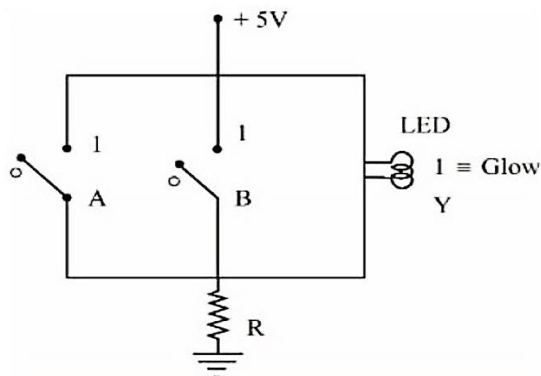


PART-I PHYSICS

SECTION-A

- For the plane electromagnetic wave given by $E = E_0 \sin(\omega t - kx)$ and $B = B_0 \sin(\omega t - kx)$, the ratio of average electric energy density to average magnetic energy density is
 (a) 1 (b) $1/2$
 (c) 2 (d) 4

- Name the logic gate equivalent to the diagram attached



- OR
- NOR
- NAND
- AND

- A small ball of mass M and density ρ is dropped in a viscous liquid of density ρ_0 . After some time, the ball falls with a constant velocity. What is the viscous force on the ball?
 (a) $F = Mg \left(1 - \frac{\rho_0}{\rho}\right)$ (b) $F = Mg \left(1 + \frac{\rho}{\rho_0}\right)$
 (c) $F = Mg \left(1 + \frac{\rho_0}{\rho}\right)$ (d) $F = Mg(1 \pm \rho\rho_0)$
- The number of air molecules per cm^3 increased from 3×10^{19} to 12×10^{19} . The ratio of collision frequency of air molecules before and after the increase in number respectively is
 (a) 1.25 (b) 0.25
 (c) 0.75 (d) 0.50
- A source supplies heat to a system at the rate of 1000 W. If the system performs work at a rate of 200 W. The rate at which internal energy of the system increases
 (a) 1200 W (b) 600 W
 (c) 500 W (d) 800 W
- A particle is moving with constant speed in a circular path. When the particle turns by an angle 90° , the ratio of instantaneous velocity to its average velocity is $\pi : x\sqrt{2}$. The value of x will be
 (a) 2 (b) 5
 (c) 1 (d) 7
- A small block of mass 100 g is tied to a spring of spring constant 7.5 N/m and length 20 cm. The other end of spring is fixed at a particular point A. If the block moves in a circular path on a smooth horizontal surface with constant angular velocity 5 rad/s about point A, then tension in the spring is
 (a) 1.5 N (b) 0.75 N
 (c) 0.25 N (d) 0.50 N
- A monochromatic light wave with wavelength λ_1 and frequency v_1 in air enters another medium. If the angle of incidence and angle of refraction at the interface are 45° and 30° respectively, then the wavelength λ_2 and frequency v_2 of the refracted wave are :
 (a) $\lambda_2 = \lambda_1, v_2 = \sqrt{2}v_1$
 (b) $\lambda_2 = \frac{1}{\sqrt{2}}\lambda_1, v_2 = v_1$

$$(c) \lambda_2 = \sqrt{2}\lambda_1, v_2 = v_1$$

$$(d) \lambda_2 = \lambda_1, v_2 = \frac{1}{\sqrt{2}}v_1$$

9. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: When a body is projected at an angle 45° , its range is maximum.

Reason R : For maximum range, the value of $\sin 2\theta$ should be equal to one.

In the light of the above statements, choose the correct answer from the options given below:

(a) Both A and R are correct but R is NOT the correct explanation of A

(b) Both A and R are correct R is the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

10. Two resistances are given as $R_1 = (10 \pm 0.5)\Omega$ and $R_2 = (15 \pm 0.5)\Omega$. The percentage error in the measurement of equivalent resistance when they are connected in parallel is

(a) 6.33

(b) 2.33

(c) 4.33

(d) 5.33

11. A planet has double the mass of the earth. Its average density is equal to the that of the earth. An object weighing W on earth will weigh on that planet:

(a) $2^{2/3} W$

(b) W

(c) $2^{1/3} W$

(d) $2 W$

12. Given below are two statements: one is labelled as

Assertion A and the other is labelled as Reason R.

Assertion A: Earth has atmosphere whereas moon doesn't have any atmosphere.

Reason R : The escape velocity on moon is very small as compared to that on earth.

In the light of the above statement, choose the correct answer from the options given below:

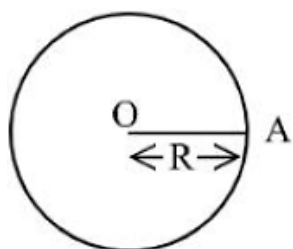
(a) A is true but R is false

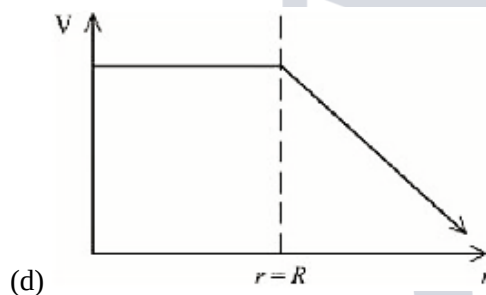
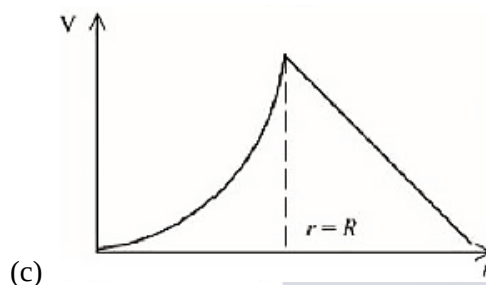
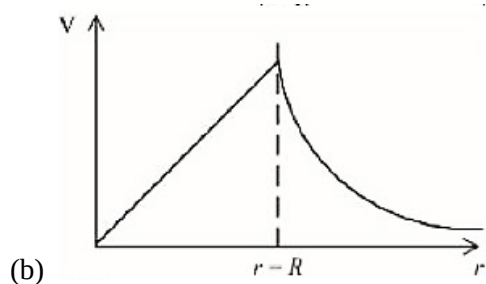
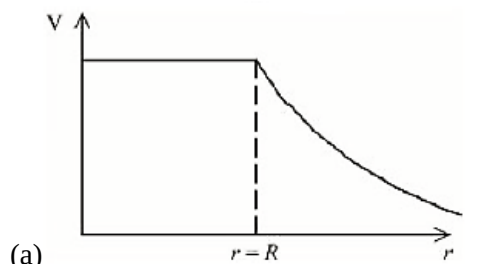
(b) A is false but R is true

(c) Both A and R are correct but R is NOT the correct explanation of A

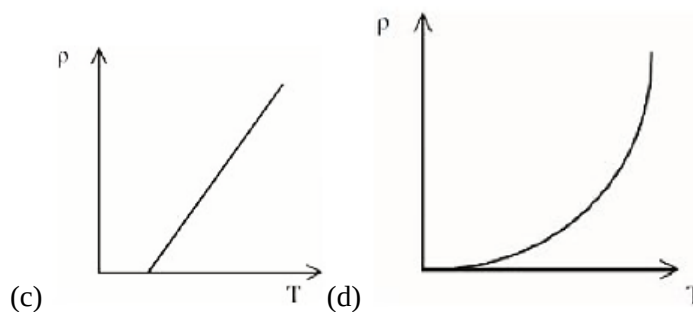
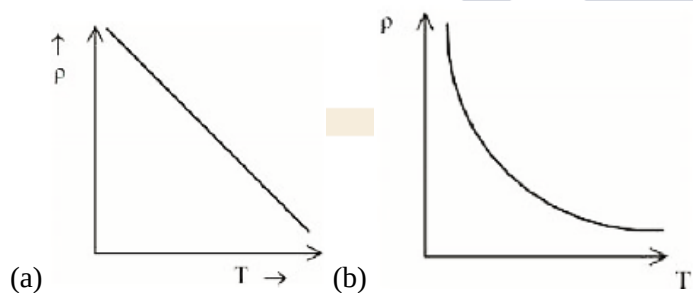
(d) Both A and R are correct and R is correct explanation of A

13. For a uniformly charged thin spherical shell, the electric potential (V) radially away from the center (O) of shell can be graphically represented as





14. The resistivity (ρ) of semiconductor varies with temperature. Which of the following curve represents the correct behavior



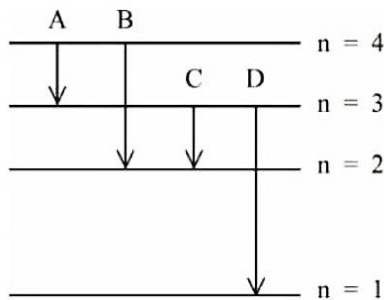
15. The kinetic energy of an electron, α -particle and a proton are given as 4 K, 2 K and K respectively. The de-Broglie wavelength associated with electron (λ_e), α -particle (λ_α) and the proton (λ_p) are as follows:

- (a) $\lambda_\alpha = \lambda_p < \lambda_e$ (b) $\lambda_\alpha > \lambda_p > \lambda_e$
 (c) $\lambda_\alpha < \lambda_p < \lambda_e$ (d) $\lambda_\alpha = \lambda_p > \lambda_e$

16. By what percentage will the transmission range of a TV tower be affected when the height of the tower is increased by 21%?

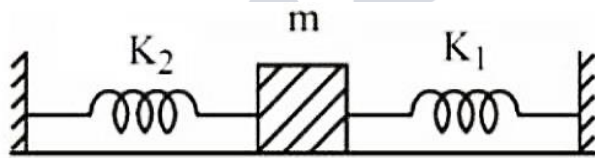
- (a) 14% (b) 12%
 (c) 10% (d) 15%

17. The energy levels of an hydrogen atom are shown below. The transition corresponding to emission of shortest wavelength is



- (a) C (b) D
 (c) B (d) A

18. A mass m is attached to two springs as shown in figure. The spring constants of two springs are K_1 and K_2 . For the frictionless surface, the time period of oscillation of mass m is



- (a) $\frac{1}{2\pi} \sqrt{\frac{K_1 + K_2}{m}}$ (b) $\frac{1}{2\pi} \sqrt{\frac{K_1 - K_2}{m}}$
 (c) $2\pi \sqrt{\frac{m}{K_1 + K_2}}$ (d) $2\pi \sqrt{\frac{m}{K_1 - K_2}}$

19. The induced emf can be produced in a coil by

- (A) moving the coil with uniform speed inside magnetic field
 (B) moving the coil with non-uniform speed inside uniform magnetic field
 (C) rotating the coil inside the uniform magnetic field
 (D) changing the area of the coil inside the uniform magnetic field

Choose the correct answer from the options given below:

- (a) B and D only (b) B and C only
 (c) A and C only (d) C and D only

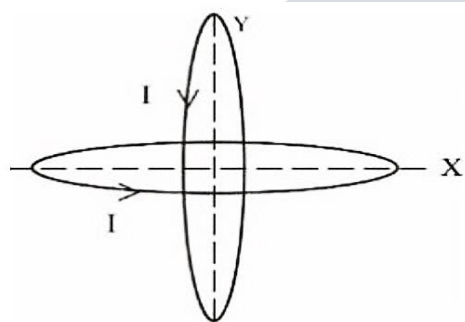
20. A long straight wire of circular cross-section (radius a) is carrying steady current I . The current I is uniformly distributed across this cross-section. The magnetic field is

- (a) Zero in the region $r < a$ and inversely proportional to r in the region $r > a$

- (b) Inversely proportional to r in the region $r < a$ and uniform throughout in the region $r > a$
- (c) Directly proportional to r in the region $r < a$ and inversely proportional to r in the region $r > a$
- (d) Uniform in the region $r < a$ and inversely proportional to distance r from the axis, in the region $r > a$

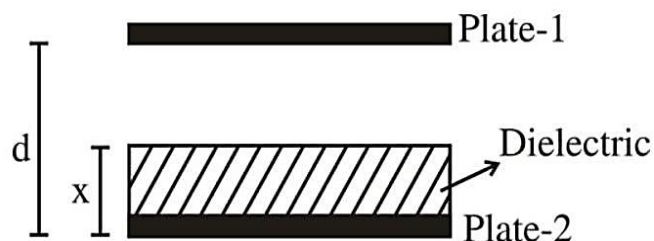
SECTION-B

21. A pole is vertically submerged in swimming pool, such that it gives a length of shadow 2.15 m within water when sunlight is incident at an angle of 30° with the surface of water. If swimming pool is filled to a height of 1.5 m, then the height of the pole above the water surface in centimetres is $\left(n_w = \frac{4}{3}\right)$ ____
22. The length of a metallic wire is increased by 20% and its area of cross section is reduced by 4%. The percentage change in resistance of the metallic wire is ____
23. A particle of mass 10 g moves in a straight line with retardation $2x$, where x is the displacement in SI units. Its loss of kinetic energy for above displacement is $\left(\frac{10}{x}\right)^{-n}$ J. The value of n will be ____
24. Two identical circular wires of radius 20 cm and carrying current $\sqrt{2}$ A are placed in perpendicular planes as shown in figure. The net magnetic field at the centre of the circular wire is $__ \times 10^{-8}$ T. (Take $\pi = 3.14$)



25. A person driving car at a constant speed of 15 m/s is approaching a vertical wall. The person notices a change of 40 Hz in the frequency of his car's horn upon reflection from the wall. The frequency of horn is ____ Hz.
(Given: Speed of sound: 330 m/s)
26. The radius of fifth orbit of the Li^{++} is $\times __ \times 10^{-12}$ m. Take: radius of hydrogen atom = $0.51 \text{ \AA}$
27. A steel rod has a radius of 20 mm and a length of 2.0 m. A force of 62.8 kN stretches it along its length. Young's modulus of steel is $2.0 \times 10^{11} \text{ N/m}^2$. The longitudinal strain produced in the wire is $__ \times 10^{-5}$
28. An ideal transformer with purely resistive load operates at 12 kV on the primary side. It supplies electrical energy to a number of nearby houses at 120 V. The average rate of energy consumption in the houses served by the transformer is 60 kW. The value of resistive load (R_s) required in the secondary circuit will be $__ \text{ m}\Omega$.
29. Two identical solid spheres each of mass 2 kg and radii 10 cm are fixed at the ends of a light rod. The separation between the centres of the spheres is 40 cm. The moment of inertia of the system about an axis perpendicular to the rod passing through its middle point is $__ \times 10^{-3} \text{ kg} - \text{m}^2$

30. A parallel plate capacitor with plate area A and plate separation d is filled with a dielectric material of dielectric constant $K = 4$. The thickness of the dielectric material is x , where $x < d$.



Let C_1 and C_2 be the capacitance of the system for $x = \frac{1}{3}d$ and $x = \frac{2}{3}d$, respectively. If $C_1 = 2\mu\text{F}$ the value of C_2 is μF

PART-II CHEMISTRY

SECTION-A

31. A compound is formed by two elements X and Y. The element Y forms cubic close packed arrangement and those of element X occupy one third of the tetrahedral voids. What is the formula of the compound?

- (a) X_2Y_3 (b) X_3Y
(c) X_3Y_2 (d) XY_3

32. Match List I with List II

List I		List II	
Element detected		Reagent used/ Product formed	
A	Nitrogen	I.	$\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]$
B	Sulphur	II.	AgNO_3
C	Phosphorous	III.	$\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$
D	Halogen	IV.	$(\text{NH}_4)_2\text{MoO}_4$

Choose the correct answer from the options given below:

- (a) A-II, B-IV, C-I, D-III (b) A-IV, B-II, C-I, D-III
(c) A-II, B-I, C-IV, D-III (d) A-III, B-I, C-IV, D-II

33. The standard electrode potential of M^+/M in aqueous solution does not depend on

- (a) Ionisation of a solid metal atom
(b) Sublimation of a solid metal
(c) Ionisation of a gaseous metal atom

(d) Hydration of a gaseous metal ion

34. Polymer used in orlon is:

- (a) Polyacrylonitrile (b) Polyethylene
(c) Polycarbonate (d) Polyamide

35. The difference between electron gain enthalpies will be maximum between:

- (a) Ne and F (b) Ne and Cl
(c) Ar and Cl (d) Ar and F

36. Match List I with List II

List I		List II	
Enzymatic reaction		Enzyme	
A	Sucrose $\rightarrow$ Glucose and Fructose	I.	Zymase
B	Glucose $\rightarrow$ ethyl alcohol and CO_2	II.	Pepsin
C	Starch $\rightarrow$ Maltose	III.	Invertase
D	Proteins $\rightarrow$ Amino acids	IV.	Diastase

Choose the correct answer from the options given below:

- (a) A-III, B-I, C-II, D-IV (b) A-I, B-IV, C-III, D-II
(c) A-III, B-I, C-IV, D-II (d) A-I, B-II, C-IV, D-III

37. The possibility of photochemical smog formation is more at

- (a) The places with healthy vegetation
(b) Himalayan villages in winter
(c) Marshy lands
(d) Industrial areas

38. The setting time of Cement is increased by adding

- (a) Clay (b) Silica
(c) Limestone (d) Gypsum

39. Given below are two statements: one is labelled as assertion and the other is labelled as reason.

Assertion: Loss of electron from hydrogen atom results in nucleus of $\sim 1.5 \times 10^{-3} \text{ pm}$ size.

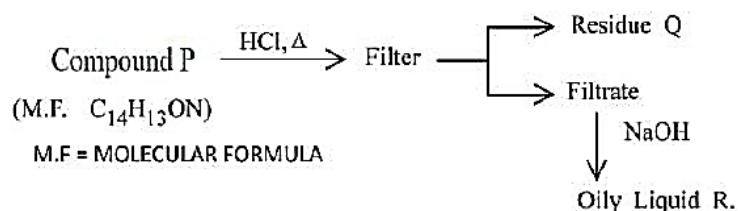
Reason: Proton (H^+) always exists in combined form

In the light of the above statements, choose the most appropriate answer from the options given below:

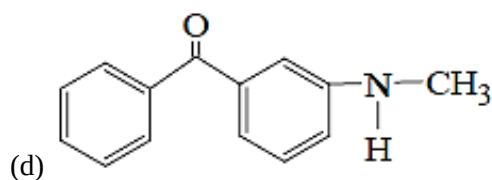
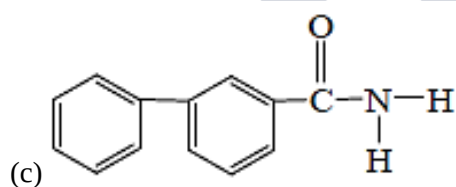
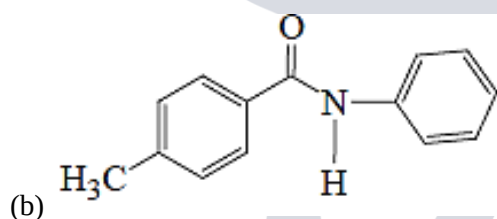
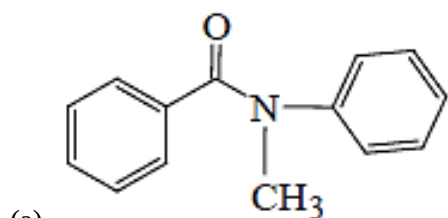
- (a) Both A and R are correct and R is the correct explanation of A

- (b) A is correct but R is not correct
 (c) A is not correct but R is correct
 (d) Both A and R are correct but R is NOT the correct explanation of A.

40.



Compound P is neutral. Q gives effervescence with NaHCO_3 while R reacts with Hinsbergs reagent to give solid soluble in NaOH . Compound P is



41. Match List I with List II

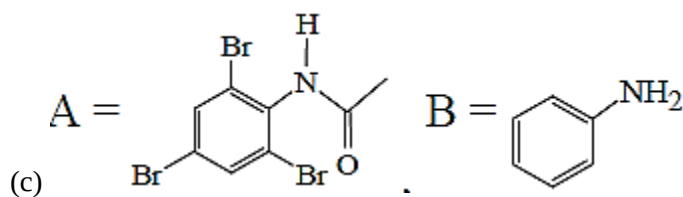
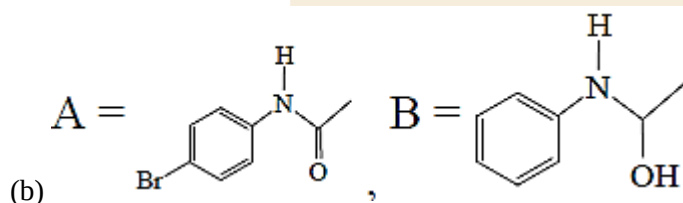
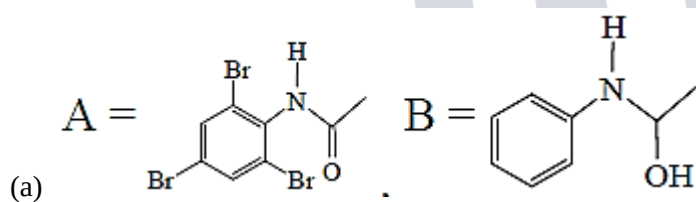
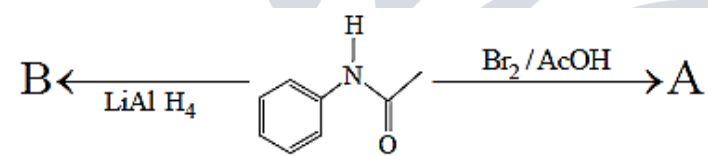
List I	List II
Name of reaction	Reagent used

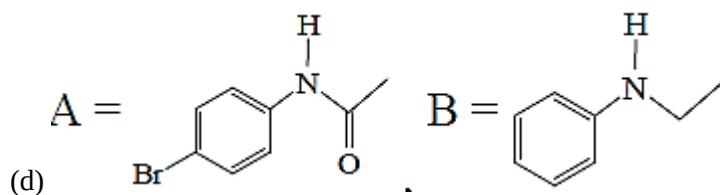
A	Hell-Volhard-Zelinsky reaction	I.	$\text{NaOH} + \text{I}_2$
B	Iodoform reaction	II.	(i) $\text{CrO}_2\text{Cl}_2, \text{CS}_2$ (ii) H_2O
C	Etard reaction	III.	(i) Br_2 / red phosphorus (ii) H_2O
D	Gatterman-Koch reaction	IV.	$\text{CO}, \text{HCl}, \text{anhyd. AlCl}_3$

Choose the correct answer from the options given below:

- (a) A-III, B-II, C-I, D-IV (b) A-III, B-I, C-IV, D-II
(c) A-I, B-II, C-III, D-IV (d) A-III, B-I, C-II, D-IV

42. The major products A and B from the following reactions are:





43. Given below are two statements, one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: The spin only magnetic moment value for $[\text{Fe}(\text{CN})_6]^{3-}$ is 1.74 BM, whereas for $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ is 5.92 BM.

Reason R : In both complexes, Fe is present in +3 oxidation state.

In the light of the above statements, choose the correct answer from the options given below:

- (a) Both A and R are true but R is NOT the correct explanation of A
 (b) A is false but R is true
 (c) A is true but R is false
 (d) Both A and R are true and R is the correct explanation of A

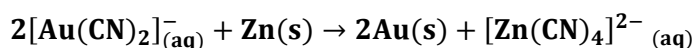
44. Match List I with List II

List I Vitamin		List II Deficiency disease	
(A)	Vitamin A	(I)	Beri-Beri
(B)	Thiamine	(II)	Cheilosis
(C)	Ascorbic acid	(III)	Xerophthalmia
(D)	Riboflavin	(IV)	Scurvy

Choose the correct answer from the options given below:

- (a) A-IV, B-II, C-III, D-I (b) A-III, B-II, C-IV, D-I
 (c) A-IV, B-I, C-III, D-II (d) A-III, B-I, C-IV, D-II

45. Which of the following options are correct for the reaction?



- A. Redox reaction
 B. Displacement reaction
 C. Decomposition reaction
 D. Combination reaction

Choose the correct answer from the options given below:

- (a) A and B only (b) A only
(c) C and D only (d) A and D only

46. Match List I with List II

List I		List II	
Oxide		Type of Bond	
(A)	N_2O_4	(I)	1 N = O bond
(B)	NO_2	(II)	1 N – O – N bond
(C)	N_2O_5	(III)	1 N – N bond
(D)	N_2O	(IV)	1 N = N/N $\equiv$ N bond

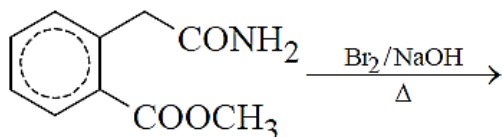
Choose the correct answer from the options given below:

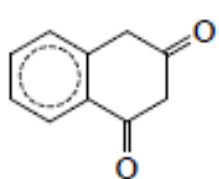
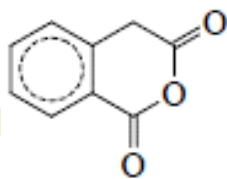
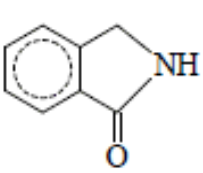
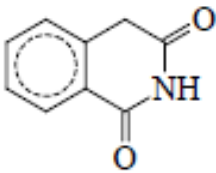
- (a) A-II, B-IV, C-III, D-I (b) A-II, B-I, C-III, D-IV
(c) A-III, B-I, C-IV, D-II (d) A-III, B-I, C-II, D-IV

47. Strong reducing and oxidizing agents among the following, respectively, are

- (a) Ce^{4+} and Eu^{2+} (b) Ce^{4+} and Tb^{4+}
(c) Ce^{3+} and Ce^{4+} (d) Eu^{2+} and Ce^{4+}

48. The major product formed in the following reaction is

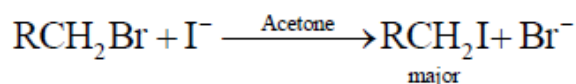


- (a)  (b) 
(c)  (d) 

49. For a concentrated solution of a weak electrolyte (K_{eq} = equilibrium constant) $A_2 B_3$ of concentration 'c', the degree of dissociation " α " is

- (a) $\left(\frac{K_{eq}}{108c^4}\right)^{\frac{1}{5}}$ (b) $\left(\frac{K_{eq}}{6c^5}\right)^{\frac{1}{5}}$
(c) $\left(\frac{K_{eq}}{5c^4}\right)^{\frac{1}{5}}$ (d) $\left(\frac{K_{eq}}{25c^2}\right)^{\frac{1}{5}}$

50. For the reaction:



The correct statement is :

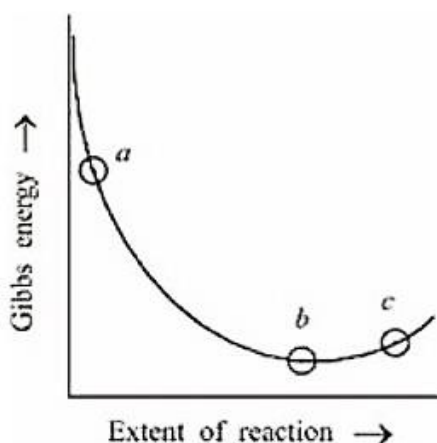
- (a) The transition state formed in the above reaction is less polar than the localised anion.
- (b) The reaction can occur in acetic acid also.
- (c) The solvent used in the reaction solvates the ions formed in rate determining step.
- (d) Br^- can act as competing nucleophile.

SECTION-B

51. The wavelength of an electron of kinetic energy $4.50 \times 10^{-29} \text{ J}$ is..... $\times 10^{-5} \text{ m}$. (Nearest integer) Given: mass of electron is $9 \times 10^{-31} \text{ kg}$, $h = 6.6 \times 10^{-34} \text{ J s}$

52. Number of bromo derivatives obtained on treating ethane with excess of Br_2 , in diffused sunlight is

53. Consider the graph of Gibbs free energy G vs Extent of reaction. The number of statement/s from the following which are true with respect to points (a), (b) and (c) is



- A. Reaction is spontaneous at (a) and (b)
- B. Reaction is at equilibrium at point (b) and nonspontaneous at point (c)
- C. Reaction is spontaneous at (a) and nonspontaneous at (c)
- D. Reaction is non-spontaneous at (a) and (b)

54. Mass of Urea (NH_2CONH_2) required to be dissolved in 1000 g of water to reduce the vapour pressure of water by 25% is.....g. (Nearest integer)

Given: Molar mass of N, C, O and H are 14, 12, 16 and 1 mol⁻¹ respectively.

55. The value of $\log K$ for the reaction $\text{A} \rightleftharpoons \text{B}$ at 298 K is (Nearest integer)

Given: $\Delta H^\circ = -54.07 \text{ kJ mol}^{-1}$

$\Delta S^\circ = 10 \text{ JK}^{-1} \text{ mol}^{-1}$

(Take $2.303 \times 8.314 \times 298 = 5705$)

56. The number of species from the following which have square pyramidal structure is

$\text{PF}_5, \text{BrF}_4^-, \text{IF}_5, \text{BrF}_5, \text{XeOF}_4, \text{ICl}_4^-$

57. Number of ambidentate ligands in a representative metal complex $[\text{M}(\text{en})(\text{SCN})_4]$ is

[en = ethylenediamine]

58. For the adsorption of hydrogen on platinum, the activation energy is 30 kJ mol^{-1} and for the adsorption of hydrogen on nickel, the activation energy is 41.4 kJ mol^{-1} . The logarithm of the ratio of the rates of chemisorption on equal areas of the metals at 300 K is ____ (Nearest integer)

Given: $\ln 10 = 2.3 R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$

59. If 5 moles of BaCl_2 is mixed with 2 moles of Na_3PO_4 , the maximum number of moles of $\text{Ba}_3(\text{PO}_4)_2$ formed is ____ (Nearest integer)

60. In ammonium-phosphomolybdate, the oxidation state of Mo is $^{+}$ ____

PART-III MATHEMATICS

SECTION-A

61. Let $5f(x) + 4f\left(\frac{1}{x}\right) = \frac{1}{x} + 3, x > 0$. Then $18 \int_1^2 f(x) dx$ is equal to:

- (a) $10 \log_e 2 - 6$ (b) $10 \log_e 2 + 6$
(c) $5 \log_e 2 + 3$ (d) $5 \log_e 2 - 3$

62. A pair of dice is thrown 5 times. For each throw, a total of 5 is considered a success. If the probability of at least 4 successes is $\frac{k}{3^{11}}$, then k is equal to

- (a) 82 (b) 123
(c) 164 (d) 75

63. If ${}^{2n}C_3 : {}^nC_3 = 10 : 1$, then the ratio $(n^2 + 3n) : (n^2 - 3n + 4)$ is

- (a) 35:16 (b) 65:37
(c) 27:11 (d) 2:1

64. If the ratio of the fifth term from the beginning to the fifth term from the end in the expansion of

$\left(\sqrt[4]{2} + \frac{1}{\sqrt[4]{3}}\right)^n$ is $\sqrt{6} : 1$, then the third term from the beginning is:

- (a) $60\sqrt{2}$ (b) $60\sqrt{3}$

(c) $30\sqrt{2}$ (d) $30\sqrt{3}$

65. Let $\vec{a} = 2\hat{i} + 3\hat{j} + 4\hat{k}$, $\vec{b} = 2\hat{i} - 2\hat{j} - 2\hat{k}$ and

$\vec{c} = -\hat{i} + 4\hat{j} + 3\hat{k}$. If $\vec{d}$ is a vector perpendicular to both $\vec{b}$ and $\vec{c}$ and $\vec{a} \cdot \vec{d} = 18$, Then $|\vec{a} \times \vec{d}|^2$ is equal to

(a) 640 (b) 760

(c) 680 (d) 720

66. The straight lines l_1 and l_2 pass through the origin and trisect the line segment of the line $L: 9x + 5y = 45$ between the axes. If m_1 and m_2 are the slopes of the lines l_1 and l_2 , then the point of intersection of the line $y = (m_1 + m_2)x$ with L lies on

(a) $6x + y = 10$ (b) $6x - y = 15$

(c) $y - x = 5$ (d) $y - 2x = 5$

67. From the top A of a vertical wall AB of height 30 m, the angles of depression of the top P and bottom Q of a vertical tower PQ are 15° and 60° respectively. B and Q are on the same horizontal level. If C is a point on AB such that $CB = PQ$, then the area (in m^2) of the quadrilateral BCPQ is equal to

(a) $600(\sqrt{3} - 1)$ (b) $300(\sqrt{3} + 1)$

(c) $200(3 - \sqrt{3})$ (d) $300(\sqrt{3} - 1)$

68. The sum of the first 20 terms of the series $5 + 11 + 19 + 29 + 41 + \dots$ is

(a) 3450 (b) 3250

(c) 3420 (d) 3520

69. The mean and variance of a set of 15 numbers are 12 and 14 respectively. The mean and variance of another set of 15 numbers are 14 and σ^2 respectively. If the variance of all the 30 numbers in the two sets is 13, then σ^2 is equal to

(a) 9 (b) 12

(c) 11 (d) 10

70. Let $A = [a_{ij}]_{2 \times 2}$ where $a_{ij} \neq 0$ for all i, j and $A^2 = I$.

Let a be the sum of all diagonal elements of A and $b = |A|$, then $3a^2 + 4b^2$ is equal to

(a) 7 (b) 14

(c) 3 (d) 4

71. Let $I(x) = \int \frac{x^2 \sec^2 x + \tan x}{(x \tan x + 1)^2} dx$. If $I(0) = 0$ the $I\left(\frac{\pi}{4}\right)$ is equal to

(a) $\log_e \frac{(x+4)^2}{16} - \frac{\pi^2}{4(\pi+4)}$ (b) $\log_e \frac{(x+4)^2}{16} + \frac{\pi^2}{4(\pi+4)}$

(c) $\log_e \frac{(x+4)^2}{32} - \frac{\pi^2}{4(\pi+4)}$ (d) $\log_e \frac{(x+4)^2}{32} + \frac{\pi^2}{4(\pi+4)}$

72. If the equation of the plane passing through the line of intersection of the planes $2x - y + z = 3$, $4x - 3y + 5z + 9 = 0$ and parallel to the line $\frac{x+1}{-2} = \frac{y+3}{4} = \frac{z-2}{5}$ is $ax + by + cz + 6 = 0$. then $a + b + c$ is equal to

(a) 14 (b) 12

(c) 13 (d) 15

73. Statement $(P \Rightarrow Q) \wedge (R \Rightarrow Q)$ is logically equivalent to

(a) $(P \vee R) \Rightarrow Q$ (b) $(P \Rightarrow R) \wedge (Q \Rightarrow R)$

(c) $(P \Rightarrow R) \vee (Q \Rightarrow R)$ (d) $(P \wedge R) \Rightarrow Q$

74. The sum of all the roots of the equation $|x^2 - 8x + 15| - 2x + 7 = 0$ is:

(a) $9 + \sqrt{3}$ (b) $11 + \sqrt{3}$

(c) $9 - \sqrt{3}$ (d) $11 - \sqrt{3}$

75. Let $a_1, a_2, a_3 \dots a_n$ be n positive consecutive terms of an arithmetic progression. If $d > 0$ is its common difference, then

$$\lim_{n \rightarrow \infty} \frac{1}{n} \left(\frac{1}{\sqrt{a_1} + \sqrt{a_2}} + \frac{1}{\sqrt{a_2} + \sqrt{a_3}} + \dots + \frac{1}{\sqrt{a_{n-1}} + \sqrt{a_n}} \right)$$

(a) 1 (b) $\sqrt{d}$

(c) $\frac{1}{\sqrt{d}}$ (d) 0

76. If the system of equations

$$x + y + az = b$$

$$2x + 5y + 2z = 6$$

$$x + 2y + 3z = 3$$

has infinitely many solutions, then $2a + 3b$ is equal to

(a) 23 (b) 28

(c) 25 (d) 20

77. If $2x^y + 3y^x = 20$, then $\frac{dy}{dx}$ at $(2, 2)$ is equal to

(a) $-\left(\frac{3+\log_e 8}{2+\log_e 4}\right)$ (b) $-\left(\frac{2+\log_e 8}{3+\log_e 4}\right)$

(c) $-\left(\frac{3+\log_e 16}{4+\log_e 8}\right)$ (d) $-\left(\frac{3+\log_e 4}{2+\log_e 8}\right)$

78. One vertex of a rectangular parallelopiped is at the origin O and the lengths of its edges along x, y and z axes are 3, 4 and 5 units respectively. Let P be the vertex $(3, 4, 5)$. Then the shortest distance between the diagonal OP and an edge parallel to z axis, not passing through O or P is:

(a) $\frac{12}{\sqrt{5}}$ (b) $\frac{12}{5\sqrt{5}}$

(c) $12\sqrt{5}$ (d) $\frac{12}{5}$

79. Let the position vectors of the points A, B, C and D be $5\hat{i} + 5\hat{j} + 2\lambda\hat{k}$, $\hat{i} + 2\hat{j} + 3\hat{k}$, $-2\hat{i} + \lambda\hat{j} + 4\hat{k}$ and $-\hat{i} + 5\hat{j} + 6\hat{k}$. Let the set $S = \{\lambda \in \mathbb{R} : \text{The points } A, B, C \text{ and } D \text{ are coplanar}\}$. Then $\sum_{\lambda \in S} (\lambda + 2)^2$ is equal to

- (a) 41 (b) 25
(c) 13 (d) $\frac{37}{2}$

80. Let $A = \{x \in \mathbb{R} : [x + 3] + [x + 4] \leq 3\}$,

$B = \left\{x \in \mathbb{R} : 3^x \left(\sum_{r=1}^{\infty} \frac{3}{10^r}\right)^{x-3} < 3^{-3x}\right\}$, where $[t]$ denotes greatest integer function. Then,

- (a) $A \cap B = \phi$ (b) $A = B$
(c) $B \subset C, A \neq B$ (d) $A \subset B, A \neq B$

SECTION-B

81. Let $a \in \mathbb{Z}$ and $[t]$ be the greatest integer $\leq t$. Then the number of points, where the function $f(x) = [a + 13\sin x]$, $x \in (0, \pi)$ is not differentiable, is

82. A circle passing through the point $P(\alpha, \beta)$ in the first quadrant touches the two coordinate axes at the points A and B. The point P is above the line AB. The point Q on the line segment AB is the foot of perpendicular from P on AB. If PQ is equal to 11 units, then the value of $\alpha\beta$ is

83. The number of ways of giving 20 distinct oranges to 3 children such that each child gets at-least one orange is___

84. If the area of the region

$S = \{(x, y) : 2y - y^2 \leq x^2 \leq 2y, x \geq y\}$ is equal to

$\frac{n+2}{n+1} - \frac{\pi}{n-1}$, then the natural number n is equal to___

85. Let the point $(p, p + 1)$ lie inside the region

$E = \{(x, y) : 3 - x \leq y \leq \sqrt{9 - x^2}, 0 \leq x \leq 3\}$ If the set of all values of p is the interval (a, b) . then $b^2 + b - a^2$ is equal to___

86. Let $y = y(x)$ be a solution of the differential equation $(x \cos x)dy + (x y \sin x + y \cos x - 1)dx = 0$, $0 < x < \frac{\pi}{2}$. If $\frac{\pi}{3}y\left(\frac{\pi}{3}\right) = \sqrt{3}$, then $\left|\frac{\pi}{6}y''\left(\frac{\pi}{6}\right) + 2y'\left(\frac{\pi}{6}\right)\right|$ is equal to___

87. The coefficient of x^{18} in the expansion of $\left(x^4 - \frac{1}{x^3}\right)^{15}$ is___

88. Let $A = \{1, 2, 3, 4, \dots, 10\}$ and $B = \{0, 1, 2, 3, 4\}$. The number of elements in the relation $R = \{(a, b) \in A \times A : 2(a - b)^2 + 3(a - b) \in B\}$ is___

89. Let the image of the point $P(1, 2, 3)$ in the plane $2x - y + z = 9$ be Q. If the coordinates of the point R are $(6, 10, 7)$, then the square of the area of the triangle PQR is_

90. Let the tangent to the curve $x^2 + 2x - 4y + 9 = 0$ at the point $P(1, 3)$ on it meet the y-axis at A. Let the line passing through P and parallel to the line $x - 3y = 6$ meet the parabola $y^2 = 4x$ at B. If B lies on the line $2x - 3y = 8$. then $(AB)^2$ is equal to