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JAM – Chemistry - 2005



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For this reaction, the relationship between
$$k_r$$
 and k_i is:
(a) $k_i = 2 \times k_r$ (b) $k_i = (1/2) \times k_r$ (c) $k_i = k_r$ (d) $k_i = (1/3) \times k_r$
7.
DNA Ba(OH)₂ (P)
MgO/ Δ
PO₄³⁻ + (Q) HCl (R) + (S) + sugar
In the scheme shown above (P), (Q), (R) and (S) are
(a) (P) = purine bases, (b) (P) = nucleotides,
(Q) = pyrimidine bases, (Q) = nucleotides,
(R) = nucleotides, (R) = purine bases,
(S) = nucleosides,
(Q) = nucleosides,
(R) = purine bases.
8. The products obtained from the following reaction are
Ph⁺O_CH + C₂H₅¹⁸OH (d) Ph⁺H₂¹⁸O_H + C₂H₅¹⁸OH
(c) Ph⁺O_H + C₂H₅¹⁸OH (d) Ph⁺H₂¹⁸O_H + C₂H₅¹⁸OH
9. The product(s) obtained in the following reaction is (are)



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(d)





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10. Match the isoelectric points with the amino acids

	Amino acid					Isoelectric point			
	(P)	P) H ₂ NCH ₂ COOH			(I)		9.5		
	(Q) HOOCCH ₂ CH ₂ CH(NH ₂)COOH) COOH	(II)		6.0		
	(R) $H_2N(CH_2)_4CH(NH_2)COOH$				(III)		3.1		
		I							
	(a)	P-II ;	Q – III ; R	GATE	(b) P	–III ;	Q – I	; $R-II$	
	(c)	P-I ;	Q – II 🔅 R	- III	(d) P	-II ;	Q – I	; R – III	
11.	The c	compound	having the hig	hest meltin	g point is	Z			
	(a) Li	Cl	(b) LiF		(c) LiI	SE	(d) LiBr	
12.	The g	geometry o	f SF ₄ is		\ltimes				
	(a) tet	rahedral	(b) trigonal	bipyramidal	(c) sq	uare plan	ar	(d) octahedral	
13.	The d	legree of h	ydration is exp	pected to be	e maximun	n for			
	(a) Mg^{2+} (b) Na^{+} (c) Ba^{2+} (d) K^{+}								
14.	The decreasing order of the first ionization energy of the following elements is								
	(a)	Xe > E	Be > As >	Al 🌺	(b) Xe	> As	> Al	> Be	
	(c)	Xe > A	As > Be >	Al	(d) Xe	> Be	> Al	> As	
15.	The r	adioactive	isotope used t	o locate bra	ain tumors	is			
	(a) ${}_{1}^{2}$ D)	(b) ¹⁵ ₇ N	(c) $^{131}_{53}$ I	((d) $^{13}_{6}$ C			
16.	The crystal field stabilization energy of high spin d ⁷ octahedral complex is							plex is	
	(a) $\frac{-4}{5}$	Δ_0	$(b) \frac{-4}{5} \Delta_0 + 3$	3P	$(c)\frac{-9}{5}\Delta_0 -$	+ 2P	(d)	$\frac{-9}{5}\Delta_0 + 3P$	
17.	The complex with the most intense colour among the following is								
	(a) [F	eF ₆] ^{3−}	(b) [MnCl ₄]	2- (0	c) $[CoCl_4]^{2-1}$	-	(d) [Co	$[F_6]^{3-1}$	
18.	On a	ddition of	a solution of	AgNO ₃ to	a solution	of Na ₂ S	$_{2}0_{3}$, it	turns black on	
	standing due to the formation of								
	(a) Ag		(b) Ag_2S	5	(c) Ag ₂	$S_{2}O_{3}$		(d) Ag_2SO_4	
19.	Amor	ng the follo	owing complex	es, the ones	s that show	chirality	are		
			[Ru(bipyridy	'l) ₃] ⁺	[Cr(EDTA)] ⁻				
	(i)				(ii)				



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	trar	ns- $[CrCl_2(oxalate)_2]^{3-}$	$cis-[CrCl_2(oxalate)_2]^{3-}$					
		(iii)	(iv	7)				
	(a) (i), (ii), (iv)	(b) (i), (ii), (iii)	(c) (ii), (iii), (iv)	(d) (i), (iii), (iv)				
20.	The electronic configurations that have orbital angular momentum contribution							
	in an octahedral environment are							
	(a) d ¹ and High	spin d ⁴	(b) d^1 and d^2					
	(c) d^2 and Low s	spin d ⁶	(d) High spin d^4 and	High spin d ⁶				
21.	For an <mark>ideal sol</mark>	or an ideal solution formed by mixing of pure liquids A and B						
	(a) $\Delta H_{\text{mixing}} = 0$	$(b) \Delta H_{\text{mixing}} < 0$	(c) $\Delta H_{\text{mixing}} > 0$	(d) $\Delta S_{\text{mixing}} = 0$				
22.	The relationshi	p between the equilibriu	<mark>um constant</mark> K ₁ for t	he reaction:				
	$GATE GATE GATE GATE GO_(g)$							
	and the equilibri	ium agentant IZ for th						
	and the equilibrium	\approx	e reaction is,					
		2CO(g) + O ₂ (g)		1)				
	(a) $2K_1 = K_2$	(b) $K_1 = K_2^2$	(c) $K_1 = K_2$	(d) $K_1^2 = K_2$				
23.	For H-like atoms, the ground state energy is proportional to							
	(Where μ is the reduced mass and Z is nuclear charge)							
	(a) $\frac{\mu}{a}$	(b) $\frac{z^2}{z}$	$(c) \mu Z^2$	$(d)\frac{1}{d}$				
24	$\sum_{i=1}^{n} Z^{2}$	μ	12	¢ γ μΖ ²				
47.	The value of the integral e^{-x^2} ux is							
	(a) $x^2e^{-x} + 2xe^{-x} + 2e^{-x}$ (b) $\frac{1}{2}(x^2e^{-x} + 2xe^{-x} + 2e^{-x})$							
	(c) $\frac{1}{2}(x^2e^{-x}+2)$	$xe^{-x} + 2e^{-x}$) (d	$) - x^2 e^{-x} - 2x e^{-x} - $	2e ^{-x}				
25.	For the reaction $\alpha A \rightarrow$ products, the plot of $\frac{1}{[A]}$ versus time (t) gives a straight line.							
	The order of the reaction is							
	(a) 0	(b) 1	(c) 2	(d) 3				
26.	The pH of a sol	ution prepared from 0.	005 mole of Ba(OH)	₂ in 100 cc water is				
	(a) 10	(b) 12	(c) 11	(d) 13				
27.	For an electron	whose x-positional uno	certainty is 1×10^{-1}	¹⁰ m, the uncertainty in				
	the x-component of the velocity (in ms ⁻¹) will be of the order of							
		(Data	$m_e = 9 \ \times \ 10^{-31} l$	kg, $h = 6.6 \times 10^{-34}$ Js)				
	(a) 10 ⁶	(b) 10 ⁹	(c) 10 ¹²	(d) 10 ¹⁵				
28.	For the following	ng system in equilibriun	1					
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	•	\bigoplus						



$$CaCO_3(s)$$
 \frown $CaO(s) + CO_2(g)$

the number of components (C), phases (P) and degrees of freedom (F), respectively, are

- 29. For the distribution of molecular velocities of gases, identify the correct order from the following (where v_{mp} , v_{av} and v_{rms} are the most probable velocity, average velocity and root mean square velocity, respectively):
 - (a) $v_{rms} > v_{av} > v_{mp}$ (b) $v_{mp} > v_{rms} > v_{av}$
 - (c) $v_{av} > v_{rms} > v_{mp}$ (d) $v_{mp} > v_{av} > v_{rms}$

30. Given that $E_{Fe^{2+}/Fe}^0 = -0.44 \text{ V}$ and $E_{Fe^{3+}/Fe^{2+}}^0 = 0.77 \text{ V}$, the $E_{Fe^{3+}/Fe}^0$ is

(a)
$$1.21 \text{ V}$$
 (b) 0.33 V (c) -0.036 V (d) 0.036 V

<u>Attempt ALL the questions. Questions 31 – 44 (subjective questions)</u> <u>carry fifteen marks each.</u>

31. Identify the major product(s) formed in the following reactions. Intermediates and reaction mechanisms need not be discussed.



- **32.** How may the following transformations be effected? Indicate the reagents/reaction conditions clearly in each step.
 - (a) (not involving any functional group transformation of the COOH group in the starting material)



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(b) (using diethyl malonate as the only source of carbon)





33. Suggest a suitable mechanism for each of the following reactions.





- **34.** Rationalize the following observations using suitable mechanisms.
 - (a) Nitration of 4-t-butyltoluene gives 4-nitrotoluene as one of the products.

CL

(b) cis-4-t-butylcyclohexyltrimethylammonium hydroxide undergoes Hoffman elimination to yield 4-t-butylcyclohexene whereas the trans isomer does not. (use conformations to explain).

(c) PhMgBr + 2 PhCHO
$$\frac{1. \text{ dry ether}}{2. \text{ acidic workup}}$$
 PhCOPh + PhCH₂OH

- 35. (a) Suggest a chemical method for the separation of a mixture containing p-N,N-dimethylaminophenol and p-aminobenzoic acid and give a confirmatory test for phenol.
 - (b) Write the structures of X, Y and Z in the following.



36. (a) Predict the hybridization and draw the structure of the following molecules based on VSEPR theory:



(i) I_3^- (ii) SO_3^{2-} (iii) $P(CH_3)_3F_2$

- (b) Explain why PCl₅ exists and PH₅ does not.
- 37. (a) Write balanced equations for the formation of
 - (i) $P_2 O_7^{4-}$ from PO_4^{3-}
 - (ii) $[(H_2O)_4Fe(OH)_2Fe(H_2O)_4]^{4+}$ from $[Fe(H_2O)_6]^{3+}$
 - (b) Which one of the two solutions has lower pH? Justify your answer.
 - (i) 0.1 M Fe(ClO₄)₂ or 0.1 M Fe(ClO₄)₃
 - (ii) 0.1 M Hg(NO₃)₂ or 0.1 M Zn(NO₃)₂
- (a) Between $[Cu(H_2O)_6]^{2+}$ and $[Co(H_2O)_6]^{2+}$, which one has more distorted 38. structure and why?
 - (b) Calculate CFSE (in units of Δ_0) and spin only magnetic moment for the following complexes:

(i)
$$[CoF_6]^{3-}$$
 (ii) $[Fe(CN)_6]^{3-}$ (iii) $[NiCl_4]^{2-}$

- (a) The radioactive element Ra (Z = 88) emits three alpha particles in 39. succession. Deduce in which group the resulting element will be found?
 - (b) A radioisotope sample has an initial activity of 23 dis/min. After $\frac{1}{2}$ h, the activity is 11.5 dis/min. How many atoms of the radioactive nuclide were present originally? $\left[\alpha t_{1/2} = 0.69\right]$
- (i) $CH_3I + H0^- \rightarrow$ (ii) $CF_3I + H0^- \rightarrow$ (a) Write the products of the following reactions: **40.**

 - (iii) $2CF_3I + Na[Mn(CO)_5] \rightarrow$
 - (b) Arrange BF₃, BCl₃ and BBr₃ in the increasing order of Lewis acidity and justify.
- **41.** Justify the following:
 - (a) Considering CO₂ as an ideal gas, equipartition theorem predicts its total energy as 6.5 kT.
 - (b) ΔS for a process is the same whether the process takes place reversibly or irreversibly.
 - The quantity ΔG equals the maximum non-expansion work done by a **(c)** system in a constant temperature – pressure process.
 - (d) At constant temperature and pressure, $\Delta G = 0$ for a reversible phase



change.

- (e) Transition states cannot be isolated as independent chemical species.
- 42. The rate constant k for a second order reaction, $P + Q \rightarrow Products$ is expressed as $\log_{10} k = 20 - \frac{3000}{T}$, where the concentration is in mol lit⁻¹, T is in absolute temperature and time is in minutes. The initial concentrations of both the reactants are 0.05 M. Calculate the activation energy and half life of the reaction at 27°C. (R = 2 cal K⁻¹mol⁻¹).
- 43. The equilibrium constant for the reaction

$$\operatorname{Fe_3O_4}(s) + \operatorname{CO}(g) \longrightarrow 3 \operatorname{FeO}(s) + \operatorname{CO_2}(g)$$

at 600 °C is 1.00. If a mixture initially consisting of 1 mole of Fe_3O_4 , 2 moles of CO, 0.5 mole of FeO and 0.3 mole of CO_2 is heated to 600 °C at constant total pressure of 5 atmospheres, how many moles of each substance would be present at equilibrium?

- 44. (a) Use the time-independent Schrödinger equation to calculate the energy of a particle of Mass "m" with V = 0 in the state, $\Psi = \sqrt{\frac{8}{a^3}} \sin \frac{\pi x}{a} \sin \frac{\pi y}{a} \sin \frac{\pi z}{a}$ in a cubical box of length "a".
 - (b) At 20 °C, the vapor pressure of two pure liquids X and Y which form an ideal solution are 70 torr and 20 torr respectively. If the mole fraction of X in solution is 0.5, find the mole fractions of X and Y in the vapor phase in equilibrium with the solution.

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

Answer Key

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