TEST SERIES GATE 2019

BOOKLET SERIES C

PHYSICAL CHEMISTRY

Paper Code: CY

Test Type: TEST SERIES

Duration: 2:30 Hours

CHEMISTRY-CY

Date: 18-01-2019

Maximum Marks: 100

Read the following instructions carefully:

1. Attempt all questions.
2. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory. The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each.
   The subject specific GATE paper section consists of **55** questions, out of which question numbers 11 to 35 are of 1-mark each, while question numbers 36 to 65 are of 2-mark each.
3. The question paper may consist of questions of **multiple choice type** (MCQ) and **numerical answer type**.
4. Multiple choice type questions will have four choices against (a), (b), (c), (d), out of which only **ONE** is the correct answer.
5. For numerical answer type questions, each question will have a numerical answer and there will not be any choices**.**
6. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of ⅓ marks for a **1-mark** question and ⅔ marks for a **2-mark** question.
7. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.
8. Non-programmable type Calculator is allowed

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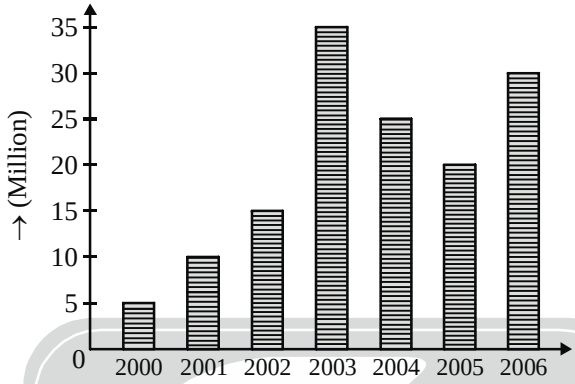
Q.1-Q. 5 carry ONE mark each.

1. Eight people A, B, C, D, E, F, G, H are sitting in a circular table facing the centre.
H is between D and G.
F is to the immediate right of E and second to the left of H.
D is second to the left of C, and to the immediate right of H.
A sits between C and E.
Who is second to the left of A ?
(a) C (b) D (c) B (d) E

2. Below is given a graph which represents, revenue of a bank in million from year 2000 to 2006. By how much percent revenue increased in 2006 as compared to average revenue over the years ?



(a) 55 % (b) 60 % (c) 75 % (d) 50 %

3. In a two dimensional plane, the area enclosed by $|x|+|y|=6$ is _____.

4. _____: horse:: Board: train
(a) Stable (b) Show (c) Ride (d) Mount

5. Native: aboriginal::Naïve : _____
(a) Learned (b) Arid (c) Unsophisticated (d) Tribe

Q.6-Q. 10 carry TWO marks each.

6. Below are given some statements. Based on these statements you have to find out how is A related to F.
(1) A is Sister of B
(2) C is Father of B
(3) D is only Daughter-in-law of E, and wife of C
(4) F is Wife of E
(a) Daughter (b) Grand-daughter (c) Grand-son (d) Daughter-in-law

7. In the equation $(7526)_5-(y)_5=(4364)_5$. What is the value of *y*, if $(x)_N$ stands for *x* to the base *N*.
(a) 3162 (b) 3112 (c) 3167 (d) 3176

8. A terrorist is noticed by a police inspector from a distance of 200 m. After seeing, the police the terrorist starts running at a speed of 10 km/hour and the police starts chasing at a speedof 11 km/hr. What is the total distance covered by the inspector when he catches the terrorist.
(a) 1.5 km (b) 3 km (c) 2.2 km (d) 2.5 km

9. Shallot: _____:: Scallop: Mollusk
(a) Shark (b) Muscle (c) Desert (d) Onion

10. Laboratory: Germs
(a) School: Students (b) Playground: Games (c) Library: Books (d) Observatory: Planets

Q.11-Q.35 carry one mark each.

11. Which of the following relation between interparticle distance and de-Broglie wavelength (Λ) holds to follow Maxwell Boltzmann stability
(a) $d >> \Lambda$ (b) $d << \lambda$ (c) $d \approx \lambda$ (d) $d = \lambda$

12. Which of the following sets will be rotational RAMAN inactive
(a) Cl_2, O_2, N_2 (b) BF_3, CH_4, SF_6
(c) NH_3, CH_3Cl, CH_3OH (d) None of the above

13. At a given temperature and pressure the ratio of the root mean square speed of the Deutrium and Neon gas is appromixately _____(Upto two decimal places).

14. At 248°C and 1 atm, the K_p for the reaction $SbCl_5(g) \rightleftharpoons SbCl_3(g) + Cl_2(g)$ is 1.07. The degree of dissociation of $SbCl_5$ is _____(Upto two decimal places).

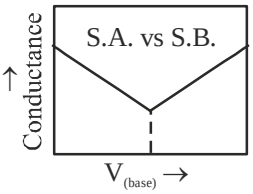
15. The vapour pressures of ice and water is expressed by following equations:

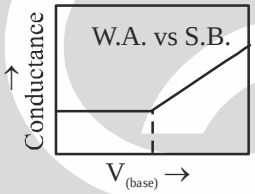
$$\ln P(\text{ice}) = -\frac{6140.1}{T} + 24$$

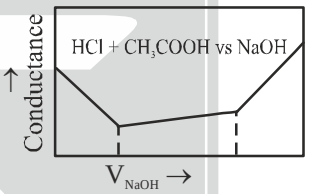
$$\ln P(\text{water}) = -\frac{5432.1}{T} + 21.41$$

where P is in mmHg. The triple point of water is
(a) 273.08 K (b) 278.59 K (c) 279.15K (d) None of these

16. On the basis of conductometric titrations which of the following option is correct

(a) 

(b) 

(c) 

(d) all of these

17. 0.50 g of benzoic acid was subjected to combustion in a bomb calorimeter. The temperature of calorimeter was found to rise by 0.55°C then enthalpy of combustion of benzoic acid is
[Given: Calorimeter constant = 23.85 kJ/K]
(a) –3201.9 kJ/mol (b) –3200.7 kJ/mol (c) both (a) and (b) (d) –3600.8 kJ/mol

18. Approximately one helium atom per cubic meter is persent in interseller space. Assuming that the H-atom has a diameter of 10^{-20} m. The mean free path approximately is
(a) 10^{20} (b) 10^{39} (c) 10^{19} (d) 10^{29}

19. The activity coefficient $(\gamma_{\pm})$ decreases with
(a) increase in concentratino of solution (b) decrease in charge number of ion
(c) by dilution of solution (d) none of these

20. The potential of the cell

$$Pb \mid PbCl_2(s) \mid PbCl_2(soln) \mid AgCl(s) \mid Ag$$

is 0.49V at 298K. The variation of potential with temperature is given as

$$E = 9 - (1.86 \times 10^{-4}\, VK^{-1})(T - 298\, K)$$

The value of ΔH is _____kJ/mol. (Upto two decimal places).

21. The energy of a 400 nm photon can be converted to the wave number equal to
(a) 2500 cm^{-1} (b) 25000 cm^{-1} (c) 24000 cm^{-1} (d) 30000 cm^{-1}

22. A particle is confined to a one dimensional box of length 4×10^{-8} m. If the length is changed by 10^{-12} m. The % change in the ground state energy is _____$\times 10^{-2}$. (Upto one decimal places).

23. The wave function of a diatomic molecule has form $\psi = 0.95\phi_{\text{covalent}} + 0.55\phi_{\text{ionic}}$. The chance that both electrons of the bond will be found on the same atom in 1000 inspectrons of the molecule approximately is _____(answer should be an integer).

24. The correct statement among the following is
(a) ΔU and ΔH are path function
(b) the efficiency of carnot engine depends on the nature of system
(c) the entropy of mixing is always negative
(d) the decrease in internal energy is a direction of spontaneous change at constant entropy and volume

25. 300J of energy is used to increase the temperature of a 3 moles of ideal gas by 5 degree at constant volume. The change in enthalpy is _____kJ mol^{-1}. (Upto two decimal places).

26. The slope and intercept of a plot of $\frac{1}{V_{ad}}$ vs $\frac{1}{P}$ are 2×10^{-4} $mmHgm^{-3}$ and 4.2×10^{-7} m^3. The distribution coefficient is _____$\times10^{-3}$ $torr^{-1}$. (Upto two decimal places).

27. The correct statement among the following is
(a) the effect of temperature on the rate of reaction will be high if reaction occuring at lower temperature
(b) At low pressure, the enzyme catalysed reaction achieve its maximum rate.
(c) Catalyst increases the equilibrium constant
(d) Lamber-Beer law is applicable at all concentration

28. The slope and intercept of second order reaction for a plot $\frac{1}{[A]}$ vs time is -10^3 $mol^{-1}Ls^{-1}$ and 0.5 $molar^{-1}$. The time required to reduce initial concentration to one-fourth of its initial value is _____$\times10^{-3}$ sec. (Upto two decimal places).

29. The specific rate constant of a reaction is represented by $\ln k = 100 - \frac{300}{T}$. The activation energy of the reaction at 500K is _____kJmol^{-1}. (Upto two decimal places).

30. CSF adopts the NaCl crystal structure if the unit cell edge is of length 4.02Å. The shortest distance between the cation and anion in the crystal is _____Å. (Upto two decimal places).

31. Matche the following with their characteristics

Column-I	**Column-II**
(P) Triclinic	(X) Least symmetry
(Q) Trigonal and hexagonal	(Y) Same number of bravais lattices
(R) Rhombic and monoclinic	(Z) Axial length $(a \neq b \neq c)$
(S) Cubic and trigonal	(W) Axial length ($a = b = c$)

(a) P-X, Q-Y, R-Z, S-W (b) P-Y, Q-Z, R-X, S-W
(c) P-W, Q-Z, R-Y, S-W (d) None of these

32. The number of C_3 axes in SF_6 is _____(answer should be an integer).

33. The sum of number of classes and order in $Fe_2(CO)_9$ molecule is _____(answer should be an integer).

34. The wavefunction $\psi(r,\theta,\phi) = \frac{1}{81\sqrt{\pi}}\left(\frac{1}{a_0}\right)^{3/2}\frac{r^2}{a_0^2}\sin\theta\cdot\cos\theta\cdot e^{-\left(\frac{r}{3a_0}+i\phi\right)}$. The value of n, ℓ and m corresponding to this wave function respectively are
(a) 3, 2, 1 (b) 3, 2, –1 (c) 3, 1, 1 (d) 2, 2, 1

35. The probability of locating the particles in the ground state one-dimensional box between $\frac{a}{4}$ and $\frac{3a}{4}$ is (where a is the width of the box) _____(upto two decimal places).

Q.36-Q.65 carry TWO marks each.

36. Total energy of N two level system having energy level ε and 2ε at $T \to \infty$ is

(a) $3N\varepsilon$ (b) $\frac{3N\varepsilon}{2}$ (c) $\frac{2N\varepsilon}{3}$ (d) $2N\varepsilon$

37. The rates of Einstein coefficient of spontaneous and stimulated emission, A and B, for transitions with 500 MHz radio frequency radiation

(a) 116 (b) 200
(c) 250 (d) Insufficient data to calculate the ratio

38. A vibrational rotational spectrum of a diatomic molecule gives P and R lines. If the separation between R(0) and P(2) is 30 cm^{-1}, the rotational quantum number corresponding to maximum intense R line at temperature 300K is _____(answer should be an integer).

39. The percentage difference in fundamental vibrational wavenumber of $^{1}H^{35}Cl$ and $^{2}H^{37}Cl$ on the assumption that their force constant is same _____%. (Upto two decimal places).

40. The translational partition function for Kr confined to a volume of 4L at 500K, having thermal wavelength of 2.50×10^{-5} m is closest to _____$\times10^{10}$ (Upto one decimal places).

41. A potential of 12 volts was applied electrodes placed 20 cm apart. A dilute solution of ammonium chloride was placed between the electrode, if NH_4^+ ion cover a distance of 1.60 cm in one hour then the mobility of NH_4^+ ion is _____$\times10^{-8}$ $m^2V^{-1}s^{-1}$. (Upto two decimal places)

42. At 25°C, the degree of dissociation of water is 1.90×10^{-9}. If the molar ionic conductances of H+ and OH– ions are 349.83×10^{-4} and 198.50×10^{-4} Sm^2mol^{-1}, respectively. The molar conductance $\left(\Lambda_m^0\right)$ and specific conductance (k) of water at this temperature is

(a) 548.33×10^{-4} and 578×10^{-6} Sm^{-1}

(b) $548.33\times10^{-4}Sm^2mol^{-1}$ and 5.78×10^{-6} Sm^{-1}

(c) $840.3\times10^{-6}Sm^2mol^{-1}$ and 578×10^{-4} Sm^{-1}

(d) None of these

43. The enthalpy of combustion of glucose $C_6H_{12}O_6(s)$ is –2816 kJ/mol at 25°C. The ΔH_f^0 for $CO_2(g)$ and $H_2O(\ell)$ are –393.5 and –285.9 kJ/mol, respectively. The value of $\Delta H_f^0\left(C_6H_{12}O_6\right)$ is

(a) –1260.4 kJ / mol (b) –2816 kJ / mol (c) –890.5 kJ / mol (d) all of these

44. The change in enthalpy for the following reaction,

$N_2(g)+3H_2(g)\rightleftarrows 2NH_3$ at 27°C was found to be –91.49 kJ. The molar heat capacities at constant pressure and 27°C for nitrogen, hydrogen and ammonia are 28.45, 28.32 and 37.07 J/K/mol respectively. The enthalpy of the reaction at 50°C is

(a) –39.28 kJ (b) –91.94 kJ (c) –92.85 kJ (d) None of these

45. The temperature at which the average velocity of oxygen equals that of hydrogen at 40K is _____K.(answer should be an integer)

46. The correct relation for mean free path and volume is

(a) $\lambda = \dfrac{V}{n\sqrt{2}\,\sigma N_A}$ (b) $\lambda = \dfrac{T}{\sqrt{2}\,\sigma PV}$ (c) $\lambda = \dfrac{VT}{\sqrt{2}\,\sigma PR}$ (d) $\lambda = \dfrac{n\sqrt{2}\,\sigma N_A}{V}$

47. The correct relation among the following for water phase diagram

(a) $\left(\dfrac{\partial P}{\partial T}\right)_{S \rightleftharpoons V} > 0$ (b) $\left(\dfrac{\partial P}{\partial T}\right)_{L \rightleftharpoons G} > 0$ (c) $\left(\dfrac{\partial P}{\partial T}\right)_{S \rightleftharpoons L} < 0$

(d) all of the above

48. The EMF of the cell:
$Pt|Q, QH_2, H^+ \,||\, KC\ell(1M)|Hg_2Cl_2|\, Hg(\ell)|\, Pt$ at pH = 5 is _____volt. (Upto two decimal places).

[Given that $\left(E^0_{\text{calomel}=0.280\,V}\ \&\ E^0_{Q,QH_2/H^+=0.699\,V}\right)$]

49. A 50 g of copper at 393K is placed with a 100 g of copper at 303K in a thermally insulated container. The ΔS for the process is _____(J/K). (Specific heat capacity of copper is 0.4184 J/g/K). (Upto two decimal places).

50. The melting point of mercury is 234.5 K at 1 atm. The melting point increases by 5.033×10^{-3} K per atm. If the densities of solid and liquid mecury are 14.19 and 13.70 g/cm^3 respectively. The molar enthalpy of fusion is _____ kJ/mol. (Upto two decimal places).

51. A carnot engine operates between reservoirs at 500K and 1000K. The amount of work done by engine is 100J. The heat absorbed by carnot engine is _____J. (Upto two decimal places)

52. The unnormalized wave function of a certain hydrogen atom eigen states $r\left(6r - r^2\right)\left(2 - 2r\right)e^{-r/3}$. The possible angular part of the eigen state is

(a) $\left(3\cos\theta - 5\cos^2\theta\right)\cos\theta$ (b) $\left(\cos\theta - 1\right)\cos\theta$

(c) 1 (d) $\left(3\cos^2\theta - 1\right)\cos^2\theta$

53. If $\psi = 0.7\phi_A + 0.3\phi_B$ is a normalized molecular orbital of a diatomic molecule AB constructed from ϕ_A and ϕ_B. The value of overlap integral between ϕ_A and ϕ_B is _____(answer should be an integer).

54. The ionisation energy of hydrogen atom in its ground state is approximately 13.6 eV. The potential energy of a Li^{2+}, in its ground state approximately is _____eV. (Upto one decimal places).

55. The correct statement among the following is

(a) Slope of a plot of $\dfrac{P}{V_{ad}}$ *vs* P is $\dfrac{1}{V_m k}$

(b) Extent of adsorption is proportional to pressure at very high pressure condition
(c) Physical adsorption favour at low temperature and chemisorption favours at high temperature
(d) In case of liquid, residual forces arises due to the unsatisfied valencies.

56. For a Langmuir dissociative adsorption of triatomic gases, the extent of adsorption is $x \times 10^{-1}$ at 5 atm. The value of x is _____(Upto two decimal places).
(Given : distribution coefficient is 5×10^{-2})

57. The activation energy and entropy of a bimolecular gas phase reaction at 600 K are 200 kJ mol^{-1} and –200 JK^{-1} mol^{-1} respectively. The free energy of activation is

(a) 70 kJ mol^{-1} (b) 80 kJ mol^{-1} (c) 310 kJ mol^{-1} (d) 320 kJ mol^{-1}

58. In a photochemical reaction A $\rightarrow$ 2B + C, the quantum efficiency with 500 nm light is 2×10^2 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 _____$\times10^{18}$. (answer should be an integer).

59. The reaction is, $2N_2O_5 \longrightarrow 4NO_2 + O_2$

The proposed mechanism is

$N_2O_5 \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} NO_2 + NO_3$

$NO_3 + NO_2 \xrightarrow{K_2} NO + NO_2 + O_2$

$NO_3 + NO \xrightarrow{K_3} 2NO_2$

The rate of formation of O_2 is

(a) $K_2 \cdot K_1[N_2O_5]$ (b) $\frac{K_1 \cdot K_2}{K_{-1}}[N_2O_5]$

(c) $\frac{K_1}{K_{-1}}[N_2O_5]^2$ (d) $\frac{K_1 \cdot K_2}{K_{-1} + 2K_2}[N_2O_5]$

60. Monochromatic X-rays having a wavelength of 10.4Å are preferentially diffracted by a crystal at an angle 25.5º, assuming that this is the first order diffraction with a 'd-spacing' between crystalline planes equal to 12.1Å. The value of θ for the angle for the second order diffraction is _____(in degree). [Upto two decimal places].

61. A hypothetical element (atomic weight 23 g/mol) crystallizes in a body centred cubic lattice for this crystal. The nearest neighbour distance is 365.9 Pm. The density of crystal is _____g/cm^3. (Upto two decimal places).

62. Consider 8 electron having spin-½ particle moving under 1-D harmonic potential. The energy difference between LUMO and HOMO is

(a) $\frac{\hbar\omega}{2}$ (b) $\frac{3\hbar\omega}{2}$ (c) $\hbar\omega$ (d) $2\hbar\omega$

63. The angle of orientation is 28º of the angular momentum vector with respect to z-axis and l = 3 for state of H-atom. The value of m_l is _____(answer should be an integer).

64. The total number of molecules having horizontal plane is _____(answer should be an integer)
Diborane, H_2O_2(cis), H_2O_2 (trans), N_2F_2 (trans), Td, BF_3, PH_5, N_2O, CO_3^{2-}

65. Identify the Mulliken notation for the following irreducible representation

E	C_n	nC_2	i	σ_h
1	1	−1	−1	−1

(a) $A_{1u}^{'}$ (b) $A_{2u}^{''}$ (c) $B_{2u}^{'}$ (d) $A_{2u}^{'}$

Space for rough work

CHEMISTRY - CY

GATE TEST SERIES-C

Date: 18-01-2019

PHYSICAL CHEMISTRY

ANSWER KEY

1. (c)	**2.** (d)	**3.** (72)	**4.** (d)	**5.** (c)
6. (b)	**7.** (b)	**8.** (c)	**9.** (d)	**10.** (d)
11. (a)	**12.** (b)	**13.** (3.15 to 3.21)	**14.** (0.70 to 0.74)	
15. (a)	**16.** (d)	**17.** (a)	**18.** (b)	
19. (a)	**20.** (-104.80 to -105.80)	**21.**(b)	**22.** (0.4 to 0.6)	
23. (301 to 304)	**24.** (d)	**25.** (0.10 to 0.15)	**26.** (1.9 to 2.3)	
27. (a)	**28.** (1.25 to 1.65)	**29.** (2.40 to 2.65)	**30.** (2.80 to 2.90)	
31. (a)	**32.** (8)	**33.** (18)	**34.** (b)	
35. (0.80 to 0.86)	**36.** (b)	**37.** (a)	**38.** (4 to 4)	
39. (28.20 to 28.80)	**40.** (25.4 to 25.8)	**41.** (7.38 to 7.48)	**42.** (b)	
43. (a)	**44.** (c)	**45.** (640 to 640)	**46.** (b)	
47. (d)	**48.** (-0.11 to -0.14)	**49.** (0.46 to 0.54)	**50.** (2.36 to 2.45)	
51. (200.00)	**52.** (b)	**53.** (1 to 1)	**54.** (-244.2 to -245.2)	
55. (c)	**56.** (3.75 to 3.85)	**57.** (c)	**58.** (3)	
59. (d)	**60.** (59.20 to 59.80)	**61.** (1.00 to 1.03)	**62.** (c)	
63. (3 to 3)	**64.** (6 to 6)	**65.** (b)		