FIITJEE (JEE-Advanced)

BATCHES – NWCM721O1S, NWCM921X1W, NWCM921A1W & PANINI921-XIIG1

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code:

Test - 18

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. In Each Section is **One Part:** Part-A.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Sections.

(i) **Part-A (01-15)** contains Six (15) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :_____

Batch :_____ **Date of Examination :**_____

Enrolment Number :_____

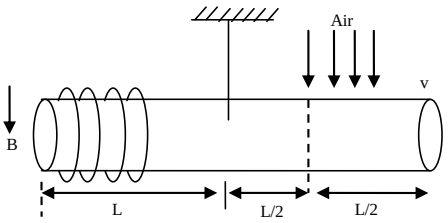
SECTION-1 : PHYSICS

PART – A

(Numerical based)

This section contains **15 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

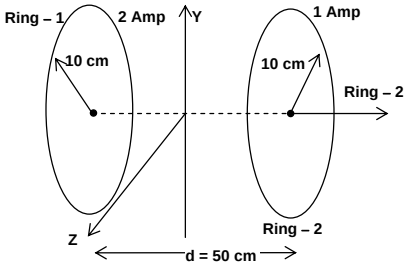
1. A non-conducting non-magnetic rod having circular cross section of radius R is suspended from a rigid support as shown in figure. A light and small coil of 300 turns is wrapped tightly at the left end of the rod where uniform magnetic field B exists in vertically downward direction. Air of density ρ hits the half of the right part of the rod with velocity V as shown in the figure. What should be current in the clockwise direction (as seen from O) in the coil so that rod remains horizontal? Give answer in mA.



Given $\frac{2}{L\nu}\sqrt{\frac{\pi RB}{\rho}} = \frac{1}{\sqrt{5}}A^{-1/2}$.

1. **2**

2. Two co–axial rings of same radius R=10 cm are placed parallel to the y–z plane, such that x–axis of the rings .Ring 1 carries a current of 2 Amp and 2 carries a current of 1 Amp in opposite sense as shown in the figure .The separation between the rings is d = 50 cm .Find the magnitude of $\frac{\int_{-\infty}^{+\infty}\vec{B}.d\vec{x}}{\mu_0}$, where $\vec{B}$ is the net magnetic field due to both the rings at any point on the axis .



2. **1**

3. A square loop of side a = 6 cm carries a current I = 0.5 A. Calculate magnetic induction B (in μT) at point P, lying on the axis of loop and at a distance x = $\sqrt{7}$ cm from the centre of loop.

3. **4.5**

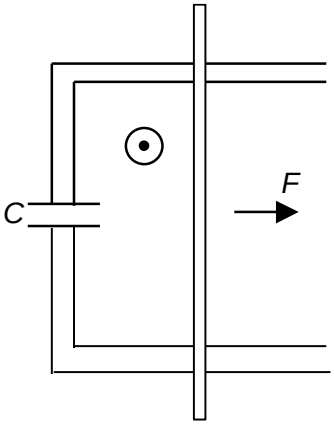
4. Magnetic field $\vec{B} = -B_0 x\hat{k}$ exists in a region of space. A particle of specific charge α (charge per unit mass) enters this region of space. Its velocity and position at time t = 0, are $\vec{v} = v_0\hat{i}$ and (0, 0, 0). Maximum x displacement of the particle is $n\left\{\sqrt{\frac{v_0}{B_0\alpha}}\right\}$. Find the value of 'n'.

4. **1.41**

5. A coil of inductance 1H and resistance 10Ω is connected to a resistance less battery of emf 50V at time t = 0. The ratio of rate at which magnetic energy is stored in the coil to the rate at which energy is supplied by the battery at t = 0.1 sec is 'x'. Find the value of '*x*'.

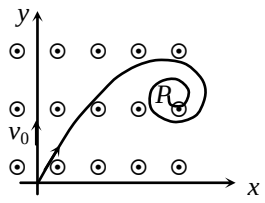
5. **0.37**

6. A conductor of mass $\frac{1}{4}$ kg and length 2 m can move without friction along two metallic parallel tracks in a horizontal plane and connected across a capacitor C = 1000 μF. The whole system is in a magnetic field of magnetic inductance B = 2 tesla directed outward to the plane. A constant force F = 1.33 N is applied to the middle of conductor perpendicular to it and parallel to the tracks. Find the acceleration of conductor neglecting all resistances. Assume that the conductor started from rest. (in m/sec^2)



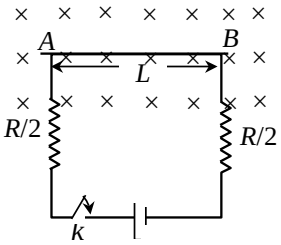
6. **5**

7. A particle having mass m, charge q is projected with velocity v_0 along y-axis in a region of uniform magnetic field B_0 which is outward and perpendicular to the plane of the paper as shown in the figure. The particle is continuously subjected to a frictional force which varies with velocity as $\vec{F}_r = -\alpha\vec{v}$, where α is a constant. Consequently the particle moves on a spiral path till it comes to rest at point P. Find the x- co-ordinate of point P.
(Take $\alpha = 10^{-3}$ kg/sec, $q = 10^{-3}$C, $B_0 = 1\text{T}$, $v_0 = 1\text{m/s}$, m = 5 gm)



7. **2.5**

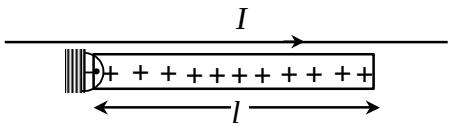
8. A wire AB of length l and mass m is placed on a two vertical supports each having resistance R/2. The wire AB is free to move.
A cell is connected to the free ends as shown in the figure. It is placed in a uniform magnetic field B. Now switch k is closed for a short time, so that charge flown in this interval in the circuit is q. Find the maximum height attained by the wire AB. Neglect the inductive effect of the wire and the loop. (Take $B_0 = 1\text{T}$, m = 1 gm, L = 5 m, q = 10^{-3}C, g = 10 m/s2)



8. **1.25**

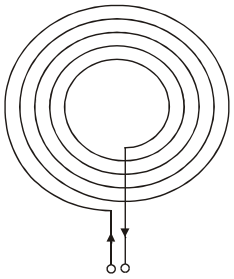
9. A non-conducting rod of length l, mass m and linear charge density λ is hinged at one end. It is kept in horizontal position in vertical plane in front of a current carrying wire as shown in figure. The system is released from horizontal position. the force on the rod at that instant when rod makes angle 60 with horizontal is

$\frac{k\lambda\mu_0 Il}{\pi}\sqrt{\frac{g}{l}}$ then find the value of k.



9. **1.22**

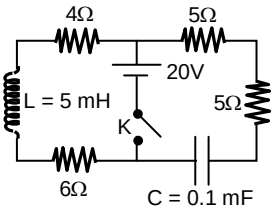
10. A thin insulated wire forms a plane spiral of N = 100 tight turns carrying a current I = 8 mA. The radii of inside and outside turns as shown in figure are equal to *a* = 50 mm and *b* = 100 mm. The magnetic moment of the spiral with a given current is $K \times 10^{-2}$ A.m^2



Then find the value of K.

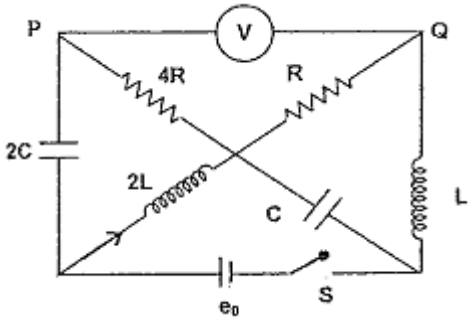
10. **1.5**

11. In the circuit shown, the key (K) is closed at t = 0, find the current through the key at the instant t = 10^{-3} ln2 sec in Amp.



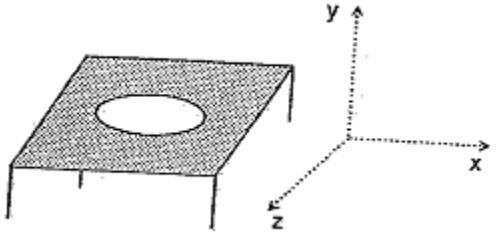
11. **2.5**

12. two ideal inductors of inductance L and 2L, two ideal capacitors of capacitance C and 2C, two resistors of resistance R and 4R , a battery of emf e_0 and an ideal voltmeter V are connected in a circuit as shown. There is a switch S which is initially closed for a long time so that steady state is reached. Assume there are no LC oscillations the total heat dissipated in 4R after the switch S is opened is equal to K x 10^{-2}J, then find the value of K.(take R =1 Ω, C = 2μF, L = 2mH and e_0 = 4 Volts)



12. **3.20**

13. A uniform conducting ring of mass π kg and radius 1 m is kept on smooth horizontal table. A uniform but time varying magnetic field $\vec{B} = (\hat{i} + t^2\hat{j})T$ is present in the region (where t is in sec and the positive y- axis is in vertically upward direction, g = 10 m/s^2). Resistance of the ring is 2Ω then find the heat generated in the ring till the instant ring starts toppling in kJ.



13. **0.21**

14. The magnetic field inside a radially symmetrical parallel stream of electrons varies with distance r from the axis as $B = k r^{3.5}$ where k is a constant. The current density j varies with the distance r as $j = Cr^n$, then find the value of n. (where C is an another constant)

14. **2.5**

15. A current I flows through a thin cylinder of radius R. If the pressure exerted on the cylinder due to the flow of current is $\frac{k\mu_0 I^2}{\pi^2 R^2}$ then find the value of 'k'.

15. **0.12**

SECTION-2 : CHEMISTRY

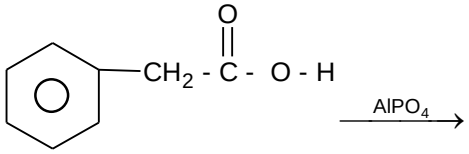
PART – A

(Numerical based)

This section contains **15 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

1. 1 mole of glucose reacts with maximum 'X' mole of phenyl hydrazine. Value of 'X' is

1. 3

2. 

   What is the degree of unsaturation in above product?

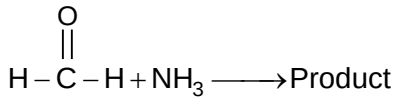
2. 6

3. The sum of molecular weights of monomers of P.H.B.V(Biodegradable polymer) [C = 12, H = 1, O = 16]

3. 222

4. Sum of number of 'Cl' atoms in molecules of each monomers of "Saran" (Polymer) is

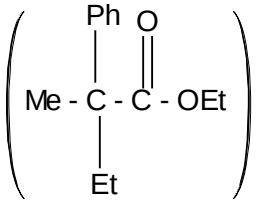
4. 3

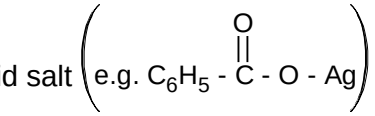
5. 

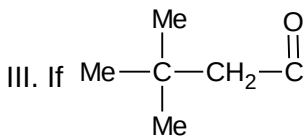
   Degree of unsaturation of product is

5. 3

6. How many of given statements are correct regarding Hunsdiecker reaction:

   I. If enantiomerically, pure silver salt like  of carboxylic acid is used product will be racemic mixture.

   II. Aromatic carboxylic acid salt  can undergo Hunsdiecker reaction.

   III. If  is used in reaction, it may undergo rearrangement.

   IV. Product alkyl bromide have one carbon atom less than the silver salt of carboxylic acid used.

   V. If I_2 is used in place of Br_2 then the reaction is known as simonini reaction

   VI. If I_2 is used in place of Br_2 then ester is formed as major product when silver-salt of carboxylic and I_2 used in 2 : 1 ratio.

VII. If $CH_3CH_2\overset{O}{\overset{\|}{C}}-OAg + Br_2$ is used, then $CH_3CH_2CH_2Br$ is the major product

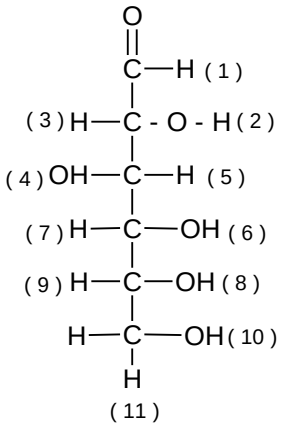
6. 5

7. In D.E.O test(Diethyl Oxalate Test), if $(CH_3)_2NH$ is treated with diethyl oxalate, the mol. wt of product is [C = 12, N = 14, H = 1, O = 16]

7. 145

8. If racemic mixture of $CH_3-\underset{OH}{\underset{|}{CH}}-\overset{O}{\overset{\|}{C}}-OH$ and racemic mixture of $CH_3CH_2\underset{OH}{\underset{|}{CH}}-\overset{O}{\overset{\|}{C}}-OH$ is allowed to react, then number of cyclic diester (Lactide) formed as product

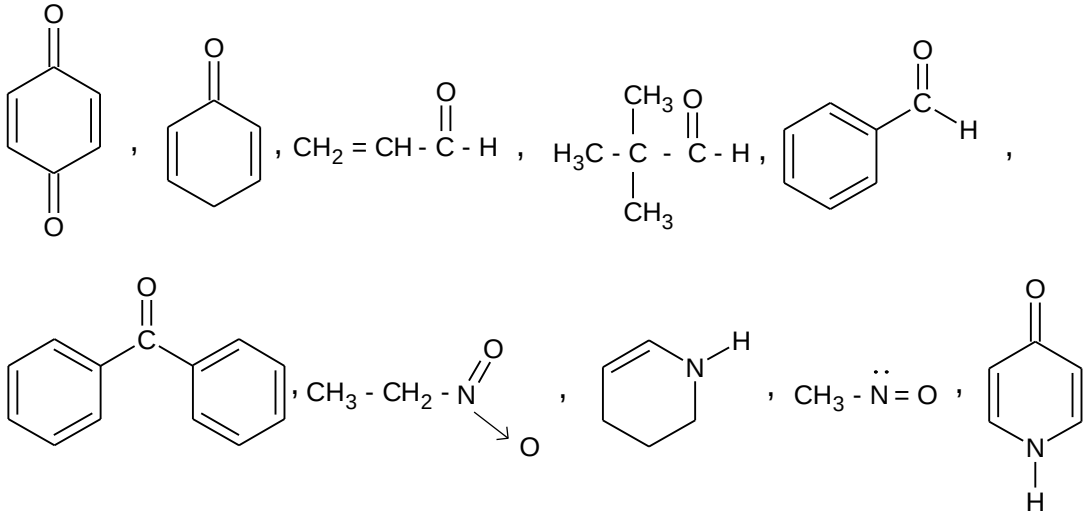
8. 10

9. 

The most acidic 'H atom is numbered as

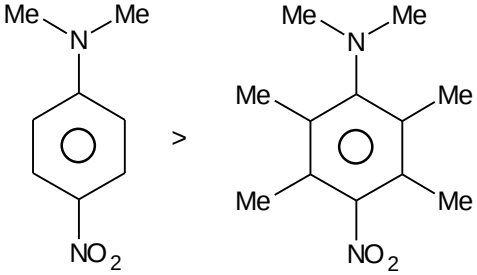
9. 3

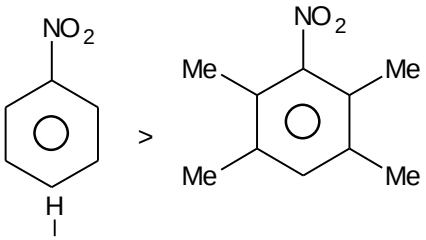
10. How many of the given molecule can show tautomerism?

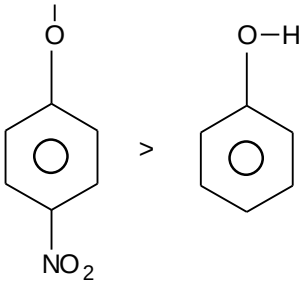


10. 5

11. In how many options correct order for dipole moment is given in

(I) 

(II) 

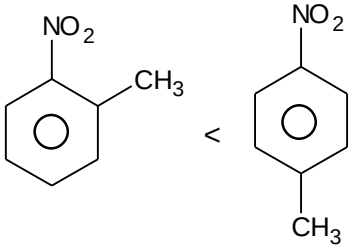
(III) 

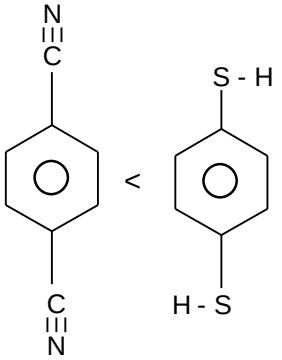
(IV) C - Cl > C - F > C - Br > C - I

(V) $NH_3 > NF_3$

(VI) $SO_2 > SO_3$

(VII) $NOF > NO_2F$

(VIII) 

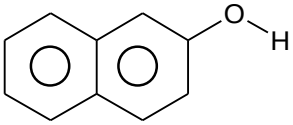
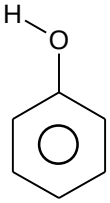
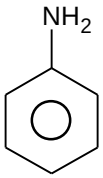
(IX) 

11. 9

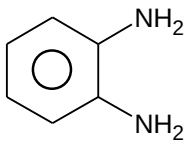
12. Which is correct statement about diazo-coupling reaction?

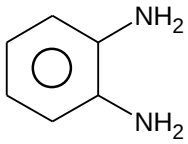
(I) Benzene diazonium ion is a strong electrophilie $\left(PhN_2^+\right)$

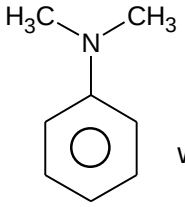
(II) For diazocoupling reaction of phenol, pH optima should be slightly basic.
(III) For diazocoupling reaction of aniline pH optima should be slightly acidic

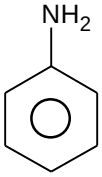
(IV)The colour of diazocoupling product with β-napthol  is red, with  is orange & with  is yellow.

(V) Diazonium ion is resonance stabilized.

(VI) If  when treated with $NaNO_2$ + HCl, major product is formed by intramoelcular N – N coupling reaction.

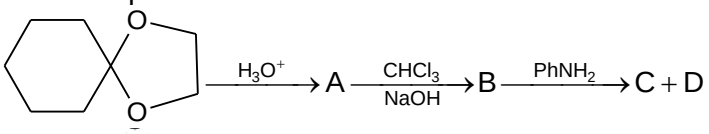
(VII) If  is treated with $NaNO_2$ + HCl, the degree of unsaturation of major product is 5.

(VIII)  when treated with PhN_2^+ then C – N coupling takes place.

(IX) If  is treated with PhN_2^+ then N – N coupling take place

12. 8

13. Given sequence of reaction is:



How many of the following statement(s) are true regarding above reaction sequence and products.

(i) Compound A is used for the formation of Aspirin.

(ii) C and D are geometrical isomers.

(iii) B on treatment with conc.NaOH followed by acidification forms an acid which is more acidic than o–toluic acid.

(iv) B can reduce fehling solution.

(v) Compound A when treated with Ph–$N_2^{\oplus}$/NaOH then it forms yellow dye.

(vi) Compound C or D is more basic than aniline.

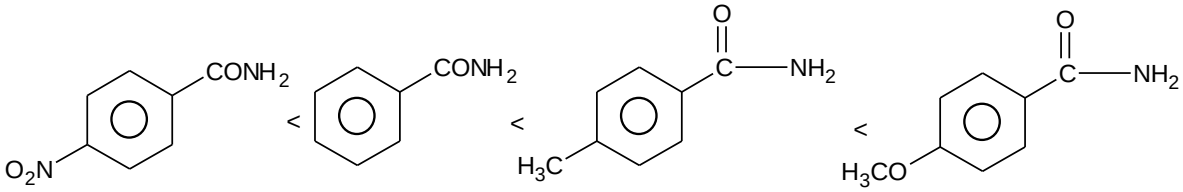
13. 5

14. An organic compound A, containing C, H, N and O on analysis gives 49.32% carbon, 9.59% hydrogen and 19.18% nitrogen. A on boiling with NaOH gives off NH_3 and a salt which on acidification gives a monobasic nitrogen free acid B. The silver salt of B contains 59.67% silver. What is the mol. wt of B. [C = 12, H = 1, O = 16]

14. 74

15. Which is/are correct about Hoffmann bromamide reaction?

(1) Greater the electron donating tendency faster will be the rate of reaction.

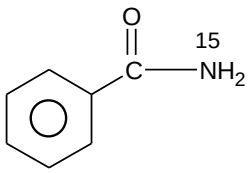


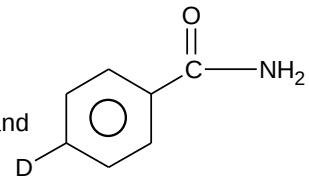
(2) Migration of group is involved in the rate determining step

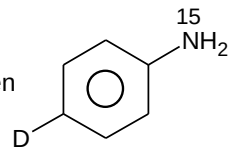
(3) Nitrene is not formed in free state

(4) Migration of group is completely intramolecular

(5) If $CH_3-\overset{\overset{O}{\|}}{C}-NH_2$ is used in Hoffmann bromamide reaction then $CH_3CH_2NH_2$ is the amine formed as product.

(6) When 

and 

then 

are allowed to react with Br_2 + NaOH then this will formed as one of the product.

(7) In Hoffmann bromamide reaction isocyanate is formed as reaction intermediate.

(8) All products of Hoffmann bromamide will give carbylamine test/reaction.

15. 5

SECTION-3 : MATHEMATICS

PART – A

(Numerical based)

This section contains **15 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

1. For natural number n, define

$a_n = 2^2 + 4^2 + 6^2 + ... + (2n)^2$

$b_n = 1^2 + 3^2 + 5^2 + ... + (2n-1)^2$

Then $\lim\limits_{n\to\infty} \dfrac{\sqrt{a_n} - \sqrt{b_n}}{\sqrt{3n}} =$

1. 0.5

2. Let $f : R \to R$ be defined as $f(x) = 8x^3 + 3x$. Evaluate $\lim\limits_{x\to\infty} \dfrac{f^{-1}(8x) - f^{-1}(x)}{x^{1/3}}$

2. 0.5

3. If $L = \lim\limits_{n\to\infty} \sum\limits_{r=1}^{n} \dfrac{1}{2^r\left(1 + 2^{\frac{1}{2^r}}\right)}$ then $\left(\dfrac{1}{\ell n 2} - L\right) =$

3. 1

4. If $f : (0,\infty) \to (0,\infty)$ and $f(1) = \sqrt{2}$ where f is a differentiable function satisfying the condition $f'\left(\dfrac{1}{x}\right) = \dfrac{1}{f(x)} \forall\, x > 0$ then $f\left(\sqrt{15}\right)$ equals

4. 4

5. If $f(x), g(x), h(x)$ and $\phi(x)$ be polynomials in x and $\left(\int\limits_1^x f(x)h(x)dx\right)\left(\int\limits_1^x g(x)\phi(x)dx\right) - \left(\int\limits_1^x f(x)\phi(x)dx\right)\left(\int\limits_1^x g(x)h(x)dx\right)$ is divisible by $(x-1)^{\lambda}$. Find maximum value of λ.

5. 4

6. Let p be a polynomial of degree at most 4 such that $p(-1) = p(1) = 0$ and $p(0) = 1$. If $p(x) \le 1$ for $x \in [-1, 1]$, then find the largest value of $\int\limits_{-1}^{1} p(x)dx$.

6. 1.6

7. The least value of function $f(x)=\dfrac{2\sec^2 x+2\sec x+1}{\sec^2 x+\sec x+5}$ is _____

7. 0.2

8. Let $f(x)$ be an injective function with domain $[a,b]$ and range [c, d]. If $\alpha-$is a point in (a, b) such that $f(x)$has left hand derivative ℓ and right hand derivative *r* at $x=\alpha$ with both ℓ and *r* being negative and different numbers. If ℓ_1 and r_1 be the left hand derivative and right hand derivative respectively of $y=f^{-1}(x)$ at $x=f(\alpha)$ then the value of the product $(\ell)(\ell_1)(r)(r_1)=$

8. 1

9. If $a_n=\dfrac{\sin\left(\dfrac{(2k-1)\pi}{2n}\right)}{\cos^2\left(\dfrac{(k-1)\pi}{2n}\right)\cos^2\left(\dfrac{k\pi}{2n}\right)}$, then evaluate $\pi^3\lim\limits_{n\to\alpha}\dfrac{\sum\limits_{k=1}^{n-1}a_k}{n^3}$

9. 8

10. $\lim\limits_{n\to\infty}\left(\sin\left(\left(2+\sqrt{3}\right)^n\pi\right)+1\right)=$

10. 1

11. Find the sum of all possible values of 'α' for which the two curves $y=\alpha x^2+\alpha x+\dfrac{1}{24}$ and $x=\alpha y^2+\alpha y+\dfrac{1}{24}$ are tangent to each other

11. 4.33

12. Consider a cubic polynomial $f(x)=ax^3+bx^2+cx+4;\ a,b\in R$ and $f''\left(-\dfrac{2}{3}\right)=0$, tangent to the graph of the function $y=f(x)$ at $x=\dfrac{-2}{3}$ is $y=\dfrac{5}{3}x+\dfrac{100}{27}$. Then the value of $(a+b+c)$ equals

12. 4

13. The number of points of local maxima/minima of the function $f:R\to R$
$f(x)=(x-1)(x-2)^2(x-3)^3(x-4)^4.....(x-100)^{100}$ is/are _____

13. 149

14. For any real number b, let $f(b)$ denote the maximum of $\left|\sin x + \frac{2}{3+\sin x} + b\right| \forall x \in R$. Then the minimum value of $f(b) \forall b \in R$ is _____

14. 0.75

15. Let $f(x) < 0 \forall x \in (-\infty, 0)$ and $f(x) > 0 \ \forall x \in (0, \infty)$. Also $f(0) = 0$. Again $f'(x) < 0 \forall x \in (-\infty, -1)$ and $f'(x) > 0 \forall x \in (-1, \infty)$ and also $f'(-1) = 0$. Given that $\lim_{x \to -\infty} f(x) = 0$ and $\operatorname{Lim}_{x \to \infty} f(x) = \infty$ and function is differentiable. If $f''(x) < 0 \forall x \in (0, \infty)$ and $f'(0) = 1$, then the number of solutions of equation $f(x) = x^2$ is

15. 2

ANSWERS

SECTION-1 : PHYSICS

PART – A

SECTION – 2 : CHEMISTRY

PART – A

SECTION – 3 : MATHEMATICS

PART – A