

## PHYSICS, CHEMISTRY & MATHEMATICS

Pattern - 1

QP Code:

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 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 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 (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 : \_\_\_\_\_

BATCHES – All 2022 batches (A – lot)

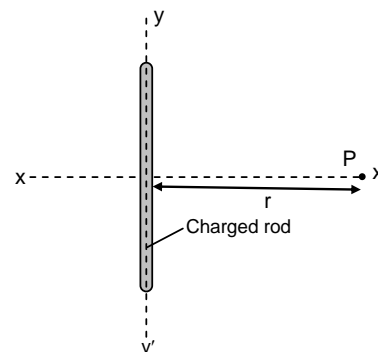
## **SECTION-1 : PHYSICS**

### **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**.

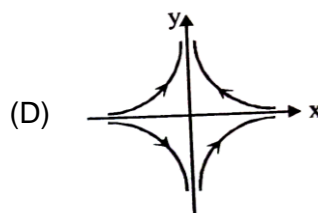
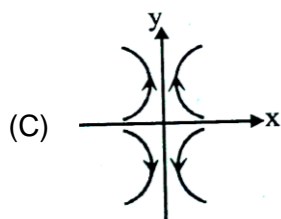
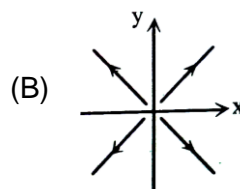
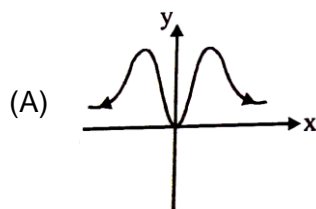
1. A uniformly charged rod is kept on y-axis with centre at origin, as shown. Which of the following actions will increase the electric field strength at the position P?
- (A) make the rod longer without changing the charge.  
 (B) make the rod shorter without changing the charge.  
 (C) make the rod shorter without changing the linear charge density.  
 (D) rotate the rod about yy'



1. **B**
2. 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.

2. **C**

3. In a certain region of space. The potential field depends on x and y coordinates as  $V = (x^2 - y^2)$ . The corresponding electric field lines x-y plane are correctly represented by

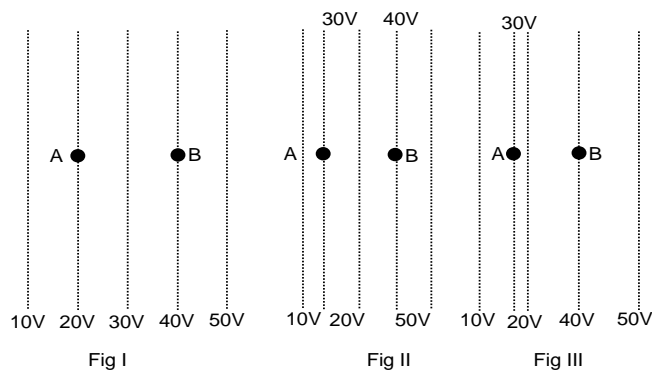


3. **D**

4. An electron moves with a velocity  $\vec{u}$  in an uniform electric field  $\vec{E}$ . If angle between  $\vec{u}$  and  $\vec{E}$  is neither 0 nor  $\pi$ , the path followed by electron is
- (A) straight line (B) circle  
 (C) ellipse (D) parabola

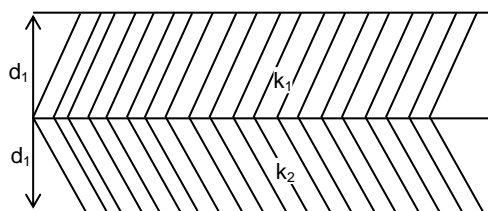
4. **D**

5. Figure shows some equipotential lines distributed in space. A charged object is moved from point A to point B.



- (A) The work done in figure (i) is the greatest.  
 (B) The work done in figure (ii) is least.  
 (C) The work done is the same in figure (i), fig (ii) and fig (iii).  
 (D) The work done in fig (iii) is greater than fig (ii) but equal to that in fig (i).
5. **C**

6. A parallel plate capacitor is made of two dielectric blocks in series. One of the blocks has thickness  $d_1$  and dielectric constant  $k_1$  and the other has thickness  $d_2$  and electric constant  $k_2$  as shown in figure. This arrangement can be thought as a dielectric slab of thickness  $d(= d_1 + d_2)$  and effective dielectric constant  $k$ . The  $k$  is



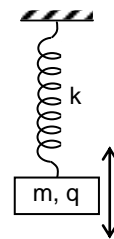
- (A)  $\frac{k_1 k_2 (d_1 + d_2)}{(k_1 d_2 + k_2 d_1)}$  (B)  $\frac{k_1 d_1 + k_2 d_2}{k_1 + k_2}$   
 (C)  $\frac{k_1 k_2 (d_1 + d_2)}{(k_1 d_1 + k_2 d_2)}$  (D)  $\frac{2k_1 k_2}{k_1 + k_2}$
6. **A**

### (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.

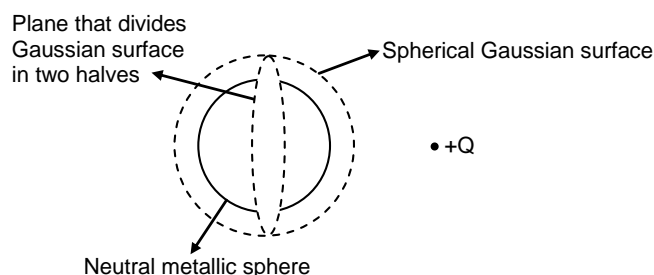
7. The electric field at a point is  
 (A) always continuous  
 (B) continuous if there is no charge at that point  
 (C) discontinuous only if there is a negative charge at that point  
 (D) discontinuous if there is a charge at that point
7. **BD**
8. If there were only one type of charge in the universe, then  
 (A)  $\oint_S \mathbf{E} \cdot d\mathbf{S} \neq 0$  on any surface  
 (B)  $\oint_S \mathbf{E} \cdot d\mathbf{S} = 0$  if the charge is outside the surface  
 (C)  $\oint_S \mathbf{E} \cdot d\mathbf{S}$  could not be defined  
 (D)  $\oint_S \mathbf{E} \cdot d\mathbf{S} = \frac{q}{\epsilon_0}$  if charges of magnitude  $q$  were inside the surface
8. **BD**

9. The following figure shows a block of mass  $m$  suspended from a fixed point by means of a vertical spring. The block is oscillating simple harmonically and carries a charge  $q$ . There also exists a uniform electric field in the region. Consider four different cases. The electric field is zero, in case-1,  $\frac{mg}{q}$  downward in case-2,  $\frac{mg}{q}$  upward in case-3 and  $\frac{2mg}{q}$  downward in case-4. The speed at mean position is same in all cases. Select the correct alternative(s).



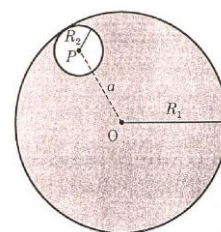
- (A) Time periods of oscillation are equal in case-1 and case-3.  
 (B) Amplitudes of displacement are same in case-2 and case-3.  
 (C) The maximum elongation (increment in length from natural length) is maximum in case-4.  
 (D) Time periods of oscillation are equal in case-2 and case-4.
9. **ABCD**

10. Figure shows a neutral metallic sphere with a point charge  $+Q$  placed near its surface. Electrostatic equilibrium conditions exist on metallic sphere. Mark the correct statements:



- (A) Net flux through Gaussian surface due to charge  $Q$  is zero.  
 (B) Net flux through Gaussian surface due to charges appearing on the outer surface of metallic sphere must be zero.  
 (C) If point charge  $Q$  is displaced towards metallic sphere, magnitude of net flux through right hemispherical closed Gaussian surface increases.  
 (D) Same reason as (C) and hence charge distribution on outer surface of sphere will change.
10. **ABCD**

11. Consider a uniform spherical charge distribution of radius  $R_1$  centered at the origin  $O$ . In this distribution, a spherical cavity of radius  $R_2$ , centered at  $P$  with distance  $OP = a = R_1 - R_2$  (see figure) is made. If the electric field inside the cavity at position  $\vec{r}$  is  $\vec{E}(\vec{r})$ , then the correct statement(s) is (are)



- (A)  $\vec{E}$  is uniform, its magnitude is independent of  $R_2$  but its direction depends on  $\vec{r}$   
 (B)  $\vec{E}$  is uniform, its magnitude depends on  $R_2$  and its direction depends on  $\vec{r}$   
 (C)  $\vec{E}$  is uniform, its magnitude is independent of  $a$  but its direction depends on  $\vec{a}$   
 (D)  $\vec{E}$  is uniform and both its magnitude and direction depend on  $\vec{a}$
11. **D**

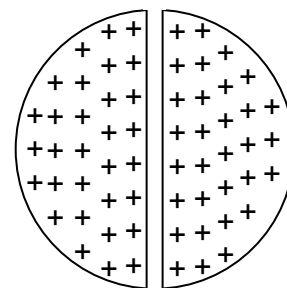
12. A dielectric slab of thickness  $d$  is inserted in a parallel plate capacitor whose negative plate is at  $x = 0$  and positive plate is at  $x = 3d$ . The slab is equidistant from the plates, the capacitor is given some charge. As  $x$  goes from 0 to  $3d$ .
- (A) the magnitude of electric field remains same.  
 (B) the direction of electric field remains same.  
 (C) the electric potential increases continuously.  
 (D) the initial potential as increases at first, then decreases and again increases.
12. **BC**

### PART – B (Numerical based)

1. The electric potential varies in space according to the relation  $V = 3x + 4y$ . A particle of mass 10 kg starts from rest from point  $(2, 3.2)$  m under the influence of this field. The velocity of the particle when it crosses the  $x$  axis is  $(N \times 10^{-3})$  m/s. Find  $N$ . Given that the charge on the particle is  $+1 \mu\text{C}$ . Assume  $v(x, y)$  are in SI units.

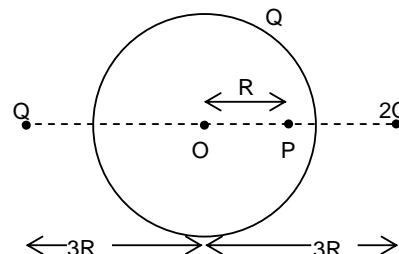
1. **2**

2. A particle of mass 2 kg and negatively charged is released from very large distance along the tunnel diametrically of uniformly positively charged spherical distribution as shown in figure. The speed at mouth of tunnel is 2 m/s. Then find KE in Joule at centre. (Assume gravity free space)



2. **6**

3. A solid conducting sphere of radius  $2R$ , carrying charge  $Q$  is surrounded by two point charges  $Q$  and  $2Q$  as shown in the figure. If the electric field at point  $P$  due to the induced charges on the conducting sphere is  $n \frac{KQ}{R^2}$ ,  $n =$

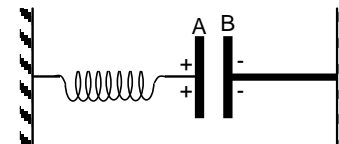


3. **0.44 (Range: 0.41 to 0.45)**

4. The field potential in a certain region of space depends only on the  $x$ -coordinate as  $\phi = -ax^3 + b$  where  $a$  and  $b$  are constants. If the distribution of space charge is  $\rho(x) = 4n\epsilon_0 ax$ . (Charge per unit volume). Find the value 'n'.

4. **1.50**

5. Plate A of a parallel plate air filled capacitor is connected to a spring having force constant  $k$  and plate B is fixed. They rest on a frictionless table top as shown in the figure. If a charge  $+q$  is placed on plate A and a charge  $-q$  on plate B, by how much does the spring expand in equilibrium ( $q^2 = 6kA\epsilon_0$ ).



5. **3**

6. An electric field given by  $\vec{E} = 4\hat{i} - 3(y^2 + 2)\hat{j}$  pierces Gaussian cube of side  $1\text{ m}$  placed at origin such that its three sides represent  $x$ ,  $y$  and  $z$  axes. The net charge enclosed within the cube is  $n\epsilon_0$ , the value of 'n' is

6. **3**

## **SECTION-2 : CHEMISTRY**

### **PART – A**

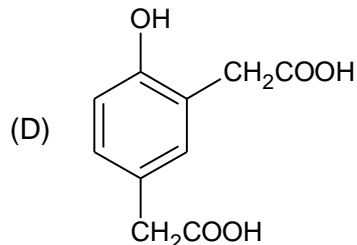
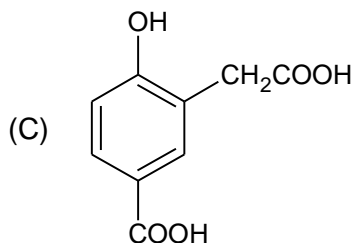
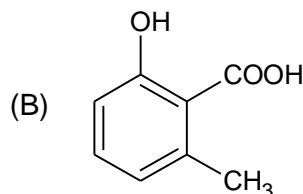
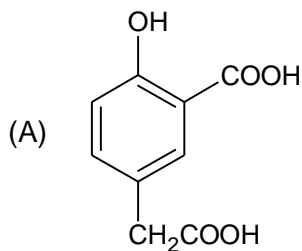
#### **(Single Correct Choice Type)**

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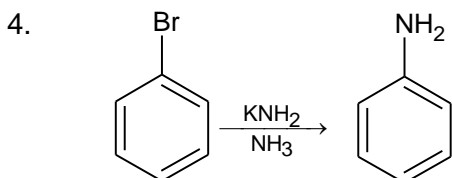
1. Which reacts with aqueous KOH at fastest rate?  
 (A)  $\text{CH}_3\text{F}$  (B)  $\text{CH}_3\text{Cl}$   
 (C)  $\text{CH}_3\text{Br}$  (D)  $\text{CH}_3\text{I}$
1. D
2. Reaction of monohydric alcohols with which substance does involve O – H bond cleavage?  
 (A)  $\text{SOCl}_2$  (B) Conc.  $\text{H}_2\text{SO}_4$   
 (C) Na (D)  $\text{PCl}_3$

2. C

3. Which compound does form ortho methyl phenol(o-cresol) when heated with sodalime followed by acidification?



3. C

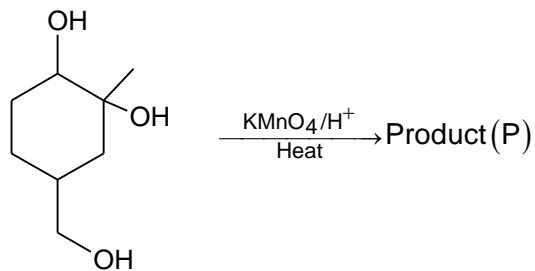


How many moles of  $\text{KNH}_2$  is needed to form 1 mole of aniline from one mole of bromobenzene?

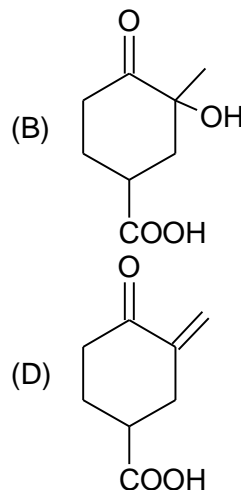
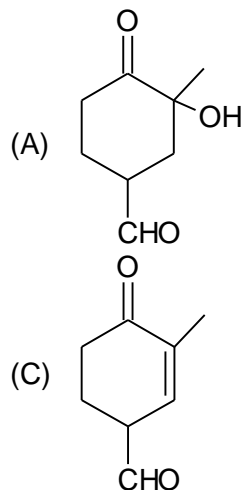
- (A) 2 (B) 1  
 (C) 3 (D) 4

4. A

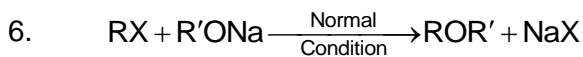
5.



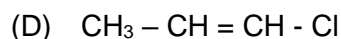
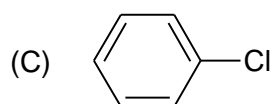
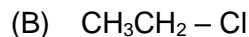
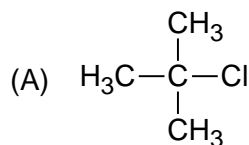
In above reaction (P) is



5. B



In above Williamson's reaction RX may be

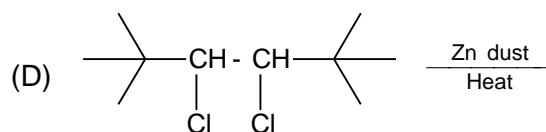
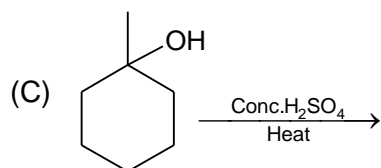
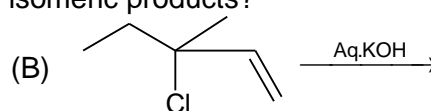
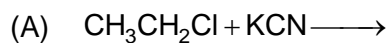


6. B

**(Multi Correct Choice Type)**

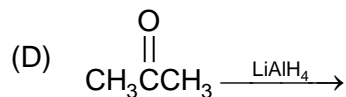
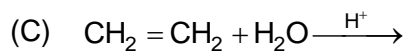
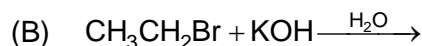
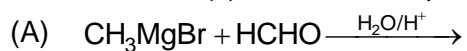
This section contains 6 **multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

7. Which of the following reaction produces two isomeric products?



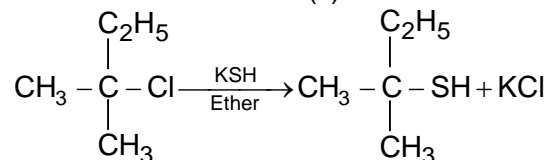
7. ABCD

8. Which reaction(s) do/does form primary alcohols?



8. ABC

9. What is/are the feature(s) of this reaction?



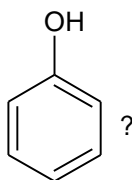
(A) It is a nucleophilic substitution reaction which proceeds through  $\text{S}_{\text{N}}1$  path.

(B) The reaction intermediate is a carbonium ion which can form eight hyperconjugation structures.

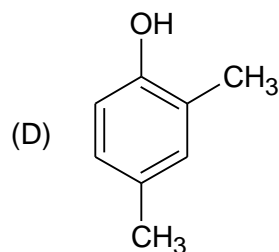
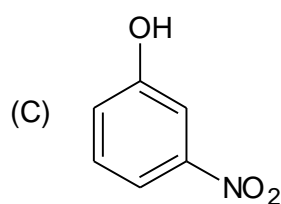
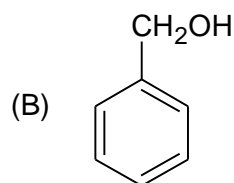
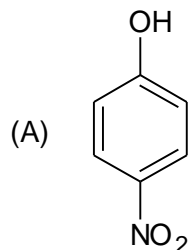
(C) Racemization takes place in the reaction.

(D) The nucleophile is  $\text{HS}^-$ .

9. ABD



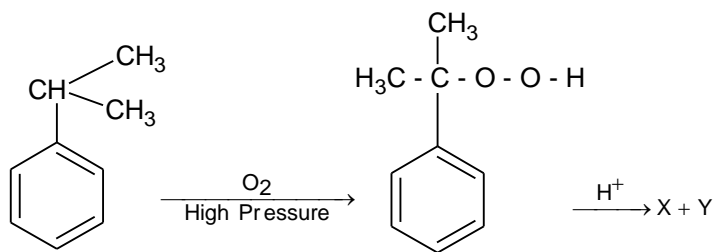
10. Which is/are more acidic than



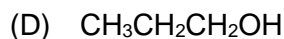
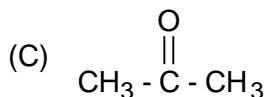
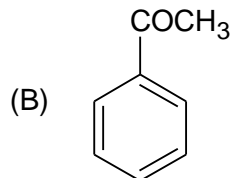
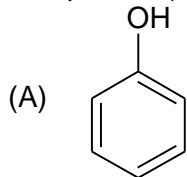
10. AC



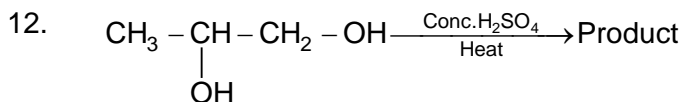
11.



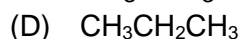
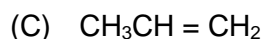
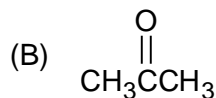
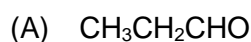
The product(s) of above reaction is/are



11. AC

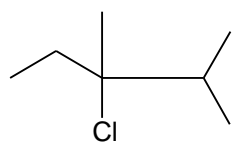


The product(s) of above reaction may be



12. AB

### PART – B (Numerical based)

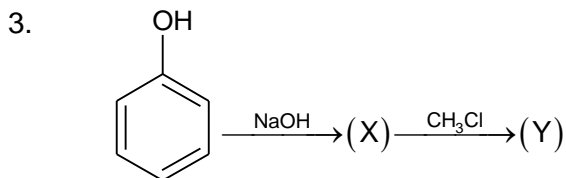


1. reacts with alcoholic KOH giving four products which are only structural isomers. How many total number of hyperconjugation structure(s) is/are possible for the products?

1. 25

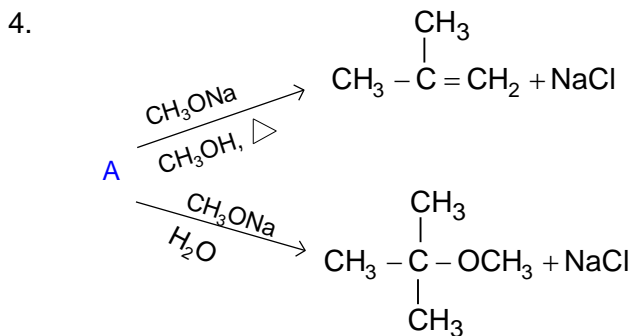
2. Dehydration reaction of with hot conc.  $\text{H}_2\text{SO}_4$  forms three alkenes as products without considering ring expansion. Each product has to form monochloro products with  $\text{Cl}_2/h\nu$ . What is the total number of monochloro products is/are possible without considering stereoisomers?

2. 13



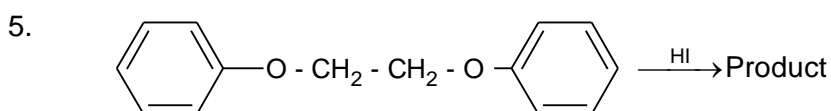
What is the difference in molar mass of X and Y?

3. 8



What is the molar mass of 'A' in  $\text{g mol}^{-1}$  unit?

4. 92.5



What is the molar mass of the hydrocarbon formed in above reaction?

5. 28

6. An alkyl polychloride upon hydrolysis forms  $\text{C}_2\text{H}_5 - \overset{\text{O}}{\parallel} \text{C} - \text{CH}_2 - \text{COOH}$ .  
How many chlorine atom(s) is/are present in one molecule of the alkyl polychloride?

6. 5

## **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. Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be a function. We say that  $f$  has

PROPERTY 1 if  $\lim_{h \rightarrow 0} \frac{f(h) - f(0)}{\sqrt{|h|}}$  exists and is finite, and

PROPERTY 2 if  $\lim_{h \rightarrow 0} \frac{f(h) - f(0)}{h^2}$  exists and is finite.

Then which of the following options is/are correct?

- (A)  $f(x) = x|x|$  has PROPERTY 2                      (B)  $f(x) = \sin x$  has PROPERTY 2  
 (C)  $f(x) = |x|$  has PROPERTY 1                      (D) None of these

1. C

2. The value of  $\lim_{n \rightarrow \infty} \cos\left(\frac{x}{2}\right) \cos\left(\frac{x}{4}\right) \cos\left(\frac{x}{8}\right) \dots \dots \cos\left(\frac{x}{2^n}\right)$  is

- (A) 1    (B)  $\frac{\sin x}{x}$   
 (C)  $\frac{x}{\sin x}$     (D) none of these

2. B

3. Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be defined as  $f(x) = 2x - 1$  and  $g : \mathbb{R} - \{1\} \rightarrow \mathbb{R}$  be defined as

$g(x) = \frac{x - \frac{1}{2}}{x - 1}$ . Then the composition function  $f(g(x))$  is:

- (A) both one – one and onto                      (B) onto but not one – one  
 (C) neither one – one nor onto                      (D) one – one but not onto

3. D

4. Let  $f : (1, 3) \rightarrow \mathbb{R}$  be a function defined by  $f(x) = \frac{x[x]}{1 + x^2}$ , where  $[x]$  denotes the greatest integer  $\leq x$ . Then the range of  $f$  is:

- (A)  $\left(0, \frac{1}{2}\right) \cup \left(\frac{3}{5}, \frac{7}{5}\right]$                       (B)  $\left(\frac{2}{5}, \frac{1}{2}\right) \cup \left(\frac{3}{5}, \frac{4}{5}\right]$   
 (C)  $\left(\frac{2}{5}, 1\right) \cup \left(1, \frac{4}{5}\right]$                       (D)  $\left(0, \frac{1}{3}\right) \cup \left(\frac{2}{5}, \frac{4}{5}\right]$

4. B

5. The value of  $\lim_{x \rightarrow \frac{\pi}{2}} \tan^2 x \left( \sqrt{2\sin^2 x + 3\sin x + 4} - \sqrt{\sin^2 x + 6\sin x + 2} \right)$  is equal to
- (A)  $\frac{1}{10}$  (B)  $\frac{1}{11}$   
 (C)  $\frac{1}{12}$  (D)  $\frac{1}{8}$
5. C
6. If  $a_1 = 1$  and  $a_{n+1} = \frac{4+3a_n}{3+2a_n}$ ,  $n \geq 1$  and if  $\lim_{n \rightarrow \infty} a_n = a$ , then the value of  $a$  is
- (A)  $\sqrt{2}$  (B)  $\sqrt{3}$   
 (C) 2 (D) none of these
6. 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.

7. If  $L = \lim_{x \rightarrow 0} \frac{a \sin x - bx + cx^2 + x^3}{2x^2 \log(1+x) - 2x^3 + x^4}$  exists and is finite, then
- (A)  $a = -6, L = -\frac{3}{40}$  (B)  $a = 6, L = \frac{3}{40}$   
 (C)  $b = 6, c = 0$  (D)  $a = -6, b = -6, L = \frac{3}{40}$
7. BC
8. Let  $f(x) = \sin\left(\frac{\pi}{6} \sin\left(\frac{\pi}{2} \sin x\right)\right)$  for all  $x \in \mathbb{R}$  and  $g(x) = \frac{\pi}{2} \sin x$  for all  $x \in \mathbb{R}$ . Let  $(f \circ g)(x)$  denote  $f(g(x))$  and  $(g \circ f)(x)$  denote  $g(f(x))$ . Then which of the following is (are) true?
- (A) Range of  $f$  is  $\left[-\frac{1}{2}, \frac{1}{2}\right]$  (B) Range of  $f \circ g$  is  $\left[-\frac{1}{2}, \frac{1}{2}\right]$   
 (C)  $\lim_{x \rightarrow 0} \frac{f(x)}{g(x)} = \frac{\pi}{6}$  (D) There is an  $x \in \mathbb{R}$  such that  $(g \circ f)(x) = 1$
8. ABC
9. If  $f(x) = \frac{1}{\sqrt{[\cos x] - [\sin x]}}$  (where  $[x]$  denotes greatest integer  $\leq x$ ). Then
- (A) domain  $f = \mathbb{R}$  (B) Range  $f = \{1\}$   
 (C) domain  $f = [2n\pi, (2n+1)\pi]$  (D) domain  $f = \left[2n\pi - \frac{\pi}{2}, 2n\pi\right]$
9. BD

10. Let  $f : \left(-\frac{\pi}{2}, \frac{\pi}{2}\right) \rightarrow \mathbb{R}$  be given by  $f(x) = (\log(\sec x + \tan x))^3$ . Then  
 (A)  $f(x)$  is an odd function (B)  $f(x)$  is one – one function  
 (C)  $f(x)$  is an onto function (D)  $f(x)$  is an even function
10. ABC
11. If  $x \in \mathbb{R}^+$  and  $x$  be a perfect square, where  $f(x)$  = the quotient when  $x$  is divided by 5 and  $g(x)$  = the remainder when  $x$  is divided by 5, then  $f(x) + g(x) = \sqrt{x}$  holds for  $x$  equals to  
 (A) 0 (B) 16  
 (C) 25 (D) none of these
11. **BC**
12. Let  $f(x) = \frac{1-x(1+|1-x|)}{|1-x|} \cos\left(\frac{1}{1-x}\right)$  for  $x \neq 1$ . Then  
 (A)  $\lim_{x \rightarrow 1^-} f(x) = 0$  (B)  $\lim_{x \rightarrow 1^-} f(x)$  does not exist  
 (C)  $\lim_{x \rightarrow 1^+} f(x) = 0$  (D)  $\lim_{x \rightarrow 1^+} f(x)$  does not exist
12. AD

**PART – B**  
**(Numerical based)**

1. Let  $X$  be a set with exactly 5 elements and  $Y$  be a set with exactly 7 elements. If  $\alpha$  is the number of one – one functions from  $X$  to  $Y$  and  $\beta$  is the number of onto functions from  $Y$  to  $X$ , then the value of  $\frac{1}{5!}(\beta - \alpha)$  is \_\_\_\_\_.
1. 119
2.  $\lim_{x \rightarrow \frac{\pi}{2}} \frac{\left[1 - \tan\left(\frac{x}{2}\right)\right][1 - \sin x]}{\left[1 + \tan\left(\frac{x}{2}\right)\right][\pi - 2x]^3}$  is equals to  $L$ , where  $96L$  equals to
2. 3
3. The integer  $n$  for which the  $\lim_{x \rightarrow 0} \frac{(\cos x - 1)(\cos x - e^x)}{x^n}$  is a finite and non – zero is
3. 3
4. Let  $S_n = \sum_{r=1}^n r!$  ( $n > 6$ ), then  $S_n - 7 \left[ \frac{S_n}{7} \right]$  (where  $[.]$  denotes the greatest integer function) is equal to
4. 5

5. If  $g: [-2, 2] \rightarrow \mathbb{R}$ , where  $g(x) = x^3 + \tan x + \left[ \frac{x^2 + 1}{P} \right]$  is an odd function, then the least integral value of parametric P is (where  $[.]$  represents greatest integer function)

5. 6

6.  $\lim_{x \rightarrow 0} \frac{x \tan 2x - 2x \tan x}{(1 - \cos 2x)^2}$  is

6. 0.5

# ANSWERS

## **SECTION-1 : PHYSICS**

PART – A

PART – B

## **SECTION – 2 : CHEMISTRY**

PART – A

PART – B

## **SECTION – 3 : MATHEMATICS**

PART – A

PART – B