

# TEST SERIES UGC-CSIR-NET/JRF Dec. 2016

BOOKLET SERIES **A**

Paper Code **01**

Test Type: **TEST SERIES**

## CHEMICAL SCIENCES

Duration: 2:00 Hours

Date: 22-11-2016

Maximum Marks: 220

Read the following instructions carefully:

\* Single Paper Test is divided into TWO Parts.

**Part - A:** This part shall carry 30 questions. Each question shall be of 2 marks.

**Part - B:** This part shall contain 40 questions. Each question shall be of 4 marks.

\* Darken the appropriate bubbles with HB pencil/Ball Pen to write your answer.

\* There will be negative marking @25% for each wrong answer.

\* The candidates shall be allowed to carry the Question Paper Booklet after completion of the exam.

\* For rough work, blank sheet is attached at the end of test booklet.



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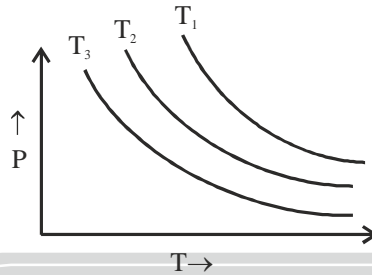
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## PART-A

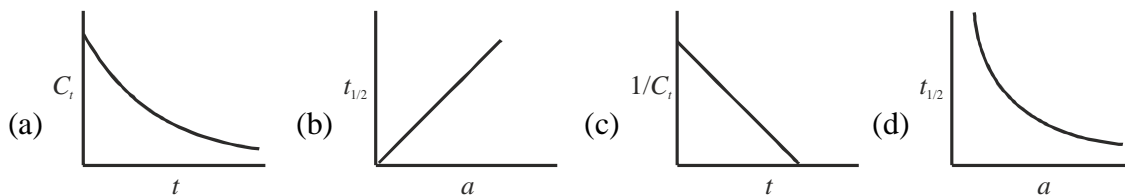
- Which of the following molecules would show alternate lines in Rotational Vibrational Spectrum  
(a) HCl (b) BrF<sub>3</sub> (c) O<sup>18</sup> = C = O<sup>16</sup> (d) none of these
- Which of the following molecule can show pure rotational spectrum O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CH<sub>4</sub>, SiH<sub>4</sub>, SF<sub>6</sub>  
(a) CO<sub>2</sub>, CH<sub>4</sub> (b) SiH<sub>4</sub> (c) SF<sub>6</sub>, since it loses its symmetry during rotation  
(d) CH<sub>4</sub>, since it shows dipole moment of 8.3 μD during rotation
- A molecule having 5 vibrational modes their frequency are  $\bar{\nu}_1$ ,  $\bar{\nu}_2$  and  $\bar{\nu}_3$ , the second and the third being doubly degenerate modes, then vibrational partition function is  
(a)  $q = 4q(\bar{\nu}_1)q(\bar{\nu}_2)q(\bar{\nu}_3)$  (b)  $q = q(\bar{\nu}_1)q^2(\bar{\nu}_2)q^2(\bar{\nu}_3) / 2!2!$   
(c)  $q = \frac{1}{4}q(\bar{\nu}_1)q(\bar{\nu}_2)q(\bar{\nu}_3)$  (d)  $q = q(\bar{\nu}_1)q^2(\bar{\nu}_2)q^2(\bar{\nu}_3)$
- $q_{trans} = \frac{V}{\Lambda^3}$  is only valid when separation distance between molecule (d) and thermal wavelength ( $\Lambda$ ) related as  
(a)  $d = \Lambda$  (b)  $d \gg \Lambda$  (c)  $d \ll \Lambda$  (d)  $d \geq \Lambda$
- On doubling the coefficient of the cell reaction,  
(a)  $\Delta G$  doubles,  $E_{cell}$  doubles (b)  $\Delta G$  remain same, E double  
(c)  $\Delta G$  doubles,  $E_{cell}$  remain same (d)  $\Delta G$  and  $E_{cell}$  remain same
- Ionic mobility decrease with  
(a) decrease in potential gradient (b) increase in charge number of ion  
(c) increase in temperature (d) decrease in viscosity of solvent
- A sparingly soluble electrolyte  $M_3X_4$  ionises as  
$$M_3X_4 \rightleftharpoons 3M^{4+} + 4X^{3-}$$
  
Then molal solubility (s) and molal activity coefficient ( $\gamma_{\pm}$ ) are related by solubility product as  
(a)  $K_{sp} = 4s^3\gamma_{\pm}^3$  (b)  $K_{sp} = 27s^3\gamma_{\pm}^5$  (c)  $K_{sp} = 6912s^7\gamma_{\pm}^7$  (d)  $K_{sp} = 10412s^9\gamma_{\pm}^9$
- The vapour pressure of Bromine is 100 torr at 9.30°C and enthalpy of vaporisation is 30.91 kJ mol<sup>-1</sup>. The normal boiling point of Br<sub>2</sub> is  
(a) 390K (b) 258K (c) 331K (d) 400K
- The correct criterion of spontaneity is  
(a)  $(dG)_{P,T} > 0$  (b)  $(dG)_{V,T} < 0$  (c)  $(dG)_{P,T} < 0$  (d)  $(dG)_{V,T} > 0$
- In which of the following system,  $\Delta U = 0$   
(a) open system (b) closed system (c) adiabatic system (d) isolated system
- If  $K < Q$ , where, K = equilibrium constant.  
Q = reaction quotient  
The reaction move in which direction to achieve equilibrium  
(a) forward direction (b) backward direction  
(c) already in equilibrium (d) cannot be predicted
- The effect of which variable is ignored for the study of two-component system  
(a) temperature (b) composition  
(c) temperature and pressure (d) pressure



13. The number 0.0008 has significant figures :  
 (a) 3 (b) 8 (c) 4 (d) 1
14.  $\frac{P_C V_C}{RT_C} = 0.375$ , for real gases the value of  $\frac{P_C V_C}{RT_C}$  does not agree with 0.375. It is due to  
 (a) Vander waal equation is accurate at all state  
 (b) Vander waal equation is not very accurate near the critical states  
 (c) Gas starts obeying ideal gas equation  
 (d) It is due to calculation error
15. The relation of temperature for the given plot is

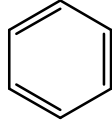


- (a)  $T_1 < T_2 < T_3$  (b)  $T_2 < T_1 < T_3$  (c)  $T_1 < T_3 < T_2$  (d)  $T_3 < T_2 < T_1$
16. Number of two fold degenerate irreducible representations for  $D_{4h}$  point group is two. What is the correct number of non-degenerate irreducible representation?  
 (a) Ten (b) Eight (c) Six (d) Five
17. The polymer having random sequence of D and L configurations are  
 (a) isotactic polymers (b) syndiotactic polymers  
 (c) Atactic polymers (d) Grafted polymers
18. The study of structure behaviour crystallinity and phase transitions of polymers is  
 (a) polymer topology (b) polymer morphology  
 (c) polymer tropology (d) none of these
19. In a cubic crystal, the value of  $d_{123}$  is 400 pm. The Edge length of the unit cell is approximately  
 (a) 1500 pm (b) 1000 pm (c) 500 pm (d) 50 pm
20. The correct plot for a second order reaction is



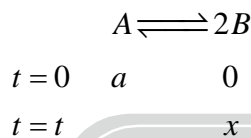
21. A first order reaction is 25% completed in 25 mins. The rate constant is  
 (a)  $1.15 \times 10^{-2} \text{ min}^{-1}$  (b)  $3.15 \times 10^{-2} \text{ liter mole}^{-1} \text{ min}^{-1}$   
 (c)  $4.15 \times 10^{-2} \text{ sec}^{-1}$  (d)  $2.25 \times 10^{-3} \text{ min}^{-1}$
22. The commutation  $\left[ x, \left[ x, \hat{H} \right] \right]$  is equal to  
 (a)  $-\hbar^2$  (b)  $-\frac{\hbar^2}{m}$  (c)  $-\frac{\hbar^2}{2m}$  (d) none

23. The time derivative of the expectation value of  $x^2$  is  
 (a)  $\frac{1}{2m} \langle Xp_x \rangle$  (b)  $\frac{1}{2m} \langle Xp_x + p_x X \rangle$  (c)  $\frac{1}{m} \langle Xp_x + p_x X \rangle$  (d) zero
24. The number of unit cells in 1g of a NaCl crystal is  
 (a)  $1.5 \times 10^{23}$  (b)  $1.50 \times 10^{21}$  (c)  $2.57 \times 10^{21}$  (d) none
25. According to Hückel theory of conjugated systems, the free valence at any electron of benzene



is

- (a) 0.20 (b) 0.40 (c) 0.60 (d) 0.80
26. For the following reversible reaction



The relaxation time ( $\rho$ ) is

- (a)  $\frac{1}{k_1 + k_{-1}}$  (b)  $\frac{1}{k_1 + k_{-1}(x_e)}$  (c)  $\frac{1}{k_1(4a_e) + k_{-1}}$  (d)  $\frac{1}{k_1\left(\frac{1}{2}\right) + k_{-1}(2x_e)}$
27. According to Arrhenius equation for  $n^{\text{th}}$  order reaction  
 (a)  $t_{1/2}$  is independent of temperature (b)  $t_{1/2}$  increases with increase in temperature  
 (c)  $t_{1/2}$  decreases with increase in temperature (d)  $t_{1/2}$  decreases with decrease in temperature
28. The incorrect matches is/are

**Isotherm**

(I) Langmuir

(II) Gibbs

(III) Freundlich

(IV) Temkin

(a) II and III

(b) I, II and IV

(c) III and IV

(d) II, III and IV

**Adsorption equation**

$$\theta = \frac{kP}{1 + kP}$$

$$\theta = kP^{1/n}$$

$$\theta = c_1 \ln(c_2 P)$$

$$\theta = -\frac{\partial \gamma}{\partial u_2}$$

29. Regarding B.E.T. equation, the B.E.T. constant can be expressed as

(a)  $K_1 P_0$

(b)  $\frac{K_1}{P_0}$

(c)  $\frac{K_L}{P_0}$

(d)  $K_L P_0$

30. In case of lattice point at the face centre in a F.C.C. lattice, the C.N. is

(a) 6, 6 from adjacent edge centres

(b) 8, 4 from adjacent corners and 4 from adjacent face centres

(c) 12, 4 from adjacent corners and 8 from adjacent face centres

(d) 12, 8 from adjacent corners and 4 from adjacent face centres



## PART-B

31. Consider given data

$v' - v''$	1-0	2-1	3-2	4-3	5-4
$G(v+1) - G(v) / \text{cm}^{-1}$	2143.1	2116.1	2088.9	2061.3	2033.5

where,  $v'$  and  $v''$  are vibrational quantum numbers of excited state and corresponding ground state and the  $\{G(v+1) - G(v)\}$  is different between adjacent energy levels.

- (a) 87 kJ                      (b) 10442.9  $\text{cm}^{-1}$                       (c) 87  $\text{kJ mol}^{-1}$                       (d) 10442.9 kJ

32. The HCl molecule is well described by the Morse-Potential with  $D_e = 5.33 \text{ eV}$ ,  $\bar{\nu} = 2989.7 \text{ cm}^{-1}$ ,  $x\bar{\nu} = 52.05 \text{ cm}^{-1}$ . Assuming that the potential is unchanged on deuteration the dissociation energy of HCl and DCl

- (a) 6.24 eV, 6.29 eV                      (b) 5.14 eV and 5.198 eV  
(c) 5.3 eV and 5.13 eV                      (d) 6.3 eV and 6.31 eV

33. The translational, rotational and vibrational partition functions for a molecule are  $f_{\text{trans}} = 10^{10}$ ,  $f_{\text{rotation}} = 10$ ,

$$f_{\text{vibration}} = 1. \frac{k_B T}{h} = 10^{13} \text{ at room temperature, } N_A = 6 \times 10^{23}.$$

Using approximate data given above, the frequency factor (A) for a reaction type.



According to conventional transition state theory is

- (a)  $2 \times 10^5$                       (b)  $2 \times 10^{12}$                       (c)  $6 \times 10^5$                       (d)  $6 \times 10^{14}$

34. The total energy of N two level system having energy level 0,  $\epsilon$  is

- (a)  $\frac{N e^{-\beta\epsilon}}{1 + e^{-\beta\epsilon}}$                       (b)  $\frac{N e^{-2\beta\epsilon}}{1 + e^{-\beta\epsilon}}$                       (c)  $\frac{\epsilon^N}{1 + e^{-\beta\epsilon}}$                       (d)  $\frac{N\epsilon}{1 + e^{\beta\epsilon}}$                       where,  $\beta = \frac{1}{RT}$

35. For polarographic experiment, the current corresponds to  $E_{1/2}$  for 0.01M solution of divalent cation is  $10 \mu\text{A}$ . When solution of the same ion is  $10^{-4} \text{ M}$ , the current flow is  $0.05 \mu\text{A}$  on applying potential of  $-0.142 \text{ V}$ . The  $E_{1/2}$  for  $10^{-4} \text{ M}$  solution is

- (a) 0.128V                      (b) -0.128V                      (c) 0.156V                      (d) -0.156V

36. The pH of solution on the electrolysis of 10L of aqueous solution of  $\text{Na}_2\text{SO}_4$  when 1F of electricity is passed through it is

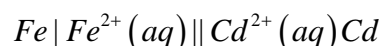
- (a) 4.6                      (b) 7                      (c) 8.3                      (d) 10.4

37. The  $E_{\text{reduction}}^0$  for Cu|CuS electrode is

$$\text{Given : } K_{sp} \text{ of CuS} = 8 \times 10^{-36}; E_{\text{Cu}^{2+}/\text{Cu}}^0 = 0.34 \text{ V}$$

- (a) 0.56                      (b) -0.43                      (c) 0.23V                      (d) -0.71V

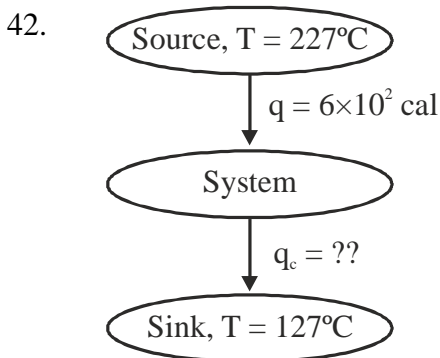
38. If temperature coefficient of  $E_{\text{cell}}$  is  $-0.125 \text{ VK}^{-1}$ . The  $\Delta S$  for the given cell at  $25^\circ\text{C}$  is



- (a)  $-26.125 \text{ kJK}^{-1}$                       (b)  $-24.125 \text{ kJK}^{-1}$                       (c)  $-22.125 \text{ kJK}^{-1}$                       (d)  $-20.125 \text{ kJK}^{-1}$

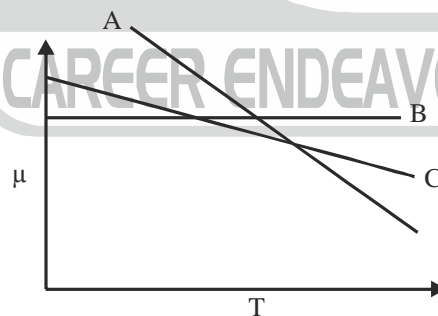


39. A thermometer of mass 0.055kg and heat capacity 46.1 J/K reads 15°C. It is then immersed in 0.3kg of water and it comes to the same final temperature as that of water. If thermometer reads 44.4°C, then the temperature of water before insertion of thermometer is (neglecting other heat losses) (heat capacity of  $H_2O/l = 4.18 JK^{-1}g^{-1}$ )  
 (a) 95°C (b) 72°C (c) 55.7°C (d) 45.5°C
40. The change in entropy of one mole of ice at 0°C when it is heated to 50°C at constant pressure is  $\Delta H_{fus} = 333.5 J/g$ ,  $C_{v,m} = 75.24 JK^{-1}mol^{-1}$   
 (a) 40  $JK^{-1}mol^{-1}$  (b) 36.5  $JK^{-1}mol^{-1}$  (c) 14.56  $JK^{-1}mol^{-1}$  (d) 22  $JK^{-1}mol^{-1}$
41. A quantity of air at 27°C and atmospheric pressure is suddenly compressed to half its original volume adiabatically. The final pressure is  $\left( C_{p,m} = \frac{7}{2}R \right)$   
 (a) 1.6 atm (b) 2.6 atm (c) 0.5 atm (d) 1 atm



The amount heat lost by system is

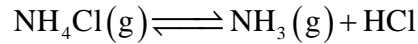
- (a) 100 calorie (b) 120 calorie (c) 480 calorie (d) 150 calorie
43. For the below diagram, which statement is correct



- (a) A represents change in  $\mu$  as a function of temperature for solid phase  
 (b) A represents change in  $\mu$  as a function of temperature for liquid phase  
 (c) A represents change in  $\mu$  as a function of temperature for gas phase  
 (d) B represents change in  $\mu$  for liquid phase
44. For the equilibrium,  $N_2 + 3H_2 \rightleftharpoons 2NH_3$ , the  $k_p$  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)  $3^4 k_p = \frac{P_{NH_3}}{P_{N_2}^3}$

45. The number of component for the reaction,



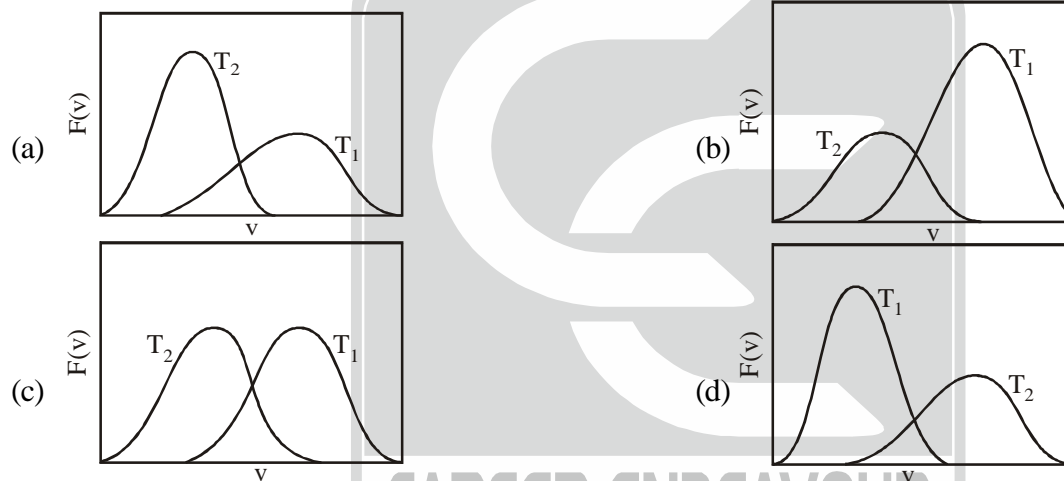
in vacuum is

- (a) 1 (b) 2 (c) 3 (d) 4
46. The mean ( $\bar{x}$ ) variance ( $\sigma^2$ ) and standard deviation ( $\sigma$ ) for the numbers 2, 4, 6, 8 is respectively
- (a) 5, 25, 5 (b) 5, 5,  $\sqrt{5}$  (c) 4, 16, 4 (d) 5, 1, 1
47. There are many phenomenon where changes in one variable are related to changes in other variables. The way the variables are related is measured by finding their correlation coefficient ( $r$ ), so if data for 'x' and 'y' are dependent on each other, then correlation coefficient ( $r$ ) is given by

[ $X = x - \bar{x}$ ,  $Y = y - \bar{y}$ ,  $\sigma_x = \text{std. deviation of 'x'}$   $\sigma_y = \text{std. deviation of y}$ ,  $n = \text{no. of values of x and y}$ ]

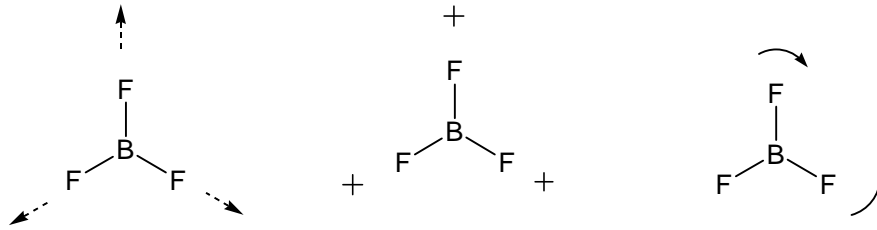
(a)  $r = \frac{\sum XY}{n\sigma_x\sigma_y}$  (b)  $r = \frac{n\sigma_x\sigma_y}{\sum XY}$  (c)  $r = n\sigma_x\sigma_y$  (d)  $r = \frac{\sum X\sum Y}{n\sigma_x\sigma_y}$

48. For temperature  $T_1 > T_2$ , the qualitative temperature dependence of the probability distribution  $F(v)$  of the speed  $v$  of a molecule in three dimensions is correctly represented by the following figure:



49. How much does the total angular momentum quantum number  $J$  change in the transition of  $\text{Cr}(3d^6)$  atom as it ionizes to  $\text{Cr}^{2+}(3d^4)$ ?
- (a) increases by 2 (b) decreases by 2 (c) decreases by 4 (d) does not change
50. In a Gouy-Chapman diffuse layer the **incorrect** option in the favour of thickness ( $r_D$ ) is
- (1) Thickness is proportional to density  
 (2) Proportional to ionic strength  
 (3) Inversely proportional to dielectric constant.  
 (4) Proportional to temperature.
- (a) 1, 2, 3 (b) 2, 3 (c) 1, 4 (d) 1 only
51. For Heavier gases,  $Z < 1$  at low pressure because
- (a) at critical temperature, gas starts change to liquid  
 (b) gas attain to Boyle temperature  
 (c) they are difficult to liquify  
 (d) strong force of attraction exist between gas molecule

52. The character table of  $D_{3h}$  group is given below. What is the symmetry type of normal modes given below.



	E	$2C_3$	$3C_2'$	$\sigma_h$	$2S_3$	$3\sigma_v$	linear rotations	quadratic
$A_1'$	1	1	1	1	1	1		$x^2 + y^2, z^2$
$A_2'$	1	1	-1	1	1	-1	$R_z$	
$E'$	2	-1	0	2	-1	0	$(x, y)$	$(x^2 - y^2, xy)$
$A_1''$	1	1	1	-1	-1	-1		
$A_2''$	1	1	-1	-1	-1	1	$z$	
$E''$	2	-1	0	-2	1	0	$(R_x, R_y)$	$(xz, yz)$

- (a)  $A_1'$   $A_2''$  and  $E''$  respectively  
 (b)  $A_1'$   $E''$  and  $A_2''$  respectively  
 (c)  $A_1'$   $A_2''$  and  $E'$  respectively  
 (d)  $A_2'$   $E''$  and  $A_2''$  respectively

53. The surface tension of dilute solutions of a solute varies with the solute concentration as

$$\gamma = \gamma_0 - a \ln c_2$$

The surface excess is given by

- (a)  $aRT$       (b)  $\frac{RT}{a}$       (c)  $\left(\frac{\gamma_0 - \gamma}{\ln c_2}\right)RT$       (d)  $\left(\frac{\gamma_0 - \gamma}{\ln c_2}\right)\frac{1}{RT}$

54. A solution of a compound ( $M = 250 \text{ gmol}^{-1}$ ) in Benzene contains 4g of the compound per litre. When this solution is dropped on a water surface, the benzene evaporates and the compound forms a mono layer film of the solid type. In order to cover an area of  $400 \text{ cm}^2$  with a monolayer, the volume of solution that should be used in litre is (The area covered by one molecule of the compound is  $0.25 \text{ nm}^2$ )

- (a)  $21.6 \times 10^{-5}$       (b)  $12.16 \times 10^{-5}$       (c)  $16.6 \times 10^{-5}$       (d)  $1.66 \times 10^{-5}$

55. In Langmuir theorem of adsorption the values of intercept and slope was found to be  $9.25 \text{ cm}^{-3}$  and  $11.25 \times 10^{-2} \text{ Pa cm}^{-3}$  respectively. The value of langmuir constant (K) is

- (a)  $1.21 \times 10^{-2} \text{ Pa}^{-1}$       (b)  $12.21 \times 10^{-2} \text{ Pa}^{-1}$       (c)  $82.22 \text{ Pa}^{-1}$       (d)  $8.222 \text{ Pa}^{-1}$

56. In sphalerite structure,

- (a) All Td Vds and half Oh Vds are occupied  
 (b) Half Td Vds and all Oh Vds are occupied  
 (c) Only all Td Vds are occupied  
 (d) Only half Td Vds are occupied

57. Equal masses of polymer molecules with  $M_1 = 10000$  and  $M_2 = 20000$  are mixed. The P.D.I. (Polydispersity Index) is

- (a) 11.25      (b) 1.125      (c) 21.25      (d) 2.125





58. In the sequential reaction,  $A \xrightarrow{k_1} B \xrightarrow{k_2} C$

the time at which the intermediate B reaches its maximum concentration is

- (a)  $\frac{\ln\left(\frac{k_1}{k_2}\right)}{k_2}$       (b)  $\frac{\ln\left(\frac{k_2}{k_1}\right)}{k_1}$       (c)  $\frac{\ln\left(\frac{k_1}{k_2}\right)}{k_1 k_2}$       (d)  $\frac{\ln\left(\frac{k_1}{k_2}\right)}{k_1 - k_2}$

59. At higher concentrations, we observe deviations from Lambert's Beer law. Then the quantity which remains constant in place of  $\epsilon$  is

- (a)  $\epsilon^2$       (b)  $\left[\frac{n}{n+2}\right]\epsilon$       (c)  $\left[\frac{n}{(n+2)^2}\right]\epsilon$       (d)  $\left[\frac{n}{(n+2)^2}\right]\epsilon^2$

60. Insulin forms crystals of orthorhombic type with unit cell dimensions of  $13 \text{ nm} \times 7.48 \text{ nm} \times 3.09 \text{ nm}$ . If the density of the crystal is  $2 \times 10^3 \text{ kg m}^{-3}$  and there are 5 insulin molecules per unit cell, the molar mass of insulin is in  $\text{kg mole}^{-1}$ .

- (a) 72.3896      (b) 723.896      (c) 7.23896      (d) none

61. The following Rice-Herzfeld mechanism has been proposed for the gas phase pyrolysis of methane

- (i)  $\text{CH}_4 \xrightarrow{k_1} \dot{\text{C}}\text{H}_3 + \text{H}^\bullet$       (ii)  $\text{CH}_3^\bullet + \text{CH}_4 \xrightarrow{k_2} \text{C}_2\text{H}_6 + \text{H}^\bullet$   
 (iii)  $\text{H}^\bullet + \text{CH}_4 \xrightarrow{k_3} \text{CH}_3^\bullet + \text{H}_2$       (iv)  $\text{H}^\bullet + \text{CH}_3^\bullet + \text{M} \xrightarrow{k_4} \text{CH}_4 + \text{M}$

In the last reaction M is a molecule ( $\text{CH}_4$  or  $\text{C}_2\text{H}_6$ ) which can carry away the energy of recombination of  $\text{H}^\bullet$  and  $\text{CH}_3^\bullet$ . Assuming SSA for  $\text{H}^\bullet$  and  $\text{CH}_3^\bullet$ . The overall activation energy of the reaction is

- (a)  $\frac{1}{3}[E_1 + E_2 + E_3 + E_4]$       (b)  $\frac{1}{3}[E_1 + E_3 - E_2 - E_4]$   
 (c)  $\frac{1}{2}[E_1 + E_3 + E_2 - E_4]$       (d)  $\frac{1}{3}[E_1 + E_2 + E_3 - E_4]$

62. In a B.C.C. lattice, the intensity of radiation for (111) planes is ( $f$  = atomic scattering factor)

- (a)  $f^2$       (b)  $4f^2$       (c)  $16f^2$       (d) none

63. The fraction of volume unoccupied in the unit cell of the B.C.C. lattice is

- (a)  $\frac{8 - \sqrt{3}\pi}{8}$       (b)  $\frac{\sqrt{3}\pi}{8}$       (c)  $\frac{6 - \sqrt{2}\pi}{6}$       (d)  $\frac{\pi}{3\sqrt{2}}$

64. The intrinsic viscosity of polyisobutylene at  $20^\circ\text{C}$  is  $250 \text{ cm}^3\text{g}^{-1}$  and relative viscosity is 2.5. The concentration of polyisobutylene in water is

- (a)  $100 \text{ gcm}^{-3}$       (b)  $10^{-2} \text{ gcm}^{-3}$       (c)  $0.005 \text{ gcm}^{-3}$       (d)  $0.006 \text{ gcm}^{-3}$

65. A particle of mass 'm' is moving under a potential of the form

$$V(x) = \begin{cases} \frac{1}{2} m\omega^2 x^2 & x > 0 \\ \infty & x \leq 0 \end{cases}$$

and the wave function of the particle is  $\psi(x) = -\frac{1}{\sqrt{5}}\psi_0 + \frac{2}{\sqrt{5}}\psi_1$

where  $\psi_0$  and  $\psi_1$  are the eigen functions of ground state and first excited state respectively. The expectation value of energy will be

- (a)  $\frac{11}{10}\hbar\omega$       (b)  $\frac{13}{10}\hbar\omega$       (c)  $\frac{25}{10}\hbar\omega$       (d)  $\frac{31}{10}\hbar\omega$



66. The expectation value of the operator  $\hat{L}_+$  in the state

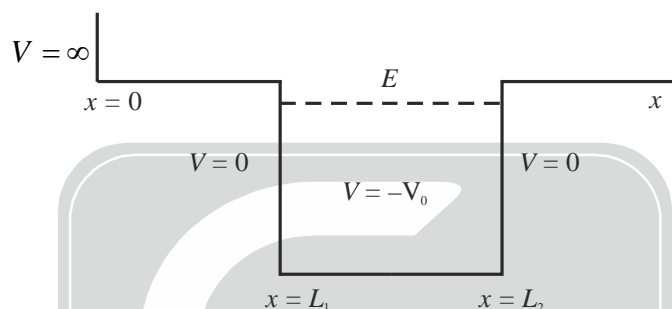
$$|\psi\rangle = \frac{1}{\sqrt{3}} [ |1,1\rangle + |1,0\rangle + |1,-1\rangle ] \text{ is}$$

- (a)  $2\sqrt{2}\hbar$                       (b)  $\frac{2\sqrt{2}}{3}\hbar$                       (c)  $\frac{\sqrt{2}}{3}\hbar$                       (d)  $\frac{4\sqrt{2}}{3}\hbar$

67. Consider a Heterodiatomic molecule AB. If the electron spends 90% of its time on 'A' and 10% of its time on 'B'. The wavefunction for the bonding molecular orbital is

- (a)  $\psi = .90\phi_A + 0.10\phi_B$                       (b)  $\psi = 0.10\phi_A + 0.90\phi_B$   
 (c)  $\psi = 0.95\phi_A + 0.32\phi_B$                       (d)  $\psi = 0.32\phi_A + 0.95\phi_B$

68. Consider a particle in a potential as shown below



The wave function of the particle (having energy eigen value E) for bound state for region in between  $L_1 < x < L_2$  is

- (a)  $A e^{\alpha x} + B e^{-\alpha x}$  with  $\alpha = \sqrt{\frac{-2mE}{\hbar^2}}$                       (b)  $A e^{\alpha x} + B e^{-\alpha x}$  with  $\alpha = \sqrt{\frac{2mE}{\hbar^2}}$   
 (c)  $A e^{i\alpha x} + B e^{-i\alpha x}$  with  $\alpha = \frac{\sqrt{2m(V_0 - E)}}{\hbar}$                       (d)  $A e^{i\alpha x} + B e^{-i\alpha x}$  with  $\alpha = \frac{\sqrt{2m(V_0 + E)}}{\hbar}$

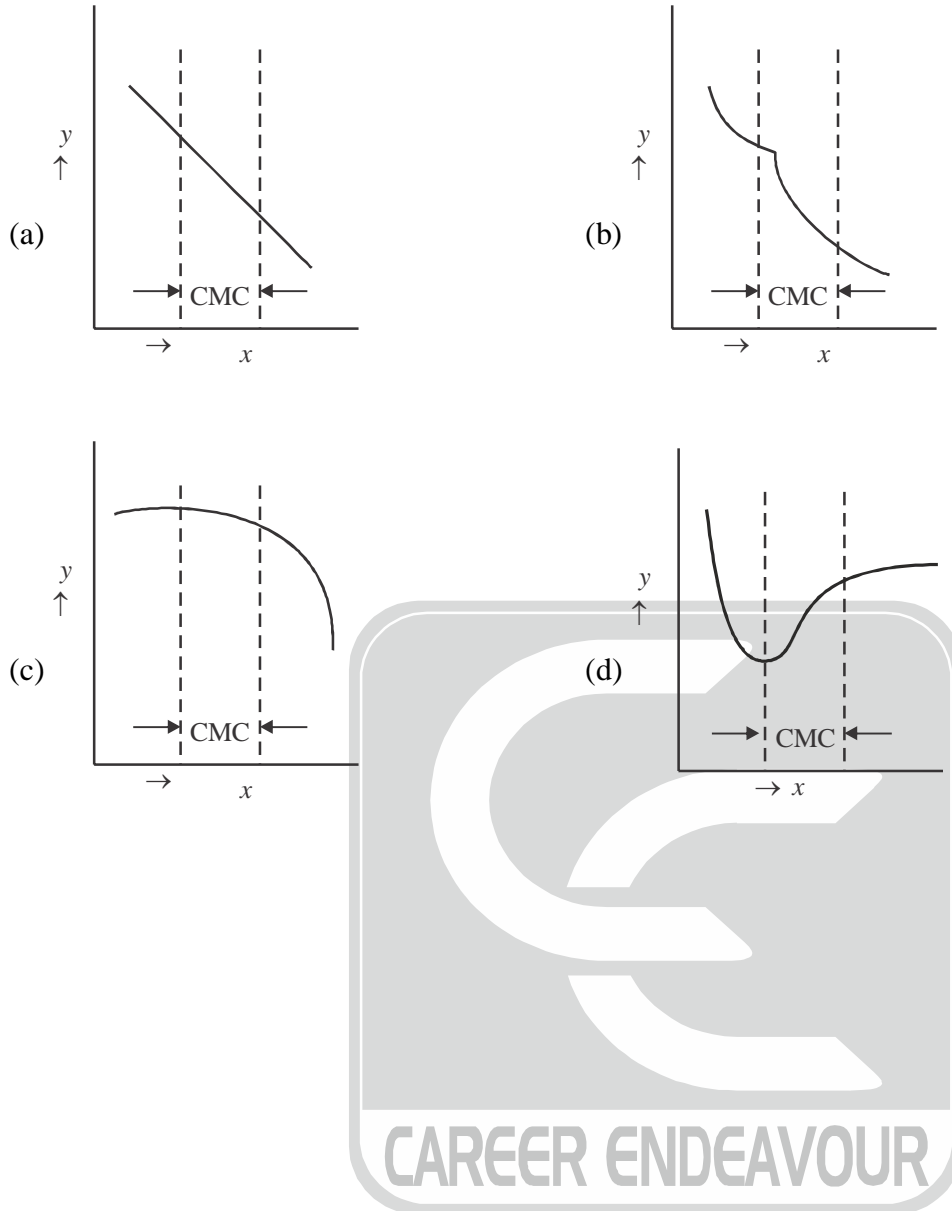
69. The wavefunction of a particle in one dimension deep square potential well extending from  $x=0$  to  $x=L$  is

$$\psi(x) = \sqrt{30} \frac{x(x-L)}{L^i}$$

the value of  $i$  is

- (a) 1                      (b) 1.5                      (c) 2                      (d) 2.5

70. The correct representation of the variation of surface tension (y-axis) with surfactant concentration (x-axis) is [CMC = critical micelle concentration].



*Space for rough work*



## ANSWER KEY

## PART-A

1. (c)	2. (b)	3. (d)	4. (c)	5. (c)	6. (b)	7. (c)
8. (c)	9. (c)	10. (d)	11. (b)	12. (d)	13. (d)	14. (b)
15. (d)	16. (b)	17. (c)	18. (b)	19. (a)	20. (d)	21. (a)
22. (b)	23. (c)	24. (c)	25. (b)	26. (d)	27. (c)	28. (d)
29. (a)	30. (c)					

## PART-B

31. (b)	32. (b)	33. (c)	34. (d)	35. (d)	36. (b)	37. (d)
38. (b)	39. (d)	40. (b)	41. (b)	42. (c)	43. (c)	44. (c)
45. (a)	46. (b)	47. (a)	48. (a)	49. (c)	50. (a)	51. (a)
52. (c)	53. (d)	54. (d)	55. (c)	56. (d)	57. (b)	58. (d)
59. (c)	60. (a)	61. (c)	62. (d)	63. (a)	64. (d)	65. (d)
66. (b)	67. (c)	68. (d)	69. (d)	70. (b)		

