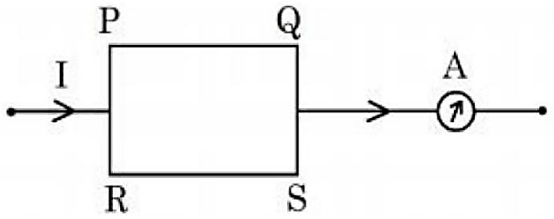
PART-I PHYSICS

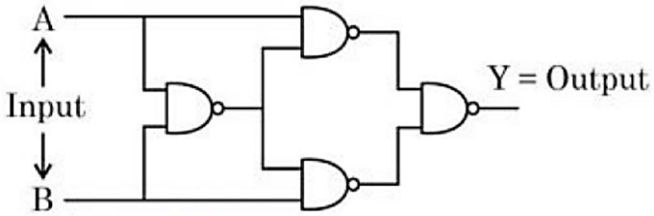
SECTION-A

1. A current carrying rectangular loop PQRS is made of uniform wire. The length PR = QS = 5 cm and = RS = 100 cm. If ammeter current reading changes from I to 2I, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively $\left(f_{PQ}^{I}: f_{PQ}^{2I}\right)$ is:



(a) 1:2 (b) 1:3
(c) 1:4 (d) 1:5

2. The output Y for the inputs A and B of circuit is given by



Truth table of the shown circuit is:

(a)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(b)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(c)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(d)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

3. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R
Assertion A: Efficiency of a reversible heat engine will be highest at $-273^{\circ}C$ temperature of cold reservoir.

Reason R: The efficiency of Carnot's engine depends not only on temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as $\eta = \left(1 - \frac{T_2}{T_1}\right)$.

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

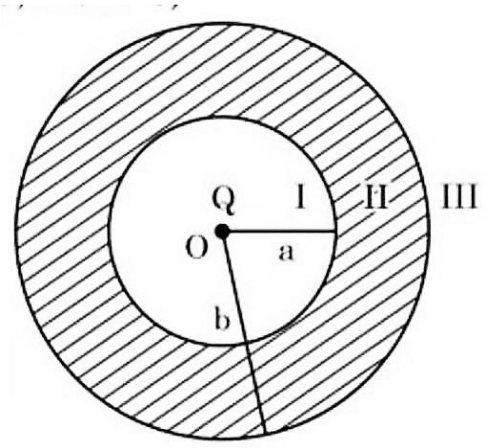
(a) Both A and R are true but R is NOT the correct explanation of A

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

(c) A is false but R is true

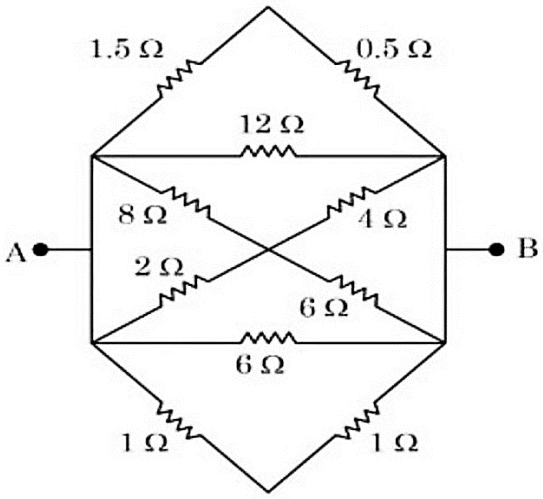
(d) A is true but R is false

4. As shown in the figure, a point charge Q is placed at the centre of conducting spherical shell of inner radius a and outer radius b. The electric field due to charge Q in three different regions I, II and III is given by: (I: r < a, II: a < r < b, III: r > b)



(a) $E_I = 0, E_{II} = 0, E_{III} = 0$
(b) $E_I = 0, E_{II} = 0, E_{III} \neq 0$
(c) $E_I \neq 0, E_{II} = 0, E_{III} \neq 0$
(d) $E_I \neq 0, E_{II} = 0, E_{III} = 0$

5. The equivalent resistance between A and B is

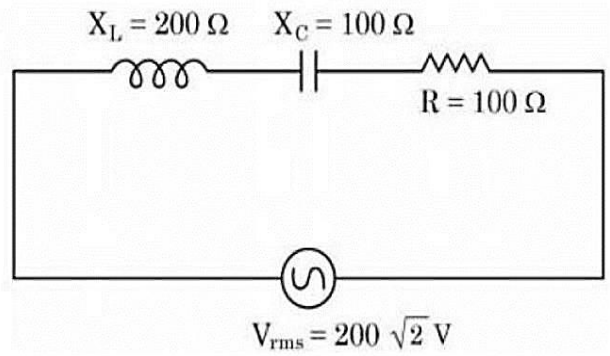


(a) $\frac{1}{3}\Omega$ (b) $\frac{1}{2}\Omega$
(c) $\frac{3}{2}\Omega$ (d) $\frac{2}{3}\Omega$

6. A vehicle travels 4 km with speed of 3 km/h and another 4 km with sped of 5 km/h, then its average speed is

(a) 3.50 km/h (b) 4.25 km/h
(c) 4.00 km/h (d) 3.75 km/h

7. In the given circuit, rms value of current (I_{rms}) through the resistor R is:

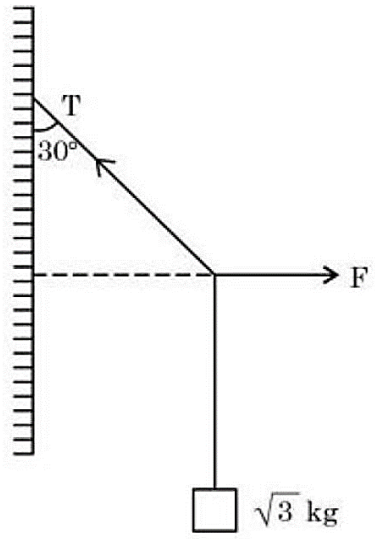


(a) $2\sqrt{2}$ A (b) 2 A
(c) 20 A (d) $\frac{1}{2}$ A

8. A point source of 100 W emits light with 5% efficiency. At a distance of 5 m from the source, the intensity produced by the electric field component is:

(a) $\frac{1}{2\pi}\frac{W}{m^2}$ (b) $\frac{1}{20\pi}\frac{W}{m^2}$
(c) $\frac{1}{10\pi}\frac{W}{m^2}$ (d) $\frac{1}{40\pi}\frac{W}{m^2}$

9. A block of $\sqrt{3}$ kg is attached to a string whose other end is attached to the wall. An unknown force F is applied so that the string makes an angle of 30° with the wall. The tension T is: (Given $g = 10\ ms^{-2}$)



(a) 20 N (b) 10 N
(c) 15 N (d) 25 N

10. Match List I with List II:

List I	List II
A. Attenuation	I.Combination of a receiver and transmitter.

B. Transducer	**II. process of retrieval of information from the carrier wave at receiver**
C. Demodulation	**III. converts one form of energy into another**
D. Repeater	**IV. Loss of strength of a signal while propogating through a medium.**

Choose the correct answer from the options given below:

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

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

11. An electron accelerated through a potential difference V_1 has a de-Broglie wavelength of λ. When the potential is changed to V_2, its de-Broglie wavelength increases by 50%. The value of $\left(\frac{V_1}{V_2}\right)$ is equal to

(a) 3 (b) $\frac{3}{2}$

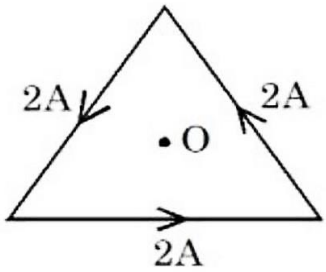
(c) 4 (d) $\frac{9}{4}$

12. A flask contains hydrogen and oxygen in the ratio of $2:1$ by mass at temperature $27^{\circ}C$. The ratio of average kinetic energy per molecule of hydrogen and oxygen respectively is:

(a) $2:1$ (b) $1:1$

(c) $1:4$ (d) $4:1$

13. As shown in the figure, a current of 2 A flowing in an equilateral triangle of side $4\sqrt{3}$ cm. The magnetic field at the centroid 0 of the triangle is



(Neglect the effect of earth's magnetic field)

(a) $1.4\sqrt{3} \times 10^{-5}$ T (b) $4\sqrt{3} \times 10^{-4}$ T

(c) $3\sqrt{3} \times 10^{-5}$ T (d) $\sqrt{3} \times 10^{-4}$ T

14. An object is allowed to fall from a height R above the earth, where R is the radius of earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be

(a) $\sqrt{2gR}$ (b) $\sqrt{\frac{gR}{2}}$

(c) $2\sqrt{gR}$ (d) $\sqrt{gR}$

15. Match List I with List II:

List I	List II
A. Torque	I. $kgm^{-1} s^{-2}$
B. Energy density	II. $kgms^{-1}$
C. Pressure gradient	III. $kgm^{-2} s^{-2}$
D. Impulse	IV. $kgm^{2} s^{-2}$

Choose the correct answer from the options given below:

(a) A - IV, B - I, C - III, D – II

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

(c) A - IV, B - I, C - II, D – III

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

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

Assertion A: The nuclear density of nuclides $^{10}_{5}B$, $^{6}_{3}Li$, $^{56}_{26}Fe$, $^{20}_{10}Ne$ and $^{209}_{83}Bi$ can be arranged as $\rho^{N}_{Bi} > \rho^{N}_{Fe} > \rho^{N}_{Ne} > \rho^{N}_{B} > \rho^{N}_{Li}$

Reason R : The radius R of nucleus is related to its mass number A as $R = R_0 A^{1/3}$, where R_0 is a constant.

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

(a) A is false but R is true

(b) A is true but R is false

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

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

17. A force is applied to a steel wire 'A', rigidly clamped at one end. As a result elongation in the wire is 0.2 mm. If same force is applied to another steel wire ' B ' of double the length and a diameter 2.4 times that of the wire 'A', the elongation in the wire ' B ' will be (wires having uniform circular cross sections)

(a) 6.06×10^{-2} mm (b) 2.77×10^{-2} mm

(c) 3.0×10^{-2} mm (d) 6.9×10^{-2} mm

18. A thin prism, P_1 with an angle 6^{th} and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is

(a) 1.3° (b) 6°

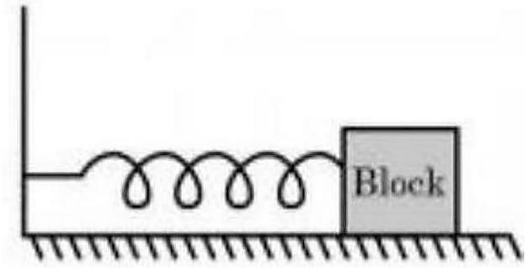
(c) 4.5° (d) 7.8°

19. A machine gun of mass 10 kg fires 20 g bullets at the rate of 180 bullets per minute with a speed of $100\ m\ s^{-1}$ each. The recoil velocity of the gun is

(a) 1.5 m/s (b) 0.6 m/s

(c) 2.5 m/s (d) 0.02 m/s

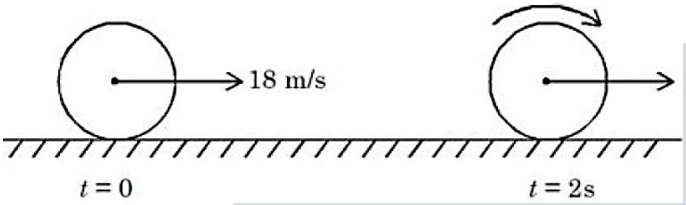
20. For a simple harmonic motion in a mass spring system shown, the surface is frictionless. When the mass of the block is 1 kg, the angular frequency is ω_1. When the mass block is 2 kg the angular frequency is ω_2. The ratio ω_2/ω_1 is



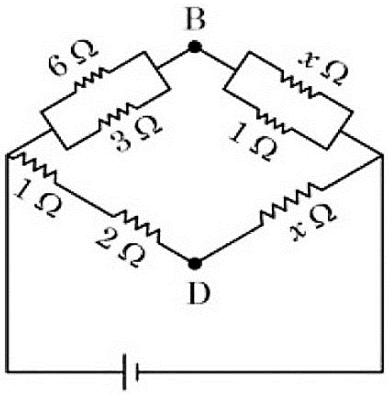
(a) $1/\sqrt{2}$ (b) $\sqrt{2}$
(c) 2 (d) $1/2$

SECTION - B

21. A uniform disc of mass 0.5 kg and radius r is projected with velocity 18 m/s at $t = 0$ s on a rough horizontal surface. It starts off with a purely sliding motion at $t = 0$ s. After 2 s it acquires a purely rolling motion (see figure). The total kinetic energy of the disc after 2 s will be J (given, coefficient of friction is 0.3 and $g = 10$ m/s^2).



22. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}\Omega$. The value of n is____



23. A stone tied to 180 cm long string at its end is making 28 revolutions in horizontal circle in every minute. The magnitude of acceleration of stone is $\frac{1936}{x}$ ms^{-2}. The value of x____

(Take $\pi = \frac{22}{7}$)

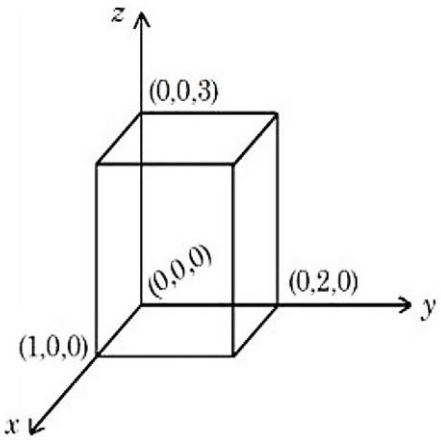
24. A radioactive nucleus decays by two different process. The half-life of the first process is 5 minutes and that of the second process is 30 s. The effective half-life of the nucleus is calculated to be $\frac{\alpha}{11}$ s. The value of α is_____

25. A faulty thermometer reads 5°C in melting ice and 95°C in stream. The correct temperature on absolute scale will be ____K when the faulty thermometer reads 41°C.

26. In an ac generator, a rectangular coil of 100 turns each having area 14×10^{-2} m^2 is rotated at 360rev/min about an axis perpendicular to a uniform magnetic field of magnitude 3.0 T. The maximum value of the emf produced will be _____ V. (Take $\pi = \frac{22}{7}$)

27. A body of mass 2 kg is initially at rest. It starts moving unidirectionally under the influence of a source of constant power P. Its displacement in 4 s is $\frac{1}{3}\alpha^2\sqrt{P}m$. The value of α will be___

28. As shown in figure, a cuboid lies in a region with electric field $= 2x^2\hat{i} - 4y\hat{j} + 6\hat{k}$ N/C. The magnitude of charge within the cuboid is n $\in_0$ C. The value of n____ is (if dimension of cuboid is $1 \times 2 \times 3$ m^3).



29. In a Young's double slit experiment, the intensities at two points, for the path differences $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$ (λ being the wavelength of light used) are I_1 and I_2 respectively. If I_0 denotes the intensity produced by each one of the individual slits, then $\frac{I_1+I_2}{I_0} =$ _____

30. The velocity of a particle executing SHM varies with displacement (x) as $4v^2 = 50 - x^2$. The time period of oscillations is $\frac{x}{7}$s. The value of x is____ (Take $\pi = \frac{22}{7}$)

PART-II CHEMISTRY

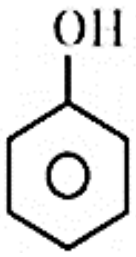
SECTION - A

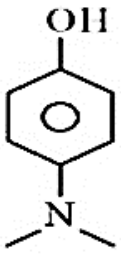
31. The Cl − Co − Cl bond angle values in a fac- $[Co(NH_3)_3Cl_3]$ complex is/are:

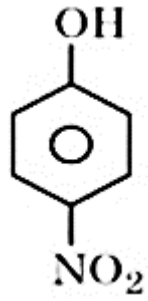
(a) 90° (b) 90°&120°

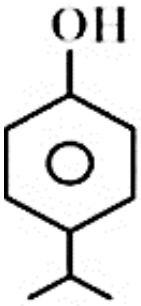
(c) 180° (d) 90°&180°

32. The correct order of pK_a values for the following compounds is:

(A) 

(B) 

(C) 

(D) 

(a) C > A > D > B (b) B > A > D > C

(c) B > D > A > C (d) A > B > C > D

33. Given below are two statements:

Statement I: During Electrolytic refining, the pure metal is made to act as anode and its impure metallic form is used as cathode.

Statement II: During the Hall-Heroult electrolysis process, purified Al_2O_3 is mixed with Na_3AlF_6 to lower the melting point of the mixture.

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

(a) Statement I is correct but Statement II is incorrect

(b) Both Statement I and Statement II are incorrect

(c) Both Statement I and Statement II are correct

(d) Statement I is incorrect but Statement II is correct

34. Match List I with List II:

List I (Mixture)		List II (Separation Technique)	
A.	$CHCl_3 + C_6H_5NH_2$	I.	Steam distillation
B.	$C_6H_{14} + C_5H_{12}$	II.	Differential extraction
C.	$C_6H_5NH_2 + H_2O$	III.	Distillation
D.	Organic compound in H_2O	IV.	Fractional distillation

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

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

35. 1 L, 0.02M solution of $[Co(NH_3)_5SO_4]Br$ is mixed with 1 L, 0.02M solution of $[Co(NH_3)_5Br]SO_4$. The resulting solution is divided into two equal parts (X) and treated with excess of $AgNO_3$ solution and $BaCl_2$ solution respectively as shown below:

1 L solution (X) + $AgNO_3$ solution (excess) → Y

1 L Solution (X) + $BaCl_2$ solution (excess) → Z

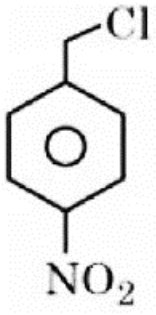
The number of moles of Y and Z respectively are

(a) 0.02,0.01 (b) 0.01,0.01

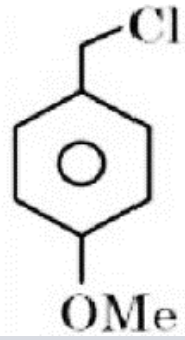
(c) 0.01,0.02 (d) 0.02,0.02

36. Decreasing order towards SN1 reaction for the following compounds is:

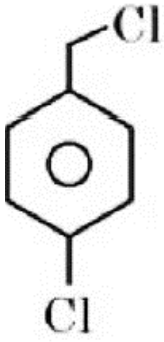
(A)



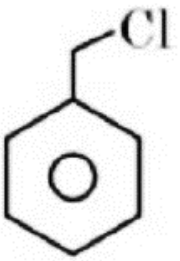
(B)



(C)



(D)



(a) A > C > D > B (b) B > D > C > A

(c) A > B > C > D (d) D > B > C > A

37. Which of the following reaction is correct?

(a) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 2\,N_2O_4 + O_2$

(b) $2LiNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

(c) $2LiNO_3 \rightarrow 2Li + 2NO_2 + O_2$

(d) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$

38. Boric acid is solid, whereas BF_3 is gas at room emperature because of

(a) Strong van der Waal's interaction in Boric acid

(b) Strong covalent bond in BF_3

(c) Strong ionic bond in Boric acid

(d) Strong hydrogen bond in Boric acid

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

Assertion A: Antihistamines do not affect the secretion of acid in stomach.

Reason: Antiallergic and antacid drugs work on different receptors.

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

(a) A is false but R is true

(b) Both A and R are true but R is not the correct explanation of A

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

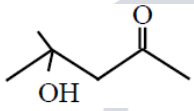
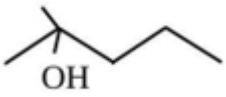
(d) A is true but R is false

40. Formulae for Nessler's reagent is:

(a) HgI_2 (b) K_2HgI_4

(c) $KHgI_3$ (d) KHg_2I_2

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

Assertion A:  **can be easily reduced using $Zn - Hg/HCl$ to** 

Reason R: $Zn - Hg/HCl$ is used to reduce carbonyl group to $-CH_2 -$ group.

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

(a) A is true but R is false

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

(c) A is false but R is true

(d) Both A and R are true but R is not the correct explanation of A

42. Maximum number of electrons that can be accommodated in shell with $n = 4$

(a) 16 (b) 32

(c) 72 (d) 50

43. The wave function (Ψ) of 2 s is given by

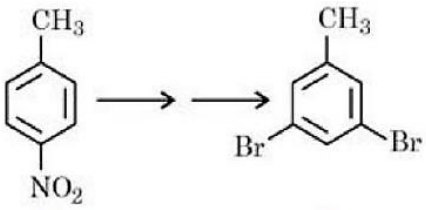
$$\Psi_{2s} = \frac{1}{2\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{1/2}\left(2 - \frac{r}{a_0}\right)e^{-r/2a_0}$$

At $r = r_0$, radial node is formed. Thus, r_0 in terms of a_0

(a) $r_0 = 4a_0$ (b) $r_0 = \frac{a_0}{2}$

(c) $r_0 = a_0$ (d) $r_0 = 2a_0$

44.



(X) (Y)

In the above conversion of compound (X) to product (Y), the sequence of reagents to be used will be:

(a) (i) Br_2 (aq) (ii) $LiAlH_4$ (iii) H_3O^+

(b) (i) Br_2, Fe (ii) Fe, H^+(iii) $LiAlH_4$

(c) (i) Fe, H^+(ii) Br_2 (aq) (iii) HNO_2 (iv) H_3PO_2

(d) (i) Fe, H^+(ii) Br_2 (aq) (iii) HNO_2 (iv) CuBr

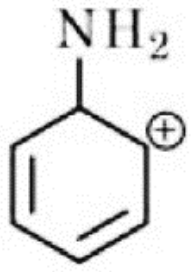
45. Match List I with List II:

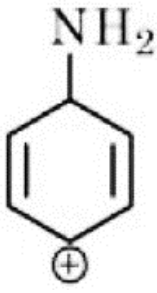
List I (Complexes)	**List II (Hybridisation)**
A. $[Ni(CO)_4]$	**I. sp^3**
B. $[Cu(NH_3)_4]^{2+}$	**II. dsp ^{2}**
C. $[Fe(NH_3)_6]^{2+}$	**III. $sp^3 d^2$**
D. $[Fe(H_2O)_6]^{2+}$	**IV. d^2sp^3**

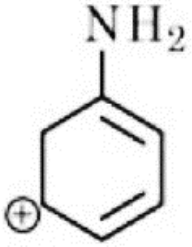
(a) A-I, B-II, C-IV, D-III (b) A-II, B-I, C-III, D-IV

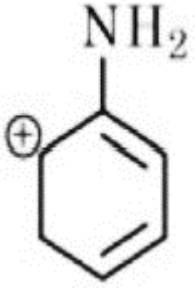
(c) A-II, B-I, C-IV, D-III (d) A-I, B-II, C-III, D-IV

46. The most stable carbocation for the following is:

(a) 

(b) 

(c) 

(d) 

47. Chlorides of which metal are soluble in organic solvents:

(a) K (b) Be

(c) Mg (d) Ca

48. $KMnO_4$ oxidises I^- in acidic and neutral/faintly alkaline solution, respectively, to

(a) IO_3^- & IO_3^- (b) I_2 & IO_3^-

(c) I_2 & I_2 (d) IO_3^- & I_2

49. Bond dissociation energy of "E-H" bond of the " H_2E " hydrides of group 16 elements (given below), follows order.

A. 0 **B. S**

C. Se **D. Te**

Choose the correct from the options given below:

(a) B > A > C > D (b) A > B > D > C

(c) A > B > C > D (d) D > C > B > A

50. The water quality of a pond was analysed and its BOD was found to be 4 . The pond has

(a) Highly polluted water

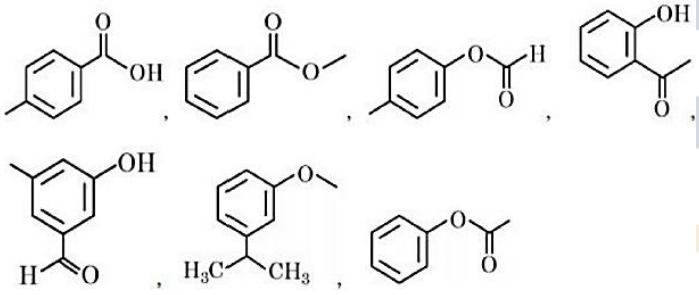
(b) Slightly polluted water

(c) Water has high amount of fluoride compounds

(d) Very clean water

SECTION -B

51. Number of compounds from the following which will not dissolve in cold $NaHCO_3$ and NaOH solutions but will dissolve in hot NaOH solution is



52. 1 mole of ideal gas is allowed to expand reversibly and adiabatically from a temperature of 27°C. The work done is 3 kJ mol^{-1}. The final temperature of the gas is_____ K (Nearest integer). Given C_V = 20 J mol^{-1} K^{-1}

53. A short peptide on complete hydrolysis produces 3 moles of glycine (G), two moles of leucine (L) and two moles of valine (V) per mole of peptide. The number of peptide linkages in it are

54. Lead storage battery contains 38% by weight solution of H_2SO_4. The van't Hoff factor is 2.67 at this concentration. The temperature in Kelvin at which the solution in the battery will freeze is _ __(Nearest integer). Given K_f = 1.8 K kg mol^{-1}

55. The strength of 50 volume solution of hydrogen peroxide is___ $\frac{g}{L}$(Nearest integer). Given:

Molar mass of H_2O_2 is 34 g mol^{-1}

Molar volume of gas at STP = 22.7 L

56. The electrode potential of the following half-cell at 298 K $X|X^{2+}(0.001M) \parallel Y^{2+}(0.01M)|Y$ is ____× 10^{-2} V (Nearest integer).

Given: $E^0_{X^{2+}{}_X} = -2.36$ V

$E^0_{Y^{+2}|Y}$

$E^0Y^{2+1Y} = +0.36$ V

$\frac{2.303RT}{F} = 0.06$ V

57. An organic compound undergoes first order decomposition. If the time taken for the 60% decomposition is 540 s, then the time required for 90% decomposition will be is___ s. (Nearest integer). Given: $\ln 10 = 2.3; \log 2 = 0.3$

58. Consider the following equation:

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g), \Delta H = -190$ kJ

The number of factors which will increase the yield of SO_3 at equilibrium from the following is

A. Increasing temperature

B. Increasing pressure

C. Adding more SO_2

D. Adding more O_2

E. Addition of catalyst

59. Iron oxide FeO, crystallises in a cubic lattice with a unit cell edge length of 5.0Å. If density of the FeO in the crystal is 4.0 g cm^{-3}, then the number of FeO units present per unit cell is____ (Nearest integer) Given: Molar mass of Fe and 0 is 56 and 16 g mol^{-1} respectively. $N_A = 6.0 \times 10^{23}$ mol^{-1}

60. The graph of $\log\frac{x}{m}$ vs log p for an adsorption process is a straight line inclined at an angle of 45° with intercept equal to 0.6020. The mass of gas adsorbed per unit mass of adsorbent at the pressure of 0.4 atm is____ $\times 10^{-1}$ (Nearest integer) Given: $\log 2 = 0.3010$

PART-III MATHEMATICS

SECTION - A

61. A vector $\vec{v}$ in the first octant is inclined at the x-axis at 60°, to the y-axis at 45 and to the z-axis at an acute angle. If a plane passing through the points $(\sqrt{2}, -1, 1)$ and (a, b, c), is normal to $\vec{v}$, then

(a) $\sqrt{2}a + b + c = 1$ (b) $a + \sqrt{2}b + c = 1$

(c) $a + b + \sqrt{2}c = 1$ (d) $\sqrt{2}a - b + c = 1$

62. Let $a, b, c > 1, a^3, b^3$ and c^3 be in A.P., and $\log_a b, \log_c a$ and $\log_b c$ be in G.P. If the sum of first 20 terms of an A.P., whose first term is $\frac{a+4b+c}{3}$ and the common difference is $\frac{a-8b+c}{10}$ is -444 , then abc is equal to:

(a) $\frac{125}{8}$ (b) 216

(c) 343 (d) $\frac{343}{8}$

63. Let $a_1 = 1, a_2, a_3, a_4, \ldots$ be consecutive natural numbers.

Then $\tan^{-1}\left(\frac{1}{1+a_1a_2}\right) + \tan^{-1}\left(\frac{1}{1+a_2a_3}\right) + \cdots + \tan^{-1}\left(\frac{1}{1+a_{2021}a_{2022}}\right)$ is equal to

(a) $\cot^{-1}(2022) - \frac{\pi}{4}$ (b) $\frac{\pi}{4} - \cot^{-1}(2022)$

(c) $\tan^{-1}(2022) - \frac{\pi}{4}$ (d) $\frac{\pi}{4} - \tan^{-1}(2022)$

64. Let $\lambda \in R, \vec{a} = \lambda\hat{i} + 2\hat{j} - 3\hat{k}, \vec{b} = \hat{i} - \lambda\hat{j} + 2\hat{k}$

If $((\vec{a} + \vec{b}) \times (\vec{a} \times \vec{b})) \times (\vec{a} - \vec{b}) = 8\hat{i} - 40\hat{j} - 24\hat{k}$, then $|\lambda(\vec{a} + \vec{b}) \times (\vec{a} - \vec{b})|^2$ is equal to

(a) 132 (b)136

(c) 140 (d) 144

65. Let q be the maximum integral value of p in $[0, 10]$ for which the roots of the equation $x^2 - px + \frac{5}{4}p = 0$ are rational. Then the area of the region $\{(x, y): 0 \le y \le (x - q)^2, 0 \le x \le q\}$ is

(a) 243 (b) 164

(c) $\frac{125}{3}$ (d) 25

66. Let f, g and h be the real valued functions defined on $\mathbb{R}$ as

$$f(x) = \begin{cases} \frac{x}{|x|}, & x \neq 0 \\ 1, & x = 0 \end{cases}, g(x) = \begin{cases} \frac{\sin(x+1)}{(x+1)}, & x \neq -1 \\ 1, & x = -1 \end{cases}$$

and $h(x) = 2[x] - f(x)$, where $[x]$ is the greatest integer $\le x$.

Then the value of $\lim_{x \to 1} g(h(x - 1))$ is

(a) -1 (b) 0

(c) sin(a) (d) 1

67. Let S be the set of all values of a_1 for which the mean deviation about the mean of 100 consecutive positive integers $a_1, a_2, a_3, \ldots . a_{100}$ is 25. Then S is

(a) N (b) ϕ

(c) 99 (d) 9

68. For $\alpha, \beta \in \mathbb{R}$, suppose the system of linear equations

$$x - y + z = 5$$

$$2x + 2y + \alpha z = 8$$

$$3x - y + 4z = \beta$$

has infinitely many solutions. Then α and β are the roots of

(a) $x^2 + 14x + 24 = 0$ (b) $x^2 + 18x + 56 = 0$

(c) $x^2 - 18x + 56 = 0$ (d) $x^2 - 10x + 16 = 0$

69. Let $\vec{a}$ and $\vec{b}$ be two vectors, Let $|\vec{a}| = 1, |\vec{b}| = 4$ and $\vec{a} \cdot \vec{b} = 2$. If $\vec{c} = (2\vec{a} \times \vec{b}) - 3\vec{b}$, then the value of $\vec{b} \cdot \vec{c}$ is

(a) -24 (b) -84
(c) -48 (d) -60

70. If the functions $f(x) = \frac{x^3}{3} + 2bx + \frac{ax^2}{2}$ and $g(x) = \frac{x^3}{3} + ax + bx^2, a \neq 2b$ have a common extreme point, then $a + 2b + 7$ is equal to:

(a) $\frac{3}{2}$ (b) 3
(c) 4 (d) 6

71. If P is a 3×3 real matrix such that $P^T = aP + (a-1)I$, where $a > 1$, then

(a) $|\text{AdjP}| = \frac{1}{2}$ (b) $|\text{AdjP}| = 1$
(c) P is a singular matrix (d) $|\text{AdjP}| > 1$

72. The number of ways of selecting two numbers a and b, $a \in \{2, 4, 6, \ldots, 100\}$ and $b \in \{1, 3, 5, \ldots, 99\}$ such that 2 is the remainder when $a + b$ is divided by 23 is

(a) 268 (b) 108
(c) 54 (d) 186

73. $\lim_{n\to\infty} \frac{3}{n}\left\{4 + \left(2 + \frac{1}{n}\right)^2 + \left(2 + \frac{2}{n}\right)^2 + \cdots + \left(3 - \frac{1}{n}\right)^2\right\}$ is equal to

(a) 12 (b) $\frac{19}{3}$
(c) 0 (d) 19

74. Let A be a point on the x-axis. Common tangents are drawn from A to the curves $x^2 + y^2 = 8$ and $y^2 = 16x$. If one of these tangents touches the two curves at Q and R, then $(QR)^2$ is equal to

(a) 81 (b) 72
(c) 76 (d) 64

75. If a plane passes through the points $(-1, k, 0), (2, k, -1), (1, 1, 2)$ and is parallel to the line $\frac{x-1}{1} = \frac{2y+1}{2} = \frac{z+1}{-1}$, then the value of $\frac{k^2+1}{(k-1)(k-2)}$ is

(a) $\frac{17}{5}$ (b) $\frac{13}{6}$
(c) $\frac{6}{13}$ (d) $\frac{5}{17}$

76. The range of the function $f(x) = \sqrt{3-x} + \sqrt{2+x}$ is:

(a) $[2\sqrt{2}, \sqrt{11}]$ (b) $[\sqrt{5}, \sqrt{13}]$
(c) $[\sqrt{2}, \sqrt{7}]$ (d) $[\sqrt{5}, \sqrt{10}]$

77. The solution of the differential equation $\frac{dy}{dx} = -\left(\frac{x^2+3y^2}{3x^2+y^2}\right), y(a) = 0$ is

(a) $\log_e|x+y| - \frac{xy}{(x+y)^2} = 0$
(b) $\log_e|x+y| + \frac{2xy}{(x+y)^2} = 0$
(c) $\log_e|x+y| - \frac{2xy}{(x+y)^2} = 0$
(d) $\log_e|x+y| + \frac{xy}{(x+y)^2} = 0$

78. The parabolas: $ax^2 + 2bx + cy = 0$ and $dx^2 + 2ex + fy = 0$ intersect on the line $y = 1$. If a, b, c, d, e, f are positive real numbers and a, b, c are in G.P., then

(a) d, e,f are in G.P. (b) $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in A.P.
(c) d, e,f are in A.P. (d) $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in G.P.

79. Consider the following statements:

P : I have fever

Q: I will not take medicine

R : I will take rest.

The statement "If I have fever, then I will take medicine and I will take rest" is equivalent to:
(a) $((\sim P) \vee \sim Q) \wedge ((\sim P) \vee R)$

(b) $(P \vee Q) \wedge ((\sim P) \vee R)$
(c) $((\sim P) \vee \sim Q) \wedge ((\sim P) \vee \sim R)$
(d) $(P \vee \sim Q) \wedge (P \vee \sim R)$

80. $x = (8\sqrt{3} + 13)^{13}$ and $y = (7\sqrt{2} + 9)^{9}$. If $[t]$ denotes the greatest integer $\leq t$, then
(a) $[x]$ is odd but $[y]$ is even
(b) $[x] + [y]$ is even
(c) $[x]$ and $[y]$ are both odd
(d) $[x]$ is even but $[y]$ is odd

SECTION - B

81. Let a line L pass through the point $P(2, 3, 1)$ and be parallel to the line $x + 3y - 2z - 2 = 0 = x - y + 2z$. If the distance of L from the point $(5, 3, 8)$ is α, then $3\alpha^2$ is equal to

82. A bag contains six balls of different colours. Two balls are drawn in succession with replacement. The probability that both the balls are of the same colour is p. Next four balls are drawn in succession with replacement and the probability that exactly three balls are of the same colour is q. If $p : q = m : n$, where m and n are coprime, then $m + n$ is equal to

83. Let $P(a_1, b_1)$ and $Q(a_2, b_2)$ be two distinct points on a circle with center $C(\sqrt{2}, \sqrt{3})$. Let O be the origin and OC be perpendicular to both CP and CQ. If the area of the triangle OCP is $\frac{\sqrt{35}}{2}$, then $a_1^2 + a_2^2 + b_1^2 + b_2^2$ is equal to

84. Let A be the area of the region $\{(x, y) : y \geq x^2, y \geq (1 - x)^2, y \leq 2x(1 - x)\}$. Then $540\,A$ is equal to___

85. The 8^{th} common term of the series

$S_1 = 3 + 7 + 11 + 15 + 19 + \cdots.$
$S_2 = 1 + 6 + 11 + 16 + 21 + \cdots.$

Is_____

86. Let $A = \{1, 2, 3, 5, 8, 9\}$. Then the number of possible functions $f : A \to A$ such that $f(m \cdot n) = f(m)$.

87. If $\int \sqrt{\sec 2x - 1}\,dx = \alpha \log_e \left|\cos 2x + \beta + \sqrt{\cos 2x\left(1 + \cos \frac{1}{\beta}x\right)}\right| +$ constant, then $\beta - \alpha$ is equal to

88. If the value of real number $a > 0$ for which $x^2 - 5ax + 1 = 0$ and $x^2 - ax - 5 = 0$ have a common real root is $\frac{3}{\sqrt{2\beta}}$ then β is equal to

89. 50^{th} root of a number x is 12 and 50^{th} root of another number y is 18 . Then the remainder obtained on dividing $(x + y)$ by 25 is

90. The number of seven digits odd numbers, that can be formed using all the seven digits $1, 2, 2, 2, 3, 3, 5$ is___