Roll No. _____ **NLCS/12/Chemistry(043)/18**

Half Yearly Examination 2024 – 2025

Time - 3:00 Hrs. **M.M. 70**

General Instructions:

Read the following instructions carefully and follow them :

(i) This question paper contains 33 questions. All questions are compulsory.

(ii) This question paper is divided into five sections Section A, B, C, D and E.

(iii) Section A questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark

(iv) Section B questions number 17 to 21 are very short answer type questions. Each question carries 2 marks

(v) Section C questions number 22 to 28 are short answer type questions. Each question carries 3 marks

(vi) Section D questions number 29 and 30 are case-based questions. Each question carries 4 marks

(vii) Section E questions number 31 to 33 are long answer type questions. Each question carries 5 marks

SECTION – A

Q.1 Which of the following is maximum boiling azeotropic :

(a) $CH_3COOH + C_5H_5N$ (b) $H_2O + C_2H_5OH$ (c) $C_6H_{12} + C_2H_5OH$ (d) $H_2O + CH_3OH$

Q.2 Which property of transition metals enables them to behave as catalyst?

(a) High melting point (b) High Ionization Enthalpy

(c) Alloy formation (d) Variable Oxidation state

Q.3 From the Elements of 3d-series given below, which element shows the maximum number of oxidation States?

(a) Scandium (b) manganese (c) Chromium (d) iron

Q.4 The correct Iupac name of $[Pt(NH_3)_2Cl_2]$ is :

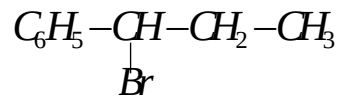
(a) Diammine dichlorido platinum (II) (b) Diammine dichlorido platinum (IV)

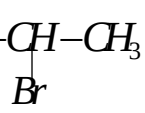
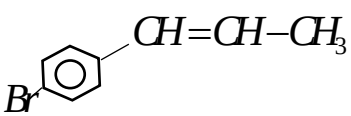
(c) Diammine dichlorido platinum (0) (d) Dichlorido diammineplatinum (IV)

Q.5 The stabilization of coordination Compounds due to chelation is called the chelate effect which of the following is the most stable complex species?

(a) $[Fe(CO)_5]$ (b) $[Fe(CN)_6]^{-3}$ (c) $[Fe(C_2O_4)_3]^{-3}$ (d) $[Fe(H_2O)_6]^{+3}$

Q.6 The reaction of C_6H_5-CH=CH-CH_3 with HBr produces :

(a) C_6H_5-CH_2-CH_2-CH_2-Br (b) 

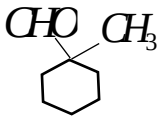
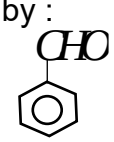
(c)  (d) 

Q.7 The synthesis of Alkyl fluoride is best accomplished by :

(a) Finkelstein Reaction (b) Swartz Reaction

(c) Free radical fluorination (d) Sandmeyer reaction

Q.8 Cannizaro's reaction is not given by :

(a)  (b)  (c) HCHO (d) CH_3CHO

Q.9 In clemmensen Reduction Carbonyl compound is treated with

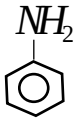
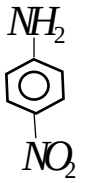
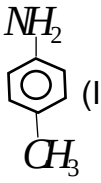
(a) Zinc amalgam + HCl (b) Sodium amalgam + HCl

(c) zinc amalgam + Nitric acid (d) Sodium amalgam + HNO_3

Q.10 Amides can be converted into amines by the reaction named :

(a) Hoffmann degradation (b) Ammonolysis (c) Carbylamine (d) Diazotisation

Q.11 The Correct increasing order of basic strength for the following compounds is:

 (I)  (II)  (III)

(a) II < III < I (b) III < I < II (c) III < II < I (d) II < I < III

Q.12 **W**hich of the following acids represents vitamin-c-?

(a) Saccharic acid (b) gluconic acid (c) Ascorbic acid (d) Benzoic acid

For Questions Number 13 to 16, two statements are given- one labelled as Assertion (A) and the other labelled as Reason (R). select to Correct answer to these Questions form Codes (A) (B), (C) and (D) as given below :

(a) Both Assertion (A) and Reason (R) are true, And Reason (R) is the Correct explanation of the Assertion (A)

(b) Both assertion (A) and Reason (R) are true, but reason (R) Is not Correct Explanation of assertion.(A)

(c) Assertion is correct statement but reason is wrong

(d) Assertion is wrong statement but reason is correct

Q.13 Assertion : When NaCl is added to water a depression in freezing point is observed.

Reason : The lowering of vapour pressure of a solution causes depression in the freezing point.

Q.14 Assertion: The highest oxidation state of osmium is +8

Reason: Osmium is a 5d-block element.

Q.15 Assertion: $[Fe(CN)_6]^{-3}$ ion shows magnetic moment corresponding to two unpaired Electrons

Reason: Because it has d^2sp^3 type Hybridization.

Q.16 Assertion: Presence of a nitro group at Ortho or para Position increases the reactivity of Haloarenes towards nucleophilic Substitution

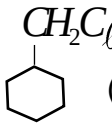
Reason: Nitro group, being an electron-withdrawing group decreases the Electron density over the benzene ring.

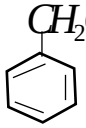
SECTION – B

Q.17 Explain “painful condition Known as Bends” with help of High altitude.

Q.18 Transition Elements Show High melting points. Why?

Q.19 Which of the following compounds would undergo SN^1 reaction faster and why?


(A)


(B)

Q.20 Give the IUPAC names of the following compounds :

(i) $CH_3-CH_2-\underset{\underset{O}{\|}}{C}-CH_2-CHO$ (ii) $CH_3-CH=CH-CHO$

Q.21 What is Hinsberg reagent?

SECTION – C

Q.22 (i) Find molarity of the solution containing 7.1 gm of Na_2SO_4 in 100 mL of aqueous solution

(ii) Write 3 difference between ideal and non-ideal Solution.

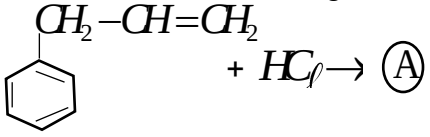
Q.23 (i) Which Element of the first Transition Series has highest Third ionization enthalpy?

(ii) Which of the following is amphoteric oxide ?

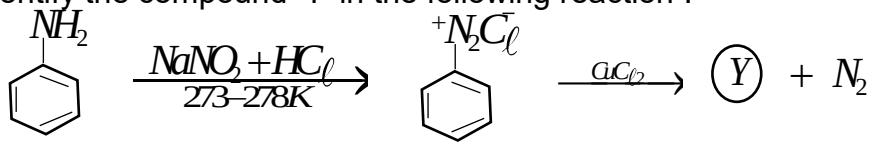
Mn_2O_7, CrO_3, Cr_2O_3, CrO, V_2O_5, V_2O_4

(iii) Write Electronic configuration of gadolinium (64).

Q.24 (i) What is ‘A’ in the following reaction? 1½×2=3



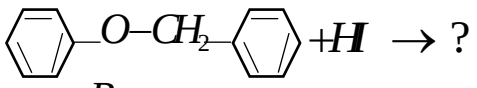
(ii) identify the compound ‘Y’ in the following reaction :

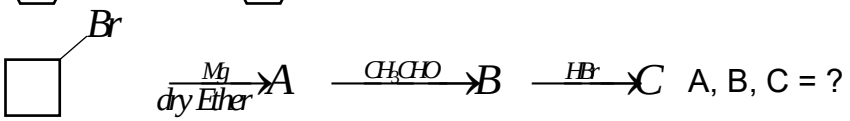


Q.25 (i) What is the correct order of reactivity of alcohol in the following reaction?

(Primary / Secondary / tertiary) 1×3=3

R-OH + HCl $\xrightarrow{ZnCl_2}$ R-Cl + H_2O

(ii) 

(iii) 
A, B, C = ?

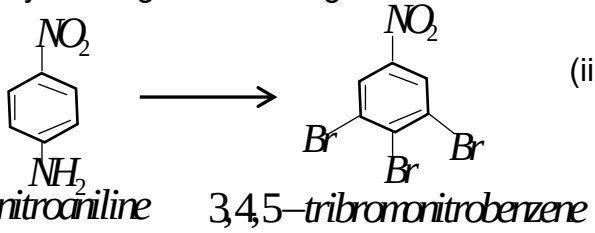
Q.26 (i) Carboxylic acids Contain carbonyl group but do not show the nucleophilic addition reaction like aldehydes or Ketones why?

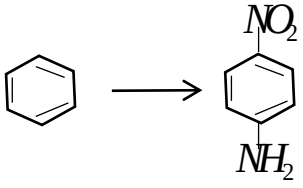
(ii) Write Gatterman-koch reaction.

OR

Kolbe reaction

Q.27 How will you bring the following conversion?

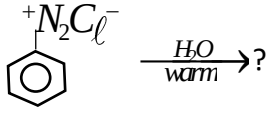
(i) 
p–nitroaniline *3,4,5–tribromonitrobenzene*

(ii) 

OR

(i) Short notes on gabriel phthalimide Synthesis (ii) Carbylamine reaction..

Q.28 (i) Give an Example of coupling reaction (ii) Comment on "isocynide test"

(iii) complete the following reaction 

Section – D

Q.29 The Boiling points of alcohols and phenols increase with increase in the number of Carbon atoms (increase in Vander Waals forces) in alcohols the boiling points decrease with increase of branching in Carbon Chain (because of decrease in Vander waals forces with decrease in surface area) the High Boiling points of Alcohols are mainly due to the presence of intermolecular Hydrogen bonding in them which is lacking in ether and Hydrocarbons.

(i) Which of the following has highest boiling point?

(a) n-Butane (b) 1-Chlorobutane (c) Butan-l-ol (d) Ethoxy ethane

(ii) Which of the following has lowest Boiling point?

(a) 1- Butanol (b) iso-butyl alcohol (c) 2-Butanol (d) 2-methyl-2-propanol

(iii) Which of the Following has highest boiling Point?

(a) CH_3OH (b) C_2H_5OH (c) $CH_3CH_2CH_2OH$ (d) $CH_3CH_2CH_2CH_2OH$

(iv) Arrange the following compounds in increasing order of boiling point

(a) Propan-1-ol, butan-2-ol, butan-1-ol, 1 Pentan-1-ol

(b) Propan-1-ol, butan-1-ol, butan-2-ol, pentan-1-ol

(c) Pentan-1-ol , butan-2-ol, butan-1-ol, propon-1-ol

(d) Pentan-1-ol, butan-1-ol, burton-2-ol, propan-1-ol

OR

Which of the following has lowest boiling point?

(a) Propanol (b) Hexanol (c) ehanol (d) octanol

Q.30 Biomolecules are complex molecules which build up living organisms. And required for their growth, maintanance and ability to reproduce. Carbohydrates are polyhydroxy aldehydes and Ketones which are major Sources of Energy. Monosaccharides are simple sugars which cannot be Hydrolyzed α-glucose and β-glucose are anomers. Proteins are Complex nitrogenous polymers of amino acids connected through Peptide bonds. The sequence in which amino acids are linked is called Primary structure. Secondary Structure are of 2 types – α-helix in globular proteins and β -pleated structure in fibrous Proteins in volving H-bonds. Tertiary Structure has H-bonds, disulphide linkage, ionic bonding and Vander Waals forces. Insulin is hormone for metabolism of glucose, has quaternary Structure. Denaturation of protein destroys Secondary & tertiary Structure, loss of biological activity but primary structure remaining the same.

Nucleic acids are polymers of nucleotides. RNA is of three types m-RNA, t-RNA, r-RNA, RNA has Adenine , cytosine, Uracil and Guanine. It helps in protein Synthesis. It

cannot replicate – DNA Contains deoxyribose, A, C, G and to thymine. It transfers genetic characteristics. DNA has double helix structure and undergoes replication.

(i) Which of the following is mono saccharide?

(a) Glucose (b) Fructose (c) galactose (d) All of these

(ii) Which of the following is fibrous protein?

(a) Albumin (b) Keratin (c) Caesin (d) Insulin

(iii) Which of the following is present in RNA but not in DNA?

(a) Thymine (b) Guanine (c) cytosine (d) Uracil

(iv) The linkage present in nucleic acid is

(a) Glycosidic (b) Peptide (c) Phosphodiester (d) All of these

OR

Which on is not part of nucleotides?

(a) Phosphate (b) pentose sugar (c) Nitrogen base (d) amino acids

Section – E

Q.31 (i) Write the IUPAC names & Hybridization of the following Complexes:

(a) $[Ni(CN)_4]^{-2}$ (b) $[Fe(H_2O)]^{+2}$

(ii) What is the difference between an ambidentate ligand and a Chelating ligand

OR

(I) Give the formulae of the following compounds:

(a) Potassium tetrahydroxido zincate (II)

(b) Hexaammine platinum (IV) Chloride

(ii) Explain Magnetic properties of $[Ni(CN)_4]^{-2}$

Q.32 (i) How would you obtain phenol from benzene?

(ii) Write Equation of the nitration of anisole?

OR

(i) What happen when phenol Is heated with Zinc dust?

(ii) How would you obtain phenol from cumene?

Q.33 (i) Name the products of Hydrolysis of lactose.

(ii) Define the ‘peptide linkage’ and ‘glycosidic linkage’

OR

(i) State Clearly what are Known as nucleosides & nucleotides.

(ii) Write short note on Names & Chemical name of vitamins.

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Roll No. _____ **NLCS/12/Mathematics (CORE)(041)/13**

Half Yearly Examination 2024 – 2025

Time - 3:00 Hrs. **M.M. 80**

General Instructions:

1. This Question Paper contains - five sections A, B, C, D and E. Each section is compulsory. However, there are internal choices in some questions.
2. Section A has 18 MCQs and 02 Assertion - Reason based questions of 1 mark each.
3. Section B has 5 Very Short Answer (VSA) - type questions of 2 marks each.
4. Section C has 6 Short Answer (SA) - type questions of 3 marks each.
5. Section D has 4 Long Answer (LA) - type questions of 5 marks each.
6. Section E has 3 source based / case based / passage based / integrated units of asses (4 marks each with sub part)

Section – A

Multiple Choice Questions One Mark each.

Q.1 The principal value of $\text{cosec}^{-1}\left(\frac{-2}{\sqrt{3}}\right)$ is

(a) $\frac{5\pi}{6}$ (b) $\frac{7\pi}{6}$ (c) $\frac{\pi}{6}$ (d) $\frac{-\pi}{3}$

Q.2 If A = $\begin{bmatrix}\cos\alpha & -\sin\alpha\\ \sin\alpha & \cos\alpha\end{bmatrix}$, and A + A' = I, if the value of α is

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{3}$ (c) $\frac{3\pi}{2}$ (d) $\frac{-\pi}{3}$

Q.3 If A is a square matrix such that $A^2 = A$, then $(I - A)^3 + A$ is equal to:

(a) I (b) I – A (c) I + A (d) 0

Q.4 If A = $\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$, then A^4 =

(a) $\begin{bmatrix}1 & 1\\ 0 & 0\end{bmatrix}$ (b) $\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$ (c) $\begin{bmatrix}0 & 0\\ 1 & 1\end{bmatrix}$ (d) $\begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix}$

Q.5 If $A = \begin{bmatrix}1 & \lambda & 2\\ 1 & 2 & 5\\ 2 & 1 & 1\end{bmatrix}$ is not invertible then $\lambda \neq$?

(a) 1 (b) 2 (c) 0 (d) –1

Q.6 If A is a 3× 3 matrix such that |A| =8, then |3 A| equals.

(a) 8 (b)72 (c) 216 (d) 64

Q.7 $f(x) = \begin{cases}\frac{\sqrt{1+px}-\sqrt{1-px}}{x} & -1 \le x < 0\\ \frac{2x+1}{x-2} & , 0 \le x \le 1\end{cases}$ is continuous in the interval [– 1, 1] then p is equal to :

(a) 1 (b) $\frac{1}{2}$ (c) – 1/2 (d) not

Q.8 If $y = \tan^{-1}\left(\frac{1-\sin x}{\cos x}\right)$ then $\frac{dy}{dx} =$?

(a) 1 (b) $\frac{1}{2}$ (c) – 1 (d) $\frac{-1}{2}$

Q.9 If f(x) = f (a –x), then , $\int_0^a xf(x)dx$ is equal to

(a) $\frac{a}{2}\int_0^a f(x)dx$ (b) $\int_0^a f(x)dx$ (c) $\frac{a^2}{2}\int_0^a f(x)dx$ (d) $-\frac{a^2}{2}\int_0^a f(x)dx$

Q.10 The solution of the differential equation $\frac{dy}{dx} = e^{x-y} + x^2e^{-y}$ is

(a) $e^x + e^y = \frac{x^3}{3} + c$ (b) $e^x - e^y = \frac{x^3}{3} + c$ (c) $y = e^{x-y} - x^2 e^{-y} + c$ (d)not

Q.11 If$\vec{a}, \overrightarrow{b}$ and$\vec{c}$ are mutually perpendicular unit vector then $|\vec{a}+\vec{b}+\vec{c}|$ =?

(a) 1 (b) $\sqrt{2}$ (c) $\sqrt{3}$ (d) 2

Q.12 If$\vec{a}$ is a non zero vector of magnitude 'a' and λ a non zero scalar, then $\lambda\vec{a}$ is a unit vector if

(a) a =$|\lambda|$ (b) a =$\frac{1}{|\lambda|}$ (c) $\lambda = 1$ (d) λ=2

Q.13 Find the sum of the vectors

$\vec{a} = \hat{\imath} - 2\hat{\jmath} + \hat{k}$, $\vec{b} = -2\hat{\imath} + 4\hat{\jmath} + 5\hat{k}$ and $\vec{c} = \hat{\imath} - 6\hat{\jmath} - 7\hat{k}$

(a) $-\hat{\imath} + 4\hat{\jmath} - \hat{k}$ (b) $-4\hat{\jmath} - \hat{k}$ (c) $-\hat{\imath} - 4\hat{\jmath} - \hat{k}$ (d) $\hat{\imath} - 4\hat{\jmath} - \hat{k}$

Q.14 The angle between the vectors $\vec{a} = \hat{\imath} - 2\hat{\jmath} + 3\hat{k}$and $\overrightarrow{b} = 3\hat{\imath} - 2\hat{\jmath} + \hat{k}$is

(a) $\cos^{-1}\frac{3}{5}$ (b) none of these (c) $\cos^{-1}\frac{5}{7}$ (d) $\frac{3}{\sqrt{14}}$

Q.15 A line makes equal angles with co - ordinate axis. Direction cosines of this line are

(a) $\pm\left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$ (b) $\pm\left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right)$ (c) $\pm(1,1,1)$ (d) $\pm\left(\frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}\right)$

Q.16 Maximize Z = 3x + 4y, subject to the constraints : x + y ≤ 1, x ≥ 0, y ≥ 0.

(a) 4 (b) 5 (c) 6 (d) 3

Q.17 The corner points of the feasible region determined by the system of linear inequalities are (0, 0), (4, 0), (2, 4), and (0, 5). If the maximum value of z = ax + by, where a, b > 0 occurs at both (2, 4) and (4, 0), then:

(a) 3a = b (b) 2a = b (c) a = 2b (d) not

Q.18 Magnitude of unit vector is

(a)1 (b) 2 (c) 0 (d) 6

Q.19 **Assertion (A)** : The matrix A = $\begin{bmatrix} 3 & -1 & 0 \\ \frac{3}{2} & 3\sqrt{2} & 1 \\ 4 & 3 & -1 \end{bmatrix}$ is rectangular matrix of order 3.

Reason (R): If A = $[a_{ij}]_{m\times 1}$, then A is column matrix.

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

Q.20 **Assertion (A):** $\int \left(\frac{1}{1+x^2}\right) dx$ = tan $^{-1}$ (x ^{2}) + c.

Reason (R): $\int \frac{1}{1+x^2} dx$ = tan $^{-1}$ x + c

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

Section – B

Q.21 Evaluate: - $\tan^{-1}\left(-\frac{1}{\sqrt{3}}\right) + \cot^{-1}\left(\frac{1}{\sqrt{3}}\right) + \tan^{-1}\left(\sin\left(-\frac{\pi}{2}\right)\right)$. 2

OR

Find the value of $\tan^{-1}\left(\tan\frac{2\pi}{3}\right)$.

Q.22 Different sinx^3 w.r.t cosx 2

Q.23 Check the continuity of the function,f(x) = |x + 2| − 1 at x =2 2

Q.24 Different the following function f given by f(x) = $2x^3y - 3x^2y - \sin xy + 7$ w.r.t.x 2

OR

Differentiate the following function f given by $f(x) = 4xy - \frac{1}{2}x^2 + \tan x$, w. r. t x

Q.25 Evaluate: $\int \frac{1}{x\log x\log(\log x)}dx$. 2

Section – C

Q.26 If x = $a\left(\frac{1+t^2}{1-t^2}\right)$ and y = $\frac{2t}{1-t^2}$, find $\frac{dy}{dx}$. 3

Q.27 Evaluate: $\int \frac{x^2(x^4+4)}{x^2+4}dx$.

Q.28 Evaluate: $\int \frac{3x+1}{\sqrt{5-2x-x^2}}dx$. 3

Q.29 Verify that the function xy = log y + C (explicit or implicit) is a solution of differential equation

$y' = \frac{y^2}{1-xy}(xy \neq 1)$. 3

OR

Find the general solution of the differential equation $(x^3 + x^2 + x + 1)\frac{dy}{dx} = 2x^2 + x$. 3

Q.30 Maximise and Minimise Z = 3x– 4y. subject to $x - 2y \leq 0$ $-3x + y \leq 4$, $x - y \leq 6$ $x, y \geq 0$. 3

Q.31 Evaluate $\int \frac{\sin x}{\sin x+\cos x}dx$. 3

Section – D

Q.32 Evalute : $\int\left(\sqrt{\tan x}+\sqrt{\cot x}\right)dx$ 5

Q.33 Find $\int \frac{(2x+3)}{(x-1)(x-2)(x-3)}dx$ 5

OR

Find $\int \frac{(4x+3)}{(x+1)(x+2)(x+3)}dx$.

Q.34 If $A = \begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}$, find A^{-1} . Using A^{-1} solve the system of equations 2x – 3y + 5z = 11; 3x + 2y – 4z = – 5; x + y – 2z = – 3 5

Q.35 Sketch the graph of y = |x + 3| and evaluate $\int_{-6}^{0}|x + 3|\,dx$. 5

OR

Using integration find the area of the region bounded by the ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$.

Section – E

Q.36 Area of a triangle whose vertices are (x_1 ,y_1), (x_2 , y_2) and (x_3 , y_3) is given by the determinant 4

$\Delta = \frac{1}{2}\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$ Since, area is a positive quantity, so we always take the absolute value of the determinant A. Also, the area of the triangle formed by three collinear points is zero.

(a) Find the area of the triangle whose vertices are (– 2, 6), (3, - 6), and (1, 5).

(b) If the points (2, – 3), (k, – 1) and (0, 4) are collinear, then find the value of 4k.

(c) If the area of a triangle ABC, with vertices A(1, 3), B(0, 0) and C{k, 0) is 3 sq. units, then a value of k is.

OR

Using determinants, find the equation of the line joining the points A(1, 2) and B(3, 6).

Q.37 If a real - valued function/(x) is finitely derivable at any point of its domain, it is necessarily continuous at that point. But its converse need not be true. For example, every polynomial, constant function are both continuous as well as differentiable and inverse trigonometric functions are continuous and differentiable in its domains etc. 4

(i) If f(x) = $\begin{cases} x, for x \leq 0 \\ 0, for x > 0 \end{cases}$, then at x = 0.

(a) f(x) is continuous but not differentiable (b) f(x) is neither continuous nor differentiable

(c) f(x) is differentiable and continuous (d) f(x) is non continuous

(ii) If f(x) = |x – 1|, x∈ R, then at x = 1.

(a) f(x) iscontinuous (b) f(x) is continuous and differentiable

(c) f(x) is continuous but not differentiable (d) f(x) is not continuous

(iii) f(x) = x^3 is :

(a) neither continuous nor differentiable at x = 3 (b) continuous but not differentiable at x = 3

(c) continuous and differentiable at x = 3 (d) noncontinuous butdifferentiable at x = 3

OR

If f(x) = [sin x] , then which of the following is true?

(a) f(x) is continuous at x = 0 but not differentiable

(b) f(x) is continuous and differentiable at x = 0

(c) f(x) is discontinuous at x = 0

(d) f(x) is differentiable but not continuous at x = $\frac{\pi}{2}$

Q.38 Let x = f(t) and y = g(t) be parametric forms with t as a parameter, then 4

$\frac{dy}{dx} = \frac{dy}{dt} \times \frac{dt}{dx} = \frac{g'(t)}{f'(t)}$,wheref(t) ≠ 0.

The derivative of f(tan x) w.r.t. g(sec x) at x = $\frac{\pi}{4}$, where f'(1) = 2 and $g'\left(\sqrt{2}\right)$ = 4, is

(a) $\sqrt{2}$ (b) $\frac{1}{\sqrt{2}}$ (c) 0 (d) not

(ii) The derivative of $\sin^{-1}\left(\frac{2x}{1+x^2}\right)$ with respect to $\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$ is :

(a) – 1 (b) 2 (c) 4 (d) 1

(iii) Find the derivative of e^{x^3} with respect to log x is

OR

Find the derivative of $\cos^{-1}(2x^2 - 1)$ w.r.t. $\cos^{-1} x$ is :

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Roll No. _____ **NLCS/12/Physics(042)/18**

Half Yearly Examination 2024 – 2025

Time - 3:00 Hrs. **M.M. 70**

General Instructions:

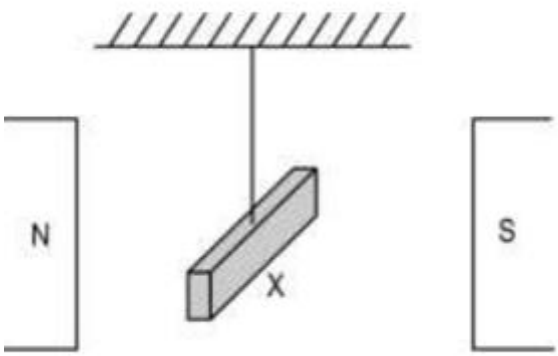
1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. All the sections are compulsory.
4. **Section A** contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, **Section B** contains five questions of two marks each, **Section C** contains seven questions of three marks each, **Section D** contains two case study based questions of four marks each and **Section E** contains three long answer questions of five marks each.
5. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
6. Use of calculators is not allowed.
7. You may use the following values of physical constants where ever necessary
    1. $c = 3 \times 10^8$ m/s
    2. $me = 9.1\ 10^{-31}$ kg
    3. $e = 1.6 \times 10^{-19}$ C
    4. $Mo = 4\ 10^{-7}\ TmA^{-1}$
    5. $h = 6.63\ 10^{-34}$ Js
    6. $Eo = 8.854\ 10^{-12}\ C^2N^{-1}m^{-2}$
    7. Avogadro's number = 6.023×10^{23} per gram mole

Section – A

Q.1 An electric dipole having a dipole moment of 4×10^{-9} C m is placed in a uniform electric field such that the dipole is in stable equilibrium. If the magnitude of the electric field is 3×10^3 N/C, what is the work done in rotating the dipole to a position of unstable equilibrium?
(a) zero (b) 1.2×10^{-5}J (c) 2.4×10^{-5}J (d) -1.2×10^{-5} J

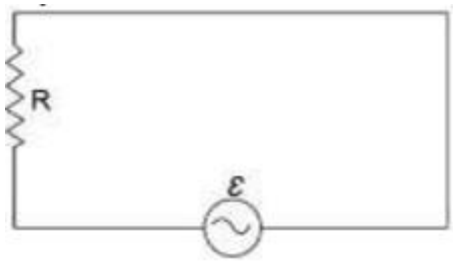
Q.2 An infinite line of charge has a linear charge density of 10^{-7} C/m. What will be the magnitude of the force acting on an alpha particle placed at a distance of 4 cm from the line of charge?
(a) 14.4×10^{-15} N (b) 7.2×10^{-15} N (c) 4.5×10^4 N (d) 9×10^4N

Q.3 A rod when suspended in a uniform magnetic field aligns itself perpendicular to the magnetic field as shown below.



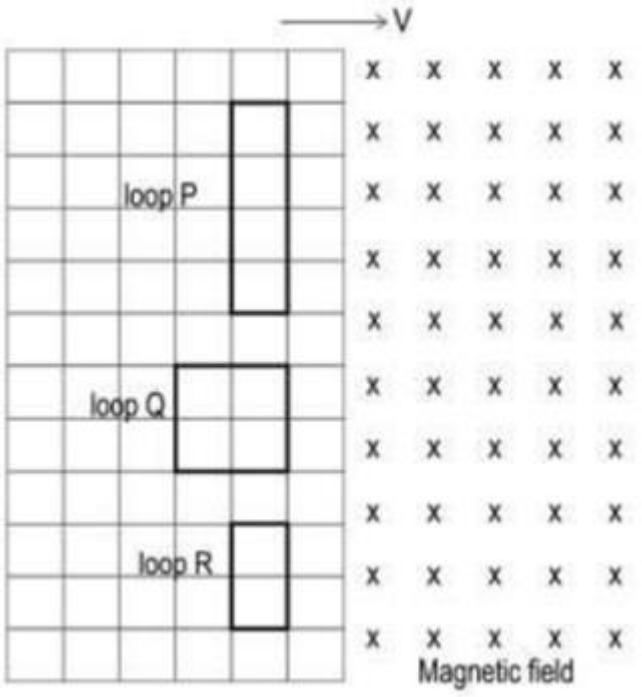
Which of the following statements is /are true for the rod?
(P) Every atom in the rod, has a zero magnetic moment.
(Q) The rod is attracted when taken near the poles of a strong magnet.
(R) The relative permeability of the material of the rod is slightly less than 1.
(S) The susceptibility of the material of the rod is directly proportional to temperature.
(a) only Q (b) only P and R (c) only Q and S (d) only R and S

Q.4 A pure resistor is connected to an AC power source as shown below.



Which of the following statement(s) is/are TRUE?
I: The average current flowing through the circuit during one full cycle is zero.
II: The current in the resistor leads the voltage by
III: The average power dissipated by the resistor is zero.
(a) only I (b) only I and II (c) only II and III (d) all - I, II and III

Q.5 Three loops as shown below move into the magnetic field with a velocity v



In which loop(s) will the induced emf be the largest at the instant when the loops enter the magnetic field?
(a) only P (b) only Q (c) only P and Q (d) only Q and R

Q.6 A point charge situated at a distance ‘r ‘ from a short electric dipole on its axis, experiences a force F. If the distance of the charge is ‘2r’, the force on the charge will be :
(a) F/16 (b)F/8 (c) F/4 (d) F/2

Q.7 The potential difference across a cell in an open circuit is 8V. It falls to 4 V when a current of 4A is drawn from it. The internal resistance of the cell is:
(a) 4Ω (b) 3Ω (c) 2Ω (d) 12Ω

Q.8 A diamagnetic substance is brought near the north or south pole of a bar magnet. It will be
(a) repelled by both the poles (b) attracted by both the poles
(c) repelled by the north pole and attracted by the south pole.
(d) attracted by the north pole and repelled by the south pole.

Q.9 A circular coil of radius 8.0 cm and 40 turns is rotated about its vertical diameter with an angular speed of 25/π rad/s in a uniform horizontal magnetic field of magnitude 3.0 x10^{-2}T. The maximum emf induced in the coil is:
(a) 0.12 V (b) 0.15 V (c) 0.19 V (d) 0.22 V

Q.10 The number of electrons flowing through a conductor per second is 3.3 x10^{-19}.The current flowing through the conductor is :
(a) 2.0 A (b) 3.4 A (c) 4.8 A (d) 5.3 A

Q.11 A bar magnet is dropped in a hollow metallic cylinder along its vertical axis. The acceleration of the falling magnet will be:
(a) zero (b) equal to g (c) less than g (d) greater than g

Q.12 Which of the following is not the property of an equipotential surface?
(a) They do not cross each other.
(b) The work done in carrying a charge from one point to another on an equipotential surface is zero.
c) For a uniform electric field, they are concentric spheres.
d) They can be imaginary spheres.

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.
(a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.

Q.13 **Assertion** : If the distance between parallel plates of a capacitor is halved and dielectric constant is three times, then the capacitance becomes 6 times.
Reason : Capacity of the capacitor does not depend upon the nature of the material.

Q.14 **Assertion** : The magnetic field produced by a current carrying solenoid is independent of its length and cross-sectional area.
Reason : The magnetic field inside the solenoid is uniform.

Q.15 **Assertion** : A capacitor is connected to a direct current source. Its reactance is infinite.
Reason : Reactance of a capacitor is given by $\chi_c = 1/\omega C$.

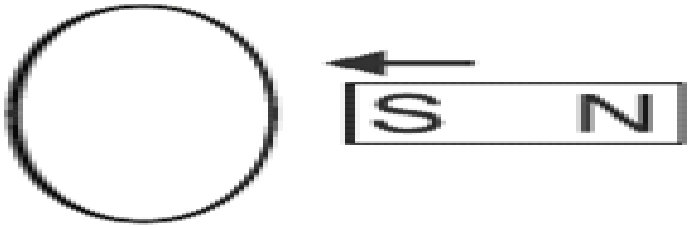
Q.16 **Assertion** : Electromagnetic wave are transverse in nature.
Reason : The electric and magnetic fields in electromagnetic waves are perpendicular to each other and the direction of propagation.

Section – B

Q.17 Define electric flux, it is scalar or vector write it's SI unit.

Q.18 Sketch a schematic diagram depicting oscillating electric and magnetic fields of an electromagnetic wave propagating along positive Z-direction.

Q.19 Give the direction of the induced current in a coil mounted on an insulating stand when a bar magnet is quickly moved along the axis of the coil from one side to the other as shown in figure.



Q.20 A slab of material of dielectric constant k has the same area as that of the plates of a parallel plate capacitor but has thickness 3d / 4 where d is the separation between the plates. Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor.

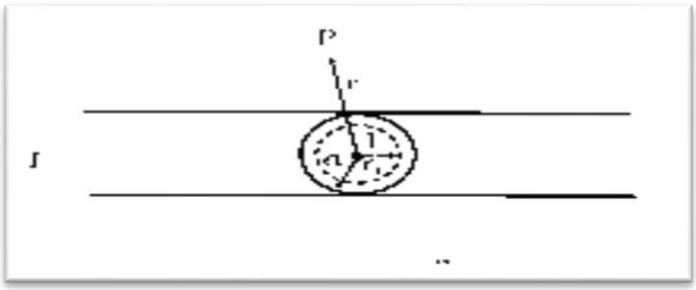
Q.21 State kirchhoff's first law for electric circuit?

OR

Using the concept of drift velocity of charge carriers in a conductor, deduce the relation between current density, conductivity and electric field of the conductor.

Section – C

Q.22 The given figure shows a long straight wire of a circular cross-section (radius a) carrying steady current I. The current I is uniformly distributed across this rosssection. Calculate the magnetic field in the region r < a and r > a.



OR

(a) Explain with the help of a labelled diagram the underlying principle, construction and working of a moving coil galvanometer.

(b) Why a galvanometer as such be used for measuring the current in a circuit? Explain.

Q.23 Deduce an expression for the mutual inductance of two long coaxial solenoids but having different radii and different number of turns,

Q.24. A 100 Ω resistor is connected to a 220 V, 50 Hz ac supply.

(a) What is the rms value of current in the circuit?

(b) What is the net power consumed over a full cycle?

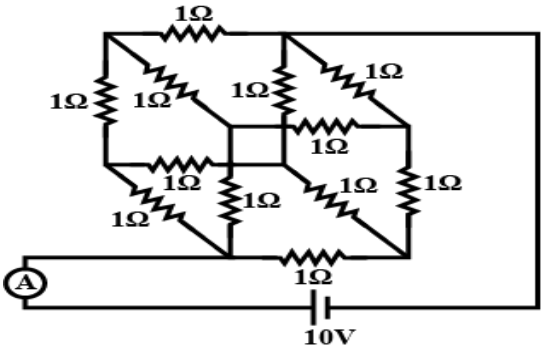
Q.25 State Lenz's law. Show that Lenz's law is accordance with law of conservation of energy.

Q.26 A silver wire has a resistance of 2.1 Ω at 27.5 °C, and a resistance of 2.7 Ω at 100°C. Determine the temperature coefficient of resistivity of silver.

OR

A battery or 10 V and negligible internal resistance is connected across the diagonally opposite corner of a cubical network consisting of 12 resistors each of resistance 1Ω. The total current I :

in the circuit external to the network is



Q.27 Derive an expression for electric potential due to an electric dipole at any point at angle θ.

Q.28 How does (i) the pole strength and (ii) magnetic moment of each part of a bar magnet change if it is cut into two equal pieces transverse to its length and longitudinally.

Section – D

Q.29 **Read the following paragraph and answer the questions that follow:**

The resistance of a conductor is the property by virtue of which it opposes the flow of charges through it. The more is the resistance, the less is the current I, for a given potential difference. The resistance depends on the length (L), cross- sectional area (A) and the given condition of temperature. It also depend on the nature of the conductor.

The resistivity or specific resistance of a material is the resistance of a conductor of that material, having unit length and unit area of cross-section or is the resistance offered by the unit cube of the material of a conductor.

1. The SI unit of specific resistance is:
   (a) Ω m (b) Ω (c) Ω^{-1} (d) no unit
2. If the length of the conductor becomes four times by stretching it, the resistivity:
   (a) becomes 16 times (b) becomes 4 times
   (c) remains same (d) reduced 4 times
3. If the length of the conductor becomes doubled by stretching it, the resistance:
   (a) becomes 4 times (b) remains same
   (c) becomes 2 times (d) reduced 4 times
4. A wire having resistance 10 Ω per cm is stretched to doubled its length and then cut equally into four equal parts, then these parts are connected in parallel, then the effective resistance will be :
   (a) 2.5 Ω (b) 40 Ω (c) 5 Ω (d) 10 Ω

OR

The resistivity of a conductor depends upon
(a) Length (b) Area (c) Temperature (d) All of These

Q.30. **Read the following paragraph and answer the questions that follow:**

An arrangement of two equal and opposite magnetic poles separated by a small distance is called a magnetic dipole. The product of its pole strength and magnetic length is called magnetic dipole moment. $M = q_m \times 2l$

When a magnetic dipole is placed in a uniform Magnetic field B, the force on the two poles are equal and opposite. They form a couple. Moment of couple or torque is given by $T = mB \sin 0$

The direction of the torque is given by right hand screw rule. The effect of the torque T is to make the magnet align itself parallel to the field B.That is why a freely suspended magnet aligns itself in the north-south direction because the earth has its own magnetic field which exerts a torque on the magnet tending it to align along the field. If the dipole is rotated against the action of this torque, work has to be done. This work is stored as a potential energy of the dipole.

1. The potential energy is maximum when magnetic dipole is in:
   (a) unstable equilibrium (b) stable equilibrium (c) at 90° (d) at 45°
2. The dimension formula of magnetic dipole is:
   (a) $[L^2A]$ (b $[AL^2]$ (c) $[MA\ L^2]$ (d) $[TAL^2M]$
3. A magnetised needle of magnetic moment 4.8×10^{-2}J/T is placed at 30° with the direction of uniform magnetic field of magnitude 3×10^{-2}T . The torque acting on the needle is:
   (a) 7.2×10^{-4}J (b) 2.7×10^{-4}J (c) $7.2 \times 10^{+4}$J (d) zero
4. A bar magnet of magnetic moment M is aligned parallel to the direction of uniform magnetic field B. The work done, to turn the magnet, so as to align its magnetic moment opposite to the field direction is:
   (a) MB (b) (MB)/2 (c) zero (d) 2MB

OR

The SI unit of magnetic dipole moment is -

(a) c-m (b) A-m^2 (c) A-m (d) c/m^2

Section – E

Q.31 (a) Using Gauss's theorem, derive an expression for electric field due to a uniformly charged infinite plane sheet having surface area A.

(b) How many electronic charges form one coulomb of charge ?

OR

(a) Using Gauss's theorem, derive an expression for electric field due to a uniformly charged infinite long wire having linear charge density λ.

(b) Find out the electric flux due to one coulomb of charge?

Q.32 (a) A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit.

(b) Plot a graph to show the variation of current with frequency of the ac source, explaining the nature of its variation for two different resistances $R_1$and R_2 ($R_1 < R_2$) at resonance.

OR

(i) State the principle and working of a transformer. Draw a schematic diagram of a step-up transformer. Explain its working.

(ii) Obtain the expression for the ratio of secondary to primary voltage in terms of the:
(a) number of secondary and primary windings and
(b) primary to secondary currents.

Q.33 Two long straight parallel current carrying conductors are kept 'a' distant apart in air. The direction of current in both the conductors is same. Find the magnitude of force per unit length and direction of the force between them. Hence define one ampere.

OR

(a) Derive an expression for the torque on a rectangular coil of area A, carrying a current I placed in a magnetic field B. The angle between the direction of B and the vector perpendicular to the plane of the coil is 0.

Also, show that planer loop carrying a current I, having N closely wound turns and area of cross-section A, possesses a magnetic moment m = NIA

(b) Write an expression for the force experienced by a charge q moving with a velocity v in a uniform magnetic filed B . Use this expression to define the unit of magnetic field.

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