Target IIT-JAM-2019

Test Series-4

PHYSICAL CHEMISTRY - II **Booklet Code: D**

Duration: 2:30 Hours **CHEMISTRY-CY** **Date: 07-01-2019**

Maximum Marks: 100

Read the following instructions carefully:

1 Attempt all the questions.

2. **Section-A** contains **30** Multiple Choice Questions (MCQ). Each question has 4 choices (a), (b), (c) and (d), for its answer, out of which **ONLY ONE** is correct. From **Q.1 to Q.10** carries 1 Marks and **Q.11 to Q.3**0 carries 2 Marks each.

3. **Section-B** contains **10** Multiple Select Questions(MSQ). Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which **ONE or MORE than ONE** is/are correct. For each correct answer you will be awarded **2 marks.**

4. Section-**C** contains **20** Numerical Answer Type (NAT) questions. From **Q.41 to Q.50** carries **1 Mark** each and **Q.51 to Q.60** carries **2 Marks** each. For each NAT type question, the value of answer in between 0 to 9.

5. In all sections, questions not attempted will result in zero mark. In Section–A (MCQ), wrong answer will result in negative marks. For all **1 mark** questions, **1/3 marks** will be deducted for each wrong answer. For all **2 marks** questions, **2/3 marks** will be deducted for each wrong answer. In Section–B (MSQ),there is no negative and no partial marking provision. There is no negative marking in Section –C (NAT) as well.

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Section-A : Multiple Choice Questions (MCQ)

Q.1 to Q.10: Carry 1 Mark each.

1. The electrical work produced in a Daniell cell for which $E^0_{cell} = 1.10\,V$. The reaction producing in the cell is

$$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

(a) –212.3 kJ/mol (b) –215.8 kJ/mol (c) –220.5 kJ/mol (d) None of these

2. The number of gaseous molecules left in a volume of 1 mm^3. If it is pumped out to give a vacuum of 10^{-6} mmHg at 300K.
(a) 3.42×10^{-3} (b) 1.38×10^{-23} (c) 6.02×10^{23} (d) 3.21×10^{7}

3. Equimolar solution in the same solvent have?
(a) same boiling point and same freezing point
(b) different boiling point and different freezing point
(c) same boiling point but different freezing point
(d) same freezing point but different boiling point.

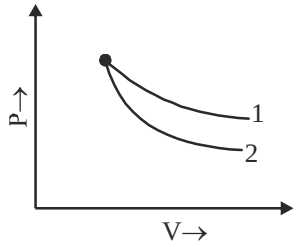
4. For a reaction at equilibrium:
(a) k_p^0 varies linearly with temperature with a positive slope
(b) k_p^0 varies linearly with inverse of temperature with a positive slope
(c) $\ln k_p^0$ varies linearly with a temperature
(d) $\ln k_p^0$ varies linearly with inverse of temperature

5. If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the decrease in freezing point of water (ΔT_f) when 0.01 mol of sodium sulphate is dissolved in 1kg of water $(k_f = 1.86\ K\ kg/mol)$ is
(a) 0.066 (b) 0.055 (c) 0.098 (d) 0.025

6. For the reaction, $4NO_2(g) + O_2(g) \rightleftharpoons 2N_2O_5(g)$. Which of the following fact holds good?
(a) $k_p = k_c$ (b) $k_p > k_c$ (c) $k_p < k_c$
(d) k_p and k_c can't be correlated unless pressure of the system is provided.

7. The volume (X) of H_2 gas effuses through a hole in a container in 5 sec. The time taken for the effusion of the same volume of the specified gas under identical condition is
(a) 10 sec : He (b) 20 sec : O_2 (c) 25 sec : CO (d) 55 sec : CO_2

8. P-V plots for two gases during adiabatic processes are shown in the figure. Plots 1 and 2 should correspond respectively to



(a) He and O_2 (b) O_2 and He (c) He and Ar (d) O_2 and N_2

9. Let f_1 and f_2 be the fractions of molecules in the range 'C' and 'C + dC' for SO_2 at 2T amnd O_2 at T respectively. Which of the following expression is correct?

(a) $f_1 > f_2$ (b) $f_1 < f_2$ (c) $f_1 = f_2$ (d) f_1 and f_2 can't be correlated

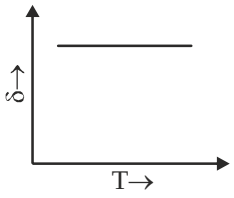
10. For a given equilibrium reaction, an increase in temperature will
(a) increase the rate of exothermic more than that of the endothermic reaction
(b) increase the rate of endothermic reaction more than that of the exothermic reaction
(c) increase both rates equally
(d) decrease both rates equally

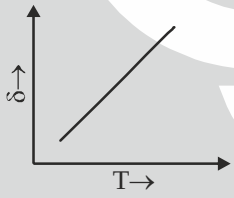
Q.11 to Q.30: Carry 2 Marks each.

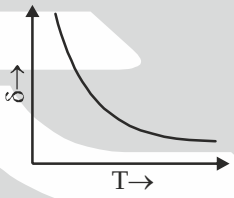
11. A binary liquid solution of n-heptane and ethyl alcohol is prepared. Which of the following statements correctly represents the behaviour of this liquid solution?
(a) The solution formed is an ideal solution
(b) The solution formed is non-ideal solution with positive deviation from Raoult's law.
(c) The solution formed is non-ideal with negative deviation from Raoult's law.
(d) n-neptane exhibits positive deviation whereas ethyl alcohol exhibits negative deviation from Raoult's law.

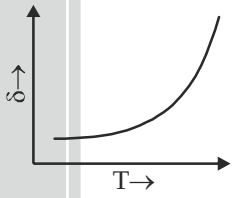
12. Which of the following indicators is best suited in the titration of a weak base versus a strong acid?
(a) Phenylpthalein (8.3–10) (b) Phenol red (6.8–8.4)
(c) Methyl orange (3.1 –4.4) (d) Litmus (4.5 –8.3)

13. An ideal gas is initially at temperature T and volume V. its volume is increased due to an increase in temperature ΔT. The quantity $\delta = \left[\frac{\Delta V}{V(\Delta T)}\right]$ varies with temperature as

(a) 

(b) 

(c) 

(d) 

14. A mixture of ethane (C_2H_6) and ethene (C_2H_4) occupied 35.5 L at 1.0 bar and 405 K. The mixture reacted completely with 110.3 g of O_2 to produce CO_2 and H_2O. The composition of the original mixture
(a) $n_1 = n_2 = 0.50$ (b) $n_1 = 0.484$ and $n_2 = 0.57$
(c) $n_1 = 0.40$ and $n_2 = 0.60$ (d) $n_1 = 0.80$ and $n_2 = 0.20$

15. In a system $A(s) \rightleftharpoons 2B(g) + 3C(g)$ if the conc. of C at equilibrium is increased by a factor of 2. It will cause the equilibrium concentration of B to be changed
(a) two times the original value (b) one half of its original value
(c) $2\sqrt{2}$ times its original value (d) $\frac{1}{2\sqrt{2}}$ times the original value

16. Consider separate solution of 0.500 M C_2H_5OH (aq), 0.100 M $Mg_3(PO_4)_2$, 0.250 M KBr(aq) and 0.125 M Na_3PO_4 (aq) at 50°C. Which statement is true about these solution's assuming all salts to be strong electrolytes?
(a) 0.500 M C_2H_5OH (aq) has the highest osmotic pressure
(b) They all have the same osmotic pressure
(c) 0.100 M $Mg_3(PO_4)_2$ (aq) has the highest osmotic pressure
(d) 0.125 M $Na_3(PO_4)_2$ (aq) has the highest osmotic pressure.

17. One mole of a monoatomic ideal gas expands adiabatic at initial temperature T against a constant pressure of 1 atm from one litre to three litres. The final temperature of the gas is

(a) T (b) $\frac{T}{3(5R/2)}$ (c) $T-\frac{2K}{(1.5\times 0.082)}$ (d) $T+\frac{2K}{(1.5\times 0.082)}$

18. The work done, when a gas at P_1, V_1 changes to P_2 and V_2 adiabatically
(a) Remains the same irrespective of the nature of gas
(b) Increases with increase in atomicity of gaseous molecules
(c) Is the same as that for an isothermal change to the same state.
(d) Is zero

19. For a concentrated solution of a weak electrolyte A_xB_y, the degree of dissociation is given as

(a) $\alpha=\sqrt{\frac{k_{eq}}{C(x+y)}}$ (b) $\alpha=\sqrt{\frac{k_{eq}\cdot C}{x\cdot y}}$ (c) $\alpha=\sqrt{\frac{k_{eq}}{x\cdot y\cdot C}}$ (d) $\alpha=\left[\frac{k_{eq}}{C^{x+y-1}\cdot x^x\cdot x^y}\right]^{1/x+y}$

20. The observed osmotic pressure for a 0.10 M solution of $Fe(NH_4)_2(SO_4)_2$ at 25°C is 10.8 atm. The expected and experimental values of Van't Hoff factor(i) will be respectively [R = 0.082 L.atm K^{-1} mol^{-1}]
(a) 5 and 4.42 (b) 4 and 4.00 (c) 5 and 3.42 (d) 3 and 5.42

21. In conversion of lime-stone to lime $CaCO_3(s)\longrightarrow CaO(s)+CO_2(g)$. The values of ΔH° and ΔS° are 179.1 kJ/mol and 160.2 J/k/mole, respectively at 298K and 1 bar. Assuming that ΔH° and ΔS° do not change with temperature, temperature above which conversion of lime stone to lime will be spotaneous is
(a) 1008K (b) 1200K (c) 845K (d) 1118 K

22. When rain is accompained by a thunderstrom the collected rain water will have a pH value
(a) Which depends on the amount of dust in air
(b) Slightly lower than that of rain water without thunderstrom
(c) Slightly higher than that when the thunderstrom is not there
(d) Uninfluenced by occurence of thunderstrom.

23. Given the following reaction at equilibrium $N_2(g)+3H_2(g)\rightleftharpoons 2NH_3(g)$ some inert gas at constant pressure is added to the system. Which of the following facts will be affected?
(a) More NH_3(g) is produced (b) Less NH_3(g) is produced
(c) No effect on the equilibrium (d) k_p of the reaction is decreased.

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24. For the reaction, $H_2(g)+I_2(g)\rightleftharpoons 2HI(g)$, $k_c^\bullet=66.9$ at 350 °C, $k_c^\bullet=50$ at 448°C. The reaction has

(a) ΔH = positive (b) ΔH = negative
(c) ΔH = zero (d) ΔH whose sing can't be predicted.

25. 'a' and 'b' are van der Waals constant of gases, chlorine is more easily liquefied than ethane because
(a) 'a' for Cl_2 > a for C_2H_6 but 'b' for Cl_2 < 'b' for C_2H_6.
(b) 'a' and 'b' for Cl_2 > 'a' and 'b' for C_2H_6
(c) 'a' and 'b' for Cl_2 < 'a' and 'b' for C_2H_6
(d) 'a' for Cl_2 < 'a' for C_2H_6 but 'b' for Cl_2 > 'b' for C_2H_6

26. Two closed bulb's of equal volume (V) containing an ideal gas initially at pressure P_i and temperature T_1 are connected through a narrow tube of negligible volume and the temperature of one of the bulbs is then raisred to T_2. The final pressure P_f is

(a) $2P_i\left[\frac{T_1}{T_1+T_2}\right]$ (b) $2P_i\left[\frac{T_2}{T_1+T_2}\right]$ (c) $2P_i\left[\frac{T_1T_2}{T_1+T_2}\right]$ (d) $P_i\left[\frac{T_1T_2}{T_1+T_2}\right]$

27. In the reaction $HCN+H_2O \rightleftharpoons H_3O^+ + CN^-$, the conjugate acid-base pair is

(a) HCN, H_2O (b) H_3O^+, CN^- (c) HCN/H_3O^+ (d) HCN/CN^-

28. The degree of dissociation (α) of the reaction $A_2(g) \rightleftharpoons 2A(g)$ in terms of the rate of diffusion (r_{mix}) of equilibrium mixture and that of a reference gas X is given by

(a) $\alpha=\left(\frac{M_{A_2}}{M_X}\right)\left(\frac{r_{mix}}{r_X}\right)^2-1$ (b) $\alpha=\left(\frac{M_{A_2}}{M_X}\right)\left(\frac{r_X^2}{r_{mix}^2}\right)-1$

(c) $\alpha=\left(\frac{M_X}{M_{A_2}}\right)\left(\frac{r_X}{r_{mix}}\right)^2-1$ (d) $\alpha=\left(\frac{M_X}{M_{A_2}}\right)\left(\frac{r_{mix}}{r_X}\right)^2-1$

29. If 100 mol of H_2O_2 decomposes at 1 bar and 300K, the work done (kJ) by one mol of O_2(g) as it expands against 1 bar pressure is (R = 8.314 J/K/mol)

$$2H_2O_2(\ell) \rightleftharpoons 2H_2O(\ell)+O_2(g)$$

(a) –2.49 kJ (b) –124.5 kJ (c) –2490 kJ (d) None of these

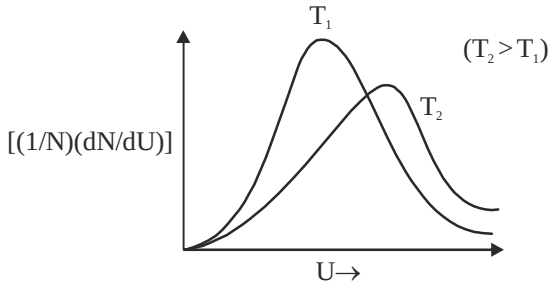
30. At Boyle temperature, the second virial coefficient has a value of

(a) zero (b) positive (c) negative (d) positive depends on pressure

Section-B : Multiple Select Questions (MSQ)

Q.31 to Q.40: Carry 2 Marks each.

31. Which of the following statement are correct on the of Maxwell Boltzmann distribution of molecular speed

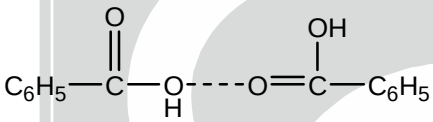


(a) The fraction of molecules having either very low speed or very high speeds are small in number
(b) The speed corresponding to maximum fraction of speed is known as the most probable speed
(c) The fraction of molecules having a lower speed range decreases whereas that having higher speed range increases on increasing the temperature of gas
(d) The distribution curve becomes boader in the middle range at higher temperature indicating that more molecules possess speed nearer to most probable speed.

32. Effect of pressure on the chemical potential versus temperature plots of a substance having $V_{m(\ell)} > V_{m(s)}$, which of the following conclusions are true?
(a) $T < T_s$ (μ_s has the lowest value and thus the solid phase is stables)
(b) $T = T_s$ ($\mu_s = \mu_g$, both solid and gaseous phases co-exists in equilibrium)
(c) $T > T_g$ (μ_g has the lowest value and gaseous phase is stable)
(d) An increase in melting point as well as boiling point of the substances, the increase in boiling point is relatively larger and this enhances the stability of the liquid phase.

33. On the basis of phase diagram of water which of the following statements are correct?
(a) The triple point of water is unique and it lies at 0.0075 °C and 4.6 mmHg
(b) A meta stable equilibrium is established due to rapidly heating and cooling effect.
(c) The vapour pressure of the system in the meta stable region is greater than that in the stable system at the same temperature.
(d) Chemical potential for both phase identical.

34. Which of the following statements are incorrects
(a) The value of k_b for water is larger than that of k_f.
(b) The elevation of boiling point of a solvent when a non-volatile solute is added to it is larger than its depression in freezing point
(c) Osmotic pressure measurement is preferred over any colligative properties in determining the molar mass of proteins and polymer
(d) The dimerized formal benzoic acid in benzene is

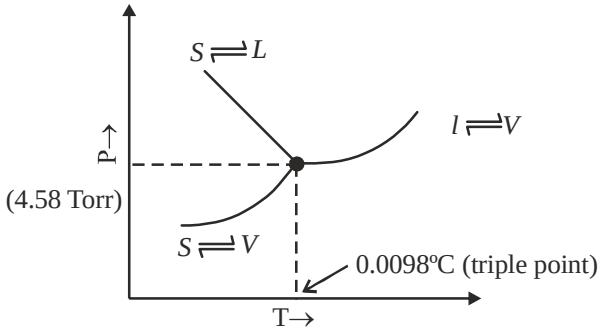


35. Which of the following statements are correct?

(a) For a real gas, the compression factor Z is defined as $\frac{V_{real}}{V_{ideal}}$

(b) At low pressure, the variation of compression factor with pressure can be explained from vander Waals equation when the term 'b' is ignored in comparision to the term V_m.
(c) AT high pressure, the variation of compression factor with pressure can be explained from the vander Waals equation when the term 'a' is ignored in comparision to the term V_m.
(d) The value of γ of gases increases with increases in the atomicity of gaseous molecular.

36. Which of the following statement are correct about phase diagram.



(a) $\ell \rightleftharpoons V$ curve extends only up to a limit of critical pressure and temperature because above these conditions it is not possible to distinguish the vapour phase from the liquid phase
(b) $T_b > T > T_m$ (only liquid phase exits)

(c) $T = T_b$ (liuqid and vapour phases in equilibrium)

(d) $T < T_m$ (only solid phase exits)

37. For the reaction, $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, the forward reaction at constant temperature is favoured by

(a) Introducing an inert gas at constant volume

(b) Introducing Cl_2(g) at constant volume

(c) Introducing an inert gas at constant pressure

(d) Increasing the volume of the container

38. The molar mass of 'NaCl' determined by osmotic pressure would be

(a) 58.5 g/mol (b) more than 58.5 g/mol

(c) less than 58.5 g/mol (d) 117 g/mol

39. Which of the following statements are correct?

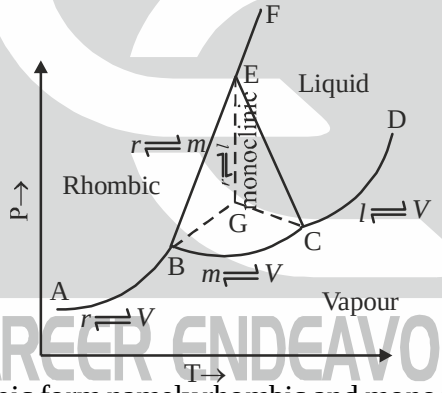
(a) The levelling effect is not observed in non-aqueous medium.

(b) The strength of an acid having general formula $(HO)_m ZO_n$ increases with increase in value of *n*.

(c) In a given reaction , the position of equilibrium favours the formation of a weak Bronsted acid and a weak bronsted base.

(d) The reaction, $HCN + OH^- \rightleftharpoons CN^- + H_2O$ is displaced to the right indicating that the acid strength of HCN is greater than water and the base strength CN^- is greater than that of OH^-.

40. On the basis of phase diagram of sulphur which of the following statements are correct?



(a) sulphur exits in two enantiotropic form namely rhombic and monoclinic

(b) the slope of the curve AB at point B is larger than that of the curve BC

(c) three triple point and one meta stable triple point exists

(d) None of these

Section-C : Numerical Answer Type (NAT)

Q.41 to Q.50: Carry 1 Mark each.

41. The $\Delta_r S$ for the reaction is _____(J/K/mole) at 5-bar pressure and 298K.

$$\frac{1}{2}N_2(g) + O_2(g) \longrightarrow NO_2(g) \qquad \Delta_r S^0_{298K} = -16.81\ J/K/mol$$

(Upto two decimal places)

42. The root mean square speed of ozone kept in a closed vessel at 20°C and 82 cmHg pressure is _____(in units of m/sec). (upto one decimal place)

43. The ionic product of water at 100ºC is 49 times that at 25ºC. The pH of pure water at 100ºC is about _____(upto two decimal places).

44. The van't hoff factor for 0.1 molal $Ba(NO_3)_2$ solution is 2.74. Its degree of dissociation is _____(upto two decimal places).

45. The amount of water must be added to 1L of an aqueous solution of HCl with a pH of 1 to create an aqueous solution with pH of 2 is _____(in litre)? (answer should be an integer).

46. A solution contains 10g of a solute and 116g of acetone at 30ºC its vapour pressure is 290 torr. If the vapour pressure of pure acetone is 300 torr at 30ºC, the molar mass of solute is _____(in g/mol). (answer should be an integer).

47. The degree of dissociation of the reaction, $AB_2 \rightleftharpoons A + B_2$ is found to be 0.4 at 400K and 1 atm pressure. If the molar mass of AB_2 is 200 g/mol. The density of the system at equilibrium would be _____g/dm^3. (answer should be an integer).

48. On the basis of the following thermochemical data

$$H_2O(\ell) \longrightarrow H^+(aq) + OH^-(aq) \quad \Delta H = 57.32\ kJ/mol$$

$$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(\ell) \quad \Delta H = -286.2\ kJ/mol$$

$$\Delta_f G^0\left(H^+, aq\right) = 0$$

The value of formation of OH^- ions at 25ºC is _____(kJ/mole) (Upto two decimal places).

49. 200 mL of a strong acid solution of pH = 2.0 is mixed with 800 mL of another acid solution of pH = 3.0. The pH of resultant solution is _____(upto two decimal places).

50. The internal energy change when a system goes from state A to B is 40 kJ/mol. If the system goes from A to B be a reversibly and returns to state A by irreversibly path. The net change in internal energy will be _____(kJ/mole) (answer should be an integer).

Q.51 to Q.60: Carry 2 Marks each.

51. The mean enthalpy of vapourization of water in the temperature range between 363.15 K and 373.15K is 2268 J/g. The vapour pressure of water at 363.15K is _____(in cmHg) if its value at 373.15K is being 76 cmHg. (Upto one decimal places)

52. The equilibrium constant k_p for the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ is 16. If the volume of the container is reduced to one-half of its original volume, the value of k_p for the reaction at the same temperature will be _____(answer should be an integer).

53. If a one-mole of a monoatomic gas $\left(C_{V_m} = 1.5\ R\right)$ at 25ºC is subjected to adiabatic irreversible expansion from $1dm^3$ to $2\ dm^3$ against a constant pressure of 1 atm. The final temperature of the gas will be _____K. (Upto one decimal place).

54. A 0.004M solution of K_2SO_4 is isotonic with a 0.01M solution of glucose at the same temperature. The % apparent degree of dissociation of K_2SO_4 is _____(upto one decimal place).

55. The enthalpy of formation of ethane is _____kJ/mol. (answer should be an integer)

[Given: $E_{C-C} = 348\ kJ/mol$, $E_{C-H} = 412\ kJ/mol$, $E_{H-H} = 436\ kJ/mol$ and enthalpy of sublimation of C(graphite) 716 kJ/mol].

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56. If 66% of $N_2O_4(g)$ is dissociated into $NO_2(g)$ at 27°C and 1 atm pressure, the volume occupied by 11.5g of N_2O_4 would be about _____L. (Upto one decimal place).

57. 20g of N_2 at 300K is compressed reversibly and adiabatically from 20 dm^3 to 10 dm^3. The ΔH for this process is _____(in kJ). (upto two decimal places)

58. If the bond dissociation energies of XY, X_2 and Y_2 (all diatomic molecules) are in the ratio of 1 : 1 : 0.5 and $\Delta_f H^0$ for the formation of XY is –200 kJ/mol. The bond dissociation energy of X_2, will be _____(kJ/mole) (answer should be an integer).

59. One mole of a monoatomic gas $(\gamma = 1.66)$ is mixed with 2-mole of a diatomic gas $(\gamma = 1.4)$. The value of γ for this mixture would be _____(Upto two decimal places).

60. The equivalence point in a titration of 40 mL of a solution of a weak monoprotic acid occurs when 35 mL of a 0.1 M NaOH solution has been added. The pH of the solution is 5.75 after the addition of 20 mL of NaOH solution. The pK_a of the acid is about _____(Upto two decimal places).

******* END OF QUESTION PAPER *******

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Space for Rough Work

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IIT-JAM CHEMISTRY-CY

TEST SERIES - 4
(Physical Chemistry-II)

Date : 07-01-2019

Booklet : D

ANSWER KEY

Section-A : Multiple Choice Questions (MCQ)

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

Section-B : Multiple Select Questions (MSQ)

31. (a),(b), (c), (d)	**32.** (a),(b), (c), (d)	**33.** (a),(b), (c), (d)	**34.** (a),(b),(d)
35. (a),(b)	**36.** (a),(b), (c), (d)	**37.** (c),(d)	**38.** (c)
39. (b), (c)	**40.** (a),(b), (c)		

Section-C : Numerical Answer Type (NAT)

41. (-11.20 to -9.58)	**42.** (389.5 to 391.5)	**43.** (6.05 to 7.05)	**44.** (0.85 to 0.95)
45. (9)	**46.** (150)	**47.**(4.30 to 4.40)	**48.** (-229.80 to -227.80)
49. (2.50 to 2.60)	**50.** (0)	**51.** (51.8 to 53.5)	**52.** (16)
53. (-291.5 to -289.8)	**54.** (75)	**55.** (-80)	**56.** (4.95 to 5.50)
57. (1.80 to 2.05)	**58.** (800)	**59.** (1.45 to 1.50)	**60.** (5.50 to 5.90)