

TEST SERIES CSIR-NET/JRF DEC. 2018

BOOKLET SERIES **C**

PHYSICAL CHEMISTRY

Paper Code **01**

Test Type: **TEST SERIES**

CHEMICAL SCIENCES

Duration: 2:00 Hours

Date: 26-11-2018

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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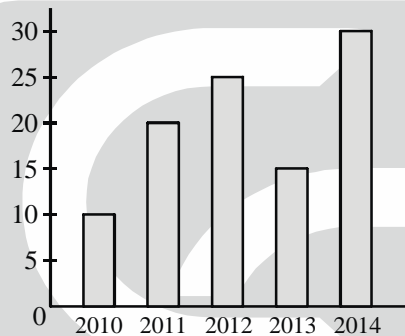


PART – A

1. Mohan is standing facing the North side. He goes 30 metres forward and then he turns left and goes for 5 metres. He then turns to his right and goes for 25 metres and finally turns to his right side and continues to walk. Which direction is he facing now ?
 (a) East (b) West (c) North (d) South
2. Find the missing number which would appear in place of question mark (?) based on the pattern followed in (I)?

1	8		2	?
2		(I)	3	

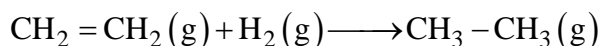
- (a) 13 (b) 18 (c) 16 (d) 20
3. Introducing a man Aparna says, “He is the only son of the father of my sister’s brother”. How is the man related to Aparna ?
 (a) Cousin (b) Brother (c) Uncle (d) Father
4. The graph represents the production of rice of a rice mill in metric ton from year 2010 to year 2014. What is the percentage increase in production of rice in year 2014 as compared to previous year ?



- (a) 100 (b) 80 (c) 70 (d) 75
5. How many triangles are there in the figure given below ?
-
- (a) 21 (b) 27 (c) 25 (d) 23
6. A circular wire has a diameter of 14 cm. If it is cut and a square is made of the wire then what is the area of the square formed ?
 (a) 144 sq. cm (b) 49 sq. cm (c) 196 sq. cm (d) 121 sq. cm
7. Ram does $\frac{1}{4}$ th of a job in 6 days and Rahim does the remaining part in 12 days. In how many days Ram and Rahim working together can complete the whole work ?
 (a) $8\frac{2}{3}$ days (b) $9\frac{3}{5}$ days (c) 7 days (d) $8\frac{1}{5}$ days
8. If $1! + 2! + 3! + 4! + \dots + 100!$ is divided by 6 then what is the remainder ?
 (a) 2 (b) 3 (c) 4 (d) 7
9. In how many ways a committee of 5 members can be formed from 6 executives and 5 technicians consisting of 3 executives and 2 technicians ?
 (a) 120 (b) 200 (c) 150 (d) 300
10. A wall clock gains 5 seconds in 3 minutes. It was properly set at 7 O' clock in the morning, if in the same day the clock indicates a time of 4 : 15 pm, then what is the true time ?
 (a) 3 : 48 pm (b) 4 : 10 pm (c) 4 pm (d) 3 : 55 pm

PART – B

11. For one component system, liquid-vapour curve finish at
 (a) Boyles temperature (b) Critical temperature
 (c) Sublimation point (d) Inversion temperature
12. 0.22g of hydrocarbon (compound of carbon and hydrogen) on complete combustion with oxygen gave 0.9g of water and 0.44g carbon dioxide. The weight of carbon and hydrogen in hydrocarbon is
 (a) C = 0.12g, H = 0.10g (b) C = 0.11g, H = 0.11g
 (c) C = 0.14g, H = 0.03g (d) C = 0.08 g, H = 0.14g
13. The enthalpy change for the following reaction is



Given: Bond energies of C–H, C–C, C = C and H–H are 99, 83, 147 and 104 kcal respectively.

- (a) 30 kcal (b) –30 kcal (c) 40 kcal (d) –40 kcal

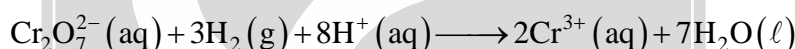
14. For an ideal gas, the product of α and β is

- (a) $\frac{nR}{P^2V}$ (b) PT (c) $\frac{1}{P^2V}$ (d) $\frac{1}{(PT)^2}$

15. A certain molecule can be treated as having only a triply degenerate state lying at 500 cm^{-1} above the doubly degenerate ground state. The approximate temperature (K) at which 20% of the molecule will be in the upper state (Given : $\ln 2 = 0.693$, $\ln 3 = 1.099$)

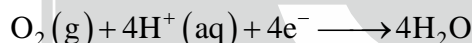
- (a) $T = \frac{500 k_B}{1.7916}$ (b) $T = \frac{500}{1.7916 \times k_B}$ (c) $T = \frac{2.9816}{k_B \times 1.7916}$ (d) $T = \frac{1.7916 \times k_B}{4.7916}$

16. To estimate the equilibrium constant at 298.15 K for the following reaction having $E_{cell}^0 = 1.232V$



- (a) 1.19×10^{125} (b) 2.9×10^{125} (c) 3.9×10^{125} (d) 4.9×10^{125}

17. The half-cell potential for the reaction :



is 1.03 V at 298.15K, when $P_{\text{O}_2} = 1$. The value of pH when standard redox potential is +1.23 V will be

- (a) 3.38 (b) 4.38 (c) 5.00 (d) 1.28

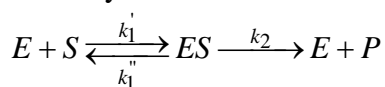
18. A particle is in the state $\phi = 3\psi_1 + 4\psi_2$ where ψ_1 and ψ_2 are eigen function of Hamiltonian of the particle with eigenvalues E_1 and E_2 respectively. The average energy of the particle is in the state ϕ is

- (a) $\frac{16E_1 + 9E_2}{25}$ (b) $\frac{9E_1 + 16E_2}{25}$ (c) $\frac{3E_1 + 4E_2}{25}$ (d) $\frac{E_1 + E_2}{25}$

19. In 1-D simple harmonic oscillator, the ratio of β and α parameters for 3rd excited state is (Given : $\alpha = 2mE / \hbar^2$ and $\beta = (mk)^{1/2} / \hbar$)

- (a) 7 (b) $\frac{1}{7}$ (c) 9 (d) $\frac{1}{9}$

20. For the following enzyme catalysed reaction



The Michaelis-Menten constant is

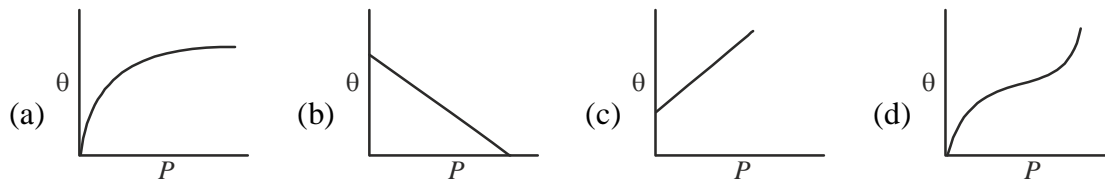
- (a) $\frac{k_1'' + k_2}{k_1'} \text{ Ms}^{-1}$ (b) $\frac{k_1'' + k_2}{k_1} \text{ M}$ (c) $\frac{k_1'' + k_2}{k_1'} \text{ s}^{-1}$ (d) None



21. The reciprocal of the time 't' concentration of reactant in a dimerisation reaction is

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

22. Which of the following isotherm represent B.E.T. Theory



23. The molar mass in Osmometry methods is given by

- (a) $\frac{\pi - BC^2RT}{RT}$ (b) $\frac{\pi - BC^2RT}{CRT}$ (c) $\frac{CRT}{\pi - BC^2RT}$ (d) $\frac{RT}{\pi - BC^2RT}$

24. The Mulliken symbol for the following representation is

E	C_n	nC_2	σ_h	i
1	1	-1	-1	-1

- (a) A'_{1g} (b) A''_{1u} (c) A''_{2g} (d) A''_{2u}

25. The anions in Fluorite structure are present in

- (a) All Oh Vds (b) Half Oh Vds (c) Half Td Vds (d) All Td Vds

26. The plane(s) which show allowed reflection in a fcc lattice is/are

- (I) (100) (II) (123) (III) (333) (IV) (246)
 (a) I and II (b) III and IV (c) I and IV (d) I, II, III and IV

27. Which of the following molecules would not give pure rotational spectrum?

H_2 , HCl, CO, CH_3Cl , H_2O (liq.), NH_3 , NH_4Cl

- (a) H_2 , NH_3 (b) H_2 , NH_4Cl , CO (c) HCl, NH_3 , NH_4Cl (d) H_2 , H_2O (liq.), NH_4Cl

28. A system consists of two identical, non-interacting particles. The system has only three single particle states ψ_1 , ψ_2 and ψ_3 with energies $\epsilon_1 = 0$, $\epsilon_2 = 2\epsilon$, $\epsilon_3 = 4\epsilon$ respectively. If the particles are bosons then out of following occupation, which would provide maximum energy to the system?

- (a) {2, 0, 0} (b) {0, 2, 0} (c) {0, 1, 1} (d) {1, 0, 1}

29. If $z^2 = 8t$ and 0.5% error is incurred for t . The percentage error involved in z will be

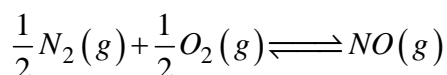
- (a) 0.4 (b) 0.05 (c) 0.50 (d) 0.25

30. Assuming that the hydrogen molecules have a root mean square speed of 1500 m/s at 400K. The root mean square speed at 1200K is

- (a) 2796 m/s (b) 2598 m/s (c) 1800 m/s (d) 1200 m/s

PART – C

31. $\Delta G^0 = 77.77 \text{ kJmol}^{-1}$ at 1000K for the reaction



The partial pressure of NO under equilibrium at 1000K for air at 1 atm pressure containing 80% N_2 and 20% O_2 is

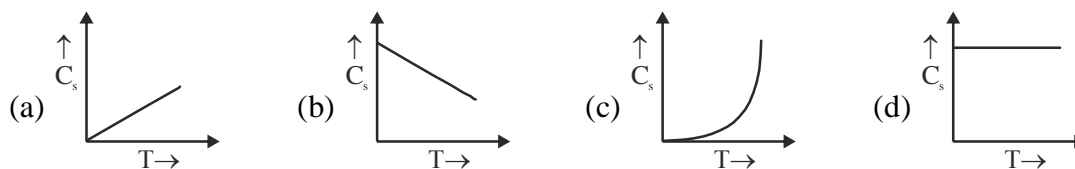
- (a) 4.3×10^{-4} atm (b) 3.8×10^{-6} atm (c) 3.47×10^{-5} atm (d) 2.4×10^{-6} atm

32. The ratio of concentration of salt of conjugate base of acetic acid and concentration of benzoic acid required to prepare buffer solution with pH of 4.5 is ($K_a = 6.5 \times 10^{-5}$)

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



33. According to equipartition theorem, the variation of specific heat capacity with temperature for He is



34. The heat change when 1 mol of gas is expand to ten times of its initial volume at 25°C is
 (a) 1.32 kJmol⁻¹ (b) 1.32 kcalmol⁻¹ (c) 1.72 kJmol⁻¹ (d) 1.72 kcalmol⁻¹

35. At 5 atm and 300K, the volume of a gas is 4.75L. The fugacity coefficient (ϕ) is
 (a) $\phi = 1$ (b) $\phi > 1$ (c) $\phi < 1$ (d) Not enough information

36. Which of the following statement(s) is/are correct

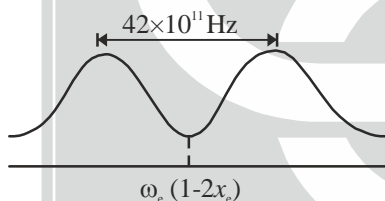
- (1) Q-branch can be observed in vibrational-rotational spectrum of the molecule other than linear molecules
- (2) Vibrational-rotational spectrum of CO₂ molecule is symmetrically distributed around its center (under rigid rotor approximation and neglecting the effect of naturally abundant ¹³CO₂ molecules)
- (3) Rotational-RAMAN spectrum of O₂ molecule is symmetrically distributed around Rayleigh line (under rigid rotor approximation)
- (4) The separation between two consecutive rotational energy levels differs in microwave and rotational RAMAN spectroscopy.

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

37. For HCl molecule $\bar{\nu} = 2989.7 \text{ cm}^{-1}$ and $\bar{\nu}_x = 52.05 \text{ cm}^{-1}$, where $\bar{\nu}$ = equilibrium vibrational frequency and x = anharmonicity constant. The zero point energy under anharmonic potential of HCl and DCl is

- (a) 1482 cm⁻¹ and 1054 cm⁻¹ (b) 1482 cm⁻¹ and 1048 cm⁻¹
 (c) 1494.85 cm⁻¹ and 1057.18 cm⁻¹ (d) 1494.85 cm⁻¹ and 1048 cm⁻¹

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

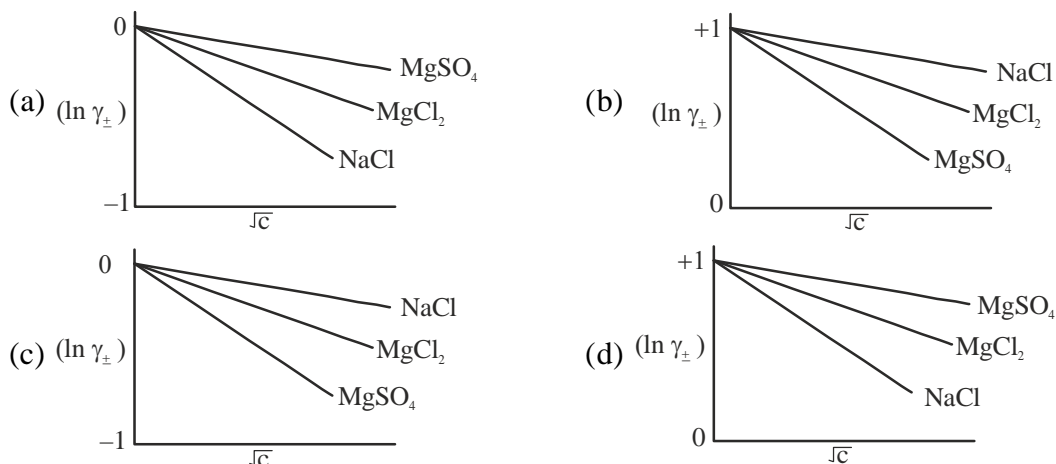


Rotational constant for CO is 5 cm⁻¹. The value of J_{max} is

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

39. Aqueous solutions of NaCl, MgCl₂ and MgSO₄ show the following plots of logarithms of mean ionic activity coefficient ($\ln \gamma_{\pm}$) vs molar concentration (c)

The correct option is



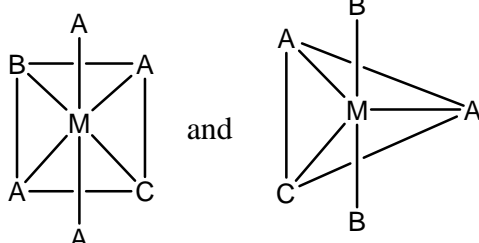
40. Two aqueous 1 : 1 electrolyte systems A and B. System A is having temperature T_A with concentration C_A and dielectric constant ϵ_r , where as other system B is having twice the temperature, one-half the concentration and double the dielectric constant as compare to system A. The relation between their Debye Huckel screening length will be
- (a) $k_B = k_A \sqrt{8}$ (b) $\frac{1}{k_B} = \frac{1}{k_A} \sqrt{8}$ (c) $\frac{1}{k_B} = \frac{1}{k_A} \sqrt{2}$ (d) $k_B = 4\sqrt{2} k_A$
41. EMF of the conc. cell with transference,
Pt | H_2 (1 atm), $HCl(a_{\pm} = 0.009)$: $HCl(a_{\pm} = 0.018)$, H_2 (1 atm) | Pt is 0.028V at 25°C. The EMF of the corresponding cell without transference is 0.017 V. The transference number of H^+ ion is
(a) 0.82 (b) 1.08 (c) 2.08 (d) 3.02
42. The unperturbed is energy levels of a system are $\epsilon_0 = 1$, $\epsilon_1 = 3$, $\epsilon_2 = 5$. The second order correction to energy to the second excited state in the presence of perturbation V for which $V_{10} = 4$, $V_{20} = 6$, $V_{12} = 8$ has been found to be
(a) 14 (b) 41 (c) 0 (d) None of these
43. The electron transition energy from LOMO \rightarrow LUMO is 10 eV in allyl radical in the frame work of Huckel theory. The transition energy from LOMO \rightarrow HOMO will be
(a) 5 eV (b) 10 eV (c) 20 eV (d) 0 eV
44. Given A and B are hermitian operators. Now consider the following operators
 $O_1 = AA^\dagger$, $O_2 = A^\dagger A$, $O_3 = [A, B]$
 $O_4 = AB^2A$, $O_5 = i[A, B]$, $O_6 = AB$
Which one of above operators is/are hermitian?
(a) All except O_3 (b) All except O_3 and O_6
(c) All except O_4 and O_6 (d) All except O_5
45. If 10 non-interacting spin 3/2 particle are filled in 3-D cubic box. The total energy of the system is (The lenth of the box $l_x = l_y = l_z = l$)
(a) $\frac{60h^2}{8ml^2}$ (b) $\frac{48h^2}{8ml^2}$ (c) $\frac{36h^2}{8ml^2}$ (d) $\frac{24h^2}{8ml^2}$
46. The rate constant for fluorescence is $8 \times 10^7 s^{-1}$ and rate constant for internal conversion is $1 \times 10^8 s^{-1}$ and rate constant for inter system crossing is $0.2 \times 10^8 s^{-1}$. The fluorescence relaxation time is
(a) 2×10^8 sec (b) 2×10^{-8} sec (c) 5×10^9 sec (d) 5×10^{-9} sec
47. The temperature coefficient of a reaction with activation energy $80 kJmole^{-1}$ at room temperature is approximately
(a) 2-3 (b) 20-30 (c) 1 (d) ∞
48. Consider the following reaction,
 $A + hv \rightleftharpoons 3B$; $2B \rightleftharpoons C + D$
The overall rate is proportional to
(a) I_a (b) $I_a^{1/3}$ (c) $I_a^{2/3}$ (d) $I_a^{1/3} [A]$
49. In Langmuir theory of adsorption for dissociative mechanism the reciprocal of \sqrt{kp} is given by
(a) $\frac{1}{\theta}$ (b) $1 - \theta$ (c) $\frac{1}{\theta} - 1$ (d) $\frac{\theta}{1 - \theta}$
50. The correct statement(s) is/are
(I) Activation energy in physical adsorption is high
(II) Entropy change in physical adsorption is negative
(III) Chemical adsorption occurs at high temperature
(a) I and II (b) I and III (c) II and III (d) I, II and III

51. The poly dispersity index for the following distribution is

N	M
10	2000
20	1000

- (a) $\frac{16}{18}$ (b) $\frac{18}{16}$ (c) $\frac{16}{17}$ (d) $\frac{17}{16}$

52. The point group symmetry for the following structures



are respectively

- (a) C_s and C_{2v} (b) C_s and C_s (c) D_{4h} and C_{2v} (d) C_{4v} and C_{2v}

53. The reducible representation of NH_3 molecule is (Basis = $3N$ co-ordinate)

(a)

	E	$2C_3$	$3\sigma_v$
$\Gamma R.R.$	4	0	1

(b)

	E	$2C_3$	$3\sigma_v$
$\Gamma R.R.$	12	0	1

(c)

	E	$2C_3$	$3\sigma_v$
$\Gamma R.R.$	4	0	2

(d)

	E	$2C_3$	$3\sigma_v$
$\Gamma R.R.$	12	0	2

54. The fraction of volume occupied in FCC lattice is

- (a) $\frac{3\sqrt{\pi}}{16}$ (b) $\frac{\sqrt{3}\pi}{16}$ (c) $\frac{3\sqrt{\pi}}{8}$ (d) $\frac{\pi\sqrt{3}}{8}$

55. If in a cubic unit cell $d_{123} = 100 \text{ \AA}$. Then the value of d_{240} is

- (a) 50 \AA (b) 200 \AA (c) 100 \AA (d) None of these

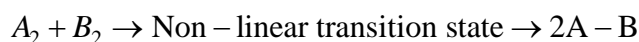
56. The ratio of population of first populated excited state with respect to populated ground state for O_2 molecule is 2.2 (consider the degeneracy of both the states). The rotational constant for the molecule is (Given : $kT = 200 \text{ cm}^{-1}$)

- (a) 31 cm^{-1} (b) 1.176 cm^{-1} (c) 27.36 cm^{-1} (d) zero

57. The ratio of population of first rotationally excited level with $J = 1$ respect to ground state rotational state ($J = 0$) for CO_2 molecule is {if $kT = 2000 \text{ cm}^{-1}$, the separation between $J = 1$ and $J = 0$ (in energy) = $16.8 \times 10^{-24} \text{ J}$, $h = 7 \times 10^{-34} \text{ J-s}$, $C = 3 \times 10^{10} \text{ cm/s}$ }

- (a) $3e^{-(8.4 \times 10^{-27})}$ (b) $3e^{-4 \times 10^{-4}}$ (c) $\frac{1}{3}e^{4 \times 10^{-4}}$ (d) zero

58. The unit of pre-exponential factor for the reaction of the type



under the treatment of conventional transition state theory

$$(q_{trans} \propto T^{3/2}, q_{rot}(\text{linear}) \propto T, q_{rot}(\text{non-linear}) \propto T^{3/2}, q_{vib} \propto T^0)$$

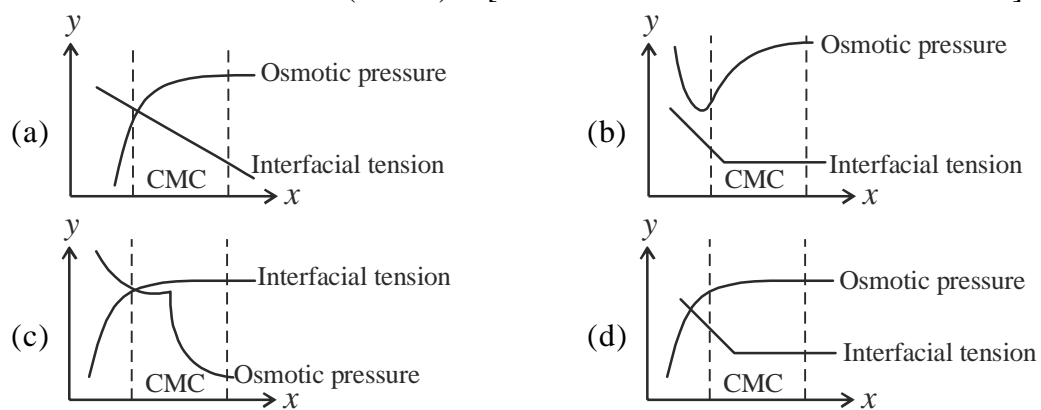
- (a) $\text{k}^{-2}\text{s}^{-1}$ (b) $\text{mol}^{-1} \text{k}^{-2} \text{s}^{-1}$ (c) $\text{mol}^{-1} \text{s}^{-1}$ (d) s^{-1}

59. The masses recorded when a substance is weighed 5 times are 10.8, 10.2, 10.6, 10.4 and 11 mg. The variance is closest to

- (a) 0.05 (b) 0.656 (c) 0.89 (d) 0.75



60. The correct representation of the variation of osmotic pressure and interfacial tension (y-axis) with surfactant concentration (x-axis) is [CMC = Critical Micelle Concentration]



Space for rough work





CHEMICAL SCIENCES

Date : 26-11-2018

TEST SERIES-C (PHYSICAL CHEMISTRY)

ANSWER KEY

PART-A

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

PART-B

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

PART-C

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

