

JAM – 2012 – Chemistry



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	Attempt ALL the questions. Q.1 – Q.30 Multiple Choice Question						
	(MCQ), carry TWO marks each (for each wrong answer: -0.66).						
1.	Molecular shape of SOCl ₂ is:						
	(a) Square planar		(b) Trigonal py	ramidal			
	(c) Triangular pla	ar (d) T-shaped					
2.	Number of three	e-centre two-elect	ron (3c-2e) bond	s present in dib	oorane is:		
	(a) 2	(b) 4	(c) 6	(d) 8	}		
3.	The lattice energy	rgy of LiF calc	ulated from Bor	n-Lande equa	tion is -1000		
	kJ mol ⁻¹ . Assu	me that for bo	oth LiF and Mg	gO the Madel	ung constants,		
	interionic distan	ces and Born exj	oonents have the	same value. Th	e lattice energy		
	of MgO in kJ mo	Ol^{-1} is: UGA^{T}	EGJAM Cr.				
	(a) -4000	(b) -2000) (c)	2000	(d) 4000		
4.	The compound f	ormed by dissolv	ing elemental gol	d in aqua regia	is:		
	(a) AuCl	(b) AuNO ₃	(c) H[AuCl	(d)	$H[Au(NO_3)_4]$		
5.	Number of moles of ions produced by complete dissociation of one mole of						
	Mohr's salt in w	ater is:					
	(a) 3	(b) 4	(c) 5		(d) 6		
6.	The tetrachloro complexes of Ni(II) and Pd(II) respectively, are (atomic numbers						
	of Ni and Pd are 28 and 46 respectively)						
	(a) diamagnetic and diamagnetic (b) paramagnetic and paramagnetic						
	(c) diamagnetic and paramagnetic (d) paramagnetic and diamagnetic						
7.	The total number of steps involved and number of beta particles emitted in the						
	spontaneous dec	ay of $^{238}_{92}U \rightarrow ^{200}_{82}$	Pb respectively,	are			
	(a) 8 and 6	(b) 14 and 6	(c) 6 and	d 8 (d	l) 14 and 8		
8.	A filter paper n	noistened with an	nmoniacal sodiur	n nitroprusside	e solution turns		
	violet on contact with a drop of alkaline Na_2S solution. The violet color is due to						
	the formation of						
	(a) $[Fe(SCN)_5(N)]$	$N_{5}(NO)]^{1-}$ (b) $[Fe(SCN)_{5}(NO)]^{2-}$					
	(c) $[Fe(CN)_5(NO)]$	$(NOS)]^{3-}$ (d) $[Fe(CN)_5(NOS)]^{4-}$					
9.	The species/com	pounds that are a	aromatic among t	he following ar	e		
		٥ ^Θ	\sim		<u>`</u>		
	H ,\⊕						
	\bigtriangleup						
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	•	(\oplus				

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P Q R

(a) R and S

(c) Q and S

(d) P and S

S

2



(b) P and Q



11. The rates of acetolysis for the following norbornyl derivatives are in the order





13. The complementary DNA sequence of the given DNA 5'-G-A-A-T-T-C-3' is:

(a) 5'-C-T-T-A-A-G-3'

- (b) 5'-C-U-U-A-A-G-3'
- (c) 3'-C-T-T-A-A-G-5'

- (d) 3'-G-A-A-T-T-C-5'
- 14. The order of nucleophilicity of the following anions in a $S_N 2$ reaction is:





12.

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18. The compounds those would not respond to tests of both nitrogen and sulfur with sodium fusion extracts are

$ \oplus $ H ₂ N-NH ₃ HSO ₄	H ₂ N NH ₂	$\stackrel{\oplus}{\mathbb{H}_2} \overset{\ominus}{\mathbb{NH}_3} \overset{\ominus}{\mathbb{H}} \overset{\ominus}{\mathbb{NO}_3}$	H ₂ N S				
Ι	II	III	IV				
(a) I and III	(b) III and IV	(c) I and IV	(d) II and IV				
The correct onimaric pair of the following is:							

19. The correct epimeric pair of the following is:



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(c) Q and S

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(d) R and S
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4

20. α -Farnesene shown below is a



- (a) diterpene having two isoprene units
- (b) triterpene having three isoprene units
- (c) triterpene having four isoprene units
- (d) sesquiterpene having three isoprene units.
- 21. For the equilibrium $N_2 + 3H_2 = 2NH_3$, the equilibrium constant, K_p is expressed as

(a)
$$3^{3} K_{p} = \frac{p_{NH_{3}}}{p_{N_{2}}^{2}}$$
 (b) $3^{3} K_{p} = \frac{p_{NH_{3}}^{2}}{p_{N_{2}} p_{H_{2}}^{3}}$ (c) $3^{3} K_{p} = \frac{p_{NH_{3}}^{2}}{p_{N_{2}}^{4}}$ (d) $3^{\frac{3}{2}} K_{p}^{\frac{1}{2}} = \frac{p_{NH_{3}}^{2}}{p_{N_{2}}^{4}}$

- 22. The average speed of H_2 , N_2 and O_2 gas molecules is in the order
 - (a) $H_2 > N_2 > O_2$ (b) $O_2 > N_2 > H_2$ (c) $H_2 > O_2 > N_2$ (d) $N_2 > O_2 > H_2$
- **23.** The enthalpy of vaporization $(\Delta_{vap}H)$ is zero at
 - (a) Boyle temperature (*DVAM*-TN-27-00 (b) critical temperature
 - (c) inversion temperature (d) boiling temperature.
- 24. The half-life of any zero-order reaction is:
 (a) independent of concentration
 (b) proportional to inverse of concentration
 (c) proportional to concentration
 (d) proportional to square of the concentration.
- 25. The molality of $(NH_4)_2SO_4$ solution that has the same ionic strength as 1 mol kg^{-1} solution of KCl is:

(a) $1/3 \mod kg^{-1}$ (b) $1/2 \mod kg^{-1}$ (c) $2/5 \mod kg^{-1}$ (d) $3/5 \mod kg^{-1}$

- 26. The standard enthalpy of formation (Δ_fH⁰₃₀₀) at 1 bar and 300 K for the formation of CF₂ClCF₂Cl (g) from its constituent elements in the standard state is -900 kJ mol⁻¹. Given R = 8.3 JK⁻¹ mol⁻¹, the standard internal energy of formation (Δ_fU⁰₃₀₀) at the same pressure and temperature is:
 (a) -905 kJ mol⁻¹
 (b) -895 kJ mol⁻¹
 (c) 895 kJ mol⁻¹
 (d) 905 kJ mol⁻¹.
- 27. The percent transmittance of a solution having absorbance (optical density) **1**. **0** is:



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The matrix which transforms $\begin{pmatrix} x \\ y \end{pmatrix}$ to $\begin{pmatrix} -y \\ -y \end{pmatrix}$ is 28.

(a)
$$(-1 \ -1)$$
 (b) $\begin{pmatrix} -1 \\ -1 \end{pmatrix}$ (c) $\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$ (d) $\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$

29. A concentration cell with two hydrogen electrodes at two different pressures is depicted as

 $H_2(g)(Pt)|HCl(aq)|H_2(g)(Pt)$

$$\mathbf{P}_{\mathbf{H}_2} = \mathbf{P}_1 \qquad \qquad \mathbf{P}_{\mathbf{H}_2} = \mathbf{P}_2$$

The potential (E_{cell}) of the cell is:

(a)
$$\frac{RT}{F} \ln \frac{p_2}{p_1}$$
 (b) $\frac{RT}{F} \ln \frac{p_1}{p_2}$ (c) $\frac{RT}{2F} \ln \frac{p_2}{p_1}$ (d) $\frac{RT}{2F} \ln \frac{p_1}{p_2}$

An aqueous solution containing 1 g L^{-1} of a polymer exerts osmotic pressure of 30. 4 torr at 300K. Given R = 0.082 L atm, the molar mass $(g \text{ mol}^{-1})$ of the polymer is:

(b) 4564 (c) 4674 (a) 4500 (d) 4800 Attempt ALL the questions. Questions 31 44 (subjective _ questions) carry fifteen marks each.

- 31. (a) Identify the most acidic compound from the following: H_3C-CH_3 , $H_2C=CH_2$ and CH=CH and justify your answer. Draw overlap of the orbitals to show bonding in the most acidic compound using the concept of hybridization.
 - (b) Write a balanced chemical equation to represent acid-base reaction of orthoboric acid in water. Addition of ethylene glycol to aqueous orthoboric acid enhances its acidity.

Explain the above statement using appropriate chemical equation.

- 32. (a) Draw the unit cell structure of NaCl. Calculate the limiting radius ratio of any ionic solid having NaCl like structure.
 - (b) Give molecular formula and structure of the compound formed by reaction of Be(OH)₂ with acetic acid.
- 33. (a) The spin-only magnetic moments of $K_3[Fe(oxalate)_3]$ and $K_3[Ru(oxalate)_3]$ are 5.91 μ_B and 1.73 μ_B , respectively. Write down their ligand field electronic configuration. Justify your answer. Atomic numbers of Fe and Ru are 26 and 44 respectively.
 - (b) Draw the structures of NO_2^+ , NO_2 and NO_2^- . Arrange them in the increasing





order of O-N-O bond angles.

- 34. (a) Show with labels the splitting of d-orbitals in an octahedral ligand field.
 Calculate the CFSE of (i) high spin d⁶ and (ii) low spin d⁶ metal ions in octahedral field.
 - (b) Schematically represent orbital overlaps in metal carbonyls. Show the correct signs of the lobes.
- 35. (a) A coordination compound is composed of one Co(III), one chloride, one sulfate and four molecules of ammonia. The aqueous solution of the compound gives no precipitate when combined with aqueous BaCl₂, while a white precipitate is formed with aqueous AgNO₃ solution. Draw its structure and explain the observations with chemical equations.
 - (b) Draw the structures of dimethylglyoxime (DMGH₂) and its Ni(II) complex formed in aqueous ammonia.
- 36. (a) Write the structures of **E**, **F** and **G** in the following scheme of reactions.
 - CHO CHOH $(CHOH)_2$ $(CHOH)_2$ (CH_2OH) (CH_2OH) (CH_2OH) $(CH_3CO)_2O$ $(C_4H_8O_4)$ $(C_4H_8O_4)$
 - (b) Identify the structures of **H** and **I** in the following synthetic transformation



37. (a) Complete the following reaction sequence with appropriate structures of J, K and L.



(b) Identify the structures of **M** and **N** in the following synthetic transformation



38. (a) In the following reaction scheme, write the structure of **O**, **P** and **Q**.



6

JAM-2012-CY

$$HC \equiv CCH_2CH_2OH \xrightarrow[H^+]{O} O \xrightarrow[C_9H_{14}O_2) P \xrightarrow[2. H^+]{O} Q$$

(b) Given below are structures of some natural products. Identify them as vitamin A, B₆, C and D and classify them according to their classes

(Isoprenoid, Alkaloid, Carbohydrate and Steroid).



39. (a) Write the appropriate structures for **R**, **S** and **T** in the following scheme.



(b) Choose the correct stereoisomer between U and V that would furnish W on controlled hydrolysis. Write the stable conformation of W.



40. The mechanism of isomerization of cyclobutene (CB) to 1, 3-butadiene (BD) is as follows.

$$CB + CB \xrightarrow{k_1} CB^* + CB$$
$$CB^* + CB \xrightarrow{k_{-1}} CB + CB$$
$$CB^* \xrightarrow{k_2} BD$$



(a) Show that the rate law is $\frac{d[DB]}{dt} = \frac{k_2 \cdot k_1 \cdot [CB]^2}{k_{-1} [CB] + k_2}$

- (b) The apparent first-order rate constant, $k_{app} = \frac{k_2 \cdot k_1 \cdot [CB]}{k_{-1} [CB] + k_2}$. At the CB concentration of 1×10^{-5} mol dm⁻³, the value of k_{app} reaches 50 % of its limiting value obtained at very high concentrations of CB. Evaluate the ratio $\frac{k_2}{k_{-1}}$.
- 41. (a) The molar conductance of 0.012 mol dm⁻³ aqueous solution of chloroacetic acid is 100 Ω^{-1} cm² mol⁻¹. The ion conductance of chloroacetate and H⁺ ions are 50 Ω^{-1} cm² mol⁻¹ and 350 Ω^{-1} cm²mol⁻¹, respectively.
 - (i) Calculate degree of dissociation and pK_a of chloroacetic acid
 - (ii) Calculate H⁺ ion concentration in the solution.
 - (b) Sketch the conductivity versus concentration of base curves for the titration of aqueous solutions of acetic acid (i) with NaOH, and (ii) with NH₄OH.
- 42. A solution of a free particle Schrodinger equation $\frac{-h^2}{8\pi^2 m} \frac{d^2\Psi(x)}{dx^2} = E\Psi(x)$ is $\Psi(x) = e^{ikx} = \cos kx + i \sin kx$
 - (a) Derive expressions for energy 'E' and momentum 'p' of the particle.
 - (b) Using the above relations, show that the wavelength (λ) is $\frac{h}{n}$
- 43. (a) Sketch the temperature composition phase diagram at 1 atm pressure for the ethanol-water system.
 - (i) Label all the areas in the diagram.
 - (ii) Indicate the temperature at which the composition of the vapour is same as that of the liquid. What is this mixture known as?
 - (iii) What is the degree of freedom at the corresponding composition?
 - (b) Estimate the pressure necessary to melt ice at -10 °C if the molar volume of liquid water is 18.01 mL and molar volume of ice is 19.64 mL. The entropy change for the melting process is 16.3 JK⁻¹. Assume that the molar volumes and entropy change remain constant in this temperature range.

[100 J = 1 L bar].

8

44. (a) (i) Show that for 'n' moles of a Vander Waals gas, $\left(\frac{\partial U}{\partial v}\right)_{T} = \frac{n^{2}a}{v^{2}}$

(ii) Can a gas that obeys the equation of state p(V - nb) = nRT be liquefied? Explain.





(b) Consider ideal mixing of 2 moles of toluene and 2 moles of benzene at 1 atm and 300K. Calculate the values of $\Delta_{mix}V$, $\Delta_{mix}U$, $\Delta_{mix}H$, $\Delta_{mix}G$ and $\Delta_{mix}S$ for the process. (ln 2 = 0.69)

Answer Key

Q.No	Ans	Q.No	Ans		Q.No	Ans	Q.No	Ans
1.	b	9.	d		17.	b	25.	а
2.	а	10.	С		18.	а	26.	b
3.	d	11.	d		19.	а	27.	b
4.	С	12.	С		20.	d	28.	d
5.	С	13.	С		21.	С	29.	d
6.	d	14.	b	l.	22.	а	30.	С
7.	b	15.	а	TE	23.	b		
8.	d	16.	b	GRIZ	24.	С		

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