GENERAL INSTRUCTIONS

1. The test is of 3 hours duration and the maximum marks is 300.
2. The question paper consists of 3 Parts (Part I: Physics, Part II: Chemistry, Part III: Mathematics). Each Part has two sections (Section 1 & Section 2).
3. Section 1 contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.
4. Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 questions have to be attempted.

   The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. In the OMR, do not bubble the sign for positive values. However, for negative values, Θ sign should be bubbled. (Example: 6, 81, 1.50,⊕ 3.25, 0.08)
5. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
6. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
7. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.
8. Do not fold or make any stray mark on the Answer Sheet (OMR).

Marking Scheme

1. Section – 1: +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. Section – 2: +4 for correct answer, 0 for all other cases. There is no negative marking.

Name of the Candidate (In CAPITALS) : ………………………………………………………

Roll Number : ………………………………………………………………………………

OMR Bar Code Number : ……………………………………………………………………

Candidate's Signature : ……………… Invigilator's Signature ……………………………..

PART – A : PHYSICS

SECTION – I

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

1. A planet is revolving around the sun in an elliptical orbit. The mass of planet is m, angular momentum of planet about sun is L, and length of semi major axis is a and eccentricity is e. Time period of revolution of planet is given by

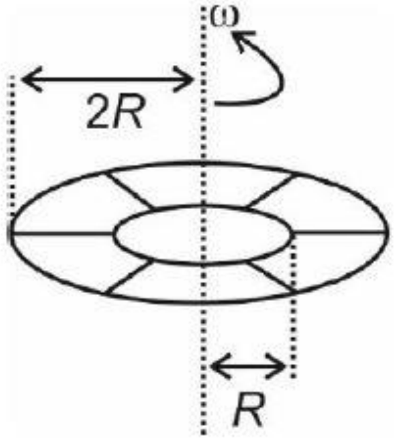
(1) $T = \frac{2\pi m a^2\sqrt{1+e^2}}{L}$

(2) $T = \frac{\pi m a^2\sqrt{1-e^2}}{L}$

(3) $T = \frac{2\pi m a^2\sqrt{1-e^2}}{L}$

(4) $T = \frac{\pi m a^2\sqrt{1-e^2}}{3L}$

2. Metallic disc of inner radius R and outer radius $2R$ is rotating with an angular speed ω. What will be the electric potential difference that appears between the inner and outer periphery. The mass of electrons is m and charge is e.



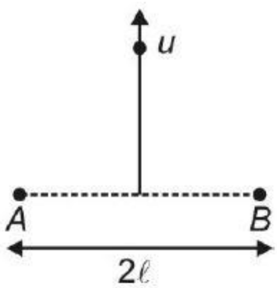
(1) $\frac{3m\omega^2R^2}{2e}$

(2) $\frac{m\omega^2R^2}{2e}$

(3) $\frac{m\omega^2R^2}{3e}$

(4) $\frac{2m\omega^2R^2}{e}$

3. Two sources of sound emitting sound of nearly equal wavelengths λ_1 $and\ \lambda_2$ are fixed at A and B respectively. A listener moves with velocity u on the perpendicular bisector of line joining A and B. Then the number of beats heard by him per second when it is at distance $2l$ from A and B, is (Speed of sound = C)



(1) $\left(C-\frac{u\sqrt{3}}{2}\right)\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_2}\right)$

(2) $\left(\frac{2C-u}{2}\right)\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_2}\right)$

(3) $\left(C-\sqrt{3}u\right)\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_2}\right)$

(4) Zero

4. An ideal gas undergoes a thermodynamic process in which internal energy (U) of the gas depends on pressure (P) of the gas as $= aP^4$, where a is a positive constant. Assuming gas to be monoatomic, the molar heat capacity of the gas for given process will be

(1) $\frac{3R}{4}$ (2) $\frac{2R}{3}$

(3) $\frac{9R}{4}$ (4) $\frac{4R}{9}$

5. A vertical cylindrical vessel contains a half litre of water having column height of 60 cm. If the density and bulk modulus of water are $10^3\ kg\ m^{-3}$ and $2 \times 10^9\ N\ m^{-2}$ respectively, then the elastic deformation potential energy (approximately) of water, is

(1) $1.8\ \mu J$ (2) $1.5\ \mu J$

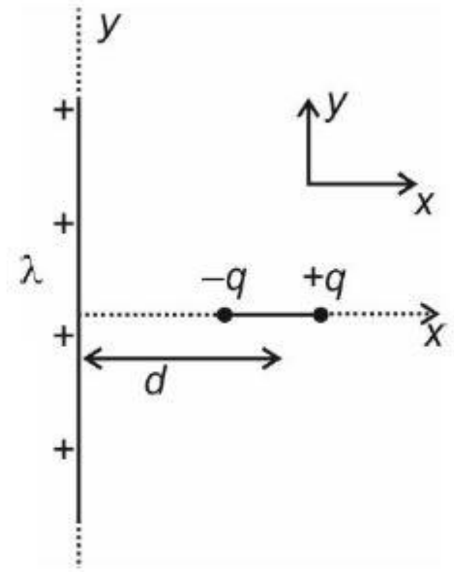
(3) $2.1\ \mu J$ (4) $2.4\ \mu J$

6. For an SHM oscillator, the amplitude is 5 cm and its time period is 4 seconds. The minimum time taken by the particle to pass between points which are at distances 4 cm and 3 cm from the centre of oscillation on the same side of it will be

(1) $0.13\ second$ (2) $0.18\ second$

(3) $0.26\ second$ (4) $0.35\ second$

7. A short dipole of dipole moment $\overline{P}$ is placed along $x - axis$ at a distance d from a long wire having uniform linear charge density $+\lambda$ (wire is along $y - axis$) as shown. Find minimum work required to align this dipole along $y\ axis$ (so that dipole moment $\overline{P}$ is along $+y$ direction)



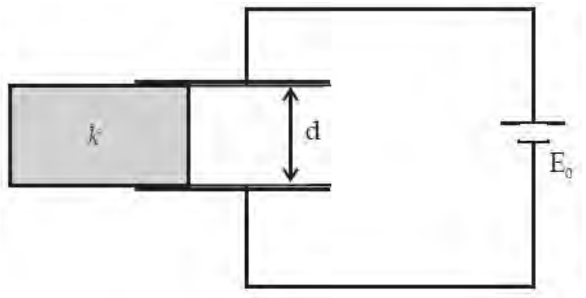
(1) $\frac{P\lambda}{\pi\varepsilon_0 d}$

(2) $-\frac{P\lambda}{\pi\varepsilon_0 d}$

(3) $\frac{P\lambda}{2\pi\varepsilon_0 d}$

(4) $-\frac{P\lambda}{2\pi\varepsilon_0 d}$

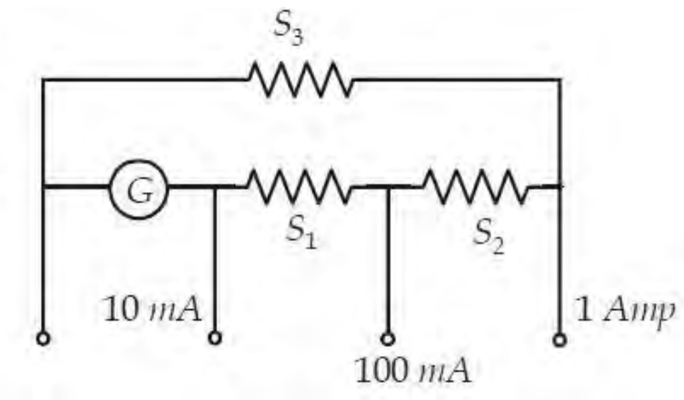
8. A dielectric slab of dielectric constants k is slowly inserted inside the parallel plate capacitor having plate area A and separation between plates d as shown in figure. If dimensions of dielectric slab is same as plates of capacitor and capacitor is connected through the battery, then work done by agent will be $(C = \varepsilon_0 A/d)$



(1) $\frac{1}{2}CE_0^2(k+1)$ (2) $CE_0^2(k-1)$

(3) $-CE_0^2(k-1)$ (4) $-\frac{1}{2}CE_0^2(k-1)$

9. A multi range current ammeter can be constructed by using a galvanometer circuit as shown in figure. We want a current meter that can measure $10\ mA, 100\ mA$ and $1A$ using a galvanometer of resistance $10\ \Omega$ and that produces maximum deflection for current $1\ mA$. Value of $S_1 + S_2 + S_3$ in ohms is

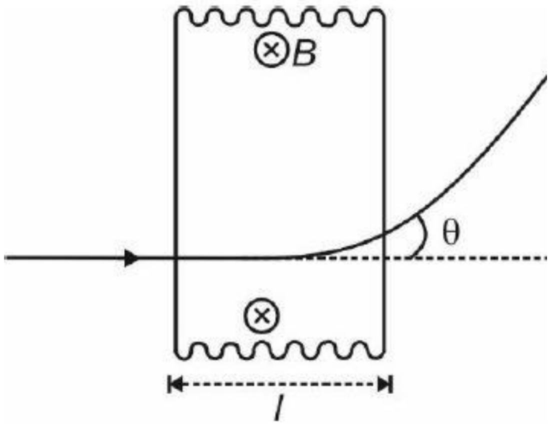


(1) $\frac{1}{9}\Omega$ (2) $\frac{10}{9}\Omega$

(3) $\frac{100}{999}\Omega$ (4) $\frac{1}{11}\Omega$

10. A positively charged particle of specific charge α, accelerated by a potential difference V moves through a uniform transverse magnetic field

B. The field occupies a region of width l. The angle θ through which the charged particle deviates from initial direction of its motion is



(1) $\sin^{-1}\left[Bl\sqrt{\frac{\alpha}{V}}\right]$

(2) $\sin^{-1}\left[2Bl\sqrt{\frac{\alpha}{V}}\right]$

(3) $\cos^{-1}\left[2Bl\sqrt{\frac{\alpha}{3V}}\right]$

(4) $\sin^{-1}\left[Bl\sqrt{\frac{\alpha}{2V}}\right]$

11. A simple LR circuit is connected to a battery at $t = 0$. The time instant at which rate of energy storage in inductor is half of power delivered by battery

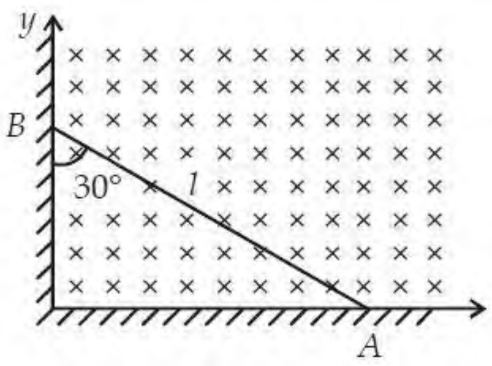
(1) $\frac{2L}{R} In\ 2$

(2) $\frac{L}{R} In\ \left(\frac{3}{2}\right)$

(3) $\frac{L}{R} In\ 2$

(4) $\frac{L}{R} In\ 3$

12. A rod of length l slides against the perpendicular wall, such that the lowest point (A) of the rod slides with a speed v on horizontal surface as shown in figure. There exist a uniform magnetic field throughout the region. Now, what is the distance of point 'P' on the rod from end 'A' such that, the induced emf across 'P' and 'A' is maximum?



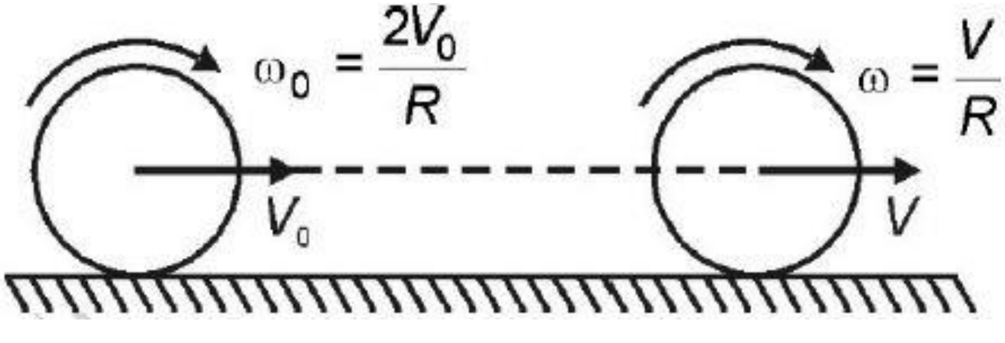
(1) $\frac{3l}{8}$

(2) $\frac{l}{4}$

(3) $\frac{3l}{4}$

(4) $\frac{l}{2}$

13. A solid circular disc (m, R) translates with V_0 and rotates with $\omega_0 = \frac{2V_0}{R}$, at $t = 0$. Because of friction, pure rolling starts at $t = t_0$. The coefficient of friction is μ. Find t_0.



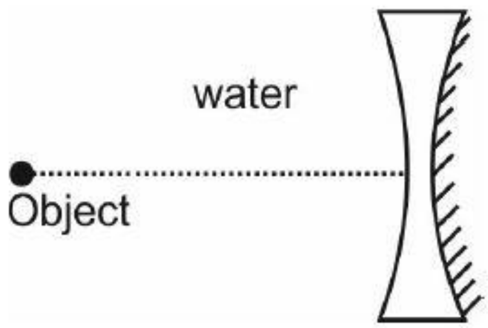
(1) $\frac{V_0}{3\mu g}$

(2) $\frac{4V_0}{3\mu.g}$

(3) $\frac{2V_0}{3\mu g}$

(4) $\frac{V_0}{\mu.g}$

14. An equi-concave lens of radius of curvature 15 cm and $\mu = 1.5$ is placed in water ($\mu = 1.33$). If one surface is silvered, then image distance from lens when an object is placed at distance of 14 cm from the lens is



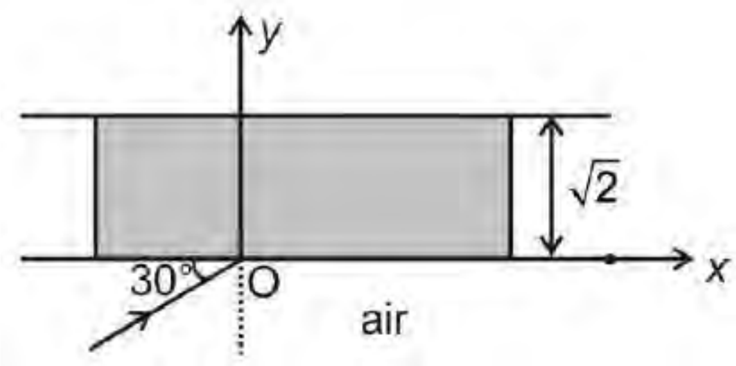
(1) 8.5 cm

(2) 4.2 cm

(3) 10.5 cm

(4) 6.4 cm

15. A ray of light is incident on a slab as shown in figure. The refractive index of medium of slab changes as $\mu = \sqrt{1 + y^2}$. The angle made by ray with $x - axis$ at $y = \sqrt{2}$ is



(1) 37^0 (2) 30^0
(3) 60^0 (4) 45^0

16. A uniform rod, of mass m, length l and r radius of cross section, is rotated about an axis passing through one of its ends and perpendicular to its length with constant angular velocity ω in horizontal plane. If Y is the Young's modulus of the material of rod, the increase in its length due to rotation of rod is

(1) $\frac{m\omega^2L^2}{\pi r^2Y}$ (2) $\frac{m\omega^2L^2}{2\pi r^2Y}$
(3) $\frac{m\omega^2L^2}{3\pi r^2Y}$ (4) $\frac{2m\omega^2L^2}{\pi r^2Y}$

17. A free particle having one electronic charge with initial kinetic energy 9 eV and de Broglie wavelength 1 mm enters a region of V_0 potential difference such that new de Broglie wavelength is now 1.5 mm. Then eV_0 is

(1) 5 eV (2) 6 eV
(3) 13.5 eV (4) 15 eV

18. A sine wave is travelling in a medium. The minimum distance between the two particles, always having same speed, is

(1) $\frac{\lambda}{4}$ (2) $\frac{\lambda}{3}$

(3) $\frac{\lambda}{2}$

(4) λ

19. A radioactive β −emission. A detector records n β −particles in $2s$ and by next $2s$ (accumulatively) it records $1.1\,n$ β −particle. Number of β −particles recorded by detector after a long time, is

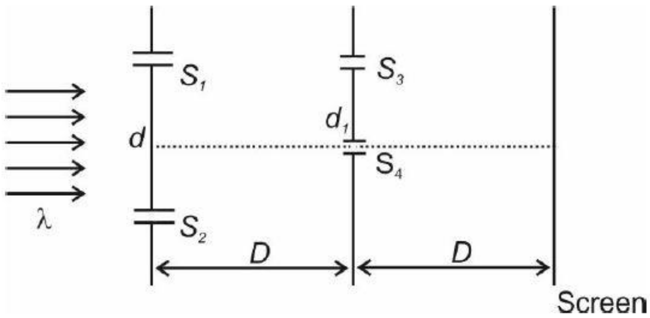
(1) $\frac{11n}{10}$

(2) $\frac{12n}{10}$

(3) $2n$

(4) $\frac{10n}{9}$

20. Consider the given arrangement. The two slits S_1 and S_2 are illuminated by monochromatic light of wavelength λ. Slits S_3 and S_4 are at separation $d_1 = \frac{\lambda D}{3d}$, then ratio of maximum and minimum intensity on the screen will be



(1) 9 : 1

(2) 8 : 1

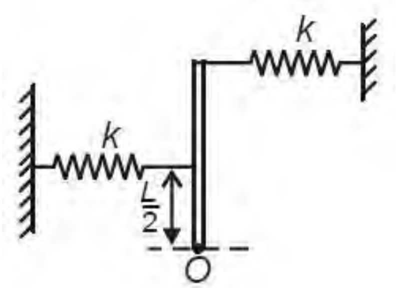
(3) 4 : 1

(4) 2 : 1

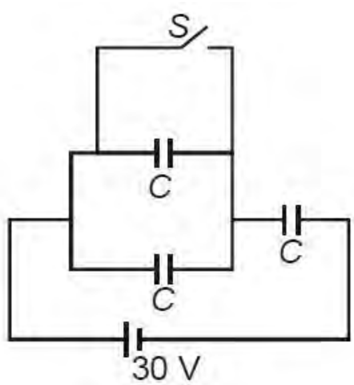
SECTION – II

Numerical Value Type Questions: This section contains 10 questions. The answer to each questions is a NUMERICAL VALUE For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. You have to attempt any five.

21. The given arrangement is in vertical plane and initially the springs are in natural length. The uniform rod is hinged at end O, about which it can freely rotate. The angular frequency of small oscillations of the rod is $\frac{n}{8}\sqrt{\frac{k}{m}}$. Find n. (Given: m = mass of rod, L = length of rod and $k = \frac{mg}{L}$)

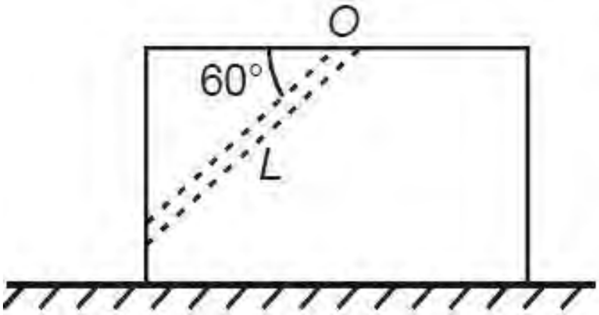


22. Three capacitors each of capacitance $C = 2\mu F$ are connected with a battery of emf $30V$ as shown in the figure. When the switch S is closed, the heat generated in circuit will be $\frac{n}{10} mJ$. Find the value of n.

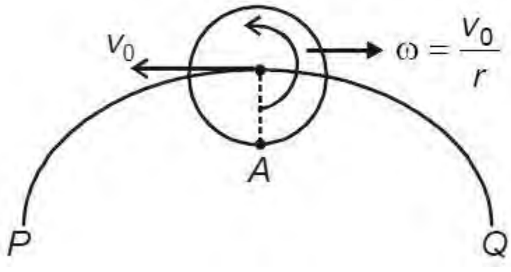


23. Radiation from hydrogen gas excited to first excited state is used for illuminating certain metallic plate. When the same plate is exposed to the radiation from some unknown hydrogen like gas excited to the same level it is found that de-Broglie wavelength of fastest photoelectron has decreased by 2.3 times. It is given that energy corresponding to longest wavelength of Lyman series of the unknown gas is 3 times the ionization energy of hydrogen gas $(13.6eV)$. The work function (in eV) of the metallic plate is $[Take\ (2.3)^2 = 5.25]$

24. Shown in figure is a block at rest having an inclined smooth groove in vertical plane. The horizontal surface is smooth. A ball of same mass as that of block at rest is released from top end. The time when ball will leave groove is $\sqrt{\frac{nL}{2g\sqrt{3}}}$. Find n.



25. A flying disc of radius r is moving with constant speed v_0 while rotating anticlockwise with angular speed $\frac{v_0}{r}$ along a curve PQ as shown below. Radius of curvature of curve at the instant is $4r$. The magnitude of acceleration of point A at the instant is $\frac{3v_0^2}{nr}$. Find n.



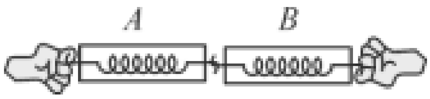
26. If the molar specific heat at constant pressure for a polyatomic non-linear gas is x and the molar specific heat at constant volume for a diatomic gas is y, find the value of x y.

27. In the colour coding system of carbon resistors, the tolerance (in %) shown by gold band is____.

28. A grass hopper can jump maximum distance 1.6 m. It spends negligible time on ground. How far can it go in $2\sqrt{2}s$ (in meters)?

29. A particle moves with a velocity $v = (5\hat{i} - 3\hat{j} + 6\hat{k})ms^{-1}$ under the influence of a constant force $F = (\hat{i} - \hat{j} - \hat{k})N$. The instantaneous power applied to the particle is ____________ Watts.

30. Consider two spring balances hooked as shown in the figure. We pull them in opposite directions with equal force. If the reading shown by A is 5 N, reading shown by B will be ________ N.



PART – B : CHEMISTRY
SECTION – I

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

31. Consider the following statements about amines and select the incorrect one.

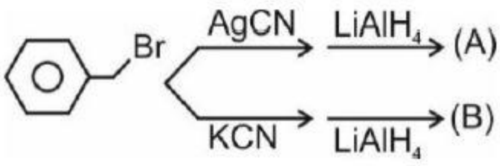
(1) Ethylamine is soluble in water whereas aniline is not

(2) Aniline does not undergo Friedel Crafts reaction

(3) Diazonium salts of aliphatic amines are more stable than those of aromatic amines

(4) Gabriel phthalimide synthesis is preferred for synthesising primary amines

32. Consider the reactions



A and B are

(1) Positional isomers (2) Identical

(3) Functional isomers (4) Not isomeric

33. 1 mole of $K_2Cr_2O_7$ cannot oxidise

(1) 3.6 moles of $FeSO_4$ to $Fe_2(SO_4)_3$ (2) 1 mole of $FeSO_4$ to $Fe_2(SO_4)_3$

(3) 1.8 moles of Sn^{2+} to Sn^{4+} (4) 4 moles of Sn^{2+} to Sn^{4+}

34. In which transition, in a sample of H atoms, only one type of photon is emitted?

(1) $n = 4 \rightarrow n = 2$ (2) $n = 3 \rightarrow n = 1$

(3) $n = 4 \rightarrow n = 1$ (4) $n = 2 \rightarrow n = 1$

35. The values of van der Waal's constants 'a' and 'b' for three different gases are given below

Gases	a	b
A_2	1.3	0.09
B_2	4.1	0.023
C_2	2.2	0.015

The correct order of liquefaction of gases is

(1) $A_2 > B_2 > C_2$ (2) $B_2 > C_2 > A_2$

(3) $C_2 > B_2 > A_2$ (4) $A_2 > C_2 > B_2$

36. In which of the following groups all the members have linear shape?

(1) NO_2, NO_3^-, ICI_2^+ (2) N_3^-, I_3^-, NO_2^+

(3) XeF_2, C_2H_2, SO_2 (4) $CO_2, BeCl_2, SnCl_2$

37. The term - $T\Delta S_{total}$ at constant temperature and pressure is known as

(1) Gibb's function (2) Bohr's function

(3) Pauli's function (d) Nernst function

38. Which one of the following complexes exhibits chirality?

(1) $[Cr(OX)_3]^{3-}$ (2) cis - $[PtCl_2(en)]$

(3) cis - $[RhCl_2\ (NH_3)2\ ]^-$ (4) mer - $[Co(NO_2)_3\ (Cl)_3]$

39. Ammonium salts on heating with slaked lime liberate a colourless gas (X). Identify the incorrect statement for gas (X).

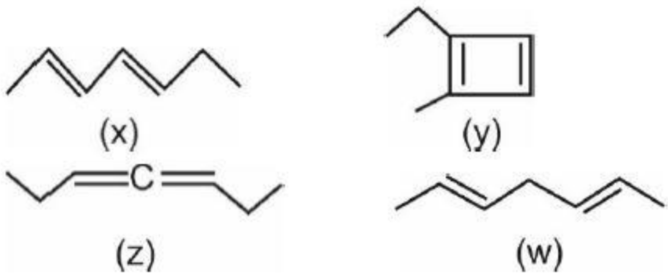
(1) (X) turns red litmus blue and produces dense white fumes in contact with dilute HCl.

(2) (X) turns filter paper moistened with mercurous nitrate black and gives intense blue boloured solution with $CuSO_4$ (aq)

(3) (X) when passed through Nessler's reagent produces a brown colour precipitate

(4) (X) does not give clear solution with Ag_2O

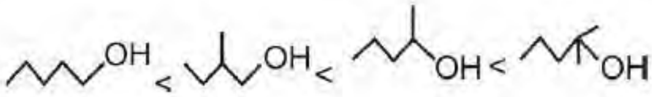
40. The correct order of heat of hydrogenation is

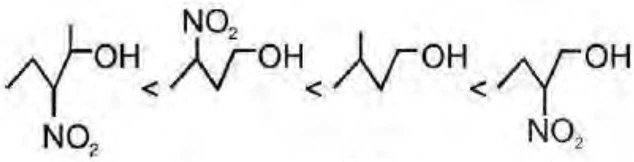


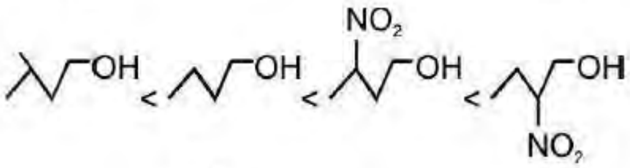
(1) $x > y > w > z$ (2) $y > x > w > z$

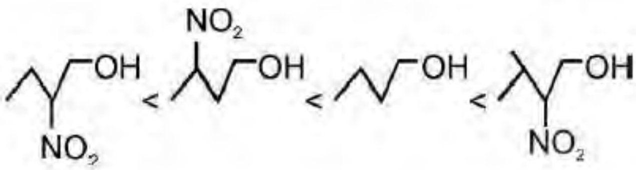
(3) $x < w < z < y$ (4) $z > x > y > w$

41. Correct reactivity order towards anhydrous $ZnCl_2 + conc. HCl$

(1) 

(2) 

(3) 

(4) 

42. Correct order of bond length is

(1) $F_2 < N_2 < O_2 < Cl_2$ (2) $N_2 < F_2 < O_2 < Cl_2$

(3) $F_2 < Cl_2 < N_2 < O_2$ (4) $N_2 < O_2 < F_2 < Cl_2$

43. Find the enthalpy of combustion of propane gas from the following data.

Bond energy (kJ/mol)

$BE_{C-H} = a_1$ $BE_{O=O} = a_2$ $BE_{C=O} = a_3$

$BE_{O-H} = a_4$

$BE_{C-C} = a_5$

(1) $6a_1 + a_5 + 5a_2 - 3a_3 - 4a_4$

(2) $8a_1 + 2a_5 + 5a_2 - 6a_3 - 8a_4$

(3) $6a_1 + a_5 + a_2 - a_3 - a_4$

(4) $8a_1 + 2a_5 + 5a_2 - 3a_3 - 8a_4$

44. Correct order of ionic size is

(1) $Be^{2+} \cong Li^+ < Na^+ < Mg^{2+}$

(2) $Be^{2+} < Mg^{2+} \cong Li^+ < Na^+$

(3) $Mg^{2+} < Na^+ < Be^{2+} < Li^+$

(4) $Li^+ < Be^{2+} < Mg^{2+} < Na^+$

45. Hexagonal unit cell is made up by $AB.AB$ ……… packing, then shortest distance between two identical layers (say AA) in a unit cell of edge length x, is

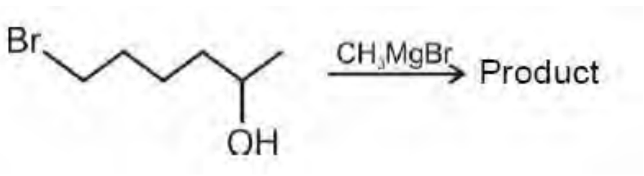
(1) $\frac{\sqrt{3}x}{2}$

(2) $\frac{2\sqrt{2}x}{\sqrt{3}}$

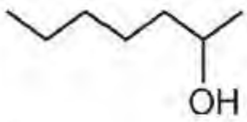
(3) $\frac{x}{\sqrt{6}}$

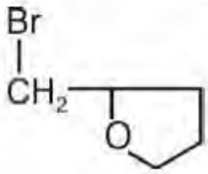
(4) $\frac{4x}{\sqrt{3}}$

46.

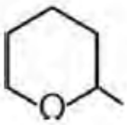


Product formed in the above reaction is

(1) 

(2) 

(3) $\overset{\text{Br}}{\overset{|}{CH_2}} - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$

(4) 

47. Out of following in which retention of configuration in product P will take place?

(1) $CH_3 - \underset{C_2H_5}{\underset{|}{CH}} - OH \xrightarrow[\text{Py}]{SOCl_2} \xrightarrow[\text{Acetone}]{\text{NaI}} P$

(2) $CH_3 - CH_2 - CH_2 - Cl \xrightarrow{\text{NaI/acetone}} P$

(3) $CH_3 - CH_2 - CH_2 - Cl \xrightarrow{\text{aq.KOH}} P$

(4) $CH_3 - CH_2 - OH + PCl_5 \longrightarrow P$

48. The following acids have been arranged in the decreasing order of their acid strength. Identify the correct order.

I. $ClOH$

II. $BrOH$

III. IOH

(1) I > II > III

(2) II > I > III

(3) III > II > I

(4) I > III > II

49. Which polymer has 'chiral' monomer(s)?

(1) Buna-N
(2) PHBV
(3) Neoprene
(4) Nylon 6, 6

50. Biochemical Oxygen Demand (BOD) is the amount of oxygen required (in ppm)

(1) By bacteria to break-down organic waste in a certain volume of water sample
(2) For sustaining life in a water body
(3) By anaerobic bacteria to break down inorganic waste present in a water body
(4) For the photochemical break down of waste present in 1 m^3 volume of a water body

Section – II

Numerical Value Type Questions: This section contains 10 questions. The answer to each questions is a NUMERICAL VALUE For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. You have to attempt any five.

51. If X metal atoms occupying the corners, Y atom at cube centre and Z atoms at the centres of the edges, then if the co-ordination number of X w.r.t. Z is a and that of Y w.r.t. Z is b, then the value a + b is

52. Out of following the number of complexes which are diamagnetic is / are

(i) $[Co(H_2O)_6]Cl_3$
(ii) $[Co(NH_3)_6]Cl_2$
(iii) $[Fe(CO)_5]$
(iv) $[Ni(NH_3)_6]^{2+}$

(v) $K_2[NiF_6]$

(vi) $K_2[PtCl_4]$

(vii) $Na_2[ZnCl_4]$

53. 0.25 M solution of pyridinium chloride $C_5H_6N^+Cl^-$ was found to have a pH of 2.699. if the value of K_b of pyridine C_5H_5N is $a \times 10^{-10}$, then the value of a is (given, $10^{-2.699} = 2 \times 10^{-3}$)

54. Percentage packing fraction of diamond is x (approximately), and the number of particle per unit cell is y. Then the value of $x + y$ is

55. 10.30 mg of O_2 is dissolved in $1L$ of sea water of density 1.03 g/mL. The concentration of O_2 in ppm is ______.

56. At critical condition of temperature and pressure for a real gas, what would be the value of 16 Z ? Here, Z is its compressibility factor.

57. Given that $\Delta_C H^o$ (combustion enthalpy) for Diamond is -834.8 kJ mole and $\Delta_C H^o$ for graphite is -832.8 kJ/mole, the value of $\Delta_f H^o_{(Diamond)}$ i.e. [C(graphite) → C(diamond)] [in kJ/mole] is:

58. Certain fixed quantity of an ideal gas expands by adiabatic manner such that w_{gas} is equal to -25 kJ and ΔH_{gas} for the expansion is -75kJ. The ratio of $\frac{C_p}{C_v}$ for this gas will be equal to:

59. The oxidation number of phosphorus in ATP (adenosine triphosphate) is :

60. The total number of stereoisomers in open-chain aldohexose (such as glucose) is :

PART – C : MATHEMATICS

SECTION – I

Multiple Choice Questions: This section contains 20 multiple choice question. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

61. The number of permutations of 4 letters from the letters of word 'KOLKATA' is

(1) 144 (2) 270

(3) 354 (4) 436

62. Let $f:(-1,1) \rightarrow R$ be a differentiable function with $f(0)=1$ and $f'(0)=-1$. If $g(x)=\left(f(nf(x)-n)\right)^{n}$, where n is a natural number and $g'(0)=4$, then n equals

(1) 0 (2) 1

(3) 2 (4) 4

63. Let f be differentiable on R and $h(x)=f(x)-\left(f(x)\right)^{2}+\left(f(x)\right)^{3}+3x+2\cos x$, then

(1) h is increasing whenever f is increasing

(2) h is increasing whenever f is decreasing

(3) h is decreasing whenever f is decreasing or increasing

(4) h us decreasing whenever f is increasing

64. Let $f(x)$ be a polynomial function with negative coefficients and $f(-x)=f(x)$ for all x. Then

(1) $f(x)$ always has point of inflexion at $x=0$

(2) $f(x)$ has no point of local extremum at $x=0$

(3) $f(x)$ always has local minima at $x=0$

(4) $f'(0)=0$

65. Area of the figure bounded by the curves $y=|x-1|$ and $y=3-|x|$ is

(1) 1 (2) 2

(3) 4 (4) 16

66. The value of c for which line $y = 2x + c$ is tangent to circle $x^2 + y^2 = (\sqrt{5})^2$ is

(1) $\pm\sqrt{5}$ (2) ± 5

(3) ± 3 (4) ± 1

67. Let α be a root of quadratic equation $ax^2 + bx + c = 0$ and β be a root of quadratic equation $-ax^2 + bx + c = 0$, where a, b, c are real numbers and $0 < \alpha < \beta, a \neq 0$. If the equation $\frac{a}{2}x^2 + bx + c = 0$ has a positive root γ, then which of the following must be true?

(1) $\gamma < max.\{\alpha, \beta\}$ (2) $\gamma > max.\{\alpha, \beta\}$

(3) $\alpha < \gamma < \beta$ (4) $\alpha < -\gamma < \beta$

68. $\int_1^{e2} [\log_e x]\, dx, x > 0$ and $[.]$is greatest integer function, is equal to

(1) $e^2 - e$ (2) $e^2 - 1$

(3) $e - 1$ (4) $e^2 + 1$

69. Negation of logical statement $(p \to q) \vee (p \vee q)$ is

(1) Contradiction (2) Tautology

(3) Neither contraction nor tautology (4) Same as $(q \to p) \leftrightarrow (p \to)$

70. Let $S_n = {}^nC_0 + {}^nC_3 + {}^nC_6 + {}^nC_9 + \ldots\ldots$, then the value of S_n, if n is not a multiple of 3, is

(1) $\frac{2^n + (-1)^n}{3}$ (2) $\frac{2^n - (-1)^n}{3}$

(3) $\frac{2^n - 1}{3}$ (4) $\frac{2^n + 1}{3}$

71. Let $\begin{vmatrix} 1+x & x & x^2 \\ x & 1+x & x^2 \\ x^2 & x & 1+x \end{vmatrix} = -(x-\alpha_1)(x-\alpha_2),\ (x-\alpha_3)(x-\alpha_4)$ be an identity in x, where $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ are independent of x. The value of $\alpha_1 \times\ \alpha_2 \times \alpha_3 \times \alpha_4$ is

(1) -1 (2) 2

(3) 4 (4) 6

72. A normal is drawn at a point $P(x, y)$ of a curve. If meets the x –axis at Q. If PQ is of constant length k, and the curve passes through $(0, k)$, then the equation of the curve is

(1) $x^2 + y^2 = k^2$ (2) $x^2 - y^2 = k^2$

(3) $x^2 + y^2 = k^2 - 1$ (4) $x^2 - y^2 = k^2 - 1$

73. The eccentricity of the conic represented by the parametric equation $x = \rho - t + 1, y = \rho + t + 1$

(1) $\frac{1}{2}$ (2) 1

(3) 2 (4) $\sqrt{3}$

74. If $A = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$, then A^{2011} is equal to

(1) $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ (2) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

(3) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ (4) $\begin{bmatrix} 1 & 0 \\ 2011 & 1 \end{bmatrix}$

75. The lines $\frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$ and $\frac{x-1}{K} = \frac{y-4}{2} = \frac{z-5}{1}$ are coplanar, if

(1) $K = 0, -3$ (2) $K = -1, 1$

(3) $K = -3, 3$ (4) $K = 0, 3$

76. $\int \frac{\cos 4x - 1}{\cot x - \tan x}\, dx$ is equal to

(1) $-\frac{1}{2}\cos 4x + C$ (2) $-\frac{1}{4}\cos 4x + C$

(3) $-\frac{1}{2}\sin 2x + C$ (4) $\frac{1}{2} In\,|\cos 2x| - \frac{\cos^2 2x}{4} + C$

77. There are 5 identical red balls and 3 identical yellow balls in a box. Two balls are drawn at random, then the probability that their colour is different is

(1) $\frac{1}{3}$ (2) $\frac{2}{3}$

(3) $\frac{15}{28}$ (4) $\frac{17}{54}$

78. If $f(x) = x\sqrt{1-x^2}$, then the range of $f(x)$ is

(1) $[-1, 1]$ (2) $\left[-\frac{1}{2}, \frac{1}{2}\right]$

(3) $(-\infty, \infty)$ (4) $[-2, 2]$

79. Vectors $\vec{a}, \vec{b}, \vec{c}$ are such that every pair is non-collinear and the vector $\vec{a} + \vec{b}$ is collinear with $\vec{c}$ and vector $(\vec{b} + \vec{c})$ is collinear with $\vec{a}$. The resultant of $\vec{a}, \vec{b}$ and $\vec{c}$ is

(1) $\vec{0}$ (2) $\vec{a}$

(3) $3\vec{c}$ (4) $2\vec{a}$

80. A point corresponding to complex number z moves on the curve $|z+4| + |z-6| = 10$, then the value of $|Z|_{max} + |Z|_{min}$ is equal to

(1) 6 (2) 4

(3) 2 (4) 10

SECTION – II

Numerical Value Type Questions: This section contains 5 questions. The answer to each question is a NUMERICAL VALUE. For each questions, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. You have to attempt any five.

81. $f(1)=2, g(1)=2, f'(x), g'(x)$ exist, then the value of

$\lim_{x\to 1}\frac{f(1)g(x)-f(1)-g(1)f(x)+g(1)}{f(1)g(x)-f(x)g(1)}$ is ________.

82. The value of $2\cos 20^0 \cos 40^0 \cos 80^0$ is equal to ________.

83. If two of the straight lines given by $3x^3+3x^2y-3xy^2+dy^3=0$, are at right angles, then d is equal to ______.

84. The value of $\cot^{-1}\left(2^2+\frac{1}{2}\right)+\cot^{-1}\left(2^3+\frac{1}{2^2}\right)+\cdots\ldots\ldots\infty$ is equal to $\tan^{-1}\lambda$, then the value of λ is equal to ________.

85. If the co-efficient of variation of a distribution is 60 and its standard deviation is 24, then its arithmetic mean is _________.

86. Number of ways in which three distinct numbers can be selected between 1 and 20 both inclusive, whose sum is even is______.

87. A circle passes through the points (2, 2) and (9, 9) and touches the x-axis. The absolute value of the difference of possible x-coordinate of the point of contact is______.

88. Let g(x) = ||x + 2| - 3|. If a denotes the number of relative minima, b denotes the number of relative maxima and c denotes the product of the zeros. Then the value of (a + 2b - c) is __________.

89. In a geometric progression the ratio of the sum of the first 5 terms to the sum of their reciprocals is 49 and sum of the first and the third term is 35. The fifth term of the G.P. is p, the value of 4p is ________.

90. Rakshit is allowed to select 1 or more books out of (2n + 1) distinct books. If the number of ways in which he may not select all of them is 126, then value of n is _________.