

(To be filled up by the candidate by blue/black ball-point pen)

Roll No.

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Roll No.

(Write the digits in words) .....

Serial No. of OMR Answer Sheet .....

Day and Date .....

(Signature of Invigilator)

### INSTRUCTIONS TO CANDIDATES

(Use only **blue/black ball-point pen** in the space above and on both sides of the Answer Sheet)

1. Within 10 minutes of the issue of the Question Booklet, check the Question Booklet to ensure that it contains all the pages in correct sequence and that no page/question is missing. In case of faulty Question Booklet bring it to the notice of the Superintendent/Invigilators immediately to obtain a fresh Question Booklet.
2. Do not bring any loose paper, written or blank, inside the Examination Hall *except the Admit Card without its envelope*.
3. A separate Answer Sheet is given. *It should not be folded or mutilated. A second Answer Sheet shall not be provided. Only the Answer Sheet will be evaluated.*
4. Write your Roll Number and Serial Number of the Answer Sheet by pen in the space provided above.
5. **On the front page of the Answer Sheet, write by pen your Roll Number in the space provided at the top, and by darkening the circles at the bottom. Also, wherever applicable, write the Question Booklet Number and the Set Number in appropriate places.**
6. No overwriting is allowed in the entries of Roll No., Question Booklet No. and Set No. (if any) on OMR sheet and also Roll No. and OMR Sheet No. on the Question Booklet.
7. Any change in the aforesaid entries is to be verified by the invigilator, otherwise it will be taken as unfair means.
8. Each question in this Booklet is followed by four alternative answers. *For each question, you are to record the correct option on the Answer Sheet by darkening the appropriate circle in the corresponding row of the Answer Sheet, by ball-point pen as mentioned in the guidelines given on the first page of the Answer Sheet.*
9. For each question, darken only one circle on the Answer Sheet. If you darken more than one circle or darken a circle partially, the answer will be treated as incorrect.
10. *Note that the answer once filled in ink cannot be changed. If you do not wish to attempt a question, leave all the circles in the corresponding row blank (such question will be awarded zero mark).*
11. For rough work, use the inner back page of the title cover and the blank page at the end of this Booklet.
12. Deposit *only the OMR Answer Sheet* at the end of the Test.
13. You are not permitted to leave the Examination Hall until the end of the Test.
14. If a candidate attempts to use any form of unfair means, he/she shall be liable to such punishment as the University may determine and impose on him/her.

11P/206/30

**No. of Questions/प्रश्नों की संख्या : 150**

**Time/समय : 2½ Hours/घण्टे**

**Full Marks/पूर्णांक : 450**

**Note/नोट :** (1) Attempt as many questions as you can. Each question carries 3 marks. One mark will be deducted for each incorrect answer. Zero mark will be awarded for each unattempted question.

अधिकाधिक प्रश्नों को हल करने का प्रयत्न करें। प्रत्येक प्रश्न 3 अंक का है। प्रत्येक गलत उत्तर के लिए एक अंक काटा जाएगा। प्रत्येक अनुत्तरित प्रश्न का प्राप्तांक शून्य होगा।

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

यदि एकाधिक वैकल्पिक उत्तर सही उत्तर के निकट प्रतीत हों, तो निकटतम सही उत्तर दें।

1. The change in entropy when two moles of a monatomic perfect gas is compressed to half its volume and simultaneously heated to twice its initial temperature is

- (1)  $R \ln 2$                       (2)  $3R \ln 2$                       (3)  $5R \ln 2$                       (4)  $7R \ln 2$

2. A heat engine operates between 1000 K and 600 K. The heat discharged into the cold sink in a reversible process when 5 kJ of heat is supplied by the hot source, is

- (1) 2 kJ                      (2) 2.5 kJ                      (3) 3 kJ                      (4) 5.5 kJ

3. For which of the following processes  $q=0$ ,  $w=0$ ,  $\Delta U=0$  and  $\Delta H=0$ ?
- (1) Reversible isothermal process in a perfect gas
  - (2) Reversible adiabatic process in a perfect gas
  - (3) Adiabatic expansion of a perfect gas into vacuum
  - (4) Reversible constant-volume process in a perfect gas
4. The fugacity of a certain gas at 200 K and 50 bars is 25 bars. The difference of its chemical potential from that of a perfect gas in the same state is
- (1)  $200R \ln 25$
  - (2)  $200R \ln 2$
  - (3)  $-200R \ln 2$
  - (4)  $-200R \ln 25$
5. The entropy of mixing 1 mole of hexane with 1 mole of heptane at 298 K is  $11.4 \text{ JK}^{-1}$ . The Gibbs energy of mixing (assuming the solution to be ideal) is
- (1)  $-1.72 \text{ kJ}$
  - (2)  $-3.44 \text{ kJ}$
  - (3)  $1.72 \text{ kJ}$
  - (4)  $3.44 \text{ kJ}$
6. The number of degrees of freedom of the system
- $$\text{KClO}_3(s) \rightleftharpoons 2\text{KCl}(s) + 3\text{O}_2(g)$$
- is
- (1) zero
  - (2) one
  - (3) two
  - (4) three
7. The expression that relates the partial molar properties of the components in a mixture is known as
- (1) van't Hoff equation
  - (2) Gibbs-Duhem equation
  - (3) Duhem-Margules equation
  - (4) Raoult's law
8. For a very dilute electrolyte solution with  $\gamma_+ < 1$ ,  $\gamma_+$  should increase with increase in
- (1) solvent's density
  - (2) solvent's dielectric constant
  - (3) ionic strength
  - (4) cationic charge

9. Which of the following statements is *not* correct?

- (1)  $\Delta G_{\text{mix}}$  at constant temperature and pressure must be negative
- (2) Intermolecular interactions are negligible in an ideal solution
- (3) Solute-solute interactions are negligible in an ideally dilute solution
- (4) Activity coefficients are never negative

10. Which of the following statements is correct?

- (1) If  $\Delta G^\circ > 0$ , no amount of products can be obtained when the reaction is run at constant temperature and pressure
- (2) It is possible for the entropy of a closed system to decrease substantially in an irreversible process
- (3) In any closed system with  $P - V$  work only,  $G$  is always minimised at equilibrium
- (4)  $\Delta(TS) = T\Delta S + S\Delta T$

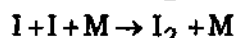
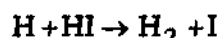
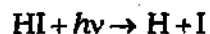
11. The condition for the attainment of phase-equilibrium in a closed electrochemical system is the equality of

- |                         |                                |
|-------------------------|--------------------------------|
| (1) surface potentials  | (2) electric potentials        |
| (3) chemical potentials | (4) electrochemical potentials |

12. The direction of a chemical reaction at constant temperature and pressure is the direction of

- (1) decrease of Gibbs free energy of the system
- (2) decrease of Helmholtz free energy of the system
- (3) increase of entropy of the system
- (4) decrease of enthalpy of the system

13. The quantum yield of the photochemical decomposition of HI



with respect to HI is

- (1) 0.5                      (2) 1                      (3) 1.5                      (4) 2
14. HI is absorbed strongly on gold. Assuming Langmuir isotherm to apply, the order of the reaction  $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$  on gold is
- (1) zero                      (2) 0.25                      (3) 0.5                      (4) 1
15. Which of the following statements is *not* correct for Langmuir isotherm?
- (1) It applies to monolayer adsorption
- (2) Under conditions  $\theta \ll 1$  and  $a$  (Freundlich exponent)  $\approx 1$ , it reduces to Freundlich isotherm
- (3) It applies to dissociative adsorption
- (4) It applies to chemisorption
16. The activation energy and entropy of a bimolecular gas phase reaction at 600 K are  $200 \text{ kJ mol}^{-1}$  and  $-200 \text{ J K}^{-1} \text{ mol}^{-1}$  respectively. The free energy of activation is
- (1)  $70 \text{ kJ mol}^{-1}$               (2)  $80 \text{ kJ mol}^{-1}$               (3)  $310 \text{ kJ mol}^{-1}$               (4)  $320 \text{ kJ mol}^{-1}$
17. Among the following statements which is the correct one?
- (1) The heat of chemisorption is always larger than that of physisorption
- (2) Langmuir isotherm specifically assumes the existence of active centres
- (3) Promoters are themselves catalysts
- (4) Increase in surface tension with concentration leads to negative adsorption

18. The activation energy of the gas-phase association between  $F_2$  and  $IF_5$ , a first-order reaction in each of the reactants, is  $58.6 \text{ kJ mol}^{-1}$ . The activation enthalpy at 340 K is

- (1)  $53 \text{ kJ mol}^{-1}$       (2)  $55.8 \text{ kJ mol}^{-1}$       (3)  $58.6 \text{ kJ mol}^{-1}$       (4)  $61.4 \text{ kJ mol}^{-1}$

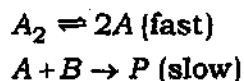
19. In a photochemical reaction  $A \rightarrow 2B + C$ , the quantum efficiency with 500 nm light is  $2 \times 10^2 \text{ mol einstein}^{-1}$ . After exposure of 300 m moles of A to the light, 2 m moles of B is formed. The number of photons absorbed by A is

- (1)  $1 \times 10^{18}$       (2)  $3 \times 10^{18}$       (3)  $6 \times 10^{18}$       (4)  $9 \times 10^{18}$

20. The condition for which the reaction rate of an enzymolysis that follows Michaelis-Menten kinetics, is half its maximum value, is

- (1)  $[S] \ll K_M$       (2)  $[S] = K_M$       (3)  $[S] = K_M / 2$       (4)  $[S] \gg K_M$

21. For the mechanism



the reaction order with respect to  $A_2$  is

- (1) 0      (2) 0.5      (3) 1      (4) 2

22. Which of the following relations does not hold for the activity (A) of a radioactive substance?

(1)  $\frac{A}{A_0} = \left(\frac{1}{2}\right)^{t/t_{1/2}}$

(2)  $\frac{A}{A_0} = \exp\left(-0.693 \frac{t}{t_{0.5}}\right)$

(3)  $t_{0.5} / t_{0.1} = \ln 2$

(4)  $\frac{A}{A_0} = 1 - 0.693 \frac{t}{t_{0.5}}$  at  $t \rightarrow 0$

23. A powder diffraction photograph from tungsten shows lines which indices as (110), (200), (211), (220), (310), (222), (321), (400), ... The symmetry of the unit cell is  
 (1) primitive            (2) end-centred        (3) face-centred        (4) body-centred
24. Among the following halides which one forms van der Waals crystals?  
 (1) NaCl                    (2) BeCl<sub>2</sub>                    (3) HgCl<sub>2</sub>                    (4) HF
25. A form of CaCO<sub>3</sub> (c) has orthorhombic lattice with  $a = 5.0 \text{ \AA}$ ,  $b = 8.0 \text{ \AA}$ ,  $c = 5.6 \text{ \AA}$  and density =  $3.0 \text{ gm cm}^{-3}$  at room temperature. The number of Ca<sup>2+</sup> ions per unit cell of the crystal is  
 (1) 1                            (2) 2                            (3) 4                            (4) 8
26. The ratio of the translational partition functions of D<sub>2</sub> and H<sub>2</sub> at the same temperature and volume is  
 (1) 2                            (2) 1.414                    (3) 2.83                    (4) 4
27. In which of the following systems is the energy level separation the largest?  
 (1) an electron in a radical in a field of 0.300 T  
 (2) a <sup>14</sup>N nucleus in 600 MHz NMR spectrometer  
 (3) a proton in the same spectrometer  
 (4) a deuteron in the same spectrometer
28. Which of the following functions is not an eigenfunction of  $\frac{d^2}{dx^2}$ ?  
 (1)  $\cos kx$                     (2)  $\exp(-kx^2)$                     (3)  $kx$                     (4)  $\exp(ikx)$
29. The ratio of mean molar masses of a given polymer sample as determined by light scattering, sedimentation and osmotic pressure measurement methods is  
 (1) 1:1:2                    (2) 2:1:2                    (3) 1:2:1                    (4) 2:2:1

30. In milk at 37 °C *Lactobacillus acidophilus* has a generation time of 75 minutes. What is the population relative to the initial value at 150 minutes?
- (1) 4.0                      (2) 2.25                      (3) 2.0                      (4) 1.75
31. If the pressure of a gas at constant temperature is doubled, the viscosity of the gas will be
- (1) quadrupled              (2) doubled                  (3) halved                      (4) unchanged
32. Among the following molecules which one shows pure rotation spectra?
- (1) N<sub>2</sub>                      (2) H<sub>2</sub>S<sup>1</sup>                      (3) CO<sub>2</sub>                      (4) CH<sub>4</sub>
33. The SI unit of radiation dose is
- (1) becquerel              (2) curie                      (3) rad                      (4) gray
34. It is found that a particle in a one-dimensional box of length of  $L$  can be excited to  $n = 2$  state from the ground state by the light of frequency  $\nu$ . If the box length is doubled, the frequency needed to produce the above transition becomes
- (1)  $\nu/4$                       (2)  $\nu/2$                       (3)  $2\nu$                       (4)  $4\nu$
35. For a hydrogen atom in an  $n = 4$  state, the maximum possible  $z$ -component of orbital angular momentum is
- (1)  $2\hbar$                       (2)  $3\hbar$                       (3)  $\sqrt{12}\hbar$                       (4)  $\sqrt{6}\hbar$
36. Which one of the following is an acceptable approximate wave function for a state of the helium atom?
- (1)  $[1s(1)1s(2) - 1s(1)1s(2)][\alpha(1)\beta(2)]$   
 (2)  $[1s(1)1s(2)][\alpha(1)\alpha(2) + \beta(1)\beta(2)]$   
 (3)  $[1s(1)2s(2) + 2s(1)1s(2)][\alpha(1)\alpha(2)]$   
 (4)  $[1s(1)2s(2) + 2s(1)1s(2)][\alpha(1)\beta(2) - \beta(1)\alpha(2)]$



37. Which one of the following statements concerning  $H_2^+$  is incorrect?
- (1) The non-degenerate LCAO—MOs (without spin) must be either symmetric or anti-symmetric for inversion
  - (2) The lowest energy MO (without spin) of the molecule is anti-symmetric for inversion
  - (3) The ground state has a multiplicity of two
  - (4) The MOs transform into AOs of the helium ion as the two nuclei are fused together
38. Which one of the following is the correct formula for the lowest energy eigenfunction for a particle in a one-dimensional box having infinite barriers at  $x = -L/2$  and  $L/2$ ?
- (1)  $\sqrt{\frac{2}{L}} \sin\left(\frac{\pi x}{L}\right)$
  - (2)  $\sqrt{\frac{2}{L}} \cos\left(\frac{\pi x}{L}\right)$
  - (3)  $\sqrt{\frac{2}{L}} \exp\left(\frac{i\pi x}{L}\right)$
  - (4)  $\sqrt{\frac{2}{L}} \exp\left(\frac{-i\pi x}{L}\right)$
39. Which of the following equations is used to calculate the number of theoretical plates?
- (1)  $\frac{t_R - t_0}{t_0}$
  - (2)  $16 \left(\frac{t_R}{W}\right)^2$
  - (3)  $\frac{k_2}{k_1}$
  - (4)  $2(t_{R_2} - t_{R_1}) / (W_1 + W_2)$
40. Which of the following techniques is based on selectively inducing radioactivity and measuring the emitted radiation?
- (1) Isotope dilution analysis
  - (2) Radiometric titration
  - (3) Neutron activation analysis
  - (4) All of the above

41. Which of the following techniques can be used only for volatile compounds?  
(1) Gas chromatography (2) HPLC  
(3) Ion chromatography (4) All of the above
42. Which of the following refers to ion exchange capacity?  
(1) Nature of exchanging ions  
(2) Nature of strong cation exchanger  
(3) Nature of strong anion exchanger  
(4) Total number of ion active groups per unit length of material
43. In electrogravimetry of cations the working electrode is  
(1) anode (2) cathode  
(3) both cathode and anode (4) neither anode nor cathode
44. Which of the following techniques is/are feasible approach in the determination of a substance that cannot be isolated in pure form for gravimetry or for determination by other methods?  
(1) Neutron activation analysis (2) Isotope dilution analysis  
(3) Radiometric titration (4) All of the above
45. Which of the following frequencies corresponds to carbonyl stretch vibration in acids?  
(1)  $1625\text{ cm}^{-1}$  (2)  $1715\text{ cm}^{-1}$  (3)  $1745\text{ cm}^{-1}$  (4)  $1800\text{ cm}^{-1}$
46. A particular vibration in a polyatomic molecule is IR active if during vibration, there is a change in  
(1) polarizability (2) dipole moment (3) frequency (4) potential energy

47. Moisture in a drug can be determined by

- (1) Malaprade reagent
- (2) EDTA reagent
- (3) Karl Fischer reagent
- (4) chloramine-T reagent

48. Which one is more toxic?

- (1) Hg
- (2)  $(\text{CH}_3)_2\text{Hg}$
- (3)  $\text{Hg}^{2+}$
- (4)  $\text{Hg}_2^{2+}$

49. The most efficient technique for the separation of amino acids is

- (1) adsorption chromatography
- (2) partition chromatography
- (3) ion-exchange chromatography
- (4) paper chromatography

50. Which one is not a pollutant?

- (1) CO
- (2)  $\text{CO}_2$
- (3)  $\text{SO}_3$
- (4)  $\text{NO}_2$

51. Which one is the sink of  $\text{CO}_2$ ?

- (1) Plant
- (2) Ocean
- (3) Air
- (4) Soil

52. Ozone layer is a protective shield against

- (1) visible light
- (2) ultraviolet light
- (3) infrared rays
- (4) cosmic rays

53. Nessler's reagent is

- (1)  $\text{KHgI}_4$
- (2)  $\text{K}_2\text{HgI}_4 + \text{NH}_4\text{OH}$
- (3)  $\text{K}_2\text{HgI}_4$
- (4)  $\text{KHgI}_4 + \text{NH}_4\text{OH}$

54. Which of the following statements is *not* correct?
- (1) In instrumental methods of analysis visual indicators are not required
  - (2) In classical volumetric titrations visual indications are not required
  - (3) In classical qualitative analysis removal of interfering radicals is essential
  - (4) Spectroanalytical techniques can be applied for qualitative and quantitative analysis
55. Visible region in the electromagnetic spectrum extends from
- (1) 200-400 nm
  - (2) 800-900 nm
  - (3) 400-4000  $\text{cm}^{-1}$
  - (4) 400-800 nm
56. Hard water can be softened in
- (1) a calorimeter
  - (2) a chromatograph
  - (3) an ion exchanger
  - (4) an earthen ware pot
57. The technique used for the separation of components of a mixture is called
- (1) chromatography
  - (2) IR spectroscopy
  - (3) electronic spectroscopy
  - (4) polarography
58. Essential constituent of an amalgam is
- (1) Ag
  - (2) Hg
  - (3) Mg
  - (4) Fe
59. Potential of which of the following electrodes does not depend on pH of the solution?
- (1) Glass electrode
  - (2) Hydrogen electrode
  - (3) Quinhydrone electrode
  - (4) calomel electrode

60. The unit of equivalent conductance is  
(1)  $\text{ohm}^{-1} \text{cm}^{-1}$  (2)  $\text{ohm}^{-1} \text{cm}^{-2}$   
(3)  $\text{ohm}^{-1} \text{cm}^2$  (4) None of the above
61. Which quantity remains unchanged on changing temperature?  
(1) Mole fraction (2) Molarity  
(3) Normality (4) None of the above
62. The strongest ligand in spectro-chemical series is  
(1)  $\text{F}^-$  (2)  $\text{OH}^-$  (3)  $\text{H}_2\text{O}$  (4)  $\text{CO}$
63. The iron is rusted, then it is  
(1) oxidized (2) reduced (3) evaporated (4) decomposed
64. Two elements cannot be combined chemically to make  
(1) a compound (2) another element  
(3) a gas (4) a liquid
65. Choose the law that states, "effective chemical changes are brought about by absorbed radiations only"  
(1) Beer's law (2) Grotthus-Draper law  
(3) Lambert's law (4) law of photochemical equivalence
66. What quantity of limestone on heating will give 56 kg of  $\text{CaO}$ ?  
(1) 10 kg (2) 55 kg (3) 44 kg (4) 100 kg

67. The unit of absorptivity is

- (1)  $\text{cm}^{-1} \text{g}^{-1} \text{L}$  (2)  $\text{cm}^{-1} \text{mol}^{-1} \text{L}$   
(3)  $\text{cm}^{-1} \text{g L}^{-1}$  (4) No unit

68. Oxine is a

- (1) precipitating reagent (2) redox reagent  
(3) drug (4) dye

69. Free radicals may be detected by

- (1) mass spectrometry (2) NMR spectroscopy  
(3) ESR spectroscopy (4) infrared spectroscopy

70. Lead can be the best analysed colorimetrically using which of the following reagents?

- (1) Dithizone (2) EDTA (3) DMG (4) Acetyl acetone

71. Which of the following is a hydride ion donor?

- (1) NAD (2) ATP (3) NADH (4) Coenzyme A

72. Na and K can be estimated using

- (1) X-ray fluorescence (2) IR spectroscopy  
(3) ion selective electrode (4) All of the above

73. How many mL of concentrated HCl (density = 1.18 g/mL, 36.0 wt % HCl, MW = 36.5) should be diluted to 1.00 L to produce a 0.100 M solution?

- (1) 8.59 mL (2) 85.9 mL (3) 0.859 mL (4) 17.18 mL

74. A  $1.00 \times 10^{-3}$  M solution of HCl includes  ${}^{36}_{17}\text{Cl}$  ( $t_{1/2} = 3.09 \times 10^5$  y). The specific activity (the activity per unit mass or unit volume) of the solution is  $5000 \text{ decays min}^{-1} \text{ mL}^{-1}$ . What fraction of Cl atoms in solution are  ${}^{36}\text{Cl}$  atoms?

- (1) 0.194                      (2) 0.0194                      (3) 1.940                      (4) 0.00194

75. A  $6.44 \times 10^{-4}$  M solution of Ti-peroxide complex had  $T = 0.340$  when measured in a 1.00 cm cell at 410 nm. What is the concentration of Ti-peroxide complex in a solution that had  $T = 0.516$  when measured at 410 nm in a 0.500 cm cell?

- (1)  $7.89 \times 10^{-2}$  M    (2)  $15.78 \times 10^{-2}$  M    (3)  $7.89 \times 10^{-4}$  M    (4)  $3.95 \times 10^{-3}$  M

76. The partition coefficient for ethyl iodide,  $E$ , between octanol and water is

$$K_p = \frac{[E]_o}{[E]_w} \approx 100$$

What percent of  $E$  present in 50.00 mL of water would remain if the water was extracted with 10.00 mL of octanol?

- (1) 47.6%                      (2) 4.76%                      (3) 9.52%                      (4) 95.2%

77. Arrange the ionization energies of the following ions in increasing order

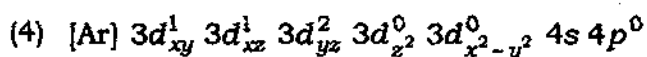
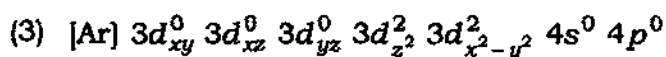
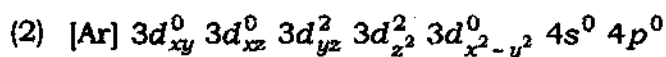
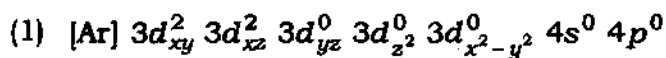
- (A)  $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$   
 (B)  $\text{Mn}^{2+} \rightarrow \text{Mn}^{3+}$   
 (C)  $\text{Fe}^{+1} \rightarrow \text{Fe}^{2+}$

Choices are

- (1)  $A < B < C$                       (2)  $C < B < A$                       (3)  $C < A < B$                       (4)  $B < C < A$

(At. No. of Fe and Mn are 26 and 25)

78. In the first row transition metal ion (2+) having four electrons in 3d orbitals (with 4s and 4p orbitals empty), the metal ion forms a hypothetical diamagnetic tetrahedral complex  $[MA_4]^{2-}$  with  $A^-$  anion. The electronic configuration of the  $M^{2+}$  ion in the complex is



79. Out of the following which has the least tendency to form M=O species?



(Ln = Lanthanides and Ac = actinides)

80. The magnetic properties of lanthanides are largely determined by the formula

(1)  $\mu_{\text{eff}} = \sqrt{n(n+2)}$

(2)  $\mu_{\text{eff}} = \sqrt{n(n+2)} + \text{some contribution of orbital contribution}$

(3)  $\mu_{\text{eff}} = \sqrt{L(L+2)}$

(4)  $\mu_{\text{eff}} = g_J \sqrt{J(J+1)}$ , where  $g_J = \frac{3}{2} + \frac{S(S+1) - L(L+1)}{2J(J+1)}$



81.  $\text{Ln}^{2+}$  ions are largely coloured while  $\text{Ln}^{3+}$  ions are not coloured. The colour of  $\text{Ln}^{2+}$  compounds are due to transition




- (1)  $4f \rightarrow 5d$
- (2)  $4f \rightarrow 4f$
- (3) charge transfer from ligand to metal ion
- (4)  $5d \rightarrow 5d$  transition

82. Transition metals (some ions) form complexes with molecular  $\text{N}_2$ . There are two modes of coordination of  $\text{N}_2$  in the complexes of the type  $[\text{M}(\text{N}_2)(\text{L})_n]$ . These modes are (a) end-on and (b) side-on. The stability of these complexes in these two modes is

- (1) end-on more stable than side-on
- (2) side-on more stable than end-on
- (3) both are highly unstable (the relative stability depends on ligands)
- (4) both are equally stable

(L = ligand)

83. The structure of hyponitrous acid molecule ( $\text{H}_2\text{N}_2\text{O}_2$ ) is

- (1) linear (A—B—C—D type)
- (2) bent (  type)
- (3) square planar (  type)
- (4) triangular (  type)

84. We have two complexes  $[\text{Mn}(\text{H}_2\text{O})_6]^{3+}$  ion ( $d^4$  system) and  $[\text{Re}(\text{H}_2\text{O})_6]^{3+}$  ion ( $d^4$  system). Their CFSE and the pairing energy (per pair of electrons) are given below

$$[\text{Mn}(\text{H}_2\text{O})_6]^{3+} - 10Dq = 250 \text{ kJ/mol; Pairing energy} = 300 \text{ kJ/mol}$$

$$[\text{Re}(\text{H}_2\text{O})_6]^{3+} - 10Dq = 400 \text{ kJ/mol; Pairing energy} = 180 \text{ kJ/mol}$$

Predict from their data, the complexes are

- (1) both high spin
- (2) Mn-high spin and Re-low spin
- (3) both low spin
- (4) Mn-low spin, Re-high spin



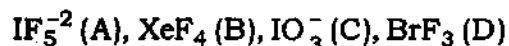
89. Although fluorine is better oxidizing agent than oxygen, but  $\text{Mn}_2\text{O}_7$  exists and  $\text{MnF}_7$  does not. This is because of

- (1) steric crowding and difficult to fitting seven fluoride ions around Mn center
- (2) very high electron affinity of fluorine as compared to oxygen
- (3) very low lattice energy of  $\text{MnF}_7$  compared to oxygen compound
- (4) very low bond energy of Mn—F bond compared to Mn—O bond

90. Covalent radius of gold (125 pm) is less than that of silver (133 pm). This is because of

- (1) transition metal contraction
- (2) lanthanide contraction
- (3) lack of shielding of  $4d$  orbitals compared to  $5d$  orbitals
- (4) relatively less effective shielding by  $3p$  and  $3s$  orbitals in silver as compared to that by  $4s$ ,  $4p$  and  $4d$

91. Using VSEPR model, the shape of the following molecules



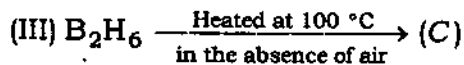
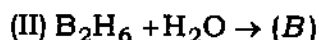
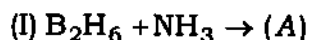
are

- (1) (A) pentagon shape, (B) square planar, (C) trigonal pyramid, (D) T-shape
- (2) (A) trigonal bipyramid, (B) tetrahedral, (C) planar, (D) planar
- (3) (A) square pyramid, (B) tetrahedral, (C) trigonal pyramid, (D) planar
- (4) (A) pentagonal pyramid, (B) tetrahedral, (C) trigonal pyramid, (D) planar

92. Arrange the hydrides of 15-group elements ( $\text{NH}_3, \text{PH}_3, \text{AsH}_3, \text{SbH}_3 < \text{BiH}_3$ ) in increasing contribution of  $p$ -orbital of X in the X—H bond. Choose the correct alternative from the following alternatives given below

- (1)  $\text{Bi} < \text{Sb} < \text{As} < \text{P} < \text{N}$  (2)  $\text{P} < \text{N} < \text{As} > \text{Bi} > \text{Sb}$   
 (3)  $\text{N} < \text{P} < \text{As} < \text{Sb} < \text{Bi}$  (4)  $\text{Bi} < \text{Sb} < \text{N} < \text{P} < \text{As}$

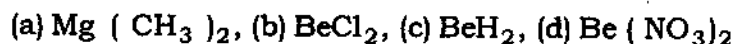
93. What are A, B and C in the following reactions?



Here A, B and C respectively are

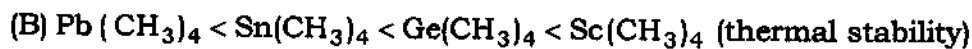
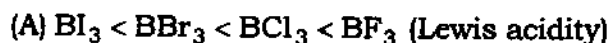
- (1) borazine,  $\text{B}_2\text{O}_3$  and  $\text{B}_4\text{H}_8$  (2)  $2\text{BH}_3 \cdot \text{NH}_3, \text{H}_3\text{BO}_3 + \text{H}_2, \text{B}_{10}\text{H}_{14}$   
 (3) BN,  $\text{H}_3\text{BO}_3$  only,  $\text{B}_4\text{H}_8$  (4) BN,  $\text{H}_3\text{BO}_3 + \text{H}_2, \text{B}_4\text{H}_8$

94. Which ones of the following contain  $(3c-2e)$  bonds?



- (1) (a), (b) and (c) (2) (a) and (c) (3) (a), (c) and (d) (4) (b) and (c)

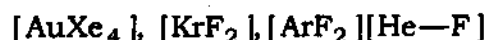
95. Which one of the following orders of two properties of 14- and 15-group elements is *not* correct?



The correct alternative from the following ones is

- (1) (B) (2) (A)  
 (3) No one is wrong (4) Both are wrong

96. Which ones of the following compounds do not exist?



Choose the correct choice out of the following

- (1)  $[\text{AuXe}_4]$  and  $[\text{He-F}]$                       (2)  $[\text{KrF}_2]$  and  $[\text{ArF}_2]$   
 (3)  $[\text{Ar-F}_2]_b$  and  $[\text{He-F}]$                       (4)  $[\text{ArF}_2][\text{He-F}]$ ,  $[\text{AuXe}_4]$

97. Alkalides and electriles are crystalline compounds of

- (1) alkali metals in (+1) oxidation states and electrons respectively  
 (2) alkali metals in (-1) oxidation states and electron acting as anion  
 (3) methyl group and electron acting as anion respectively  
 (4) methyl group and alkali metal group

98. Among the molecules,  $\text{BiF}_3$ ,  $\text{BiCl}_3$ ,  $\text{BiBr}_3$  and  $\text{BiI}_3$ , the one which is most coloured is

- (1)  $\text{BiF}_3$                       (2)  $\text{BiBr}_3$                       (3)  $\text{BiCl}_3$                       (4)  $\text{BiI}_3$

99.  $[\text{CrO}_8]^{3-}$  ion is known. This ion probably is

- (1) complex of peroxide ion with  $\text{Cr}^{5+}$  ion  
 (2) polymeric complex with oxide ion acting as bridges  
 (3) complex of molecular oxygen and oxide ion (e.g.  $\text{Cr}^{5+}(\text{O}_2)_2\text{O}_4]^{3-}$ )  
 (4) complex of molecular oxygen and peroxide ions

100. Iodine dissolves in oleum to give bright blue colour. The blue colour is due to the formation of A, where A is

- (1)  $\text{I}^-$  ion                      (2)  $\text{I}_3^-$  ion                      (3)  $\text{I}_2^+$  ion                      (4)  $\text{I}_4^+$  ion



- 105.** In borazine ( $B_3N_3H_6$ ) molecule, the number of isomers which are possible of its desubstituted borazine molecule of the formula  $[B_3N_3H_4X_2]$  without changing its ring structure is
- (1) one                      (2) two                      (3) four                      (4) six
- 106.** Solution of alkali metals in liquid  $NH_3$  conducts electricity. It is due to formation of
- (1)  $Na^+ + Na^-$  ion in liquid ammonia  
 (2)  $Na^+ + e^-(NH_3)_x$  in liquid ammonia  
 (3)  $Na^-$ ,  $(NH_2)^-$  and  $NH_4^+$  ion in liquid  $NH_3$   
 (4) The solution conducts like a metallic conductor with solvated electrons carrying the charge
- 107.** A compound alloy of metals P and Q has a unit cell containing P atoms at the corners, while atom Q are present at the face centers. The formula of the compound should be
- (1) PQ                      (2)  $PQ_2$                       (3)  $PQ_3$                       (4)  $P_3Q$
- 108.** A complex of a certain metal ion has a magnetic moment of 4.90 BM (4 unpaired electrons) and another complex of the same metal ion in the same oxidation state is diamagnetic. The complex is octahedral. The central metal could be one of the following
- $(Cr^{3+}, Mn^{2+}, Fe^{2+}, Mn^{3+}, Fe^{3+}, Co^{2+})$
- $Cr^{3+}$  ion is  $[Ar]4d^3$  system. The metal ion is
- (1)  $Mn^{2+}$                       (2)  $Fe^{2+}$                       (3)  $Co^{2+}$                       (4)  $Fe^{3+}$
- 109.** The enthalpy of hydration ( $\Delta H$ ) of  $Cr^{2+}$  [ $d^4$  system octahedral complex  $(Cr(H_2O)_6)^{2+}$ ] is  $-460$  kcal/mol. In the absence of CFSE, this value of  $\Delta H$  is  $(-435)$  kcal/mole. The value of  $10Dq$  (or  $\Delta_0$ ) is
- (1)  $14600\text{ cm}^{-1}$                       (2)  $21500\text{ cm}^{-1}$                       (3)  $9525\text{ cm}^{-1}$                       (4)  $25252\text{ cm}^{-1}$
- (1 kcal =  $350\text{ cm}^{-1}$ )

110. Which of the  $d^n$  ion will have the smallest CFSE if  $\Delta$  (or  $10Dq$ ) is greater than pairing energy  $d^6, d^7, d^8, d^9, d^{10}$ ?

- (1)  $d^6, d^{10}$                       (2)  $d^7, d^9$                       (3)  $d^{10}$                       (4)  $d^5, d^8, d^{10}$

111. During excessive physical stress (like running), the body makes A which reacts with water to form its conjugate base and B ions. These, in turn, lowers the pH in the muscles which causes pain in the muscles. Here A and B respectively are

- (1) citric acid and  $H_3O^+$                       (2) lactic acid and  $H_3O^+$   
 (3) enzyme and  $NH_4^+$                       (4) gluconic acid and  $NH_4^+$

112. Which ones of the following are closed packed structures?

- (a) AABB AABB... (b) ABAC ABAC... (c) AB AB AB... (d) ABC ABC ABC...

Choose the correct choice out of the following

- (1) a, b, c                      (2) a, c, d                      (3) b, c, d                      (4) b, c

113. Out of following actinides (I) Np, (II) Pu, (III) Es, (IV) Am one having +2 oxidation state as the only relatively important state is

- (1) Np                      (2) Pu                      (3) Es                      (4) Am

114. Which is not an ambident nucleophile?

- (1)  $CN^-$                       (2)  $SCN^-$                       (3)  $NO_2^-$                       (4) DMSO

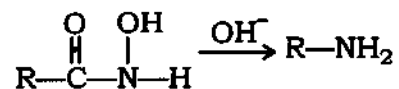
115. What is the increasing order of stability of following carbocations (give least stable first)?

- (I) Tropylium cation      (II)  $CH_2=CH-CH_2^+$       (III)  $(C_6H_5)_2C^+$       (IV)  $CH_3^+$

- (1) III < I < II < IV      (2) IV < II < III < I      (3) I < III < II < IV      (4) IV < III < II < I



116. The type of rearrangement



is

- (1) Lossen                      (2) Beckmann                      (3) Schmidt                      (4) Curtius

117. What is the nucleophilicity order for  $S_N2$  reaction?

- (I)  $\text{C}_6\text{H}_5\text{S}^-$                       (II)  $\text{C}_2\text{H}_5\text{O}^-$                       (III)  $\text{NO}_3^-$                       (IV)  $\text{CN}^-$   
 (V)  $\text{I}^-$

- (1)  $\text{V} > \text{II} > \text{IV} > \text{I} > \text{III}$                       (2)  $\text{III} > \text{IV} > \text{V} > \text{II} > \text{I}$   
 (3)  $\text{I} > \text{IV} > \text{V} > \text{II} > \text{III}$                       (4)  $\text{II} > \text{IV} > \text{V} > \text{III} < \text{I}$

118. Select order of effectiveness of Lewis acid catalyst in Friedel-Crafts reaction

- (1)  $\text{AlCl}_3 > \text{FeCl}_3 > \text{ZnCl}_2 > \text{BF}_3$                       (2)  $\text{AlCl}_3 > \text{BF}_3 > \text{ZnCl}_2 > \text{FeCl}_3$   
 (3)  $\text{AlCl}_3 > \text{ZnCl}_2 > \text{BF}_3 > \text{FeCl}_3$                       (4)  $\text{AlCl}_3 > \text{FeCl}_3 > \text{BF}_3 > \text{ZnCl}_2$

119. One of the modern methods of studying free radical is

- (1) IR spectra                      (2) CIDNP                      (3) UV spectra                      (4) microwave spectra

120. For a reaction between alkyl halide and  $\text{OH}^-$  increase in solvent polarity generally

- (1) decreases the rate of  $S_N1$  reaction  
 (2) increases the rate of  $S_N1$  reaction  
 (3) increases the rate of  $S_N2$  reaction  
 (4) does not alter the rate of  $S_N1$  and  $S_N2$  reactions

121. Ethyl acetoacetate is prepared from ethyl acetate by

- (1) Benzoin condensation                      (2) Aldol condensation  
(3) Claisen condensation                      (4) Dieckmann condensation

122. Conversion of acetophenone to acetanilide is best accomplished by using

- (1) Curtius              (2) Hofmann              (3) Lossen              (4) Beckmann

123. The order of the ease of the following leaving groups would be

- (I)  $\text{CH}_3\text{COO}^-$       (II)  $\text{CH}_3\text{O}^-$       (III)  $\text{CH}_3\text{SO}_3^-$       (IV)  $\text{CF}_3\text{SO}_3^-$   
(1)  $\text{IV} > \text{III} > \text{I} > \text{II}$                       (2)  $\text{I} > \text{II} > \text{III} > \text{IV}$   
(3)  $\text{I} > \text{III} > \text{II} > \text{IV}$                       (4)  $\text{I} > \text{II} > \text{IV} > \text{III}$

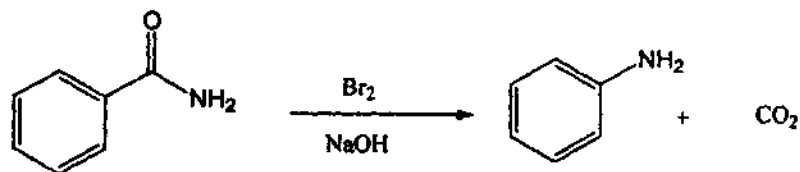
124. In an  $\text{S}_\text{N}2$  reaction there is

- (1) complete racemisation  
(2) mostly inversion and little racemisation  
(3) partial racemisation  
(4) a little inversion and mostly racemisation

125. The number of carbon atoms in piperine is

- (1) 13                      (2) 15                      (3) 17                      (4) 19

- 126.** In Beckmann rearrangement, the migrating group
- (1) is always syn to the hydroxyl group
  - (2) is always anti to the hydroxyl group
  - (3) is either anti or syn
  - (4) depends on the stereochemistry of the molecule
- 127.** In Baeyer-Villiger oxidation, rate of reaction is accelerated by
- (1) electron donating groups in the ketone
  - (2) electron withdrawing groups in the peracid
  - (3) Both 1 and 2 are correct
  - (4) None of these
- 128.** Reactive intermediate formed in the following reaction is



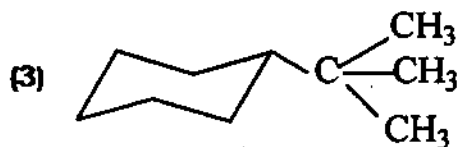
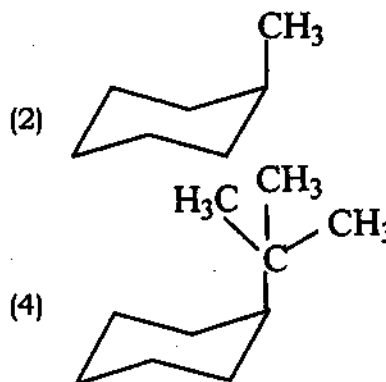
- (1) carbene            (2) nitrene            (3) carbocation        (4) carbanion
- 129.** The increasing order of energy of various conformations of cyclohexane molecule is
- (1) twist boat < boat < chair < half chair
  - (2) boat < twist boat < half chair < chair
  - (3) chair < half chair < twist boat < boat
  - (4) chair < twist boat < boat < half chair

130. In cyclohexane molecule, when one chair conformation changes to other



- (1) all hydrogens originally axial become equatorial
- (2) potential energy of chair conformation increases
- (3) angle strain reduces
- (4) None of the above

131. Which of the following is least stable?



(4)

132. Which of the following is not an alkaloid?

- (1) Quinine            (2) Reserpine            (3) Camphor            (4) Piperine

133. Indigo dye is deep blue colored due to

- (1) conjugation of double bond and non-planarity of molecule
- (2) conjugation of double bond and planarity of molecule
- (3) hydrogen bonding and planarity of molecule
- (4) None of the above

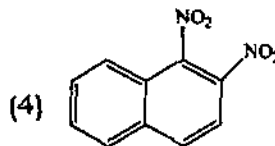
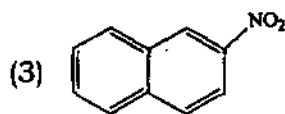
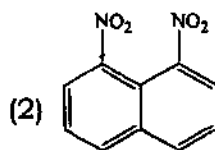
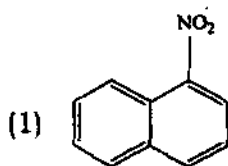
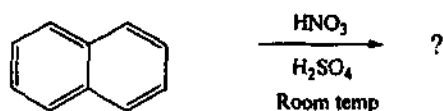
134. A powerful anti-malarial agent obtained from cinchona bark is

- (1) emetine            (2) piperine            (3) quinine            (4) colchicine

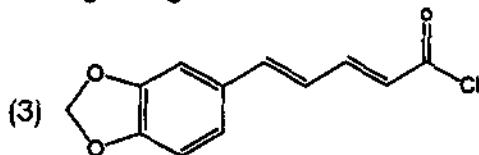
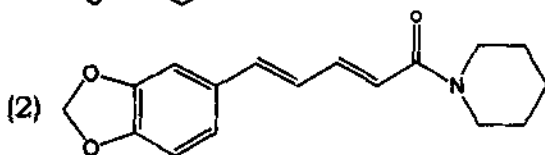
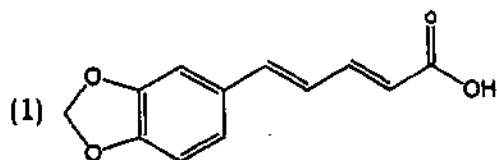
135. A polynuclear compound having three benzene rings fused angularly is  
 (1) naphthalene (2) anthracene (3) phenanthrene (4) chrysene

136. IUPAC name of nicotine is  
 (1) *N*-methyl-(3'-pyridyl)-2-pyrrolidine (2) 2'-(*N*-methylpyrrolidyl)-3-pyridine  
 (3) *N*-methyl-(2'-pyrrolidyl)-3-pyridine (4) *N*-methyl-(5'-pyridyl)-2-pyrrolidine

137. Predict the product for the following reaction



138. Structure of piperine is



(4) None of these

139. In Chichibabin reaction, base used is  
(1)  $\text{KNH}_2$                       (2)  $\text{NaNH}_2$                       (3)  $\text{C}_6\text{H}_5\text{NH}_2$                       (4)  $\text{NH}_3$
140. Sulphonation in indole takes place at  
(1) position-2                      (2) position-3                      (3) both                      (4) None of these
141. Isoquinoline on oxidation with alkaline  $\text{KMnO}_4$  gives  
(1) phthalic acid                      (2) benzoic acid  
(3) cinchomeric acid                      (4) both 1 and 3
142.  $\alpha$ -Terpineol gives *p*-Cymene on treatment with  
(1)  $\text{HNO}_3$                       (2)  $\text{H}_2\text{SO}_4$                       (3)  $\text{HCl}$                       (4)  $\text{CH}_3\text{COOH}$
143. The sweetest sugar amongst the following is  
(1) lactose                      (2) fructose                      (3) glucose                      (4) sucrose
144. The bond that determines the secondary structure of protein is  
(1) coordinate bond                      (2) covalent bond  
(3) hydrogen bond                      (4) ionic bond
145. The main structural feature of protein is  
(1) ester linkage                      (2) ether linkage  
(3) peptide linkage                      (4) ionic linkage

**146.** Buna-S is obtained by the polymerization of butadiene and

- (1) chloroprene
- (2) styrene
- (3) acrylonitrile
- (4) adipic acid

**147.** Terylene is a polymer of

- (1) adipic acid and hexamethylene diamine
- (2) terephthalic acid and ethylene glycol
- (3) phenol and formaldehyde
- (4) adipic acid and ethylene glycol

**148.** Which is an example of thermosetting polymer?

- (1) Polyethene
- (2) Neoprene
- (3) Polyvinyl chloride
- (4) Bakelite

**149.** Which of the following is chain growth polymer?

- (1) Glyptal
- (2) Nylon-66
- (3) Nylon-6
- (4) Polypropylene

**150.** Alkaloids are found in

- (1) seeds
- (2) root
- (3) bark
- (4) All of the above

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## अभ्यर्थियों के लिए निर्देश

(इस पुस्तिका के प्रथम आवरण-पृष्ठ पर तथा उत्तर-पत्र के दोनों पृष्ठों पर केवल नीली या काली बाल-प्वाइंट पेन से ही लिखें)

1. प्रश्न पुस्तिका मिलने के 10 मिनट के अन्दर ही देख लें कि प्रश्नपत्र में सभी पृष्ठ मौजूद हैं और कोई प्रश्न छूटा नहीं है। पुस्तिका दोषयुक्त पाये जाने पर इसकी सूचना तत्काल कक्ष-निरीक्षक को देकर सम्पूर्ण प्रश्नपत्र की दूसरी पुस्तिका प्राप्त कर लें।
2. परीक्षा भवन में लिफाफा रहित प्रवेश-पत्र के अतिरिक्त, लिखा या सादा कोई भी खुला कागज साथ में न लायें।
3. उत्तर-पत्र अलग से दिया गया है। इसे न तो मोड़ें और न ही विकृत करें। दूसरा उत्तर-पत्र नहीं दिया जायेगा, केवल उत्तर-पत्र का ही मूल्यांकन किया जायेगा।
4. अपना अनुक्रमांक तथा उत्तर-पत्र का क्रमांक प्रथम आवरण-पृष्ठ पर पेन से निर्धारित स्थान पर लिखें।
5. उत्तर-पत्र के प्रथम पृष्ठ पर पेन से अपना अनुक्रमांक निर्धारित स्थान पर लिखें तथा नीचे दिये वृत्तों को गाढ़ा कर दें। जहाँ-जहाँ आवश्यक हो वहाँ प्रश्न-पुस्तिका का क्रमांक तथा सेट का नम्बर उचित स्थानों पर लिखें।
6. ओ० एम० आर० पत्र पर अनुक्रमांक संख्या, प्रश्न-पुस्तिका संख्या व सेट संख्या (यदि कोई हो) तथा प्रश्न-पुस्तिका पर अनुक्रमांक सं० और ओ० एम० आर० पत्र सं० की प्रविष्टियों में उपरिलेखन की अनुमति नहीं है।
7. उपर्युक्त प्रविष्टियों में कोई भी परिवर्तन कक्ष निरीक्षक द्वारा प्रमाणित होना चाहिये अन्यथा यह एक अनुचित साधन का प्रयोग माना जायेगा।
8. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार वैकल्पिक उत्तर दिये गये हैं। प्रत्येक प्रश्न के वैकल्पिक उत्तर के लिये आपको उत्तर-पत्र की सम्बन्धित पंक्ति के सामने दिये गये वृत्त को उत्तर-पत्र के प्रथम पृष्ठ पर दिये गये निर्देशों के अनुसार पेन से गाढ़ा करना है।
9. प्रत्येक प्रश्न के उत्तर के लिये केवल एक ही वृत्त को गाढ़ा करें। एक से अधिक वृत्तों को गाढ़ा करने पर अथवा एक वृत्त को अपूर्ण भरने पर वह उत्तर गलत माना जायेगा।
10. ध्यान दें कि एक बार स्याही द्वारा अंकित उत्तर बदला नहीं जा सकता है। यदि आप किसी प्रश्न का उत्तर नहीं देना चाहते हैं, तो सम्बन्धित पंक्ति के सामने दिये गये सभी वृत्तों को खाली छोड़ दें। ऐसे प्रश्नों पर शून्य अंक दिये जायेंगे।
11. रफ़ कार्य के लिये प्रश्न-पुस्तिका के मुखपृष्ठ के अन्दर वाले पृष्ठ तथा अंतिम पृष्ठ का प्रयोग करें।
12. परीक्षा के उपरान्त केवल ओ०एम०आर० उत्तर-पत्र परीक्षा भवन में जमा कर दें।
13. परीक्षा समाप्त होने से पहले परीक्षा भवन से बाहर जाने की अनुमति नहीं होगी।
14. यदि कोई अभ्यर्थी परीक्षा में अनुचित साधनों का प्रयोग करता है, तो वह विश्वविद्यालय द्वारा निर्धारित दंड का/की, भागी होगा/होगी।