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FOR KUET EXAM PREPARATION

# KUET 2021 Question Paper · M.Sc. Chemistry

| EXAM | YEAR | TYPE | SUBJECT |
| --- | --- | --- | --- |
| KUET | 2021 | Question Paper | M.Sc. Chemistry |

Sr. No. .....

# ENTRANCE TEST-2021

## SCHOOL OF PHYSICAL & MATHEMATICAL SCIENCES

## CHEMISTRY

**Question Booklet Series** **A**

**Total Questions : 60**
**Time Allowed : 70 Minutes**

**Roll No. :** | | | | | | |

**Instructions for Candidates :**

1. Write your Entrance Test Roll Number in the space provided at the top of this page of Question Booklet and fill up the necessary information in the spaces provided on the OMR Answer Sheet.
2. OMR Answer Sheet has an Original Copy and a Candidate's Copy glued beneath it at the top. While making entries in the Original Copy, candidate should ensure that the two copies are aligned properly so that the entries made in the Original Copy against each item are exactly copied in the Candidate's Copy.
3. All entries in the OMR Answer Sheet, including answers to questions, are to be recorded in the Original Copy only.
4. Choose the correct / most appropriate response for each question among the options A, B, C and D and darken the circle of the appropriate response completely. The incomplete darkened circle is not correctly read by the OMR Scanner and no complaint to this effect shall be entertained.
5. Use only blue/black ball point pen to darken the circle of correct/most appropriate response. In no case gel/ink pen or pencil should be used.
6. Do not darken more than one circle of options for any question. A question with more than one darkened response shall be considered wrong.
7. There will be **'Negative Marking'** for wrong answers. Each wrong answer will lead to the deduction of 0.25 marks from the total score of the candidate.
8. Only those candidates who would obtain positive score in Entrance Test Examination shall be eligible for admission.
9. Do not make any stray mark on the OMR sheet.
10. Calculators and mobiles shall not be permitted inside the examination hall.
11. Rough work, if any, should be done on the blank sheets provided with the question booklet.
12. OMR Answer Sheet must be handled carefully and it should not be folded or mutilated in which case it will not be evaluated.
13. Ensure that your OMR Answer Sheet has been signed by the Invigilator and the candidate himself/herself.
14. At the end of the examination, hand over the OMR Answer Sheet to the invigilator who will first tear off the original OMR sheet in presence of the Candidate and hand over the Candidate's Copy to the candidate.



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1. What is correct for $ClF_3$ molecule ?

   (A) It has 2 axial lone pairs

   (B) It has two equatorial lone pairs

   (C) It has all fluorine's of equal bond length

   (D) It has one axial and one equatorial lone pair

2. Match these compounds with their right geometries ?

   (a) $Ni(CO)_4$ (I) Tetrahedral

   (b) $ICl_2^-$ (II) Linear

   (c) $ICl_4^-$ (III) Square Planar

   (d) FClO (IV) Bent

   (e) $FClO_3$

| | (a) | (b) | (c) | (d) | (e) |
|---|---|---|---|---|---|
| (A) | (III) | (II) | (I) | (II) | (III) |
| (B) | (III) | (II) | (I) | (III) | (II) |
| (C) | (I) | (II) | (III) | (IV) | (I) |
| (D) | (I) | (II) | (III) | (IV) | (III) |

3. Assuming the energy difference between 4s and 3d orbitals to be small, the exchange energy for Cr as $4s^2\,3d^4$ and $4s^1\,3d^5$ will correspond to :

   (A) 6 and 15 exchanges respectively

   (B) 15 and 10 exchanges respectively

   (C) 6 and 10 exchanges respectively

   (D) 10 and 15 exchanges respectively

4. Which of the following sandwich compounds can be a good one electron oxidizing agent ?

   (A) Ferrocene

   (B) Cobaltocene

   (C) Manganocene

   (D) Nickelocene

5. Match up the following acids to the basicities. Which pairing is correct ?

   (A) Phosphoric acid; dibasic

   (B) Phosphinic acid; monobasic

   (C) Phosphonic acid; monobasic

   (D) Phosphorous acid is monobasic

6. All of the following, except one, are radicals. Which is diamagnetic ?

   (A) $NO_2$

   (B) NO

   (C) FNO

   (D) $NF_2$

7. Find the incorrect match among the following :

   (A) Zinc(II); Carbonic anhydrase

   (B) Iron transport; Ferritin

   (C) Cadmium toxicity; Metallothoniens

   (D) Cytochrome 450; monooxygenase

8. On structural analogy to hydrogen peroxide, peroxosulphuric acids: Caro's and Marshall's can be considered as :

   (A) Completely analogous to $H_2O_2$

   (B) Caro's as monosulphonic derivative of $H_2O_2$

   (C) Marshall's as monosulphonic derivative of $H_2O_2$

   (D) Caro's as disulphonic derivative of $H_2O_2$

9. Which of the following non metal systems shows electrical anisotropy with a possible superconductivity application around 0.26K ?

   (A) Phosphonitrilic halides

   (B) Polyphosphazenes

   (C) Polythiazyls

   (D) Polyphosphates

10. Match the Boron compounds to their structure :

| | | | |
|---|---|---|---|
| (I) | $B_7H_7^{2-}$ | (i) | closo |
| (II) | $B_9H_{15}$ | (ii) | nido |
| (III) | $B_6H_{10}$ | (iii) | arachno |
| (IV) | $B_6H_{12}$ | | |

| | (I) | (II) | (III) | (IV) |
|---|---|---|---|---|
| (A) | (i) | (ii) | (iii) | (i) |
| (B) | (i) | (iii) | (ii) | (iii) |
| (C) | (iii) | (ii) | (i) | (iii) |
| (D) | (ii) | (i) | (i) | (iii) |

11. The soft sulphur donor ligands can stabilize which of the following uncommon transition metal oxidation states ?

(A) $Fe^{2+}$

(B) $Cu^{+}$

(C) $Co^{3+}$

(D) $Cu^{3+}$

12. Which isotope is produced by an (n, ?) reaction starting from $^{230}Th$ ?

(A) $^{229}Th$

(B) $^{229}Ac$

(C) $^{231}Th$

(D) $^{231}Pa$

13. In the coordination chemistry of Ln(III) centres, bulky amido ligands are used to stabilize :

(A) high coordination numbers (>10)

(B) coordination numbers of 6 to 8

(C) coordination numbers of 8 to 10

(D) low coordination numbers (<6)

14. As a comparative property of 3d,4d and 5d transition metals which of these is incorrect ?

(A) $[MnO_4]^-$ is very strong oxidizing agent compared to $[TcO_4]^-$ and $[ReO_4]^-$

(B) The metal bonding strength of group 8 dimers is $[Mn_2Cl_8]^{2-} > [Tc_2Cl_8]^{2-} > [Re_2Cl_8]^{2-}$

(C) $RuO_4$ is thermodynamically more stable than $FeO_4$

(D) The kinetic inertness of coordination compounds follows the order $Cr^{3+} > Mo^{3+} > W^{3+}$

15. Identify the correct match for Titrations as analytical methods :

| | (I) | | (II) |
|---|---|---|---|
| (i) | Xylenol orange | (a) | Acid Base Titration |
| (ii) | Methyl Orange | (b) | Redox Titration |
| (iii) | Diphenylamine | (c) | Complexometric titrations |
| (iv) | Sodium chromate | (d) | Mohr Titration |

| | (i) | (ii) | (iii) | (iv) |
|---|---|---|---|---|
| (A) | (c) | (d) | (a) | (d) |
| (B) | (c) | (b) | (d) | (a) |
| (C) | (d) | (c) | (a) | (b) |
| (D) | (c) | (a) | (b) | (d) |

16. The volume of 0.1 M $AgNO_3$ required for precipitation of chloride ions present in 30 mL of 0.01 M solution of $[Cr(H_2O)_5Cl]Cl_2$, as silver chloride will be :

(A) 3 mL

(B) 4 mL

(C) 5 mL

(D) 6 mL



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17. Wilson's disease is related to :

(A) Hyper-accumulation of copper

(B) Deficiency of copper

(C) Hyper-accumulation of copper and is treated effectively with EDTA

(D) Hyper-accumulation of copper and is treated effectively with d- Penicillamine

18. For the ligands $F^-$, $NH_3$, $CN^-$ and CO, the correct order of their position in spectrochemical series will be :

(A) $F < CN^- < NH_3 < CO$

(B) $CO < NH_3 < F^- < CN^-$

(C) $F^- < NH_3 < CN^- < CO$

(D) $CN^- < NH_3 < CO < F^-$

19. Identify the correct statement about $[Ni(H_2O)_6]^{2+}$ and $[Cu(H_2O)_6]^{2+}$ :

(A) All Ni-O and Cu-O bond lengths of individual species are equal

(B) Ni-O(equatorial) and Cu-O(equatorial) are only equal

(C) All Ni—O bond lengths are equal whereas Cu—O (equatorial) bonds are shorter than Cu—O(axial) bonds

(D) All Cu—O bond lengths are equal whereas Ni—O (equatorial) bonds are shorter than Ni—O(axial) bonds

20. Which of the following possesses highest degree of aromatic character ?

(A) Cyclopentadienyl anion

(B) Pyrrole

(C) Furan

(D) Thiophene

21. Identify the most stable carbocation among the following :

(A) Ph+

(B) $CH_2=CH^+$

(C) $CH_3-C^+=O$

(D) $CH_3-CH_2^+$

22. Which of the following reaction intermediates is stereo-chemically unstable and rapidly inverts like ammonia ?

(A) Carbocations

(B) Carbanion

(C) Free-radicals

(D) Carbenes

23. The least stable conformer of cyclohexane is :

(A) Chair form

(B) Half chair form

(C) Twist boat form

(D) Boat form

24. What type of stereoisomers would you expect for the compound $CH_3CH(OH)CH(OH)CH_3$ ?

(A) A pair of enantiomers

(B) Two pair of enantiomers

(C) A pair of enantiomers and a meso-dia-stereoisomer

(D) A pair of enantiomers and a pair of dia-stereoisomers

25. Addition of HCl to 3-methyl-1-butene at $0^0C$ gives :

(A) 2-Choloro-3-methyl butane

(B) 2-Choloro-2-methyl butane

(C) Both (A) and (B)

(D) 40:60 mixture of (A) and (B)

26. The rate of Diels-Alder reaction of maleic anhydride is fastest with :

(A) 1.3 butadiene

(B) 2-methyl-1.3 butadiene

(C) 2,3 Dimethyl-1.3 butadiene

(D) Cyclopentadiene

27. Which of the following will undergo fastest $SN_2$ reaction ?

(A) Allyl halide

(B) Benzyl halide

(C) a halo acetone

(D) Ethyl halide

28. Friedal Craft's acylation of benzene in presence of $CH_3COCl/AlCl_3$ is an example of :

(A) Free radical substitution

(B) Nucleophilic substitution

(C) Electrophilic substitution

(D) Electrophilic addition

29. Aldol condensation does not take place between :

(A) Two moles of formaldehyde

(B) Two moles of acetaldehyde

(C) Two moles of acetone

(D) One mole of acetaldehyde and one mole of acetone

30. Which of the following is not correctly matched ?

(A) >C=O on Clemmenson' reduction yields $>CH_2$

(B) >C=O on Wolf Kishner reduction yields >CHOH

(C) -COCl on Rosenmunds reduction yields -CHO

(D) -C≡N on Stephen's reduction yields -CHO

31. Which of the following acids have lowest $pK_a$ value ?

(A) HCOOH

(B) $C_6H_5COOH$

(C) $CH_3COOH$

(D) $CH_3CH_2COOH$

32. The least basic amines among the following is :

(A) $C_6H_5NH_2$

(B) $(C_6H_5)_2NH$

(C) $CH_3NH_2$

(D) $(CH_3)_2NH$

33. $\tilde{\lambda}_{max}$ for the compound cyclopent-2-en-one :

(A) 245nm

(B) 202nm

(C) 320nm

(D) 340nm

34. The absorption band in the IR spectrum for -O-H is observed at the frequency of :

(A) 3000-2850 $cm^{-1}$

(B) 3550-3200 $cm^{-1}$

(C) 2260-2200 $cm^{-1}$

(D) 1660-1640 $cm^{-1}$

35. The chemical shift (d ) for aromatic proton in $^1$HNMR spectra is in the range :

(A) 5.5-6.5

(B) 4.2

(C) 7-8

(D) 10



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36. The total no peaks in the $^1H$ NMR spectra of the organic compound $CH_3CH_2CH_2$-OH will be :

(A) 3

(B) 5

(C) 4

(D) 6

37. The carbohydrate which serves as reserve glucose in body is :

(A) Sucrose

(B) Starch

(C) Glycogen

(D) Fructose

38. The sequence in which amino acids are arranged in protein is called its :

(A) Primary structure

(B) Secondary structure

(C) Tertiary structure

(D) Quaternary structure

39. Which among the following are not the essential molecules of life ?

(A) Proteins

(B) Carbohydrates

(C) Lipids

(D) Vitamins

40. The root mean square velocity of $SO_2$ molecule will become double its value at STP when the temperature is :

(A) 1192K

(B) 819 $^oC$

(C) 298K

(D) 40 $^oC$

41. As per the Maxwell distribution of molecular velocities, the fraction of total gas molecules which has acquired the most probable velocity will ———— with the decrease in temperature.

(A) Increase

(B) Decrease

(C) Remains constant

(D) Can't say without knowing the pressure

42. The number of atoms in each different cubic unit cells of monoatomic substances is :

(A) SC-1, BCC-2, FCC-4

(B) SC-8, BCC-9, FCC-14

(C) SC-1, BCC-9, FCC-3

(D) SC-2, BCC-3, FCC-4

43. Which liquid crystal phase has the least order and is most liquid-like ?

(A) Smectic liquid crystal

(B) Cholesteric liquid crystal

(C) Nematic liquid crystal

(D) Discotic liquid crystals

44. For the first-order reaction, after two average lives ($t_{av}$) , the concentration of reactant is reduced to _____. (Given $t_{av} = 1/k$, k being its rate constant)

(A) 25%

(B) 75%

(C) 100/e %

(D) $100/e^2$ %

45. For a reaction, $A(g) + 2B(g) \rightarrow C(g) + D(g)$, $dx/dt = k[A][B]$. The initial concentration of A and B are respectively 0.1 M and 0.2 M. Now if the concentration of A is reduced to 0.05 M and that of Y to 0.05 M, then the rate of reaction relative to the initial value would be :

(A) 1/6

(B) 1/8

(C) 1/12

(D) 1/200

46. The rate constant of a first order reaction at 27 °C is $10^{-3}$ $min^{-1}$. The temperature coefficient of this reaction is 2. What is the rate constant (in $min^{-1}$)at 17 °C for this reaction ?

(A) $10^{-3}$

(B) $5 \times 10^{-4}$

(C) $2 \times 10^{-3}$ $s^{-1}$

(D) $10^{-2}$ $s^{-1}$

47. Consider the following statements :

(1) Half life period of first order reaction is independent of the initial concentration of reactants

(2) The plot of rate of reaction vs concentration of reactant is a straight line with slope 2k for a unimolecular second order reaction

(3) A zero order reaction takes finite time for completion while the first order reaction would get completed in infinite time

Which of the above statement(s) is/are correct ?

(A) (1) and (2)

(B) (2) and (3)

(C) (1) and (3)

(D) (1), (2) and (3)

48. Which of the following photochemical reactions shows highest quantum yield ?

(A) Decomposition of HI

(B) Decomposition of HBr

(C) Formation of HBr from $H_2$ and $Br_2$

(D) Formation of HCl from $H_2$ and $Cl_2$

49. Which among the following plots are linear ? (a-x) is the concentration of reactant remaining after time, t :

(A) (a-x) vs t, for a first order reaction

(B) (a-x) vs t, for a half order reaction

(C) (a-x) vs t, for a second order reaction

(D) $(a-x)^{-1}$ vs t, for a second order reaction



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50. Strike out the INCORRECT statement(s) from the following ?

(1) H, U, w and q are all zero for expansion of an ideal gas under isothermal conditions

(2) The entropy change during an irreversible adiabetic process is zero

(3) Entropy is a state function

(A) (1) only

(B) (2) only

(C) (2) and (3)

(D) (1), (2) and (3)

51. Consider the following statements :

(1) For the $H_2O$ system, no. of degrees of freedom at its triple point is three

(2) Water expands on melting and has fusion curve with a positive slope

(3) No. of phases existing on a line in its phase diagram is two

Which of these statements is/are correct ?

(A) (1) and (3)

(B) (1) and (2)

(C) (2) only

(D) (3) only

52. When one mole of an ideal gas is heated to three times its initial temperature at constant volume, then the change in entropy would be :

(A) Zero

(B) $(R-C_v)\ln 3$

(C) $C_v \ln 3$

(D) $C_p \ln 3$

53. During the conductometric titration of an acid (placed in beaker) by an alkali (taken in burette), the plot between the conductance and volume of alkali added was found to initially decrease and followed by a constant value. Which of the following combinations would give such a plot ?

(A) Strong acid and strong base

(B) Weak acid and strong base

(C) Strong acid and weak base

(D) Weak acid and weak base

54. The standard Gibbs free energy of the electrochemical reaction

$$Cr_2O_7^{2-} + 2Fe + 14H^+ \rightarrow 2Cr^{3+} + 2Fe^{3+} + 7H_2O$$

is –793 kJ/mol. What would be the standard cell emf ? (Given F=96500 C $mol^{-1}$; R = 8.314 $JK^{-1}mol^{-1}$)

(A) +1.37 V

(B) +4.11 V

(C) + 2.74 V

(D) +2.05 V

55. What is the molar solubility(s) of $Al_2(SO_4)_3$ in terms of $K_{sp}$ ?

(A) $s = (K_{sp}/27)^{1/5}$

(B) $s = (K_{sp}/72)^{1/5}$

(C) $s = (K_{sp}/6)^{1/2}$

(D) $s = (K_{sp}/108)^{1/5}$

56. For $Cu^{2+}/Cu$, $E^o = 0.34V$ and for $Cu^{2+}/Cu^+$, $E^o = 0.15V$. The $E^o$ for the disproportionation of $Cu^+$ would be :

(A) –0.19V

(B) 0.19V

(C) 0.49 V

(D) 0.38V

57. Which of the following is the expression for Hamiltonian operator ?

(A) $\frac{-h^2}{8p^2m}\nabla^2 + V$

(B) $\frac{-h^2}{8p^2m}\nabla + V$

(C) $\frac{-h^2}{4p^2}\frac{\partial^2}{\partial x^2}$

(D) $\frac{-h^2}{4p^2}\frac{\partial^2}{\partial f^2} + V$

58. Which of the following is an eigenfunction of the operator $d^2/dx^2$ ?

(A) Cos(ax)

(B) $e^{ax}$

(C) Sin(ax)

(D) All of these

59. The selection rule for a vibrational transition in the simple harmonic oscillator is :

(A) $\Delta v = 0$

(B) $\Delta v = \pm 1$

(C) $\Delta v = \pm 2$

(D) $\Delta v = \pm 1, \pm 2, \pm 3$ etc

60. The frequency of the absorption of a rigid diatomic rotating molecule when it undergoes the rotational transition from j= 2 → j = 3 energy level will be :

(A) 3B

(B) 4B

(C) 6B

(D) 12B

## ROUGH WORK

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