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Nun	aber of Pages in this Booklet · <b>40</b>	Nı	mber of	L Questi	ions in	this	Book	let ·	100
<ol> <li>1.</li> <li>2.</li> <li>3.</li> <li>4.</li> <li>5.</li> </ol>	<ul> <li>Instructions for the Candidates</li> <li>Write your Seat No. and OMR Sheet No. in the space provided on the top of this page.</li> <li>This paper consists of 100 objective type questions. Each question will carry two marks. All questions of Paper II will be compulsory. At the commencement of examination, the question booklet will be given to the student. In the first 5 minutes, you are requested to open the booklet and compulsorily examine it as follows: <ul> <li>(i) To have access to the Question Booklet, tear off the paper seal on the edge of this cover page. Do not accept a booklet without sticker-seal or open booklet.</li> <li>(ii) Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Faulty booklets due to missing pages/questions or questions repeated or not in serial order or any other discrepancy should not be accepted and correct booklet will be replaced nor any extra time will be given. The same may please be noted.</li> <li>(iii) After this verification is over, the OMR Sheet Number should be entered on this Test Booklet.</li> </ul> </li> <li>Each question has four alternative responses marked (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.</li> <li>Example : where (C) is the correct response.</li> <li>(i) (ii) You responses to the items are to be indicated in the <b>OMR Sheet given inside the Booklet only.</b> If you mark at any place the velocity of the time with the tot of the time time the text.</li> </ul>	1. 2. 3. 4.	परीक्षार्थींनी अ तसेच आपणां सदर प्रश्नपत्रि आहेत. या प्रश्न परीक्षा सुरू झ 5 मिनिटांमध्ये तपासून पहाव्य (i) प्रश्न (ii) पहिल् (ii) पहिल् (iii) पहिल (iii) पहिल (iii) पहिल (iii) वरीत वाढल (iii) वरीत आ.ए प्रत्येक प्रश्नास आहेत. त्याती काळा/निळा क <b>उदा. :</b> जर (C	विद्यार्थ्यांस पि दिलेल्या उ किंत 100 व नपत्रिकेतील गल्यावर विव गल्यावर विव गल्यावर विव गल्यापण सन पत्रिका उघड नसलेली वि ल्या पृष्ठावर कमी असले लेली किंवा इ निटातच पर्य कमी असले तेली किंवा इ निटातच पर्य कमी असले तेला प्रेण्या उ त्रावा. हो योग्य उ तिल प्रश्नांची	गठी महत्त्वा । क्रमांक या '। क्रद्रापत्रिकेचा क्रद्रापत्रिकेचा क्रद्राप्रयत्रिकेचा श्रध्यांला प्रश् इण्यासाठी प्रत् क्रंवा सील उ : नमूद केल् केतील एकूण् केतील एकूण् केतील एकूण् केतील एकूण् केतील एकूण् केतील एकूण् केतील एकूण् केतील प्रत् प्रिकेचा न ज्रि चडताळू रपत्रिकेचा न (C) आणि तराचा रकान क्र असेल त	च्या सूच पृष्ठावरीत । क्रमांक इन आहेत सोडविणे नपत्रिका बका उघड श्नपत्रिके घडलेली याप्रमाणे । प्रश्नांच श्व असल् श्तिरा खाली । (D) अश् । खाली त.	ना न वरच्या : त्याखाली : प्रत्येक दिली ज दिली ज दिली ज दून खाल वर लावल प्रश्नपत्रि प्रश्नपत्रि प्रश्नपत्रि दसरी प्रश्न वा. दर्शविल्य क्रिप्रावित्य क्रिप्रावित्य क्रिप्रावित्य क्रिप्रावित्य	कोप-यात लिहावा. प्रश्नास इंल. सुर हेल. सुर हेल. सुर हेल. सुर के सील का स्वीक केची एव में सील के सील मांचा चुक रिका सुर श्नपत्रिक नाही तसे नाही तसे के स्वर प्रश्नपत्र के स्वर के स्व के स्व के स्वर के स्व के के स्व के के स्व के स्व के स्व के के स्व के स्व के स्व के के स्व के स्व के स्व के के स्व के स के स के स के स के स के स के स के स	लिहावा. दोन गुण व्वातीच्या । अवश्य उघडावे. जुरू नये. कूण पृष्ठे । पहावी. नेचा क्रम व्ववेळही वी. चिव्ववेत चेंद्र क्रिकेवर त्तरे दिली उळकपणे
6. 7. 8.	Read instructions given inside carefully. Rough Work is to be done at the end of this booklet. If you write your Name, Seat Number, Phone Number or put any mark on any part of the OMR Sheet, except for the space allotted for the relevant entries, which may disclose your identity, or use abusive language or employ any other unfair	6. 7. 8.	इतर ठिकाणी ति आत दिलेल्या प्रश्नपत्रिकेच्य जर आपण ओ नाव, आसन ब्र केलेली आदन्य	तहिलेली उत्ते सूचना काळ 1 शेवटी जोड 1.एम.आर. व कमांक, फोन ज आल्याम्	रे तपासली ज जीपूर्वक वा डलेल्या कोन्ज वर नमूद केल 1 नंबर किंवा अथवा अग्रम्भ	ाणार नाहीत चाव्यातः या पानावर लेल्या ठिव ओळख आळेच्ण	त. एच कच्चे काणाव्यति पटेल अध्	काम क तेरिक्त इत शी कोणतं	रावे. र कोठेही गेही खूण
9. 10.	means, you will render yourself liable to disqualification. You have to return original OMR Sheet to the invigilator at the end of the examination compulsorily and must not carry it with you outside the Examination Hall. You are, however, allowed to carry the Test Booklet and duplicate copy of OMR Sheet on conclusion of examination. Use only Blue/Black Ball point pen.	9. 10.	अवलंब केल्य परीक्षा संपल्या परत करणे आव द्वितीय प्रत आ फक्त निळ्या वि	ास विद्यार्थ्य नंतर विद्यार्थ्य त्रश्यक आहे. पल्याबरोबर कंवा काळ्य	ति परीक्षेस यनि मूळ ओः तथापि, प्रश्न नेण्यास विद्य ॥ बॉल पेनच	अपात्र ठ एम.आर. ापत्रिका व प्रार्थ्यांना प ाच वापर	रविण्यात उत्तरपत्रि ओ.एम. रवानगी करावा.	येईल. का पर्यवे आर. उत्तर आहे.	क्षकांकडे पत्रिकेची
11.	Use of any calculator or log table, etc., is prohibited.	11. 12	कलक्युलेटर 1 चकीच्या उत्तर	कवा लॉग टे ासाठी गण व	खल वापरण्य फपात केली	थास परवा जाणार ना	ानगा नाहं ही.	T.	
12.	There is no negative marking for incorrect answers.	_ <b>_</b> .		<u>ى</u> .			~		

# Chemical Science Paper II

Time Allowed : 120 Minutes][Maximum Marks : 200Note : This Paper contains Hundred (100) multiple choice questions. Each question<br/>carrying Two (2) marks. Attempt All questions.

1. Which one is the *correct* expression for zeroth order reaction ?

(A) 
$$-\int_{[A]_{o}}^{[A]_{t}} d[A] = K_{0} \int_{o}^{t} dt$$
 (B)  $-\int_{[A]_{o}}^{[A]_{t}} d[A] = \int_{o}^{t} dt$   
(C)  $-\int_{[A]_{o}}^{[A]_{t}} d[A] = K_{0}$  (D)  $-d[A] = K_{0} \int_{o}^{t} dt$ 

2. Mechanism for ionic reaction in the light of activated complex theory is written as :

$$\mathbf{A}^{\mathbf{Z}_1} + \mathbf{B}^{\mathbf{Z}_2} \rightleftharpoons (\mathbf{A}\mathbf{B})^{\neq \mathbf{Z}_1 + \mathbf{Z}_2} \to \mathbf{P}$$

and corresponding rate law

$$\frac{d[P]}{dt} = \frac{\gamma_{A} \gamma_{B}}{\gamma^{\neq}} \times \frac{K_{2} K_{1}}{K-1} [A] [B]$$

 $:: \gamma \equiv$  Activity coefficients

If we hypothetically "Put-off" the charges on reactants, then the portion of equation,

(A) 
$$\frac{\gamma_A \cdot \gamma_B}{\gamma^{\neq}} \rightarrow 1$$
 (B)  $\frac{\gamma_A \gamma_B}{\gamma^{\neq}} = 0$ 

(C) 
$$\frac{K_2 K_1}{K-1} \rightarrow \infty$$
 (D)  $\frac{K_2 K_1}{K-1} \rightarrow 0$ 

3. Which of the following energy surface (diagram) most appropriately represents gist of activated complex theory ?



4. Collision theory based bimolecular rate constant is given as :

$$K = N_A \sqrt{\frac{8k_BT}{\pi\mu}}$$
 .  $\pi d^2 e^{-Ea/RT}$ 

Applying this theory to the following gases state reaction,

(1) 2NOCl  $\xrightarrow{K_1}$  2NO + 2Cl (2) 2ClO  $\xrightarrow{K_2}$  Cl<sub>2</sub> + O<sub>2</sub> The rate constants, K<sub>1</sub> and K<sub>2</sub> should be in the order of : (A) K<sub>1</sub> > K<sub>2</sub> (B) K<sub>2</sub> < K<sub>1</sub> (C) K<sub>1</sub>  $\approx$  K<sub>2</sub> (D) K<sub>1</sub>  $\geq$  K<sub>2</sub>

- 5. Concept of electrochemical potential (EMF) is associated to :
  - (A) half cell
  - (B) Complete electrochemical cell
  - (C) Electrochemical reaction at equilibrium
  - (D) Potential difference of cell
- 6. Consider the cell

$$Cd(s)/Cd^{2+}$$
 (1.0M) ||  $Cu^{2+}$  (1.0M) |  $Cu(s)$ 

Voltage of the cell can be raised by :

- (A) Raising  $[Cu^{2+}]$  or/and decreasing  $(Cd^{2+})$
- (B) Raising  $[Cu^{2+}]$  and  $[Cd^{2+}]$
- (C) Raising [Cd<sup>2+</sup>]
- (D) Decreasing [Cu<sup>2+</sup>]
- 7. For the calomel half cell,

$$Hg(s)/Hg_2Cl_2$$
 (s)/Cl<sup>-</sup> (aq.)

Change in electrode potential w.r.t. [Cl<sup>-</sup>] would look like :



8. Average value of distance of an electron from nucleus in hydrogen atom in its lowest energy is expressed as :

(A) 
$$\langle r \rangle = \frac{1}{\pi a^3} - \int_0^\infty r^3 e^{-2r/a_0} dr$$
  
(B)  $\langle r \rangle = \frac{1}{\pi a^3} \int_0^\infty r^3 e^{-r/a_0} \left( e^{-r/a_0} \right)^* dr$   
(C)  $\langle r \rangle = \frac{1}{\pi a^3} \left( \int_0^\infty r^3 e^{-2r/a_0} dr \right)^* \left( \int_0^\pi \sin \theta d\theta \right)^* \left( \int_0^{2\pi} d\phi \right)$   
(D)  $\langle r \rangle = \frac{5}{2} a_0$ 

9.  $-\frac{\hbar^2}{2}\left(\frac{1}{me}+\frac{1}{mh}\right) \frac{d^2\psi}{dx^2} + \frac{z^2}{4\pi r}$ .  $\Psi = E\Psi$  could be a Schrödinger equation for :

- (A) A particle in 1-D box problem
- (B) Two particles in 2D box problem
- (C) Simple harmonic motion between two particles
- (D) Two charged particles in 1-D box problem
- 10. The following function is acceptable as state function over the range  $(-\infty t_0 + \infty)$ :

(A) 
$$e^{-x^2}$$
 (B)  $\tan x$ 

(C)  $\cot x$  (D)  $xe^{-x^2}$ 

- 11. Apart from X-ray crystallography, the most important method to estimate protein structure with atomic resolution :
  - (A) 2-D NMR spectroscopy (B) LC-MS-MS
  - (C) Circular Dichroism (D) Fluorescence spectroscopy
- 12. 0.1 Mol of NaOH is added into 250 ml buffer solution. Change in pH is noted to be 0-2 units. The buffer capacity of buffer(s) is :

$$(A) = 1$$
  $(B) = 2$ 

$$(C) = 3$$
  $(D) = 4$ 

13. The drift speed of bovine serumalbumin under the electric field is measured at various pH :

pH	4.1	4.6	5.0	5.7	6.4	7.1
Speed µm/s	+0.50	+0.25	-0.25	-0.7	-0.9	-1.5

The isoelectric point of the protein should be, approximately in the range :

- (A) 4.1 (B) 5.2
- (C) 4.8 (D) 7.0
- 14. pH of 0.05 M (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> is (Given :  $K_b(NH) = 10^{-5}$ ) :
  - (A) pH = 5 (B) pH = 4
  - (C) pH = 6 (D) pH = 3

15. Which of the following equations for the pressure of a gas is correct?

(A) 
$$dP = \frac{2RT}{(V-b)^2} dV + \frac{R}{(V-b)} dT$$
 (B)  $dP = \frac{-RT}{(V-b)^2} dV + \frac{R}{(V-b)} dT$ 

(C) 
$$dP = \frac{2RT}{(V-b)^2}dV + \frac{R}{(V-b)^2}dT$$
 (D)  $dP = \frac{-RT}{(V-b)^2}dV + \frac{R}{(V-b)^2}dT$ 

- 16. Which of the following statements is *correct* regarding standard free energy change and the equilibrium constant for a mixture of ideal gases ?
  - (A) Standard free energy change and equilibrium constant are independent of total pressure and temperature
  - (B) Both properties depend on total pressure and temperature
  - (C) Both properties are independent of temperature but depend on total pressure
  - (D) Both properties depend on temperature but independent of total pressure
- 17. Consider an ideal solution of two liquids A and B. If partial vapour pressures of both liquids are same, then total pressure of the solution is :

(A) 
$$\frac{P_A^o P_B^o}{P_A^o + P_B^o}$$
 (B)  $\frac{2P_A^o P_B^o}{P_A^o + P_B^o}$ 

(C) 
$$\frac{P_A^o}{P_A^o + P_B^o}$$
 (D)  $\frac{2P_B^o}{P_A^o + P_B^o}$ 

18. For a non-linear triatomic gas, the molar heat capacity is :

(C) 6R (D) 
$$\frac{9}{2}$$
R

- 19. For a system with non-degenerate zero energy state and doubly degenerate upper state (with energy E), the partition function is :
  - (A)  $2e^{-E/kT}$  (B)  $2+e^{-E/kT}$
  - (C)  $3e^{-E/kT}$  (D)  $1+2e^{-E/kT}$
- 20. At low temperature, heat capacity of solids at constant volume is proportional to : (A)  $T^3$  (B)  $\left(\frac{1}{T}\right)^3$ (C)  $(RT)^2$  (D)  $\left(\frac{R}{T}\right)^2$

21. The variation of intensities of spectral lines shown in the figure corresponds to :



10

22. The selection rule for vibrational Raman spectra is :

- (A)  $\Delta v = \pm 1, \pm 2, \dots$  (B)  $\Delta v = 0, \pm 1, \pm 2, \dots$
- (C)  $\Delta v = \pm 1, \pm 2, \dots$  (D)  $\Delta v = \pm 2$

23. In rotational fine structure of vibration-electronic transitions of a diatomic molecule, the band head will appear in R-branch if :

(A) B' < B''(B) B' = B''(C) B' > B''(D) B' = -B''

24. In electronic spectra of molecules, the vibrational quantum number leading to convergence of vibrational spectral lines is given by :

(A) 
$$\frac{1}{x_e} - 1$$
 (B)  $\frac{1}{\overline{w}_e} - 1$   
(C)  $\frac{1}{2x_e} - 1$  (D)  $\frac{1}{\overline{w}_e x_e} - 1$ 

25. The excess population of nuclear spins in lower state is given by :

(A) 
$$\frac{n_{\text{lower}}}{n_{\text{lower}} + n_{\text{upper}}}$$
 (B)  $\frac{n_{\text{lower}} + n_{\text{upper}}}{n_{\text{lower}} - n_{\text{upper}}}$   
(C)  $\frac{n_{\text{upper}} - n_{\text{lower}}}{n_{\text{upper}} + n_{\text{lower}}}$  (D)  $\frac{n_{\text{lower}} - n_{\text{upper}}}{n_{\text{lower}} + n_{\text{upper}}}$ 

26. Calculate the wavelength of an electron accelerated through a potential of 16 V :

		(Given	: $(2 \text{ me})^{\frac{1}{2}} =$	5.4 × 1	$10^{-25}$	$\frac{\text{kg.m}}{\text{S.V}^{\frac{1}{2}}}$	)
(A)	0.307 nm			(B)	0.123	nm	
(C)	0.0123 nm			(D)	3.07	nm	

- 27. The first order correction term to the ground state energy of hydrogen like atom is :
  - (A) Positive (B) Negative
  - (C) Zero (D) Can be positive or negative
- 28. The slater determinant of helium atom is :

$$\begin{array}{ll} \text{(A)} & \Psi(1,2) = \frac{1}{\sqrt{2!}} \begin{vmatrix} 1S(2)\alpha(2) & 1S(1)\alpha(1) \\ 1S(2)\beta(2) & 1S(1)\beta(1) \end{vmatrix} \\ \text{(B)} & \Psi(1,2) = \frac{1}{\sqrt{2!}} \begin{vmatrix} 1S(1)\alpha(1) & 1S(2)\alpha(2) \\ 1S(1)\beta(1) & 1S(2)\beta(2) \end{vmatrix} \\ \text{(C)} & \Psi(1,2) = \frac{-1}{\sqrt{2!}} \begin{vmatrix} 1S(1)\alpha(1) & 1S(2)\alpha(2) \\ 1S(1)\beta(1) & 1S(2)\beta(2) \end{vmatrix} \\ \text{(D)} & \Psi(1,2) = \frac{1}{2} \begin{vmatrix} 1S(1)\alpha(1) & 1S(2)\beta(1) \\ 1S(1)\alpha(2) & 1S(2)\beta(2) \end{vmatrix} \end{array}$$

29. In the study of solution of a polymer, the plot of  $\frac{\pi}{C}$  versus 'C' results into the information of :

- (A) Mn as reciprocal of intercept and polymer-solvent interaction constant as slope
- (B) Mn as an intercept and concentration as slope
- (C) Mn as the slope and polymer-solvent interaction constant as an intercept
- (D) Only Mn as ratio intercept and slope

30. According to Langmuir model :

- (I) All adsorption sites are equivalent
- (II) Adsorption and desorption are cooperative processes
- (III) Probability of adsorption is not affected by occupancy state of adsorption site
- (IV) Only monolayer adsorption
- (A) (I), (II) and (III) (B) (I) and (IV)
- (C) (II) and (III) (D) (II) and (IV)

- 31. Systematic change in  $\lambda_{max}$  with size in case of semiconductor nanoparticles is due to the phenomenon :
  - (A) Surface plasmon resonance (B) Size quantization effect
  - (C) Nano-effect (D) Band theory
- 32. The following UV-vis spectra recorded on various sizes of semiconductor nanoparticles :



The blue shift in the spectra is correlated to :

- (A) decrease in size of nanoparticles (B) Increase in size of nanoparticles
- (C) Surface plasmon resonance (D) Nothing to do with size
- 33. According to variation theorem, energy eigenvalue obtained from an approximate wave function is :
  - (A) Always equal to  $E_0$  (B) Upper bound to  $E_0$
  - (C) Lower bound to E<sub>0</sub> (D) Always positive

34. The adsorbent which has higher adsorptive power in column chromatography is :

- (A) SiO<sub>2</sub> (B) MgO
- (C)  $CaCO_3$  (D)  $Al_2O_3$

 $[BrF_4]^-$  has : 35.(B)  $sp^3d$  hybridization (A) Shape similar to  $SF_4$ (D)  $sp^3d^2$  hybridization (C)  $sp^3$  hybridization 36. The number of significant figures in the answer of addition (0.6540 + 6.54 + 6.54)65.4 + 654) is : (A) 725 (B) 3 (C) 4 (D) 8 37. The EPR lines predicted for  ${}^{\bullet}CF_{2}H$  radical will be ( ${}^{12}C$ ; I = O, F, H; I =  ${}^{1/2}$ ) (A) 6 (B) 0 (C) 3 (D) 2 38. Drug metabolism occurs mainly in : (A) Liver (B) Brain (C) Spleen Kidney (D) 39. Catalytic converters are used in reduction and oxidation on reactions to reduce harmful emissions. The oxidation of CO and hydrocarbons was carried out by catalyst consisting the following metals :

- (A) Pt, Rh (B) Pt, Pd
- (C) Co, Rh (D) Co, Ni

40. Which one of the following molecules is an anti-fungal agent ?

- (A) Sulfa drug (B) Amphotericin-B
- (C) Oseltamivir (Tamiflu) (D) Remdesivir

41. The complex  $[{\rm FeF}_6]^{3-}$  is colorless, whereas  $[{\rm CoF}_6]^{3-}$  is colored; this is because :

- (A) Both are high spin complexes
- (B) Spin forbidden transitions in  ${\rm [FeF_6]}^{3-}$  and spin allowed transitions in  ${\rm [CoF_6]}^{3-}$
- (C) Spin-allowed transitions in  $[{\rm FeF}_6]^{3-}$  and spin-forbidden transitions in  $[{\rm CoF}_6]^{3-}$
- (D)  $[FeF_6]^{3-}$  is low spin complex, and  $[CoF_6]^{3-}$  is high spin complex
- 42. The species with the lowest Valence Electron (VE) count is :
  - (A)  $[V(CO)_6]^-$  (B)  $[Cu(MA_3)_6]^{2+}$
  - (C)  $[AuCl_4]^-$  (D)  $[Zn(en)_3]^{2+}$
- 43. The Wade's rules can be applied to the naked clusters of *p*-block elements. According to Wade's rules, the number of skeletal electrons in  ${\rm Pb}_5^{7^{2-}}$  cluster is :
  - (A) 18 (B) 22
  - (C) 8 (D) 12

- 44. In an axially symmetric field, NQR transition/s expected for nuclear spin quantum number I = 7/2 is/are :
  - (A) 1 (B) 2
  - (C) 3 (D) 4
- 45.  ${}^{31}P \{{}^{1}H\}$  spectrum of diamagnetic complex mer-RhCl<sub>3</sub> (PEt<sub>3</sub>)<sub>3</sub> would show (103Rh,  ${}^{31}P$ ; I =  $\frac{1}{2}$ )
  - (A) a doublet
  - (B) a triplet
  - (C) doublet of doublet and doublet of triplet
  - (D) triplet of doublet and doublet of doublet

46. Based on Pauling's electronegativity scale hydrogen can oxidize :

- (A) Boron (B) Carbon
- (C) Nitrogen (D) Oxygen
- 47. The following reaction

$$\rm 3CH_3Li~+~SbCl_3~\rightarrow~(CH_3)_3Sb~+~3LiCl$$

is an example of :

- (A) Oxidative addition (B) Reductive elimination
- (C) Metal-halogen exchange (D) Metathesis reaction

48. Consider the given Frost diagram for chlorine species in acidic (solid line) and basic (dashed line) media. The INCORRECT statement about their reactivities is :



- (A)  $ClO_2^-$  is more susceptible to disproportionation in acidic than in basic medium
- (B) All species disproportionate in acidic medium
- (C)  $ClO_4^-$  is a stronger oxidizing agent in basic than in acidic medium
- (D) Except Cl<sup>-</sup>, other chlorine species are strongly oxidizing in acidic than in basic medium
- 49. The radionuclide <sup>135</sup>Te undergoes four successive  $\beta^-$  emission to give the stable isotope :
  - (A)  $^{135}I$  (B)  $^{135}Xe$
  - (C)  $^{135}Cs$  (D)  $^{135}Ba$
- 50. The molecule which does not have Td symmetry :
  - (A)  $SiF_4$  (B)  $CH_4$
  - (C) P<sub>4</sub> (D) XeF<sub>4</sub>

- 51. Historically, oxygen was prepared by the decomposition of metal oxides. The *correct* set of oxides that give dioxygen on heating is :
  - (A) HgO, CaO, BaO (B)  $KO_2$ ,  $BaO_2$ ,  $Na_2O$
  - (C)  $Na_2O$ , CaO, BaO (D) HgO,  $KO_2$ , BaO<sub>2</sub>
- 52. The  ${}_{P}\!K_a$  of coordinated water is lowest for :

  - $(C) \quad [Zn(H_2O)_6] \quad Cl_2 \qquad \qquad (D) \quad [Ru(H_2O)_6] \quad Cl_3 \quad \\$
- 53. The results of a copper analysis are found to give 42.50% of metal as compared to true value of 42.92%. The relative error of analysis is :
  - (A) -0.97% (B) +0.97%

(C) 
$$-0.42\%$$
 (D)  $+0.42\%$ 

- 54. The set of compounds that show autoionization is :
  - (A) Cl<sub>2</sub>O<sub>6</sub>, POCl<sub>3</sub>, HF
  - (B) IF<sub>3</sub>, HF, POCl<sub>3</sub>
  - (C) HF, IF<sub>3</sub>, Cl<sub>2</sub>O<sub>6</sub>
  - (D)  $POCl_3$ ,  $IF_3$ ,  $Cl_2O_6$
- 55. The radionuclide  ${}^{22}_{11}$ Na decays by a positron emission. The ratio of the atomic mass and atomic number of the resulting nuclide is given by :
  - (A)  $\frac{22}{10}$  (B)  $\frac{22}{11}$ (C)  $\frac{21}{10}$  (D)  $\frac{21}{11}$
- 56. R-S terms possible for a first-row transition metal complex in a weak field of ligands are <sup>2</sup>H, <sup>2</sup>G, <sup>4</sup>F, <sup>2</sup>F, <sup>2</sup>D, <sup>2</sup>D and <sup>2</sup>P. The ground term of this complex is/are :

(A)	$^{2}\mathrm{H}$	(B)	$^{4}P$
(C)	$^4\mathrm{P}$ and $^4\mathrm{F}$	(D)	${}^{4}\mathrm{F}$

- 57. Lanthanides and actinides are not known to form neutral carbonyl complexes because :
  - (A) They lack electrons in d orbitals
  - (B) Their d orbitals do not overlap with  $\pi$  orbitals of CO
  - (C) They tend to hydrate CO under ambient conditions
  - (D) Their large metal atoms cannot interact with smaller diatomic ligands
- 58. Concurrent bond formation between metal and the entering group and bond cleavage between metal and the leaving group is observed in a/an :
  - (A) Associative reaction (B) Dissociative reaction
  - (C) Interchange reaction (D) Reductive elimination reaction
- 59. Hemocyanin is an oxygen transport protein in arthropodes. The mode of oxygen binding to copper in hemocyanin is :
  - (A)  $\mu \eta^1 : \eta^1 O_2^{2-}$  (B)  $\mu \eta^2 : \eta^2 O_2^{2-}$

(C) 
$$\mu - \eta^1 : \eta^1 - O_2^-$$
 (D)  $\mu - \eta^2 : \eta^2 - O_2^-$ 

- 60. The observed magnetic moment for the complex  $Cs_2[CoCl_4]$  is 4.59 B.M. The magnetic moment can be best explained by :
  - (A) The spin only value
  - (B) Spin-orbit coupling
  - (C) Orbital contribution to the magnetic moment
  - (D) Temperature independent paramagnetism
- 61. Biological nitrification is identified by :

(A) 
$$2[NO_3]^+ + 12H^+ + 10e^- \rightarrow N_2 + 6H_2O$$

- (B)  $[\mathrm{NH}_4]^+ + 2\mathrm{O}_2 \rightarrow [\mathrm{NO}_3]^- + \mathrm{H}_2\mathrm{O} + 2\mathrm{H}^+$
- (C) N<sub>2</sub> + 10H<sup>+</sup> + 8e<sup>-</sup>  $\rightarrow$  2[NH<sub>4</sub>]<sup>+</sup> + H<sub>2</sub>
- (D) N<sub>2</sub> +  $3H_2 \rightarrow 2NH_3$

- 62. The Pairing Energy (P) contribution to the CFSE of a high spin  $d^7$  ion in an octahedral geometry is :
  - (A) O (B) P
  - (C) 2P (D) 3P
- 63. The number of EPR lines observed in the *p*-dinitro benzene radical anion will be (I for  ${}^{14}N = 1$  and  ${}^{16}O = 0$ ) :
  - (A) 5 (B) 25
  - (C) 30 (D) 10
- 64. Zinc is present at the active site of many hydrolytic enzymes where at least one water molecule is coordinated to zinc. The activation of this zinc-bound water to form [Zn-OH]<sup>+</sup> depends on the ligand environment around zinc. In which of the following, the formation of [Zn-OH]<sup>+</sup> is more facile ?



65. Crystal field splitting parameter ( $\Delta$ ) decreases in the order :

(A) 
$$[CoF_6]^{3-} > [CoF_6]^{4-} > [Co(H_2O)_6]^{2+}$$

- (B)  $[Co(H_2O)_6]^{2+} > [CoF_6]^{4-} > [CoCl_6]^{4-}$
- (C)  $[CoCl_6]^{4-} > [CoCl_4]^{2-} > [CoF_6]^{3-}$
- (D)  $[CoF_6]^{3-} > [CoCl_6]^{4-} > [CoF_6]^{4-}$

66. R-S term symbol of  $Eu^{2+}$  (At. No. = 63) is :

(A)  ${}^{8}S_{7/2}$  (B)  ${}^{7}F_{6}$ (C)  ${}^{6}H_{5/2}$  (D)  ${}^{7}F_{0}$ 

67. The most widely used flame in Atomic Absorption Spectroscopy is :

- (A) Air-coal gas (B) Air-acetylene
- (C) Air-LPG (D) N<sub>2</sub>-acetylene

68. When crystals of  $Al_2O_3$  are grown from a solution containing a low concentration of  $V^{3+}$ , the vanadium ions occupy octahedral aluminum sites. The crystal has absorption bands at 17400, 25200 and 34500 cm<sup>-1</sup>. The  $\Delta_0$  of this complex is :

- (A) 17400 (B) 25200
- (C) 21750 (D) 14500

69. The monomeric complex, Fe (Pyridine)<sub>4</sub> Cl<sub>2</sub>, is tetragonally distorted, transoctahedral complex. The <sup>57</sup>Fe Mössbauer spectrum of this complex at 297 K shows doublet with isomer shift,  $\delta = 1.06$  mm s<sup>-1</sup>, and quadrupole splitting,  $\Delta = 3.08$  mm s<sup>-1</sup>. The spin state of this complex is :

- (A) High spin, s = 2
- (B) Low spin, s = 0
- (C) High spin, s = 5/2
- (D) Low spin,  $s = \frac{1}{2}$

70.  $SrF_2$  solid adopts a fluorite structure. The coordination number of cation and anion in this structure is :

71. E factor is calculated by kg of waste producted per kg of product. The E factor for the following conversion is :

$$2 \ C_6H_5I + Cu \rightarrow C_6H_5 - C_6H_5 + CuI_2$$

The reaction gave 100% conversion :

- (A) 2.0 (B) 4.0
- (C) 1.0 (D) 8.3
- 72. When (R)-Citronellal is treated with anhydrous ZnBr<sub>2</sub> the major product formed is :



73. The major products (P & Q) of the following reactions are :





74. The major product of the following reaction is :

24

## 75. Predict the major product of the following reaction :



76. Predict the major product of the following reaction :





77. The major product of the following reaction is :











80. The major product of the following reaction is :

81. Predict the major product of the following reactions :



- OH(i)  $Me_3SiCl (1.0 eq.)$  $Et_3N$ ;  $CH_2Cl_2$ (ii) PDC, CH<sub>2</sub>Cl<sub>2</sub> 1 (*iii*) dil. HCl € OH OH(A) (B) ≣ OH 0 (C) (D) 11 0
- 82. The major product of the following reaction is :

83. Predict the major product of the following reaction :





84. Predict the major product of the following reaction :

[P.T.O.



85. Which of the following will produce chiral product on treatment with :

86. The *correct* order for carbonyl stretching frequencies in IR-spectra of the following compounds is :



87. The correct match of compounds given in Column I with spectral data given in column II is :

Column I

- 1, 2-Dichloroethane (a)
- (*b*) 1, 4-Dibromobenzene
- (c)2-Methyl-1,3-butadiene

#### Cyclopropane (d)

### **Column II**

- $\lambda_{max}$  220 nm (i)
- (ii) Only one singlet at  $3.7\delta$  in  $^{1}H - NMR$  spectrum
- (iii) Peaks at 234, 236, 238 m/e with intensity (1:2:1) in MS-spectrum
- (*iv*) Absorption at 1815  $cm^{-1}$  in IR spectrum
- (A) (a-iii), (b-ii), (c-i), (d-iv)
- (B) (*a–ii*), (*b–iii*), (*c–i*), (*d–iv*)
- (C) (*a-iv*), (*b-i*), (*c-ii*), (*d-iii*)
- (D) (*a*-*i*), (*b*-*iv*), (*c*-*iii*), (*d*-*ii*)
- 88. The major product of the following reaction is :





89. The major product of the following reaction is :

90. Suggest most suitable reagent/condition for the following conversion :



- (A)  $MnO_2$ ;  $CH_2Cl_2$
- (B) TEMPO (2.0%); NaOCl (1.25 eq), CH<sub>2</sub>Cl<sub>2</sub>
- (C) Pyridinium dichromate (PDC);  $CH_2Cl_2$
- (D) Dimethyldioxirane (DMDO); CH<sub>2</sub>Cl<sub>2</sub>

91. The correct reagents for the following conversion are :



92. The major product of the following reaction is :



93. Rank the following molecules in decreasing order of basicity :



94. Arrange the following intermediates into increasing order of stability :



[P.T.O.



95. Identify antiaromatic compound from the following :

96. Which statement is *correct* for the following four molecules ?













(B) II and IV are chiral(D) I and IV are chiral

97. How many geometrical isomers are possible for the following molecule :



98. The major product of the following reaction is :



99. What is the relationship between  $H_a$  and  $H_b$  in the product P formed in the following reaction ?



100. The IUPAC name of the following compound is :



- (A) 3-Ethyl-2, 4, 5-trimethyl heptane
- (B) 5-Ethyl-3, 4, 6-trimethyl heptane
- (C) 3-isopropyl-4, 5-dimethyl heptane
- (D) 5-isopropyl-3, 4-dimethyl heptane

MAR- 33223/II—D

### **ROUGH WORK**

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