

IIT-JEE-Chemistry-1998**Time :** 2 hrs.**Max. Marks :**100**Instructions**

1. This question paper is in two sections and contains eight pages. Section I has 40 objective type questions. Section II has 15 question. There are no negative marks for wrong answers.
2. Answer section I only on the printed form on the third page of the answer book.
3. Answer questions-problems of section II starting from page 4 of the answer book. All parts of a question must be answered sequentially at one place only.
4. Attempt all questions.
5. Answers must be written only in the language of your choice as shown in your admit card.
6. Use of logarithmic tables is permitted.
7. Use of slide rule/Calculator is not permitted.

Useful data :

Gas constant, $R = 0.082 \text{ litre atm K}^{-1} \text{ mol}^{-1}$
 $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
 $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

1 Faraday constant = 96.500 Coulombs mol^{-1}

SECTION I**Instructions :**

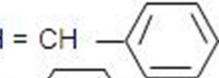
1. You must first transfer the Question Paper Code given on top of this section to your answer book in the appropriate box marked Question Paper Code.
2. Answer Section I only on the printed form on the third page of your answer book by writing the appropriate letters (A), (B), (C), (D) against the question number in the table. Answers for section I written in this space alone will be awarded marks.
3. Section I consists of 40 objective type questions.
4. This section should take about one hour to answer.
5. Each question in this section carries 2 marks.
6. Read questions 1 to 28 carefully and choose from amongst the alternatives given below each question the correct lettered choice(s). A question may have one or more correct alternatives. In order to secure any marks for a given question, all correct lettered alternative(s) must be chosen.

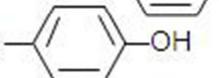
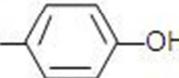
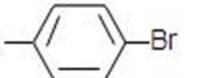
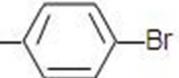
1. Which of the following statement(s) is(are) correct when a mixture of NaCl and $K_2Cr_2O_7$ is gently warmed with conc. H_2SO_4 :

- (A) A deep red vapour is evolved
- (B) The vapour when passed into NaOH solution gives a yellow solution of Na_2CrO_4
- (C) Chlorine gas is evolved
- (D) Chromyl chloride is formed.

2. Highly pure dilute solution of sodium in liquid ammonia :

- (A) Shows blue colour
- (B) exhibits electrical conductivity
- (C) produces sodium amide
- (D) produces hydrogen gas

3. The reaction $CH_3CH=CH-$  $-OH$ with HBr gives :

- (A) $CH_3CHBrCH_2-$  $-OH$ (B) CH_3CH_2CHBr-  $-OH$
- (C) $CH_3CHBrCH_2-$  $-Br$ (D) CH_3CH_2CHBr-  $-Br$

4. p-Chloroaniline and anilinium hydrochloride can be distinguished by:

- (A) Sandmeyer reaction
- (B) $NaHCO_3$
- (C) $AgNO_3$
- (D) Carbylamine test

5. The energy of an electron in the first Bohr orbit of H atom is -13.6 eV. The possible energy value(s) of the excited state(s) for electrons in Bohr orbits of hydrogen is(are) :

- (A) -3.4 eV
- (B) -4.2 eV
- (B) -6.8 eV
- (D) $+6.8$ eV

6. In nitroprusside ion the iron and NO exist as Fe^{II} and NO^+ rather than Fe^{III} and

NO. These forms can be differentiated by :

- (A) estimating the concentration of iron.
- (B) measuring the concentration of CN.
- (C) measuring the solid state magnetic moment.
- (D) thermally decomposing the compound.

7. Which of the following statement(s) is(are) correct :

- (A) The coordination number of each type of ion in CsCl crystal is 8.
- (B) A metal that crystallizes in bcc structure has a coordination number of 12.
- (C) A unit cell of an ionic crystal shares some of its ions with other unit cells.
- (D) The length of the unit cell in NaCl is 552 pm. ($r_{Na^+} = 95$ pm; $r_{Cl^-} = 181$ pm)

- 8.** Sodium nitrate decomposes above -8000C to give :
- (A) N_2 (B) O_2
(C) NO_2 (D) Na_2O
- 9.** Which of the following statement(s) is(are) correct with reference to the ferrous and ferric ions :
- (A) Fe^{3+} gives brown colour with potassium ferricyanide.
(B) Fe^{2+} gives blue precipitate with potassium ferricyanide.
(C) Fe^{3+} gives red colour with potassium thiocyanate.
(D) Fe^{2+} gives brown colour with ammonium thiocyanate.
- 10.** Which of the following statement(s) is(are) correct :
- (A) The electronic configuration of Cr is $[\text{Ar}] 3d^5 4s^1$. (Atomic Number of Cr = 24.)
(B) The magnetic quantum number may have a negative value.
(C) In silver atom, 23 electrons have a spin of one type and 24 of the opposite type. (Atomic Number of Ag = 47).
(D) The oxidation state of nitrogen in HN_3 is -3 .
- 11.** A new carbon-carbon bond formation is possible in
- (A) Cannizzaro reaction (B) Friedel-Crafts alkylation
(C) Clemmensen reduction (D) Reimer-Tiemann reaction
- 12.** White phosphorus (P_4) has :
- (A) six P-P single bonds (B) four P-P single bonds
(C) four lone pairs of electrons (D) PPP angle of 60° .
- 13.** Which of the following will react with water :
- (A) CHCl_3 (B) Cl_3CCHO
(C) CCl_4 (D) $\text{ClCH}_2\text{CH}_2\text{Cl}$
- 14.** The standard reduction potential values of three metallic cations, X, Y, Z are 0.52, -3.03 and -1.18V respectively. The order of reducing power of the corresponding metals is:
- (A) $Y > Z > X$ (B) $X > Y > Z$
(C) $Z > Y > X$ (D) $Z > X > Y$
- 15.** Among the following compounds, which will react with acetone to give a product containing $>\text{C} = \text{N} -$:
- (A) $\text{C}_6\text{H}_5\text{NH}_2$ (B) $(\text{CH}_3)_3\text{N}$
(C) $\text{C}_6\text{H}_5\text{NHC}_6\text{H}_5$ (D) $\text{C}_6\text{H}_5\text{NHNH}_2$
- 16.** Which of the following compounds will show geometrical isomerism:

- (A) 2-butene (B) propene
(C) 1-phenylpropene (D) 2-methyl-2-butene

17. The geometry and the type of hybrid orbital present about the central atom in BF_3 is:

- (A) linear, sp (B) trigona planar, sp^2
(C) tetrahedral, sp^3 (D) pyramidal, sp^3

18. Benzyl chloride ($\text{C}_6\text{H}_5\text{CH}_2\text{Cl}$) can be prepared from toluene by chlorination with :

- (A) SO_2Cl_2 (B) SOCl_2
(C) Cl_2 (D) NaOCl

19. Which of the following will undergo aldol condensation :

- (A) acetaldehyde (B) propanaldehyde
(C) benzaldehyde (D) trideuteroacetaldehyde

20. Addition of high proportions of manganese makes steel useful in making rails

- (A) gives hardness to steel.
(B) helps the formation of oxides of iron.
(C) can remove oxygen and sulphur
(D) can show highest oxidation state of +7.

21. Decrease in atomic number is observed during :

- (A) alpha emission
(B) beta emission
(C) positron emission
(D) electron capture.

22. Benzenediazonium chloride on reaction with phenol in weakly basic medium gives :

- (A) diphenyl ether
(B) p-hydroxyazobenzene
(C) chlorobenzene
(D) benzene

23. Among the following compounds, the strongest acid is:

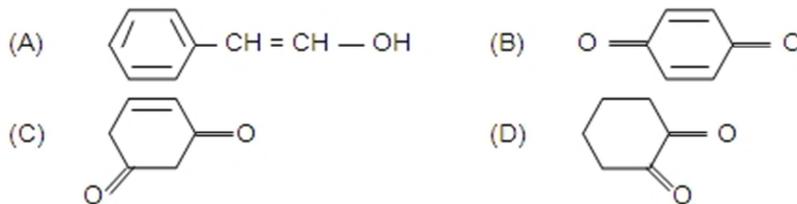
- (A) $\text{HC} \equiv \text{CH}$
(B) C_6H_6
(C) C_2H_6
(D) CH_3OH

24. For a first order reaction :

- (A) the degree of dissociation is equal to $(1 - e^{-kt})$.
(B) a plot of reciprocal concentration of the reactant vs. time gives a straight line.
(C) the time taken for the completion of 75% reaction is thrice the $t_{1/2}$ of the reaction.

(D) the pre-exponential factor in the Arrhenius equation has the dimension of time, T^{-1} .

25. Tautomerism is exhibited by:



26. According to Graham's law, at a given temperature the ratio of the rates of diffusion r_A/r_B of gases A and B is given by:

- (A) $(P_A / P_B) (M_A / M_B)^{1/2}$
 (B) $(M_A / M_B) (P_A / P_B)^{1/2}$
 (C) $(P_A / P_B) (M_B / M_A)^{1/2}$
 (D) $(M_A / M_B) (P_B / P_A)^{1/2}$

27. For the reaction $\text{CO(g)} + \text{H}_2\text{O(g)} \rightleftharpoons \text{CO}_2\text{(g)} + \text{H}_2\text{(g)}$ at a given temperature, the equilibrium amount of $\text{CO}_2\text{(g)}$ can be increased by:

- (A) adding a suitable catalyst
 (B) adding an inert gas
 (C) decreasing the volume of the container.
 (D) increasing the amount of CO(g) .

28. Which of the following statement(s) is(are) correct :

- (A) The pH of 1.0×10^{-8} M solution of HCl is 8.
 (B) The conjugate base of H_2PO_4^- is HPO_4^{2-} .
 (C) Autoprotolysis constant of water increases with temperature.
 (D) When a solution of a weak monoprotic acid is titrated against a strong base, at half-neutralisation point $\text{pH} = (1/2) \text{pK}_a$.

ASSERTION-REASON TYPE QUESTIONS

Directions : The questions below (29 to 40) consist of an assertion in column 1 and the reason in column 2. Against the specific question number, write in the appropriate space.

- (A) If both assertion and reason are correct, and reason is the correct explanation of the assertion.
 (B) If both assertion and reason are correct, but reason is not the correct explanation of the assertion.
 (C) If assertion is correct but reason is incorrect.
 (D) If assertion is incorrect but reason is correct.

Example :

Assertion

F-F bond in F₂ molecule is strong.
Answer : (D)

Reason

F atom is small in size.

29. Benzointrile is prepared by the reaction of chlorobenzene with potassium cyanide.

30. F atom has a less negative electron affinity than Cl atom.

31. Nuclide ³⁰Ai¹³ is less stable than ⁴⁰Ca²⁰.

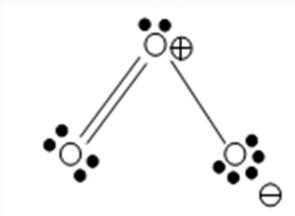
32. Al(OH)₃ is amphoteric in nature

33. The value of Van der Waals' constant 'a' is larger for ammonia than for nitrogen.

34. Zn²⁺ is diamagnetic.

35. Addition of Br₂ to 1-butene gives two optical isomers.

36. The electronic structure of O₃ is



37. LiCl is predominantly a covalent

Cyanide (CN⁻) is a strong nucleophile.

Additional electrons are repelled more effectively by 3p electrons in Cl atom than by 2p electrons in F atom.

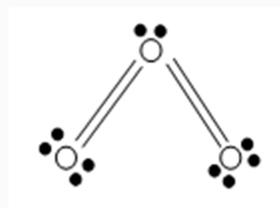
Nuclides having odd number of protons and neutrons are general unstable.

Al-O and O-H bonds can be broken with equal ease in Al(OH)₃.

Hydrogen bonding is present in ammonia.

The electrons are lost from 4s orbital to form Zn²⁺.

The product contains one asymmetric carbon.



structure is not allowed because octet around O cannot be expanded.

Electronegativity difference between Li and Cl is too small.

In HNO₃ there are two nitrogen-to-oxygen bonds whereas in HNO₂ there is only one.

compound.	Ionic radius of Mg^{2+} is smaller than that of Ba^{2+} .
38. HNO_3 is a stronger acid than HNO_2 .	Acetic acid has no alpha hydrogens.
39. Sulphate is estimated as $BaSO_4$ and not as $MgSO_4$.	
40. Acetic acid does not undergo haloform reaction.	

SECTION II

Instructions :

1. There are 15 questions in this section.
2. At the end of the answer to a question, leave 3 cm blank space, draw a horizontal line and start the answer to the next question. The corresponding question number must be written in the left margin. Answer all parts of a question at one place only.
3. The use of Arabic numerals (0, 1, 2,9) only is allowed in answering the questions irrespective of the language in which you answer.

1. (a) When the ore haematite is burnt in air with coke around $2000^{\circ}C$ along with lime, the process not only produces steel but also produces a silicate slag that is useful in making building materials such as cement. Discuss the same and show through balanced chemical equations.

(b) Draw the structure of a cyclic silicate, $(Si_3O_9)^{6-}$ with proper labeling.

(c) During the qualitative of a mixture containing Cu^{2+} and Zn^{2+} ions, H_2S gas is passed through an acidified solution containing these ions in order to test Cu^{2+} alone. Explain briefly.

2. (a) Thionyl chloride can be synthesized by chlorinating SO_2 using PCl_5 . Thionyl chloride is used to prepare anhydrous ferric chloride starting from its hexahydrated salt. Alternatively, the anhydrous ferric chloride can also be prepared from its hexahydrated salt by treating with 2, 2-dimethoxypropane. Discuss all this using balanced chemical equations.

(b) Reaction of phosphoric acid with $Ca_5(PO_4)_3F$ yields a fertilizer "triple superphosphate" Represent the same through balanced chemical equation.

3. (a) Complete and balance the following chemical equations.



(b) Work out the following using chemical equations.

(i) In moist air, copper corrodes to produce a green layer on the surface.

(ii) Chlorination of calcium hydroxide produces bleaching powder.

4. (a) An aqueous solution containing 0.10g KIO_3 (formula weight = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated I_2 consumed 45.0 mL of thiosulphate solution decolourise the blue starch-iodine complex. Calculate the molarity of the sodium thiosulphate solution.

(b) Calculate the equilibrium constant for the reaction, $2Fe^{3+} + 3I^- \rightleftharpoons 2Fe^{2+} + I_3^-$.

The standard reduction potentials in acidic conditions are 0.77 V and 0.54 V respectively for $Fe^{3+}|Fe^{2+}$ and $I_3^-|I_3^-$ couples.

5. (a) Interpret the non-linear shape of H_2S molecule and non-planar shape of PCl_3 using valence shell electron pair repulsion (VSEPR) theory. (Atomic numbers : H = 1; P = 15, S = 16; Cl = 17)

(b) Hydrogen peroxide acts both as an oxidizing and as a reducing agent in alkaline solution towards certain first row transition metal ions. Illustrate both these properties of H_2O_2 using chemical equations.

6. Give reasons for the following in one or two sentences.

(a) Acid catalysed dehydration of t-butanol is faster than that of n-butanol.

(b) The central carbon-carbon bond in 1, 3-butadiene is shorter than that of n-butane.

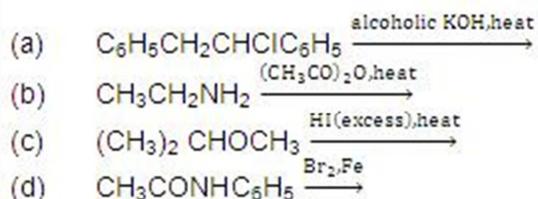
(c) Dimethylamine is a stronger base than trimethylamine.

(d) Nitrobenzene does not undergo Friedel-Crafts alkylation.

7. (a) An ester A ($C_4H_8O_2$), on treatment with excess methyl magnesium chloride followed by acidification, gives an alcohol B as the sole organic product. Alcohol B, on oxidation with $NaOCl$ followed by acidification, gives acetic acid. Deduce the structures of A and B. Show the reactions involved.

(b) An aldehyde A ($C_{11}H_{20}O$), which does not undergo self aldol condensation, gives benzaldehyde and two moles of B on ozonolysis. Compound B, on oxidation with silver ion gives oxalic acid. Identify the compounds A and B.

8. Each of the following reactions gives two products. Write the structures of the products.



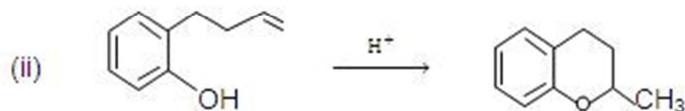
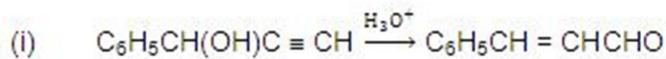
9. (a) Write the intermediate steps for each of the following reactions.

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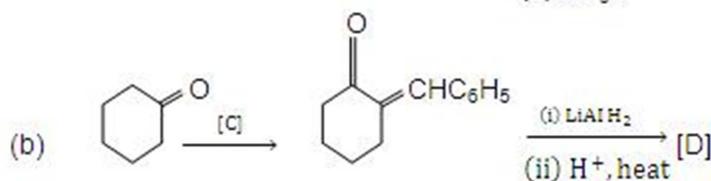
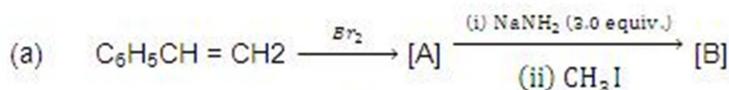


(b) Show the steps to carry out the following transformations.

(i) Ethylbenzene \rightarrow benzene

(ii) Ethylbenzene \rightarrow 2-phenylpropionic acid

10. Complete the following reactions with appropriate structures of products/reagents.



11. (a) A evacuated glass vessel weighs 50.0 g when empty, 148.0 g when filled with a liquid of density 0.98 mL^{-1} and 50.5 g when filled with an ideal gas at 760 mm Hg at 300 K. Determine the molar mass of the gas.

(b) From the following data, calculate the enthalpy change for the combustion of cyclopropane at 298 K. The enthalpy of formation of $CO_2(g)$, $H_2O(l)$ and propene (g) are -393.5 , -285.8 and $20.42 \text{ kJ mol}^{-1}$ respectively. The enthalpy of isomerisation of cyclopropane to propene is $-33.0 \text{ kJ mol}^{-1}$.

12. (a) The degree of dissociation is 0.4 at 400 K and 1.0 atm for the gaseous reaction $PCl_5 \rightleftharpoons PCl_3 + Cl_2$. Assuming ideal behaviour of all the gases, calculate the density of equilibrium mixture at 400 K and 1.0 atmosphere. (Relative atomic mass of P = 31.0 and Cl = 35.5)

(b) Given : $Ag(NH_3)_2^+ \rightleftharpoons Ag^+ + 2NH_3$, $K_c = 6.2 \times 10^{-8}$ and K_{sp} of $AgCl = 1.8 \times 10^{-10}$ at 298 K. If ammonia is added to a water solution containing excess of $AgCl(s)$ only, calculate the concentration of the complex in 1.0 M aqueous ammonia.

13. (a) Using Van der Waal's equation, calculate the constant, 'a' when two moles of a gas

confined in a four litre flask exert a pressure of 11.0 atmospheres at a temperature of 300 K. The value of 'b' is 0.05 L mol^{-1} .

(b) A solution of a non-volatile solute in water freezes at -0.300°C . The vapour pressure of pure water at 298K is 23.51 mm Hg and K_f for water is 1.86 Kg mol^{-1} . Calculate the vapour pressure of this solution at 298 K.

14. (a) The rate constant of a reaction is $1.5 \times 10^7 \text{ s}^{-1}$ at 500°C and $4.5 \times 10^7 \text{ s}^{-1}$ at 1000°C . Evaluate the Arrhenius parameters A and E_a .

(b) For the reaction, $\text{N}_2\text{O}_5(\text{g}) = 2\text{NO}_2(\text{g}) + 0.5 \text{O}_2(\text{g})$, calculate the mole fraction $\text{N}_2\text{O}_5(\text{g})$ decomposed at a constant volume and temperature, if the initial pressure is 600 mm Hg and the pressure at any time is 960 mm Hg. Assume ideal gas behaviour.

15. (a) Find the solubility product of a saturated solution of Ag_2CrO_4 in water at 298K if the emf of the cell $\text{Ag} | \text{Ag}^+(\text{satd. Ag}_2\text{CrO}_4 \text{ soln.}) || \text{Ag}^+(0.1\text{M}) | \text{Ag}$ is 0.164 V at 298 K.

(b) What will be the resultant pH when 200 mL of an aqueous solution of HCl (pH = 2.0) is mixed with 300 mL of an aqueous solution of NaOH (pH = 12.0)?