

ASSOCIATION OF CHEMISTRY TEACHERS

National Standard Examination in Chemistry – 2024

Date of Examination: December 22, 2024

Time: 11:30 AM to 1:30 PM

Question Paper Code: 35

Student's Roll No:																			
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Write the Question Paper Code (mentioned above) on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the Question Paper.

Instructions to Candidates:

- Use of mobile phone, smart watch, and iPad during examination is STRICTLY PROHIBITED.
- In addition to this Question Paper, you are given OMR Answer Sheet along with candidate's copy.
- On the OMR sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
- On the OMR Answer Sheet, use only **BLUE** or **BLACK BALL POINT PEN** for making entries and filling the bubbles.
- Your **Eleven-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials means login id and password respectively for accessing your performance / result in National Standard Examination in Chemistry – 2024.

Question paper has two parts. In part A-1 (Q. No.1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q.No.12 a c d c

In part A-2 (Q. No. 49 to 60) each question has four alternatives out of which any number of alternative(s) (1, 2, 3, or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

Q.No.52 a c

- Attempt all sixty questions. For **Part A-1**, each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A-2**, you get 6 marks if all the correct alternatives are marked and no incorrect. No negative marks in this part.
- Rough work may be done in the space provided. There are **15** printed pages in this paper
- Use of **Non-programmable scientific** calculator is allowed.
- No candidate should leave the examination hall before the completion of the examination.
- After submitting Answer Paper, take away the Question Paper & Candidate's copy of OMR sheet for your future reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR Answer Sheet.

OMR Answer Sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE OMR ANSWER SHEET.

Instructions to Candidates (Continued) :

You may read the following instructions after submitting the Answer Sheet.

12. **Comments/Inquiries/Grievances regarding this Question Paper, if any, can be shared on the Inquiry/Grievance column on www.iapt.org.in on the specified format till Dec 26, 2024.**
13. **The answers/solutions to this Question Paper will be available on the website: www.iapt.org.in by Dec 24, 2024.** The score card may be downloaded after Dec 30, 2024
14. **CERTIFICATES and AWARDS:**
Following certificates are awarded by IAPT/ACT to students, successful in the National Standard Examination in Chemistry – 2024
- (i) “CENTRE TOP 10 %” To be downloaded from iapt.org.in after 30.01.25
 - (ii) “STATE TOP 1 %” Will be dispatched to the examinee
 - (iii) “NATIONAL TOP 1 %” Will be dispatched to the examinee
 - (iv) “GOLD MEDAL & MERIT CERTIFICATE” to all students who attend OCSC – 2025 at HBCSE Mumbai
- Certificate for centre toppers shall be uploaded on iapt.org.in
15. List of students (with centre number and roll number only) having score above **Minimum Admissible Score (MAS)** will be displayed on the website: www.iapt.org.in by **Dec 28, 2024**. See the **MAS clause** on the student’s brochure on the web.
16. List of students eligible to appear for Indian National Chemistry Olympiad (INChO – 2025) shall be displayed on www.iapt.org.in by Dec 31, 2024.

Useful constants

Charge of electron, $e = 1.602 \times 10^{-19} C$

Mass of electron, $m_e = 9.1 \times 10^{-31} kg$

Planck’s constant, $h = 6.63 \times 10^{-34} J s$

Speed of light, $c = 3.0 \times 10^8 ms^{-1}$

Avogadro constant, $N_A = 6.022 \times 10^{23} mol^{-1}$

Faraday constant, $F = 96500 C mol^{-1}$

Molar gas constant, $R = 0.082 Latmmol^{-1}K^{-1}$
 $= 8.314 J mol^{-1} K^{-1}$

ASSOCIATION OF CHEMISTRY TEACHERS
NATIONAL STANDARD EXAMINATION IN CHEMISTRY
(NSEC - 2024)

Time: 120 minute

Max. Marks: 216

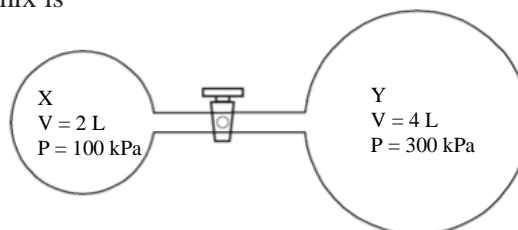
Attempt All Sixty Questions

A – 1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION.

1. At 300 K, a 2 L vessel with gas X at a pressure of 100 kPa is attached through a tube and tap of negligible volume to a 4 L vessel with gas Y at a pressure of 300 kPa. The final pressure in the vessels when the tap is opened, and the gases are given time to mix is [X and Y are non-reacting gases at 300 K]

- (a) 100 kPa
 (b) 133 kPa
 (c) 200 kPa
 (d) 233 kPa



2. A typical passenger-side airbag in the cars contain x g of NaN₃ which dissociates to produce nitrogen gas during the crash. The air bag can expand up to a volume 30.0 L. What mass of sodium azide would be used to produce 30.0 L of nitrogen gas when measured at 27°C and 100 kPa?

[R = 8.314 kPa L K⁻¹ mol⁻¹]

- (a) 45.2 g (b) 30.1 g (c) 52.1 g (d) 35.4 g

3. 1.0 mL of 0.1 M sulphuric acid was diluted to 100.0 mL using deionised water. 10.0 mL of this solution was then diluted to 100.0 mL again using deionised water. The pH of the final solution is [Assume complete dissociation of sulphuric acid]

- (a) 3.0 (b) 3.7 (c) 4.0 (d) 4.5

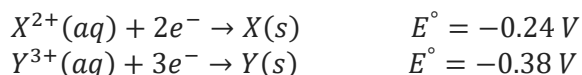
4. Solid calcium carbonate was added to a hydrochloric acid solution. Which of the following best depicts how each species' concentration changes over time as the reaction progresses?

[H⁺] [Ca²⁺] [Cl⁻]

- (a) decreases increases increases
 (b) decreases increases no change
 (c) decreases no change increases
 (d) no change increases increases

5. A galvanic cell is constructed under standard conditions using metal X in its aqueous salt solution X(NO₃)₂ and metal Y in its aqueous salt solution Y(NO₃)₃.

Given:

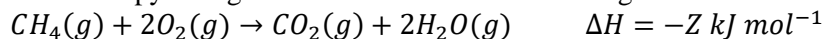


Which statement(s) from the following about this cell is/are correct?

- I. The standard cell potential is – 0.14 V
 II. Y is the anode
 III. X is undergoing reduction as the reaction proceeds
- (a) I only (b) II only (c) I and II only (d) II and III only

6. 'CYD', a car manufacturing company has developed a fuel engine using liquid methane and liquid oxygen. The enthalpy change of vaporization of methane is $+X \text{ kJ mol}^{-1}$ and the enthalpy change of vaporization of oxygen is $+Y \text{ kJ mol}^{-1}$.

The enthalpy change for combustion of methane as given below is $-Z \text{ kJ mol}^{-1}$.



The change in enthalpy of reaction in kJ when one mole of liquid methane reacts completely with liquid oxygen to form $\text{CO}_2(g)$ and $\text{H}_2\text{O}(g)$ is given by

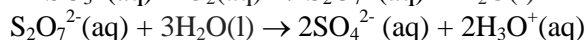
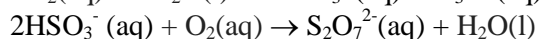
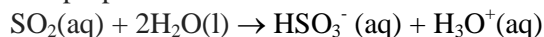
- (a) $X + Y + Z$ (b) $X + 2Y - Z$ (c) $X + 2Y + Z$ (d) $Y - X + 2Z$
7. A 20.00 g metal piece is heated to 77.1°C and submerged in 200.0 g of water at 30.0°C . The metal and water are at 30.5°C after the system reaches equilibrium.

The metal is:

[Given: Specific heat capacity of $\text{H}_2\text{O} = 4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$]

- (a) P ($C_p 0.24 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$) (b) Q ($C_p 0.39 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$)
 (c) R ($C_p 0.45 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$) (d) S ($C_p 0.90 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$)
8. Water (with traces of dilute sulphuric acid) is electrolysed by passing a current of 0.2 A for 4 hours. The number of moles of hydrogen gas produced at the cathode and the volume in Litres it occupies as a dry gas at a pressure of 1 atm and 27°C respectively are
- (a) 0.0298 mol; 0.734 L (b) 0.0149 mol; 0.367 L
 (c) 0.0186 mol; 0.464 L (d) 0.0372 mol; 0.928L

9. The proposed mechanism for the acid rain due to SO_2 gas is given as

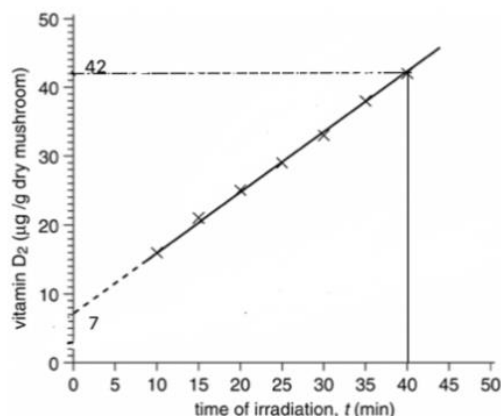


Choose the correct option?

Reactant	Catalyst	Intermediate
(a) $\text{SO}_2(\text{aq})$	$\text{O}_2(\text{aq})$	$\text{HSO}_3^-(\text{aq}), \text{H}_3\text{O}^+(\text{aq})$
(b) $\text{SO}_2(\text{aq})$	$\text{HSO}_3^-(\text{aq})$	$\text{S}_2\text{O}_7^{2-}(\text{aq})$
(c) $\text{SO}_2(\text{aq}), \text{H}_2\text{O}(\text{l})$	$\text{S}_2\text{O}_7^{2-}(\text{aq})$	$\text{HSO}_3^-(\text{aq})$
(d) $\text{SO}_2(\text{aq}), \text{H}_2\text{O}(\text{l})$	None	$\text{HSO}_3^-(\text{aq}), \text{S}_2\text{O}_7^{2-}(\text{aq})$

10. Mushrooms are a rich source of ergosterol, a precursor of vitamin D_2 which is formed when dry mushrooms are exposed to UV light. The kinetics of this reaction was studied by monitoring the production of vitamin D_2 . The order of the reaction with respect to ergosterol and the rate constant for the production of vitamin D_2 from dry mushroom respectively are

- (a) Zero order, $0.875 \mu\text{g (g dry mushroom)}^{-1} \text{ s}^{-1}$
 (b) First order, 0.04478 s^{-1}
 (c) First order; $0.875 \mu\text{g s}^{-1}$
 (d) Zero order; $0.0146 \mu\text{g (g dry mushroom)}^{-1} \text{ s}^{-1}$



11. Which of the following electronic configuration represents an atom in an excited state?

- (a) $1s^2 2s^2 2p^5$ (b) $1s^2 2s^2 2p^5 3s^2$
 (c) $1s^2 2s^2 2p^6 3s^1$ (d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

12. Properties of substances P, Q and R were experimentally studied in the laboratory. The data collected is given below:

Substance	P	Q	R
Melting point (°C)	1800	600	1506
Electrical Conductivity in Solid Phase	None	High	None
Electrical Conductivity in Liquid Phase	None	High	High

Choose the correct bonding in substances P, Q and R

- | Substance P | Substance Q | Substance R |
|----------------------|------------------|------------------|
| (a) Network covalent | Ionic | Metallic |
| (b) Ionic | Molecular | Network covalent |
| (c) Molecular | Network covalent | Metallic |
| (d) Network covalent | Metallic | Ionic |

13. A mixture of $NO_2(g)$ and $N_2O_4(g)$ is at equilibrium in a rigid reaction vessel. The equilibrium is represented by the equation given below:



Which of the following statement(s) are correct?

- The most accurate determination of the concentration of the $NO_2(g)$ at equilibrium can be done by measuring the colour intensity.
- The forward reaction is thermodynamically favoured at all temperatures.
- If temperature of the mixture is decreased, then $[N_2O_4]$ will increase and the mixture will turn a lighter brown.
- If temperature of the mixture is increased, then $[NO_2]$ will increase and the mixture will turn a darker brown.

Choose the correct option.

- (a) I and II only (b) I, III and IV only (c) III and IV only (d) I and III only

14. The valence electronic configuration of element X is $3s^2 3p^1$ and that of Y is $2s^2 2p^4$. The probable empirical formula for a compound of the two elements is

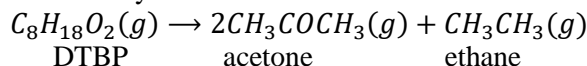
- (a) X_2Y_3 (b) XY_2 (c) X_3Y_2 (d) X_2Y

15. $SO_3(g)$ dissociates into $SO_2(g)$ and $O_2(g)$ at 1350°C .

4.80 moles of SO_3 were placed into an evacuated 4.0 L flask. The concentration of SO_2 gas measured at equilibrium was found to be 0.20 M. The equilibrium constant, K_c , for the reaction is

- (a) 1.6×10^{-4} (b) 1.0×10^{-3} (c) 2.0×10^{-3} (d) 4.0×10^{-3}

16. Di-*t*-butyl peroxide (DTBP) is a commonly used radical initiator. In the gaseous state, DTBP decomposes into acetone and ethane by a first-order reaction.



If the initial pressure of DTBP and the total pressure at time 't' are p_0 and p_t respectively,

Partial pressure of DTBP at time 't' (p_{DTBP}) can be given as

- (a) $\left(\frac{p_t - 3p_0}{2}\right)$ (b) $p_0 - p_t$ (c) $3p_0 - p_t$ (d) $\left(\frac{3p_0 - p_t}{2}\right)$

17. Metal having atomic mass 120g/mol has cubic unit cell with edge length of 400pm. Density of the metal is 12.5 g/cm^3 . The metal belongs to

- (a) Simple Cubic (b) Body Centered Cubic
(c) Face Centered Cubic (d) End Centered Cubic

18. Potentially toxic transition metal, 'M' which naturally does not occur in metallic form and exist in two oxidation states. Lower oxidation state of 'M' is more stable. Salts of 'M' in lower oxidation state are usually pink in colour but in acidic medium acquire blue colour. 'M' is:

- (a) Cr (b) Co (c) Cd (d) As

19. An aqueous solution of (X) does not give a precipitate on passing H_2S in mild acidic condition. (X) during flame test imparts green color to the flame. (X) upon heating with solid $\text{K}_2\text{Cr}_2\text{O}_7$ and conc. H_2SO_4 , evolves reddish brown gas(Y). The gas (Y) when passed through an aqueous solution of NaOH turns it yellow due to formation of (Z). (X), (Y) and (Z) are respectively:

- (a) BaCl_2 , CrO_2Cl_2 , Na_2CrO_4 (b) CuCl_2 , CrO_2Cl_2 , $\text{Na}_2\text{Cr}_2\text{O}_7$
 (c) BaCl_2 , $\text{Cr}_2(\text{SO}_4)_3$, Na_2CrO_4 (d) CuCl_2 , $\text{Cr}_2(\text{SO}_4)_3$, $\text{NaCr}(\text{OH})_4$

20. Which one of the following sequences depicts an increasing oxidation number of the central atom?

- (a) MnO_4^- , CrO_2^- , ClO_3^- , CrO_4^{2-} (b) CrO_2^- , CrO_4^{2-} , MnO_4^- , ClO_3^-
 (c) ClO_3^- , CrO_2^- , MnO_4^- , CrO_4^{2-} (d) CrO_2^- , ClO_3^- , CrO_4^{2-} , MnO_4^-

21. The incorrect trend regarding hydrides of group 16 (H_2E) is:

- (a) The H-E-H bond angle increases down the group.
 (b) The acidic character of these increases down the group.
 (c) Thermal stability of these decreases down the group.
 (d) Bond enthalpy for the dissociation of H-E decreases down the group.

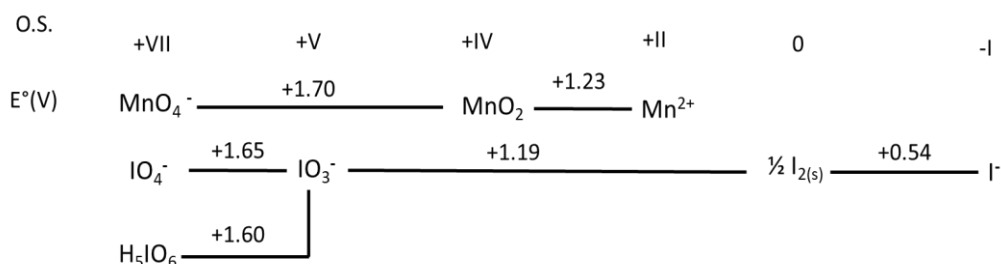
22. The reaction not involved in the mechanism related to depletion of ozone layer in the stratosphere from the following reactions is:

- (a) $\text{CF}_2\text{Cl}_2(\text{g}) \xrightarrow{\text{UV}} \text{Cl}\cdot(\text{g}) + \text{CF}_2\text{Cl}\cdot(\text{g})$ (b) $\text{ClO}\cdot + \text{O}(\text{g}) \rightarrow \text{Cl}\cdot(\text{g}) + \text{O}_2(\text{g})$
 (c) $3\text{CH}_4 + 2\text{O}_2 \rightarrow 3\text{CH}_2 = \text{O} + 3\text{H}_2\text{O}$ (d) $\text{ClO}\cdot(\text{g}) + \text{NO}_2(\text{g}) \rightarrow \text{ClONO}_2(\text{g})$

23. A blue colored water insoluble compound is used as a pigment. Blue colour is due to charge transfer spectra. It is prepared by reacting ferrous salt with potassium ferricyanide.

- (a) $\text{K}_4[\text{Fe}(\text{CN})_6]$ (b) $\text{K}_3[\text{Fe}(\text{CN})_6]$ (c) $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ (d) $\text{Fe}_3[\text{Fe}(\text{CN})_6]_2$

24. Observe the following changes in oxidation states (OS) with the reduction potentials ($E^0\text{V}$) involving various species of Mn and I_2 .



When the reaction is carried out by adding the acidic KMnO_4 dropwise to the KI solution, the oxidized and reduced products I_2 and Mn^{2+} are formed respectively. But when instead KI solution is added dropwise to acidified KMnO_4 , which of the following statements is correct explaining the formation of products initially, using the above diagram?

- (a) KMnO_4 will reduce to MnO_2 and iodide will oxidise to IO_3^- and IO_4^-
 (b) KMnO_4 will reduce to Mn^{2+} and iodide will oxidise to IO_3^-
 (c) KMnO_4 will reduce to Mn^{2+} and iodide will oxidise to IO_4^-
 (d) KMnO_4 will reduce to Mn^{2+} and iodide will oxidise to I_2

25. A reddish brown gas is obtained when three crystalline solids (X, Y and Z) are each warmed with sulphuric acid and metallic copper. When X is heated it gives a yellowish white crystalline solid and liberates a gas which relights a glowing wooden splint. When Y is heated it produces a reddish brown gas; a gas which relights a glowing wooden splint and a yellow residue which fuses with the glass of the test tube. When Z is heated it gives no solid. On warming Z with NaOH solution it liberates a gas which turns moist red litmus paper blue. Identify X, Y and Z from the following options.

- (a) KNO_3 , PbNO_3 and NH_4NO_3 (b) NaNO_3 , MgNO_3 and KNO_3
 (c) PbNO_3 , MgNO_3 and NH_4NO_3 (d) MgNO_3 , NH_4NO_3 and NaNO_3

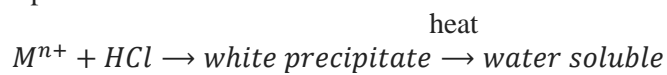
26. A sulphide ore (p) on roasting leaves a residue (q). This residue (q) on heating with chlorine gives (r), soluble in water, addition of excess KI to a solution of (r) gives a solution (s). A brown precipitate is formed when a solution of ammonium sulphate is added to an alkaline solution of (s). Identify the correct option:

- | (p) | (q) | (r) | (s) |
|---------------------------|--------------|-----------------|---|
| (a) Ag_2S | AgO | AgCl | $\text{K}_2[\text{AgI}_4]$ |
| (b) HgS | HgO | HgCl_2 | $\text{K}_2[\text{HgI}_4]$ |
| (c) Cu_2S | CuO | CuCl_2 | $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$ |
| (d) CuFeS_2 | FeO | FeCl_2 | $\text{K}_2[\text{FeI}_4]$ |

27. Which of the method can be used to get highly pure titanium and zirconium from impure metals?

- (a) Kroll process (b) Van Arkel-de Boer method
 (c) Mond's Process (d) Zone refining method

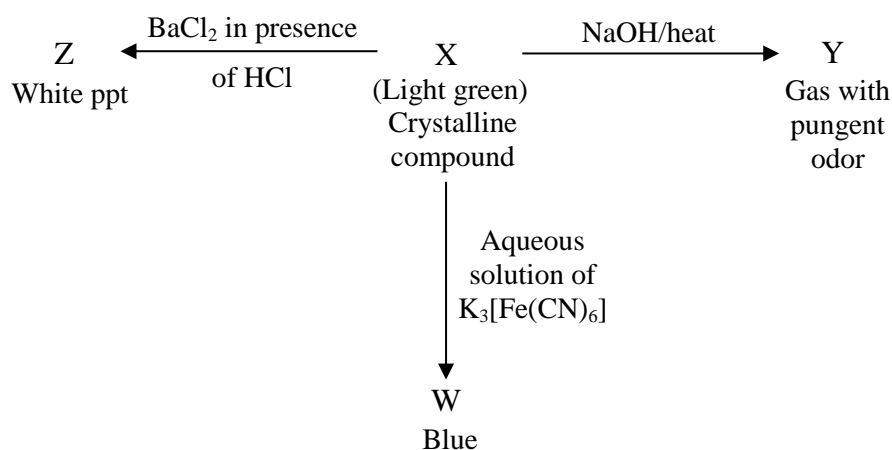
28. Consider the following experimental observation:



The metal ion M^{n+} is

- (a) Hg^{2+} (b) Ag^+ (c) Pb^{2+} (d) Sn^{2+}

29. Following observations are made during qualitative analysis of a salt (X)



'X' is

- (a) FeSO_4 (b) $(\text{NH}_4)_2\text{SO}_4$
 (c) $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ (d) Fe_2O_3

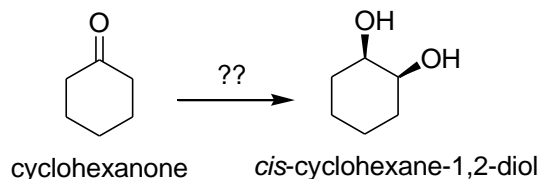
30. Given below are some complexes of nickel.

- (i) $[\text{Ni}(\text{H}_2\text{O})_6]^{+2}$ (ii) $[\text{Ni}(\text{NH}_3)_6]^{+2}$ (iii) $[\text{Ni}(\text{NO}_2)_6]^{-4}$

The correct order of absorption wavelengths for above complexes is

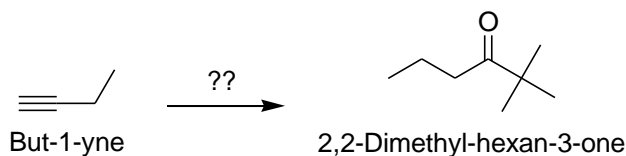
- (a) $i > ii > iii$ (b) $ii > i > iii$ (c) $iii > ii > i$ (d) $iii > i > ii$

31. Which one of the following factors is of no significance for roasting sulphides ores to the oxides and not subjecting the sulphides ores to carbon reduction directly?
- Metal sulphides are thermodynamically more stable than CS_2
 - CO_2 is thermodynamically more stable than CS_2
 - Metal sulphides are less stable than the corresponding oxides.
 - CO_2 is more volatile than CS_2
32. Which of the following statements is not correct?
- K_2CO_3 can't be prepared by Solvay process because KHCO_3 is highly soluble in water.
 - Li^+ ionic mobility in aqueous phase $>$ Na^+ ionic mobility in aqueous phase.
 - Lithium is the strongest reducing alkali metal in aqueous phase.
 - KOH is used as absorber of CO_2 gas.
33. The largest number of hydrogens can be exchanged for deuterium when treated with KOD in D_2O by:
- 3-methyl-1,2-cycloheptanedione
 - 2-methyl-1,3-cycloheptanedione
 - 5-methyl-1,3-cycloheptanedione
 - 6-methyl-1,4-cycloheptanedione
34. *para*-Chloroaniline on treatment with acetic anhydride in pyridine yielded a mixture of 94% of *para*-chloroacetanilide, contaminated with 6% unreacted amine. Among the following, the best used methodology to purify the *para*-chloroacetanilide is to wash the solution of crude product in ether with:
- methyl iodide.
 - with concentrated brine (aq. NaCl).
 - with 5% aqueous sulfuric acid.
 - with 5% aqueous sodium carbonate.
35. The best reagent for converting the amide of 2-phenylpropanoic acid, $\text{C}_6\text{H}_5\text{CH}(\text{CH}_3)\text{CONH}_2$, into 1-amino-2-phenylpropane is:
- excess H_2 & Pt
 - NaOBr in aqueous base
 - NaBH_4 in methanol
 - LiAlH_4 in ether
36. Two isomeric hydrocarbons (X and Y) with molecular formula C_5H_8 undergo catalytic (Pt) hydrogenation to form hydrocarbon with molecular formula C_5H_{10} as the product. On ozonolysis followed by oxidative workup (H_2O_2), one isomer (X) gave a $\text{C}_5\text{H}_8\text{O}_4$ diacid, while the other isomer (Y) gave a $\text{C}_5\text{H}_8\text{O}_3$ ketoacid. X and Y respectively are:
- cyclopentene and 1-pentyne
 - cyclopentene and 1-methylcyclobutene
 - 1-methylcyclobutene and 3-methylcyclobutene
 - cyclopentene and 3-methylcyclobutene
37. The number of sp hybridized carbon atoms are present in 3-methyl-4-vinyl-1,2-heptadien-5-yne is:
- 2
 - 3
 - 4
 - 5
38. N-Bromosuccinimide (NBS) is a versatile reagent, commonly employed for allylic and benzylic bromination via free radical pathway. Reaction of 1-hexene with NBS forms two isomeric bromohexenes, one of which is 3-bromo-1-hexene. Among the following the other isomer is:
- 1-bromo-2-hexene
 - 6-bromo-1-hexene
 - 1-bromo-1-hexene
 - 2-bromo-1-hexene
39. The sequence of reagents which would be best suitable for the following conversion is:



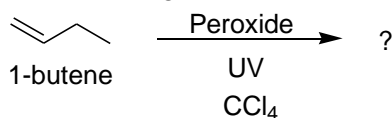
- PCC in CH_2Cl_2 and base
- (i) NaBH_4 ; (ii) H_3PO_4 & heat; (iii) Baeyer's reagent
- (i) NaBH_4 ; (ii) H_3PO_4 & heat; (iii) $\text{K}_2\text{Cr}_2\text{O}_7$
- (i) NaBH_4 ; (ii) Alkaline KMnO_4

40. Among the following, the best sequence of reactions suitable for the following conversion is:



- (a) (i) 2 equivalents of HBr, with peroxides, hydrolysis; (ii) addition of *tert*-butylmagnesium bromide in ether; (iii) hydrolysis; (iv) PCC in CH_2Cl_2
- (b) (i) 2 equivalents of HBr, with peroxides; (ii) NaBH_4 ; (iii) PBr_3 ; (iv) Mg in ether; (v) 2,2-dimethylpropanal, followed by hydrolysis
- (c) (i) Use of BH_3 in THF followed by the treatment of $\text{H}_2\text{O}_2/\text{HO}^-$; (ii) heated with 2,2-dimethylpropanal under alkaline medium; (iii) palladium on calcium carbonate (Pd/CaCO_3); (iv) PCC in CH_2Cl_2
- (d) (i) Using HgSO_4 , H_2SO_4 (aq.); (ii) addition of *tert*-butylmagnesium bromide in ether; (iii) hydrolysis workup; (iv) PCC in CH_2Cl_2

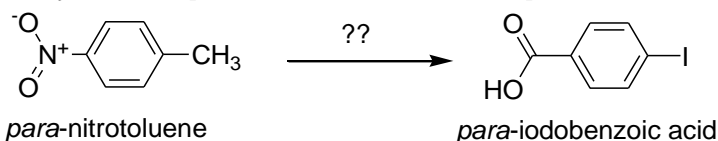
41. Consider the following reaction:



The major product formed and the correct intermediate involved with 1-butene in the given reaction is:

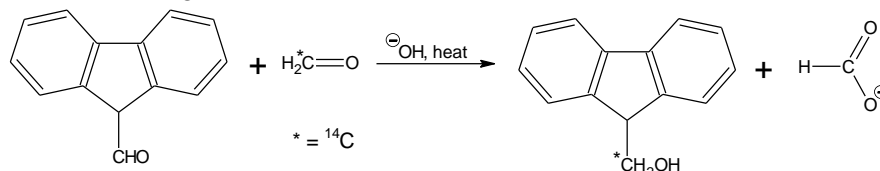
- (a) 1,1,1,3-tetrachloropentane; $\cdot\text{CCl}_3$ (b) 1,1,1,2-tetrachloropentane; $\cdot\text{Cl}$
- (c) 1-chloro-2-trichloromethylbutane; $(^+)\text{CCl}_3$ (d) 1,1-dichloro-2-ethylcyclopropane; $(^+)\text{Cl}$

42. The synthesis of *para*-iodobenzoic acid from *para*-nitrotoluene is performed using:



- (a) (i) $\text{Br}_2 + \text{FeBr}_2$ (ii) Mg in ether, then CO_2 (iii) 3H_2 & Pt or Ni catalyst (iv) HNO_2 0°C (v) KI solution
- (b) (i) NBS in CCl_4 & heat (ii) NaI in acetone (iii) 3H_2 & Pt or Ni catalyst (iv) HNO_2 0°C (v) H_3PO_2
- (c) (i) 3H_2 & Pt or Ni catalyst (ii) HNO_2 0°C (iii) $\text{Cu}_2\text{Br}_2 + \text{HBr}$ (iv) KMnO_4 & heat (v) KI solution
- (d) (i) KMnO_4 & heat (ii) 3H_2 & Pt or Ni catalyst (iii) HNO_2 0°C (iv) KI solution

43. Consider the following reaction:

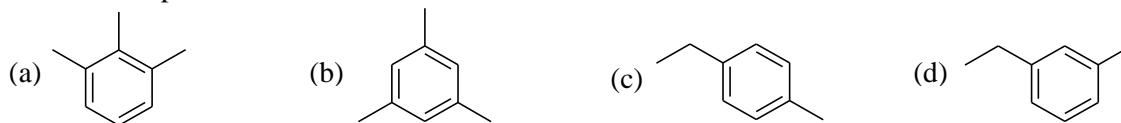


The correct statement among the following is:

- (a) Only 'Crossed Cannizaro' reaction will give the desired products.
- (b) Only 'Crossed Aldol' reaction will give the desired products.
- (c) 'Crossed Cannizaro' reaction followed by 'Crossed Aldol' reaction will give the desired products.
- (d) 'Crossed Aldol' reaction followed by 'Nucleophilic Substitution' reaction will give the desired products.

44. A hazardous environmental pollutant ('X'), consists of 44.8% carbon, 1.25% hydrogen, and 44.0% chlorine. The empirical formula of 'X' is:
 (a) $C_{10}H_8O_4Cl_4$ (b) $C_{12}H_6O_2Cl_4$ (c) $C_6H_2OCl_2$ (d) $C_{10}H_6OCl_4$

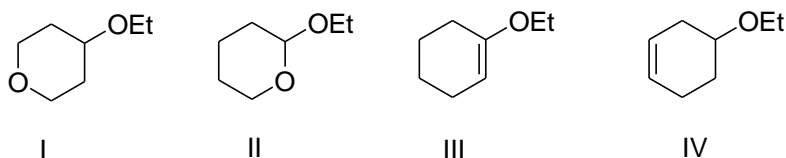
45. From the following the compound which will give a single mono sulphonic acid as the product upon aromatic electrophilic sulfonation is:



46. The amino acids that will exhibit three neutralization points each, when titrated against NaOH separately are:

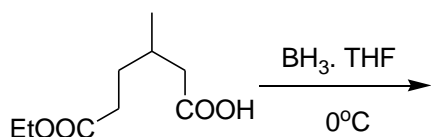
- (a) Valine and Isoleucine (b) Alanine and Valine
 (c) Arginine and Aspartic acid (d) Aspartic acid and Leucine

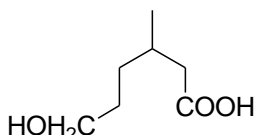
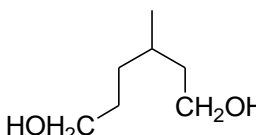
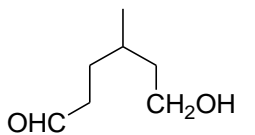
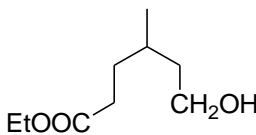
47. The structures of four ethyl ethers are shown below. Two of them undergo cleavage by aqueous acid significantly more readily than the other two. Which of these ethers are more easily hydrolyzed?



- (a) I and II (b) II and III (c) III and IV (d) I and IV

48. Predict the product of the following reaction?



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

A – 2

ANY NUMBER OF OPTIONS (4, 3, 2 or 1) MAY BE CORRECT
MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT.

49. Winkler method is one of the most accurate methods for measuring the concentration of Dissolved Oxygen (DO) in water. Mn^{2+} is rapidly oxidised to Mn^{3+} under alkaline conditions by dissolved oxygen, producing a pale brown precipitate of $\text{Mn}(\text{OH})_3$.
25.0 mL of a sample of river water is shaken with excess alkaline Mn^{2+} , and the resulting pale brown precipitate is then reacted with an excess of potassium iodide, which is oxidised to iodine. 25.0 mL of 0.001 M sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) solution was used in the titration to estimate the iodine released (iodometric titration).

Which of the following options is/are correct?

- (a) The reactions involved in the oxidation of $\text{Mn}(\text{OH})_2$ to $\text{Mn}(\text{OH})_3$ is

$$4\text{Mn}(\text{OH})_2 + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{Mn}(\text{OH})_3\downarrow$$
- (b) The oxidation of KI by $\text{Mn}(\text{OH})_3$ is given by

$$\text{Mn}(\text{OH})_3 + \text{KI} \rightarrow \frac{1}{2} \text{I}_2 + \text{Mn}(\text{OH})_2 + \text{KOH}$$
- (c) 1 mole of sodium thiosulphate requires 2 mol of iodine during the titration.
- (d) The concentration of the dissolved oxygen in the given sample is 8 mg L^{-1}
50. Human blood contains 0.1% by mass of glucose, the correct option/s is /are
- (a) Blood contains 1000 ppm of glucose.
 (b) The molality of glucose is $5.6 \times 10^{-3} \text{ m}$
 (c) Molarity of glucose cannot be calculated as the density of the blood is not known.
 (d) 0.1% glucose solution is isotonic with 0.1% urea solution (aq).
51. $[\text{Ni}(\text{CO})_4]$, $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{Ni}(\text{Cl})_4]^{2-}$ are the three complex species. Identify set of correct statement about them.
- (a) $[\text{Ni}(\text{CO})_4]$ and $[\text{Ni}(\text{CN})_4]^{2-}$ are diamagnetic while $[\text{Ni}(\text{Cl})_4]^{2-}$ is paramagnetic.
 (b) The metal-ligand bond is stronger in $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{Ni}(\text{Cl})_4]^{2-}$ as compared to the one in $[\text{Ni}(\text{CO})_4]$.
 (c) $[\text{Ni}(\text{CO})_4]$ is used in the purification of nickel.
 (d) $[\text{Ni}(\text{CO})_4]$ exhibits tetrahedral geometry while $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{Ni}(\text{Cl})_4]^{2-}$ exhibit square planer geometry.
52. In which of the following compound synergic bonding is found
- (a) $\text{Ni}(\text{CO})_4$ (b) $\text{Fe}_2(\text{CO})_9$ (c) $\text{BH}_3:\text{CO}$ (d) $\text{K}[\text{Pt}(\text{C}_2\text{H}_4)\text{Cl}_3]$
53. A water sample dose not lather with soap. When 10mL of this water sample is titrated against 0.01M Na_2EDTA solution using Eriochrome black T as indicator, 9.6mL concordant reading is obtained. When same sample is titrated against same Na_2EDTA solution and Calcon indicator, 5.5 mL burette reading is obtained. Water is boiled and then titrated as Na_2EDTA using Eriochrome black T, 4.3mL burette reading is obtained. Which of the following statement is/are correct? (Molar mass of CaCO_3 is 100g/mol)
- (a) Total hardness of the water is 960ppm of CaCO_3
 (b) Permanent hardness of the water sample is 430ppm of CaCO_3
 (c) Hardness due to Calcium ions is 410ppm of CaCO_3
 (d) Hardness of the water sample before boiling due to magnesium ions is 410ppm of CaCO_3 .
54. Which of the following statement/s is/are correct?
- (a) XeF_2 undergoes slow hydrolysis but more rapid in alkaline medium.
 (b) XeF_4 reacts violently with water, giving highly explosive solid
 (c) Xe reacts with fluorine in 1:5 ratios to give XeF_6
 (d) XeOF_4 is trigonal bipyramidal

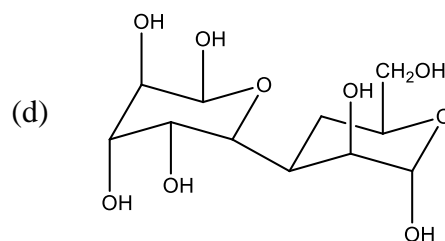
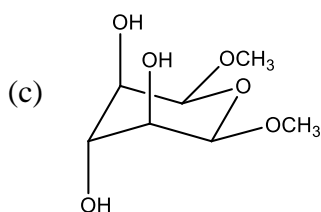
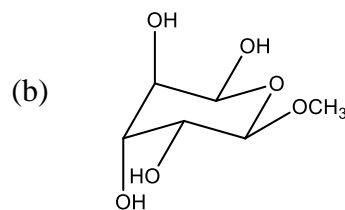
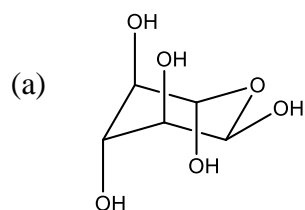
55. Correct decreasing order of different properties:

- (a) $K_{sp} :- Ba(OH)_2 > Sr(OH)_2 > Ca(OH)_2 > Mg(OH)_2 > Be(OH)_2$
 (b) Electronegativity : - $Be > Mg > Ca > Ba$
 (c) Heat of hydration : - $Be^{+2} > Sr^{+2} > Ca^{+2} > Ba^{+2}$
 (d) Basic strength : - $CsOH > LiOH > KOH$

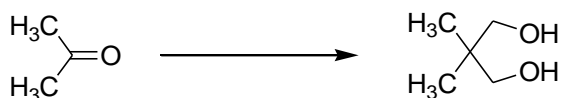
56. The possible product(s) formed when glucose is treated with alkali is/are:

- (a) Mannose
 (b) Fructose
 (c) Maltose
 (d) Glutaric acid

57. Which of the following compound(s) give positive Tollen's test?



58. Consider the following transformation:



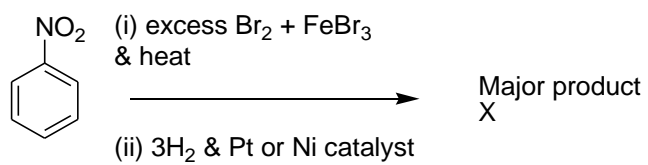
The correct route(s) to carry out the following conversion is:

- (a) (i) aq. NaHSO_3 , KCN ; (ii) $\text{H}_3\text{O}^{(+)}$, heat; (iii) LiAlH_4 in dry ether; (iv) $\text{H}_3\text{O}^{(+)}$, distilled; (v) $\text{CH}_2=\text{O}/\text{HO}^{(-)}$
 (b) (i) MeMgI in dry ether followed by addition of aq. NH_4Cl ; (ii) H_3PO_4 heat; (iii) Bayer's reagent; (iv) $\text{H}_3\text{O}^{(+)}$, distilled; (v) $\text{CH}_2=\text{O}/\text{HO}^{(-)}$
 (c) (i) Hydrazine, KOH , heat; (ii) $\text{CH}_2=\text{O}/\text{HO}^{(-)}$
 (d) (i) PCl_5 , heat; (ii) $\text{CH}_2=\text{O}/\text{HO}^{(-)}$

59. Which of the following procedure(s) is/are not feasible for preparing phenyl benzyl ether ($\text{C}_6\text{H}_5\text{OCH}_2\text{C}_6\text{H}_5$)?

- (a) $\text{C}_6\text{H}_5\text{Cl} + \text{C}_6\text{H}_5\text{CH}_2\text{O}^{(-)} \text{Na}^{(+)}$
 (b) $\text{C}_6\text{H}_5\text{O}^{(-)} \text{Na}^{(+)} + \text{C}_6\text{H}_5\text{CH}_2\text{Cl}$
 (c) $2 \text{C}_6\text{H}_5\text{Cl} + \text{Na}_2\text{O}$
 (d) $2 \text{C}_6\text{H}_5\text{MgBr} + \text{CH}_2\text{O}$

60. Identify the set of correct statement/s about the major product X formed in the following reaction sequence:



- (a) Molar mass of X is 251
- (b) X will consume two moles of acetic anhydride per mole for complete acetylation
- (c) X dissolves in 1:1 HCl
- (d) X is not an aromatic compound

1 IA 1A	2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 9	10 VIII 10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008	2 Li Lithium 6.941	3 Na Sodium 22.990	4 K Potassium 39.098	5 Rb Rubidium 84.468	6 Cs Cesium 132.905	7 Fr Francium 223.020	8 Be Beryllium 9.012	9 Mg Magnesium 24.305	10 Ca Calcium 40.078	11 Sc Scandium 44.956	12 Y Yttrium 88.906	13 B Boron 10.811	14 C Carbon 12.011	15 N Nitrogen 14.007	16 O Oxygen 15.999	17 F Fluorine 18.998	18 Ne Neon 20.180
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.09	35 Br Bromine 79.904	36 Kr Krypton 84.80
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium [98.907]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [209]	86 Rn Radon [222]
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium [289]	114 Ff Flerovium [289]	115 Uup Ununpentium [291]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]

Periodic Table of the Elements

Rough Work