

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code: 100981

Common Test – 1

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 option(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: – 1 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 **– 1 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

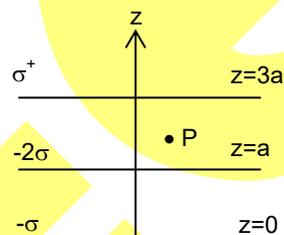
(Single Correct Choice Type)

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 dipole of dipole moment $p\hat{i}$ is placed at $P(1, 0)$ in the field $\vec{E} = 3x^2\hat{i}$. The torque exerted on dipole is
 (A) $\vec{F} = 6p\hat{i}$ (B) $\vec{F} = -6p\hat{i}$
 (C) $U = -3p$ (D) $\vec{\tau} = 0$

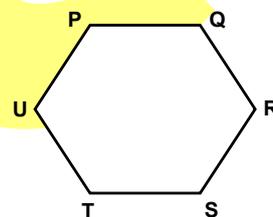
2. Infinite parallel plates are placed in x-y plane at $z = 0$, $z = a$, $z = 3a$. Find the electric field at point P

- (A) $\frac{4\sigma}{\epsilon_0}\hat{k}$ (B) $\frac{-4\sigma}{\epsilon_0}\hat{k}$
 (C) $\frac{-2\sigma}{\epsilon_0}\hat{k}$ (D) $\frac{2\sigma}{\epsilon_0}\hat{k}$



3. Three negative and three positive charges of equal magnitude are kept at vertices PQRSTU of a regular hexagon. Find the possible arrangement of charges so that the electric field at O is twice the electric field when only one positive charge is kept at R

- (A) + + + - - - (B) + - + - + - +
 (C) - + - - + + (D) - + + - + -



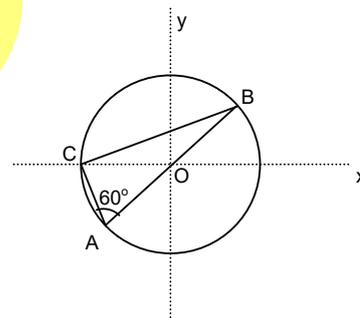
4. Consider a system of three charges $\frac{q}{3}$, $\frac{q}{3}$ and $-\frac{2q}{3}$ placed at points A, B and C, respectively, as shown in the figure. Take O to be the centre of the circle of radius R and angle CAB = 60°

- (A) the electric field at point O is $\frac{q}{8\pi\epsilon_0 R^2}$ directed along the negative x-axis

- (B) the potential energy of the system is zero

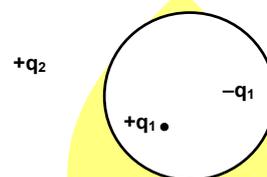
- (C) the magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\epsilon_0 R^2}$

- (D) the potential at point O is $\frac{q}{12\pi\epsilon_0 R}$



Space For Rough Work

5. A positively charged particle is released from rest in an uniform electric field. The electric potential energy of the charge
 (A) remains a constant because the electric field is uniform.
 (B) increases because the charge moves along the electric field.
 (C) decreases because the charge moves along the electric field.
 (D) decreases because the charge moves opposite to the electric field.
6. The value of electric field on the Gaussian surface as shown in the figure is
 (A) zero
 (B) due to q_2 only
 (C) due to all charge
 (D) due to q_1 and q_2

**(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. Choose the correct statements from the following:
 (A) if the electric field is zero at a point, the electric potential must also be zero at that point.
 (B) if electric potential is constant in a given region of space, the electric field must be zero in that region.
 (C) two different equipotential surfaces can never intersect.
 (D) electrons move from a region of lower potential to a region of higher potential.
8. A parallel plate capacitor is charged and the charging battery is then disconnected. If the plates of the capacitor are moved further apart by means of insulating handles:
 (A) The charge on the capacitor increases.
 (B) The voltage across the plate increases.
 (C) The capacitance increases.
 (D) The electrostatic energy stored in the capacitor increases.
9. Two capacitors of capacitance $3 \mu\text{F}$ and $6 \mu\text{F}$ are charged to a potential of 12 V each. They are now connected to each other, with the positive plate of one to the negative plate of the other. Then
 (A) the potential difference across $3 \mu\text{F}$ is zero
 (B) the potential difference across $3 \mu\text{F}$ is 4 V
 (C) the charge on $3 \mu\text{F}$ is zero
 (D) the charge on $3 \mu\text{F}$ is $12 \mu\text{C}$

Space For Rough Work

10. A ring with a uniform charge distribution with a total charge Q and radius R is placed in the yz plane with its centre at the origin then which of the following is/are correct about this situation:

(A) The field at the origin is zero.

(B) The potential at the origin is $\frac{1}{4\pi\epsilon_0} \frac{Q}{R}$

(C) The field at the point $(x, 0, 0)$ is $\frac{1}{4\pi\epsilon_0} \frac{Q}{x^2}$

(D) The field at the point $(x, 0, 0)$ is $\frac{1}{4\pi\epsilon_0} \frac{Q}{R^2 + x^2}$

11. A large insulating thick sheet of thickness $2d$ is charged with a uniform volume charge density ρ . A particle of mass m , carrying a charge q having a sign opposite to that of the sheet, is released from the surface of the sheet. The sheet does not offer any mechanical resistance to the motion of the particle. Find the oscillation frequency ν of the particle inside the sheet:

(A) $\nu = \frac{1}{2\pi} \sqrt{\frac{q\rho}{m\epsilon_0}}$

(B) $\nu = \frac{1}{2\pi} \sqrt{\frac{2q\rho}{m\epsilon_0}}$

(C) $\nu = \frac{1}{4\pi} \sqrt{\frac{q\rho}{m\epsilon_0}}$

(D) $\nu = \frac{1}{3\pi} \sqrt{\frac{q\rho}{m\epsilon_0}}$

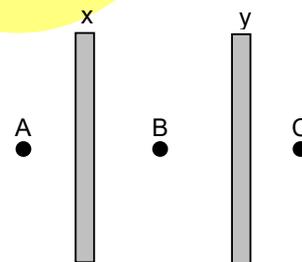
12. X and Y are large, parallel conducting plates close to each other. Each face has an area A . Plate X is given a charge Q . Y is without any charge. Points A, B and C are as shown in the given figure. Which of the following statement about electric field is correct:

(A) The field at B is $\frac{Q}{2\epsilon_0 A}$

(B) The field at B is $\frac{Q}{\epsilon_0 A}$

(C) The field at A, B and C are of the same magnitude.

(D) The fields at A and C are of the same magnitude, but in opposite directions.



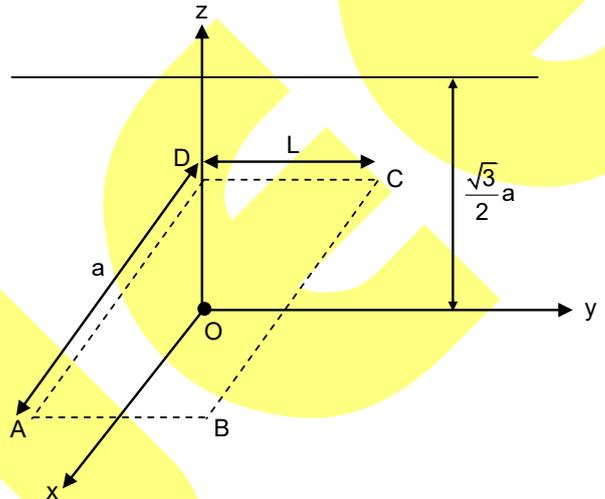
PART – B (Numerical Type)

1. Two equal positive point charges are separated by a distance $2a$. The distance of a point from the centre of the line joining two charges on the equatorial line (perpendicular bisector) at which force experienced by a test charge q_0 becomes maximum is $\frac{a}{\sqrt{x}}$. The value of x is _____.

Space For Rough Work

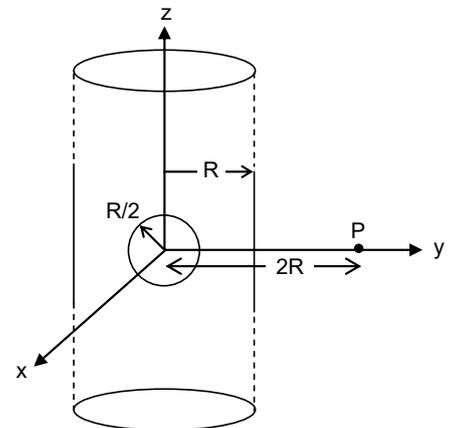
2. A stream of a positively charged particles having $\frac{q}{m} = 2 \times 10^{11} \frac{C}{kg}$ and velocity $\vec{v}_0 = 3 \times 10^7 \hat{i} \text{ m/s}$ is deflected by an electrons field $1.8 \hat{j} \text{ k V/m}$. The electric field exists in a region of 10 cm along x direction. Due to the electric field, the deflection of the charge particles in the y direction is _____ mm.
3. A particle, of mass 10^{-3} kg and charge 1.0 initially at rest. At time $t = 0$, the particle comes under the influence of an electric field $\vec{E}(t) = E_0 \sin \omega t \hat{i}$, where $E_0 = 1.0 \text{ NC}^{-1}$ and $\omega = 10^3 \text{ rad s}^{-1}$. Consider the effect of only the electrical force on the particle. Then the maximum speed, in ms^{-1} , attained by the particle at subsequent times is _____.

4. An infinitely long uniform line charge distribution of charge per unit length λ lies parallel to the y-axis in y-z plane at $z = \frac{\sqrt{3}}{2} a$ (see figure). If the magnitude of the flux of the electric field through the rectangular surface ABCD lying in the x-y plane with its center at the origin is $\frac{\lambda L}{n \epsilon_0}$ ($\epsilon_0 =$ permittivity of free space), then the value of 'n' is



5. A solid sphere of radius R has a charge Q distributed in its volume with a charge density $\rho = kr^a$, where k and a are constants and r is the distance from its centre. If the electric field at $r = R/2$ is $1/8$ times that at $r = R$, find the value 'a'.

6. An infinitely long cylinder of radius R has a uniform volume charge density ρ . It has a spherical cavity of radius $R/2$ with its centre on the axis of the cylinder, as shown in the figure. The magnitude of the electric field at the point P, which is at a distance $2R$ from the axis of the cylinder, is given by the expression $\frac{23\rho R}{16k\epsilon_0}$. The value of 'k' is



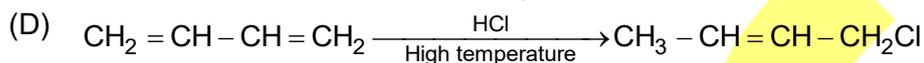
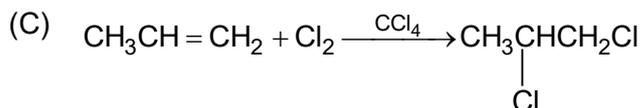
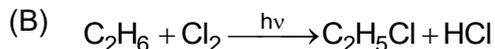
Space For Rough Work

SECTION-2 : CHEMISTRY**PART – A**

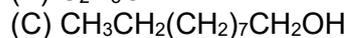
(Single Correct Choice Type)

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

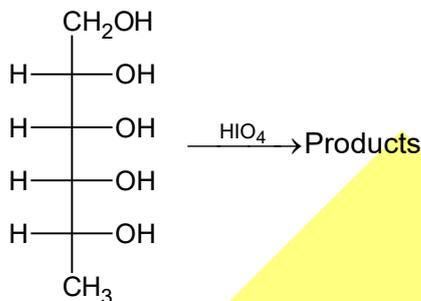
1. Which reaction produces an alkyl chloride by substitution reaction?



2. Which alcohol is most soluble in water?



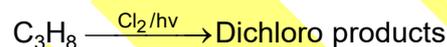
3.



In above reaction the following product is formed?



4.



How many dichloro products including stereoisomers are formed in above reaction?

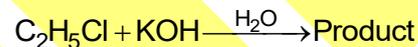
(A) 3

(B) 4

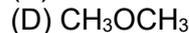
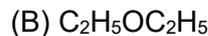
(C) 5

(D) 2

5.



Which organic compound is formed in above reaction?

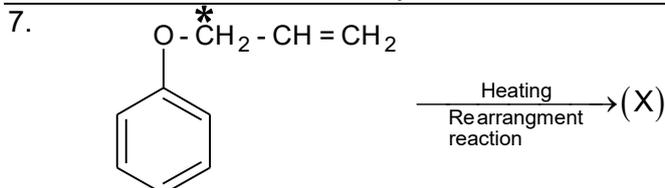


Space For Rough Work

6. Which of the following compound upon dehydration in presence of hot conc. H_2SO_4 forms $\text{CH}_3\text{CH}=\text{CH}_2$?
- (A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ (B) $\text{CH}_3\underset{\text{Cl}}{\text{CH}}\text{CH}_3$
- (C) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (D) $\text{CH}_3\text{OCH}_2\text{CH}_3$

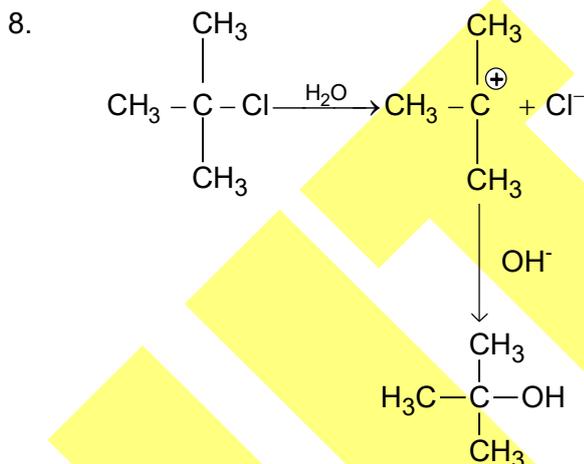
(Multi Correct Choice Type)

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.



The correct statement(s) regarding the characteristic(s) of (X) is/are

- (A) it contains more acidic hydrogen atom than the reactant
 (B) it undergoes electrophilic substitution as well as electrophilic addition of Br_2 in presence of CS_2
 (C) when treated with HCl it forms a product in which chlorine is attached to the benzylic carbon atom.
 (D) reaction of the compound with $\text{NBS}/h\nu$ too form a products in which bromine is attached to the benzylic carbon atom.

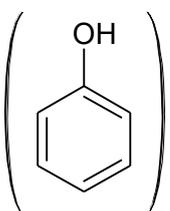


A nucleophilic substitution reaction is given above. It is called $\text{S}_{\text{N}}1$ reaction. Which is/are the characteristic(s) of the reaction?

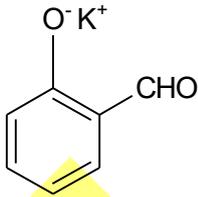
- (A) It proceeds in two steps.
 (B) A reaction intermediate(carbocation) is formed in the reaction.
 (C) The rate determining step is formation of carbocation.
 (D) The rate determining step is combination of carbocation and the nucleophile(OH^-)

Space For Rough Work

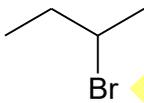
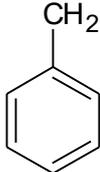
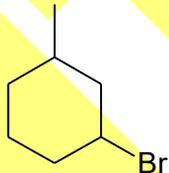
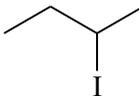
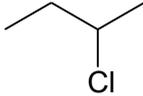
9. Alcohols undergo dehydrogenation reactions when they are passed over copper metal at 300°C . Choose the correct statement(s) from the following.
- (A) $\text{CH}_3\text{CH}_2\text{OH}$ will produce CH_3CHO in the reaction.
 (B) 2° -alcohols form ketones in the reaction.
 (C) inspite of the presence of OH group, phenols do not undergo this reaction.
 (D) tertiary(3°) alcohol do not form any product in the reaction.

10. The characteristic(s) of phenol  is/are

- (A) it is more acidic than CH_3OH
 (B) it produces salt with NaOH

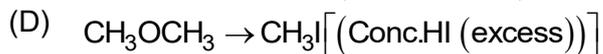
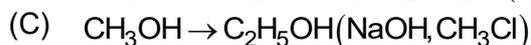
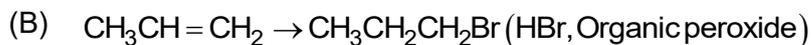
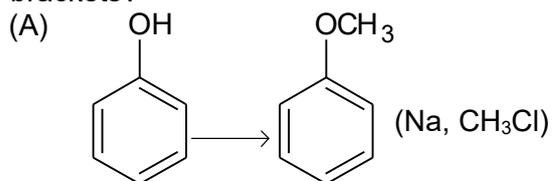
- (C) it reacts with CHCl_3/KOH forming  and  in absence of acid
- (D) it reacts with $\text{Br}_2/\text{H}_2\text{O}$ forming 2, 4, 6-tribromophenol

11. In which option(s) the left side compound undergo(es) faster unimolecular nucleophilic substitution reaction($\text{S}_{\text{N}}1$) than the right side compound.

- (A)  ,  (B)  , 
- (C)  ,  (D)  , 

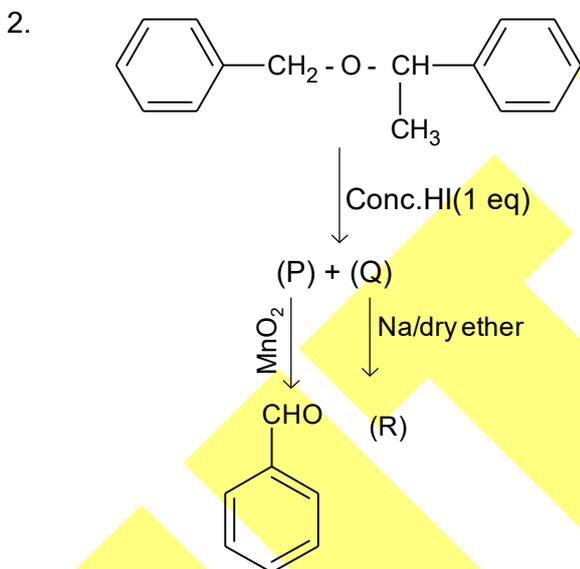
Space For Rough Work

12. In which option(s), the given reaction(s) can be carried out by using the chemicals given in brackets?



PART – B (Numerical Type)

1. An alkyl chloride (X) forms an alcohol (Y) upon treatment with aqueous solution of KOH. (Y) upon mild oxidation with PCC produces HCHO. What is the molar mass of (X) in g mol^{-1} unit?



If x = Number of sp^2 -carbon atoms present in (R)

y = Number of π -bonds in (R)

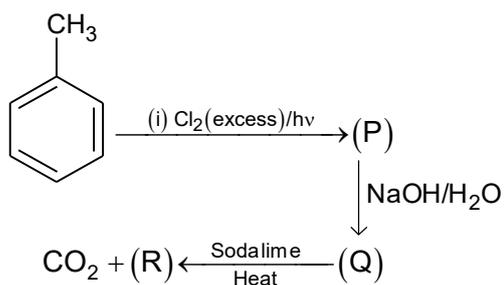
and z = Number of oxygen atoms in (P)

What is the value of $\frac{x+y+z}{10}$?

Space For Rough Work

3. Phenol undergoes reduction when treated with Zn dust. The product is a hydrocarbon. If the number of C – H bonds present in the hydrocarbon is x, what is the value of $\frac{x}{4}$?

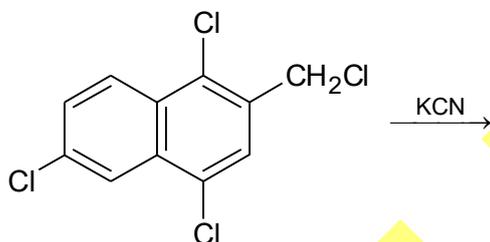
4.



If x = Number of Cl atoms present in (P)
 y = The number of oxygen atoms present in (Q)
 and z = the number of pi-electrons present in (R)

What is the value of $\left(\frac{x + y + 2z}{10}\right)$?

5.



If the percentage of **chlorine atoms** out of the **total number of chlorine atoms** present in above reactant undergo S_N (Nucleophilic substitution) reaction is x%, what is the value of $\frac{x}{20}$?

6. $\text{CH}_3\text{CH}_2\text{Br}$, CH_3Br , CH_3I , $\text{CH}_3\text{CH}_2\text{I}$, CH_3Cl , CH_3OH , $\text{C}_2\text{H}_5\text{OH}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$, $\text{CH}_3\text{CH}(\text{Cl})\text{CH}_3$
 If the number of compounds in above list which is/are more reactive than $\text{C}_2\text{H}_5\text{Cl}$ towards S_N2 reaction with a common nucleophile is x, what is $\frac{x}{2}$?

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. If $R = \{(x, y) : x, y \in \mathbb{Z}, x^2 + 3y^2 \leq 8\}$ is a relation on the set of integers \mathbb{Z} , then the domain R^{-1} is:
 (A) $\{-2, -1, 0, 1, 2\}$ (B) $\{-2, -1, 1, 2\}$
 (C) $\{-1, 0, 1\}$ (D) $\{0, 1\}$
2. If $2f(x^2) + 3f(1/x^2) = x^2 - 1$ ($x \neq 0$) then $f(x^2)$ is:
 (A) $\frac{1-x^4}{5x^2}$ (B) $\frac{1-x^2}{5x}$
 (C) $\frac{5x^2}{1-x^4}$ (D) $-\frac{2x^4 + x^2 - 3}{5x^2}$
3. Consider the two sets:
 $A = \{m \in \mathbb{R} : \text{both the roots of } x^2 - (m+1)x + m + 4 = 0 \text{ are real}\}$ and $B = [-3, 5]$.
 Which of the following is not true?
 (A) $A \cap B = \{-3\}$ (B) $B - A = (-3, 5)$
 (C) $A - B = (-\infty, -3) \cup (5, \infty)$ (D) $A \cup B = \mathbb{R}$
4. Let $[t]$ denote the greatest integer $\leq t$. If for some $\lambda \in \mathbb{R} - \{0, 1\}$, $\lim_{x \rightarrow 0} \frac{1-x+|x|}{\lambda-x+[x]} = L$, then L is equal to:
 (A) 0 (B) 1
 (C) $\frac{1}{2}$ (D) 2
5. Let $g(x) = |4x^3 - x| \cos(\pi x)$ then number of points where $g(x)$ is non-differentiable in $(-\infty, \infty)$, is equal to
 (A) 1 (B) 2
 (C) 3 (D) 4
6. Let $[t]$ denote the greatest integer $\leq t$. Then the equation in x , $[x]^2 + 2[x + 2] - 7 = 0$ has:
 (A) infinitely many solutions (B) exactly two solutions
 (C) no integral solution (D) exactly four integral solutions

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. The $\lim_{x \rightarrow 0} x^8 \left[\frac{1}{x^3} \right]$ (where $[x]$ is greatest integer function) is
 (A) a nonzero real number (B) a rational number
 (C) an integer (D) zero
8. If the function $f(x) = ax + b$ is its own inverse then the ordered pair (a, b) can be
 (A) $(1, 0)$ (B) $(-1, 0)$
 (C) $(-1, 1)$ (D) $(1, 1)$
9. If $f(x) = \sin \left\{ [x+5] + \{x - \{x - \{x\}\}\} \right\}$ for $x \in \left(0, \frac{\pi}{4} \right)$ is invertible, where $\{.\}$ and $[.]$ represent fraction part and greatest integer functions respectively, then $f^{-1}(x)$ is
 (A) $\sin^{-1} x$ (B) $\frac{\pi}{2} - \cos^{-1} x$
 (C) $\sin^{-1} \{x\}$ (D) $\cos^{-1} \{x\}$
10. Let $A = \mathbb{R} - \{3\}, B = \mathbb{R} - \{1\}$. Let $f : A \rightarrow B$ be defined by $f(x) = \frac{x-2}{x-3}$. Then
 (A) f is bijective (B) f is one - one
 (C) f is onto (D) one - to - one but not onto
11. If $f(x) = x \frac{e^{[x]+|x|} - 2}{[x] + |x|}$ then (where $[.]$ is G.I.F)
 (A) $\lim_{x \rightarrow 0^+} f(x) = -1$ (B) $\lim_{x \rightarrow 0^-} f(x) = 0$
 (C) $\lim_{x \rightarrow 0^+} f(x)$ does not exist (D) $\lim_{x \rightarrow 0} f(x)$ does not exist
12. $f(x) = x^2 - 2ax + a(a+1), f : [a, \infty) \rightarrow (a, \infty)$ If one of the solutions of the equation $f(x) = f^{-1}(x)$ is 5049, then the other may be
 (A) 5051 (B) 5048
 (C) 5052 (D) 5050

Space For Rough Work

PART – B
(Numerical Type)

1. Let $f(x) = \frac{x - [x]}{1 + x - [x]}$, $x \in \mathbb{R}$, then the range of f is $\left[0, \frac{1}{k}\right]$ where k is (where $[x]$ is greatest integer function)
2. Let $f(x) = \begin{cases} e^{-\frac{1}{x^2}} \sin \frac{1}{x} & x \neq 0 \\ 0 & x = 0 \end{cases}$, then $f'(0) =$
3. If $\lim_{x \rightarrow 1} \frac{x + x^2 + x^3 + \dots + x^n - n}{x - 1} = 820$, ($n \in \mathbb{N}$) then the value of n is equal to _____
4. If $g(x) = x^2 + \frac{1}{x^2}$ and $f(g(x)) = x^6 + \frac{1}{x^6}$ then $f'(2) =$ _____
5. Suppose a differentiable function $f(x)$ satisfies the identity $f(x + y) = f(x) + f(y) + xy^2 + x^2y$, for all real x and y . If $\lim_{x \rightarrow 0} \frac{f(x)}{x} = 1$ then $f'(3)$ is equal to _____.
6. Find the number of point of discontinuity of $f(x) = [5x] + \{3x\}$ in $[0, 5]$ where $[y]$ and $\{y\}$ denotes G.I.F and fractional parts of y .

Space For Rough Work

QP Code: 100981

ANSWERS

SECTION-1 : PHYSICS

PART – A

- | | | | |
|-------|--------|--------|---------|
| 1. D | 2. C | 3. D | 4. C |
| 5. C | 6. C | 7. BCD | 8. BD |
| 9. BD | 10. AB | 11. A | 12. ACD |

PART – B

- | | | | |
|------|------|------|------|
| 1. 2 | 2. 2 | 3. 2 | 4. 6 |
| 5. 2 | 6. 6 | | |

SECTION – 2 : CHEMISTRY

PART – A

- | | | | |
|--------|----------|---------|---------|
| 1. B | 2. A | 3. C | 4. C |
| 5. C | 6. C | 7. ABCD | 8. ABC |
| 9. ABC | 10. ABCD | 11. ACD | 12. ABD |

PART – B

- | | | | |
|---------|--------|--------|--------|
| 1. 50.5 | 2. 1.9 | 3. 1.5 | 4. 1.7 |
| 5. 1.25 | 6. 2.5 | | |

SECTION – 3 : MATHEMATICS

PART – A

- | | | | |
|--------|---------|---------|--------|
| 1. C | 2. D | 3. C | 4. D |
| 5. A | 6. A | 7. BCD | 8. ABC |
| 9. ABC | 10. ABC | 11. ABD | 12. BD |

PART – B

- | | | | |
|-------|-------|-------|------|
| 1. 2 | 2. 0 | 3. 40 | 4. 9 |
| 5. 10 | 6. 30 | | |