FIITJEE (JEE-Advanced)

BATCHES – XII

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 1 | **QP Code: 100049** | **RIT – 3**

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 **Two Parts**: **Part-A & B** 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 Two Parts.

(i) **Part-A (01-06) –** Contains Six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-A (07-12) –** Contains Six (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 (01-06)** contains Six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimal places** (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 :_____

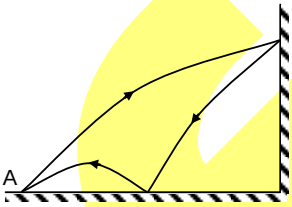
SECTION-1 : PHYSICS

PART – A

(Single Correct Choice Type)

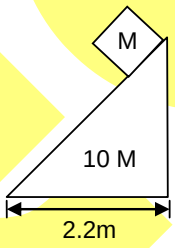
This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. A small ball is projected from point a on the floor towards a vertical wall as shown in the figure. It hits the wall when its velocity is horizontal. Ball reaches point A after one bounce on the floor. If the coefficient of restitution is the same for the collisions, find its value.



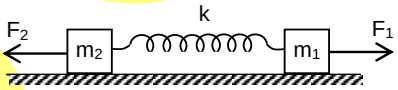
(A) 0.5 (B) 0.25
(C) 0.75 (D) 0.33

2. A block of mass M is placed on the top of a bigger block of mass 10 M as shown in figure. All the surfaces are frictionless. The system is released from rest, then the distance moved by the bigger block at the instant the smaller block reaches the ground:



(A) 0.22m (B) 0.20 m
(C) zero (D) 0.24 m

3. Two blocks of masses m_1 and m_2 are connected with a spring of string constant k. They are kept on a smooth horizontal surface as shown in figure. Initially, the blocks are at rest and the spring is unstretched. If the blocks are pulled by forces F_1 and F_2 as shown in figure, then maximum extension in the spring will be



(A) $\frac{F_1m_1+F_2m_2}{K(m+m_2)}$ (B) $\frac{F_1m_2+F_2m}{K(m+m_2)}$

(C) $2\frac{F_1m_2+F_2m_1}{K(m_1+m_2)}$ (D) $\frac{F_1m_1+F_2m_2}{2K(m_1+m_2)}$

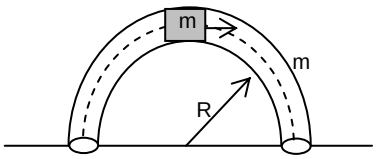
4. If the linear density of the rod of length L varies as $\lambda = A + Bx$, then its centre of mass is given by:

(A) $X_{CM}=\frac{L(2A+BL)}{3(3A+2BL)}$ (B) $X_{CM}=\frac{L(3A+2BL)}{3(2A+BL)}$

(C) $X_{CM}=\frac{L(3A+2BL)}{3}$ (D) $X_{CM}=\frac{L(2A+3BL)}{3}$

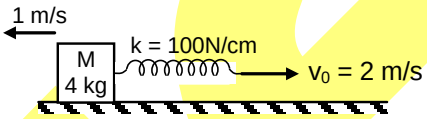
Space For Rough Work

5. In a vertical plane inside a smooth hollow thin tube, a block of same mass as that of tube is released as shown. When it is slightly disturbed it moves towards right. By the time the block reaches the right end of the tube, the displacement of the tube will be (where 'R' is the mean radius of tube the assume that the tube remains in vertical plane) towards left



(A) $\frac{2R}{\pi}$ (B) $\frac{4R}{\pi}$ (C) $\frac{R}{2}$ (D) R

6. The spring block system lies on a smooth horizontal surface. The free end of the spring is being pulled towards right with constant speed v_0 = 2 m/s. At t = 0 sec, the spring of constant k = 100 N/cm is unstretched and the block has a speed 1 m/s to left. The maximum extension of the spring is

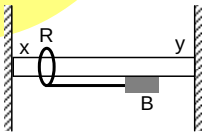


(A) 2 cm (B) 4 cm (C) 6 cm (D) 8 cm

(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.

7. The ring *R* in the arrangement shown can slide along a smooth fixed, horizontal rod XY. It is attached to the block *B* by a light string. The block is released from rest, with the string horizontal. Then:



(A) One point in the string will have only vertical motion
(B) R and B will always have momenta of the same magnitude
(C) When the string becomes vertical, the speeds of *R* and *B* will be inversely proportional to their masses
(D) R will lose contact with the rod at some point

8. Two friends P and Q (each weighing 40 kg) are sitting on a frictionless platform at some distance d apart. P rolls a ball of mass 4 kg towards Q which Q catches. Then, Q rolls the ball towards P and P catches it. The ball keeps on moving back and forth between P and Q. The ball has a fixed speed 5 ms^{-1} on the platform. Choose the correct option(s).

(A) Speed of P after he catches the ball for the first time is $\frac{10}{11}ms^{-1}$

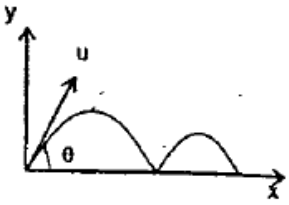
(B) Speed of P after he catches the ball for the first time is $\frac{10}{9}ms^{-1}$

(C) The centre of mass of the system remains stationary irrespective of the direction of motion of the ball.

(D) P can roll the ball only for 6 times.

Space For Rough Work

9. A projectile is fired from a horizontal ground. Coefficient of restitution between projectile and ground is e. Let a, b and c be the ratio of time of flight $\left(\frac{T_1}{T_2}\right)$ maximum height $\left(\frac{H_1}{H_2}\right)$ and horizontal range $\left(\frac{R_1}{R_2}\right)$ in first two collisions with the ground. Then



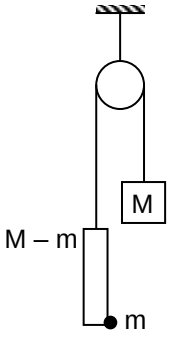
(A) $a = \frac{1}{e}$ (B) $b = \frac{1}{e^2}$

(C) $c = \frac{1}{e^2}$ (D) all of the above

10. Choose the correct statement (s) of the following.
(A) Force acting on a particle for equal time intervals can produce the same change in momentum but different change in kinetic energy.
(B) Force acting on a particle for equal displacements can produce same change in kinetic energy but different change in momentum.
(C) Force acting on particle for equal time intervals can produce different change in momentum but same change in kinetic energy.
(D) Force acting on a particle for equal displacements can produce different change in kinetic energy but same change in momentum.

11. Which one of the following statement are incorrect with reference to elastic collision between two bodies?
(A) momentum and total energy are conserved but kinetic energy may change.
(B) both kinetic energy and total energy are conserved but momentum may change.
(C) both kinetic energy and momentum are conserved but total energy may change.
(D) neither momentum nor kinetic energy are conserved but total energy must be conserved.

12. A rod of mass 'M – m' carries an insect of mass 'm' at its bottom end and its top end is connected with a string which passes over a smooth pulley and the other end of the string is connected to a counter mass M. Initially the insect is at rest. Choose the correct option(s).
(A) As insect starts moving up relative to rod, the acceleration of centre of mass of the system (insect + rod + counter mass) becomes non-zero
(B) As insect starts moving up relative to rod, tension in the string remains constant and is equal to Mg.
(C) As insect starts moving up relative to rod, the tension in the string becomes more than Mg.
(D) Acceleration of centre of mass of the system (insect + rod +counter mass) is zero when insect moves with constant velocity.



Space For Rough Work

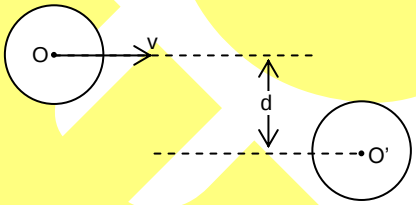
PART – B

(Numerical based)

1. A sphere of mass m collides elastically with another stationary sphere of mass m/2 obliquely. Both the spheres are smooth and there are no external forces acting on them. Maximum angle through which sphere of mass m can be deflected wrt its initial direction of motion is $x\frac{\pi}{9}$.. Value of x is

2. The mass per unit length of a rod varies as $m = \left(\frac{M_0}{L}\right)x$ where M_0 is a constant and x is the distance of any point on rod measured from one end. Centre of mass of the rod from the given end is at a distance KL on the rod. Find the value of K.

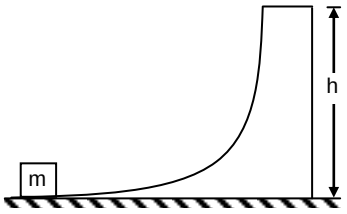
3. A disc of radius r and mass m moving on perfectly smooth surface at a speed v= $\frac{15}{\sqrt{17}}$ m/s undergoes an elastic collision with an identical stationary disc of mass 2 m. The magnitude of velocity (in m/s) of the first disc after the collision will be (given d = $\frac{8r}{5}$)



4. Two blocks of masses m_1 = 2 kg and m_2 = 5 kg are moving in the same direction along a frictionless surface with speeds 10 m/s and 3 m/s respectively, m_2 being ahead of m_1. An ideal spring with k = 1120 N/m is attached to the back side of m_2. The maximum compression of the spring when the blocks collide is n metre

5. A disc of mass 0.1 kg is kept floating horizontally in mid air by firing bullets of mass 0.05 kg each vertically at it, at the rate of 10 per sec. If the bullets rebound with the same speed with which they hit then it (in m/s) is =

6. In situation shown in figure a small body of mass 'm' = 1kg placed over a large mass M = 3 kg, whose surface is horizontal near the smaller mass and gradually curves to become vertical. The smaller mass is pushed on the larger one at a speed u = 10 m/s towards right. Assume that all the surfaces are frictionless. The maximum speed of larger mass in m/s will be



Space For Rough Work

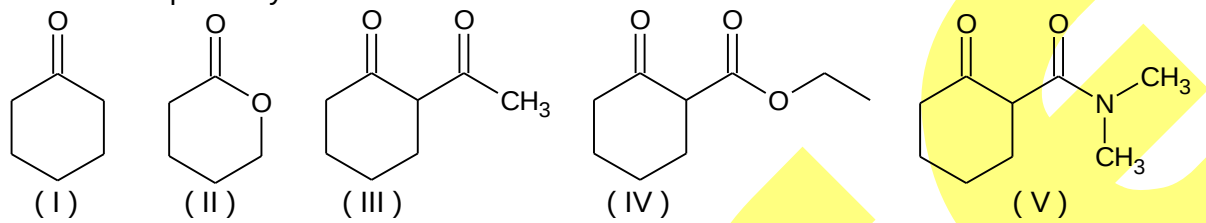
SECTION-2 : CHEMISTRY

PART – A

(Single Correct Choice Type)

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

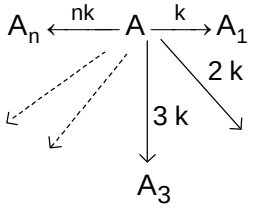
1. Out of the five compounds shown below, the compound which is most acidic and least acidic are respectively.



(I) (II) (III) (IV) (V)

(A) IV and I
(B) III and I
(C) III and II
(D) V and II

2. Mechanism of the reaction is: (all the reactions are of 1st order)



What is the $\dfrac{\dfrac{d[A_1]}{dt}}{\dfrac{-d[A]}{dt}}$ for same time.

(A) n
(B) $\dfrac{1}{n(n+1)}$
(C) $\dfrac{2}{n(n+1)}$
(D) $\dfrac{n}{n(n+1)}$

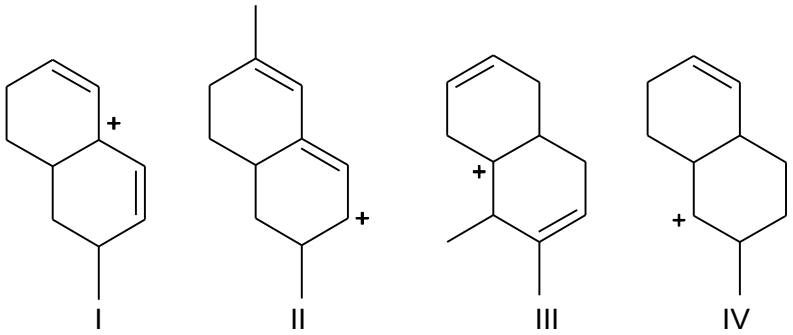
3. $X(g) + Y(g) \longrightarrow$ Product

The rate of above complex reaction increases by four times if the concentration of both X and Y are doubled. What should be the rate equation of the reaction?

(A) Rate = $k[X]^2[Y]^2$
(B) Rate = $[X]^2[Y]^0$
(C) Rate = $k[X]^2[Y]$
(D) Rate = $k[X][Y]^0$

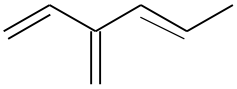
Space For Rough Work

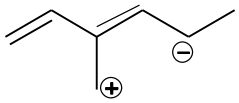
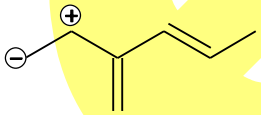
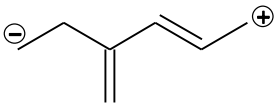
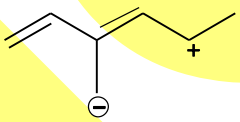
4. Which one is the correct order of increasing order of stability of carbocations shown below?



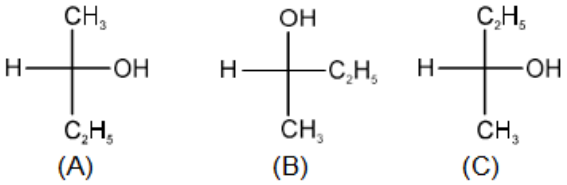
(A) I < II < III < IV
(B) IV < I < III < II
(C) IV < II < I < III
(D) IV < III < I < II

5. Which of the following is not a resonance structure of the following?



(A) 
(B) 
(C) 
(D) 

6. The correct statement/s about compounds A, B and C is/are :



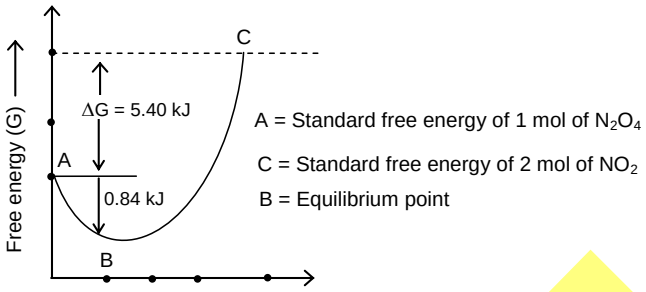
(A) 'A' and 'B' are enantiomers
(B) 'B' and 'C' are diastereomer
(C) 'A' and 'C' are enantiomers
(D) 'A' and 'C' are diastereomers

Space For Rough Work

(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.

7. Following the graph, which of the statement/s is/are correct?



(A) The complete conversion of N_2O_4 into NO_2 $\left(N_2O_4 \longrightarrow 2NO_2\right)$ is spontaneous

(B) At point B, free energy of the system becomes constant with time

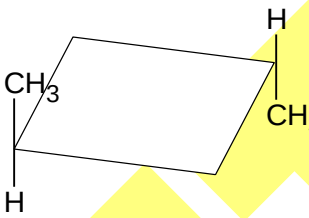
(C) In the region between A and B reaction has tendency to move in forward direction

(D) In the region between B can C, ΔG for the reaction $(N_2O_4 \rightleftharpoons 2NO_2)$ is greater than zero

8. Which of the following is/are true for the first order reaction?

(A) $t_{3/4} = 2t_{1/2}$ (B) $t_{15/16} = 4t_{1/2}$

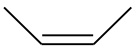
(C) $t_{15/16} = 3t_{3/4}$ (D) $t_{7/8} = 2t_{3/4}$

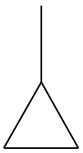
9. In  What elements of symmetry is/are present?

(A) Plane (B) Alternate axis of symmetry

(C) Centre (D) Axis of symmetry

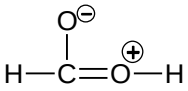
10. Which of the following isomer(s) is/are possible with formula C_4H_8?

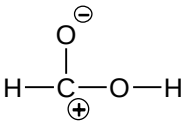
(A)  (B) 

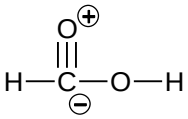
(C)  (D) 

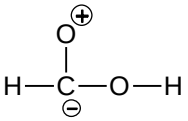
Space For Rough Work

11. Which of the following is/are the resonating structure(s) of formic acid?

(A) 

(B) 

(C) 

(D) 

12. For the consecutive reaction. $A \xrightarrow{k_1(\text{time}^{-1})} B \xrightarrow{k_2(\text{time}^{-1})} C$ following curves were obtained depending upon the relative values of k_1 and k_2.

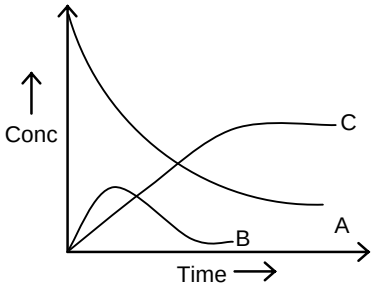


Figure – 1

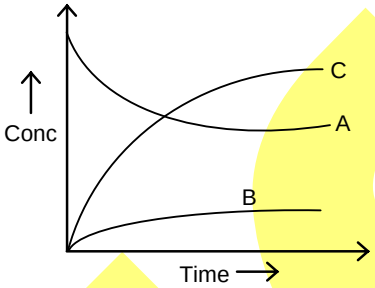


Figure – 2

Now, which of the following is correct match?

(A) Figure 1 – ($k_1 < k_2$)
(B) Figure 2 – ($k_1 < k_2$)
(C) Figure 2 – ($k_1 >> k_2$)
(D) Figure 1 – ($k_1 >> k_2$)

PART – B

(Numerical based)

1. $A \xrightarrow[T_A]{k_A} \text{Product}$, $B \xrightarrow[T_B]{k_B} \text{Product}$

Two reaction with half life periods T_A, T_B (in mins) and $k_A(\text{min}^{-1})$ and $k_B(\text{in mol}^{-1}\ \text{lit.min}^{-1})$. If half life periods are equal at the start of reaction, the reaction rate ratio at the start of reaction would be (assume $[A]_0 = [B]_0$)

2. For a second order reaction
$T_{75\%} = Xt_{50\%}$
Find the value of X

3. CN^-, NO_2, CH_3, Cl, F, NH_2, COOH, CHO, OCH_3, $NHCH_3$ and SO_3H.
How many of the above group(s) and atom(s) exert +R and – I effect when attached to benzene ring?

Space For Rough Work

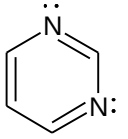
4. For the reaction A $\rightarrow$ Products, the following data is given for a particular reaction.

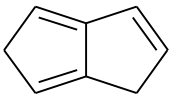
time(min)	0	5	15	35
$\frac{1}{[A]}\left(M^{-1}\right)$	1	2	4	8

Determine the order of reaction.

5. The conjugate base of cyclopent-1, 3-diene is aromatic ion. The negative charge on carbon is delocalized over how many carbon atoms?

6. How many of the following compounds (A through J), which would be considered aromatic by application of Huckel rule?


A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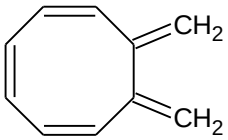
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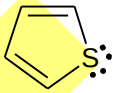
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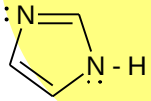
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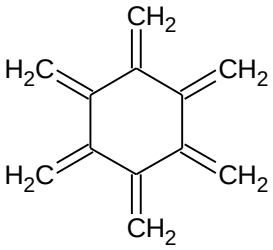
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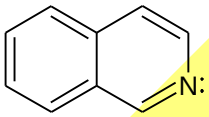
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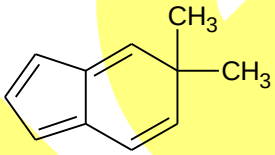
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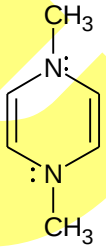
I


J

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Single Correct Choice Type)

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

1. The number of elements in the set $\{x \in R : (|x|-3)|x-4| = 6\}$ is equal to

(A) 3 (B) 4
(C) 2 (D) 1

2. Set of values of 'a' for which the equation $x^3(x+1) = 2(x+a)(x+2a)$ has four real solutions is

(A) $[-1, 2]$ (B) $[-3, 7]$
(C) $[-2, 4]$ (D) $\left[-\frac{1}{8}, \frac{1}{2}\right]$

3. If the equation $ax^2 + bx + c = 0 (a > 0)$ has two roots α and β such that $\alpha < -2$ and $\beta > 2$, then which is **NOT** correct?

(A) $b^2 - 4ac < 0$ (B) $c < 0$
(C) $a + |b| + c < 0$ (D) $4a + 2|b| + c < 0$

4. Let z be a non – real complex number with $z^{23} = 1$. Then $\sum_{k=0}^{22} \frac{3}{1 + z^k + z^{2k}}$ equals

(A) 42 (B) 44
(C) 46 (D) 48

5. For certain real values of a, b, c and d, the equation $x^4 + ax^3 + bx^2 + cx + d = 0$ has four non – real roots. The product of two of these roots is 13 + i and the sum of the other two roots is $3 + 4i$, where $i = \sqrt{-1}$. Then the value of b equals

(A) 69 (B) 54
(C) 51 (D) 46

6. The complete set of real values of 'a' for which the equation $9^x - (4a)3^x + 4 - a^2 = 0$ has a unique root in the interval (0, 1) is

(A) (–12, 0) (B) (0, 11)
(C) $(-11, -1) \cup \left\{\frac{2}{\sqrt{5}}\right\}$ (D) $(-13, -5) \cup \left\{\frac{2}{\sqrt{5}}\right\}$

Space For Rough Work

(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.

7. Let $-\frac{\pi}{6}<\theta<-\frac{\pi}{12}$. Suppose α_1 and β_1 are the roots of the equation $x^2-2x\sec\theta+1=0$ and α_2 and β_2 are the roots of the equation $x^2+2x\tan\theta-1=0$. If $\alpha_1>\beta_1$ and $\alpha_2>\beta_2$, then $\alpha_1+\beta_2$ equals

(A) $2(\sec\theta-\tan\theta)$ (B) $2\sec\theta$

(C) $-2\tan\theta$ (D) $-2\sin\theta\sec\theta$

8. Consider the equation $z^{40}-z^{20}-a(a+1)=0\ (a\in R^+)$. Which of the following are true, where α is a root of the equation?

(A) Number of α's with $\text{Re}(\alpha)<0$ is 20. (B) Number of α's with $\text{Re}(\alpha)>0$ is 19.

(C) Number of α's with $\text{Re}(\alpha)\le 0$ is 21. (D) Number of α's with $\text{Re}(\alpha)\ge 0$ is 20.

9. If $|z|=1$ and 'a' and 'b' respectively are the minimum and maximum values of $|1+z|+|1-z+z^2|$, then

(A) $a=\sqrt{3}$ (B) $a=\sqrt{2}+1$

(C) $b=3$ (D) $b=\frac{13}{4}$

10. If $S_n(x)=\sum_{k=0}^{n}{}^nC_k\sin(kx)\cos((n-k)x)$, then

(A) $S_5\left(\frac{\pi}{2}\right)=16$ (B) $S_7\left(\frac{\pi}{2}\right)=-64$

(C) $S_{100}(\pi)=0$ (D) $S_{101}(\pi)=2^{100}$

11. If $P(z_1), Q(z_2)$ and $R(z_3)$ are three points in the Argand plane such that $|z_1+z_2|=|z_1|-|z_2|$ and $|(1-i)z_1+iz_3|=|z_1|+|z_3-z_1|$, then

(A) $|z_2-z_3|=|z_2+z_3-2z_1|$

(B) P, Q, R are the vertices of a right angled triangle

(C) P, Q, R are the vertices of an equilateral triangle

(D) P, Q, R lie on a circle with radius $\frac{1}{2}|z_3-z_2|$

Space For Rough Work

12. The set of values of real parameter 'm' for which the equation $m\sin^2 x+(m-1)\sin x+(m-2)=0$ has

(A) no real roots is $(-\infty,1)\cup\left(1+\frac{2}{\sqrt{3}},\infty\right)$ (B) 5 roots in $[0,2\pi]$ is $\{2\}$

(C) 4 roots in $[0,2\pi]$ is $(1,2)\cup\left(2,\frac{\sqrt{3}+2}{\sqrt{3}}\right)$ (D) 2 roots in $[0,2\pi]$ is $\left\{-1,1,\frac{\sqrt{3}+2}{\sqrt{3}}\right\}$

PART – B
(Numerical based)

1. Let $z_1=3$ and $z_2=7$ represent two points A and B respectively on complex plane. Let the curve C_1 be the locus of points P(z) satisfying $|z-z_1|^2+|z-z_2|^2=10$ and the curve C_2 be the locus of points P (z) satisfying $|z-z_1|^2+|z-z_2|^2=16$. Least distance between curves C_1 and C_2 is

2. If α,β be real numbers, and
$\left((\cos\alpha+i\sin\alpha)+(\cos\beta+i\sin\beta)\right)^7+\left((\cos\alpha-i\sin\alpha)+(\cos\beta-i\sin\beta)\right)^7$
$=2^m\cos^7\left(\frac{\alpha-\beta}{2}\right)\cos\left(n(\alpha+\beta)\right)$, then $\frac{m+2n}{30}=$

3. Let $A=\{z\,|\,z^{18}=1\}$ and $B=\{\omega\,|\,\omega^{48}=1\}$, Consider the set $C=\{z\omega\,|\,z\in A \text{ and } \omega\in B\}$. If n be the number of distinct elements in C, then $\sqrt{n}-3$ is equal to

4. Let α,β be the roots of the equation $x^2+x-3=0$. The value of $\frac{\alpha^3-4\beta^2+29}{4}$ is equal to

5. Given that a, b are integers and the two real roots α,β of the equation $3x^2+3(a+b)x+4ab=0$ satisfy the relation $\alpha(\alpha+1)+\beta(\beta+1)=(\alpha+1)(\beta+1)$. The number of ordered pairs (a, b) is equal to

6. Consider the polynomials $P(x)=x^6-x^5-x^3-x^2-x$ and $Q(x)=x^4-x^3-x^2-1$. Given that z_1,z_2,z_3 and z_4 are the roots of $Q(x)=0$, then $P(z_1)+P(z_2)+P(z_3)+P(z_4)$ equals

Space For Rough Work

QP Code: 100049

ANSWERS

SECTION-1 : PHYSICS

PART – A

1.	**A**	2.	**B**	3.	**C**	4.	**A**
5.	**C**	6.	**C**	7.	**AC**	8.	**ACD**
9.	**AB**	10.	**AB**	11.	**BCD**	12.	**ACD**

PART – B

1.	**1.50**	2.	**0.66**	3.	**3.00**	4.	**0.25**
5.	**1.00**	6.	**5.00**				

SECTION – 2 : CHEMISTRY

PART – A

1.	C	2.	**C**	3.	B	4.	D
5.	C	6.	C	7.	BCD	8.	AB
9.	ABCD	10.	ABCD	11.	ABCD	12.	BD

PART – B

1.	0.693	2.	3	3.	5	4.	2
5.	5	6.	4				

SECTION – 3 : MATHEMATICS

PART – A

1.	C	2.	D	3.	**A**	4.	C
5.	C	6.	**D**	7.	**CD**	8.	**BC**
9.	**AD**	10.	**ABC**	11.	**ABD**	12.	**ABCD**

PART – B

1.	**1.00**	2.	**0.50**	3.	**9.00**	4.	**2.50**
5.	**4.00**	6.	**6.00**				