FIITJEE (JEE-Advanced)

BATCHES – NWCM721O1S, NWCM921X1W, NWCM921A1W & PANINI921-XIIG1

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code: **Test- 17**

Time Allotted: 3 Hours **Maximum Marks: 198**

- 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. Each **Section** is further divided into **Three Parts**: **Part-A, B & Part-C** in the OMR.
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 Parts.

(i) **Part-A (01-06) –** Contains seven (06) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(ii) **Part-B (07-12)** contains Six (06) Numerical based questions with single digit integer as answer, ranging from 0 to 9 (both inclusive) and each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-C (13-18)** contains Six (06) 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 :_____

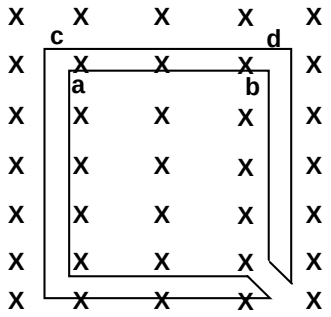
SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

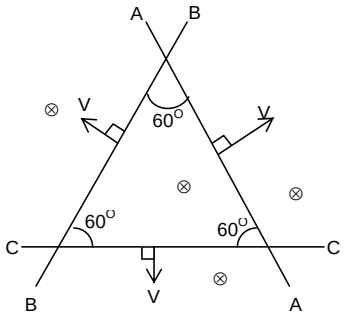
This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. The figure shows certain wire segments joined together to form a coplanar loop. The loop is placed in a perpendicular magnetic field in the direction going into the plane of the figure. The magnitude of the field increase with time. If I_1 and I_2 are the currents in the segments ab and cd. Then
(A) $I_1 > I_2$
(B) $I_1 < I_2$
(C) I_1 is in the direction ba I_2 is in the direction cd
(D) I_1 is in the direction ab I_2 is in the direction dc



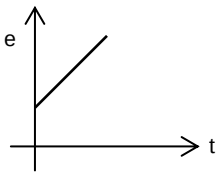
1. **D**

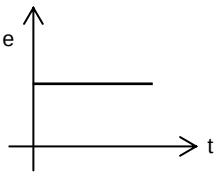
2. Three long rods AA, BB, CC are moving with a speed v in a uniform magnetic field B_o perpendicular to the plane of paper as shown in the figure. The triangle formed between the three wires is always an equilateral triangle. The induced the three wires is always an equilateral triangle. The induced current in the triangle is (resistance per unit length of wire is λ)
(A) $B_o v/3\lambda$ (B) $2B_o v/3\lambda$
(C) $B_o v/\sqrt{3\lambda}$ (D) vB_o/λ

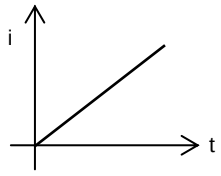


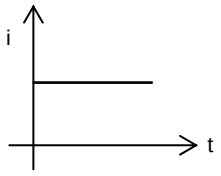
2. **D**

3 Two parallel long straight conductors lie on a smooth horizontal surface. Two other parallel conductors rest on them at right angles so as to form a square of side a initially. A uniform magnetic field B exists in vertical direction. Now all the four conductors start moving outwards with a constant velocity v. The induced e.m.f. e and induced current i will vary with time t as (more than one option may be correct)

(A) 

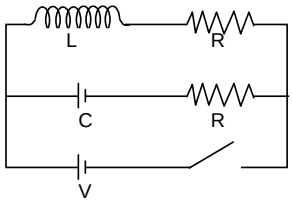
(B) 

(C) 

(D) 

3. **AD**

4. In the circuit shown $R = \sqrt{\frac{L}{C}}$. Switch S is closed at time t = 0. The time constant of L-R and C-R, part of the circuit is τ_L and τ_C then



(A) $\tau_L = \tau_C$

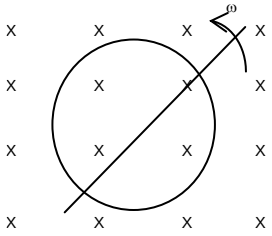
(B) $\tau_L = 2\tau_C$

(C) After time t = CR In2, the current through capacitor and inductor will be equal

(D) After time t = $\frac{L}{R\ In2}$, the current through inductor and capacitor will be equal

4 **AC**

5. A circular conducting loop is being rotated with a constant angular speed ω about an axis (which is the diameter) in a uniform magnetic field. Which of these following statements. are true [N is the no of turns, B is the magnitude of magnetic field & A is the area of the loop]



(A) Average induced emf in the loop is zero

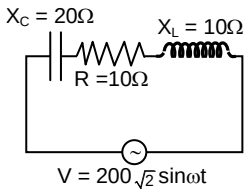
(B) Average induced emf in the loop is $\frac{BA\omega N}{2}$

(C) A sinusoidal current flows in the loop

(D) Amplitude of induced emf is $\frac{BA\omega N}{2}$

5. **AC**

6. In the LCR circuit shown in figure:
(A) current will lead the voltage
(B) rms value of current is 20 A
(C) power factor of the circuit is $\frac{1}{\sqrt{2}}$
(D) voltage drop across resistance is 100 V



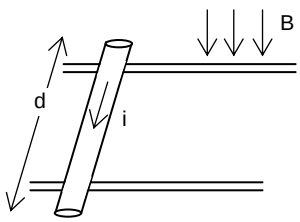
6. **AC**

PART – B

Integer Answer Type

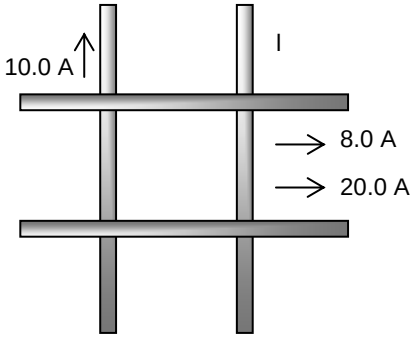
This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. A cylindrical uniform rod of mass 0.72 kg and radius 6 cm rests on two parallel rails, that are d = 50 cm apart. The rod caries a current I = 48A (In the direction shown) and rolls along the rails without slipping. If it starts from rest, uniform magnetic field of magnitudes 0.25 T is directed perpendicular to the rod and the rail, then the friction force(In N) between rod and rails is



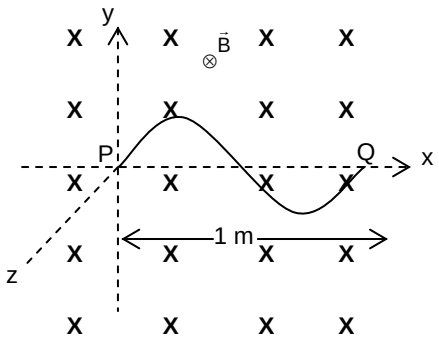
7. **2**

8. Four very long, current carrying wires in the same plane intersect to form a square 40.0 cm on each side as shown in Figure. Find the magnitude and direction of the current I so that the magnetic field at the centre of the square is zero



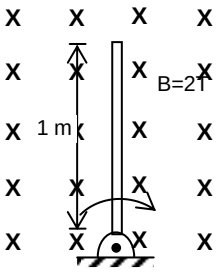
8. **2**

9. A wire forming one cycle of sine curve is moved in x – y plane with velocity $\vec{V} = 3\hat{i} + 2\hat{j}$. There exit a magnetic field $\vec{B} = -3\hat{k}$. Find the motional emf develop across the ends PQ of wire



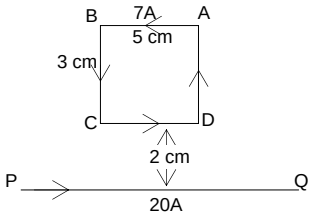
9. **6**

10. A rod of length 1 m rotates about one of its end point with an angular velocity 2 rad/ sec in a plane perpendicular to the magnetic field B = 2T as shown in the figure. Then find magnitude of electric field(In SI unit) at the mid point of the rod



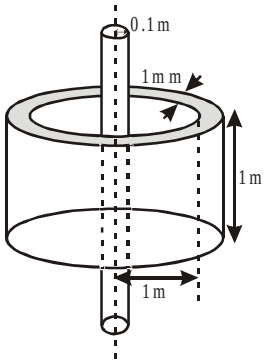
10. **2**

11. A small rectangular loop of sides 5.0 cm and 3.0 cm carries a current of 0.5A. It is placed with its longer side parallel to a long straight conductor of length 5.0 m at a distance of 2 cm from it. If current in the long conductor is 20 A, find the net force(In micro N) on the loop.



11. **3**

12. A long solenoid of radius 0.1 m and number of turns 1000 per unit length is enclosed by cylindrical shell of radius 1 metre thickness 1 mm and length 1 m. A variable current $I = 10^2 \sin 10^3 t$ amp flows through the solenoid coil. If the resistivity of the material of cylindrical shell is $0.5 \times 10^{-3}\ \Omega \times m$, find the maximum induced current in the shell. (Take $\pi^2 \cong 10$)



12. **8**

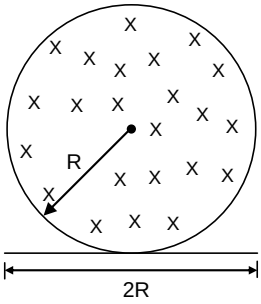
PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

1. A uniform disc of radius R having charge Q distributed uniformly all over its surface is placed on a smooth horizontal surface. A magnetic field, $B = kxt^2$, where k is a constant, x is the distance (in metre) from the centre of the disc and t is the time (in second), is switched on perpendicular to the plane of the disc. Find the torque (in N-m) acting on the disc after 15 sec. (Take 4kQ = 1 S.I. unit and R = 1m).

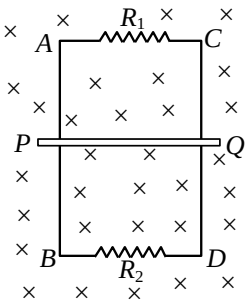
1. **1**

2. A uniform but time varying magnetic field is present in a circular region of radius R = 4 m. The magnetic field is perpendicular and into the plane of the paper and the magnitude of the field is increasing at a constant rate $\alpha = \frac{1}{\pi}$ T sec^{-1}. There is a straight conducing rod of length 2R placed as shown in the figure. Find the magnitude of induced emf (in volt) across the rod.



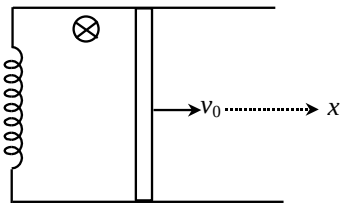
2. **4**

3. Two parallel vertical metallic rails AB and CD are separated by 1 m. They are connected at the two ends by resistances R_1 and R_2 as shown. A horizontal metallic bar PQ of mass 0.2 kg slides without friction, vertically down the rails under the action of gravity. There is uniform horizontal magnetic field of 0.6 T perpendicular to plane of the rails. It is observed that when the terminal velocity attained, the power dissipated in R_1 and R_2 are 0.76 W and 1.2 W respectively. Find the terminal velocity of bar in m/s. ($g = 9.8\ m/s^2$)



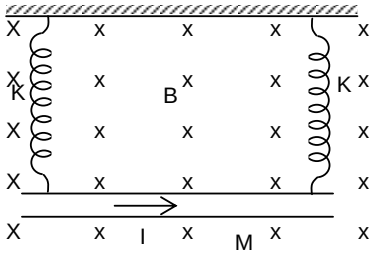
3. **1**

4. A loop is formed by two parallel conductors connected by a solenoid with inductance L = 2 H and a conducting rod of mass m = 8 kg which can freely (without friction) slide over the conductors. The conductors are located in a horizontal plane and in a uniform vertical magnetic field $B = \pi T$. The distance between the conductors is l = 2m. At the moment t = 0, the rod is imparted on initial velocity V_o = 2m/s directed to the right. Find the minimum time (in second) in which it will come to initial position if the resistance of loop is negligible.



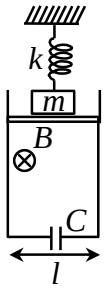
4. **2**

5. A metal rod of mass 10gm and length 25 cm is suspended on two springs as shown in figure. The springs are extended by 4 cm. When a 20 ampere current passes through the rod it rises by 1 cm. The magnetic field is $x \times 10^{-2}$ T ($g = 10$ m/s^2). Find the value of 'x'.



5. **0.5**

6. A block is attached to the ceiling by a spring that has a force constant k = 200 N/m. A conducting rod is rigidly attached to the block. The combined mass of the block and the rod is m = 0.3 kg. The rod can slide without friction along two vertical parallel rails, which are a distance l = 1 m apart. A capacitor of known capacitance C = 500 μF is attached to the rails by the wires. The entire system is placed in a uniform magnetic field B = 20 T directed as shown. The angular frequency (in rad/sec) of the vertical oscillations of the block is y. Neglect the self-inductance and electrical resistance of the rod and all wires. The value of 'y' will be



6. **20**

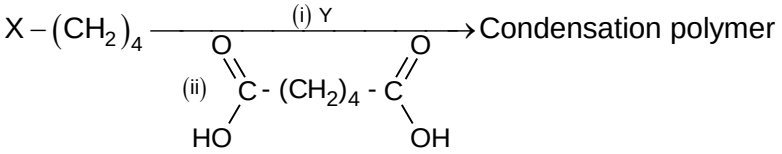
SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

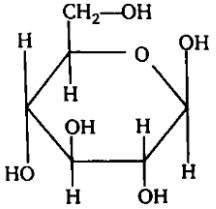
1. The correct functional group X and the reagent/reaction conditions Y in the following scheme are

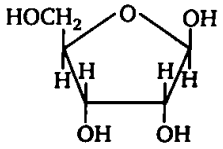


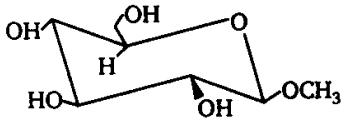
(A) X = $COOCH_3$, Y = H_2/Ni/Heat
(B) X = $CONH_2$, Y= H_2.Ni/Heat
(C) X = $CONH_2$, Y = Br_2/NaOH
(D) X = CN, Y = H_2/Ni/Heat

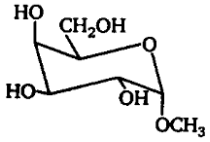
1. CD

2. Which of the following compound will show mutarotation?

(A) 

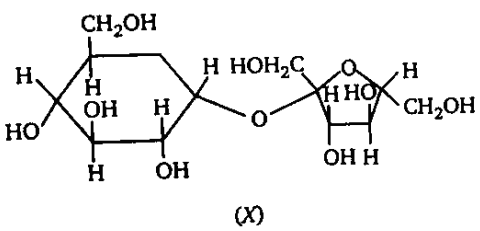
(B) 

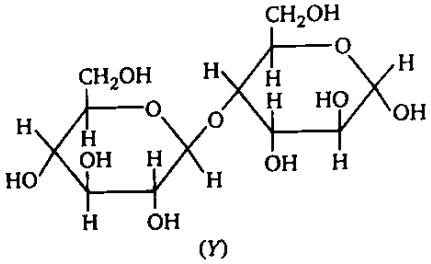
(C) 

(D) 

2. AB

3. The correct statement(s) about the following sugars X and Y is(are)

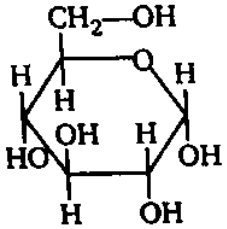

(X)

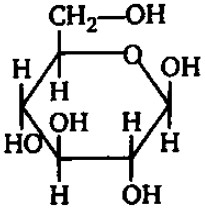

(Y)

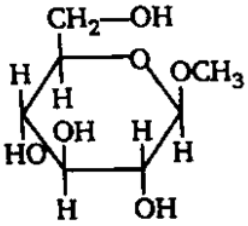
(A) X is a reducing sugar and Y is a non-reducing sugar
(B) X is a non-reducing sugar and Y is a reducing sugar
(C) The glucosidic linkages in X and Y are α and β, respectively
(D) The glucosidic linkages in X and Y are β and α, respectively

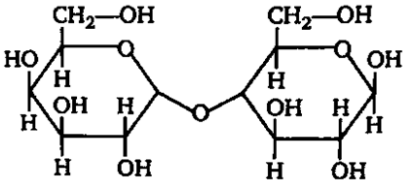
3. BC

4. Which of the following is reducing sugar?

(A) 

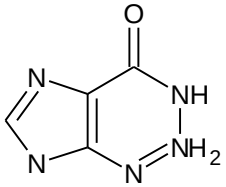
(B) 

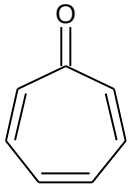
(C) 

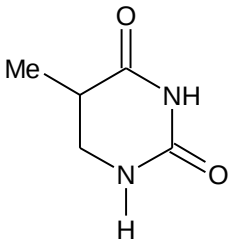
(D) 

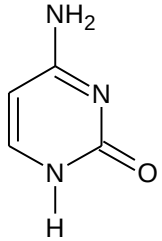
4. ABD

5. Which of the following are aromatic?

(A) 

(B) 

(C) 

(D) 

5. ABCD

6. Which of the following is/are biodegradable polymer?
(A) PHBV (B) Polyglycolic acid
(C) Dacron (D) Nylon-2-Nylon-6

6. AB

PART – B

Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

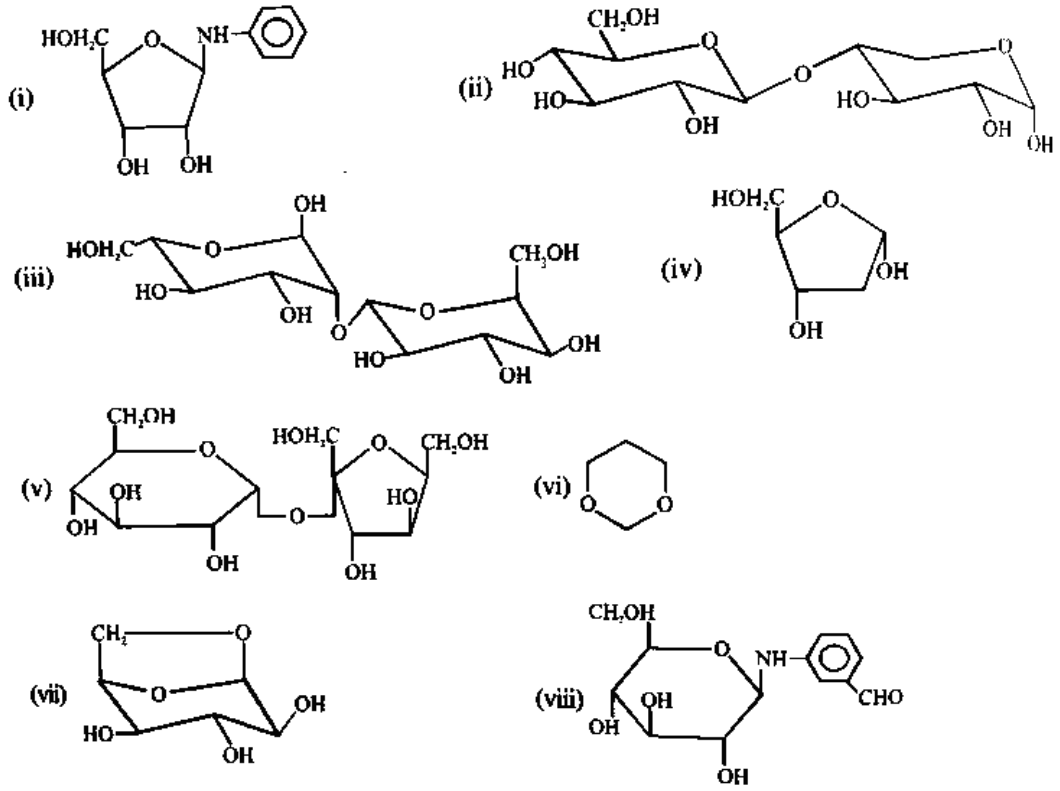
7. Glucose molecule reacts with 'X' number of molecule of phenylhydrazine to yield osazone. The value of X is

7. 3

8. A decapeptide(Mol. wt. 796) on complete hydrolysis gives glycine(Mol.wt. 75), alanine and phenylalanine. Glycine contributes 47.0% to the total weight of the hydrolysed products. The number of glycine units present in the decapeptide is

8. 6

9. Number of compound which can form silver mirror on reaction with Ag^+, NH_3 is



9. 4

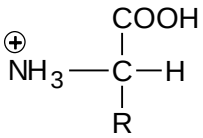
10. How many of the following vitamins are soluble in water?
Vitamin –A, Vitamin –B, Vitamin –C, Vitamin –D, Vitamin –K, Vitamin –H

10. 3

11. When a monosaccharide reacts to give the pyranose form from its open-chain form, how many distinct pyranose forms are possible?

11. 2

12. The given structure of α-amino acid will exist at which pH?

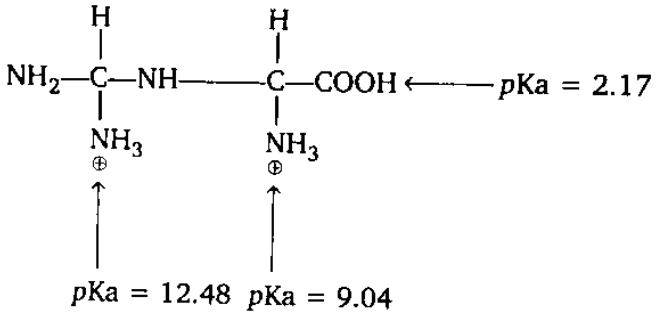


12 0

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. What is the pI of arginine? The structure of pKa values are shown below

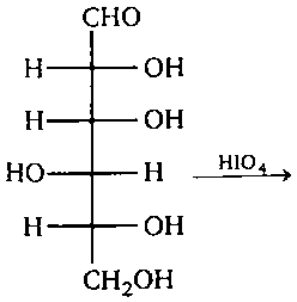


13. 10.76

14. 0.099 g of an organic compound when heated with fuming nitric acid in the presence of silver nitrate in a carius tube gave 0.287 g silver chloride. The percentage of chlorine in the compound is about

14. 71.72

15.



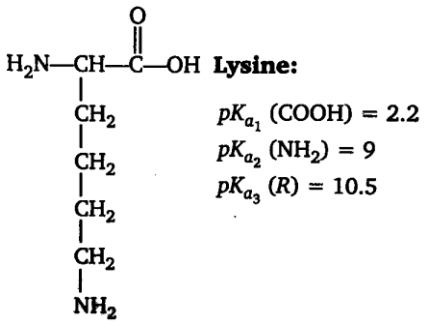
16-isomer of above compound when reacts with periodic acid(HIO_4). How many mole of periodic acid will consumed

15. 80

16. 1.0 g of an organic compound containing nitrogen on Kjeldahlising required 58.0 mL of N/5 H_2SO_4 for complete neutralization of ammonia. The percentage of nitrogen in the compound is about

16. 16.24

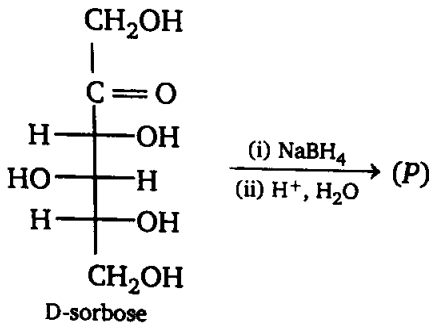
17.



What is the PI of lysine?

17. 9.75

18.



D-sorbose

What is the value of P/4?

18. 2.5

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Let $f(x)=\frac{(x-1)^2.e^x}{(1+x^2)^2}$, then which of the following statement(s) is (are) correct>

(A) $f(x)$ is strictly increasing in $(-\infty,-1)$

(B) $f(x)$ is strictly decreasing in $(-\infty,-1)$

(C) $f(x)$ has two points of local extremum

(D) $f(x)$ has a point of local minimum at some $x\in(-1,0)$

1. AC

2. If f is an odd continuous function [–1, 1] and differentiable in (–1, 1), then which of the following statement(s) is (are) correct?

(A) $f'(a)=f(1)$ for some $a\in(-1,0)$

(B) $f'(b)=f(1)$ for some $b\in(0,1)$

(C) $n(f(\alpha))^{n-1}f'(\alpha)=(f(1))^n$ for some $\alpha\in(-1,0)$ and $\forall n\in N$

(D) $n(f(\beta))^{n-1}f'(\beta)=(f(1))^n$ for some $\beta\in(0,1)$ and $n\in N$

2. ABD

3. Let $f(x)=\begin{cases}(1-x)^{\alpha}.x.(1-\cos(2\pi x)), & 0\le x\le 1\\ 0, & x=0\end{cases}$. If Rolle's theorem is applicable to $f(x)$ for $x\in(0,1)$, then α can be:

(A) –2 (B) –1

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

3. CD

4. Let $f(x)=\int_0^x e^{-t^2}(t-5)(t^2-7t+12)dt$ for all $x\in(0,\infty)$, then

(A) f has a local maximum at x = 4 and a local minimum at x = 3

(B) f is decreasing on $(3,4)\cup(5,\infty)$ and increasing on $(0,3)\cup(4,5)$

(C) There exists at least two $c_1,c_2\in(0,\infty)$ such that $f''(c_1)=0$ and $f''(c_2)=0$

(D) There exists some $c\in(0,\infty)$ such that $f'''(c)=0$

4. ACD

5. For which of the following functions Rolles's Theorem is applicable?

(A) $f(x)=\frac{x}{2}+\frac{2}{x}, x\in[1,4]$ (B) $f(x)=x+1-x^{\frac{3}{2}}, x\in[0,1]$

(C) $f(x)=|x+1|^3, x\in[-2,0]$ (D) $f(x)=\text{sgn}(x)+\text{sgn}(-x), x\in\left[\frac{-5}{2},\frac{1}{2}\right]$

[Note: $\text{sgn}(x)$ denotes signum function of x.]

5. ABCD

6. If $f(x)=\min.(1,\cos x, 1-\sin x), -\pi\le x\le\pi,$ then:

(A) $f(x)$ is not differentiable at x = 0

(B) $f(x)$ has local maximum at x = 0

(C) $f(x)$ is differentiable at $x=\frac{\pi}{4}$

(D) $f(x)$ is continuous and bounded in $x\in[-\pi,\pi]$

6. ABCD

PART – B

Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. Let $f(x)=\int_0^x 3^t\left(3^t-4\right)(x-t)dt(x\ge 0)$. If $x=a$ is the point where $f(x)$ attains its local minimum value then find the value of 3^a.

7. 7

8. If $f(x)=a|\cos x|+b|\sin x|(a,b\in R)$ has a local minimum at $x=\frac{-\pi}{3}$ and satisfies $\int_{-\pi/2}^{\pi/2}\left(f(x)\right)^2dx=2$. Find the value of a and b and hence find $\frac{b^2}{a^2}$.

8. 3

9. Let f be a differentiable function on R and satisfying $f(x)=-\left(x^2-x+1\right)e^2+\int_0^x e^{x-y}.f'(y)dy$. If $f(1)+f'(1)+f''(1)=ke,$ where $k\in N$, then find k.

9. 9

10. Let $a_n\left(n \geq 1\right)$ be the value of x for which $\int_x^{2x} e^{-t^n}\,dt\left(x > 0\right)$ is maximum. If $L = \lim_{n\to\infty} \ln\left(a_n\right)$ then find the value of e^{-L}.

10. 2

11 Find the number of distinct real roots of the equation $54x^4 - 36x^3 + 18x^2 - 6x + 1 = 0$

11. 0

12. Let α, β be real number with $0 \leq \alpha \leq \beta$ and $f\left(x\right) = x^2 - \left(\alpha + \beta\right)x + \alpha\beta$ such that $\int_{-1}^{1} f\left(x\right)dx = 1$. If the maximum value of $\int_0^{\alpha} f\left(x\right)dx$ is $\frac{\sqrt{6}}{\lambda}$ then sum of all digits in λ is

12. 9

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. A polynomial function $P\left(x\right)$ of degree 5 with leasing coefficient one, increases in the interval $\left(-\infty, 1\right)$ and $\left(3, \infty\right)$ and decreases in the interval (1, 3). Given that P (0) = 4 and P'(2) = 0. Find the value $P'\left(6\right)$.

13. 12

14. Let $f\left(x\right)$ be a cubic polynomial which has local maximum at x = –1 and $f'\left(x\right)$ has a local minimum at $x = 1$. If $f\left(-1\right) = 10$ and $f\left(3\right) = -22$, then find the distance between its two horizontal tangents.

14. 32

15. Find the length of the shortest path that begins at the point (2, 5), touches the x – axis and then ends at a point on the circle $x^2 + y^2 + 12x - 20y + 120 = 0$.

15. 13

16. Let f be a twice differentiable function defined in $\left[-3, 3\right]$ such that $f\left(0\right) = -4, f'\left(3\right) = 0, f'\left(-3\right) = 12$ and $f''\left(x\right) \geq -2 \forall\, x \in \left[-3, 3\right]$. If $g\left(x\right) = \int_0^x f\left(t\right)dt$ then find maximum value of $g\left(x\right)$.

16. 48

17. Let $f(x)=\int_{x}^{x+\frac{\pi}{3}}|\sin\theta|d\theta,\ 0\le x\le\pi$. If m and M are minimum and maximum value of $f(x)$ and $m+M=\sqrt{p}-\sqrt{q}$ where $p,q\in N$, then find the value of $(p+q)$.

17. 12

18. If the maximum value of the expression $y=\frac{x^4-x^2}{x^6+2x^3-1}$ for $x>1$, is $\frac{p}{q}$ and it occurs at $x=\frac{a+\sqrt{b}}{c}$ where p and q are in their lowest term and a, b, c are pairwise relatively prime positive numbers, find the value of $(a+b+c+p+q)$.

18. 15

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B