

Max Mark: 70

Time: 3 Hours

General Instructions:

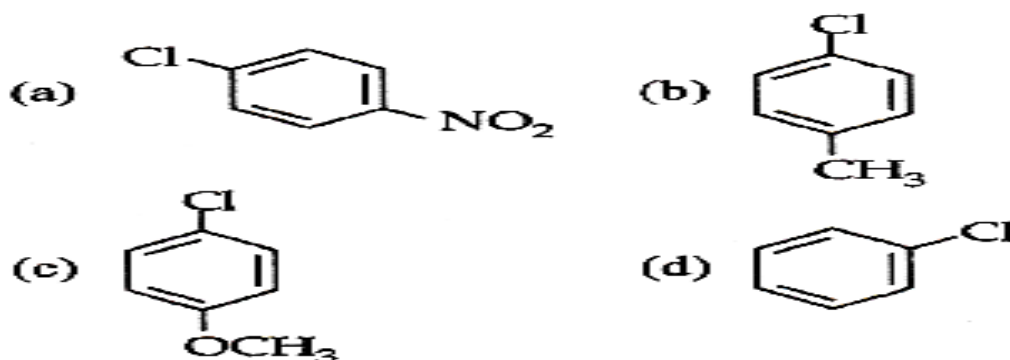
Read the following instructions carefully.

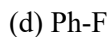
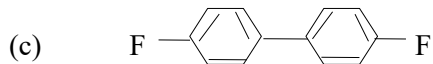
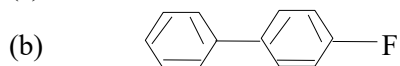
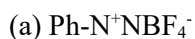
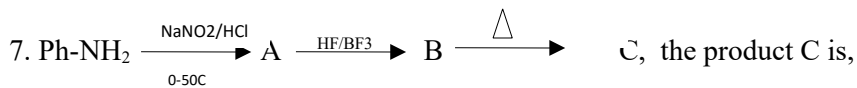
- (a) There are 33 questions in this question paper with internal choices.
 - (b) Section-A consists of 16 multiple-choice questions carrying 1 mark each.
 - (c) Section-B consists of 5 short answer questions carrying 2 mark each.
 - (d) Section-C consists of 7 short answer questions carrying 3 mark each.
 - (e) Section-D consists of 2 case-based questions carrying 4 mark each.
 - (f) Section-E consists of 3 long answer questions carrying 5 mark each.
 - (g) All questions are compulsory.
 - (h) Use of log table and calculator is not allowed.
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SECTION - A

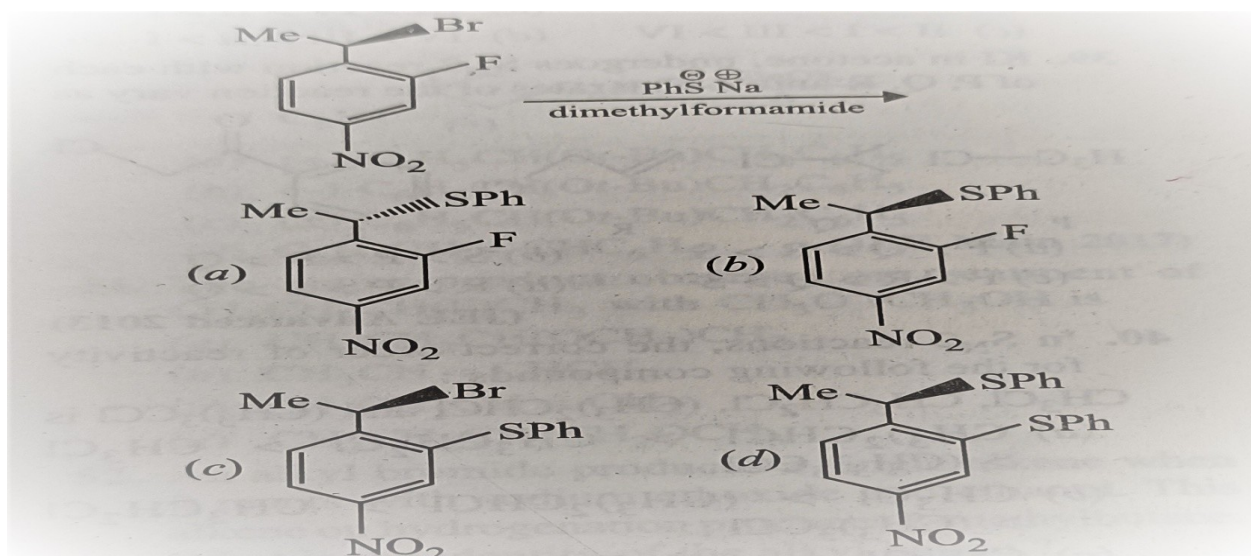
The following questions are multiple choice questions with one correct answer. Each question carries one mark. There is no internal choice in this section.

1. A 5.2 molal aqueous solution of methyl alcohol is supplied. What is the mole fraction of methyl alcohol in the solution?
(a) 0.190 (b) 0.086 (c) 0.050 (d) 0.100
2. Correct order of melting point is.
(a) Hg>Cd>Zn (b) Zn>Cd>Hg (c) Hg>Zn>Cd (d) Cd>Zn>Hg
3. The rise in the boiling point of a solution containing 1.8 g of glucose in 100 g of a solvent is 0.1°C . The molal elevation constant of the solvent is
(a) 1K/m (b) 10K/m (c) 0.01 K/m (d) 2731 K/m
4. Three faradays of electricity is passed through molten Al_2O_3 , aqueous solutions of CuSO_4 and molten NaCl . The amounts of Al, Cu and Na deposited at the cathodes will be in the molar ratio of
(a) 1:2:3 (b) 3:2:1 (c) 1:1.5:3 (d) 6:3:2
5. A 0.004 M solution of Na_2SO_4 is isotonic with a 0.010 M solution of glucose at the temperature. The apparent degree of dissociation of Na_2SO_4 is
(a) 25% (b) 50% (c) 75% (d) 85%
6. Which of the following compounds undergo nucleophilic substitution reaction most easily?





8. The major product of the following reaction is



9. The reaction of Lucas reagent is fast with

- (a) Ethanol (b) methanol (c) 2-propanol (d) 2-methyl-2-propanol

10. Phenol reacts with bromine in CS_2 to give

- (a) o-bromophenol (b) m-bromophenol (c) o- and p-bromophenol (d) 2,4,6-tribromophenol

11. Reaction of phenol with chloroform in presence of dilute sodium hydroxide finally introduces which one of the following functional groups

- (a) $-\text{COOH}$ (b) $-\text{CHCl}_2$
 (c) $-\text{CHO}$ (d) $-\text{CH}_2\text{Cl}$

12. $\Delta^0 \text{H}_2\text{O}$ is equal to

- (a) $\Delta^0_{\text{m}(\text{HCl})} + \Delta^0_{\text{m}(\text{NaOH})} - \Delta^0_{\text{m}(\text{NaCl})}$
 (b) $\Delta^0_{\text{m}(\text{HNO}_3)} + \Delta^0_{\text{m}(\text{NaNO}_3)} + \Delta^0_{\text{m}(\text{NaOH})}$
 (c) $\Delta^0_{\text{m}(\text{HNO}_3)} + \Delta^0_{\text{m}(\text{NaOH})} - \Delta^0_{\text{m}(\text{NaNO}_3)}$
 (d) $\Delta^0_{\text{m}(\text{NH}_4\text{OH})} + \Delta^0_{\text{m}(\text{HCl})} - \Delta^0_{\text{m}(\text{NH}_4\text{Cl})}$

13. Given below two statements are labelled as Assertion (A) and Reason (R)

Assertion (A): Alcohol react as both electrophile and nucleophiles.

Reason (R): The bond between C-O is broken when alcohol react as nucleophile.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true and R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) R is true but A is false.

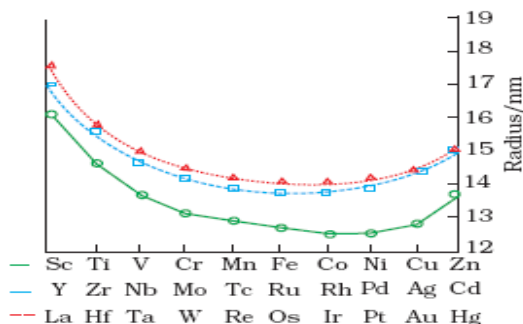
14. Given below two statements are labelled as Assertion (A) and Reason (R)

Assertion (A): Generally, transition elements form coloured salts due to the presence of unpaired electrons.

Reason (R): The d-d transition is possible, and spin of election remain same.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true and R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) R is true but A is false.

15. Given below two statements are labelled as Assertion (A) and Reason (R)



Assertion (A):

The above graph shows the trend of melting point of d-block.

Reason (R): The ionization energy is the energy required to remove and electron.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true and R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) R is true but A is false.

16. Given below two statements are labelled as Assertion (A) and Reason (R)

Assertion (A): During electrolysis of aqueous copper sulphate solution using copper electrode hydrogen gas is released at the cathode.

Reason (R): The electrode potential of Cu^{2+}/Cu is greater than that of H^+/H_2 .

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true and R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) R is true but A is false.

SECTION - B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type contain only 2 marks each.

17. (a) Arrange the following compounds in order of increasing dipole moment.
(I) Toluene (II) m-dichlorobenzene (III) o-dichlorobenzene (IV) p-dichlorobenzene
(b) Explain why electrophile aromatic substitution in haloarenes occurs slower and require more drastic condition as compared to those in benzene.
18. Arrange the following compounds in the increasing order of their property indicated:
p-Nitrophenol, ethanol, phenol (Acidic character)
or
Propanol, propane, propanal (boiling point)
19. Calculate the molality of H_2SO_4 if the density of 10% w/w aqueous solution of H_2SO_4 is 1.84 g/cm^3 .
20. Write equation and emf for Pb storage battery for charging .
21. Compare melting point 3d, 4d and 5d series and write the factors which affect melting point .

SECTION - C

This section contains 7 questions with internal choice in one question. The following questions are short answer type contain only 3 marks each.

22. Define Kohlrausch's Law. How can it be used to find the degree of dissociation of a weak electrolyte?

Or

Define molar conductivity. Express the relationship between degree of dissociation of an electrolyte and its molar conductivities.

23. Explain why electrolysis of an aqueous solution of NaCl gives H_2 at cathode and Cl_2 at anode? Write overall reaction



24. Define the terms 'osmosis' and 'osmotic pressure'. What is the advantage of using osmotic pressure as compared to other colligative properties for the determination of molar masses of solutes in solution.
25. Define azeotropes. What type of azeotrope is formed by positive deviation from Raoult's law? Give an example.
26. Draw the structure and name the product formed if the following alcohols are oxidized. Assume that an excess of oxidizing agent is used.

- (a) 2-butanol (b) 2-methyl-1-propanol (c) butanol

27. Which of the following is the correct method for synthesizing methyl tert-butyl ether why?

- (i) $(\text{CH}_3)_3\text{CBr} + \text{NaOMe}$ (ii) $\text{CH}_3\text{Br} + \text{NaO tert bu}$

28. Match the following:

Column I (Catalyst)

- (i) Ni in presence of hydrogen
(ii) Cu_2Cl_2
(iii) V_2O_5
(iv) Finely Divided Iron
(v) $\text{TiCl}_4 + \text{Al}(\text{OH})_3$

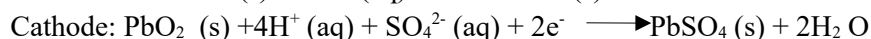
Column II (Process)

- (a) Ziegler Natta Catalyst
(b) Contact Process
(c) Vegetable oil to ghee
(d) Sandmeyer Reaction
(e) Haber's Process
(d) Decomposition of KClO_3

SECTION – D

The following questions are case-based questions. Each question has an internal choice and carries **4(1+1+2)** Marks each. Read the passage carefully and answer the questions that follow.

29. The lead-acid battery represents the oldest rechargeable battery technology. Lead acid batteries can be found in a wide variety of applications including small-scale power storage such as UPS systems, ignition power sources for automobiles, along with large, grid-scale power systems. The spongy lead act as the anode and lead dioxide as the cathode. Aqueous sulphuric acid is used as an electrolyte. The half-reactions during discharging of lead storage cells are: Anode: $\text{Pb(s)} + \text{SO}_4^{2-}(\text{aq}) \longrightarrow \text{PbSO}_4(\text{s}) + 2\text{e}^-$



There is no safe way of disposal and these batteries end - up in landfills. Lead and sulphuric acid are extremely hazardous and pollute soil, water as well as air. Irrespective of the environmental challenges it poses, lead-acid batteries have remained an important source of energy. Designing green and sustainable battery systems as alternatives to conventional means remains relevant. Fuel cells are seen as the future source of energy. Hydrogen is considered a green fuel. Problem with fuel cells at present is the storage of hydrogen. Currently, ammonia and methanol are being used as a source of hydrogen for fuel cell. These are obtained industrially, so add to the environmental issues. If the problem of storage of hydrogen is overcome, is it still a “green fuel?” Despite being the most abundant element in the Universe, hydrogen does not exist on its own so needs to be extracted from the water using electrolysis or separated from carbon fossil fuels. Both of these processes require a significant amount of energy which is currently more than that gained from the hydrogen itself. In addition, this extraction typically requires the use of fossil fuels. More research is being conducted in this field to solve these problems. Despite the problem of no good means to extract Hydrogen, it is a uniquely abundant and renewable source of energy, perfect for our future zero-carbon needs.

Answer the following questions:

- (a) How many coulombs have been transferred from anode to cathode in order to consume one mole of sulphuric acid during the discharging of lead storage cell?
- (b) How much work can be extracted by using lead storage cell if each cell delivers about 2.0 V of voltage?
(1 F = 96500 C)
- (c) Do you agree with the statement – “Hydrogen is a green fuel.” Give your comments for and against this statement and justify your views.

OR

- (d) Imagine you are a member of an agency funding scientific research. Which of the following projects will you fund and why?
- (i) safe recycling of lead batteries
(ii) extraction of hydrogen

30. Nucleophilic substitution reactions are of two types; substitution nucleophilic bimolecular ($\text{S}_{\text{N}}2$) and substitution nucleophilic unimolecular ($\text{S}_{\text{N}}1$) depending on molecules taking part in determining the rate of reaction. Reactivity of alkyl halide towards $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ reactions depends on various factors such as steric hindrance, stability of intermediate or transition state and polarity of solvent. $\text{S}_{\text{N}}2$ reaction mechanism is favoured mostly by primary alkyl halide or transition state and polarity of solvent, $\text{S}_{\text{N}}2$ reaction mechanism is favoured mostly by primary alkyl halide then secondary and then tertiary. This order is reversed in case of $\text{S}_{\text{N}}1$ reactions.

Answer the following questions:

(i) Which of the following is most reactive towards nucleophilic substitution reaction?

- (a) $\text{C}_6\text{H}_5\text{Cl}$ (b) $\text{CH}_2=\text{CHCl}$ (c) $\text{ClCH}_2\text{CH}=\text{CH}_2$ (d) $\text{CH}_3\text{CH}=\text{CHCl}$

(ii) Isopropyl chloride undergoes hydrolysis by

- (a) $\text{S}_{\text{N}}1$ mechanism (b) $\text{S}_{\text{N}}2$ mechanism
(c) $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ mechanism (d) neither $\text{S}_{\text{N}}1$ nor $\text{S}_{\text{N}}2$ mechanism

(iii) The most reactive nucleophile among the following is

- (a) CH_3O^- (b) $\text{C}_6\text{H}_5\text{O}^-$ (c) $(\text{CH}_3)_2\text{CHO}^-$ (d) $(\text{CH}_3)_3\text{CO}^-$

(iv) Tertiary alkyl halides are practically inert to substitution by $\text{S}_{\text{N}}2$ mechanism because of

- (a) insolubility (b) instability (c) inductive effect (d) steric hindrance

OR

Which of the following is the correct order of decreasing $\text{S}_{\text{N}}2$ reactivity?

- (a) $\text{RCH}_2\text{X} > \text{R}_2\text{CHX} > \text{R}_3\text{CX}$
(b) $\text{R}_3\text{CX} > \text{R}_2\text{CHX} > \text{RCH}_2\text{X}$
(c) $\text{R}_2\text{CHX} > \text{R}_3\text{CX} > \text{RCH}_2\text{X}$
(d) $\text{RCH}_2\text{X} > \text{R}_3\text{CX} > \text{R}_2\text{CHX}$

SECTION - E

The following questions are long answer type and carry 5 mark each. All questions have an internal choice.

31. (a) How the phenol is obtained from: (2)
(i) benzene sulphonic acid (ii) benzene diazonium chloride
(b) How it be converted into: (attempt any three) (3)
(i) aspirin (ii) phenyl salicylate (iii) P-hydroxybenzene (iv) phenyl benzoate
32. (a) State Kohlrausch law of independent migration of ions. (1)
(b) What is a primary battery? Write one example with the cell reaction. (1)
(c) Three electrolytic cells A, B and C containing electrolytes ZnSO_4 , AgNO_3 and CuSO_4 respectively connected in series. A steady current of 1.5 A was passed through them. 1.45 g of Ag were deposited at the cathode of cell B. (3)
(i) How long did the current flow
(ii) What mass of copper and zinc were deposited?

Or

Write the primary and confirmation test for Cl^- , S^{2-} .

33. Explain following:

- (a) Why on $\text{pH} > 7$ dichromate ion changes its colour from orange to yellow. (1)
(b) Write equation for following oxidation where $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$ used as oxidizing agent. (2)
(i) Sn^{2+} (ii) Fe^{2+} (iii) Sulphite
(c) Calculate Van't Hoff factor for an aqueous solution of $\text{K}_3[\text{Fe}(\text{CN})_6]$ if the degree of dissociation (α) is 0.852. What will be boiling point of this solution if its concentration is 1 molal? ($K_b = 0.52 \text{ K kg/mol}$) (2)

Or

- (a) What type of deviation from Raoult's Law is expected when phenol and aniline are mixed with each other? What change in the net volume of the mixture is expected? Graphically represent the deviation. (1)
(b) The vapor pressure of pure water at a certain temperature is 23.80 mm Hg. If 1 mole of a non-volatile non-electrolytic solute is dissolved in 100g water, Calculate the resultant vapour pressure of the solution. (2)
(c) Write 5 physical properties of d-block elements and explain it. (2)