (0.5 L) *i.e.*, 2 atm L. The work done along the solid line is equal to area under the line and is given by the expression :

$$-w_s = n(RT)\ln\left(\frac{V_2}{V_1}\right)$$

$$= (1\text{ mol})\ (2\text{ atm L mol}^{-1})\ \ln\left(\frac{5.5}{0.5}\right)$$

$$= 4.794\text{ L atm} \qquad (\because PV = RT)$$

The work done along the dotted line (which is sum of the areas under each line) is

$$-w_d = P\Delta V$$

$$-w_d = (4\text{ atm})\ [(2.0 - 0.5)\text{ L}] + (1\text{ atm})\ [(3.0 - 2.0)\text{ L}] + (0.6\text{ atm})[(5.5 - 3.0)\text{ L}]$$

$$= (6 + 1 + 1.5)\text{ L atm} = 8.5\text{ L atm}$$

$$\frac{(-w_d)}{(-w_s)} = \frac{8.5}{4.794} = 1.77 \approx 2$$

9. **(1):** Weight of cubic crystal

= No. of unit cells × Mass of one unit cell

Mass of one unit cell = 4 × mass of 1 NaCl formula unit

$$= \frac{4\times 58.5}{6.022\times 10^{23}}\text{ g} = 3.885\times 10^{-22}\text{ g}$$

Thus, weight of cubic crystal

$$= 2.57 \times 10^{21} \times 3.885 \times 10^{-22}$$

$$= 9.98 \times 10^{-1} \simeq \frac{10}{10} = 1\text{ g}$$

10. (6)

11. (4): $H_2O_2 + 2I^- + 2H^+ \longrightarrow 2H_2O + I_2$

$I_2 + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2I^-$

$N_1V_1 = N_2V_2$
$(H_2O_2)\ \ (Na_2S_2O_3)$

$N_1 \times 8.4 = 0.3 \times 20 \Rightarrow N_1 = 0.7143$ N

Normality of H_2O_2 is related to x (*i.e.*, volume strength) by relation,

$$N = \frac{x}{5.6} \Rightarrow x = N_1 \times 5.6 = 0.7143 \times 5.6 = 4$$

12. (8) : It has three chiral carbons, hence number of stereoisomers will be 8.

13. (d): $\underset{1\text{ g}}{CaCO_3} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}$

100g $CaCO_3$ gives = 56 g CaO and 44 g CO_2

∴ 1 g $CaCO_3$ will give 0.56 g of CaO and 0.44 g of CO_2 respectively.

14. (d): (a) $\underset{1\text{ g}}{2H_2} + \underset{1\text{ g}}{O_2} \longrightarrow \underset{1.125\text{ g}}{2H_2O}$; O_2 is limiting reagent.

18 g of $H_2O = 6.022 \times 10^{23}$ molecules of H_2O

$$1.125 \text{ g of } H_2O = \frac{6.022 \times 10^{23}}{18} \times 1.125$$

$= 0.38 \times 10^{23}$ molecules

(b) $\underset{1\text{ g}}{C} + \underset{1\text{ g}}{O_2} \longrightarrow \underset{1.375\text{ g}}{CO_2}$; O_2 is limiting reagent

44 g of $CO_2 = 6.022 \times 10^{23}$ molecules of CO_2

$$1.375 \text{ g of } CO_2 = \frac{6.022 \times 10^{23}}{44} \times 1.375$$

$= 0.19 \times 10^{23}$ molecules

(c) $\underset{1\text{ g}}{CaCO_3} \longrightarrow CaO + \underset{0.44\text{ g}}{CO_2}$

44 g of $CO_2 = 6.022 \times 10^{23}$ molecules of CO_2

$$0.44 \text{ g of } CO_2 = \frac{6.022 \times 10^{23}}{44} \times 0.44$$

$= 0.06 \times 10^{23}$ molecules

(d) $\underset{1\text{ g}}{N_2} + \underset{1\text{ g}}{3H_2} \longrightarrow \underset{1.2\text{ g}}{2NH_3}$

17 g of $NH_3 = 6.022 \times 10^{23}$ molecules of NH_3

$$1.2 \text{ g of } NH_3 = \frac{6.022 \times 10^{23}}{17} \times 1.2$$

$= 0.42 \times 10^{23}$ molecules

15. (b): (a) $\underset{1\text{ g}}{C} + \underset{1\text{ g}}{O_2} \longrightarrow \underset{1.375\text{ g}}{CO_2}$

44 g CO_2 = 3 N_A atoms

$$1.375 \text{ g } CO_2 = \frac{3}{44} \times 1.375\ N_A \text{ atoms}$$

$= 0.094\ N_A$ atoms

(b) $\underset{1\text{ g}}{N_2} + \underset{1\text{ g}}{3H_2} \longrightarrow \underset{1.2\text{ g}}{2NH_3}$

17 g NH_3 = 4 N_A atoms

$$1.2 \text{ g } NH_3 = \frac{4}{17} \times 1.2\ N_A \text{ atoms}$$

$= 0.28\ N_A$ atoms

(c) $\underset{1\text{ g}}{2H_2} + \underset{1\text{ g}}{O_2} \longrightarrow \underset{1.125\text{ g}}{2H_2O}$

18 g H_2O = 3 N_A atoms

$$1.125 \text{ g } H_2O = \frac{3}{18} \times 1.125\ N_A \text{ atoms}$$

$= 0.19\ N_A$ atoms

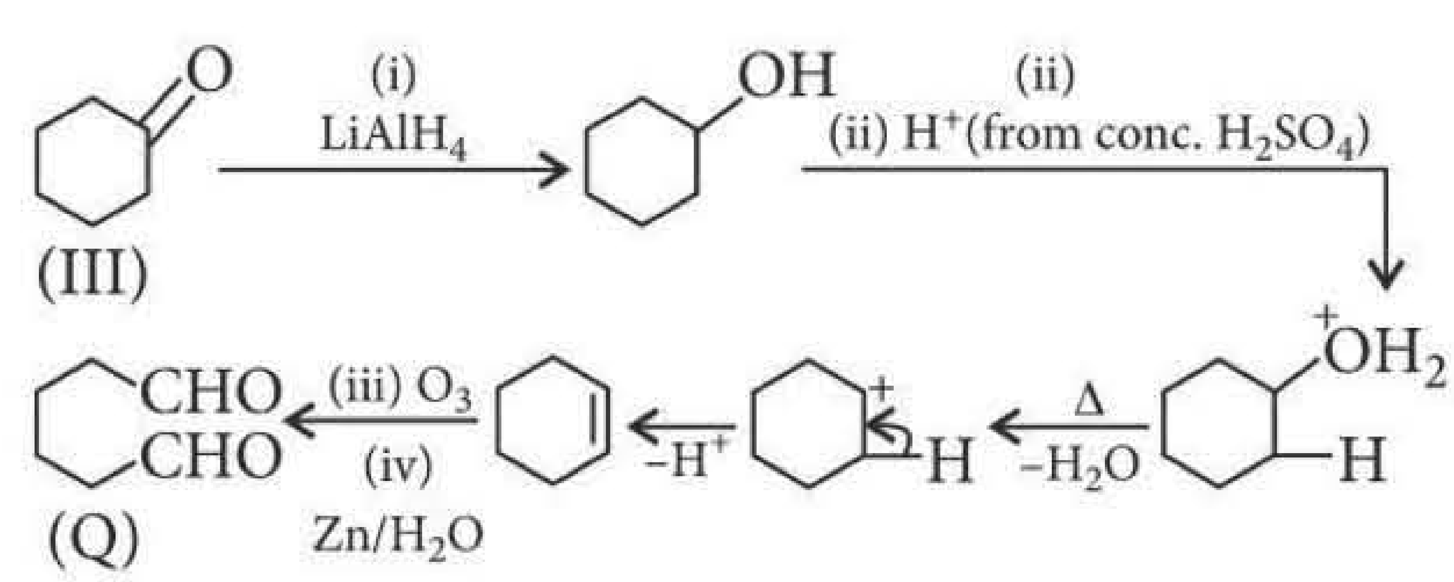
(d) $\underset{1\text{ g}}{CaCO_3} \longrightarrow CaO + \underset{0.44\text{ g}}{CO_2}$

44 g CO_2 = 3 N_A atoms

$$0.44 \text{ g } CO_2 = \frac{3}{44} \times 0.44\ N_A \text{ atoms}$$

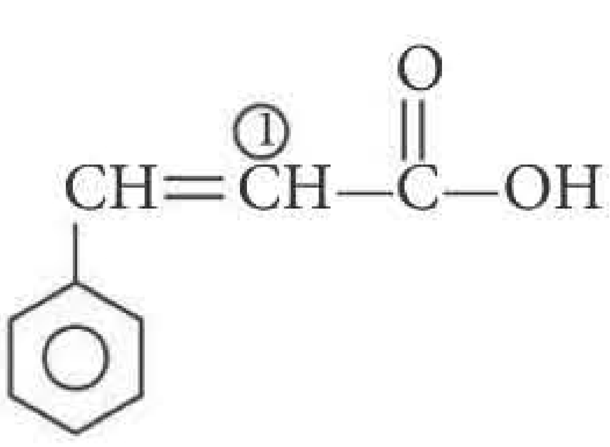
$= 0.03\ N_A$ atoms

16. (c) :



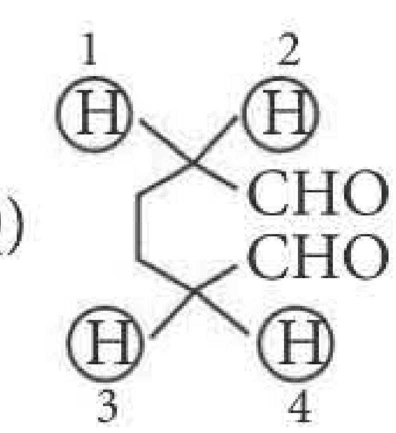
17. (b)

18. (a): (P)

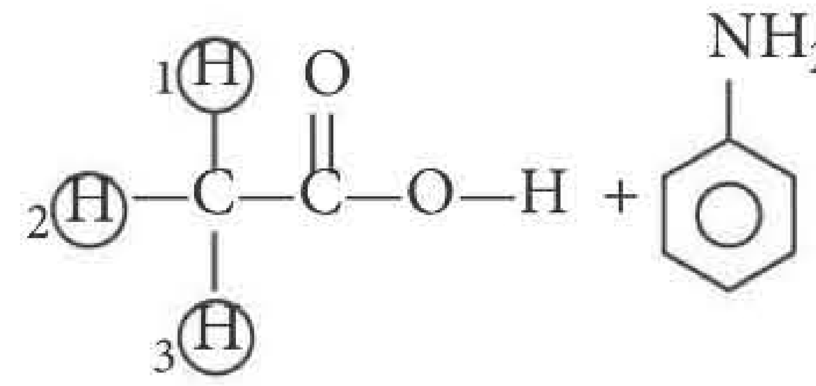


One α-hydrogen

(Q)



Four α-hydrogens

(S) 

Three α-hydrogens

19. (b): $\frac{R_{n_1}}{R_{n_2}} = \frac{n_1^2}{n_2^2} = \frac{1}{4} \quad \therefore \quad \frac{n_1}{n_2} = \frac{1}{2}$

Among the first four orbits n_1 and n_2 can be 1 and 2 or 2 and 4.

∴ Energy difference can be :

$E_2 - E_1 = 10.2$ eV or $E_4 - E_2 = 2.55$ eV

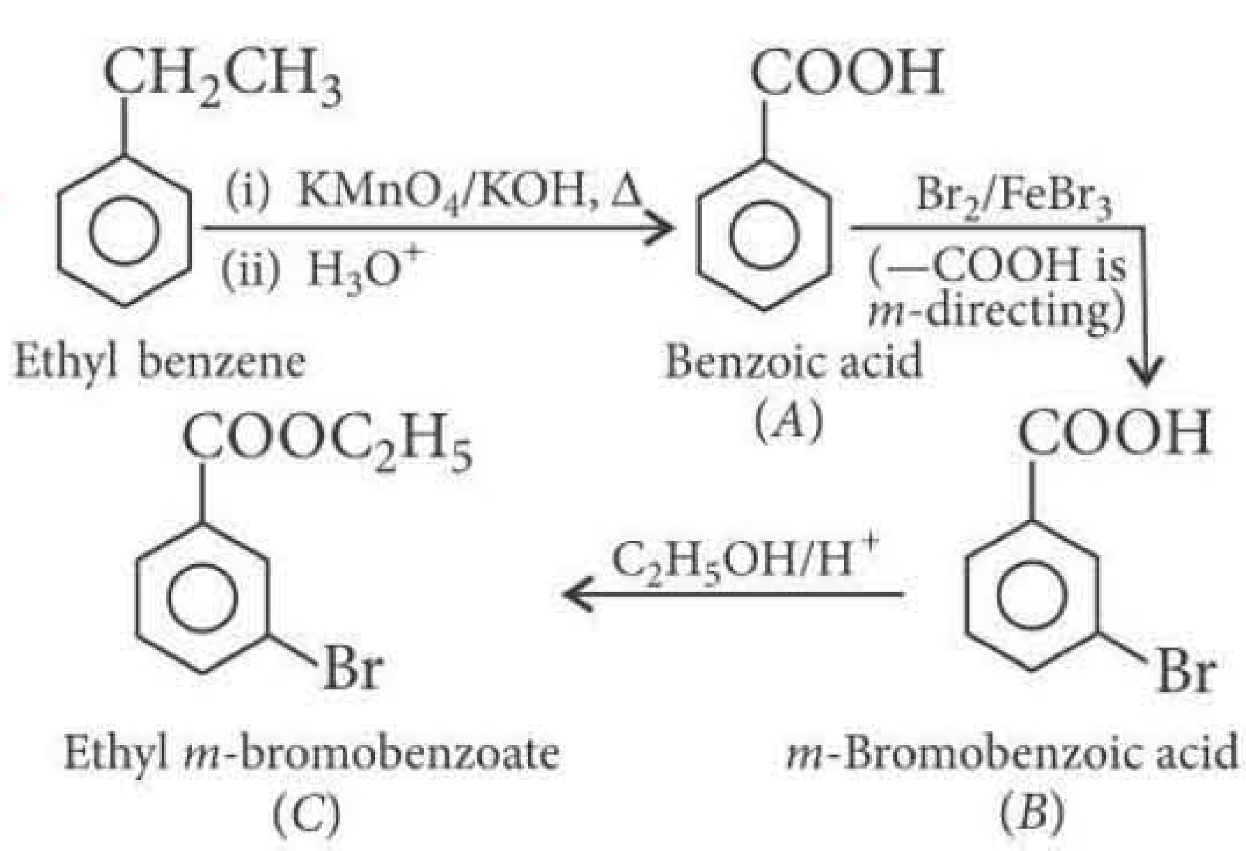
20. (d): For P, if $t_{50\%} = x$ then $t_{75\%} = 2x$

This is true only for first order reaction.

So, order with respect to P is 1.

The graph shows that amount of the substance reacted is proportional to the time, which is true for zero order reaction. Hence, order with respect to to Q is zero.

So, overall order is 1 + 0 = 1

21. (a): 

22. (b): We know that, $G = H - TS$ ...(i)

$G = E + PV - TS$ $[\because H = E + PV]$

$\Delta G = \Delta E + P\Delta V + V\Delta P - T\Delta S - S\Delta T$

$T\Delta S = \Delta E + P\Delta V$

$\Delta G = V\Delta P - S\Delta T$

At constant pressure, $\Delta P = 0$

$$\frac{\Delta G}{\Delta T} = -S \quad \text{...(ii)}$$

From eqns (i) and (ii),

$$G = H + T\left(\frac{\Delta G}{\Delta T}\right) \text{ or } G = H + T\left(\frac{\partial G}{\partial T}\right)_P$$

$$-\frac{H}{T^2} = -\frac{G}{T^2} + \frac{1}{T}\left(\frac{\partial G}{\partial T}\right)_P = \left[\frac{\partial (G/T)}{\partial T}\right]_P$$

$$H = -T^2\left[\frac{\partial (G/T)}{\partial T}\right]_P$$

23. (b): Contribution by 8 X atoms present at the corners $= \frac{1}{8} \times 8 = 1$

Contribution by 6 X atoms present at the face centres $= 6 \times \frac{1}{2} = 3$

Total X atoms in one unit cell = 3 + 1 = 4

Contribution by 4 M atoms present at edge centres

$$= 4 \times \frac{1}{4} = 1$$

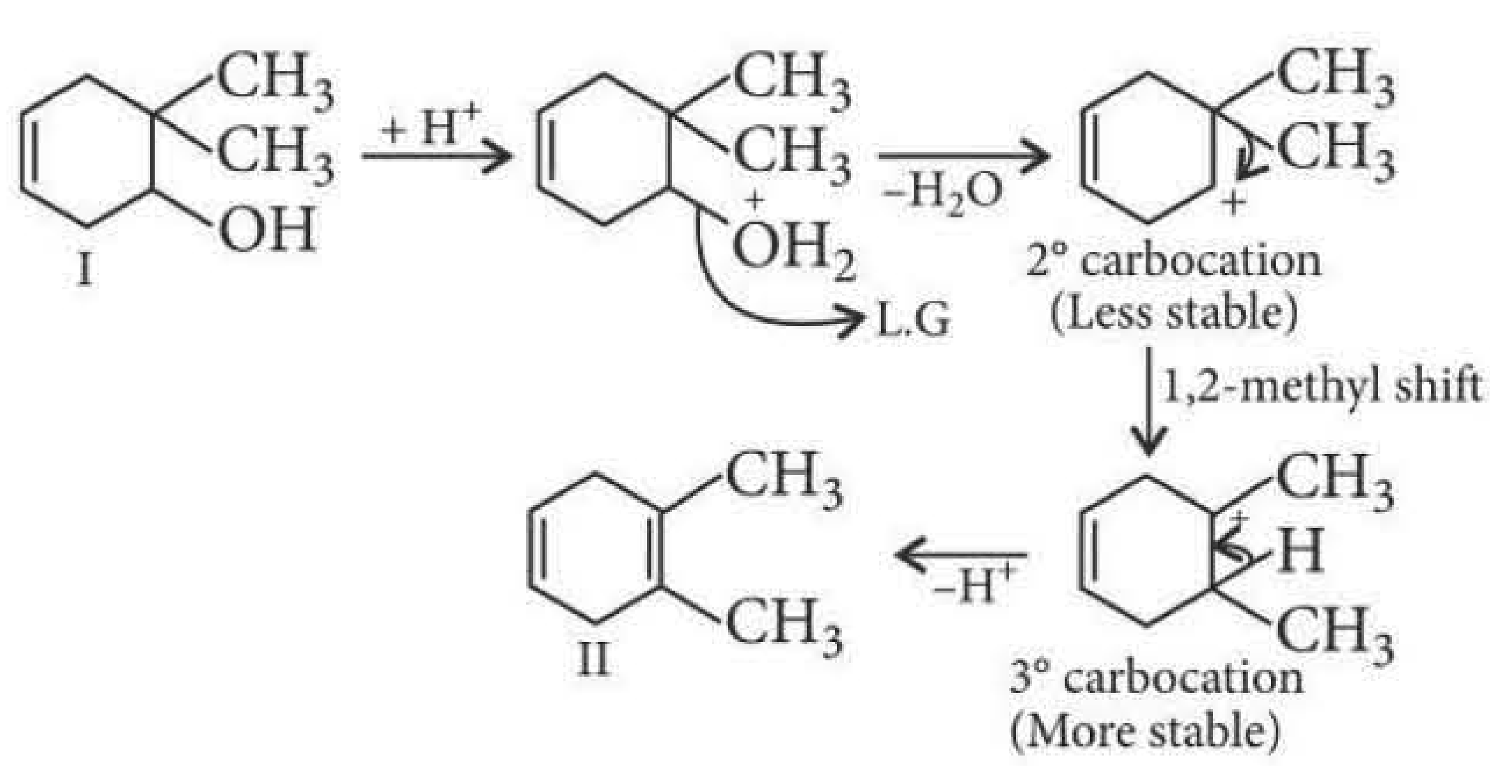
Contribution by 1 M atom present at body centre = 1×1 = 1

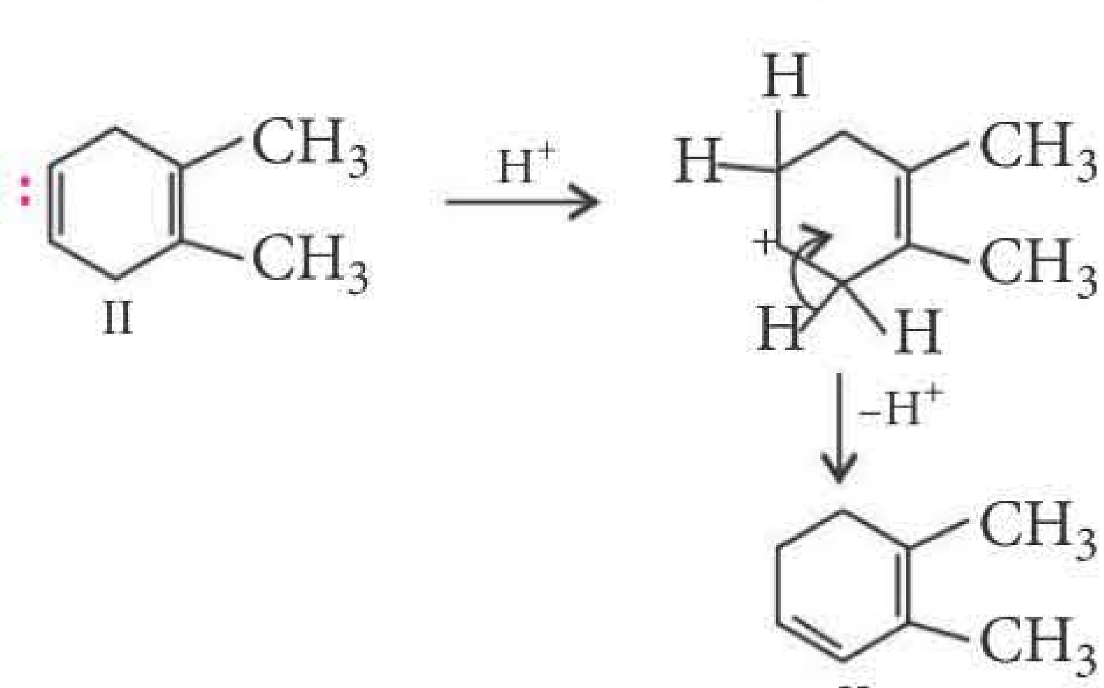
Thus, total M atoms in one unit cell = 1 + 1 = 2

Ratio is $M : X$ = 2 : 4 = 1 : 2

Thus, empirical formula is MX_2.

24. (c) :



25. (b) : 

◆◆

PRACTICE PAPER

BITSAT

1. At 700 K, the equilibrium constant for the reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ is 54.8. If 0.5 mol/L of $HI_{(g)}$ is present at equilibrium at 700 K, what are the concentrations of $H_{2(g)}$ and $I_{2(g)}$, assuming that only $HI_{(g)}$ was present initially?
(a) 0.0675, 0.0675 (b) 0.0675, 0.0337
(c) 0.0337, 0.0675 (d) 0.0337, 0.0337

2. When MnO_2 is fused with KOH, a coloured compound is formed. Which of the following is the correct pair of compound and its colour?
(a) K_2MnO_4, purple green (b) $KMnO_4$, purple
(c) Mn_2O_3, brown (d) Mn_3O_4, black

3. Which reagent is useful in separating benzoic acid from phenol?
(a) Dil. HCl (b) Dil. H_2SO_4
(c) Conc. H_2SO_4 (d) 5% $NaHCO_3$

4. Which of the following is not correct regarding physical adsorption?
(a) On increasing temperature, it increases continuously.
(b) Its molar enthalpy is low.
(c) This is not specific in nature.
(d) It is reversible in nature.

5. The enthalpy of combustion of carbon to CO_2 is -393.5 kJ mol^{-1}. The heat released upon the formation of 35.2 g of CO_2 from carbon and dioxygen gas is
(a) 4.8×10^2 kJ (b) 3.1×10^2 kJ
(c) 5.9×10^2 kJ (d) 6.7×10^2 kJ.

6. When phosphorous acid is allowed to react with sufficient quantity of KOH, which of the following product is obtained?
(a) K_3PO_3 (b) KH_2PO_3
(c) K_2HPO_3 (d) $KHPO_3$

7. In which of the following species, Cr is in the +3 oxidation state?
(a) CrO_4^{2-} (b) $Cr_2O_7^{2-}$ (c) CrO_2 (d) Cr_2O_3

8. Which of the following will produce a buffer solution when mixed in equal volumes?
(a) 0.1 mol dm^{-3} NH_4OH and 0.1 mol dm^{-3} HCl
(b) 0.05 mol dm^{-3} NH_4OH and 0.1 mol dm^{-3} HCl
(c) 0.1 mol dm^{-3} NH_4OH and 0.05 mol dm^{-3} HCl
(d) 0.1 mol dm^{-3} CH_3COONa and 0.1 mol dm^{-3} NaOH

9. The portion of edge length not occupied by atoms for *scc*, *fcc* and *bcc* are respectively (*a* is edge length)
(a) $0;\ a\left(1-\frac{\sqrt{3}}{2}\right);\ a\left(1-\frac{1}{\sqrt{2}}\right)$
(b) $a\left(1-\frac{\sqrt{3}}{2}\right);\ 0;\ a\left(2-\frac{1}{\sqrt{2}}\right)$
(c) $0;\ a\left(1-\frac{1}{\sqrt{2}}\right);\ a\left(1-\frac{\sqrt{3}}{2}\right)$
(d) $a;\ 2\sqrt{2}\,a;\ \frac{\sqrt{3}}{2}a$

10. Which of the following chlorides cannot be obtained in the anhydrous state by heating the hydrated salt?
(a) $MgCl_2$ (b) $CaCl_2$ (c) $SrCl_2$ (d) $BaCl_2$

11. The following data pertain to a reaction between *A* and *B* :

S.No.	$[A]$ (mol L^{-1})	$[B]$ (mol L^{-1})	**Rate** (mol L^{-1} s^{-1})
I	1×10^{-2}	2×10^{-2}	2×10^{-4}
II	2×10^{-2}	2×10^{-2}	4×10^{-4}
III	2×10^{-2}	4×10^{-2}	8×10^{-4}

Which of the following inference(s) can be drawn from the above data?
(i) Rate constant of the reaction is 10^{-4}.
(ii) Rate law of the reaction is $k[A]\,[B]$.
(iii) Rate of reaction increase four times on doubling the concentration of both the reactants.
(a) (i), (ii) and (iii) (b) Only (i) and (ii)
(c) Only (ii) and (iii) (d) Only (iii)

12. Which one would give H_2O_2 on addition of HCl?
(a) MnO_2 (b) PbO_2
(c) BaO (d) None of these

13. The $\Delta_f H^\circ$ for $CO_{2(g)}$, $CO_{(g)}$ and $H_2O_{(g)}$ are –393.5, –110.5 and –241.8 kJ mol^{-1} respectively. The standard enthalpy change (in kJ) for the reaction $CO_{(g)} + H_2O_{(g)} \longrightarrow CO_{2(g)} + H_{2(g)}$ is
(a) 524.1 (b) 41.2 (c) –262.5 (d) –41.2

14. Which of the following compounds can exhibit tautomerism?
(a) C_6H_5CHO (b) $C_6H_5COC(CH_3)_3$
(c) $C_6H_5COCH_2CHO$ (d) $C_6H_5COC_6H_5$

15. The time required to coat a metal surface of 80 cm^2 with 5×10^{-3} cm thick layer of silver (density 1.05 g cm^{-3}) with a passage of 3 A current through a silver nitrate solution is
(a) 115 s (b) 125 s (c) 135 s (d) 145 s

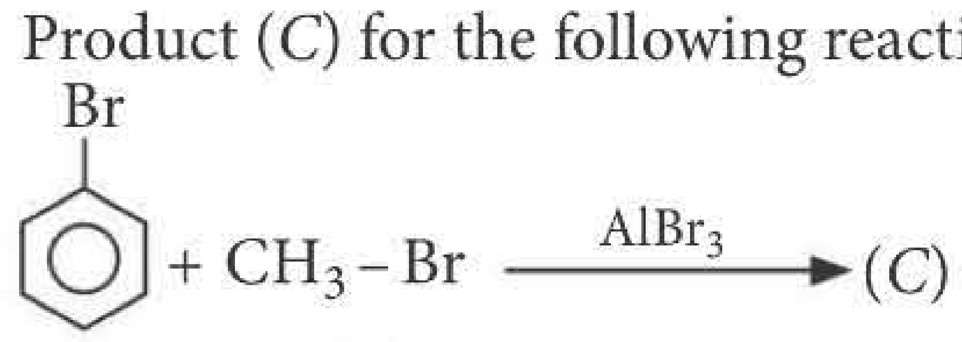
16. Which one of the following statements is true?
(a) In aqueous medium, HF is a stronger acid than HCl.
(b) $HClO_4$ is a weaker acid than $HClO_3$.
(c) HNO_3 is a stronger acid than HNO_2.
(d) H_3PO_3 is a stronger acid than H_2SO_3.

17. Two aqueous solutions *A* and *B*, are separated by a semi-permeable membrane. The osmotic pressure of solution *A* immediately begins to decrease. Which of the following statements is true?
(a) The solvent molecules are moving from the solution of higher osmotic pressure to that of lower osmotic pressure.
(b) The initial osmotic pressure of solution *B* is greater than that of solution *A*.
(c) Solvent molecules are moving from solution *B* into solution *A*.
(d) Both (a) and (b).

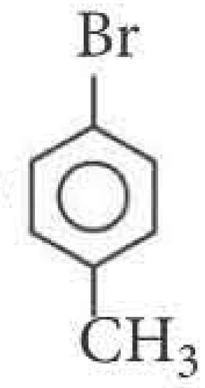
18. Which of the following alkenes is most reactive towards cationic polymerisation?
(a) $CH_2{=}CHCH_3$ (b) $CH_2{=}CHCl$
(c) $CH_2{=}CHC_6H_5$ (d) $CH_2{=}CHCOOCH_3$

19. Which of the following hybridisations is possible for square planar molecules?
(a) sp^3d (b) dsp^3 (c) dsp^2 (d) sp^3d^2

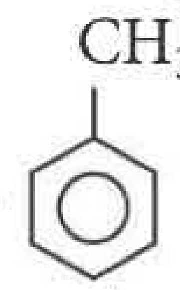
20. Product (*C*) for the following reaction is



(*A*) (*B*)

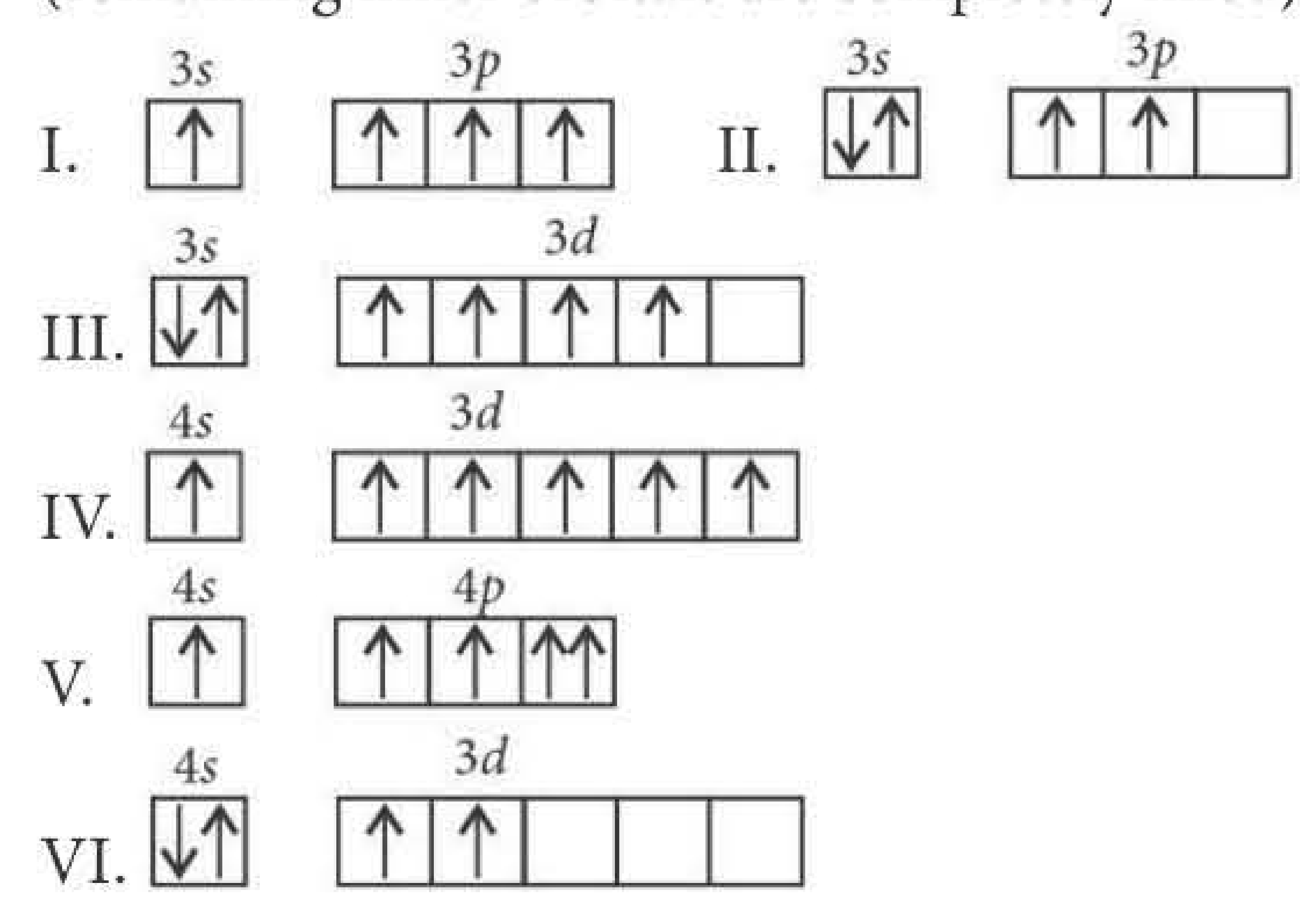
(a) 

(b) 

(c) 

(d) none of these.

21. Consider the following six electronic configurations (remaining inner orbitals are completely filled) :



Mark the correct option.
(a) Stability order : V > I > IV > III.
(b) Order of spin multiplicity : IV > III = I > II.
(c) V does not violate all rules of electronic configuration.
(d) If VI represents *A* and when A^+ kept near a magnet, acts as diamagnetic substance.

22. Volatile nature of halogens is because
(a) the halogen molecules are more reactive
(b) the force existing between the molecules are only weak van der Waals' forces
(c) halogen molecules are bounded by strong forces
(d) halogen molecules are bounded by electrostatic forces.

23. Addition of BH_3 to *trans*-2-butene followed by reaction with H_2O_2, would give the product which is
(a) achiral compound (b) racemic mixture
(c) meso compound
(d) optically active compound.

24. Fructose on oxidation with HIO_4 gives
(a) two moles of formaldehyde + four moles of formic acid
(b) two moles of formaldehyde + three moles of formic acid + one mole of carbon dioxide
(c) one mole of formaldehyde + five moles of formic acid
(d) three moles of formaldehyde + three moles of formic acid.

25. Determine the enthalpy of formation of B_2H_6 in kJ/mol of the following reaction :
$B_2H_{6(g)} + 3O_{2(g)} \longrightarrow B_2O_{3(s)} + 3H_2O_{(g)}$
Given : $\Delta_r H° = -1941$ kJ/mol;
$\Delta_f H°$ (B_2O_3, s) = -1273 kJ/mol;
$\Delta_f H°$ (H_2O, g) = -241.8 kJ/mol
(a) -75.6 (b) $+75.6$ (c) -57.4 (d) -28.4

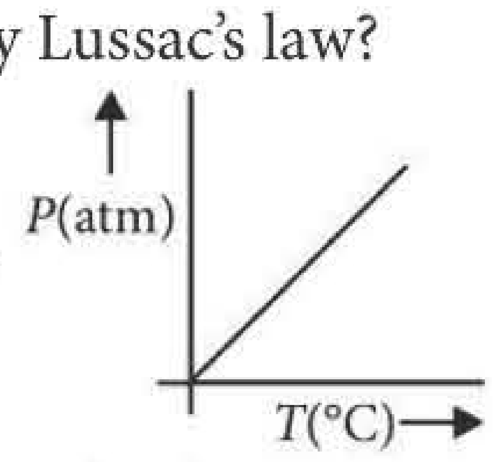
26. Coordination number of Cr is six. A complex with $C_2O_4^{2-}$, ethylene diamine (*en*) and superoxide, O_2^- will be in the ratio to make complex $[Cr(C_2O_4)_x(en)_y(O_2)_z]^-$.

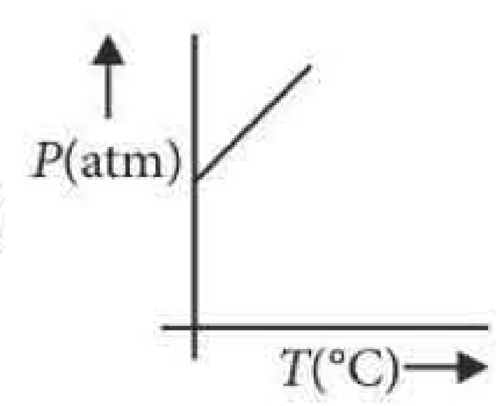
	x	y	z		x	y	z
(a)	1	1	1	(b)	1	1	2
(c)	1	2	2	(d)	2	1	1

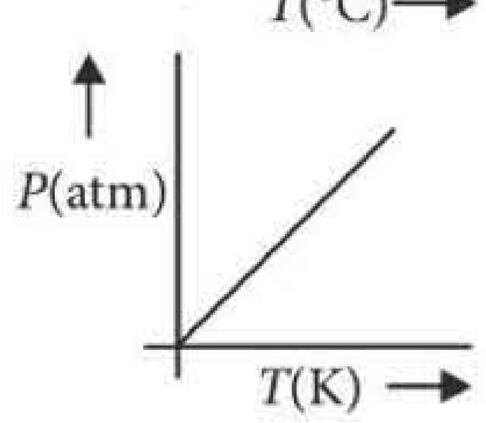
27. When propanol is heated with Al_2O_3 at 380 °C, the product obtained is
(a) dipropyl ether (b) propene
(c) ethene (d) diethyl ether.

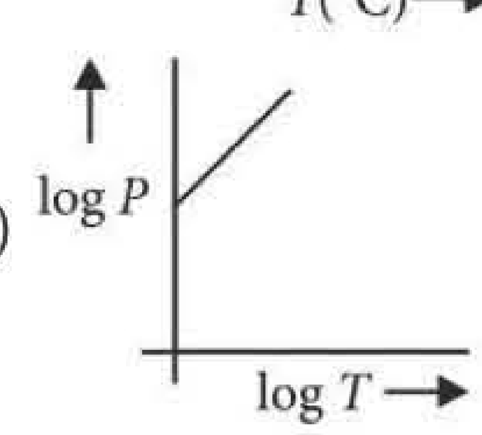
28. The compound which on reaction with aqueous nitrous acid at low temperature produces an oily nitrosoamine is
(a) methylamine (b) ethylamine
(c) diethylamine (d) triethylamine.

29. Which of the following curve does not represent Gay Lussac's law?

(a) 

(b) 

(c) 

(d) 

30. An explosion takes place when conc. H_2SO_4 is added to $KMnO_4$. Which of the following is formed?
(a) Mn_2O_7 (b) MnO_2 (c) $MnSO_4$ (d) Mn_2O_3

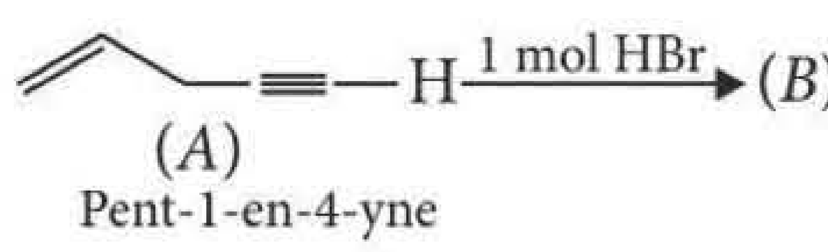
31. When CH_3CHO reacts with excess of HCHO in the presence of a base, which statement is true?
(a) Only aldol-type (Claisen-Schmidt) reaction takes place.
(b) Only Cannizzaro-type (crossed Cannizzaro) reaction takes place.
(c) Both aldol-type and Cannizzaro-type reactions take place.
(d) None of these.

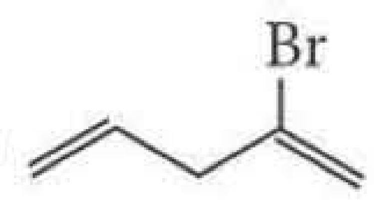
32. $CoCl_2$ gives blue colour with NH_4SCN due to the formation of
(a) $(NH_4)_2[Co(SCN)_4]$ (b) $(NH_4)_4[Co(SCN)_6]$
(c) $(NH_4)_3[Co(SCN)_6]$ (d) $(NH_4)[Co(SCN)_4]$

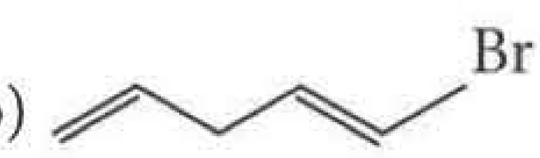
33. The "volume strength" of 1.5 N H_2O_2 solution is
(a) 4.8 (b) 8.4 (c) 3.0 (d) 8.0

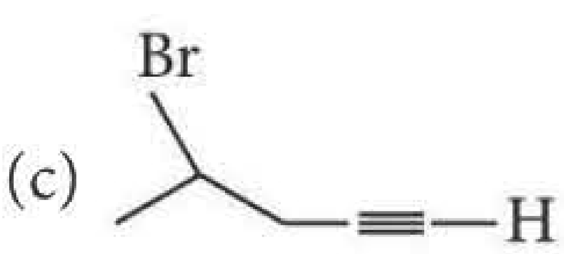
34. Sodium metal is produced commercially by the electrolysis of molten sodium chloride and chlorine is produced as a by product. How many litres of chlorine at 1.8 atm and 27 °C will be produced if a current of 1×10^3 A is passed through $NaCl_{(l)}$ for 9.65 h?
(a) 2463 (b) 460 (c) 1800 (d) 1231.6

35. Identify the product (*B*) in the following reaction.



(a) 

(b) 

(c) 

(d) 

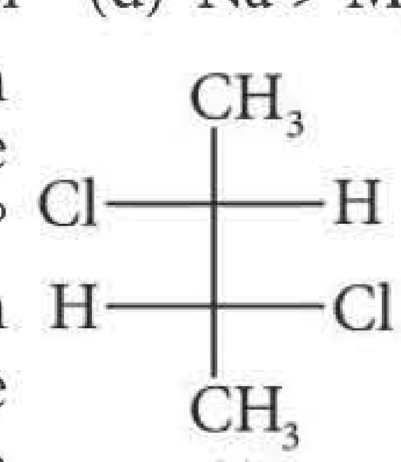
36. The molar masses of oxygen and sulphur dioxide are 32 and 64 respectively. If 1 L of oxygen at 25 °C and 760 mm Hg pressure contains *N* molecules, then the number of molecules in 2 L sulphur dioxide under same conditions of temperature and pressure is
(a) $N/2$ (b) $3N/2$ (c) $2N$ (d) $6N$

37. Which of the following is not a step of Cannizzaro reaction mechanism?
$2PhCHO \xrightarrow{\overline{O}H} PhCH_2OH + PhCOO^-$
(a) The attack of $\overline{O}H$ at the (C$=$O) group.
(b) The transfer of H^- ion to the (C$=$O) group.
(c) The abstraction of H^+ ion from carboxylic acid.
(d) The deprotonation of $PhCH_2OH$.

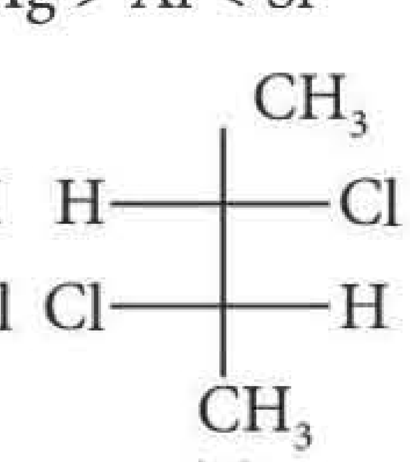
38. The reaction which proceeds in the forward direction is
(a) $Fe_2O_3 + 6HCl \longrightarrow 2FeCl_3 + 3H_2O$
(b) $NH_3 + H_2O + NaCl \longrightarrow NH_4Cl + NaOH$
(c) $2CuI + I_2 + 4H^+ \longrightarrow 2Cu^{2+} + 4HI$
(d) both (b) and (c).

39. The first ionisation enthalpies of Na, Mg, Al and Si are in the order
(a) Na < Mg > Al < Si (b) Na > Mg > Al > Si
(c) Na < Mg < Al < Si (d) Na > Mg > Al < Si

40. If optical rotation produced by the compound (I) is +52° then optical rotation produced by the compound (II) will be



(I)



(II)

(a) −52° (b) +52°
(c) 0° (d) unpredictable.

SOLUTIONS

1. **(a)** : At equilibrium, the concentrations of H_2 and I_2 would be equal. Let the equilibrium concentrations of H_2 and I_2 be x mol/L.

Then, $K_c = \frac{[HI]^2}{[H_2][I_2]} \Rightarrow \frac{(0.5)^2}{x^2} = 54.8$

$\Rightarrow x^2 = \frac{(0.5)^2}{54.8} \Rightarrow x = 0.0675$ mol/L

Thus, the equilibrium concentrations of H_2 and I_2 are 0.0675 mol/L each.

2. **(a)** : $2MnO_2 + 4KOH + O_2 \longrightarrow \underset{\text{Purple green}}{2K_2MnO_4} + 2H_2O$

3. **(d)** : 5% $NaHCO_3$ reacts with benzoic acid and gives effervescences with the evolution of CO_2 whereas phenol does not react.

4. **(a)** : On increasing temperature, physical adsorption decreases continuously.

5. **(b)** : $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$; $\Delta H_c = -393.5$ kJ mol^{-1}

No. of moles in 35.2 g $CO_2 = \frac{35.2 \text{ g}}{44 \text{ g/mol}} = 0.80$ mol

Formation of 1 mol of CO_2 releases 393.5 kJ of heat.
∴ Formation of 0.80 mol of CO_2 releases
= 0.80 × 393.5 kJ = 3.1 × 10^2 kJ of heat.

6. **(c)** : $H_3PO_3 + 2KOH \longrightarrow K_2HPO_3 + 2H_2O$

7. **(d)** : Cr_2O_3
$2x + 3(-2) = 0 \Rightarrow 2x = +6 \Rightarrow x = +3$

8. **(c)** : In option (c), all HCl will be neutralized and NH_4Cl will be formed. Also some NH_4OH will be left unneutralized. Thus, the final solution will contain NH_4OH and NH_4Cl and it will form a buffer.

9. **(c)** : For simple cubic, distance between nearest neighbours = a
Empty space = 0
For *fcc*, distance between nearest neighbours, $d = \frac{a}{\sqrt{2}}$

Empty space $= a - \frac{a}{\sqrt{2}} = a\left(1 - \frac{1}{\sqrt{2}}\right)$

For *bcc*, $d = \frac{\sqrt{3}a}{2}$

Empty space $= a - \frac{\sqrt{3}a}{2} = a\left(1 - \frac{\sqrt{3}}{2}\right)$

10. **(a)** : $MgCl_2.6H_2O \xrightarrow{\Delta} Mg(OH)Cl + HCl + 5H_2O$
$Mg(OH)Cl \longrightarrow MgO + HCl$

11. **(c)** : To find the order w.r.t. A, from I and II.

$\frac{1\times10^{-2}}{2\times10^{-2}} = \frac{2\times10^{-4}}{4\times10^{-4}} \Rightarrow \frac{1}{2} = \frac{1}{2} \Rightarrow$ order = 1

To find the order w.r.t. B, from II and III.

$\frac{2\times10^{-2}}{4\times10^{-2}} = \frac{4\times10^{-4}}{8\times10^{-4}} \Rightarrow \frac{1}{2} = \frac{1}{2} \Rightarrow$ order = 1

∴ Rate law of the reaction is $k[A][B]$.
From I, $r = k[A][B]$

$k = \frac{r}{[A][B]} = \frac{2\times10^{-4}}{(1\times10^{-2})(2\times10^{-2})} \Rightarrow k = 1$

From the rate law expression, $r = k[A][B]$ on doubling the concentrations of both the reactants, $r_1 = k[2A][2B]$, $r_1 = 4k[A][B]$, $r_1 = 4r$

12. **(d)** : None of the oxides is a peroxide, hence would not give H_2O_2.

13. **(b)** : $\Delta_f H^\circ = \Delta_f H^\circ(CO) + \Delta_f H^\circ(H_2O) - \Delta_f H^\circ(CO_2) - \Delta_f H^\circ(H_2)$
$= -110.5 + (-241.8) - (-393.5) - 0 = 41.2$ kJ/mol

14. **(c)** : The carbonyl compounds containing atleast one α-hydrogen atom undergo tautomerism. Hence, among the given compounds, $C_6H_5COCH_2CHO$ can exhibit tautomerism.

15. **(b)** : Mass of Ag required = 80 × 5 × 10^{-3} × 1.05 = 0.42 g

$\because w = \frac{ZIt}{96500}$ ∴ $0.42 = \frac{108\times3\times t}{96500} \Rightarrow t = 125$ s

16. **(c)** : The order of acidic strength is :
HCl > HF; $HClO_4 > HClO_3$; $HNO_3 > HNO_2$; $H_2SO_3 > H_2PO_3$

17. **(c)** : Solvent molecules are moving from solution B into solution A hence, osmotic pressure of solution A immediately begins to decrease.

18. **(c)** : In cationic polymerisation, carbocations are formed. Greater the stability of the carbocation, more reactive is the alkene. Since, the stability of the intermediate carbocation follows the order :

$CH_3\overset{+}{C}HC_6H_5 > CH_3\overset{+}{C}HCH_3 > CH_3\overset{+}{C}HCl > CH_3\overset{+}{C}HCOOCH_3$

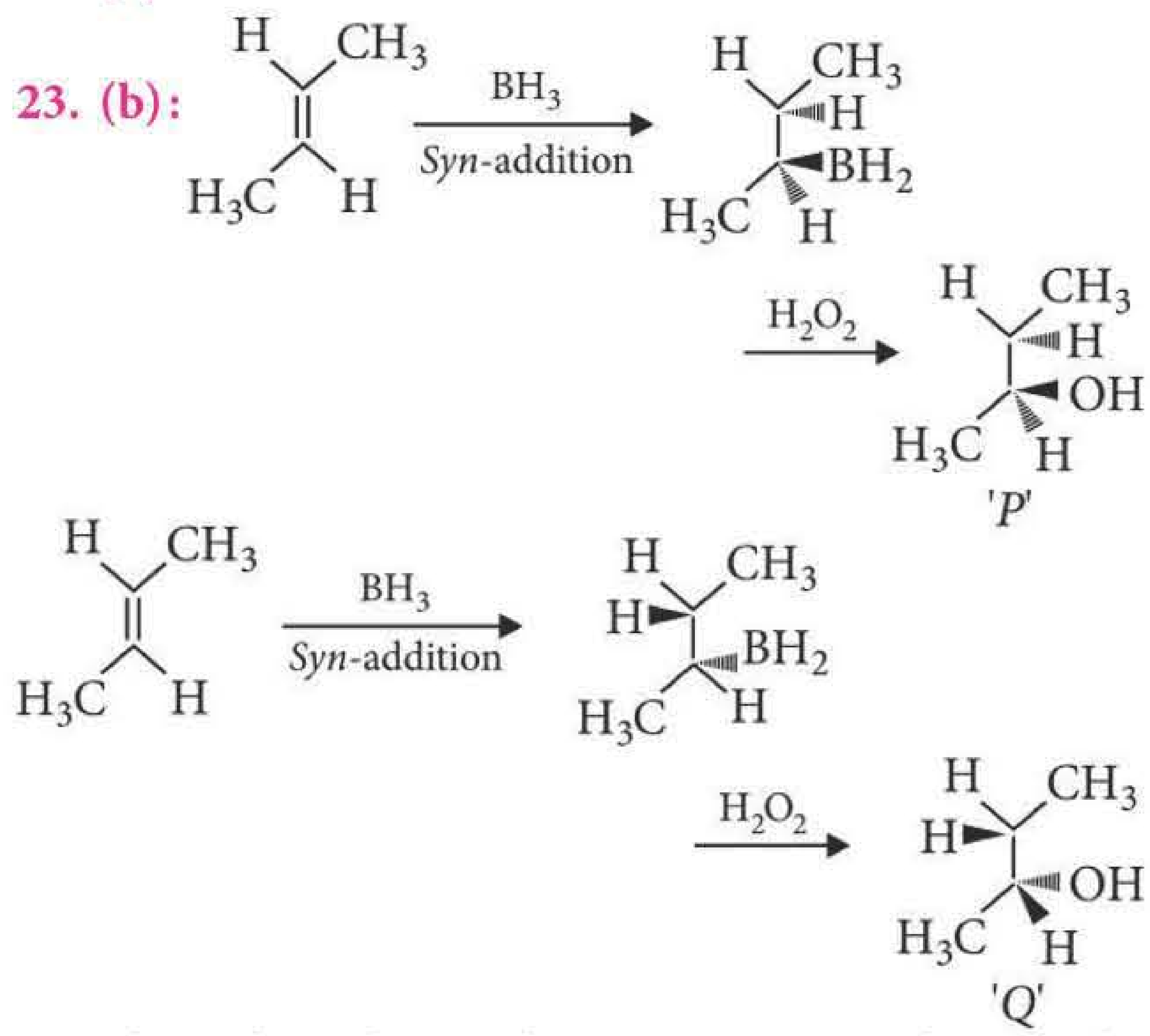
Therefore, reactivity decreases in the same order. Thus, styrene is most reactive.

19. **(c)** 20. **(a)**

21. **(b)** : (b) : Spin multiplicity = $2S + 1$
For IV : $2S + 1 = 7$; III : $2S + 1 = 5$; I : $2S + 1 = 5$; II : $2S + 1 = 3$
(c) V Violate Hund's rule.
(d) A^+ when kept near a magnet, it acts as a paramagnetic substance due to presence of unpaired electrons.

22. (b)

23. (b):



P and *Q*, thus obtained are enantiomers hence, the overall product is racemic mixture.

24. (b): $\underset{\text{Fructose}}{CH_2OH-CO-(CHOH)_3CH_2OH} \xrightarrow{HIO_4}$

$HCHO + HOOC-(CHOH)_3-CH_2OH \xrightarrow{HIO_4}$

$OHC-(CHOH)_2-CH_2OH + CO_2 \xrightarrow{HIO_4}$

$HCO_2H + OHC-CHOH-CH_2OH \xrightarrow{HIO_4}$

$HCO_2H + OHC-CH_2OH \xrightarrow{HIO_4} HCO_2H + HCHO$

25. (c): $\Delta_r H^\circ = \{\Delta_f H^\circ(B_2O_3) + 3\Delta_f H^\circ(H_2O)\} - \Delta_f H^\circ(B_2H_6)$

$-1941 = -1273 + 3(-241.8) - \Delta_f H^\circ(B_2H_6)$

$(\Delta_f H^\circ)B_2H_6 = -1273 - 725.4 + 1941 = -57.4$ kJ/mol

26. (b): $C_2O_4^{2-}$ and *en* are bidentate ligands.

C.N. of $Cr^{3+} = 6$, So, $x = 1$, $y = 1$, $z = 2$

Sum of charges = Net charge

$+3 + (-2 \times x) + 0(y) + (-1 \times z) = -1$

$\therefore\ +3 + (-2) + 0 + (-1 \times 2) = -1$

Thus, the complex will be $[Cr(C_2O_4)(en)(O_2)_2]^-$.

27. (b): $\underset{\text{Propanol}}{CH_3-CH_2-CH_2-OH} \xrightarrow[380\ ^\circ C]{Al_2O_3}$

$\underset{\text{Propene}}{CH_3-CH=CH_2} + H_2O$

28. (c): 2° amines react with HNO_2 at low temperature to give oily nitrosoamine.

$Et_2NH + HNO_2 \longrightarrow \underset{\text{N-Nitrosodiethylamine}}{Et_2N-N=O} + H_2O$

29. (a)

30. (a): $2KMnO_4 + H_2SO_4 \longrightarrow$

$\underset{\text{(Explosive)}}{Mn_2O_7} + K_2SO_4 + H_2O$

31. (c): $CH_3-CHO + HCHO \xrightarrow[\text{Aldol type reaction}]{\text{Base}}$

$HO-CH_2-CH_2-CHO$

$\downarrow \Delta$

$CH_2=CH-CHO$

α, β-unsaturated aldehyde

$HCHO + HCHO \xrightarrow[\text{Cannizaro reaction}]{\text{Base}}$

$HCOOH + CH_3OH$

32. (a)

33. (b): Volume strength = 5.6 × Normality

= 5.6 × 1.5 = 8.4

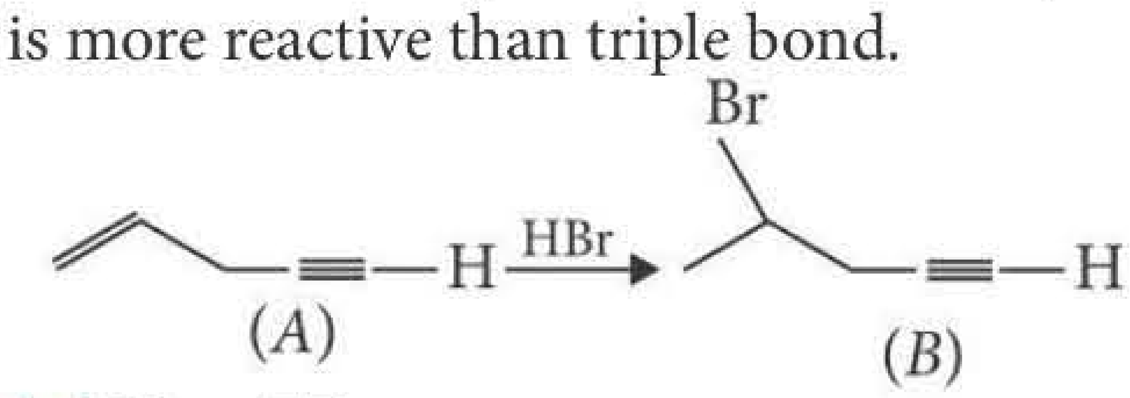
34. (a): Equivalents of Cl_2 produced

$= \dfrac{1000 \times 9.65 \times 3600}{96500} = 360$

Moles of Cl_2 = 180

Now, $V = \dfrac{nRT}{P} \Rightarrow \dfrac{180 \times 0.0821 \times 300}{1.8} = 2463$ L

35. (c): In the given compound, electrophilic addition of 1 mol of HBr takes place at double bond, as double bond is more reactive than triple bond.



36. (c): $PV = nRT$

$P = 760$ mmHg = 1 atm

Moles of $O_2 = \dfrac{PV}{RT} = \dfrac{1 \times 1}{RT}$

$\therefore$ No. of molecules $(N) = \dfrac{N_0}{RT}$ ...(i)

Moles of $SO_2 = \dfrac{PV}{RT} = \dfrac{1 \times 2}{RT}$

$\therefore$ No. of molecules $(M) = \dfrac{2N_0}{RT}$ ...(ii)

Dividing both eq. we get, $\dfrac{N}{M} = \dfrac{1}{2} \Rightarrow M = 2N$

37. (d)

38. (a): $Fe_2O_3 + 6HCl \longrightarrow 2FeCl_3 + 3H_2O$

Backward reaction will not take place due to the lack of hydrolysis of $FeCl_3$.

39. (a): $Na(3s^1) < Mg(3s^2) > Al(3s^2 3p^1) < Si(3s^2 3p^2)$

40. (a): Two given compounds are enantiomers *i.e.*, non-superimposable mirror image of each other which rotate the plane polarised light by same angle but in opposite direction *i.e.*, if one rotates by +52° then another compound rotates by −52°.

CONCEPT MAP

CLASS XI

ESSENTIAL CONCEPTS OF ORGANIC CHEMISTRY

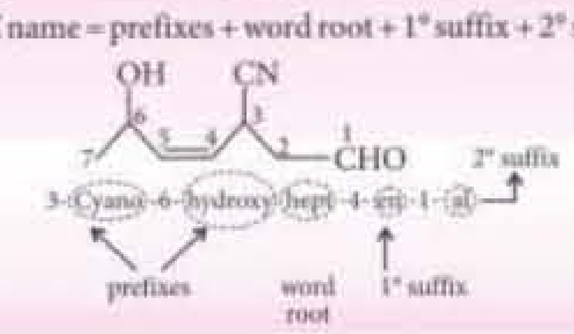
Get well-prepared for exams with quick revision of important concepts of organic chemistry.

Organic Chemistry - Some Basic Principles and Techniques

IUPAC Nomenclature

IUPAC name = prefixes + word root + 1° suffix + 2° suffix

e.g.,



Order of Species Showing Inductive Effect

- **–I-effect:** $R_3\overset{+}{N}- > -NO_2 > -SO_2R > -CN > -COOH > -F > -Cl > -Br > -I > -OR > -COR > -OH > -C_6H_5 > -CH=CH_2 > -H$
- **+I-effect:** $(CH_3)_3C- > (CH_3)_2CH- > CH_3CH_2- > CH_3- > -D > -H$

Order of Species Showing Resonance or Mesomeric Effect

- **+R-effect:** $-Cl, -Br, -I, -NH_2, -NHR, -NR_2, -NHCOR, -OH, -OR, -SR, -SH, -OCH_3, -OCOR$
- **–R-effect:** $-NO_2, -CN, >C=O, -CHO, -COOH, -COOR$

- Bond order in compounds which exhibit resonance

$$= \frac{\text{Total number of bonds between two atoms in all the structures}}{\text{Total number of resonating structures}}$$

Hyperconjugation

Number of hyperconjugating structures ∝ number of α-hydrogens ∝ stability ∝ 1/heat of hydrogenation ∝ polarity ∝ dipole moment ∝ 1/bond length

Stability of Free Radicals

- Stability of free radicals ∝ +I-effect ∝ $\frac{1}{-I\text{-effect}}$ ∝ +R-effect ∝ $\frac{1}{-R\text{-effect}}$

$Ph_3\dot{C} > Ph_2\dot{C}H > Ph\dot{C}H_2 >$ Allyl > 3° > 2° > 1° > $\dot{C}H_3 > CH_2=\dot{C}H$

Stability of Carbocations

- Stability of carbocations ∝ +I-effect ∝ $\frac{1}{-I\text{-effect}}$ ∝ +R-effect ∝ $\frac{1}{-R\text{-effect}}$

$Ph_3\overset{+}{C} > Ph_2\overset{+}{C}H > Ph\overset{+}{C}H_2 >$ Allyl > 3° > 2° > 1° > $\overset{+}{C}H_3$

Stability of Carbanions

- Stability of carbanions ∝ –I-effect ∝ $\frac{1}{+I\text{-effect}}$ ∝ –R-effect ∝ $\frac{1}{+R\text{-effect}}$

$Ph_3\bar{C} > Ph_2\bar{C}H > Ph\bar{C}H_2 >$ Allyl > $\bar{C}H_3$ > 1° > 2° > 3°

Stability of Carbene

Triplet > Singlet

Thin Layer Chromatography

Retention factor (R_f)

$$= \frac{\text{Distance travelled by the compound from base line } (x)}{\text{Distance travelled by the solvent from base line } (y)}$$

Quantitative Analysis

- $\% \text{ of C} = \frac{12}{44} \times \frac{\text{mass of } CO_2 \text{ formed}}{\text{mass of compound taken}} \times 100$
- $\% \text{ of H} = \frac{2}{18} \times \frac{\text{mass of } H_2O \text{ formed}}{\text{mass of compound taken}} \times 100$

(Liebig's combustion method)

- $\% \text{ of N} = \frac{28}{22400} \times \frac{\text{vol. of } N_2 \text{ at STP}}{\text{mass of compound taken}} \times 100$
- $\% \text{ of N} = \frac{1.4 \times \text{normality of acid} \times \text{vol. of acid used}}{\text{mass of compound taken}}$

(Dumas method)

- $\% \text{ of N} = \frac{1.4 \times \text{molarity of acid} \times \text{vol. of acid used} \times \text{basicity of acid}}{\text{mass of compound taken}}$

(Kjeldahl's method)

- $\% \text{ of Cl} = \frac{35.5}{143.5} \times \frac{\text{mass of AgCl formed}}{\text{mass of compound taken}} \times 100$
- $\% \text{ of Br} = \frac{80}{188} \times \frac{\text{mass of AgBr formed}}{\text{mass of compound taken}} \times 100$
- $\% \text{ of I} = \frac{127}{235} \times \frac{\text{mass of AgI formed}}{\text{mass of compound taken}} \times 100$
- $\% \text{ of S} = \frac{32}{233} \times \frac{\text{mass of } BaSO_4 \text{ formed}}{\text{mass of compound taken}} \times 100$

(Carius method)

- $\% \text{ of P} = \frac{62}{222} \times \frac{\text{mass of } Mg_2P_2O_7 \text{ formed}}{\text{mass of compound taken}} \times 100$

(Ignition method)

- $\% \text{ of O} = \frac{32}{88} \times \frac{\text{mass of } CO_2 \text{ formed}}{\text{mass of compound taken}} \times 100$
- $\% \text{ of O} = \frac{5 \times 16}{2 \times 127} \times \frac{\text{mass of } I_2 \text{ formed}}{\text{mass of compound taken}} \times 100$

(Iodine method)

ESSENTIAL CONCEPTS OF PHYSICAL CHEMISTRY

Get well-prepared for exams with quick revision of important concepts of physical chemistry.

CONCEPT MAP

CLASS XII

Solid State

Packing efficiency

$$= \frac{\text{Volume occupied by two spheres in the unit cell}}{\text{Total volume of the unit cell}} \times 100$$

- Mass of the atoms of unit cell = Number of atoms in a unit cell (Z) × Mass of atom (M_{atom})
- Mass of one atom = $\frac{\text{Molar mass } (M)}{\text{Avogadro's constant } (N_A)}$
- Density (ρ) of unit cell of a cubic crystal $= \frac{ZM}{V \times N_A} = \frac{ZM}{a^3 N_A}$

- Bragg's equation: $2d \sin\theta = n\lambda$
- Number of octahedral voids = No. of particles present in the close packing
- Number of tetrahedral voids = 2 × No. of octahedral voids

Characteristics of Different Types of Unit Cells

Crystal	No. of atom(s)/unit cell	Packing efficiency	C.No.	Relation in d, a and r
scc	1	52.4%	6	$r = d/2 = a/2$
bcc	2	68%	8	$r = d/2 = \sqrt{3}a/4$
fcc	4	74%	12	$r = d/2 = a/2\sqrt{2}$

Void	Radius Ratio
Triangular	$0.155 \le r^+/r^- < 0.225$
Tetrahedral	$0.225 \le r^+/r^- < 0.414$
Octahedral	$0.414 \le r^+/r^- < 0.732$
Body-centred cubic	$0.732 \le r^+/r^- < 1$

Solids on the Basis of Electrical Properties

- **Conductors:** Electrical conductivity, 10^4 to 10^7 $ohm^{-1}\,m^{-1}$
- **Insulators:** Electrical conductivity, 10^{-20} to 10^{-10} $ohm^{-1}\,m^{-1}$
- **Semiconductors:** Electrical conductivity, 10^{-6} to 10^4 $ohm^{-1}\,m^{-1}$
  - ***n*-type semiconductors:** Group 14 elements doped with group 15 elements, free electrons increase conductivity.
  - ***p*-type semiconductors:** Group 14 elements doped with group 13 elements, holes increase conductivity.

Solutions

- Molality $(m) = \frac{M}{\rho - \frac{MM_2}{1000}}$
- Molarity $(M) = \frac{n_1}{(n_1M_1 + n_2M_2)/\rho}$

- **Henry's law:** $p_A = K_H \cdot x_A$: K_H increases with increase of temperature implying that solubility decreases with increase of temperature at the same pressure.
- **Raoult's law:** $p_1 = p_1^\circ x_1$, this law is applicable only if the two components form a homogeneous mixture.
- **Dalton's law of partial pressure:** $p_{total} = p_1 + p_2 + \dots p_n$ and for two components system, $p_{total} = p_1^\circ + (p_2^\circ - p_1^\circ)x_2$

Ideal and Non-ideal Solutions

Ideal Solutions	Non-ideal Solutions
$p_1 = x_1p_1^\circ; p_2 = x_2p_2^\circ$ $\Delta H_{mix} = 0, \Delta V_{mix} = 0$ $A - B$ interactions = $A - A$ and $B - B$ interactions.	$p_1 \ne x_1p_1^\circ; p_2 \ne x_2p_2^\circ$ $\Delta H_{mix} \ne 0, \Delta V_{mix} \ne 0$ $A - B$ interactions ≠ $A - A$ and $B - B$ interactions.

Non-ideal Solutions Showing Positive and Negative Deviations from Raoult's Law

Solutions showing positive deviation	Solutions showing negative deviation
$A - B << A - A$ or $B - B$ interactions. $\Delta H_{mix} > 0, \Delta V_{mix} > 0$ $p_1 > p_1^\circ x_1$	$A - B >> A - A$ or $B - B$ interactions. $\Delta H_{mix} < 0, \Delta V_{mix} < 0$ $p_1 < p_1^\circ x_1$

Colligative Properties

- **Relative lowering of vapour pressure:** $(p_A^\circ - p_A)/p_A^\circ = x_B$
- **Elevation in boiling point:** $\Delta T_b = T_b - T_b^\circ = K_b m$
- **Depression in freezing point:** $\Delta T_f = T_f^\circ - T_f = K_f m$
- **Osmotic pressure:** $\pi = CRT = (n/V)RT$

van't Hoff Factor and its Significance

$$i = \frac{\text{Observed value of colligative property}}{\text{Calculated value of colligative property}}$$

- **For association of solute:** $nA \rightarrow (A)_n$
  Degree of association $(\alpha) = (1 - i)\,n/n - 1; i < 1$
- **For dissociation of solute:** $(A)_n \rightarrow nA$
  Degree of dissociation $(\alpha) = i - 1/n - 1; i > 1$
- **Modified colligative properties:**
  $p_A^\circ - p_A/p_A^\circ = ix_B; \Delta T_b = iK_b m; \Delta T_f = iK_f m; \pi = iCRT$

MONTHLY TEST DRIVE

XI

This specially designed column enables students to self analyse their extent of understanding of all chapters (Class XI). Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120 **Time Taken : 60 min**

NEET

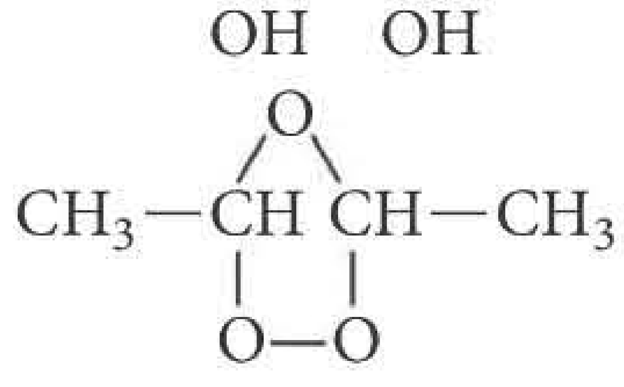
Only One Option Correct Type

1. When water is dropped over sodium peroxide, the colourless gas produced is
   (a) dinitrogen (b) dioxygen
   (c) dihydrogen (d) hydrogen peroxide.

2. Among the following ionisations, which one will have the maximum value of ionisation energy?
   (a) $Be \rightarrow Be^+$ (b) $Be^+ \rightarrow Be^{2+}$
   (c) $Sr \rightarrow Sr^+$ (d) $Sr^+ \rightarrow Sr^{2+}$

3. The concentration of oxalic acid solution is x mol L^{-1}. 40 mL of this solution reacts with 16 mL of 0.05 M acidified $KMnO_4$ solution. Assuming that oxalic acid dissociates completely, pH of the given oxalic acid solution is
   (a) 1.0 (b) 1.3 (c) 1.699 (d) 2.0

4. $2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(s)}; \Delta H° = -851.4 \text{ kJ mol}^{-1}$.
   How much heat is released when 72.0 g of Al reacts with excess Fe_2O_3?
   (a) 1136 kJ mol^{-1} (b) 1278 kJ mol^{-1}
   (c) 2.28×10^3 kJ mol^{-1} (d) 2.54×10^3 kJ mol^{-1}

5. Product 'P' of the given reaction,
   $CH_3-CH=CH-CH_3 \xrightarrow[-78\,°C]{O_3/CH_2Cl_2} P$, will be
   (a) CH_3-CHO (b) CH_3-COOH
   (c) $CH_3-\underset{OH}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH}}-CH_3$
   (d) 

6. A mineral containing iron (II) sulphide but no other sulphide is treated with excess of hydrochloric acid to produce hydrogen sulphide gas. If 3.15 g sample of mineral yielded 448 mL of hydrogen sulphide gas at 0 °C and 760 mm pressure, the mass percentage of iron (II) sulphide in the sample is
   (a) 20.6 (b) 35.2
   (c) 55.8 (d) 72.4

7. The normality and volume strength of a solution made by mixing 1.0 L each of 5.6 volume and 11.2 volume H_2O_2 solution are
   (a) 1 N, 5.6 vol (b) 1.5 N, 5.6 vol
   (c) 1.5 N, 8.4 vol (d) 1 N, 8.4 vol

8. Which of the following is not true?
   (a) SH_6 and $BiCl_5$ do not exist.
   (b) There are two $p\pi-d\pi$ bonds in SO_3^{2-}.
   (c) SeF_4 and CH_4 are tetrahedral species.
   (d) I_3^- is a linear molecule with sp^3d-hybridisation.

9. Fluorosis, a bone disease, is caused by the presence of
   (a) carbon monoxide in air
   (b) SO_2 in air (c) pesticides in water
   (d) fluoride in water.

10. Considering that NaOH neither oxidises nor reduces CrO_2Cl_2, which of the following species will be formed when CrO_2Cl_2 is dissolved in NaOH solution?
    (a) CrO_4^{2-} (b) Cl_2O
    (c) ClO_2 (d) $Cr(OH)_3$

11. A pre-weighed vessel was filled with oxygen at N.T.P. and weighed. It was then evacuated, filled with SO_2 at the same temperature and pressure, and again weighed. The weight of oxygen will be

(a) the same as that of SO_2

(b) $\frac{1}{2}$ that of SO_2 (c) twice that of SO_2

(d) one fourth that of SO_2.

12. Which of the following sets of quantum numbers is correct for a 4*d*-electron?

(a) $4, 3, 2, +\frac{1}{2}$ (b) 4, 2, 1, 0

(c) $4, 2, -2, +\frac{1}{2}$ (d) $4, 2, 3, -\frac{1}{2}$

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

13. Assertion : A spectral line will be seen for a $2p_x \rightarrow 2p_y$ transition.

Reason : Energy is released in the form of wave of light when the electron drops from the $2p_x$ to the $2p_y$ orbital.

14. Assertion : Sodium reacts with oxygen to form Na_2O_2 whereas potassium reacts with oxygen to form KO_2.

Reason : Potassium is more reactive than sodium.

15. Assertion : An endothermic reaction gives a better yield of products at higher temperature.

Reason : The equilibrium constant of an endothermic reaction increases with increasing temperature.

JEE MAIN / ADVANCED

Only One Option Correct Type

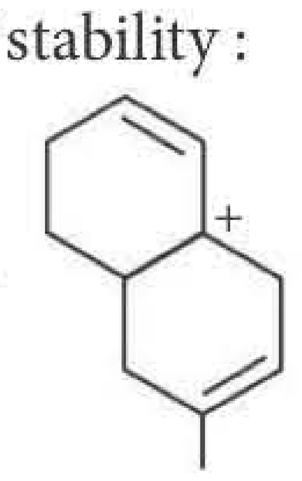
16. Which of the following are isoelectronic and isostructural?

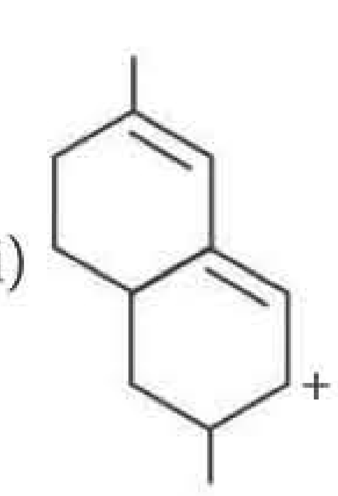
NO_3^-, CO_3^{2-}, ClO_3^-, SO_3

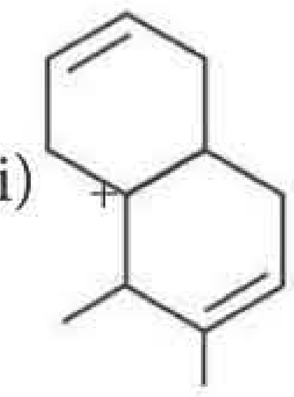
(a) CO_3^{2-}, ClO_3^- (b) CO_3^{2-}, NO_3^-

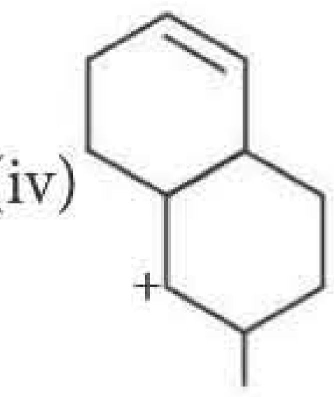
(c) SO_3, ClO_3^- (d) SO_3, NO_3^-

17. Rank the following carbocations in increasing order of stability :

(i) 

(ii) 

(iii) 

(iv) 

(a) iv < iii < i < ii (b) iv < i < iii < ii

(c) iii < ii < i < iv (d) i < iii < ii < iv

18. Na_2SiO_3 is a polymer. How many O-atoms are shared by each SiO_4^{4-} tetrahedron with other SiO_4^{4-} tetrahedra?

(a) 0 (b) 1 (c) 2 (d) 3

19. The pK_a of acetyl salicylic acid (aspirin) is 3.5. The pH of gastric juice in the human stomach is about 2 to 3 and the pH in the small intestine is 8. Aspirin will be

(a) unionised in the small intestine and in the stomach

(b) completely ionised in the small intestine and in the stomach

(c) ionised in the stomach and almost unionised in the small intestine

(d) ionised in the small intestine and almost unionised in the stomach.

More than One Options Correct Type

20. The $\Delta_i H$ and $\Delta_{eg} H$ of an element A are + 450 kJ mol^{-1} and −100 kJ mol^{-1}. Which of the following options are true with respect to A^+ and A^- ions?

(a) $\Delta_{eg} H$ of $A^+ = -450$ kJ mol^{-1}

(b) $\Delta_i H$ of $A^- = -100$ kJ mol^{-1}

(c) $\Delta_{eg}H$ of $A^+ = +350$ kJ mol^{-1}

(d) $\Delta_i H$ of $A^- = +550$ kJ mol^{-1}

21. Which of the following reactions involve increase in entropy?

(a) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

(b) $2HI_{(g)} \rightarrow H_{2(g)} + I_{2(g)}$

(c) $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(l)}$

(d) S (Rhombic) + $O_{2(g)} \rightarrow SO_{2(g)}$

22. Which of the following statements are false?

(a) $BeCl_2$ exists as dimer in the vapour state and polymeric in the solid state.

(b) Calcium hydride is called hydrolith.

(c) The oxides of Be and Ca are amphoteric.

(d) Bicarbonates of Na and Sr are insoluble in water.

23. Which of the following reactions are correctly represented?

(a) $R-CH=CH_2 + HCl \rightarrow R-\underset{\underset{\displaystyle Cl}{|}}{CH}-CH_3$

(b) $R-CH=CH_2 + HI \xrightarrow{\text{Peroxide}} R-CH_2-CH_2-I$

(c) $R-CH=CH_2 + HBr \xrightarrow{\text{Peroxide}} R-CH_2-CH_2-Br$

(d) $R-CH=CH_2 + HI \xrightarrow{\text{Peroxide}} R-\underset{\underset{\displaystyle I}{|}}{CH}-CH_3$

Numerical / Integer Type

24. An alkaloid contains 17.28% of nitrogen and its molecular mass is 162. The number of nitrogen atoms present in one molecule of the alkaloid is

25. The number of stereoisomers obtained by bromination of *trans*-2-butene is

26. A diatomic molecule has a dipole moment of 1.2 D. If the bond distance is 1 Å, $1/x$ of an electronic charge exists on each atom. The value of x is

Comprehension Type

Rocks, clays and soils are made up of silicates of aluminium, iron, magnesium and other metals. All silicates are made up of SiO_4 tetrahedral units in which Si is sp^3-hybridised and is surrounded by four oxygen atoms. The SiO_4 tetrahedra can be linked together in several different ways. Depending on the number of corners of the SiO_4 tetrahedra shared, various kinds of silicates are formed.

27. Quartz watches contain
(a) a crystal of quartz as an essential component
(b) a coating of quartz on the outer body
(c) hands made up of quartz
(d) silica coated on the numbers.

28. Which of the following is not a crystalline form of silica?
(a) Quartz
(b) Tridymite
(c) Cristobalite
(d) Kieselguhr

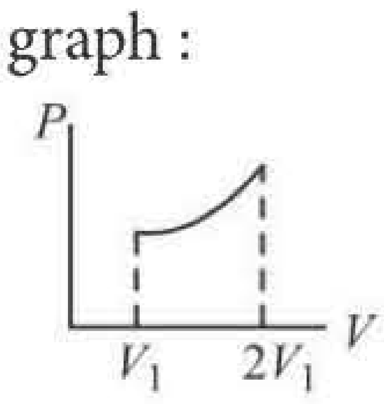
Matrix Match Type

29. Match the List I with List II and choose the correct answer using the codes given below the lists.

List I (Conversion)	List II (Reagents)
P. $(CH_3)_3C—CH{=}CH_2 \rightarrow (CH_3)_2C(OH)—CH(CH_3)_2$	(i) $B_2H_6/H_2O_2/OH^-$
Q. $(CH_3)_3C—CH{=}CH_2 \rightarrow (CH_3)_3C—CH(OH)—CH_3$	(ii) $H_2O/H^+/MnO_2$
R. $C_6H_5—CH{=}CH_2 \rightarrow C_6H_5—CHO$	(iii) $Hg(OAc)_2/H_2O/NaBH_4$
S. $C_6H_5—C{\equiv}CH \rightarrow C_6H_5—CH_2—CHO$	(iv) H_2O/H^+

	P	Q	R	S
(a)	(i)	(ii)	(iii)	(iv)
(b)	(iv)	(iii)	(ii)	(i)
(c)	(iv)	(ii)	(i)	(iii)
(d)	(i)	(iv)	(ii)	(iii)

30. Match List I containing a list of processes involving expansion of an ideal gas with List II describing the thermodynamic change during corresponding process and choose the correct answer using the codes given below the lists.

List I	List II
P. An insulated container has two chambers separated by a valve. Chamber I contains an ideal gas and the chamber II has vacuum. The valve is opened.	(i) The temperature of the gas decreases.
Q. An ideal monoatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^2}$; where, V is the volume of the gas.	(ii) The temperature of the gas remains constant.
R. An ideal monoatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^{4/3}}$; where, V is its volume.	(iii) The temperature of the gas increases.
S. An ideal monoatomic gas expands such that its pressure P and volume V follows the behaviour shown in the graph : 	(iv) The gas loses heat.
	(v) The gas gains heat.

	P	Q	R	S
(a)	(i, iii)	(ii)	(iv)	(i, ii)
(b)	(ii)	(i, iv)	(i, iii)	(ii, iv)
(c)	(ii)	(i, v)	(i, v)	(iii, v)
(d)	(iii, iv)	(i, ii)	(iv)	(i)

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted ......
No. of questions correct ......
Marks scored in percentage ......

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

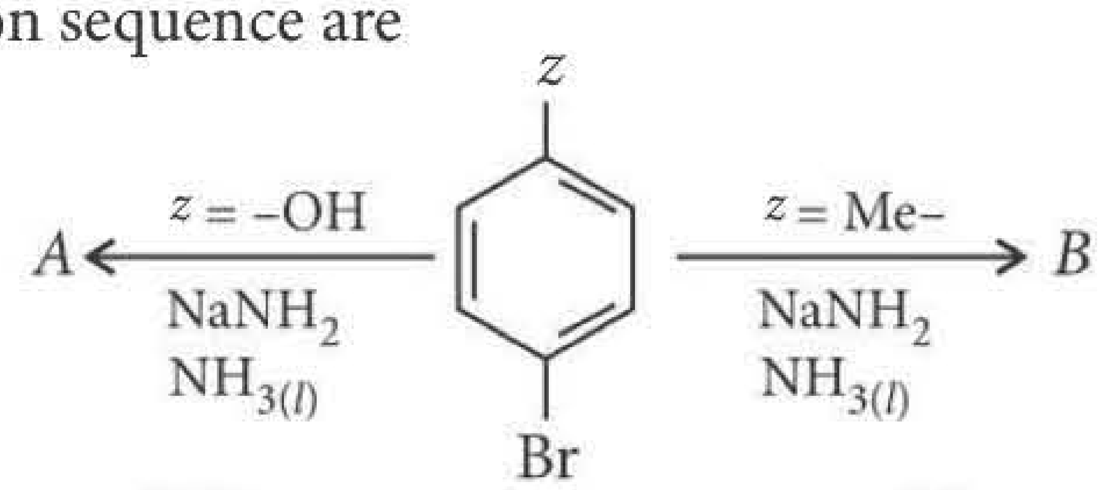
JEE WORK CUTS

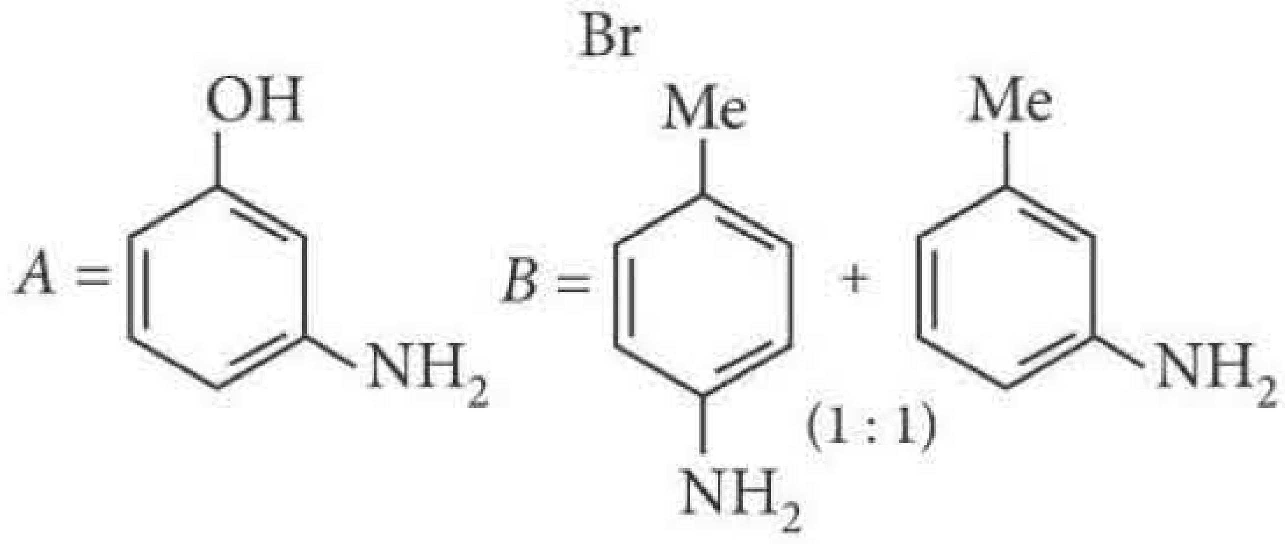
*Arunava Sarkar

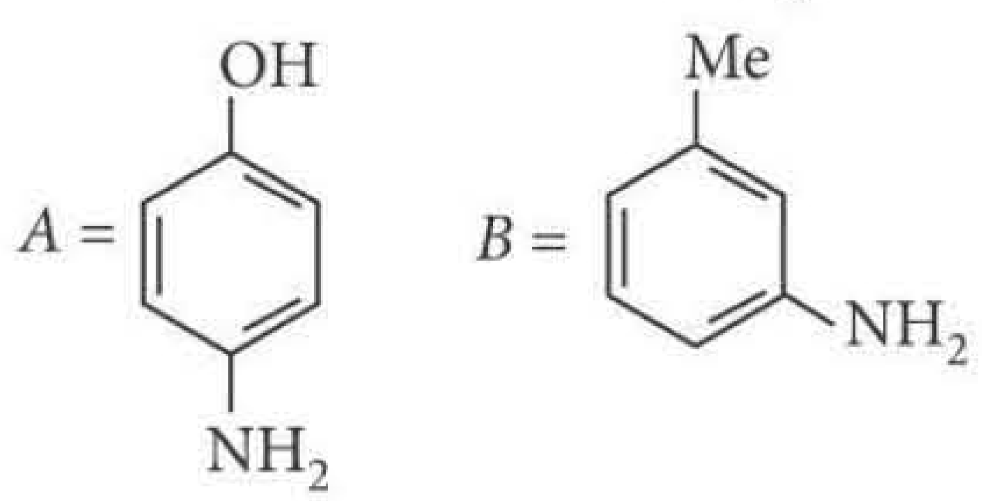
SECTION-1

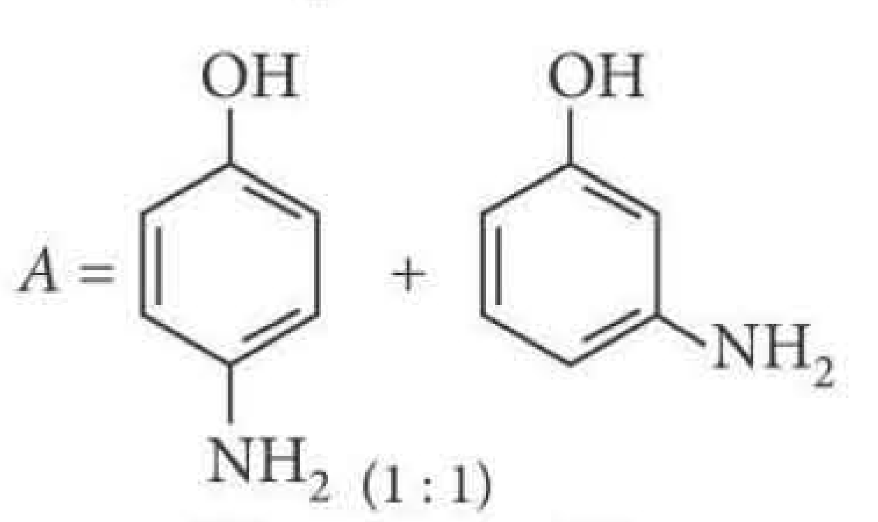
(One or More than One Option Correct)

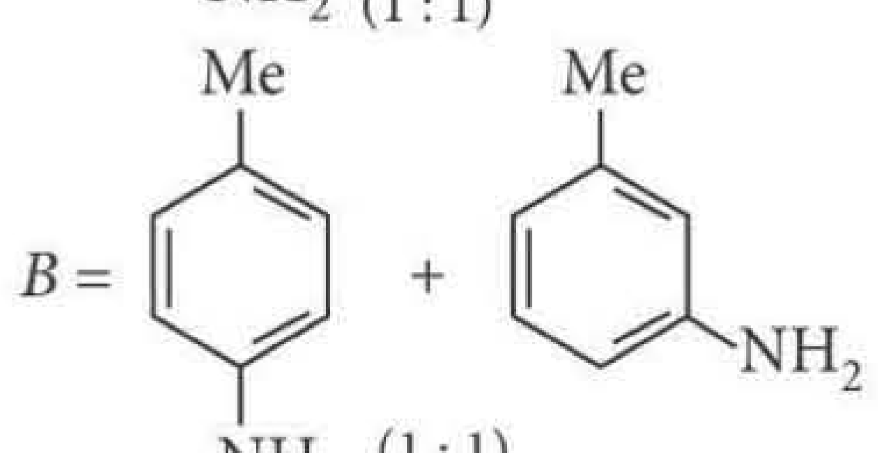
1. The major products A and B in the following reaction sequence are

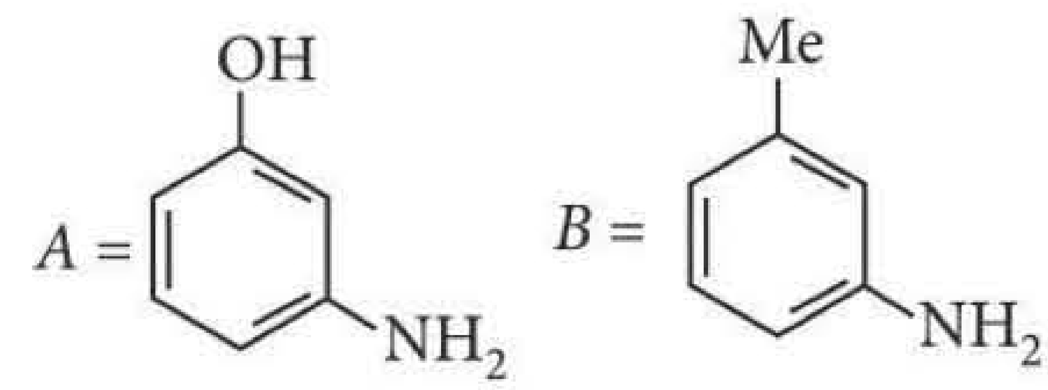


(a) 

(b) 

(c) 



(d) 

2. Which of the following thermodynamic relation(s) is/ are correct?

(a) $\left(\frac{\partial P}{\partial V}\right)_S = \left(\frac{\partial P}{\partial S}\right)_V$ (b) $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$

(c) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ (d) $\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$

3. Select the correct statement(s).

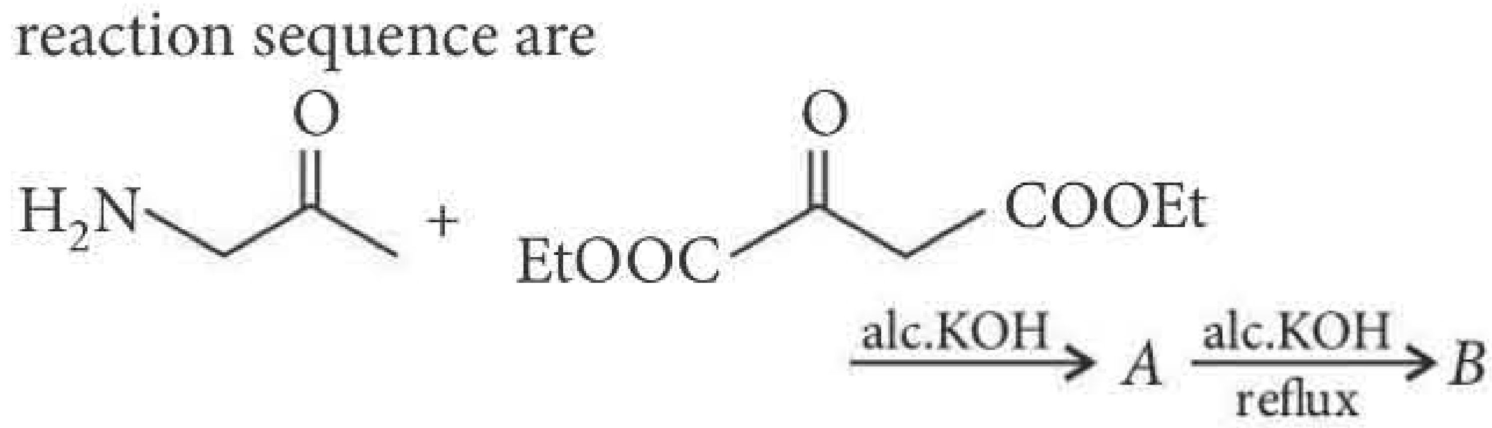
(a) In a mixture of $KMnO_4$ and $H_2C_2O_4$, $KMnO_4$ decolourises faster at higher temperature than lower temperature.

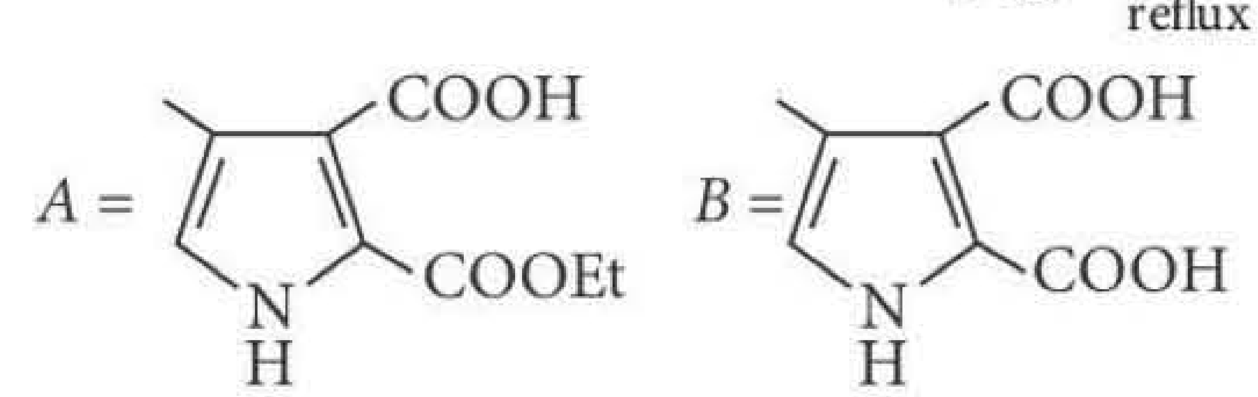
(b) A catalyst participates in a chemical reaction by forming temporary bonds with the reactant resulting in an intermediate complex.

(c) In collision theory, only activation energy determines the criteria for effective collision.

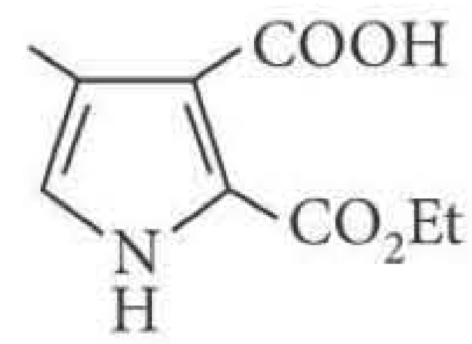
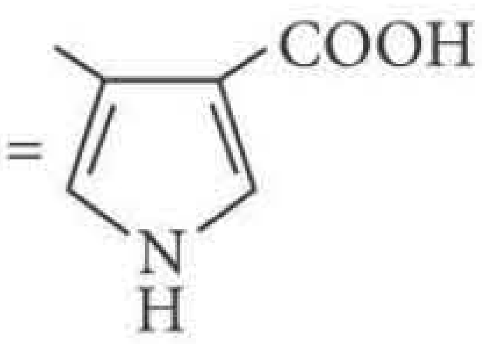
(d) Collision theory assumes molecules to be soft spheres and consider their structural aspects.

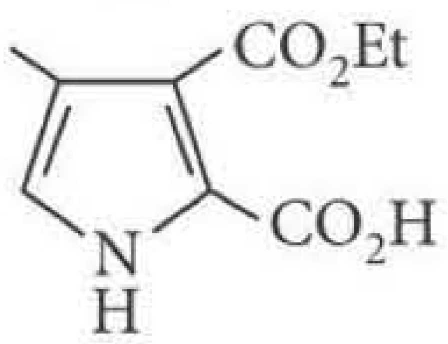
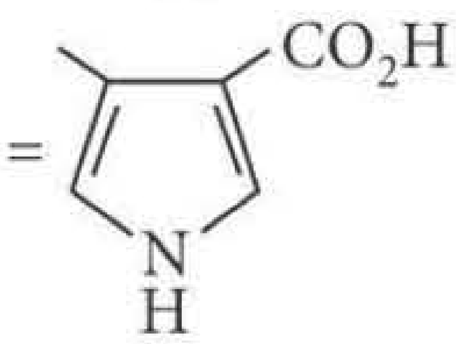
4. The major products A and B in the following reaction sequence are

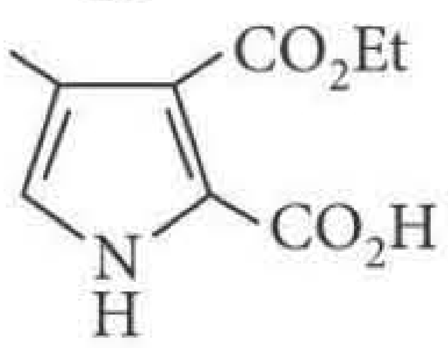
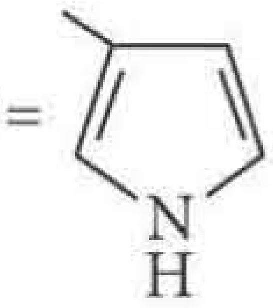


(a) 

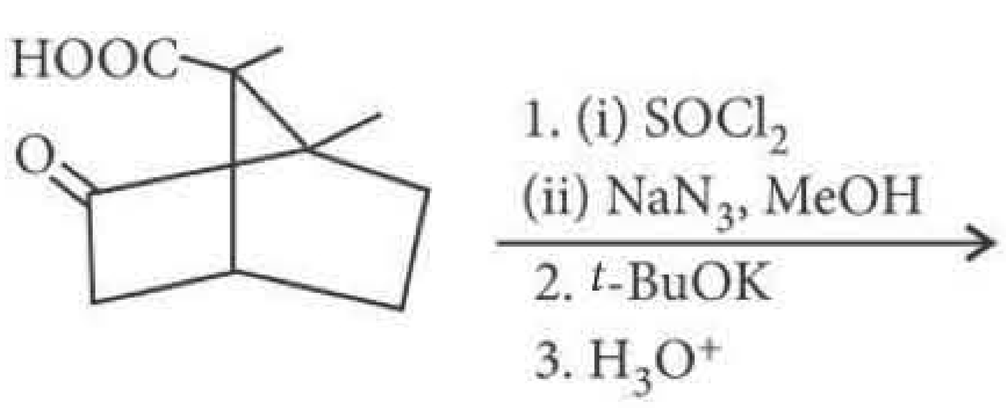
*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

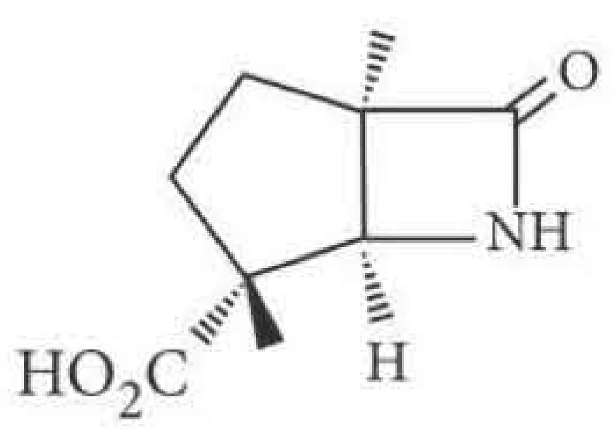
(b) A =  B = 

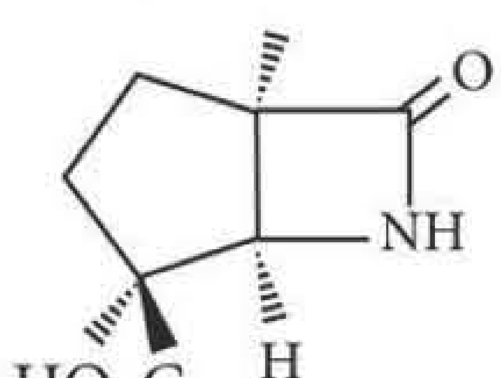
(c) A =  B = 

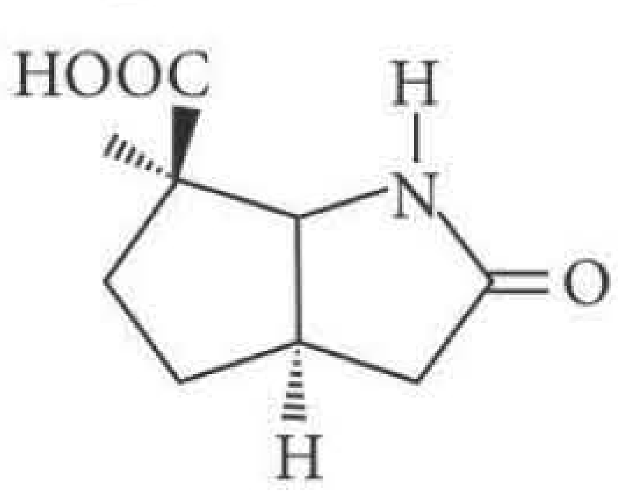
(d) A =  B = 

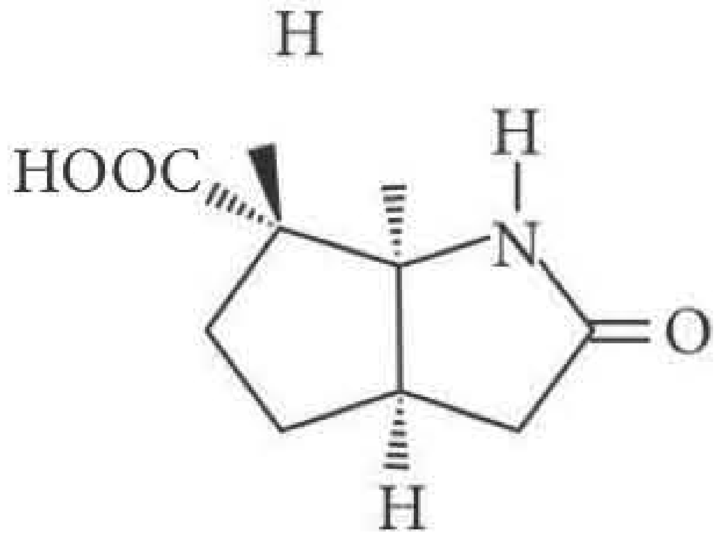
5. Identify the product.



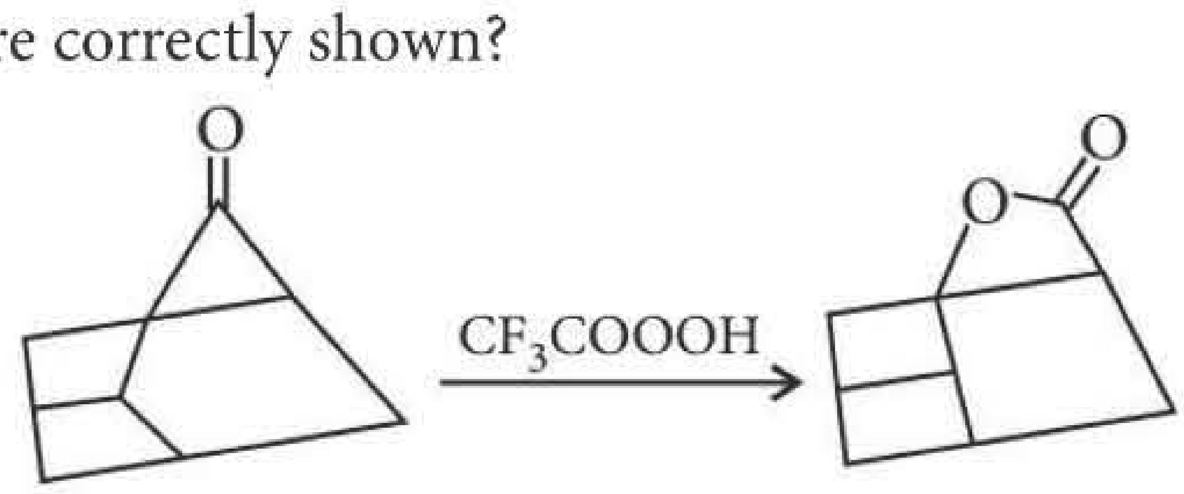
(a) 

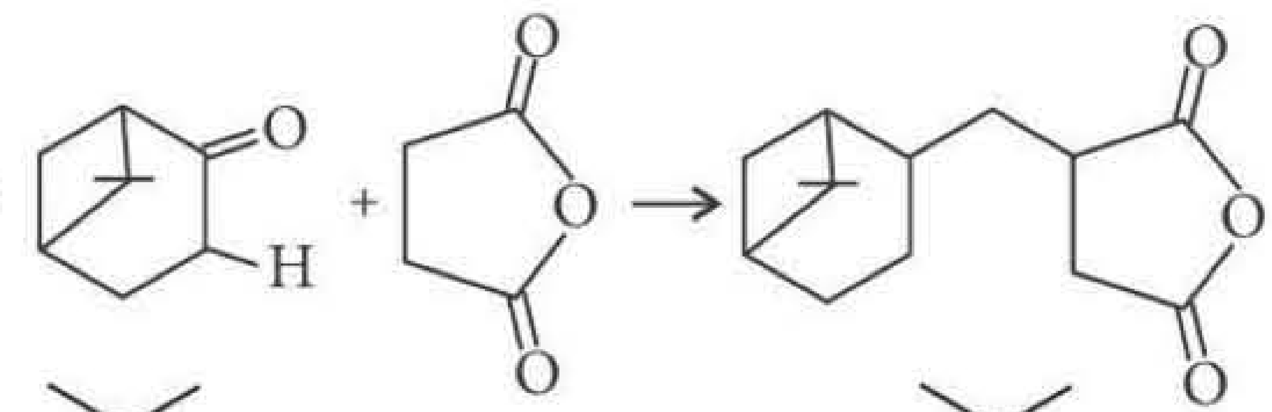
(b) 

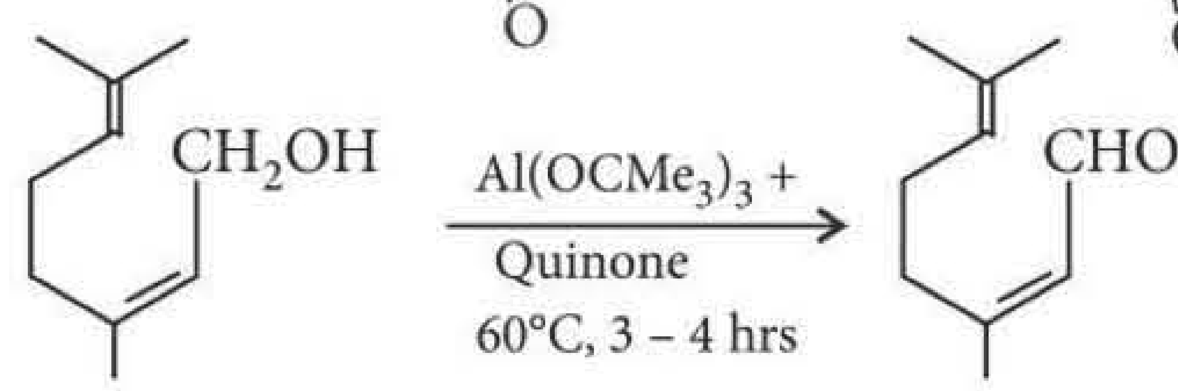
(c) 

(d) 

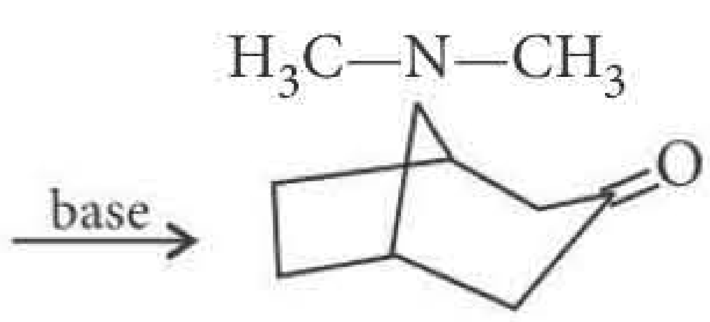
6. In how many of the following case(s) product(s) is/are correctly shown?

(a) 

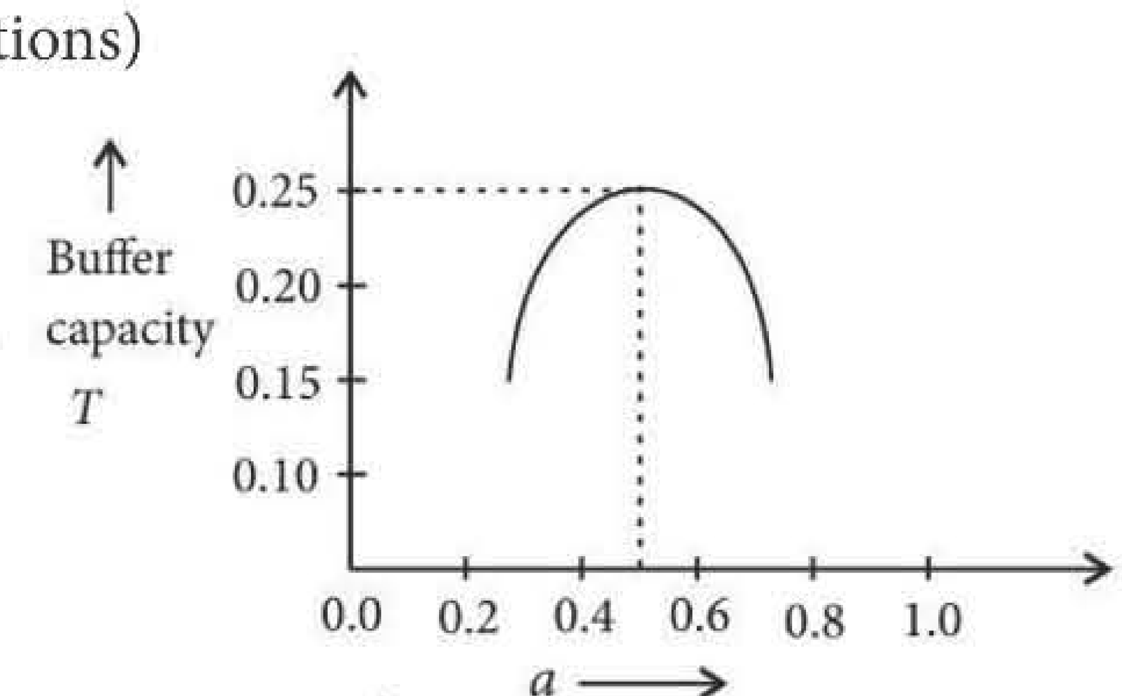
(b) 

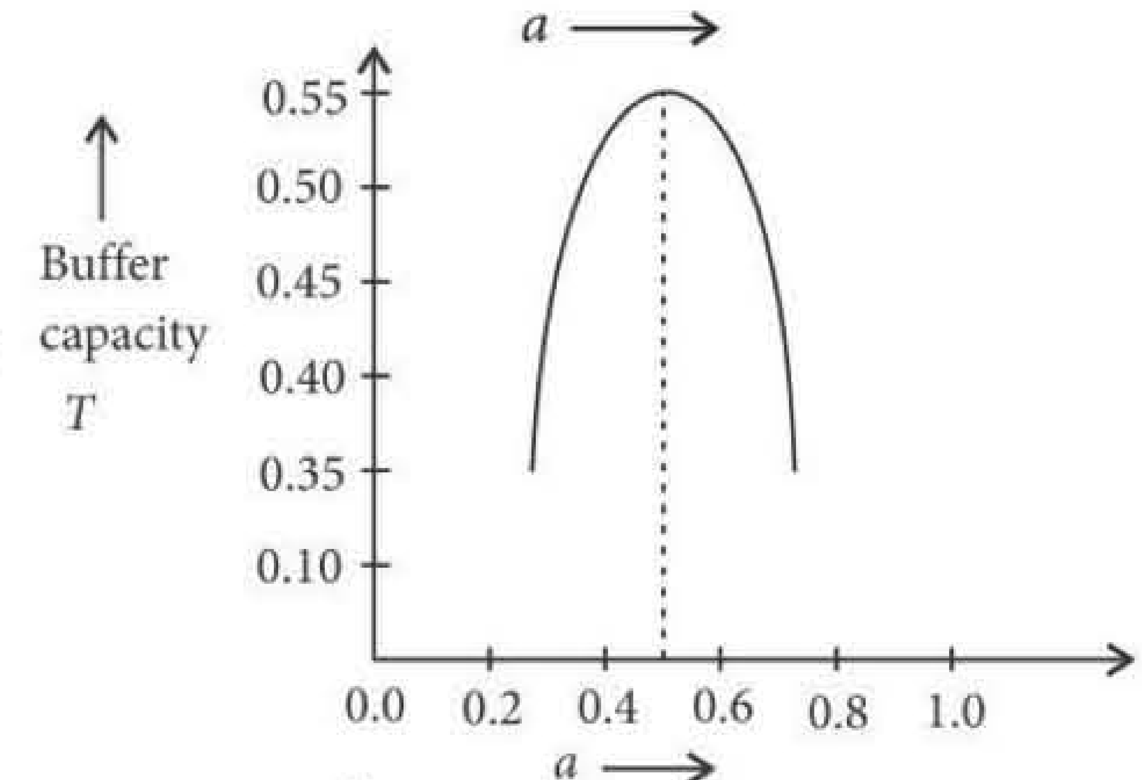
(c) 

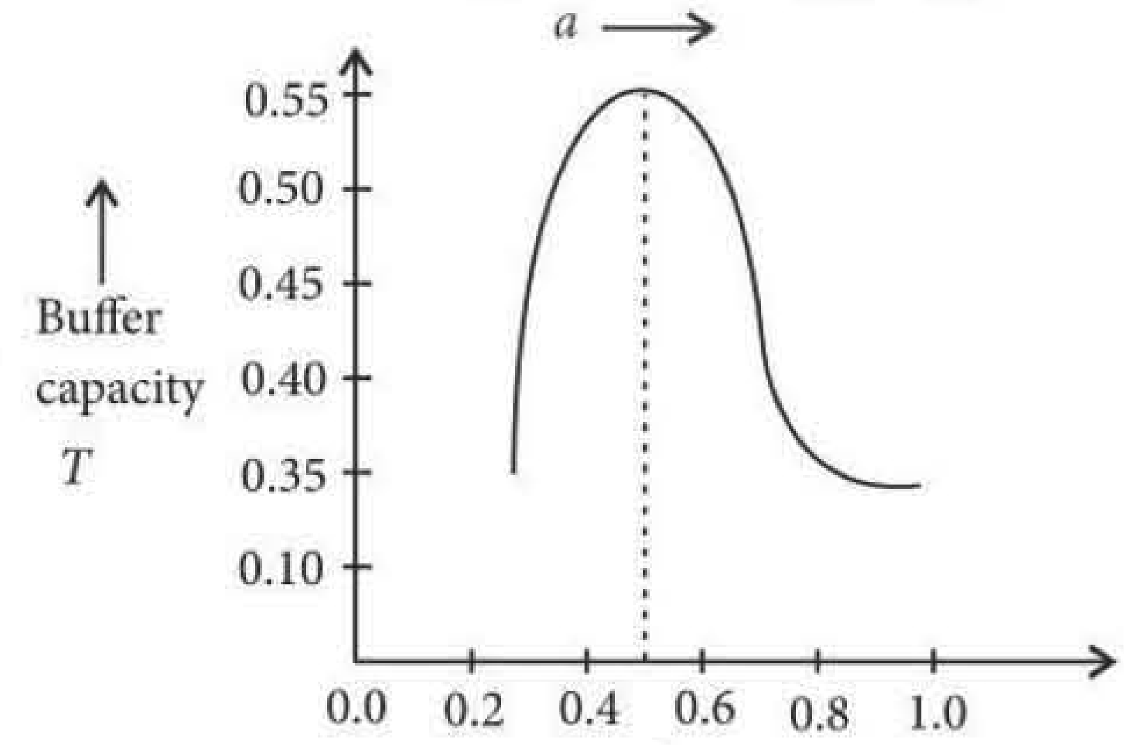
(d) $\begin{array}{l} CH_2-CHO \\ | \\ CH_2-CHO \end{array} + CH_3NH_2 + CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$

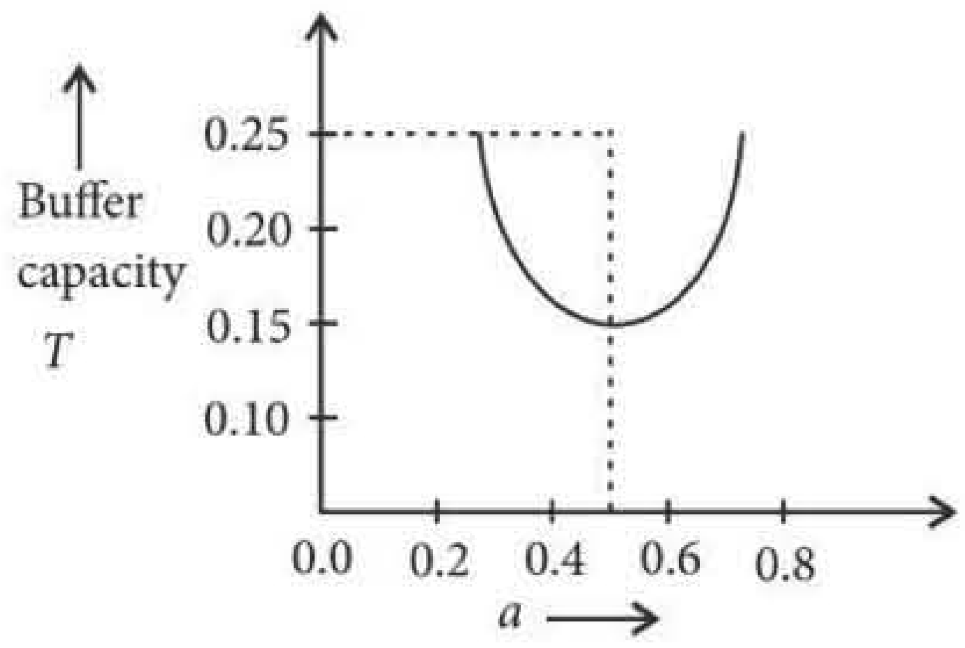


7. A buffer solution is prepared by mixing 'a' moles of CH_3COONa and 'b' moles of CH_3COOH such that $(a + b) = 1$, into water to make 1 L buffer solution. If the buffer capacity of this buffer solution is plotted against moles of salt CH_3COONa 'a' then the plot obtained will be (to the scale) approximately (as shown in fig. in options)

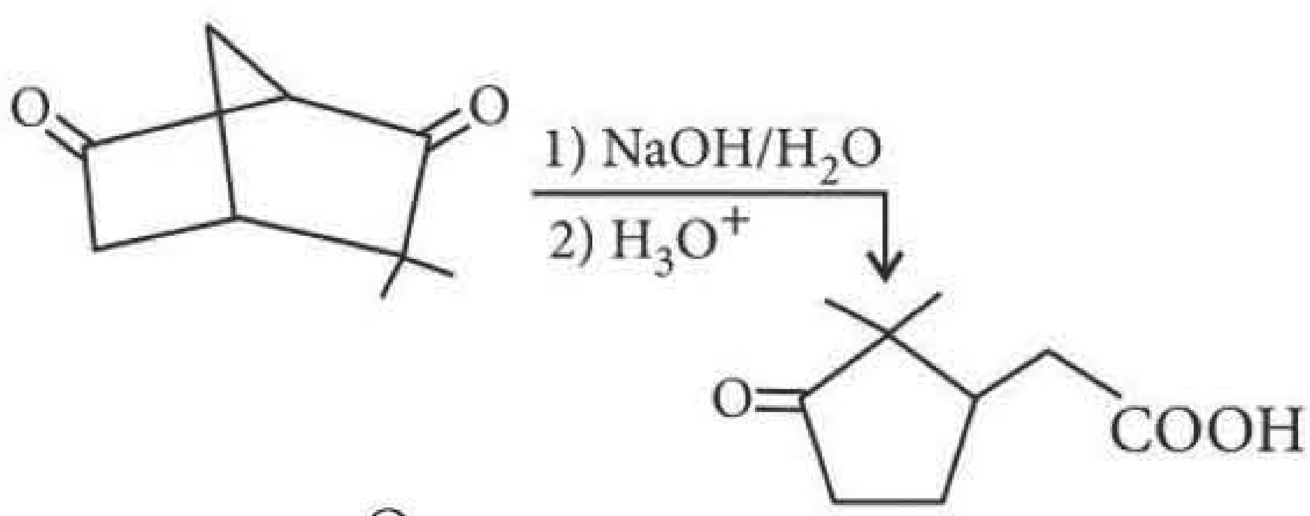
(a) 

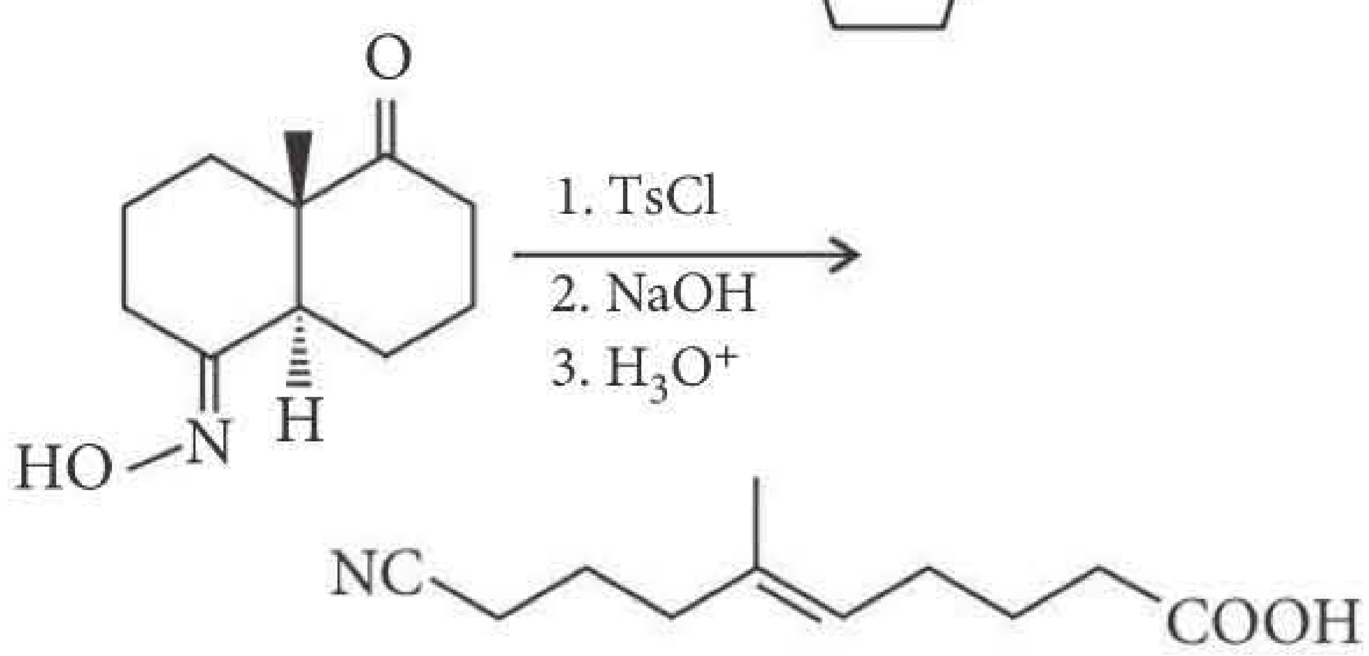
(b) 

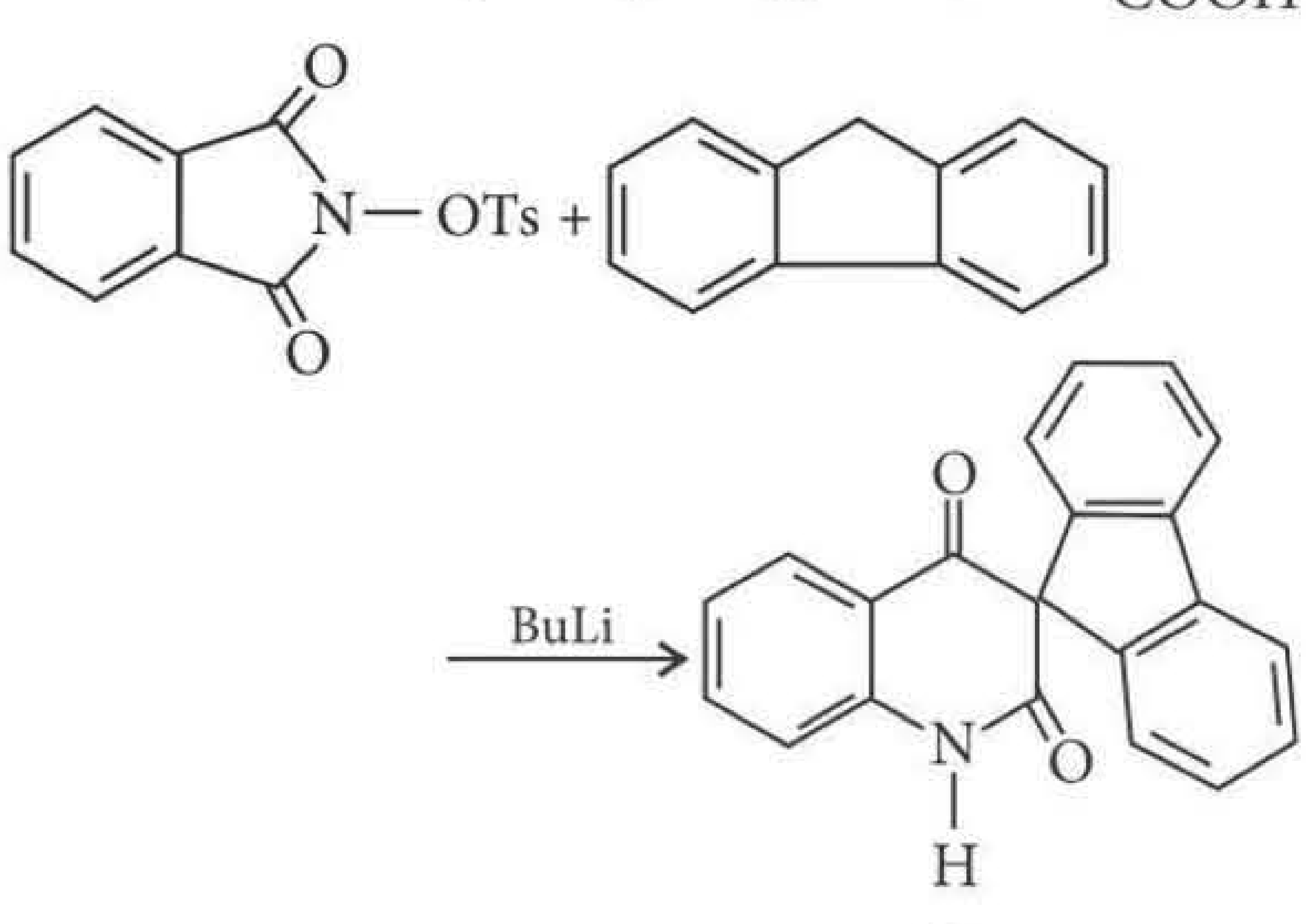
(c) 

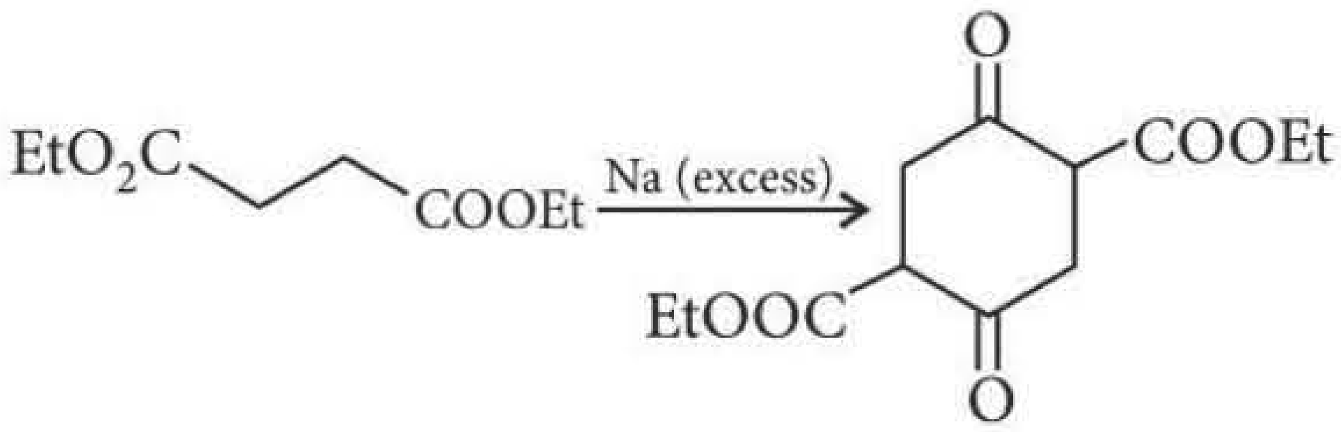
(d) 

8. In how many cases product(s) is/are correctly matched?

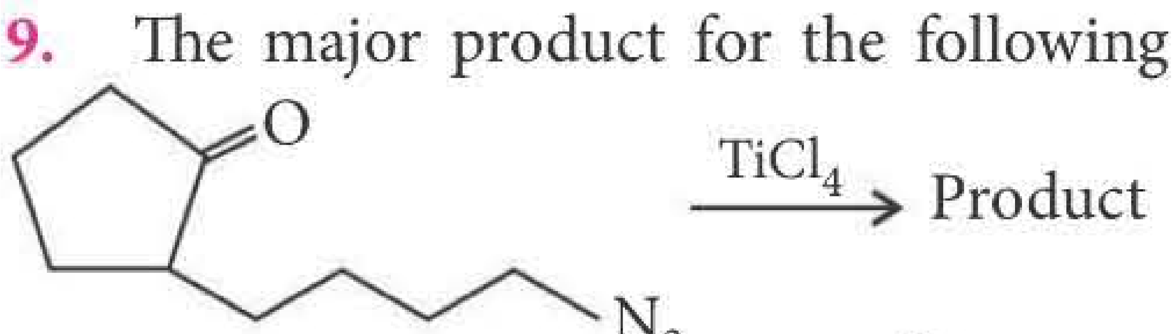
(a) 

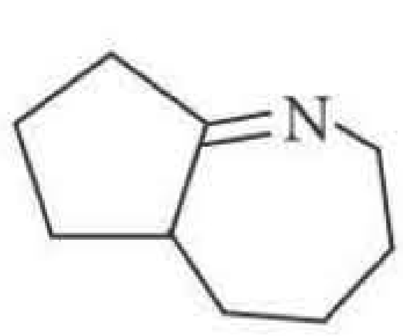
(b) 

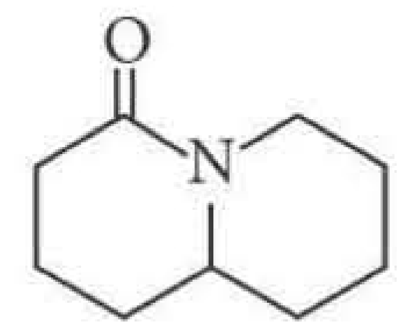
(c) 

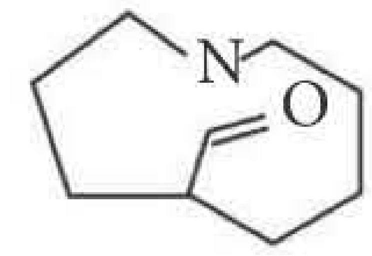
(d) 

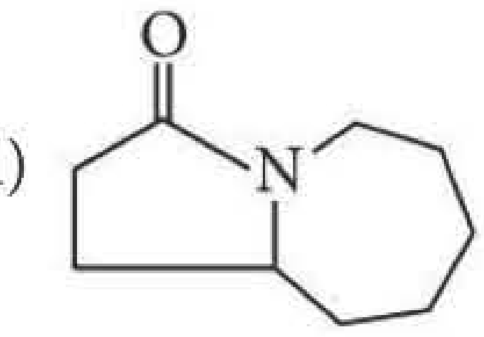
9. The major product for the following reaction is



(a) 

(b) 

(c) 

(d) 

SECTION-2

Numerical Answer Type OR Integer Type

10. At 400 K, the half-life period for the decomposition of a sample of gaseous compound initially at 55.5 kPa was 340 sec. When the pressure was 28.9 kPa the half-life period was 178 sec. What is the order of the reaction?

11. **(a)** $CuSO_4$ reacts with KI in acidic medium to liberate I_2, $2CuSO_4 + 4KI \rightarrow Cu_2I_2 + 2K_2SO_4 + I_2$

(b) Mercuric iodate $Hg_5(IO_6)_2$ reacts with a mixture of KI and HCl as per the following equations :

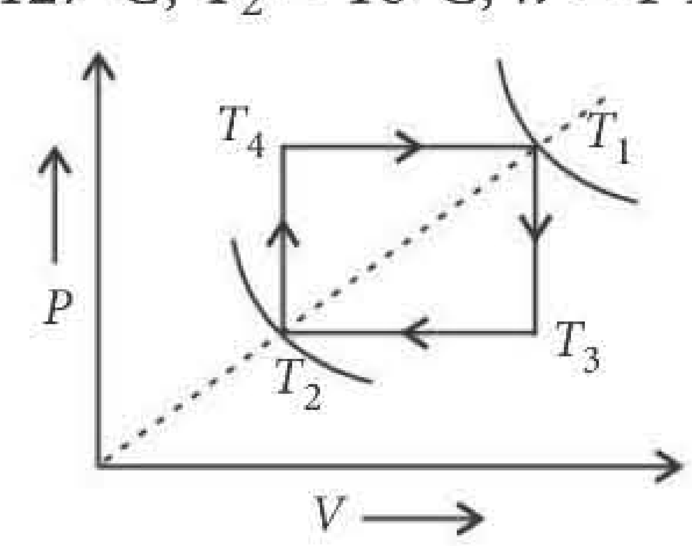
$$Hg_5(IO_6)_2 + 34KI + 24HCl \rightarrow 5K_2HgI_4 + 8I_2 + 24KCl + 12H_2O$$

The liberated iodine is titrated against $Na_2S_2O_3$ solution, 1 mL of which is equivalent to 0.0499 g of $CuSO_4 \cdot 5H_2O$. What volume in mL of $Na_2S_2O_3$ solution will be required to react with I_2 liberated from 0.7245 g of $Hg_5(IO_6)_2$?

Molecular wt. of $Hg_5(IO_6)_2$ = 1448.5 and

Molecular wt.of $CuSO_4 \cdot 5H_2O$ = 249.5

12. Between two isotherms we have a cycle as shown. Find the work done by the gas during the cycle in (J). (Given: T_1 = 127°C; T_2 = 16°C, n = 1 mole)



13. A sample weighing 0.3 g contains $K_3[Fe(C_2O_4)_3] \cdot 3H_2O$, $FeCl_3 \cdot 6H_2O$ and inert impurity is dissolved in dil. H_2SO_4 and volume made upto 100 mL. A 20 mL portion of this solution required 3.75 mL of 0.005 M acidified $KMnO_4$ solution to reach the equivalence point. In an another experiment 50 mL sample of the same stock solution is treated with Zn-amalgam and the resulting solution required 17.5 mL of permanganate solution of same strength. If mass percentage of $FeCl_3 \cdot 6H_2O$ in the original sample is x, then find x.

SECTION-3

Comprehension Type

In three dimension, wave function may be expressed in spherical co-ordinate system (r, θ, ϕ) :

r = distance of electron from the nucleus
θ = angle from z-axis, varying from 0 to π
ϕ = angle from x axis, varying from 0 to 2π
ψ may be represented as $\psi(r, \theta, \phi) = R(r), A(\theta, \phi)$
The $R(r)$ is determined by n and l. Then $A(\theta, \phi)$ is determined by l and m.

14. Which of the following is $R(r)$ part of $3p$ atomic orbital of hydrogen atom? (Given : $a_0 = 0.529$ Å)

(a) $\dfrac{2}{(a_0)^{3/2}} \cdot e^{-r/a_0}$

(b) $\dfrac{2}{27}\left(\dfrac{1}{3a_0}\right)^{3/2}\left(27-18\dfrac{r}{a_0}+2\dfrac{r}{a_0^2}\right)\cdot e^{-r/3a_0}$

(c) $\dfrac{2}{(2a_0)^{3/2}}\left(2-\dfrac{r}{a_0}\right)\cdot e^{-r/2a_0}$

(d) $\dfrac{1}{81\sqrt{3}}\left(\dfrac{2}{a_0}\right)^{3/2}\left(6-\dfrac{r}{a_0}\right)e^{-r/3a_0}$

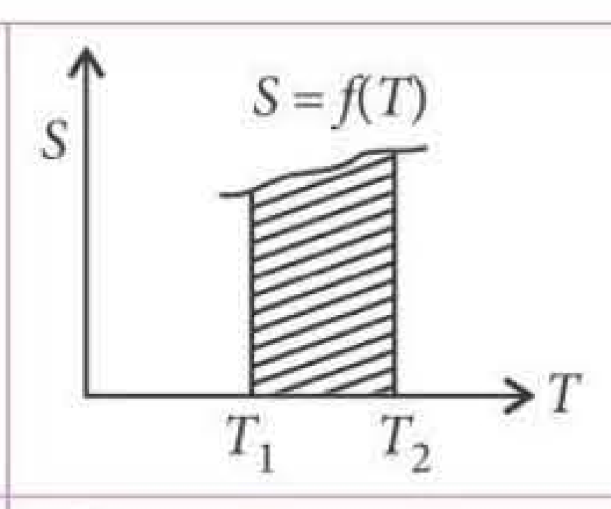
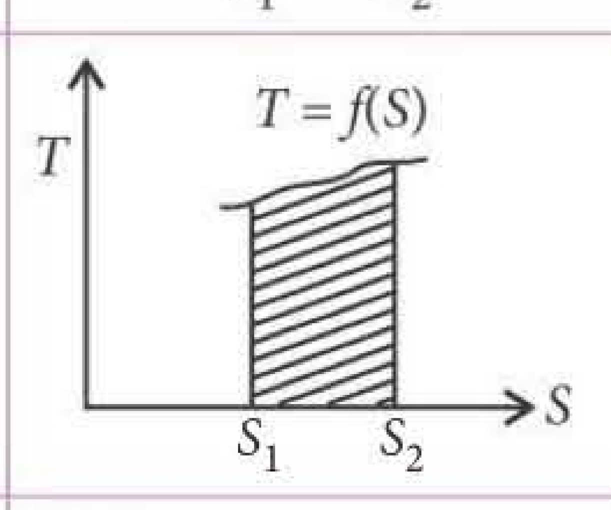
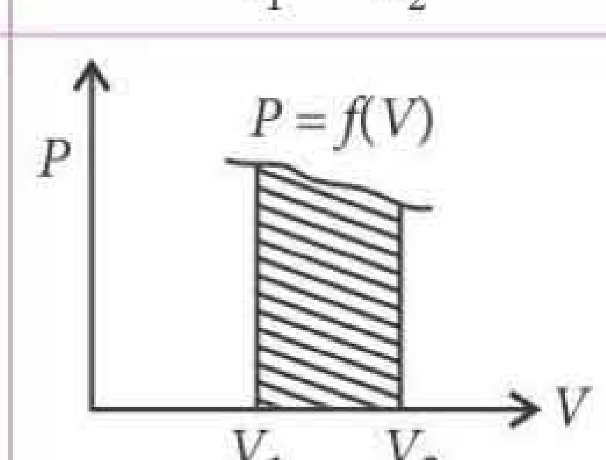
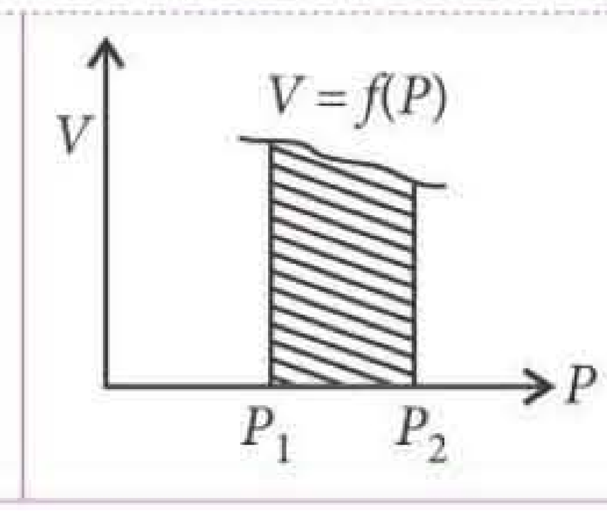
15. Angular part of H atom wave equation $A(\theta, \phi) = \dfrac{1}{\sqrt{4\pi}}$. Hence atomic orbital is

(a) d_{xz} (b) p_x (c) p_y (d) s

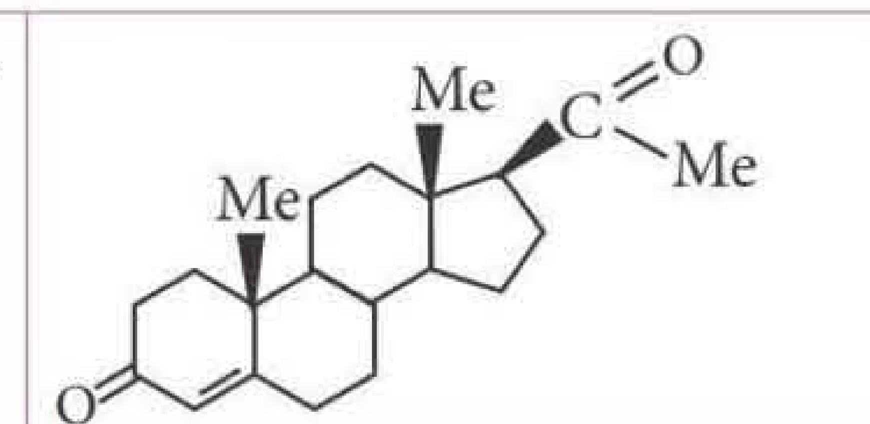
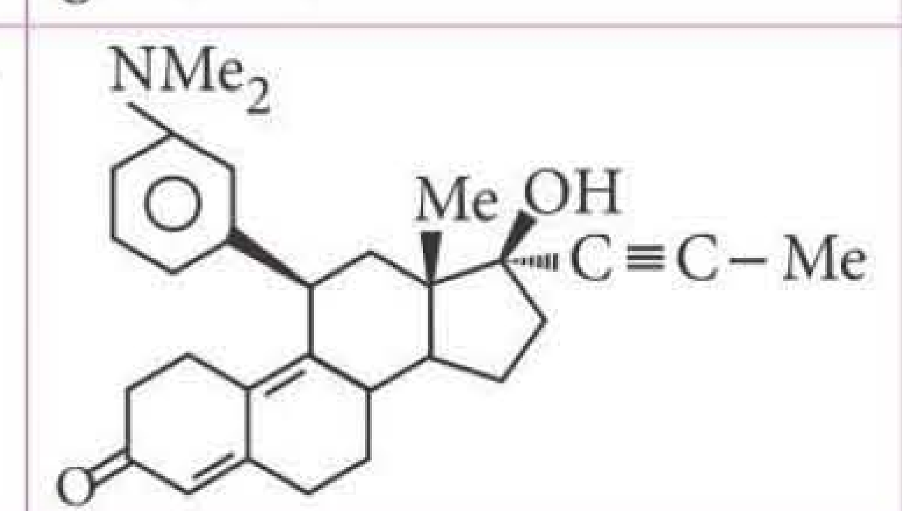
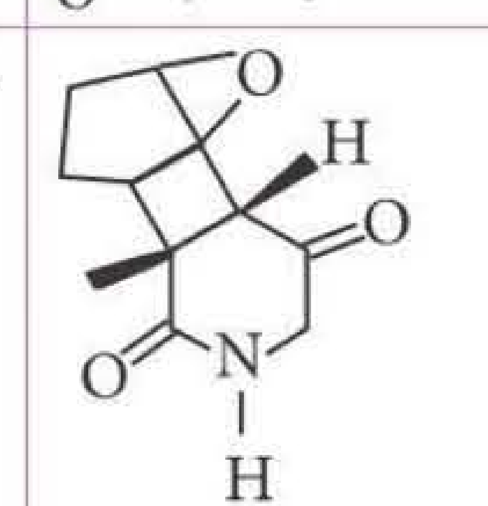
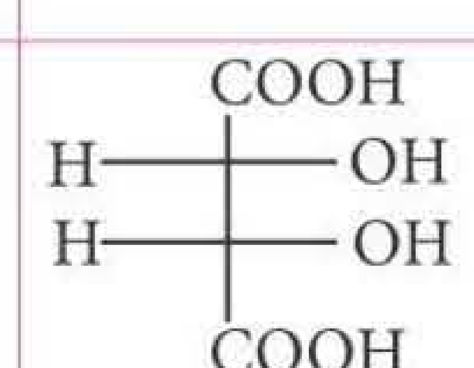
SECTION-4

Column Matching Type

16. Match the following :

Column-1 (Graph)		Column-2 (Area represents magnitude of)	
A.		p.	q
B.		q.	W
C.		r.	$(\Delta G)_T$
D.		s.	$(\Delta G)_P$

17. Match the following :

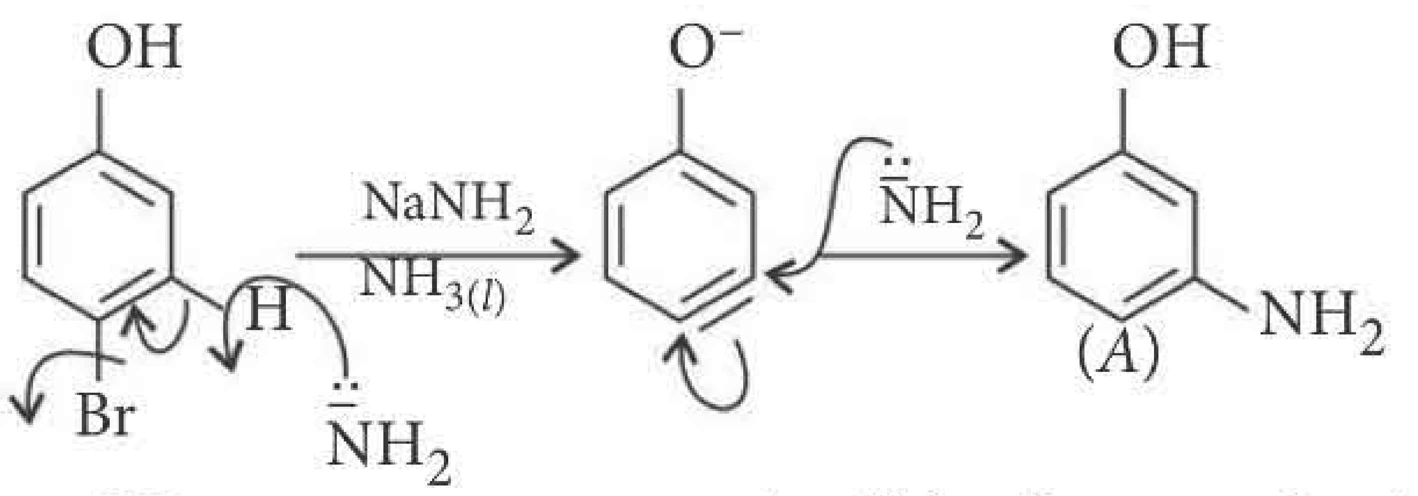
Column-1 (Molecule)		Column-2 (Property)	
A.		p.	Meso compound
B.		q.	Compound having even number of chiral centres
C.		r.	Optically active compound
D.		s.	Compound having odd number of chiral centres

18. One mole of $N_{2(g)}$ is taken in 1 litre empty container fitted with a movable piston at 300 K. If it is heated to 1200 K at constant pressure then match the change (Column-2) with parameters (Column-1) of gas as compared to initial state.

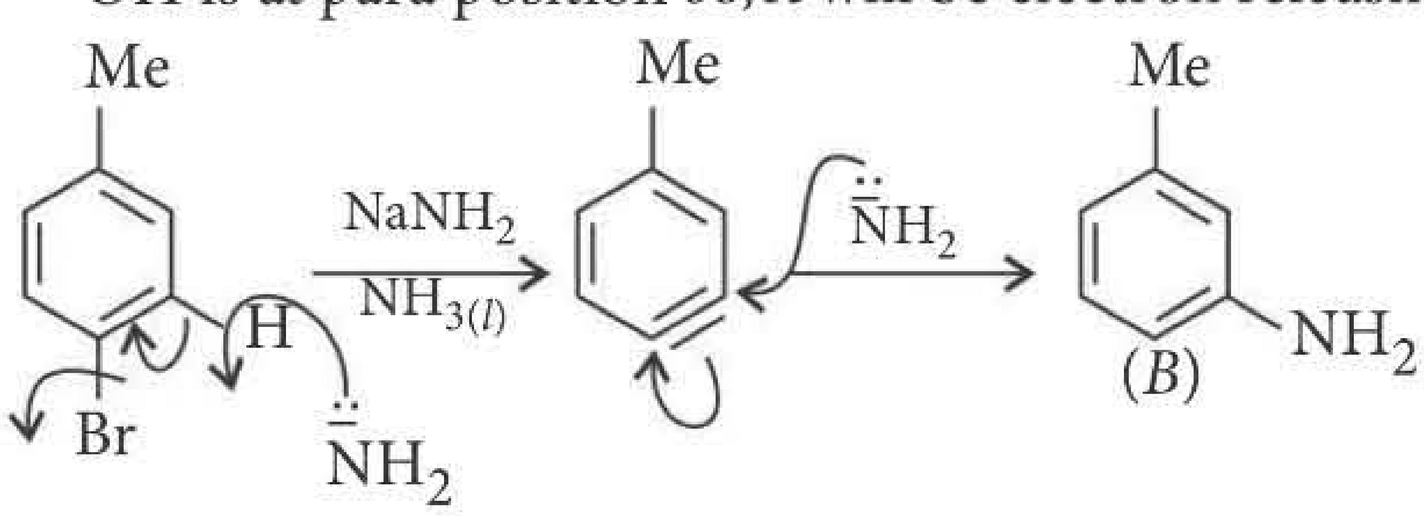
Column-1 (Parameter)		Column-2 (Change)	
A.	Z_1(Number of collisions made by a molecule per unit time)	p.	1/8
B.	Z_{11} (Collision frequency)	q.	2
C.	λ (Mean free path)	r.	1/2
D.	U_{rms} (Root mean square speed)	s.	4

SOLUTIONS

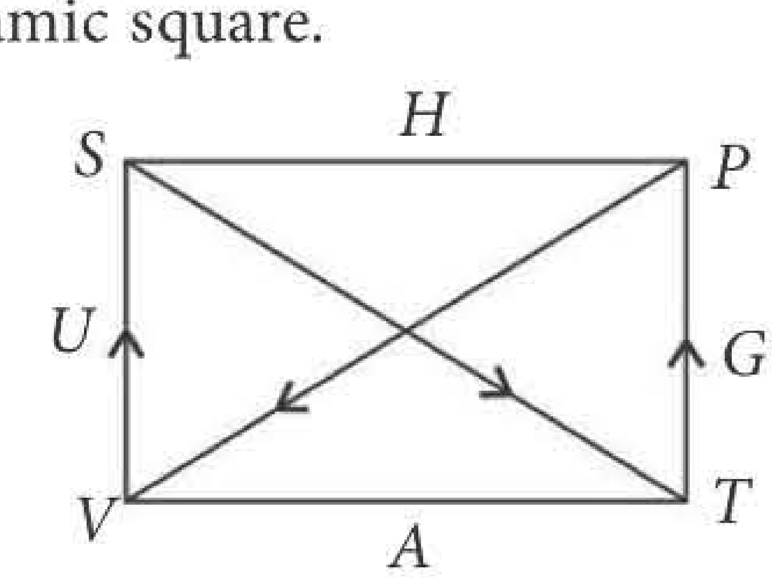
1. (d) :



—OH is at para position so, it will be electron releasing.



2. (b, c) : As a shortcut, we can use Maxwell thermodynamic square.



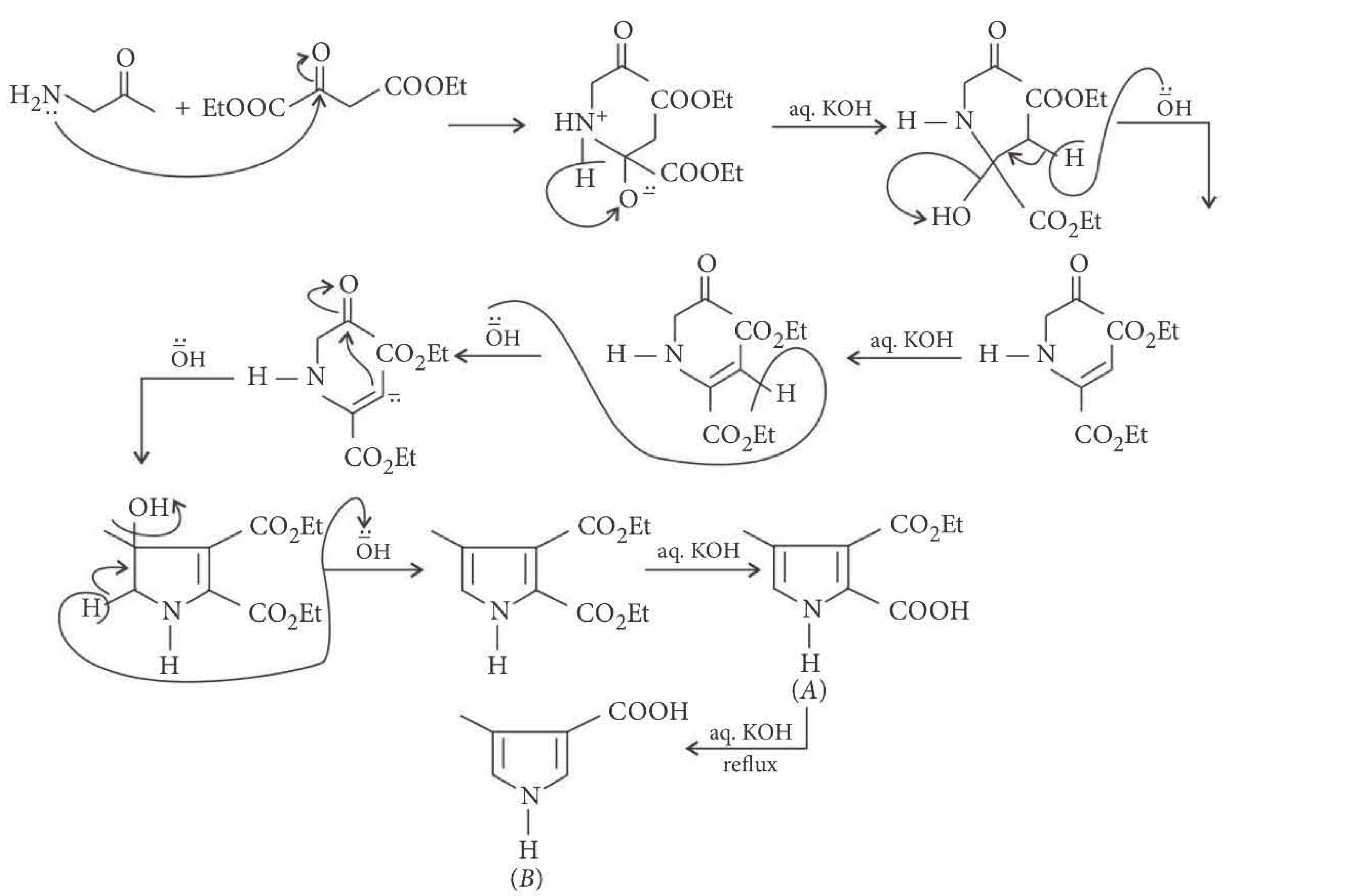
Thermodynamic variables:
S = Entropy, P = Pressure
T = Temperature, V = Volume
A = Helmholtz function
Thermodynamic potential :
G = Gibbs free energy,
U = Internal energy
The Maxwell relationship is

$$-\left(\frac{\partial T}{\partial P}\right)_S = -\left(\frac{\partial V}{\partial S}\right)_P \text{ or } \left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$$

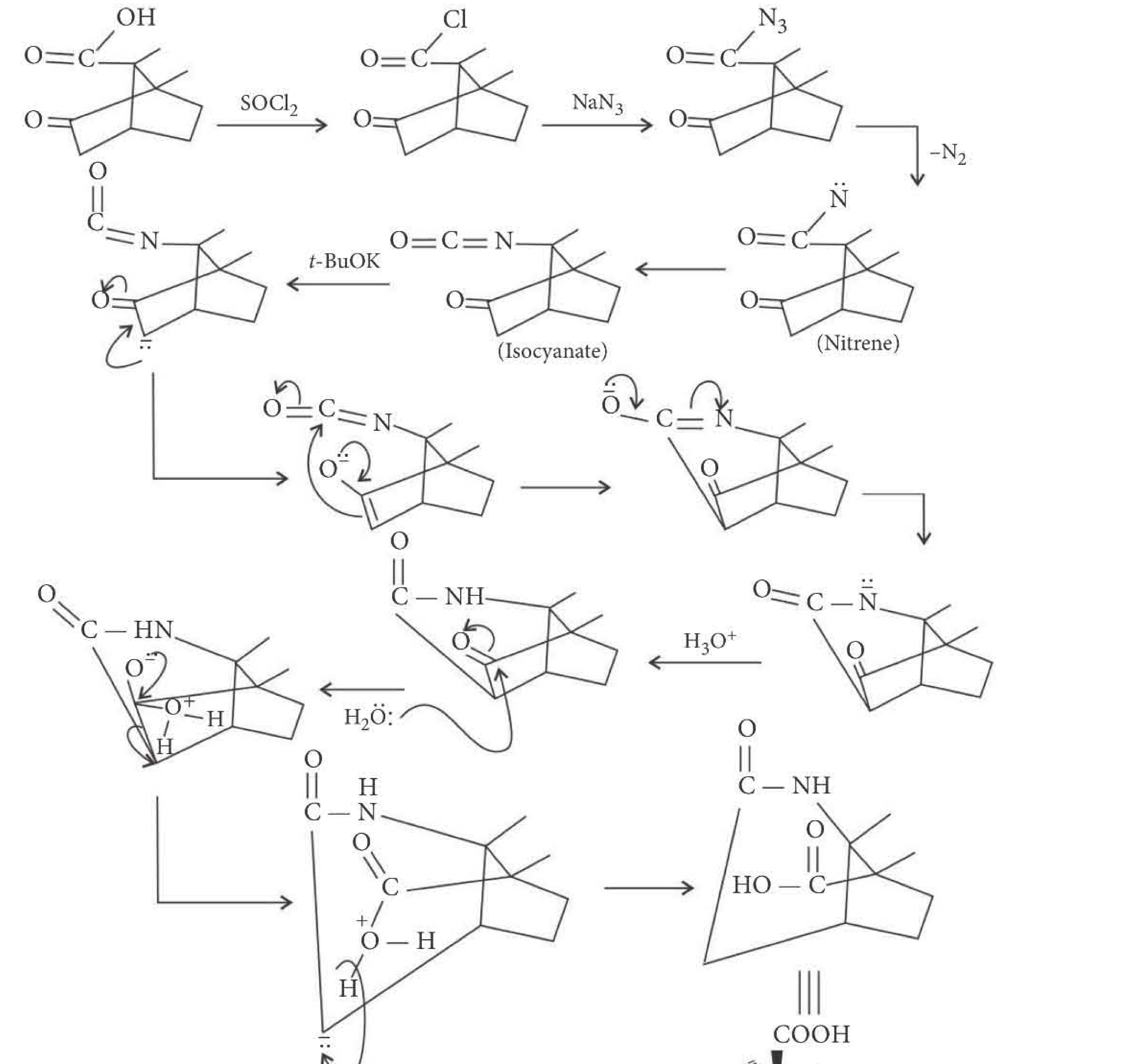
$$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$$

3. (a, b) : In collision theory, apart from activation energy criteria, orientation factor also plays a big role. So, (c) is NOT correct. In collision theory, molecules are assumed to be hard spheres. So, (d) is NOT correct. At higher temperature, reactivity increases.
$Mn^{+7} \rightarrow Mn^{+2}$ can take place at a faster rate.
Catalysts make temporary bonds with the reactants to give an intermediate complex.

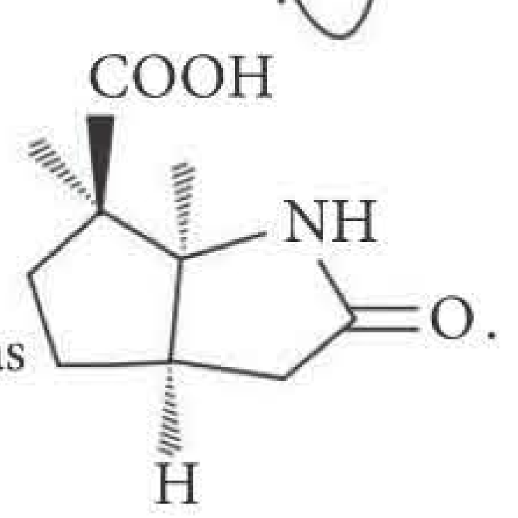
4. (c) : Read alc. KOH in the question as aq. KOH.



5. (c) :



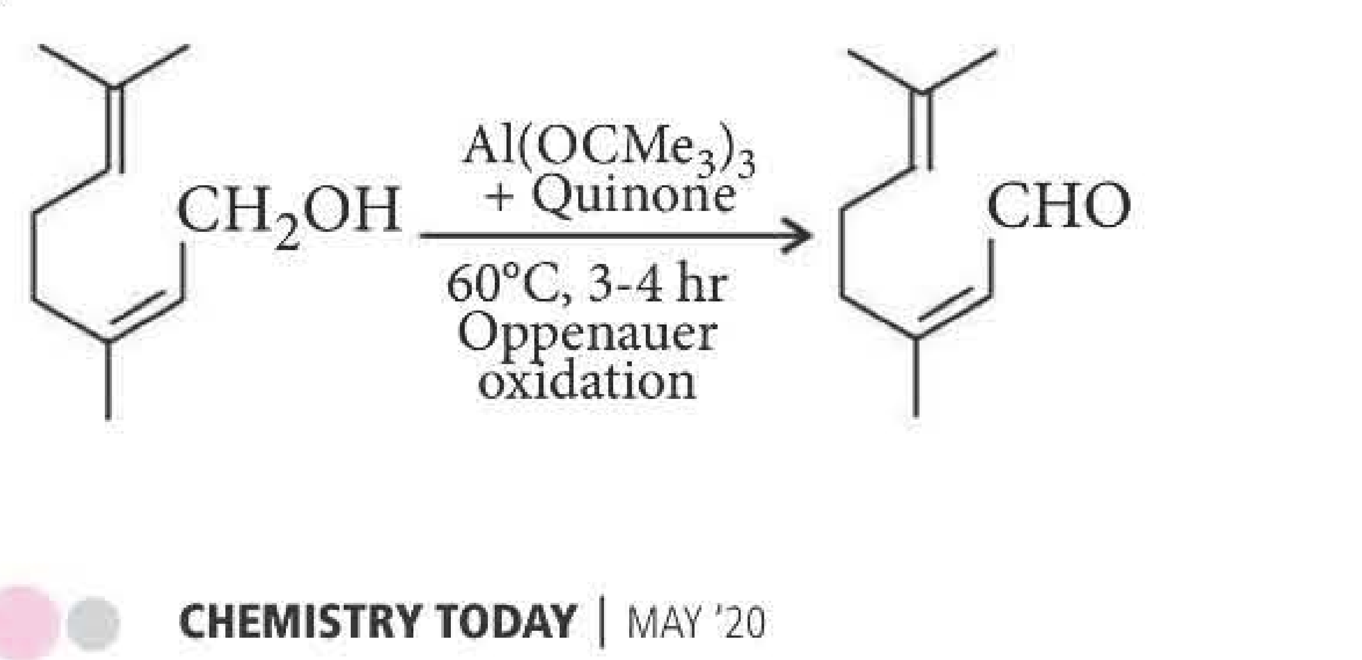
Read option (c) in the question as



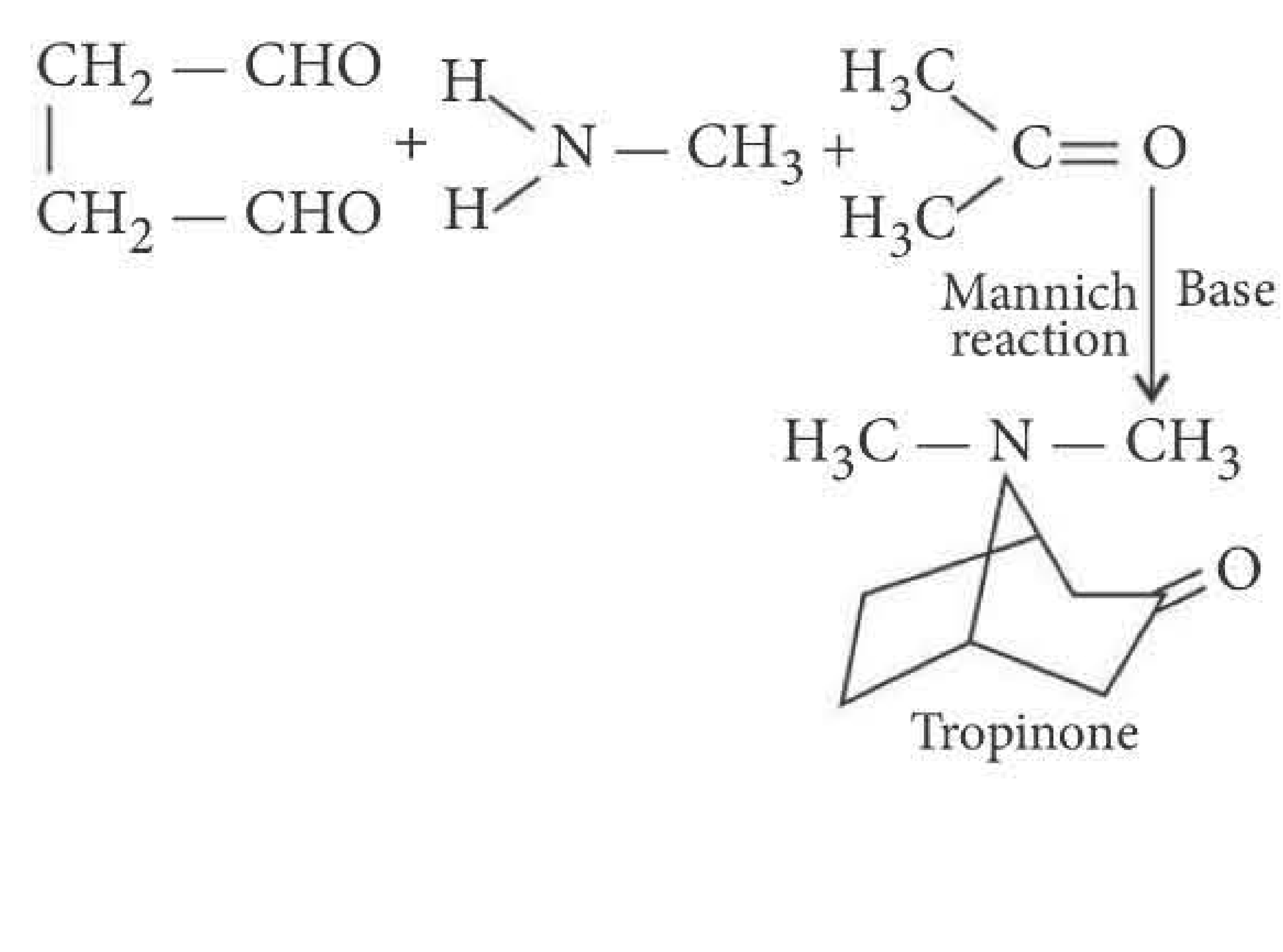
6. (a,c,d) : (a) Baeyer-Villiger oxidation. Migration of electron donor takes place.

(b) Carbon number is increasing without any external reagent addition.

(c)



(d)

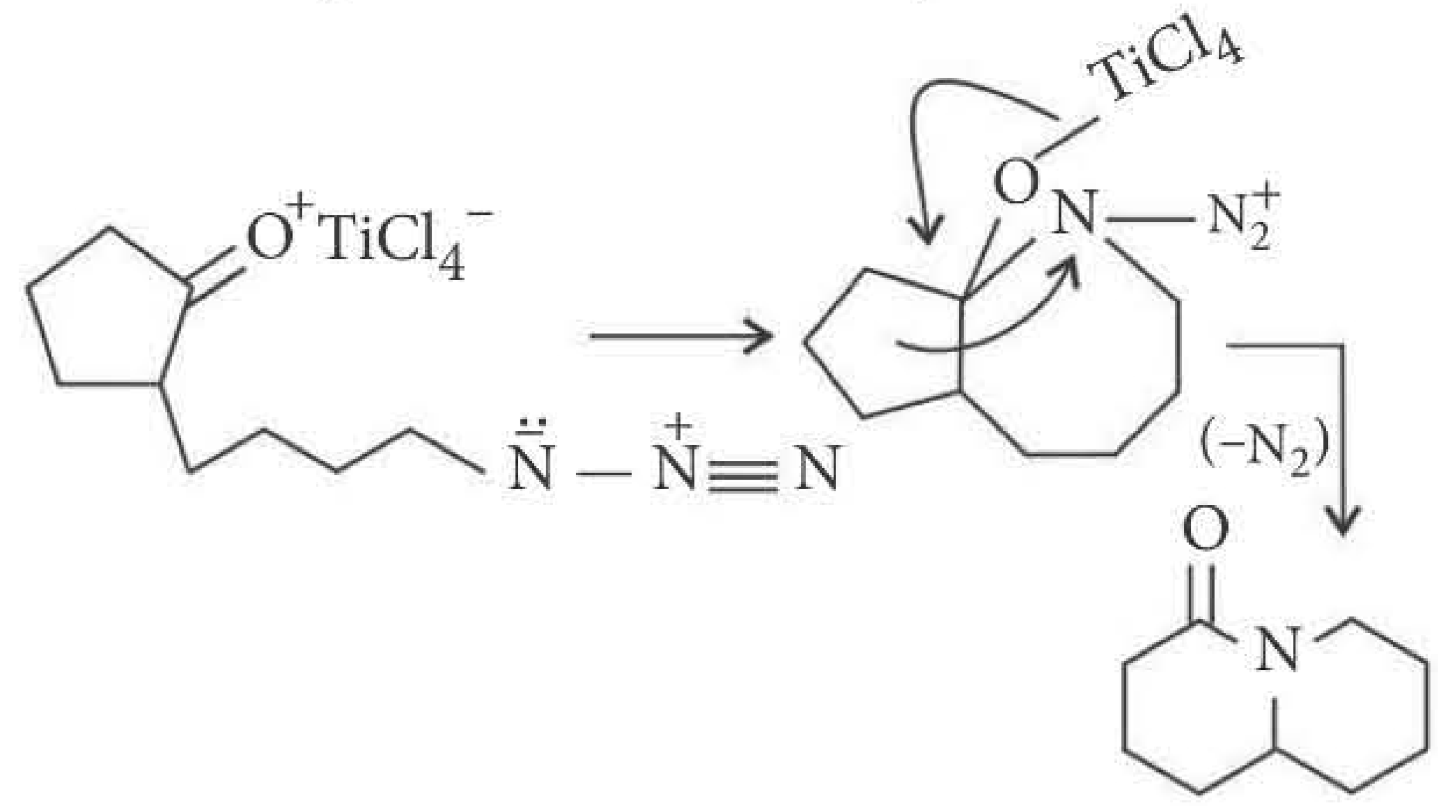


7. (b) : Maximum buffer capacity, $\eta = 2.303\dfrac{ab}{a+b}$

$$= 2.303 \times \frac{0.5 \times 0.5}{(0.5+0.5)} \cong 0.57$$

8. (a, b, c, d)

9. (b) : Ti metal has great affinity to oxygen atom and it is coordinated with carbonyl oxygen and makes carbonyl carbon more electrophilic. Intramolecular nucleophilic attack takes place on more electrophilic site.



10. (0) : Remember that order $(\eta) = \dfrac{\log\dfrac{t_1}{t_2} + \log\dfrac{a_2}{a_1}}{\log\dfrac{a_2}{a_1}}$

t_1 is half-life when initial amount is a_1 and t_2 is half-life when initial amount is a_2.

According to the problem,

$a_1 = 55.5$ kPa; $t_1 = 340$ sec ; $a_2 = 28.9$ KPa;

$t_2 = 178$ sec

$$\therefore\ \eta = \frac{\log\dfrac{340}{178} + \log\dfrac{28.9}{55.5}}{\log\dfrac{28.9}{55.5}} = 8.24 \times 10^{-3} \approx 0$$

11. (40)

12. (225) : $\dfrac{P_2}{P_1} = \dfrac{V_2}{V_1} \Rightarrow P_2V_1 = P_1V_2$

$$W = P_2(V_2 - V_1) - P_1(V_2 - V_1)$$
$$= nRT_2 + nRT_1 - P_2V_1 - P_1V_2$$

$$P_2 = \frac{nRT_2}{V_2};\ P_1 = \frac{nRT_1}{V_1}$$

$$\frac{P_2}{P_1} = \frac{T_2}{T_1} \times \frac{V_1}{V_2} \Rightarrow \frac{V_2}{V_1} = \frac{T_2}{T_1} \cdot \frac{V_1}{V_2} \Rightarrow \frac{V_2}{V_1} = \sqrt{\frac{T_2}{T_1}}$$

$$\Rightarrow\ P_2V_1 = P_1V_2 = nR\sqrt{T_1T_2}$$

$$\therefore\ W = nR\left(\sqrt{T_1} - \sqrt{T_2}\right)^3 = 1 \times \frac{25}{3}(20-17)^3 = 225$$

13. (71.84) : m_{eq} of $KMnO_4 = 3.75 \times 0.005 \times 5$
$= 93.75 \times 10^{-3}$

Total m_{eq} of $C_2O_4^{2-} = 93.75 \times 10^{-3} \times 5 = 0.46875$

$\Rightarrow$ millimoles of $K_3[Fe(C_2O_4)_3].3H_2O$

$$= \frac{0.46875}{6} = 78.125 \times 10^{-3}$$

Now, in experiment II,

m_{eq} of $MnO_4^- = 17.5 \times 0.005 \times 5 = 0.4375$

$\Rightarrow$ Total m_{eq} of Fe^{2+} ion $= 0.4375 \times 2 = 0.875$

$=$ millimoles of Fe^{2+}

$\Rightarrow$ millimoles of Fe^{2+} from $FeCl_3.6H_2O$

$= 0.875 - 78.125 \times 10^{-3} = 0.7968$

$\therefore$ Mass % of $FeCl_3.6H_2O = \dfrac{0.2155}{0.300} \times 100 = 71.84$

($\because$ $0.2155 = 0.7968 \times$ molecular mass of $FeCl_3$)

14. (d)

15. (d)

16. A $\rightarrow$ s; B $\rightarrow$ p; C $\rightarrow$ q; D $\rightarrow$ r

Area	Represents
(A) $\int_{T_1}^{T_2} SdT$	$-(\Delta G)_P$; $dG = VdP - SdT$
(B) $\int_{S_1}^{S_2} TdS$	q_{rev}
(C) $-\int_{V_1}^{V_2} PdV$	W
(D) $\int_{P_1}^{P_2} VdP$	$(\Delta G)_T$; $dG = VdP - SdT$

17. A $\rightarrow$ q, r; B $\rightarrow$ r, s; C $\rightarrow$ q, r; D $\rightarrow$ p, q

18. A $\rightarrow$ r; B $\rightarrow$ p; C $\rightarrow$ s; D $\rightarrow$ q

$$Z_1 \propto \frac{P}{\sqrt{T}};\quad Z_{11} \propto \frac{P}{T^{3/2}};\quad \lambda \propto \frac{T}{P}$$

$U_{rms} \propto \sqrt{P}$; Now, T is made 4 times

$\therefore$ Z_1 becomes $\dfrac{1}{2}$ times; Z_{11} becomes $\dfrac{1}{8}$ times

λ becomes 4 times and U_{rms} becomes 2 times.

10 MIND BLOWING OLYMPIAD PROBLEMS

OBJECTIVE PROBLEMS

1. Relative decrease in vapour pressure of an aqueous solution containing 2 mol of $[Cu(NH_3)_3Cl]Cl$ in 3 mol H_2O is $\frac{1}{2}$. When the given solution reacts with excess of $AgNO_3$ solution, the number of moles of AgCl produced is

(a) 1 (b) 0.25 (c) 2 (d) 0.40

2. For $NH_2OH{\cdot}HCl + NaNO_2 \longrightarrow (A) \xrightarrow{Cu} (B) + (X)_g$, which of the following is correct?

(a) (*B*) is an amphoteric oxide.
(b) (*X*) is a colourless, diamagnetic gas which combines with Al on heating.
(c) (*X*) can be produced by action of (Zn + NaOH) on $NaNO_2$.
(d) None of these

3. A 5.0 g mixture of lead nitrate and sodium nitrate was heated below 600 °C until the mass of the residue was constant. If the loss of mass is 28%, find the mass of sodium nitrate in the original mixture. (Pb = 207 u ; N = 14 u ; O = 16 u ; Na = 23 u)

(a) 3.32 g (b) 1.68 g
(c) 1.92 g (d) 3.6 g

4. Which statement about the composition of the vapour over an ideal 1 : 1 molal mixture of benzene and toluene is correct? (T = 25°C)

Compound	Vapour pressure data
Benzene	75 mmHg
Toluene	22 mmHg

(a) Vapour will contain a higher number of benzene.
(b) Vapour will contain a higher percentage of toluene.
(c) Vapour will contain equal amounts of benzene and toluene.
(d) Not enough information is given to make a prediction. *(US Olympiad)*

5. $\underset{\text{Salicylic acid}}{C_7H_6O_3} + \underset{\text{Acetic anhydride}}{C_4H_6O_3} \longrightarrow \underset{\text{Aspirin}}{C_9H_8O_4} + \underset{\text{Acetic acid}}{C_2H_4O_2}$

What is percent yield of 0.85 g of aspirin formed in the reaction of 1 g of salicylic acid with excess of acetic anhydride?

Substance	Molar mass
$C_7H_6O_3$	135.12 g/mol
$C_4H_6O_3$	102.09 g/mol
$C_9H_8O_4$	180.15 g/mol
$C_7H_4O_2$	60.05 g/mol

(a) 65% (b) 75%
(c) 8% (d) 91% *(US Olympiad)*

SUBJECTIVE PROBLEMS

6. (i) An inorganic iodide (*A*) on heating with a solution of KOH gives a gas (*B*) and the solution of a compound (*C*).
(ii) The gas (*B*) on ignition in air gives a compound (*D*) and water.
(iii) Copper sulphate is reduced to the metal on passing (*B*) through the solution.
(iv) A precipitate of the compound (*E*) is formed on reaction of (*C*) with copper sulphate solution.

Identify (*A*) to (*E*) and give chemical equations for reactions at steps (i) to (iv).

7. Compound (*A*) with empirical formula C_7H_9N on diazotisation gives a product which undergoes Sandmeyer's reaction with Cu_2Cl_2 and HCl to give a compound (*B*). (*B*) on oxidation gives a compound (*C*) which when heated with soda lime gives chlorobenzene. Give the structures of (*A*), (*B*) and (*C*) and the reactions.

8. In order to get maximum calorific output, a burner should have an optimum fuel to oxygen ratio which corresponds to 3 times as much oxygen as required theoretically for complete combustion of the fuel. A burner which has been adjusted for methane as fuel (with x litre/hour of CH_4 and $6x$ litre/hour of

O_2) is to be readjusted for butane, C_4H_{10}. In order to get the same calorific output, what should be the rate of supply of butane and oxygen? Assume that losses due to incomplete combustion etc. are the same for both fuels and that the gases behave ideally. Enthalpies of combustion : CH_4 = 809 kJ mol^{-1}; C_4H_{10} = 2878 kJ mol^{-1}.

9. An electrochemical cell is constructed with a piece of copper wire in a 1.00 M solution of $Cu(NO_3)_2$ and a piece of chromium wire in a 1.00 M solution of $Cr(NO_3)_3$.
The standard reduction potentials for $Cr^{3+}_{(aq)}$ and $Cu^{2+}_{(aq)}$ are :

$$Cr^{3+}_{(aq)} + 3e^- \rightarrow Cr_{(s)} \ ; \ -0.744V$$
$$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)} \ ; \ 0.340V$$

(a) Write a balanced equation for the spontaneous reaction that occurs in this cell and calculate the potential it produces.
(b) Sketch a diagram for this cell.
 (i) Label the anode.
 (ii) Show the direction of electron flow in the external circuit.
 (iii) Show the direction of movement of nitrate ions. Explain.
(c) The cell is allowed to operate until the $[Cu^{2+}]$ = 0.10 M.
 (i) Find the $[Cr^{3+}]$.
 (ii) Calculate the cell potential at these concentrations.

(US National Chemistry Olympiad)

10. An LPG cylinder weighs 14.8 kg when empty, when full, it weighs 29.0 kg and shows a pressure of 2.5 atm. In course of use at 27 °C, the mass of full cylinder reduced to 23.2 kg. Find out the volume of gas in cubic metres used up at the normal usage conditions and the final pressure inside the cylinder.
(LPG is n-butane with normal boiling point 0 °C)

(NSEC)

SOLUTIONS

1. (a) : Let the degree of ionisation of the complex, $[Cu(NH_3)_3Cl]Cl$ be α.

$$[Cu(NH_3)_3Cl]Cl \rightleftharpoons [Cu(NH_3)_3Cl]^+ + Cl^-$$
$$i = 1 + \alpha$$
$$\frac{\Delta p}{p^\circ} = \frac{n_1(1+\alpha)}{n_1(1+\alpha)+n_2} = \frac{2(1+\alpha)}{2(1+\alpha)+3} = \frac{1}{2}$$
$$\alpha = \frac{1}{2} \Rightarrow 50\% \text{ dissociation}$$

Thus, 2 moles of $[Cu(NH_3)_3Cl]Cl$ will give 1 mole of Cl^- ions.
∴ 1 mole of AgCl is produced.

2. (b) : $$NH_2OH{\cdot}HCl + NaNO_2 \longrightarrow \underset{(A)}{N_2O} \xrightarrow{Cu} \underset{(B)}{CuO} + \underset{(X)}{N_2}$$

(a) CuO is a basic oxide.
(b) N_2 is a colourless, diamagnetic gas which combines with Al.
$$2Al + N_2 \longrightarrow 2AlN$$
(c) Zn + NaOH evolves H_2 which reduces $NaNO_2$ to form NH_3 gas.
$$NaNO_2 + 6[H] \longrightarrow NaOH + NH_3 + H_2O$$

3. (b) : Let the mass of $Pb(NO_3)_2$ in the mixture is x g.
∴ The mass of sodium nitrate in the mixture = $(5 - x)$ g
The desired reactions are :
$$\underset{662\text{ g}}{2Pb(NO_3)_2} \longrightarrow \underset{446\text{ g}}{2PbO} + 4NO_2 + O_2$$
$$\underset{170\text{ g}}{2NaNO_3} \longrightarrow \underset{138\text{ g}}{2NaNO_2} + O_2$$
Loss of mass is 28% of 5 g = 28/100 × 5 = 1.4 g
Mass of residue left = (5 – 1.4) g = 3.6 g ... (i)
662 g lead nitrate on heating produces PbO = 446 g
x g lead nitrate on heating would produce PbO
$$= \frac{446}{662} \times x \text{ g}$$
Similarly, 170 g $NaNO_3$ on heating produces $NaNO_2$ = 138 g
$(5.0 - x)$g $NaNO_3$ on heating produces $NaNO_2$
$$= \frac{138}{170} \times (5-x)$$
Total residue after heating = $\frac{446}{662}x + \frac{138}{170} \times (5-x)$ ... (ii)
Equating (i) with (ii), $\frac{446}{662}x + \frac{138}{170}(5-x) = 3.6$
On solving, x = 3.32
Mass of lead nitrate in the mixture = 3.32 g
Mass of sodium nitrate in the mixture = (5 – 3.32)g
= 1.68 g

4. (a)

5. (a) : 135.12 g/mol of salicylic acid produces 180.15 g/mol of aspirin.
⇒ 1 g/mol of salicylic acid produces = $\frac{180.15}{135.12}$ = 1.33 g of aspirin
∴ 1.33 g of aspirin will be formed when the yield is 100%.
Thus, 0.85 g of aspirin formed when the yield is
1.33 × 0.85 = 63.9%

6. Gas (B) on ignition gives water, therefore, hydrogen is present in the gas.
An inorganic iodide with alkali (KOH) gives a gas (B), a hydrogen compound, so (A) may be NH_4I or PH_4I. As NH_3 does not reduce $CuSO_4$, therefore, the compound (A) is PH_4I.
(i) $$\underset{(A)}{PH_4I} + KOH \longrightarrow \underset{(B)}{PH_3} + \underset{(C)}{KI} + H_2O$$

(ii) $4PH_3 + 8O_2 \longrightarrow \underset{(D)}{P_4O_{10}} + 6H_2O$

(iii) $3CuSO_4 + 2PH_3 \longrightarrow Cu_3P_2 + 3H_2SO_4$

$$\downarrow$$

$$3Cu + 2P$$

(iv) $\underset{(C)}{2CuSO_4} + 4KI \longrightarrow \underset{(E)}{Cu_2I_2} + 2K_2SO_4 + I_2$

7. Given: $C_7H_9N \xrightarrow{\text{Diazotisation}}$ Diazotised product $\xrightarrow[\text{HCl}]{Cu_2Cl_2} (B) \xrightarrow{[O]} (C) \xrightarrow[\Delta]{\text{Soda lime}}$ Chlorobenzene

Since chlorobenzene is obtained from (*C*) on soda lime treatment, hence (*C*) is chlorobenzoic acid. As (*C*) is obtained from (*B*) on oxidation, considering molecular formula of (*A*), a $-CH_3$ group should be attached to benzene ring which gets oxidised to $-COOH$. (*B*) is obtained after diazotisation and Sandmeyer's reaction of (*A*).

Structure of *A*: $\underset{(A)}{C_6H_4\begin{matrix} CH_3 \\ NH_2 \end{matrix}}$ (*o*-, *m*- or *p*-) toluidines

Reactions:

$$\underset{(A)}{C_6H_4\begin{matrix} CH_3 \\ NH_2 \end{matrix}} \xrightarrow{\text{diazotisation}} \underset{\substack{\text{Diazotised} \\ \text{product}}}{C_6H_4\begin{matrix} CH_3 \\ N_2Cl \end{matrix}} \xrightarrow[\text{HCl}]{Cu_2Cl_2} \underset{\substack{(B) \\ \text{Chlorotoluene}}}{C_6H_4\begin{matrix} CH_3 \\ Cl \end{matrix}}$$

$$\underset{(B)}{C_6H_4\begin{matrix} CH_3 \\ Cl \end{matrix}} \xrightarrow{[O]} \underset{\substack{(C) \\ \text{Chlorobenzoic acid}}}{C_6H_4\begin{matrix} COOH \\ Cl \end{matrix}} \xrightarrow[\Delta]{\text{Sodalime}} \underset{\text{Chlorobenzene}}{C_6H_5Cl}$$

8. The combustion reactions are

$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$,

$C_4H_{10(g)} + \frac{13}{2}O_{2(g)} \longrightarrow 4CO_{2(g)} + 5H_2O_{(g)}$

Calorific value of $CH_4 = \frac{809}{16}$ kJ g^{-1}

Calorific value of $C_4H_{10} = \frac{2878}{58}$ kJ g^{-1}

Mass of C_4H_{10} having the same calorific output as that of $CH_4 = \frac{809}{16} \times \frac{58}{2878}$ g

Amount of C_4H_{10} having the same calorific output as that of $CH_4 = \frac{809}{16 \times 2878}$ mol

Now, $\frac{1}{16}$ mol CH_4 requires the supply x L/h of CH_4

$\frac{809}{16 \times 2878}$ mol C_4H_{10} requires the supply of

$\frac{x}{1/16} \times \frac{809}{16 \times 2878} = 0.28x$ L/h of C_4H_{10}

The corresponding supply of O_2

$$= 0.28x \times 3 \times \frac{13}{2} = 5.48\, x \text{ L/h}$$

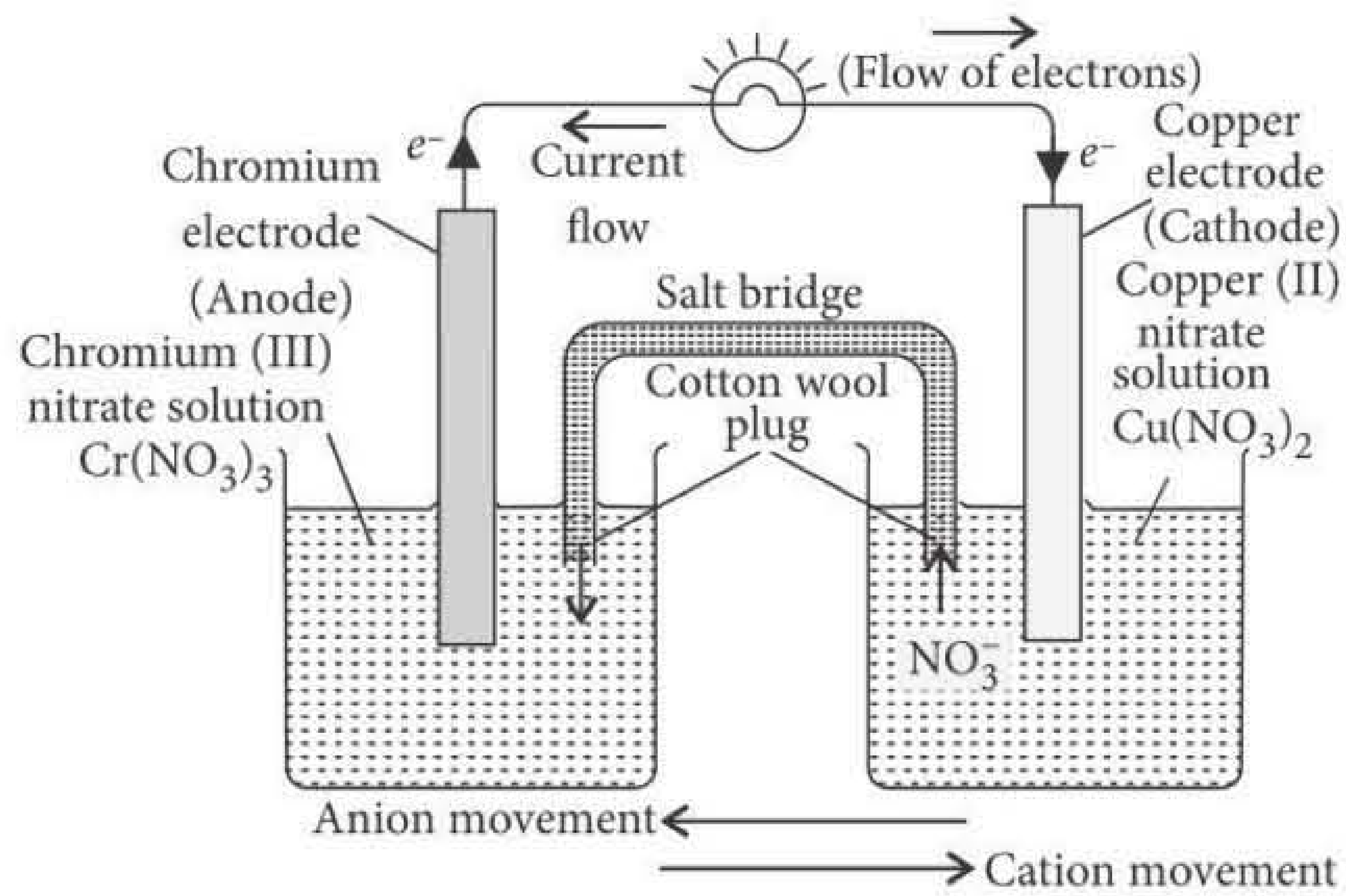
9. The balanced equation for the spontaneous reaction is

(a) $2Cr_{(s)} + 3Cu^{2+}_{(aq)} \longrightarrow 2Cr^{3+}_{(aq)} + 3Cu_{(s)}$

$E^\circ_{cell} = E^\circ_{Cu^{2+}/Cu} - E^\circ_{Cr^{3+}/Cr}$

$= 0.340 \text{ V} - (-0.744) \text{ V} = 1.084 \text{ V}$

(b)



Electrons flow from anode to cathode in the external circuit. Anions (NO_3^-) move away from cathode, where they are present in excess, towards anode, where they are needed to balance the charge of the cations formed, through salt bridge.

(c) (i) $[Cu^{2+}]$ goes from 1.0 M to 0.10 M, so

$\Delta[Cu^{2+}] = -0.90$; $\Delta[Cr^{3+}] = 0.90 \times 2/3 = 0.60$

So, $[Cr^{3+}] = 1 + 0.6 = 1.60$

(ii) Put these values into the following equation :

$$E = E^\circ - \frac{RT}{nF}\log\frac{\left[Cr^{3+}\right]^2}{\left[Cu^{2+}\right]^3}$$

$$E = 1.084 - \frac{0.0591}{6}\log\frac{(1.60)^2}{(0.10)^3} = 1.084 - 0.033 = 1.051 \text{ V}$$

10. (a) : Weight of LPG originally present = 29 – 14.8 = 14.2 kg

Weight of LPG present after use = 23.2 – 14.8 = 8.4 kg

Weight of used gas = 14.2 – 8.4 = 5.8 kg

Moles of gas $= \frac{5.8 \times 10^3}{58} = 100$ mol

At normal conditions, $P = 1$ atm, $T = 273 + 27 = 300$ K

As, $V = \frac{nRT}{P} = \frac{100 \times 0.082 \times 300}{1} = 2463 \text{ dm}^3$

$\therefore \quad V = 2.463 \text{ cm}^3$

Since, volume is constant. $PV = nRT$, pressure = 2.5 atm

$\frac{P_1}{P_2} = \frac{n_1}{n_2} = \frac{w_1/M}{w_2/M} = \frac{w_1}{w_2} \Rightarrow \frac{2.5}{P_2} = \frac{14.2}{8.4}$

$\Rightarrow P_2 = \frac{2.5 \times 8.4}{14.2} = 1.48$ atm

MONTHLY TEST DRIVE

XII

This specially designed column enables students to self analyse their extent of understanding of all chapters (Class XII). Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

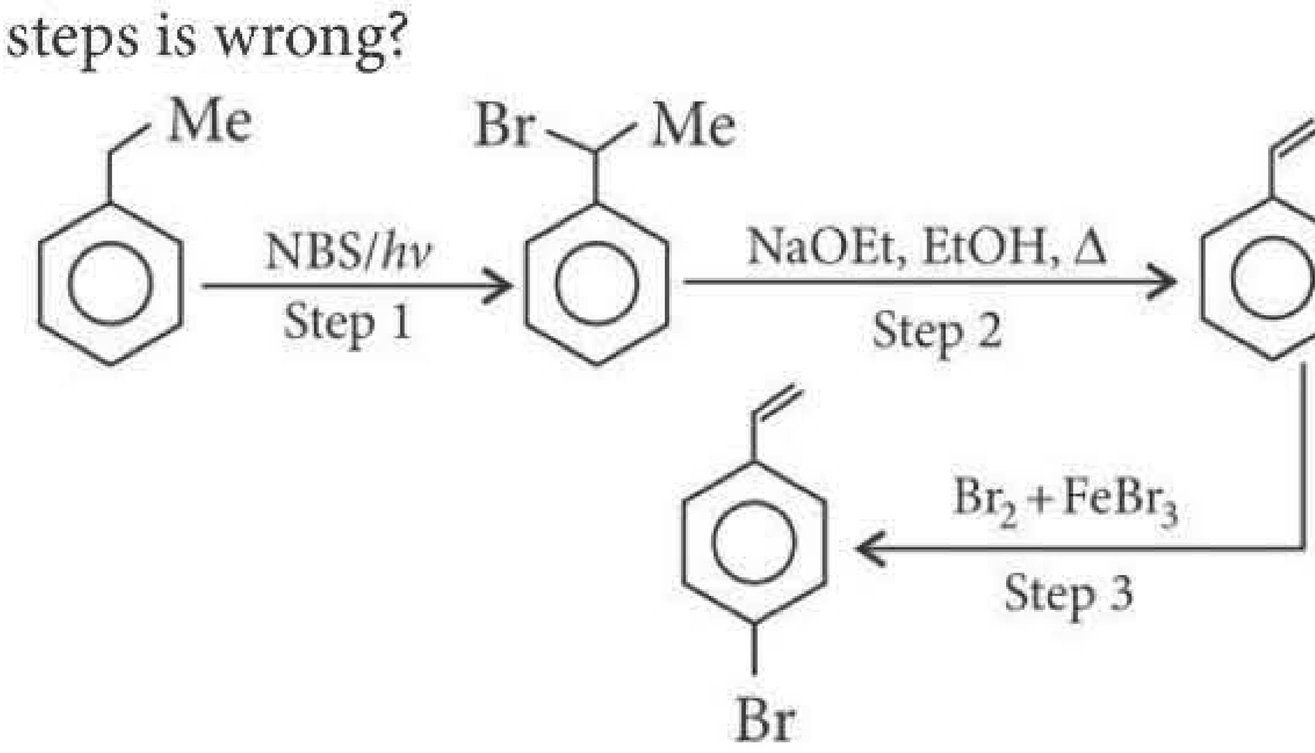
Total Marks : 120 **Time Taken : 60 min**

NEET

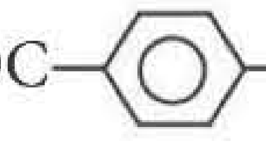
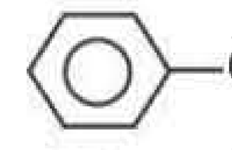
Only One Option Correct Type

1. In a mixture of PbS, ZnS and FeS, each component is separated from other by using the reagents in the following sequence in froth floatation process
   (a) potassium ethyl xanthate, KCN
   (b) potassium ethyl xanthate, KCN, NaOH, $CuSO_4$, acid
   (c) KCN, $CuSO_4$, acid
   (d) none of these.

2. In the following reaction, which of the following steps is wrong?



   (a) Step 1 (b) Step 2
   (c) Step 3 (d) None of these

3. Which one of the following sets of monomers forms the biodegradable polymer?
   (a) $HO-CH_2-CH_2-OH$ and
   HOOC——COOH
   (b) $-CH=CH_2$ and $CH_2{=}CH-CH{=}CH_2$
   (c) $CH_2{=}CH-CN$ and $CH_2{=}CH-CH{=}CH_2$
   (d) H_2N-CH_2-COOH
   and $H_2N-(CH_2)_5-COOH$

4. The resistance of 0.01 N solution of an electrolyte was found to be 210 ohm at 298 K, using a conductivity cell of cell constant 0.66 cm^{-1}. The equivalent conductance of solution is
   (a) 314.28 mho cm^2 eq^{-1}
   (b) 3.14 mho cm^2 eq^{-1}
   (c) 314.28 mho^{-1} $cm^2 eq^{-1}$
   (d) 3.14 mho^{-1} $cm^2 eq^{-1}$

5. Hydrolysis of one mole of peroxodisulphuric acid produces
   (a) two moles of sulphuric acid
   (b) two moles of peroxomonosulphuric acid
   (c) one mole of sulphuric acid and one mole of peroxomonosulphuric acid
   (d) one mole of sulphuric acid, one mole of peroxomonosulphuric acid and one mole of hydrogen peroxide.

6. A compound has molecular formula, $C_6H_{12}O$. It does not reduce Tollens' or Fehling's reagent, but gives a crystalline derivative with 2, 4-dinitrophenyl hydrazine. With alkali and I_2, it gives yellow solid with a medicinal odour. Clemmensen reduction converts it to 2-methylpentane. The structural formula of the compound is most likely to be
   (a) $CH_3-COCH_2-CH-(CH_3)_2$
   (b) $CH_3-CH_2-CO-CH-(CH_3)_2$
   (c) $CH_3CH_2CH_2-CO-CH_2CH_3$
   (d) $(CH_3)_2-CH-CO-CH-(CH_3)_2$

7. An organic compound with the molecular formula C_3H_5N, on acidic hydrolysis forms an acid which reduces Fehling's solution. The compound can be

(a) ethanenitrile (b) *iso*-cyanoethane
(c) ethoxyethane (d) propanenitrile.

8. The edge length of face centred cubic unit cell is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is
(a) 144 pm (b) 288 pm
(c) 628 pm (d) 398 pm.

9. Absolute alcohol (100% ethanol) are prepared from rectified spirit (95% ethanol) by mixing a suitable amount of ______ and subjected to fractional distillation (azeotropic distillation).
(a) toluene (b) *o*-xylene
(c) methanol (d) benzene

10. When white light is passed through a colloidal solution containing fine suspended particles of gold, then the scattered light seen in a direction different from that of the incident light is
(a) yellow coloured (b) blue coloured
(c) green coloured (d) red coloured.

11. An element of 3*d*-transition series shows two oxidation states x and y that differ by two units then
(a) compounds in oxidation state x are ionic if $x > y$
(b) compounds in oxidation state x are ionic if $x < y$
(c) oxidation state has no relation to the nature of bond
(d) compounds in oxidation state y are covalent if $y > x$.

12. The reaction, $X \longrightarrow$ product, follows first order kinetics. In 40 minutes, the concentration of X changes from 0.1 M to 0.025 M, then rate of reaction, when concentration of X is 0.01 M, is
(a) 1.73×10^{-4} M/min
(b) 3.47×10^{-5} M/min
(c) 3.47×10^{-4} M/min
(d) 1.73×10^{-5} M/min.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. Assertion : The $[Ni(en)_3]Cl_2$ (en = ethylenediamine) has lower stability than $[Ni(NH_3)_6]Cl_2$.
Reason : In $[Ni(en)_3]Cl_2$ the geometry of Ni is trigonal bipyramidal.

14. Assertion : Glycine exists as zwitter ion but *o*-and *p*-amino benzoic acid do not.
Reason : Due to the presence of $-NH_2$ and $-COOH$ groups within the same molecule, they neutralise each other and hence α-amino acids exist as dipolar ions or zwitter ions.

15. Assertion : Hydrometallurgy involves dissolving

the ore in a suitable reagent followed by precipitation of the metal by a more electropositive metal.
Reason : Copper is extracted by hydrometallurgy.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. A 3.42% (mass/vol.) solution of cane sugar is isotonic with a 5.96% (mass/vol.) solution of raffinose. The molecular mass of raffinose is
(a) 59.6 (b) 596
(c) 5.96 (d) 5960

17. Under the same reaction conditions, initial concentration of 1.386 mol dm^{-3} of a substance becomes half in 40 seconds and 20 seconds through first order and zero order kinetics, respectively. Ratio (k_1/k_0) of the rate constant for first order (k_1) and zero order (k_0) of the reactions is
(a) 0.5 mol^{-1} dm^3 (b) 1.0 mol dm^{-3}
(c) 1.5 mol dm^{-3} (d) 2.0 mol^{-1} dm^3

18. A coordination complex of type MX_2Y_2 (M-metal ion; X, Y-monodentate ligands), can have either a tetrahedral or a square planar geometry. The maximum number of possible isomers in these two cases are respectively
(a) 1 and 2 (b) 2 and 1
(c) 1 and 3 (d) 3 and 2

19. Predict the direction of migration of following tripeptide at pH 6.
Lys – Gly – Glu;
[Lys = $H_2N-(CH_2)_4-\underset{\underset{NH_2}{|}}{CH}-COOH$,
Gly = H_2N-CH_2-COOH,
Glu = $HOOC-(CH_2)_2-\underset{\underset{NH_2}{|}}{CH}-COOH$]
(a) Cathodal (b) Anodal
(c) Stationary (d) Unpredictable

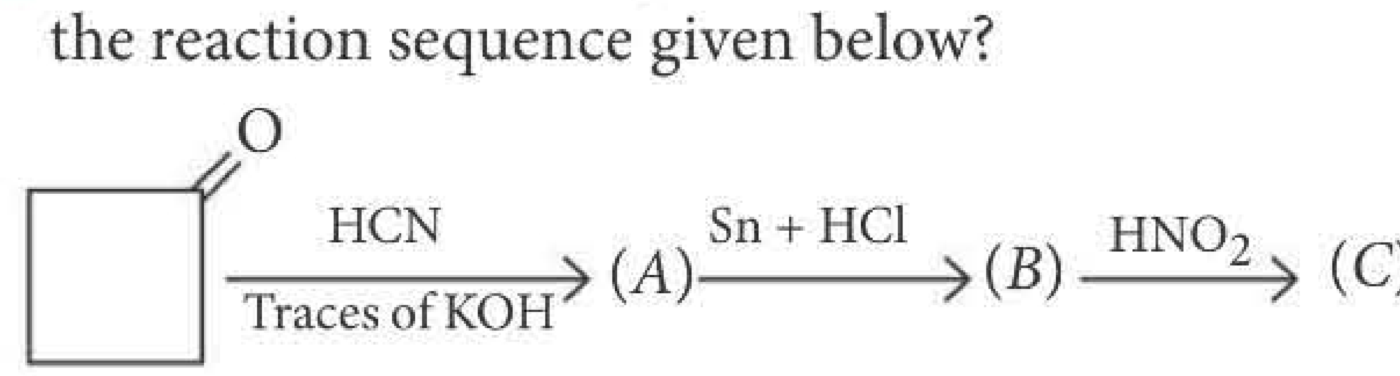
More than One Options Correct Type

20. 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 are
(a) O_2 is physisorbed
(b) heat is released
(c) occupancy of π^*_{2p} of O_2 is increased
(d) bond length of O_2 is increased.

21. Aryl halides are less reactive towards nucleophilic substitution reaction as compared to alkyl halides due to
(a) the formation of less stable carbonium ion
(b) resonance stabilisation
(c) the inductive effect
(d) sp^2-hybridised carbon attached to the halogen.

22. Which of the following statements are correct?
(a) An acidified solution of potassium permanganate oxidizes nitric oxide to nitrate ion.
(b) The reaction, $2HNO_3 + NO \rightarrow 3NO_2 + H_2O$ completely moves in the forward direction with conc. HNO_3.
(c) The action of conc. HNO_3 on metals produces NO_2 because the equilibrium of the reaction, $2HNO_3 + NO \rightleftharpoons 3NO_2 + H_2O$ lies far towards the right.
(d) The action of dilute HNO_3 on metals produces NO because of the reaction,
$HNO_3 + NO \rightleftharpoons 3NO_2 + H_2O$

23. Which of the following statements are correct about the reaction sequence given below?



(a) In the formation of (C) from (B), ring expansion takes place.
(b) The product (C) is cyclopentanone.
(c) The product (C) is α, β-unsaturated cyclopentanone.
(d) Conversion of (A) to (B) can also be carried out with $LiAlH_4$.

Numerical / Integer Type

24. A metal 'X' crystallises in a unit cell in which the radius of atom (r) is related to edge of unit cell (a) as $r = 0.3535\ a$. The total number of atoms present per unit cell is

25. How many of the following substances are more acidic than phenol?
o-Cresol, m-cresol, p-cresol, water, methyl alcohol, ethyl alcohol, 2,4-dimethylphenol, p-ethylphenol, dimethylcarbinol

26. An alloy of Pb-Ag weighing 1.08 g was dissolved in dilute HNO_3 and the volume made to 100 mL. A silver electrode was dipped in the solution and EMF of the cell set up was

$Pt_{(s)}, H_{2(g)}|H^+ (1\ M)||\ Ag^+_{(aq)}|Ag_{(s)}$

0.62 V. The percentage of Ag in the alloy is

$[E^\circ_{cell} = 0.80\ V, 2.303\ RT/F = 0.06$ at 25 °C]

Comprehension Type

Synthetic tranquilizers are mostly barbituric acid derivatives while, other tranquilizers are not barbituric acid derivatives. Opium alkaloids such as morphine and codeine are powerful analgesics (reduce pain). Drugs which are used to cure diseases caused by microbes are called antimicrobials. These may be either sulphadrugs or they may be antibiotics. Antibiotics which inhibit the growth of microbes are called bacteriostatic while others which kill the microbes are called bactericidal antibiotics.

27. Among the following the narcotic analgesic is
(a) heroin
(b) ibuprofen
(c) naproxen
(d) aspirin.

28. The bactericidal and bacteriostatic antibiotics respectively are
(a) penicillin, ofloxacin
(b) erythromycin, tetracycline
(c) penicillin, chloramphenicol
(d) tetracycline and penicillin.

Matrix Match Type

29. Match the List I with List II and select the correct answer using the codes given below the lists :

	List I (Equimolar solute)		List II (Osmotic pressure ratio)
P.	Glucose, NaCl, $MgCl_2$	1.	2 : 3: 3
Q.	NaCl, $MgCl_2$, K_2SO_4	2.	1 : 0.8 : 1
R.	$Al_2(SO_4)_3$, Na_3PO_4, $K_4[Fe(CN)_6]$	3.	1 : 2 : 3
S.	Urea, glucose, fructose	4.	1 : 1 : 1

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	1	4
(c)	2	1	4	3
(d)	3	1	2	4

30. Match the List I with List II and select the correct answer using the codes given below the lists :

	List I (Compound/element)		List II (Uses)
P.	Individual lanthanoid oxide	1.	Production of alloys
Q.	Lanthanoid	2.	Television screen
R.	Mischmetal	3.	Petroleum cracking
S.	Mixed oxides of lanthanoids	4.	Produce bullets, shell and lighter flint.

	P	Q	R	S
(a)	1	2	3	4
(b)	2	1	4	3
(c)	4	3	1	2
(d)	3	2	4	1

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted ......
No. of questions correct ......
Marks scored in percentage ......

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

YOU ASK WE ANSWER

Do you have a question that you just can't get answered?
Use the vast expertise of our MTG team to get to the bottom of the question. From the serious to the silly, the controversial to the trivial, the team will tackle the questions, easy and tough. The best questions and their solutions will be printed in this column each month.

1. Why radiation is harmful for humans?

Ans. Radiations are harmful or not, depend on the following points :

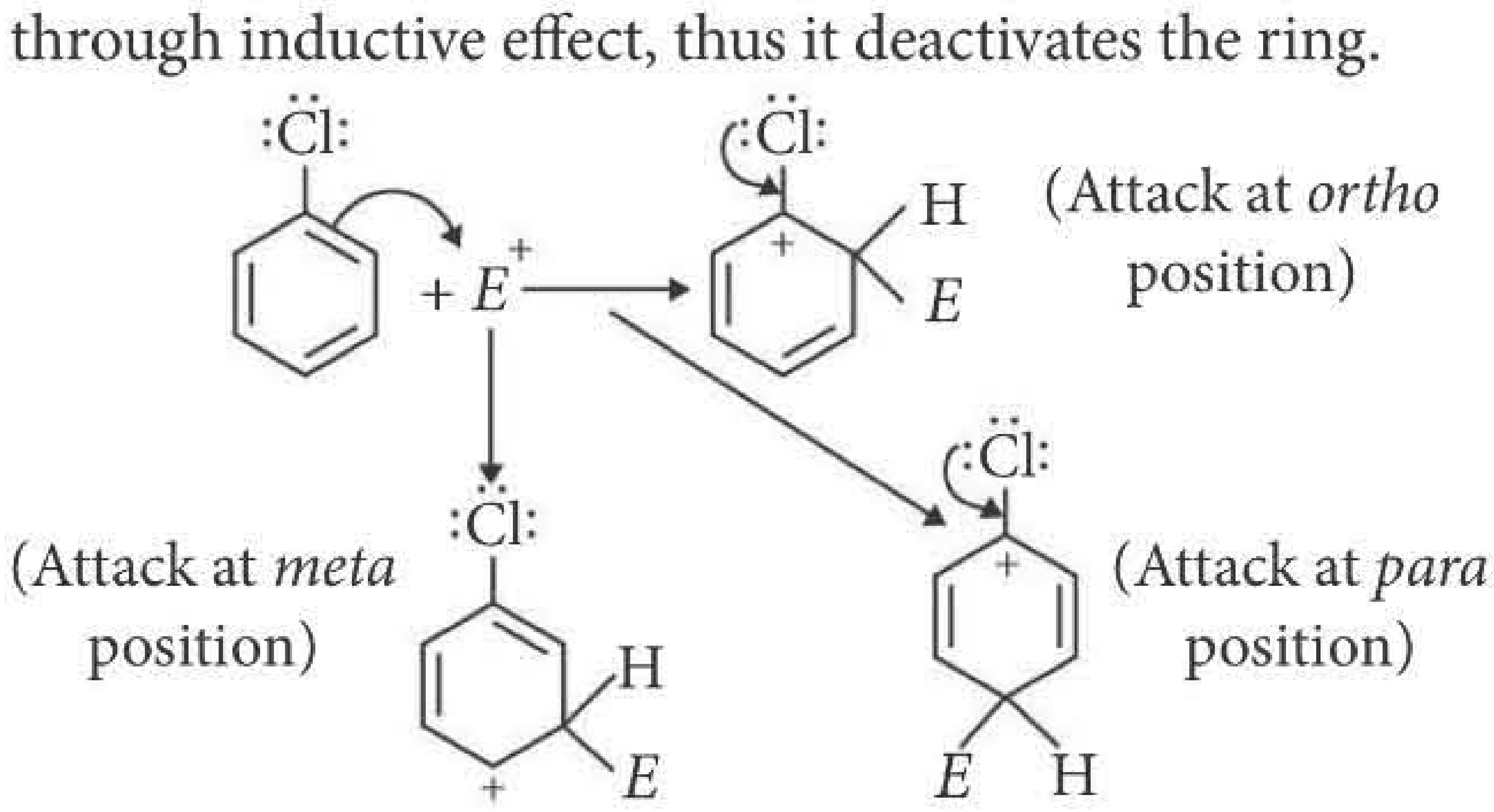
- How it is used?
- How strong it is?
- How often a person is exposed?
- What type of exposure occurs?
- How long exposure last?

Radiations are harmful because when they collide with molecules in living cells they can damage them. If the DNA in the nucleus of a cell is damaged, the cell may become cancerous. Then cell goes out of control, divides rapidly and causes serious health problems.

The greater the dose of radiation a cell get, the greater the chance that the cell will become cancerous. However, very high doses of radiation can kill the cell completely. If use smartly, this property of radiations can be used to kill cancer cells and also harmful bacteria and other micro-organisms.

2. Why chlorine is deactivating but *ortho*, *para* directing group?

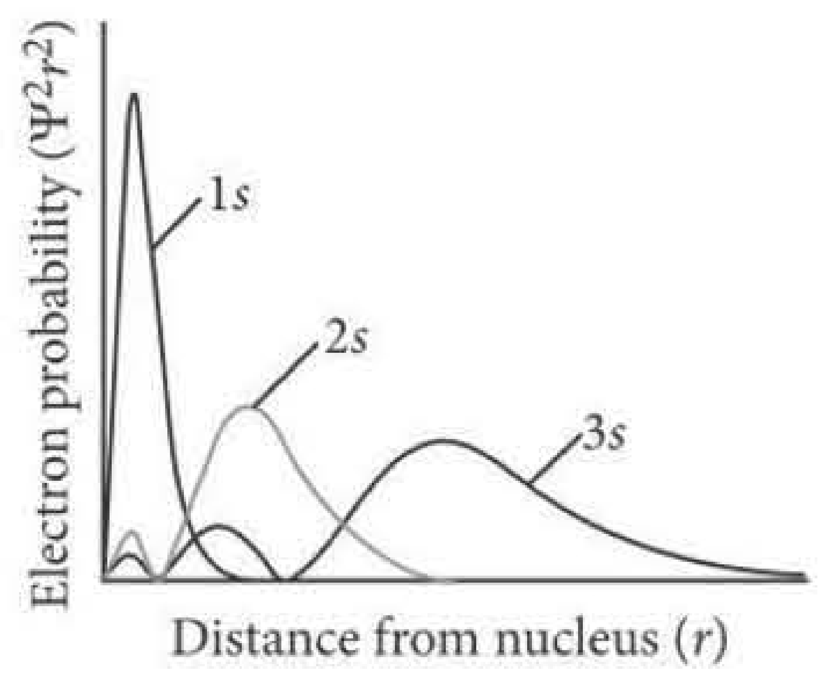
Ans. Chlorine shows $-I$ effect as well as has three lone pairs of electrons. These three electron pairs can cause resonance in benzene ring. Chlorine withdraws electrons through inductive effect, thus it deactivates the ring.



The intermediate carbocation can be stabilised by resonance when the attack is on *ortho* or *para* position, thus chlorine is *ortho*, *para* directing group.

2. The probability density and probability distribution graphs of orbitals start more or less near $r = 0$ whether it is $2s$ or $1s$ or $2p$. But $2p$ or $2s$ is not near the nucleus. So, how can the graphs start from near $r = 0$? Does the graphs mean that the orbitals are merging at nucleus?

Ans. Every orbital has origin from nucleus itself, however, probability of finding the electron decrease around nucleus as value of n increase but it could not be zero. In this plot of electron probability as a function of distance from the nucleus (r) in all directions (radial probability), the most probable radius increases as n increases, but the $2s$ and $3s$ orbitals have regions of significant electron probability at small values of r.



◈◈

Monthly Test Drive CLASS XI ANSWER KEY

1. (b)	**2.** (b)	**3.** (b)	**4.** (a)	**5.** (d)
6. (c)	**7.** (c)	**8.** (c)	**9.** (d)	**10.** (a)
11. (b)	**12.** (c)	**13.** (d)	**14.** (b)	**15.** (a)
16. (b)	**17.** (a)	**18.** (c)	**19.** (d)	**20.** (a,b)
21. (b,d)	**22.** (c,d)	**23.** (a,c)	**24.** (2)	**25.** (1)
26. (4)	**27.** (a)	**28.** (d)	**29.** (b)	**30.** (c)