FIITJEE (JEE-Advanced)

BATCHES – NWCM721O1S, NWCM921X1W, NWCM921A1W & PANINI921-XIIG1

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern - CPT-1 | **QP Code:** | **TEST - 16**

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 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 (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)

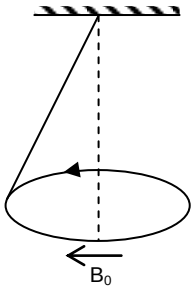
This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. A particle of charge q and mass m starts moving from the origin under the action of an electric field $\vec{E} = E_0\hat{i}$ and $\vec{B} = B_0\hat{i}$ with a velocity $\vec{v} = v_0\hat{j}$. The speed of the particle will become $2v_0$ after a time

(A) $t = \frac{2mv_0}{qE}$ (B) $t = \frac{2Bq}{mv_0}$ (C) $t = \frac{\sqrt{3}\,Bq}{mv_0}$ (D) $t = \frac{\sqrt{3}\,mv_0}{qE}$

1. **D**

2. A uniform current carrying ring of mass m and radius R is connected by a massless string as shown in figure. A uniform magnetic field B_0 exists in the region to keep the ring in horizontal position, then the current in the ring is (l = length of string)



(A) $\frac{mg}{\pi RB_0}$ (B) $\frac{mg}{RB_0}$

(C) $\frac{mg}{3\pi RB_0}$ (D) $\frac{mg\,\ell}{\pi R^2B_0}$

2. **A**

3. Each of two long parallel wires carries a constant current i along the same direction. The wires are separated by a distance 2l. The magnitude of resultant magnetic induction in the symmetric plane of this system located between the wire at a distance R from each wire will be

(A) $\frac{\mu_0 i}{\pi R}$ (B) $\frac{\mu_0 i}{2\pi R}$

(C) $\frac{\mu_0 i}{\pi\sqrt{R^2 - l^2}}$ (D) $\frac{\mu_0 i}{\pi R}\sqrt{1 - \frac{l^2}{R^2}}$

3. **D**

4. A positively charged (+q) particle of mass m has kinetic energy K enters vertically downward in a horizontal field of magnetic induction $\vec{B}$. The acceleration of the particle is (neglect gravity)

(A) $qB\sqrt{\frac{2K}{m}}$ (B) $\frac{qB\sqrt{2K}}{(m)^{3/2}}$

(C) $\frac{2qB}{(m)^{3/2}}\sqrt{2K}$ (D) $2qB\sqrt{\frac{2K}{m}}$

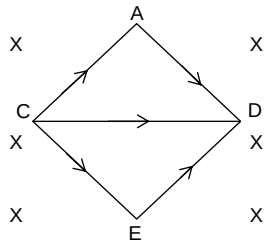
4. **B**

5. A charged particle is thrown perpendicular to a uniform magnetic field only, then

(A) it must move in a circular path. (B) it may not move on a circular path.
(C) it must move on a straight path. (D) it may move on a straight path.

5. **A**

6. Constant current of 1A flows along all the three branches of wire frame as shown. The frame is a combination of two equilateral triangles ACD and CDE of side 1m. It is placed in uniform magnetic field B = 4T acting perpendicular to the plane of paper. The magnitude of magnetic force acting on the frame is



(A) 12 N (B) 24 N
(C) 36 N (D) Zero

6. **A**

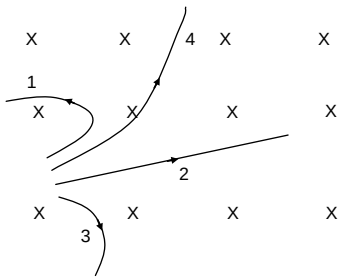
(Multi Correct Choice Type)

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. An electron and a proton are moving on straight parallel paths with same velocity. They enter a semi-infinite region of uniform magnetic field perpendicular to the velocity. Which of the following statement(s) is/are true?
(A) They will never come out of the magnetic field region.
(B) They will come out travelling along parallel paths.
(C) They will come out at the same time.
(D) They will come out at different times.

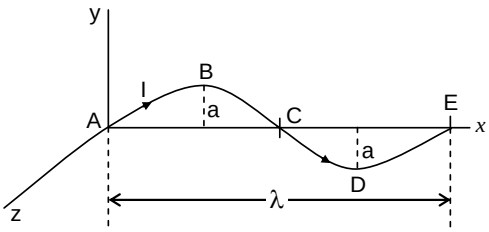
7. **BD**

8. Four particles are projected from a point with equal speeds in an inward magnetic field. The paths of the particles are shown. Then:
(A) the particle 2 is neutral.
(B) the particle 1 and 4 are positive.
(C) the particle 3 is negative.
(D) the specific charge of the particle 1 is more than that of particle 3 and specific charge of particle 3 is greater than that of the particle 2.



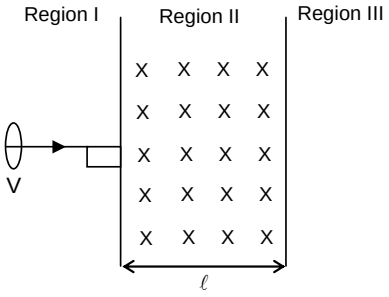
8. **ABCD**

9. A conductor ABCDE, shaped as shown, carries current I. It is placed in the x–y plane with the ends A and E on the x-axis. A uniform magnetic field of magnitude B exists in the region. The force acting on it will be
(A) zero, if B is in the x-direction.
(B) λBI in the z-direction, if B is in the y-direction.
(C) λBI in the negative y-direction, if B is in the z-direction.
(D) λaBI, if B is in the x-direction.



9. **ABC**

10. A particle of mass m and charge q, moving with velocity V enters Region II normal to the boundary as shown in figure. Region II has a uniform magnetic field B perpendicular to the plane of the paper. The length of the Region II is ℓ. Choose the correct choice(s).



(A) The particle enters Region III only if its velocity $V > \frac{q\ell B}{m}$

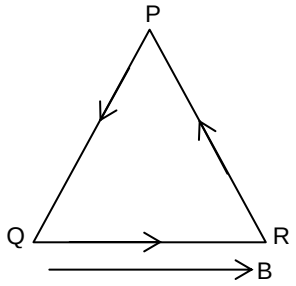
(B) The particle enters Region III only if its velocity $V < \frac{q\ell B}{m}$.

(C) Path length of the particle in Region II is maximum when velocity $V = \frac{q\ell B}{m}$

(D) Time spent in Region II is same for any velocity V as long as the particle returns to Region I.

10. **ACD**

11. An equilateral triangular loop PQR of side l carries a currents i in the direction shown. The loop is kept in uniform magnetic field B, directed parallel to the base of triangle QR as shown. Net force F and torque τ acting on loop is

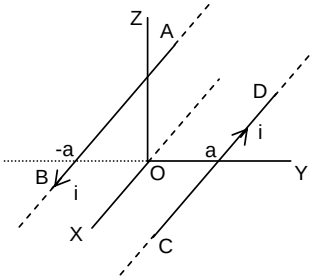


(A) F = 0 (B) $F = \sqrt{3}$ ilB

(C) $\tau = 0$ (D) $\tau = \frac{\sqrt{3}l^2iB}{4}$

11. **AD**

12. Two long parallel wires, AB and CD, carry equal currents in opposite directions. They lie in the xy plane, parallel to the x-axis, and pass through the points (0, -1, 0) and (0, 1, 0) respectively. The resultant magnetic field is

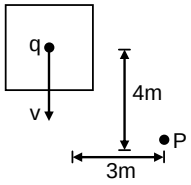


(A) zero on the x-axis
(B) maximum on the x-axis
(C) directed along the z-axis at the origin, but not at other points on the z-axis
(D) directed along the z-axis at all points on the z-axis

12. **BD**

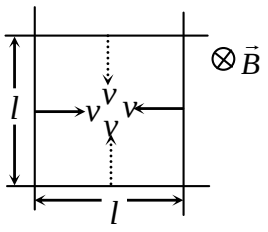
PART – B
(Numerical based)

1. An elevator carrying a charge of 0.7 C is moving down with a velocity of 5×10^3 m/s. The elevator is 4 m from the bottom (in μT) does it produce at point P.



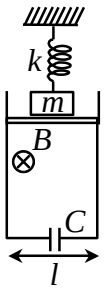
1. **8.40**

2. In the figure shown the four rods have λ = 0.5 Ω/m resistance per unit length. The arrangement is kept in a magnetic field of constant magnitude B = 0. 2T and directed perpendicular to the plane of the figure and directed inwards. Initially the rods form a square of side length l = 15m as shown. Now each wire starts moving with constant velocity v = 5 m/s towards opposite wire. Find the magnetic force (in newton) at t = 1 sec.



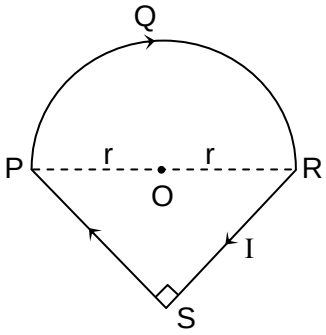
2. **2**

3. 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 4y. Neglect the self-inductance and electrical resistance of the rod and all wires. The value of 'y' will be



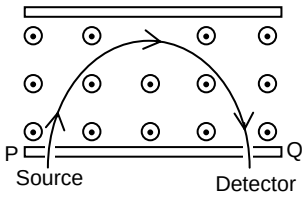
3. **5**

4. A steady current I = 10 A goes through a wire loop PQRS. Part PQR is semi-circle of radius r = 1 m. RS = SP and $\angle$RSP = 90°. Find the magnetic field at O in 10^{-6}T to the nearest integer.



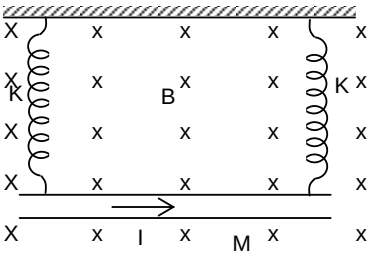
4. **7**

5. A uniform magnetic field with a slit system as shown in the figure is to be used as a momentum filter for high energy charged particles (enter and exit perpendicular to PQ) . With a field of 1T, it is found that the filter transmits α particle each of energy 2.2 MeV. The magnetic field is increased to 2.13T and deuteron ions are passed into the filter. What is the approximate energy (In MeV) of each deuteron ions transmitted by the filter?



5. **5**

6. 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 × 10^{-2} T (g = 10 m/s^2). Find the value of x.



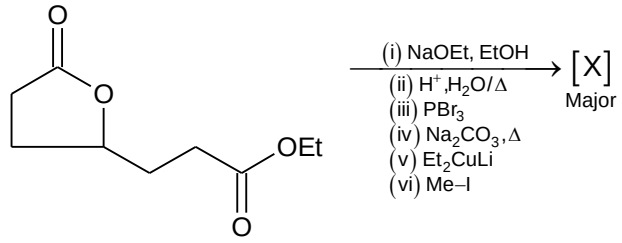
6. **0.50**

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. 

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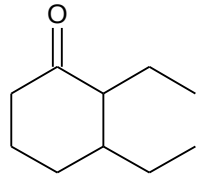
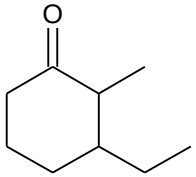
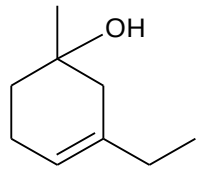
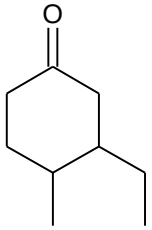
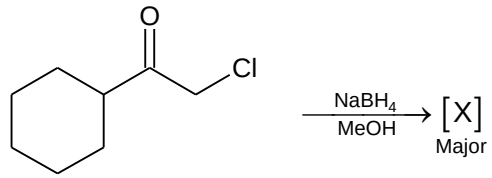
(A) 

(B) 

(C) 

(D) 

1. B

2. 

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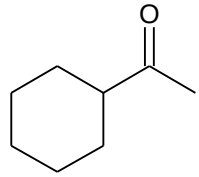
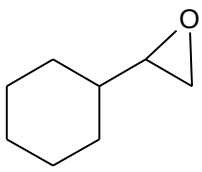
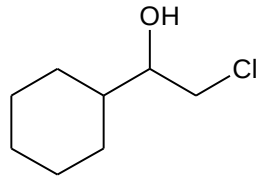
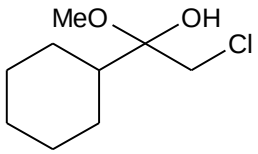
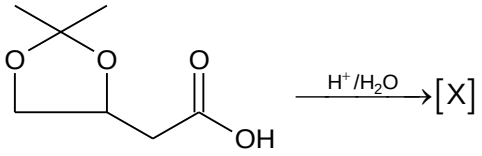
(A) 

(B) 

(C) 

(D) 

2. B

3. 

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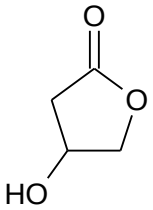
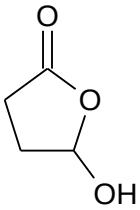
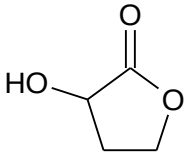
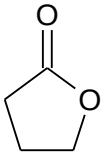
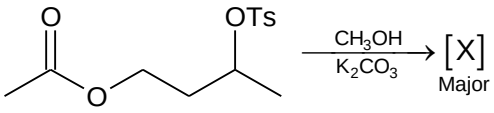
(A) 

(B) 

(C) 

(D) 

3. A

4. 

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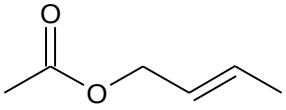
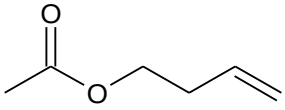
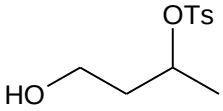
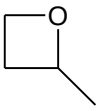
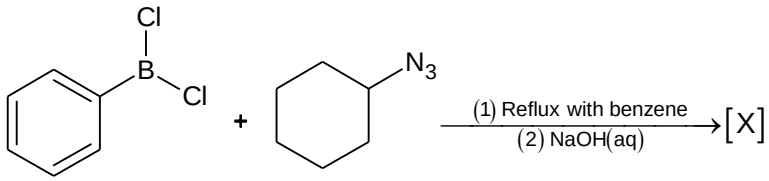
(A) 

(B) 

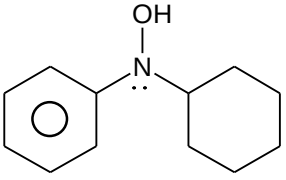
(C) 

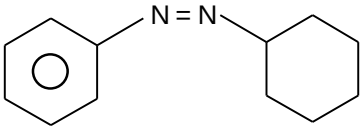
(D) 

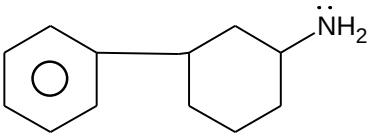
4. D

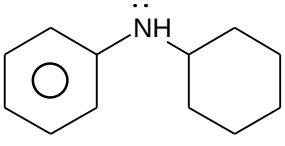
5. 

The major compound [X] is

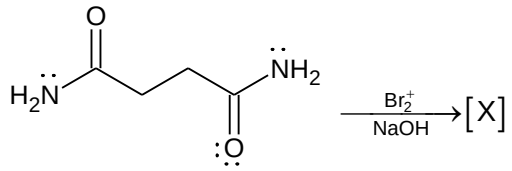
(A) 

(B) 

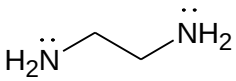
(C) 

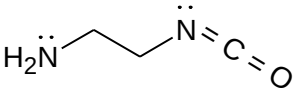
(D) 

5. D

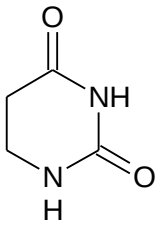
6. 

The final major compound [X] is

(A) 

(B) 

(C) $O = C = N - CH_2 - CH_2 - NCO$

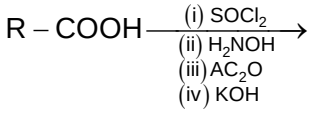
(D) 

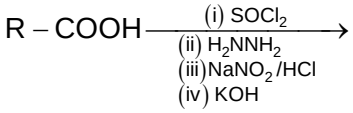
6. D

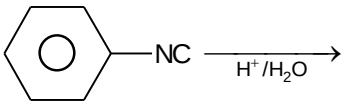
(Multi Correct Choice Type)

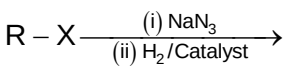
This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

7. How many of these reaction(s) leading into formation of primary amine?

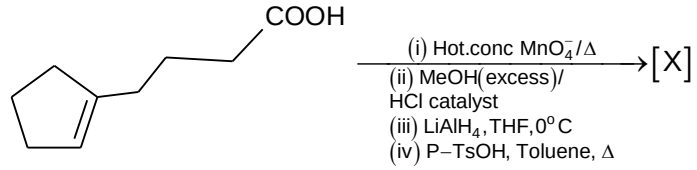
(A) 

(B) 

(C) 

(D) 

7. ABCD

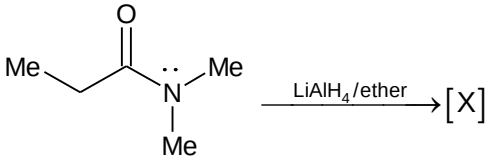
8. 

Which of the following statement(s) is are correct for [X]?

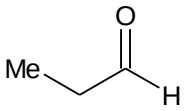
(A) [X] is a chiral molecule
(B) [X] is spiro compound
(C) [X] is gem diether
(D) The M.F of [X] is $C_9H_{16}O_2$

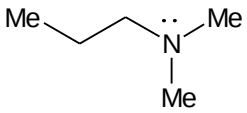
8. ABCD

9. For the following reduction



The correct statement(s) is/are

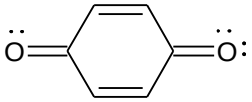
(A) The reduction product[X] is 

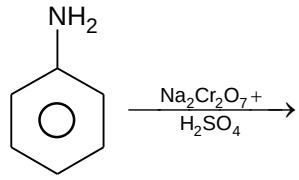
(B) The reduction product[X] is 

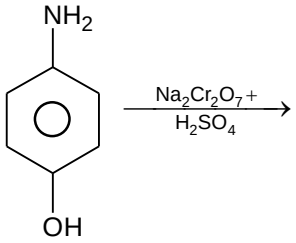
(C) The above amide reduced to 3^o amine due to reduction of imminium ion

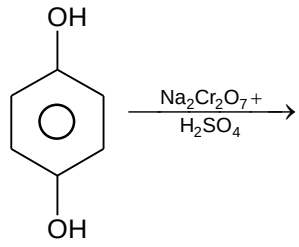
(D) The above amide is unaffected by $LiAlH_4$

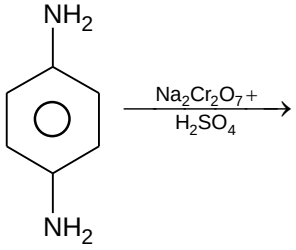
9. BC

10. How many of these reaction lead into formation of : 

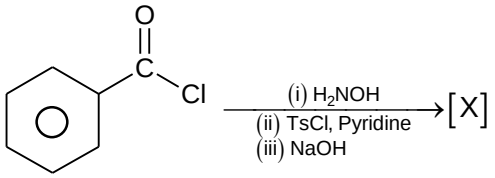
(A) 

(B) 

(C) 

(D) 

10. ABCD

11. 

Which of the following statement(s) is/are correct for [X]?

(A) [X] is aniline

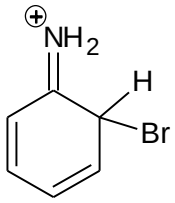
(B) The formation of [X] involves the intermediate Ph – NCO

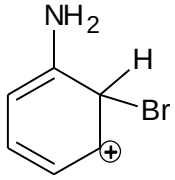
(C) The formation of [X] involves Beckmann rearrangement

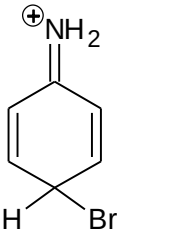
(D) The formation of [X] involves Phenyl migration

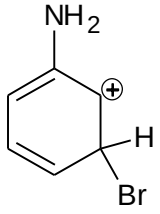
11. ABD

12. Arenium ion involved in the formation of aniline is/are

(A) 

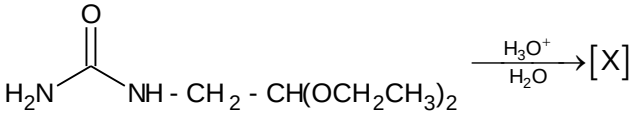
(B) 

(C) 

(D) 

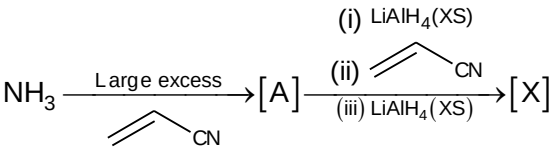
12. ABC

PART – B
(Numerical based)

1. 

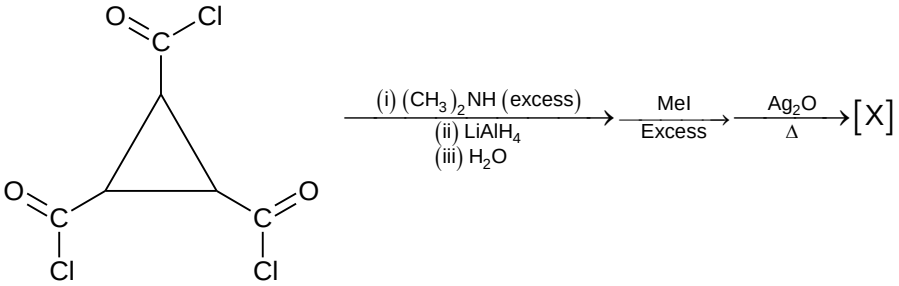
If the ring size in the cyclic organic compound is 'a', the number of hetroatoms are 'b' and the number of π-bonds are z, then what is the value of $\frac{(a \times b)}{z}$?

1. 7.5

2. 

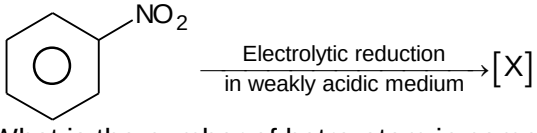
In the final organic compound[X], white is the ratio of carbon atom and hetro-atom?
[XS stands for excess]

2. 2.7

3. 

How many π-bonds are in compound[X]?

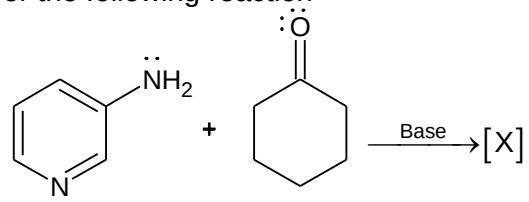
3. 3

4. 

What is the number of hetro-atom in compound [X]

4. 3

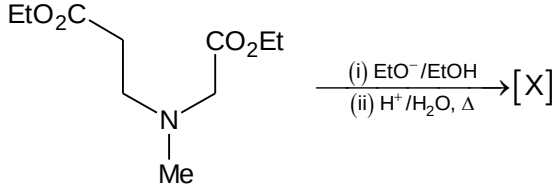
5. For the following reaction



[X] is the tricyclic aromatic hetrocycle. The algebric sum of the number of π-bonds and number of hetroatom is Y. What is Y?

5. 6

6. For the following reaction



If the number of ring size in [X] is divided by number of hetroatom, we get a number Y. What is Y?

6. 2.5

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. The value of $\lim\limits_{x\to 2}\dfrac{\sec^x\theta-\tan^x\theta-1}{x-2}$ is equal to

(A) $\sec^2\theta.\ln\sec\theta+\tan^2\theta.\ln\tan\theta$ (B) $\sec^2\theta.\ln\tan\theta+\tan^2\theta.\ln\tan\theta$

(C) $\sec^2\theta.\ln\tan\theta-\tan^2\theta.\ln\sec\theta$ (D) $\sec^2\theta.\ln\sec\theta-\tan^2\theta.\ln\tan\theta$

1. D

2. If $f(x)=\begin{cases}x+\{x\}+x\sin\{x\} & \text{for } x\neq 0\\ 0 & \text{for } x=0\end{cases}$ where $\{x\}$ denotes the fractional part function, then:

(A) 'f' is continuous and diff. at x = 0
(B) 'f' is continuous but not diff. at x = 0
(C) 'f' is continuous and diff. at x = 2
(D) None of the above

2. D

3. Let $f(x)=\begin{cases}\lim\limits_{n\to\infty}\dfrac{ax(x-1)\left(\cot\dfrac{\pi x}{4}\right)^n+\left(px^2+2\right)}{\left(\cot\dfrac{\pi x}{4}\right)^n+1}, & x\in(0,1)\cup(1,2)\\ 0, & x=1\end{cases}$

If $f(x)$ is differentiable for all $x\in(0,2)$, then $\left(a^2+p^2\right)$ equals:

(A) 18 (B) 20
(C) 22 (D) 24

3. B

4. The set of all points where the function $f(x)=\dfrac{x}{1+|x|}$ is differentiable is:

(A) $(-\infty,\infty)$ (B) $[0,\infty)$

(C) $(-\infty,0)\cup(0,\infty)$ (D) $(0,\infty)$

4. A

5. Let $f(x)=[n+p\sin x]$, $x\in(0,\pi)$, $n\in I$ and p is a prime number. The number of points where $f(x)$ is not differentiable is:

(A) $p-1$ (B) $p+1$
(C) $2p+1$ (D) $2p-1$

5. D

6. $\lim_{x\to 0}\left(\frac{(x+1)^x}{x^x.e}\right)^x$ equals:

(A) $\sqrt{e}$ (B) $\frac{1}{\sqrt{e}}$

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

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 limits tends to unity?

(A) $\lim_{x\to 0}\frac{1-\cos x+2\sin x-\sin^3 x-x^2+3x^4}{\tan^3 x-6\sin^2 x+x-5x^3}$

(B) $\lim_{x\to\infty}\frac{x}{[x]}$

(C) $\lim_{x\to\infty}\frac{1}{\left(\sqrt{x+\sqrt{x+\sqrt{x}}}-\sqrt{x}\right)}$

(D) $\lim_{x\to\infty}\left(\frac{\sqrt{x}}{\sqrt{x+\sqrt{x+\sqrt{x}}}}\right)$

7. BD

8. $f(x)=\frac{3x^2+ax+a+1}{x^2+x-2}$ then which of the following can be correct?

(A) $\lim_{x\to 1}f(x)$ exists $\Rightarrow a=-2$ (B) $\lim_{x\to -2}f(x)$ exists $\Rightarrow a=13$

(C) $\lim_{x\to 1}f(x)=\frac{4}{3}$ (D) $\lim_{x\to -2}f(x)=\frac{-1}{3}$

8. ABCD

9. Which of the statement(s) is/are incorrect?

(A) If $f+g$ is continuous at x = a, then f and g are continuous at x = a

(B) If $\lim_{x\to a}(fg)$ exists, then $\lim_{x\to a}f$ and $\lim_{x\to a}g$ both exists

(C) Discontinuity at $x=a\Rightarrow$ non existence of limit

(D) All functions defined on a closed interval attain a maximum or minimum value on that interval

9. ABCD

10. If $f(x)=\begin{cases}\frac{\sin ax}{bx}, & x<0\\ ax+1, & 0\le x<1\\ cx^2-2, & 1\le x<2\\ \frac{d\left(x^2-4\right)}{\sqrt{x}} & 2\le x<4\\ 12 & x\ge 4\end{cases}$ is continuous $\forall\, x\in R$, then which of the following hold good?

(A) $d=4c$ (B) $a\neq b$

(C) $a+b+d=-3$ (D) $a+b+c+d=-\frac{5}{2}$

10. ACD

11. For a function $f(x)=\frac{\ln\left(\{\sin x\}.\{\cos x\}+1\right)}{\{\sin x\}\{\cos x\}}$ where $\{x\}$ denotes fractional part function, then:

(A) $f\left(0^-\right)=f\left(\frac{\pi^+}{2}\right)$ (B) $f\left(\frac{\pi^-}{2}\right)=f\left(0^+\right)$

(C) $\lim\limits_{x\to 0} f(x)=1$ (D) $\lim\limits_{x\to\frac{\pi}{2}} f(x)=1$

11. AB

12. The function $f(x)=\begin{cases}|x-3|, & x\ge 1\\ \left(\frac{x^2}{4}\right)-\left(\frac{3x}{2}\right)+\left(\frac{13}{4}\right), & x<1\end{cases}$ is:

(A) continuous at x = 1 (B) differentiable at x = 1

(C) continuous at x = 3 (D) differentiable at x = 3

12. ABC

PART – B
(Numerical based)

1. Find the area bounded by the curves $\lim\limits_{t\to 1}\left(\frac{x}{1-t^x}-\frac{y}{1-t^y}\right)=1$ and the coordinate axes.

1. 2

2. A function f is defined as, $f(x)=\begin{cases}\frac{1}{|x|} & \text{if } |x|\ge\frac{1}{2}\\ a+bx^2 & \text{if } |x|<\frac{1}{2}\end{cases}$. If $f(x)$ is derivable at $x=\frac{1}{2}$, then find $(a-b)$.

2. 7

3. If $\lim\limits_{x\to 0}\dfrac{1-\cos\left(1-\cos\dfrac{x}{2}\right)}{2^m x^n}$ is equal to the left hand derivative of $e^{-|x|}$ at x = 0, then find the value of $(n-10m)$.

3. 74

4. $f(x)$ is a differentiable function satisfy the relationship $f^2(x)+f^2(y)+2(xy-1)=f^2(x+y)\,\forall\, x,y\in R$. Also, $f(x)>0\,\forall\, x\in R$ and $f\left(\sqrt{2}\right)=2$. Determine $f\left(\sqrt{34}\right)$.

4. 6

5. The function $f(x)=\dfrac{\sin 3x+A\sin 5x+B\sin x}{x^4\tan^{-1}x}, x\neq 0$ and $f(0)=C$. If f is continuous at x = 0. find the value of $\dfrac{AB+C}{A}$.

5. 14

6. If $f(x)=\cot\left(\dfrac{x}{2^n}\right)$, then $\lim\limits_{x\to\frac{\pi}{4}}\left(f(x)-\sum\limits_{r=1}^{n}\operatorname{cosec}\dfrac{x}{2^{r-1}}\right)$ is equal to:

6. 1

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B