



Shri. A. R. Tambe Sir's

**SHRADDHA**  
GROUP OF INSTITUTIONS

## ONLINE TEST SERIES SAMPLE QUESTION PAPER

### SHRADDHA SAFALATA : JEE-ADVANCED - PAPER 2

#### IMPORTANT INSTRUCTIONS

1. On the Answer Sheet, fill in the particulars on Side-1 and Side-2 carefully with blue/black ball point pen only.
2. The test is of 3 hours duration and this Test Booklet contains 75 questions. Each question carries 4 marks. For each correct response, the candidate will get 4 marks. For each incorrect response, one mark will be deducted from the total scores. The maximum marks are 300.
3. In this Test Paper, Each Subject will have two sections. Section A will be of Multiple-Choice Questions (MCQs) and Section B will contain Questions whose answers are to be filled in as a numerical value. There will be negative marking for incorrect answer in Section A and Section B. For each question in Section B, a candidate has to enter the correct integer value of the answer using the mouse and the on- screen virtual numeric keypad in the place designated to enter the answer. For Section B, the answer should be rounded off to the nearest integer.
4. In case of more than one option correct in any question, the best correct option will be considered as answer.
5. Use Blue/Black Ball Point Pen only for writing particulars on this page/markings responses.
6. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
7. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator before leaving the Room/Hall. The candidates are allowed to take away this Test Booklet with them.
8. The candidates should ensure that the Answer Sheet is not folded. Do not make any stray marks on the Answer Sheet. Do not write your Form No. anywhere else except in the specified space in the Test Booklet/Answer Sheet.
9. Use of white fluid for correction is not permissible on the Answer Sheet.

**SUBJECT : PHYSICS**

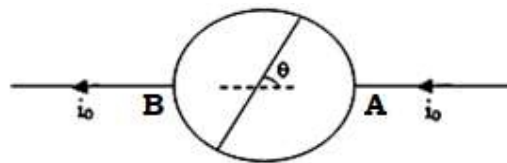
**SECTION 1 (Maximum Marks: 12)**

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:  
 Full Marks : +3 If **ONLY** the correct option is chosen;  
 Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);  
 Negative Marks : - 1 In all other cases.

1) Measurements show that a semi-transparent mirror lets through about 1/5 of the incident light, the rest is reflected. If two identical mirrors of this kind are set perpendicular to the incident light beam, then the fraction of incident energy coming out is

- 1)  $\frac{1}{25}$                       2)  $\frac{1}{10}$                       3)  $\frac{1}{3}$                       4)  $\frac{1}{9}$

2) Consider a circuit made of a wire with uniform resistance in a shape of a circle as shown in the picture. The circle is connected diagonally from point A to point B with the same type of wire. If the current passing through the wire AB as a function of angle  $\theta$ ?



- 1) 0                      2)  $\frac{\theta}{\pi - \theta} i_0$                       3)  $\frac{\pi - 2\theta}{\pi + 2} i_0$                       4)  $\frac{\pi - 2\theta}{\pi + 4} i_0$

3) Experiment shows that two perfectly neutral parallel metal plates separated by a small distance  $d$ , attract each other via a very weak force, known as the casimer force. The force per unit area of the plates,  $F$  depends only on the Planck constant  $h$ , on the speed of light  $c$ , and on  $d$ . which of the following has the best chance of being correct for  $F$ ?

- 1)  $F = \frac{hc}{d^2}$                       2)  $F = \frac{hc}{d^4}$                       3)  $F = \frac{hd^2}{c}$                       4)  $F = \frac{d^4}{hc}$

4) A plane electromagnetic wave propagating in free space is given by the electric field

$$\vec{E} = E_0 \left( \frac{-4\hat{i} + 3\hat{j}}{5} \right) \sin(\omega t - 3x - 4y + 5z) \frac{V}{m}$$

where  $\hat{i}$ ,  $\hat{j}$  and  $\hat{k}$  are unit vectors along X, Y and Z -

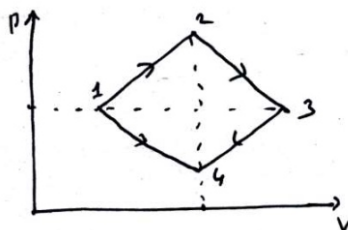
axes respectively and  $C$  is speed of electromagnetic wave The magnetic field of the wave is given by

- 1)  $\vec{B} = \frac{E_0}{C} \left( \frac{3\hat{i} + 4\hat{j} + 5\hat{k}}{5\sqrt{2}} \right) \sin(\omega t - 3x - 4y + 5z) T$                       2)  $\vec{B} = -\frac{E_0}{C} \left( \frac{3\hat{i} + 4\hat{j} + 5\hat{k}}{5\sqrt{2}} \right) \sin(\omega t - 3x - 4y + 5z) T$
- 3)  $\vec{B} = \frac{E_0}{C} \left( \frac{3\hat{i} + 4\hat{j}}{5} \right) \sin(\omega t - 3x - 4y + 5z) T$                       4)  $\vec{B} = -\frac{E_0}{C} \left( \frac{3\hat{i} + 4\hat{j}}{5} \right) \sin(\omega t - 3x - 4y + 5z) T$

**SECTION 2 (Maximum Marks: 12)**

- This section contains **THREE (03)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:  
Full Marks : +4 **ONLY** if (all) the correct option(s) is(are) chosen;  
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- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to correct answers, then  
choosing **ONLY** (A), (B) and (D) will get +4 marks;  
choosing **ONLY** (A) and (B) will get +2 marks;  
choosing **ONLY** (A) and (D) will get +2 marks;  
choosing **ONLY** (B) and (D) will get +2 marks;  
choosing **ONLY** (A) will get +1 mark;  
choosing **ONLY** (B) will get +1 mark;  
choosing **ONLY** (D) will get +1 mark;  
choosing no option (i.e. the question is unanswered) will get 0 marks; and  
choosing any other combination of options will get - 2 marks

- 5) An ideal gas undergoes a cyclic process in (P, v) plane through a path forming a rhombus. The points 1 and 3 lie on the isobar and the point 2 and 4 lies on the isochore.



- 1) The internal energy change during  $1 \rightarrow 2$  is same in magnitude to the internal energy change during  $3 \rightarrow 4$
  - 2) The heat absorbed during  $1 \rightarrow 2$  is more than the heat rejected during  $3 \rightarrow 4$
  - 3) The heat absorbed during  $1 \rightarrow 2$  is less than the heat rejected during  $3 \rightarrow 4$
  - 4) The work done during  $1 \rightarrow 4$  is more than the work done during  $3 \rightarrow 4$  in magnitude.
- 6) Two satellites, both with a mass  $m$ , are orbiting around a planet with a mass  $M \gg m$  on Circular orbits of radii  $R_1$  and  $R_2 = 2R_1$ . The satellites are connected to each other with a tensioned cable of negligible mass and of length  $R_1$ . Because of that the orbital period of both of the satellites is  $T$ .  $V_1$  and  $V_2$  are the velocities of the satellites and  $V_1^1$  and  $V_2^1$  are the velocities they will have in their respective orbits if then were no cable.

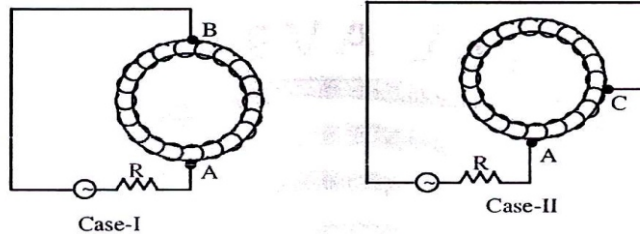
1)  $V_1$  is  $\sqrt{\frac{12}{5}}$  times smaller than  $V_1^1$       2)  $V_1$  is  $\sqrt{\frac{8}{5}}$  times smaller than  $V_1^1$

3)  $V_2$  is  $\sqrt{\frac{8}{3}}$  times larger than  $V_2^1$       4)  $V_2$  is  $\sqrt{\frac{10}{3}}$  times larger than  $V_2^1$

- 7) An ideal toroid is wound uniformly over a soft iron core. The two end points of wire used for toroid are joined at point 'A' as shown in figure. Two points 'B' and 'C' are selected on it so that point 'B' divides toroid in two identical halves and 'C' divides in three quarter and one quarter. The self inductance of one half toroid in between point A and B is

$L = \frac{0.4}{\pi}$  H. This toroid is fed with an ac source of emf  $e = (200V) \sin 100\pi t$  along with a

series resistor of resistance  $R = 40 \Omega$  in two different ways. In case-I point 'A' and 'B' are feeding point while in case-II 'A' and 'C'. Consider the ohmic resistance of the coil is negligible and toroid has no magnetic field outside. Ignore any inductance due to remaining parts of the loop.

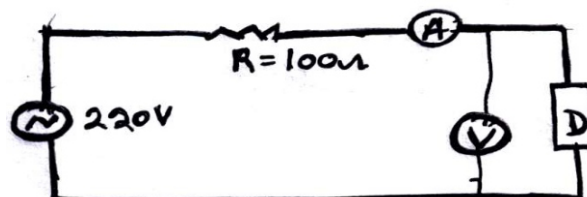


- 1) Current across source of emf in case-I is  $(5A) \sin(100\pi t)$
- 2) Current across source of emf in case-I is  $(4\sqrt{5}A) \sin\left(100\pi t - \tan^{-1} \frac{1}{2}\right)$
- 3) Current across source of emf in case-II is  $= (5A) \sin(100\pi t)$
- 4) Current across source of emf in case-II is  $3A \sin(100\pi t + 37^\circ)$

**SECTION 3 (Maximum Marks: 24)**

- This section contains **SIX (06)** questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**.
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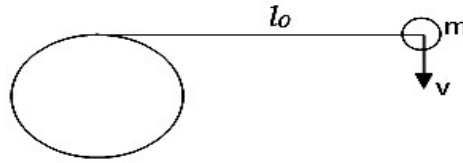
- 8) An electric device D is connected in series to a 220V A.C network and a  $100\Omega$  resistor. An ammeter shows a current of 0.5A, and a voltmeter shows a voltage of 200V. What is the device power consumption in watts?



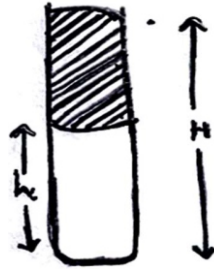


- 9) A vertical cylinder of radius  $R$  is fixed on a smooth horizontal surface. A thread is tightly wound on the cylinder, the free end of which is  $l_0$  long and attached to a small puck of mass  $m$ . The puck is initially given a horizontal velocity  $v$ , which is perpendicular to the thread. How long will it take for the thread to be torn up if the maximum tension form it can withstand is  $T$ .

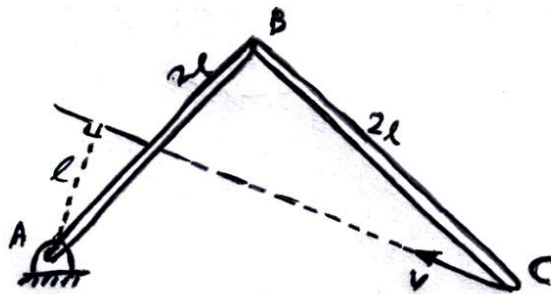
**Data:**  $T = 10 \text{ N}$ ;  $m = 1 \text{ kg}$ ;  $l_0 = \sqrt{8.16} \text{ m}$ ;  $v = 2 \text{ m/s}$ ;  $R = 1 \text{ m}$



- 10) A body is thrown horizontally away from the incline. The body follows periodic trajectories after elastic collisions with the incline. The coefficient of friction between the body and the incline is  $\mu = \sqrt{3}$ . The angle of the incline in degrees is \_\_\_\_\_.
- 11) A small air column of height  $h = 76 \text{ cm}$  is plugged by a mercury column in a vertical tube of height  $H = 152 \text{ cm}$ . The atmospheric pressure is  $10^5 \text{ Pa}$  and the temperature is  $T_0 = 16^\circ\text{C}$ . To what minimum temperature  $T_1$  must the air in the tube be heated to drive all the mercury out of the tube?



- 12) In the given figure a hinged construction is pictured, it consists of two rods with a length  $2\ell = 2\sqrt{3}$  one of the rod's tip is fixed to an unmoving point  $A$  and the other rod's tip  $C$  moves with a constant velocity  $v = \sqrt{3} \text{ m/s}$  along a direction which passes the point  $A$  at the distance  $\ell = \sqrt{3} \text{ m}$ . Find the acceleration of the connection point  $B$  of the rods during the moment when the distance between the points  $A$  and  $C$  is  $2\ell$ .



- 13) A paper bag of flour falls from a height  $h = 4 \text{ cm}$  without initial velocity on the measuring pan of a spring scale. The scale pointer had initially deviated to  $m_1 = 6 \text{ kg}$  and eventually settled at  $m_0 = 2 \text{ kg}$  when oscillations decayed. The spring constant is  $K = 1.5 \text{ KN/m}$ . Determine the mass  $M$  of the measuring pan in  $\text{kg}$ . Assume the free fall acceleration to be  $g = 10 \text{ m/s}^2$ .

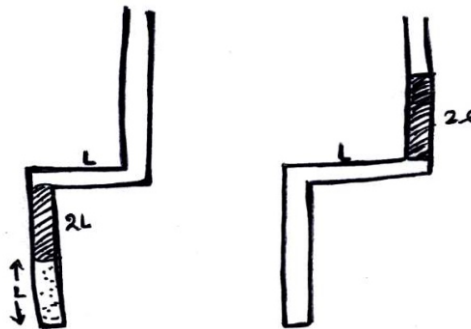
**SECTION 4 (Maximum Marks: 12)**

This section contains **TWO (02)** paragraphs.

- Based on each paragraph, there are **TWO (02)** questions.
- The answer to each question is a **NUMERICAL VALUE**.
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**Paragraph - 1**

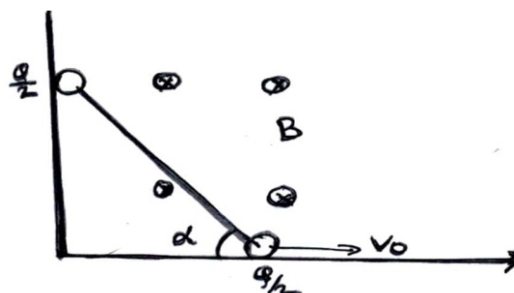
The tube of cross-section  $A$  seen in the figure is closed at one end, bent twice in right angles and resides in a vertical plane. The length  $L = 38$  cm long air column of temperature  $t_0$  in the vertical part of the tube is closed off by a  $2l$  long mercury column. The length of the horizontal part of the tube is  $L$ . The  $P_0$  air pressure outside equals with the hydrostatic pressure of the  $2L$  high mercury column. Let  $LA$  be termed as  $V_0$ .



- 14) The work done by the expanding air while the mercury flows to the upper vertical tube is  $xP_0V_0$ . The value of  $x$  is \_\_\_\_\_
- 15) What percentage of the heat transmitted to the air increases the internal energy?

**Paragraph - 2**

A thin rod of length  $L$  is moved in a vertical plane in a right corner such that the speed of the lower horizontally moving end of the rod has a constant speed of  $v_0 = 1$  m/s, and the other end touches the vertical wall at every moment. At both ends of the rod there are two small charged spheres of charge  $Q/2$  ( $Q = 1$  C). The whole system is in uniform magnetic field of  $B = 1$  Tesla.



- 16) The magnetic force on the rod when it makes an angle  $\alpha = 30^\circ$  with the horizontal is \_\_\_\_\_ newton.

- 17) Now the spheres at the ends are removed and there is only one sphere with charge  $Q$  at the mid point. In this case the magnetic force at the A shown instant is \_\_\_Newton.

**SUBJECT : CHEMISTRY**

**SECTION 1 (Maximum Marks: 12)**

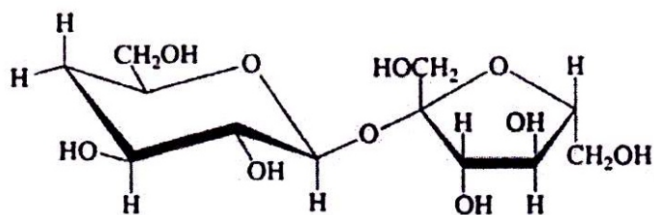
- This section contains **FOUR (04)** questions.
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 Negative Marks : - 1 In all other cases.

- 18) Select the correct statements:

- gold and  $As_2S_3$  solution are multimolecular colloids and hydrophobic sols.
- cleansing action of soap is due to adsorption of oily, dirt and greasy material at hydrophobic centres of soap
- hydrophobic part of soap penetrates in oil and hydrophilic part in water to impart stability to emulsion
- hydrophobic solution show more brighter Tyndall light than hydrophilic solution.
- conductance of soap solution changes sharply at CMC

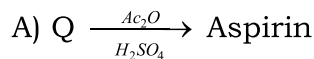
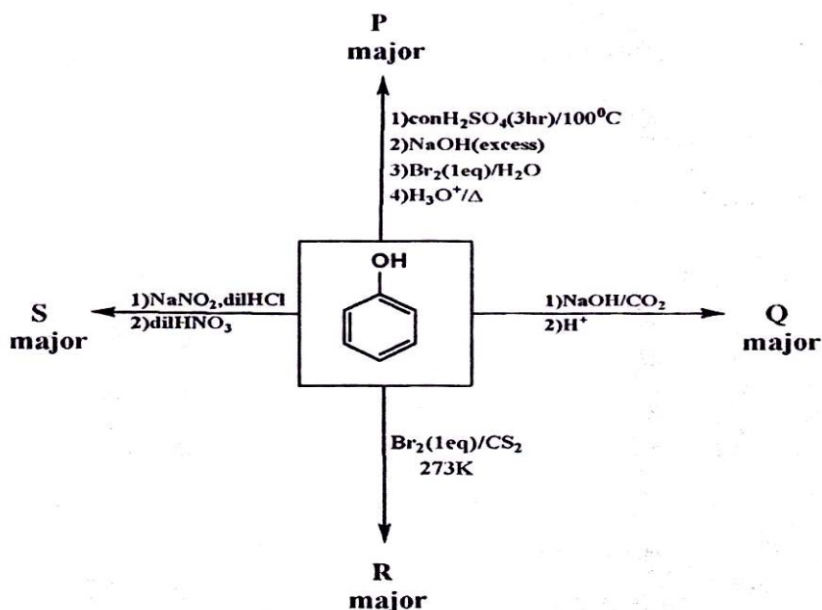
- ii, iii and iv and v only
- i, ii, iii and iv only
- i, ii, iii and v only
- all of these

- 19) Which of the following statement(s) is(are) incorrect for the following disaccharide?



- It is a nonreducing sugar.
  - It forms an osazone.
  - It exists in two anomeric forms.
  - It undergoes mutarotation.
- I, II only
  - II, III only
  - II, IV only
  - II, III, IV only

20) Number of correct statement(s) regarding given reaction scheme



B) Q and R are functional isomers

C) P and R are positional isomers

D) S is a less acidic than picric acid

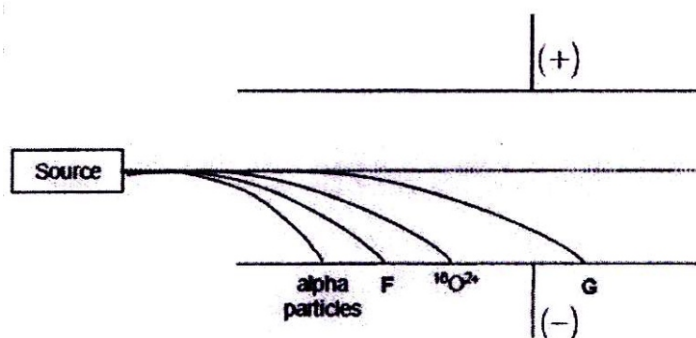
1) 1

2) 2

3) 3

4) 4

21) Alpha particles  ${}^4\text{He}^{2+}$ , are commonly emitted by. large radioactive nuclei. The path of a mixture  ${}^{16}\text{O}^{2+}$  ions, alpha particles and two unknown ions, F and G, upon entering an electric field is shown below:



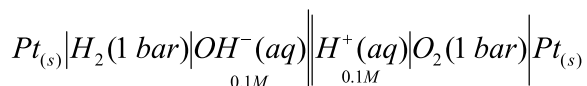
Which of the following can be F and G

	<b>F</b>	<b>G</b>
1)	${}^1\text{H}^{+1}$	${}^9\text{Be}^{2+}$
<b>2)</b>	${}^{12}\text{C}^{2+}$	${}^{27}\text{Al}^{3+}$
3)	${}^9\text{Be}^{2+}$	${}^{14}\text{N}^{3+}$
4)	${}^{12}\text{C}^{+}$	${}^1\text{H}^{+}$

**SECTION 2 (Maximum Marks: 12)**

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 choosing **ONLY** (D) will get +1 mark;  
 choosing no option (i.e. the question is unanswered) will get 0 marks; and  
 choosing any other combination of options will get - 2 marks

22) A galvanic cell is given below. Identify the correct options



[Given  $O_{2(g)} + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$ ;  $E^0 = + 1.23 \text{ V}$

$$\left( \frac{2.303 RT}{F} = 0.06 \right) \text{ and } K_w = 10^{-14}]$$

- EMF of the given cell is 1.95 V
  - Both anodic and cathodic half cells are 'gas - ion' type
  - $\frac{1}{2} O_{2(g)} + H_2O(l) + 2e^- \rightarrow 2OH^-(aq)$ ;  $E^0 = + 0.39 \text{ V}$
  - $2H_2O(l) + 2e^- \rightarrow H_{2(g)} + 2OH^-(aq)$ ;  $E^0 = - 0.84 \text{ V}$
- 23) Select the correct statement(s) about  $Ma_2bcde$ ? (a, b, c, d, e -monodentate ligands)
- It has 15 stereoisomers
  - It has 12 optically active and 3 optically inactive isomers
  - It has six cis geometrical isomers, with respect to two 'a'
  - It has three trans isomers with respect to two 'a'.
- 24) Select the **CORRECT** statements:  
 Given that: [ $r_c$  = radius of cation,  $r_a$  = radius of anion]

- 1) For CsCl unit cell (edge-length = a),  $rc + ra = \frac{\sqrt{3}}{2} a$
- 2) For NaCl unit cell (edge-length = a),  $rc + ra = \frac{\ell}{2}$
- 3) The packing fraction of metal in a.b.c.c. unit cell is 0.68
- 4) The void fraction in a face-centered cubic unit cell is 0.74

**SECTION 3 (Maximum Marks: 24)**

- This section contains **SIX (06)** questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on screen virtual numeric keypad in the place designated to enter the answer.
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- 25) Consider the following oxyanions  
 $\text{PO}_4^{3-}$ ,  $\text{P}_2\text{O}_6^{4-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{MnO}_4^-$ ,  $\text{CrO}_4^{2-}$ ,  $\text{S}_2\text{O}_5^{2-}$ ,  $\text{S}_2\text{O}_7^{2-}$  and find the value of  $R + Q - P$   
Where  
P = Number of oxy anions having three equivalent  
X – O bonds per central atom  
Q = Number of oxy anions having two equivalent  
X – O bonds per central atom  
R = Number of oxy anions having four equivalent  
X – O bonds per central atom
- 26) An optically active substance A is decomposing into optically active substance B and C (in a constant volume solution) as  $A \xrightarrow{k=10^{-3} \text{ min}^{-1}} 2B + C$   
The specific rotations of A, B and C are  $+40^\circ$ ,  $+10^\circ$  and  $-30^\circ$  per mole, respectively, initially A and C were present in 4: 3 mole ratio. After what time (in min), the sample becomes optically inactive?  
[Given:  $\ln 20 = 2.995$ ,  $\ln 13 = 2.565$ ]
- 27) A hydrogen-like atom (atomic number Z) is in a higher excited state of quantum number n. this excited atom can make a transition to the first excited state by successively emitting two photons of energies 10.20 eV and 17.00 eV respectively. alternatively, the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energy 4.25 eV and 5.95 eV respectively. Determine the values of n+ Z?
- 28) When phenol is dissolved in a particular solvent, it is partially dimerized. If 2.58 g of phenol is dissolved in 100 g of the solvent, the freezing point of solvent ( $K_f = 14.1 \text{ K mol}^{-1} \text{ kg}$ ) is depressed by 2.37 K. how much weight of phenol is dimerized in the solution (Approx)
- 29)  $\text{H}_2\text{S}$  (5 moles) reacts completely with acidified aqueous potassium permanganate solution. In this reaction, the number of moles of water produced is x, and the number of moles of electrons involved is y. Find out the value of (x + y)



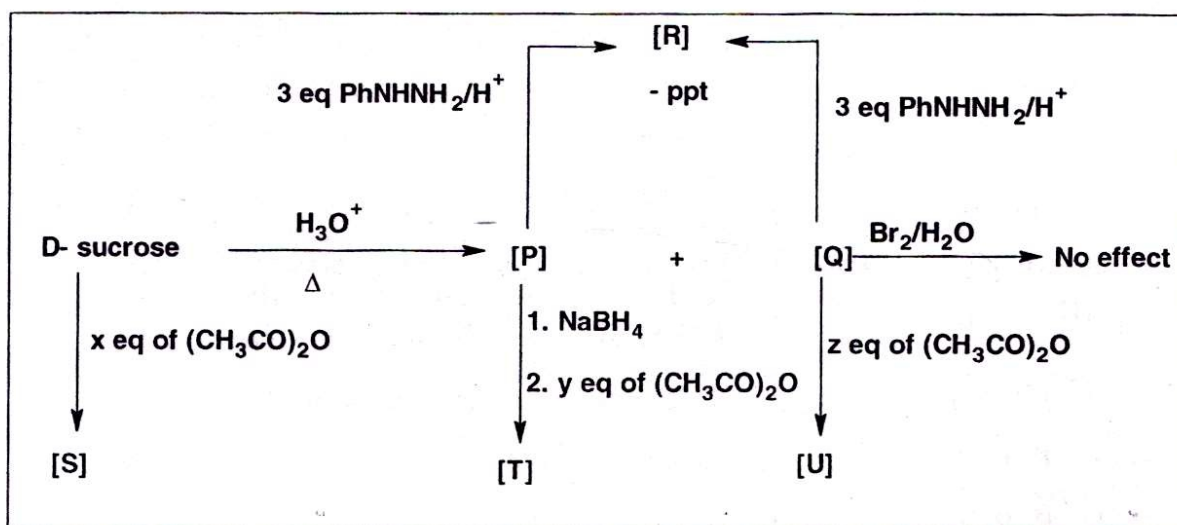
- 30) An organic compound (A)  $C_xH_6O_2$  was treated with  $I_2/NaOH$  consumes 6 moles of  $I_2$  to produce iodoform and a dibasic acid (B) which when treated with alkaline  $KMnO_4$ , pink color of  $KMnO_4$  gets decolorized with no organic compound left as residue. The minimum value of X is ----

**SECTION 4 (Maximum Marks: 12)**

This section contains **TWO (02)** paragraphs.

- Based on each paragraph, there are **TWO (02)** questions.
- The answer to each question is a **NUMERICAL VALUE**.
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 Zero Marks : 0 In all other cases.

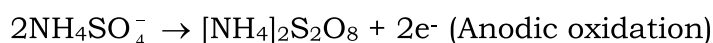
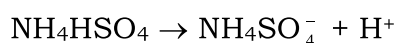
**Paragraph - 1**



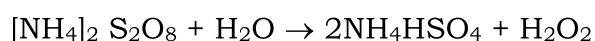
- 31) The total number of heteroatoms in [R] is \_\_\_\_  
 (Atoms other than C and H are considered as heteroatoms)
- 32) The value of  $x + y - z$  is

**Paragraph - 2**

$H_2O_2$  can be produced by the electrolysis of ammonium hydrogen sulphate. Reactions occurring in electrolytic cell:



Hydrolysis of ammonium persulphate forms  $H_2O_2$ :



Assume 100 % yield of hydrolysis reaction

20 Amp current is passed for 9650 seconds in order to produce 17 gm of  $H_2O_2$ .

(assume the gases collected are dry; Molar volume of ideal gas at 1 atm and 273 K = 22.4L)

- 33) The current efficiency (in %) is  
34) The volume of hydrogen gas at 1 atm and 273 K produced at cathode (in litres) is

**SUBJECT : MATHEMATICS**

**SECTION 1 (Maximum Marks: 12)**

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:  
Full Marks : +3 If **ONLY** the correct option is chosen;  
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);  
Negative Marks : - 1 In all other cases.

- 35) If  $a \sin \theta - b \cos \theta = -\sin 4\theta$  and  $a \cos \theta + b \sin \theta = \frac{5}{2} - \frac{3}{2} \cos 4\theta$ , then  $(a+b)^{2/5} + (a-b)^{2/5}$  is \_\_\_\_\_.
- 1) -5                                      2) 8                                      3) 2                                      4) 6

- 36) If the solution of the differential equation  $\frac{dy}{dx} - y \left( \frac{x^4 + 3x^2}{(x^2 + 1)^2} \right) = (4x + 3)e^{\left(\frac{x^3}{x^2 + 1}\right)}$  is in the form  $y = f(x)$  (where  $f(0) = 1$ , then the value of  $f(1) + f(-1)$  is equal to \_\_\_\_\_
- 1)  $2\sqrt{e}$                                       2)  $3\sqrt{e}$                                       3)  $4\sqrt{e}$                                       4)  $6\sqrt{e}$

- 37) If the number of real solution(s) of the equation given by  $\begin{vmatrix} 2023 + 2024x^2 & 2023x^2 + 2024 & 2025 \\ 2017 + 2018x^2 & 2017x^2 + 2018 & 2019 \\ 2006 + 2007x^2 & 2006x^2 + 2007 & 2008 \end{vmatrix} = 0$  are  $\lambda$ , then the unit's digit of  $\lim_{t \rightarrow \lambda} \frac{\sin^{2024}(2023t)}{t^{2024}}$  will be \_\_\_\_\_.
- 1) 1                                      2) 2024                                      3) 2023                                      4) 0

- 38) For all  $x \geq 1$ , let  $f(x)$  be the function defined as

$$f(x) = \begin{cases} [x] \cdot \left| x - [x] - \frac{1}{2[x]} \right|, & \text{if } x < [x] + \frac{1}{[x]} \\ f\left(x - \frac{1}{[x]}\right) & \text{otherwise} \end{cases} \quad (\text{where } [.] \text{ denote greatest integer function})$$

The number of points at which  $f(x)$  is not differentiable in the interval  $x \in (4, 5)$  is

- 1) 8                                      2) 7                                      3) 4                                      4) 2

**SECTION 2 (Maximum Marks: 12)**

- This section contains **THREE (03)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:  
Full Marks : +4 **ONLY** if (all) the correct option(s) is(are) chosen;  
Partial Marks : +3 If all the four options are correct but **ONLY** three options are chosen;  
Partial Marks : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct;  
Partial Marks : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option;  
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);  
Negative Marks : - 2 In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to correct answers, then  
choosing **ONLY** (A), (B) and (D) will get +4 marks;  
choosing **ONLY** (A) and (B) will get +2 marks;  
choosing **ONLY** (A) and (D) will get +2 marks;  
choosing **ONLY** (B) and (D) will get +2 marks;  
choosing **ONLY** (A) will get +1 mark;  
choosing **ONLY** (B) will get +1 mark;  
choosing **ONLY** (D) will get +1 mark;  
choosing no option (i.e. the question is unanswered) will get 0 marks; and  
choosing any other combination of options will get - 2 marks

39) Let A and B are two non-singular matrices of order 3 with real entries such that  $\text{adj}(A) = 2B$  and  $\text{adj}(B) = A$ , then (where  $|A| = \det A$ )

1)  $|A| + |B| = 6$

2)  $|A| + |B| = -6$

3)  $\text{adj}(A^2 B) + \text{adj}(AB^2) = 4(A + 2B)$

4)  $\text{adj}(A^2 B) + \text{adj}(AB^2) = 4(2A + B)$

40) In an ellipse with foci  $F_1$  and  $F_2$ . Suppose P, Q are 2 vertices of the ellipse such that  $F_1P = 3$  units and  $F_2P = 2$  units then length PQ can be

1) 5

2)  $\sqrt{7}$

3)  $\sqrt{17}$

4)  $\sqrt{27}$

41)  $z_1, z_2, z_3$  are three non-zero distinct points satisfying  $|z-1|=1$  and  $z_2^2 = z_1 z_3$ , then

1)  $\frac{z_3 - z_2}{z_2 + z_3 - 2}$  is purely imaginary

2)  $\text{Arg}\left(\frac{z_2 - 1}{z_1 - 1}\right) = 2\text{Arg}\left(\frac{z_3}{z_2}\right)$

3)  $\text{Arg}\left(\frac{z_2 - 1}{z_1 - 1}\right) = 2\text{Arg}\left(\frac{z_3}{z_1}\right)$

4)  $\left|\frac{1}{z_2} - \frac{1}{z_3}\right| + \left|\frac{1}{z_1} - \frac{1}{z_2}\right| = \left|\frac{1}{z_1} - \frac{1}{z_3}\right|$

**SECTION 3 (Maximum Marks: 24)**

- This section contains **SIX (06)** questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:  
Full Marks : +4 If **ONLY** the correct integer is entered;  
Zero Marks : 0 In all other cases

- 42) Find number of 8-digits permutations of 2, 0, 3, 4, 20, 34 with first digit being non-zero \_\_\_\_\_.
- 43) Suppose integers  $a_1, a_2, a_3, \dots, a_{2019}$  satisfy  $a_1 = 1 \leq a_2 \leq a_3 \dots \leq a_{2019} = 99$   
Suppose  $f = (a_1^2 + a_2^2 + a_3^2 + \dots + a_{2019}^2) - (a_1 a_3 + a_2 a_4 + a_3 a_5 + \dots + a_{2017} a_{2019})$  Then find the minimum value of  $f$ .
- 44) In the coordinate plane, the region  $M$  consists of all the points  $(x, y)$  satisfying the inequalities  $y \geq 0, y \leq xy$  and  $y \leq 2 - x$  simultaneously. The region  $N$ , which varies with the parameter  $t$ , consists of all the points  $(x, y)$  satisfying the inequalities  $t \leq x \leq t + 1$  and  $0 \leq t \leq 1$  simultaneously. The area of  $M \cap N$  is  $-k_1 t^2 + k_2 t + \frac{1}{2}$ , then  $k_1 + k_2$  is \_\_\_\_\_.
- 45) If  $\left(1 + \frac{1}{x}\right)^{x+1} = \left(1 + \frac{1}{2021}\right)^{2021}$ , then  $|x|$  is equal to \_\_\_\_\_.
- 46) If two events  $A$  and  $B$  are such that  $P(\bar{A}) = 0.3, P(B) = 0.4, P(A \cap \bar{B}) = 0.5$ , then the value of  $P(B/(A \cup \bar{B}))$  is \_\_\_\_\_.
- 47) The volume of tetrahedron  $AKHI$  is  $1/6$  unit<sup>3</sup>,  $\angle KIH = \pi/4$  and  $\sqrt{2}(AK + HI) + KI = 3\sqrt{2}$ ,  $AK = 1$ , then  $\sqrt{3}AI$  is equal to \_\_\_\_\_.

**SECTION 4 (Maximum Marks: 12)**

- This section contains **TWO (02)** paragraphs.
- Based on each paragraph, there are **TWO (02)** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:  
Full Marks : +3 If **ONLY** the correct numerical value is entered in the designated place;  
Zero Marks : 0 In all other cases.

**Paragraph - 1**

Let  $f: \mathbb{R} \rightarrow \mathbb{R}$  be a function defined as  $f(x) = 3x^5 - 25x^3 + 60x + 5$  and

$$g(x) = \begin{cases} \max\{f(t) : -4 \leq t \leq x\} & ; \quad -4 \leq x \leq 0 \\ \min\{f(t) : 0 < t \leq x\} & ; \quad 0 < x \leq 2 \\ f(x) - 16 & ; \quad x > 2 \end{cases}$$

- 48) Total number of points at which  $y = f(x)$  and  $y = g(x)$  is non differentiable in  $[-4, \infty)$  is \_\_\_  
49) If  $f(x) + \lambda = 0$  has exactly 3 distinct real roots then number of integral values of  $\lambda =$  \_\_\_

**Paragraph - 2**

A person repeatedly tosses a fair dice. He gets two points for a throw of a perfect square and one point otherwise. Let  $P_n$  denote the probability that he reaches a score of exactly  $n$  then

50)  $\frac{P_{10} - P_9}{P_8 - P_9} =$  \_\_\_\_\_

51)  $\lim_{n \rightarrow \infty} P_n =$  \_\_\_\_\_