TEST SERIES CSIR-NET/JRF June 2017

BOOKLET SERIES B

PHYSICAL CHEMISTRY

Paper Code 01 **Test Type: TEST SERIES**

CHEMICAL SCIENCES

Duration: 2:00 Hours

Date: 27-05-2017
Maximum Marks: 180

Read the following instructions carefully:

* Single Paper Test is divided into **THREE** Parts.

Part - A: This part shall carry **10** questions. Each question shall be of **2 marks.**

Part - B: This part shall carry **20** questions. Each question shall be of **2 marks.**

Part - C: This part shall contain **30** 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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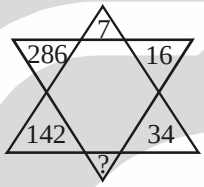
PART – A

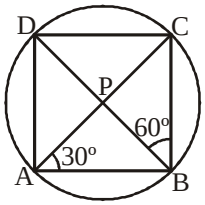
1. After distributing the sweets equally among 25 children, 8 sweets remain. Had the number of children been 28, 22 sweets would have been left after equally distributing. What was the total number of sweets?
   (a) 328 (b) 348 (c) 358 (d) Data inadequate
2. A student marks were wrongly entered as 83 instead of 63. Due to that the average marks for the class got increased by half. The number of pupils in the class is
   (a) 10 (b) 20 (c) 40 (d) 73
3. A man went 15 Km to the west from my house, then turned left and walked 20 Km. He then turned east and walked 25 Km and finally turning left covered 20 Km. How for is he now from his house?
   (a) 15 Km (b) 20 Km (c) 25 Km (d) 10 Km
4. Find the sum:

$$\frac{1}{2}+\frac{1}{6}+\frac{1}{12}+\frac{1}{20}+\frac{1}{30}+\frac{1}{42}+\frac{1}{56}+\frac{1}{72}+\frac{1}{90}+\frac{1}{110}+\frac{1}{132}$$

   (a) $\frac{7}{8}$ (b) $\frac{11}{12}$ (c) $\frac{15}{16}$ (d) $\frac{17}{18}$
5. Find the missing number.



   (a) 38 (b) 66 (c) 68 (d) 70
6. There are 600 boys in a hostel. Each plays either hockey or football or both. If 75% play hockey and 45% play football. How many play both?
   (a) 48 (b) 60 (c) 80 (d) 120
7. A vendor loses the selling price of 4 oranges on selling 36 oranges. His loss percentage is:
   (a) 10% (b) $11\frac{1}{9}\%$ (c) $12\frac{1}{2}\%$ (d) None of these
8. In the given figure, *ABCD* is a cyclic quadrilateral and diagonals bisect each other at P. If $\angle DBC = 60^\circ$ and $\angle BAC = 30^\circ$ then $\angle BCD$ is



   (a) 90° (b) 60° (c) 80° (d) 120°
9. In a chess tournament, each of six players will play with all other players exactly once. How many matches will be played during the tournament.
   (a) 12 (b) 15 (c) 30 (d) 36
10. A is twice as good as workman B and together they finish a piece of work in 14 days. The number of days taken by A alone to finish the work is
   (a) 11 (b) 21 (c) 28 (d) 42

PART – B

11. 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

12. 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) $K_{sp} = 10412s^9\gamma_{\pm}^9$

13. A gas X when dissolved in water, heat is evolved. Then the solubility of X will increase at
(a) Low pressure, high temperature (b) Low pressure, low temperature
(c) High pressure, high temperature (d) High pressure, low temperature

14. Sodium sulphate is completely ionised in an aqueous solution. The number of component is
(a) 1 (b) 2 (c) 3 (d) 4

15. For water, the variation of pressure with temperature is
(a) Increase in pressure with temperature for fussion
(b) Increase in pressure with temperature for vaporisation
(c) Decrease in pressure with temperature for vaporisation
(d) Decraese in pressure with temperature for sublimation

16. Which one of the following is not a criterion of spontaneity
(a) $(\partial S)_{U,V} \geq 0$ (b) $(\partial U)_{S,P} \leq 0$ (c) $(\partial A)_{T,V} \leq 0$ (d) $(\partial H)_{S,P} \leq 0$

17. $C_p - C_V$ for 1 mole of a gas representing equation P(V-nb) = nRT is
(a) R (b) RT (c) $\frac{nR}{P}$ (d) 0

18. The intermolecular Vander waals potential is inversely proportional to r^8. The corresponding force is proportional to
(a) $\frac{1}{r^6}$ (b) $\frac{1}{r^8}$ (c) $\frac{1}{r^9}$ (d) $\frac{1}{r^7}$

19. Rotational RAMAN spectrum of CH_3Cl molecule gives three consecutive stokes lines at 18540.12 cm^{-1}, 18544.21 cm^{-1} and 18548.3 cm^{-1}. The rotational constant for CH_3Cl is
(a) 1.0225 cm^{-1} (b) 2.045 cm^{-1} (c) 3090.02 cm^{-1} (d) 0.1278 cm^{-1}

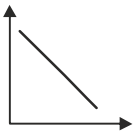
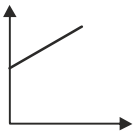
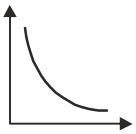
20. In a Gouy-Chapman diffuse layer the ***incorrect*** option in the favour of thickness (r_D) is
(1) Thickness is proportional to density
(2) Proportional to ionic strength
(3) Inversely proportional to dielectric constant.
(4) Proportional to temperature.
(a) 1, 2, 3 (b) 2, 3 (c) 1, 4 (d) 1 only

21. Let x and p denote, respectively, the coordinate and momentum operators satisfying the canonical commutation relation $[x, p] = i$ in natural units $(\hbar = 1)$. Then the commutator $[x, pe^{-p}]$ is

(a) $i(1-p)e^{-p}$ (b) $i(1-p^2)e^{-p}$ (c) $i(1-e^{-p})$ (d) ipe^{-p}

22. At a given temperature, for a rigid rotor, the probability that the system is in the rotational state J = 0 is 0.6, in state J = 1 is 0.3, and 0.1 in J = 2. The energy in a rotational state J is given by J (J+1)B, where B is the rotational constant. The average energy of the rotor at the given temperature is
(a) – 6.0 B (b) 1.2 B (c) 3.6 B (d) 4.8 B

23. The correct plot representing the variation of surface film pressure against surface area is

(a)  (b)  (c)  (d) none of these

24. Suppose particles is negligible. The fugacity of a gas at 10 atm any 298K is [Given : $e^{0.01515} = 1.0152$]

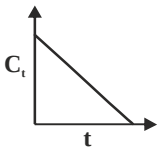
if $\left(b = 3.707 \times 10^{-2}\ Lmol^{-1}\right)$

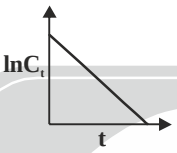
(a) 9.85 atm (b) 9.5 atm (c) 10.15 atm (d) 10.59 atm

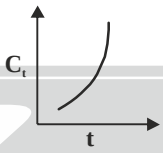
25. The unit of the slope of $\frac{P}{V_{ad}}$ versus P plot in Langmuir theory of adsorption is

(a) Pa (b) Pa cm^{-3} (c) cm^{-3} (d) Pa^{-1}

26. The correct plot representing a first order reaction is/are

(a) 

(b) 

(c) 

(d) none of these

27. A first order reaction is 50% completed in 4 mins, the time required for 75% completion is
(a) 8 mins (b) 12 mins (c) 16 mins (d) none of these

28. In case of sphelerite structure the anions occupy
(a) half of Td Vd (b) all Td Vd (c) All Oh Vd (d) none of these

29. In case of n-type extrinsic semiconductor the fermi energy level lies in between
(a) Valence band and donar band (b) Donar band and conduction band
(c) Below valence band (d) Above conduction band

30. The point group of the SF_4 molecule if two of its equatorial F atoms are replaced by Cl atoms will result in
(a) Td (b) C_{2V} (c) C_1 (d) none of these

PART – C

31. If temperature coefficient of E_{cell} is $-0.125 VK^{-1}$. The ΔS for the given cell at 25°C is

$$Fe \mid Fe^{2+}(aq) \| Cd^{2+}(aq) Cd$$

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

32. What volume of 0.3M NH_4OH should be mixed with 30 mL of 0.2M solution of NH_4Cl to give buffer solution of pH 8.65 (Given $pK_b = 4.75$)
(a) 10 mL (b) 30 mL (c) 5 mL (d) 20 mL

33. The correct order of residual entropy of SbH_3 and NF_3 is
(a) $SbH_3 > NF_3$ (b) $SbH_3 < NF_3$
(c) $SbH_3 \approx NF_3$ (d) sufficient information is not provided

34. For polarographic experiment, the current corresponds to $E_{1/2}$ for 0.01M solution of divalent cation is 10μA. When solution of the same ion is 10^{-4} M, the current flow is 0.05μA on applying potential of –0.142V. The $E_{1/2}$ for 10^{-4} M solution is
(a) 0.128V (b) –0.128V (c) 0.156V (d) –0.156V

35. The pH of solution on the electrolysis of 10L of aqueous solution of Na_2SO_4 when 1F of electricity is passed through it is

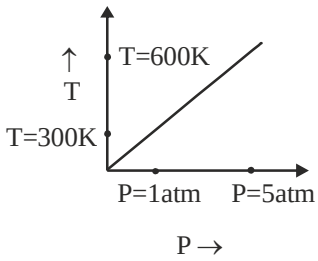
(a) 4.6 (b) 7 (c) 8.3 (d) 10.4

36. The $E^0_{\text{reduction}}$ for Cu|CuS electrode is

Given : K_{sp} of CuS = 8×10^{-36}; $E^0_{Cu^{2+}|Cu} = 0.34V$

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

37. The change in enthalpy is 40 kJ mol^{-1}. The temperature at which change in molar volume is 0.0567 m^3.



(a) 600 K (b) 300K (c) 529 K (d) 423 K

38. For a gas α (isobaric expansion coefficient) can be expressed as

(a) $\left(\frac{\partial U}{\partial T}\right)_P - C_V$ (b) $\frac{\left\{\left(\frac{\partial U}{\partial T}\right)_P - C_V\right\}}{\pi V}$ (c) $\left(\frac{\partial U}{\partial T}\right)_P$ (d) $\frac{\left\{\left(\frac{\partial U}{\partial T}\right)_V - C_V\right\}}{\pi V}$

39. Which of the following is correct statement

(a) $n_1 dY_{1,m} + n_2 dY_{2,m} + Y_{1,m} dn_1 + T_{2,m} dn_2 = 0$

(b) Gibb's-Duhem equation is studied for chemical potential

(c) In Gibbs-Duhem equation , assumption was made that number of moles of components remain constant even though mole fraction can be changed

(d) Gibbs-Duhem equation was derived at constant temperature and pressure

40. The necessary condition for a molecule to be vibrationally RAMAN active.

(I) It should show oscillation of polarizability ellipsoid during vibration of the bond.

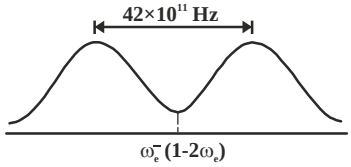
(II) It should follow the condition $\frac{\partial \alpha}{\partial \xi} \neq 0$

(III) It should follow the condition $\frac{\partial \alpha}{\partial \xi} = 0$

(IV) Molecule should be anisotropically polarizable.

(a) IV (b) I and III (c) I and IV (d) II

41. Low resolution vibrational rotational spectrum of CO molecule is shown below



Rotational constant for CO is 5 cm^{-1}. The value of J_{max} is

(a) 7 (b) 6 (c) 5 (d) 4

42. The masses recorded when a substance is weighed 4 times are 16.8, 16.4, 16.6 and 17.0 mg. The variance (square of the standard deviation) and standard deviation closest to

(a) $\sqrt{0.10}$ and 0.10 (b) 0.05 and $\sqrt{0.05}$ (c) $\sqrt{0.05}$ and 0.05 (d) 0.10 and $\sqrt{0.10}$

43. In an ideal monoatomic gas the speed of sound is given by $\sqrt{\frac{4}{3}\frac{RT}{M}}$. If the speed of sound in argon at 25ºC is 1260 km/h. The root mean square velocity is

(1) 1890 km/h (2) 1245 km/h (3) 1890 m/s (4) 525 m/s

(a) 1, 4 (b) 1, 2 (c) 3, 4 (d) 2, 4

44. The M–X bond length is 200 pm in MX_4 (spherical rotor). The moment of inertia of MX_4 would be close to (masses of M = 1.9×10^{-27} kg and masses of X = 2.5×10^{-27} kg respectively)

(1) 2.67×10^{-46} kgmtr^2 (2) 2.67×10^{-51} kgmtr^2

(3) 2.67×10^{-42} kgcm^2 (4) 3.67×10^{-51} kgcm^2

(a) 1, 3 (b) 2, 3 (c) 3, 4 (d) 1, 4

45. Following two reactions,

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

$$COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$$

are simultaneously at equilibrium in a container at constant volume. A few moles of CO(g) is added into the vessel, the new equilibrium concentration of

(a) PCl_5 remain unchanged (b) Cl_2 will be greater

(c) PCl_5 become greater (d) PCl_5 become less

46. If θ_r denotes the characteristics temperature of rotation then the magnitude of $\frac{\left[\theta_r(HD)\right]^2}{\left[\theta_r(H_2)\theta_r(D_2)\right]}$ is

[Bond length for HD = 2 mtr, H_2 = 4mtr, D_2 = 3mtr]

(a) $\frac{81}{8}$ (b) $\frac{8}{9}$ (c) $\frac{8}{81}$ (d) $\frac{9}{8}$

47. The surface tension of dilute solution of a solute is given by

$$\gamma = \gamma_0 - ae^{ac_2}$$

where γ_0 is surface tension of pure solvent and 'a' is some arbitrary constant and c_2 is concentration of solute.

Using Gibbs adsorption equation, the surface excess per unit surface area is given by

(a) $\frac{\gamma_0 - \gamma}{RT}$ (b) $\frac{ac_2}{RT}$ (c) $\frac{ac_2(\gamma_0 - \gamma)}{RT}$ (d) None of these

48. The ground state energy of 6 identical spin-1/2 particles which are subject to a 1-D simple harmonic oscillator potential of frequency ω is

(a) $\left(\frac{15}{2}\right)\hbar\omega$ (b) $\left(\frac{13}{2}\right)\hbar\omega$ (c) $\left(\frac{1}{2}\right)\hbar\omega$ (d) $9\hbar\omega$

49. The minimum energy of a collection of 6 non-interacting electrons of spin $-\frac{1}{2}$ placed in a one dimensional infinite square well potential of width L is

(a) $14\pi^2\hbar^2 / mL^2$ (b) $91\pi^2\hbar^2 / mL^2$ (c) $7\pi^2\hbar^2 / mL^2$ (d) $3\pi^2\hbar^2 / mL^2$

50. In the adsorption of 5.2g of an acid (molar mass = 100 $gmole^{-1}$) on an adsorption site, the total surface area covered was found to be 150 cm^2. The area corresponding to 1 molecule is (in cm^2)

(a) 478.93×10^{-21} (b) 478.93×10^{-20}

(c) 4.78×10^{-23} (d) 4.78×10^{-21}

51. Consider the reactions

$A(g)+B(g)\longrightarrow Pdt(g)$ ... (1)

$C(g)+D(g)\longrightarrow Pdt(g)$ ... (2)

According to Collision theory the squares of pre-exponential factors of reaction (1) and reaction (2) is

Species	M$(g/mole)$	Diameter(nm)
A	2	1
B	4	3
C	6	2
D	8	4

(a) $\frac{149}{96}$ (b) $\frac{96}{149}$ (c) $\frac{96}{189}$ (d) $\frac{189}{96}$

52. A first order reaction involves energy of activation to be 2 $kcalmole^{-1}$. The ratio $\frac{k_{400K}}{k_{200K}}$ is approximate

(a) 0.0025 (b) $e^{0.0025}$ (c) $e^{2.5}$ (d) e^{25}

53. For the elementary bimolecular reaction involving same reactants. The correct rate law is

(a) $kt=\frac{1}{a-x}+\frac{1}{a}$ (b) $kt=\frac{a}{x(a-x)}$ (c) $kt=\frac{x}{a^2}(1+akt)$ (d) $kt=a^2(1+akt)$

54. For the reaction, $2A^{++}+B^{---}+C^{+++}\longrightarrow$ Product . For the ionic strengths, $I_1=25\,unit$ and $I_2=16\,unit$, the ratio of $\log\left(\frac{k_{I_2}}{k_{I_1}}\right)$ is (in units of Debye Hückel constant)

(a) 10 A (b) –10 A (c) 6 A (d) – 6 A

55. If $\psi=0.6\psi_A+x\psi_B$ is a normalized molecular orbital of a diatomic molecule AB. Constructed from ϕ_A and ϕ_B which are also normalized. The overlap between ϕ_A and ϕ_B and value of *x* are

(a) 0, 0.8 (b) 0.31, 0.64 (c) 0.8, 0.31 (d) 0.64, 0.31

56. In a fcc lattice, the $\sin^2\theta$ values obained from X-ray powder diffraction pattern of a solid are observed at

(a) 1K, 2K, 3K, ... (b) 3K, 4K, 6K, ...

(c) 3K, 4K, 8K, ... (d) 3K, 5K, 9K, ...

57. In a cubic crystal, the value of interplanar spacing for (444) planes is 25 pm. The cell constant is

(a) 100 pm (b) $100\sqrt{3}$ pm (c) $\frac{100}{\sqrt{3}}$ pm (d) none of these

58. In admantane molecule, two irreducible representations are of one dimensions and one irreducible representation of two dimension. The number of three dimensional irreducible representation is/are

(a) 1 (b) 2 (c) 3 (d) 4

59. For a certain particle encountering a barrier, the tunnelling probability is approximately e^{-10}. If the mass is doubled and the width of the barrier is halved, approximate value of the tunnelling probability will be

(a) $e^{-10/\sqrt{2}}$ (b) $e^{-10\sqrt{2}}$ (c) $e^{-20\sqrt{2}}$ (d) $e^{-20/\sqrt{2}}$

60. The angle from z-direction is 60°. If the value of ℓ is 1. Then the value of m_ℓ will be

(a) 1 (b) 2 (c) $\sqrt{3}$ (d) none of these

Space for rough work

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CHEMICAL SCIENCES

TEST SERIES-B

Date : 27-05-2017

ANSWER KEY

PART-A

1. (c)	2. (c)	3. (d)	4. (b)	5. (d)	6. (d)	7. (a)
8. (a)	9. (b)	10. (b)				

PART-B

11. (b)	12. (c)	13. (d)	14. (b)	15. (b)	16. (b)	17. (a)
18. (c)	19. (b)	20. (a)	21. (a)	22. (b)	23. (c)	24. (c)
25. (c)	26. (b)	27. (a)	28. (d)	29. (b)	30. (b)	

PART-C

31. (b)	32. (c)	33. (b)	34. (d)	35. (b)	36. (d)	37. (c)
38. (b)	39. (d)	40. (d)	41. (b)	42. (b)	43. (a)	44. (a)
45. (d)	46. (a)	47. (c)	48. (d)	49. (a)	50. (d)	51. (d)
52. (c)	53. (c)	54. (a)	55. (a)	56. (c)	57. (b)	58. (b)
59. (a)	60. (d)					