VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Main-2 | JEE-2024

Date: 17/07/2023 **Maximum Marks: 300**

Timing: 4:00 PM to 7:00 PM **Duration : 3.0 Hours**

General Instructions

1. The test is of **3 hours** duration and the maximum marks is **300.**
2. The question paper consists of **3 Parts** (Part I: **Physics**, Part II: **Chemistry**, Part III: **Mathematics**). Each Part has **two** sections (Section 1 & Section 2).
3. **Section 1** contains **20 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.
4. **Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. You will NOT be allowed to attempt the sixth question. If you wish to attempt any other question apart from the five already attempted, then you will have to delete any one response from the five previously answered and then proceed to answer the new one.**
   The answer to each question should be **rounded off to the nearest integer**.
5. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
6. On completion of the test, the candidate must hand over the Answer Sheet to the **Invigilator** on duty in the Room/Hall. **However, the candidates are allowed to take away this Test Booklet with them**.

Marking Scheme

1. **Section – 1:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. **Section – 2:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

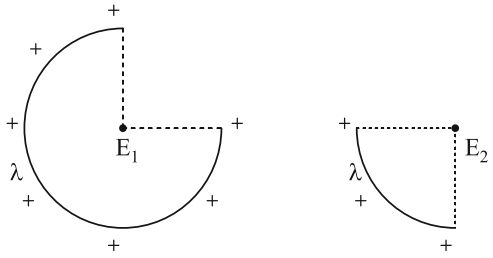
Candidate's Signature : _____ **Invigilator's Signature** _____

PART I : PHYSICS	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. Uniform charge is given on two circular arcs as shown in the figure. E_1 and E_2 are the magnitude of electric fields at centre, then:



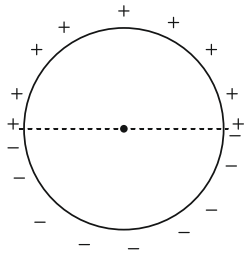
(A) $E_1 > E_2$ **(B)** $E_2 > E_1$

(C) $E_1 = E_2$ **(D)** Can't be determined from given information

2. A hollow cylinder having length 'ℓ' and radius 'r' is placed in a uniform electric field 'E_0'. Direction of electric field is perpendicular to the axis of the cylinder, then electric flux entering the cylinder will be:

(A) $2\pi r\ell E_0$ **(B)** $\pi r^2 E_0$ **(C)** $\pi r\ell E_0$ **(D)** $2r\ell E_0$

3. Equal and opposite uniform charges are given on a non-conducting ring as shown in the figure.

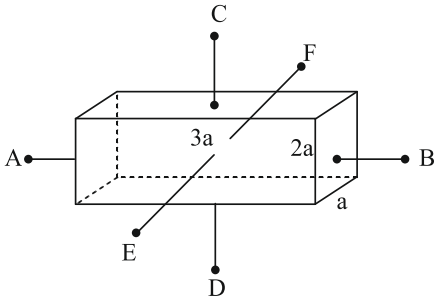


E and V are the electric field and potential at the centre, then:

(A) $V = 0, E = 0$ **(B)** $V = 0, E \neq 0$ **(C)** $V \neq 0, E = 0$ **(D)** $V \neq 0, \neq E \neq 0$

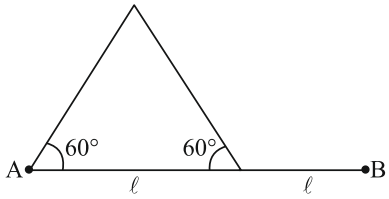
SPACE FOR ROUGH WORK

4. A cuboidal conductor has dimension $(a \times 2a \times 3a)$ as shown in the figure. Resistance across AB, CD and EF are x, y and z respectively, then:



(A) $x = y = z$ **(B)** $z > y > x$ **(C)** $y > x > z$ **(D)** $x > y > z$

5. A wire having resistance R is bent as shown in the figure. The effective resistance between A and B is:



(A) $\frac{5}{12}R$ **(B)** $\frac{5}{24}R$ **(C)** $\frac{R}{8}$ **(D)** $\frac{R}{2}$

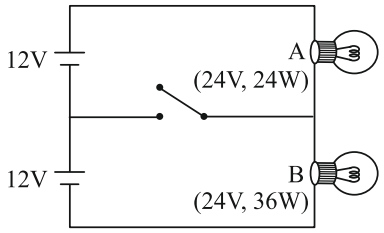
6. Two light bulbs in the circuit have rating A(24V, 24W) and B(24V, 36W) as shown. After closing the switch,

(A) The intensity of light bulb A increases

(B) The intensity of light bulb A decreases

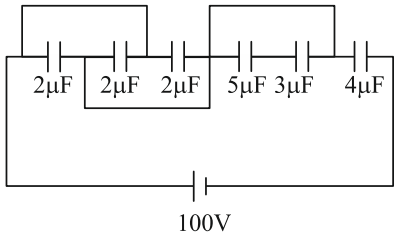
(C) The intensity of light bulb B remains unchanged

(D) The intensity of light bulb B decreases



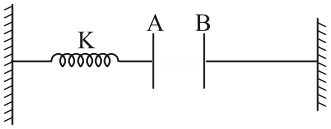
SPACE FOR ROUGH WORK

7. In the circuit shown in the figure charge stored in the capacitor of capacitance $5\mu F$ is:



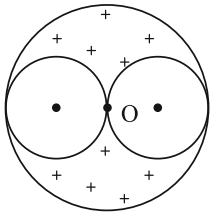
(A) $60\,\mu C$ **(B)** $20\mu C$ **(C)** $30\mu C$ **(D)** Zero

8. Plate A of a parallel air filled capacitor is connected to a spring having force constant K and plate B is fixed. If a charge +q is placed on plate A and charge –q on plate B then find out extension in spring in equilibrium. Assume area of plate is 'A'.



(A) $\frac{q^2}{K\varepsilon_0 A}$ **(B)** $\frac{q^2}{4K\varepsilon_0 A}$ **(C)** $\frac{q^2}{2K\varepsilon_0 A}$ **(D)** $\frac{2q^2}{K\varepsilon_0 A}$

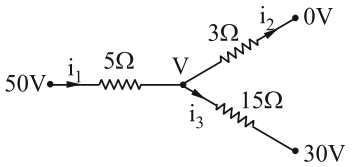
9. From a uniformly charged sphere two spherical cavities are removed as shown in the figure, then:



(A) Electric field in both the cavities will be uniform and will be equal
(B) Electric field in both the cavities will be uniform and direction of field will be opposite
(C) Electric field in both the cavities will be non-uniform
(D) Electric field at centre *O* will be non-zero

SPACE FOR ROUGH WORK

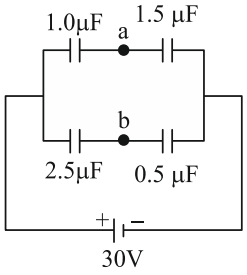
10. For given circuit:



(A) Potential of junction $V = 30\ V$ **(B)** Current $i_1 = 6A$

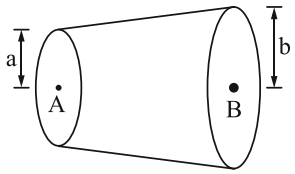
(C) Current $i_2 = 10A$ **(D)** $i_3 = 1A$

11. Four capacitors are connected to a 30 V battery as shown in figure. The potential difference between points *b* and a is:



(A) 5 V **(B)** 9 V **(C)** 10 V **(D)** 13 V

12. An electric current passes through non uniform cross-section wire made of homogeneous material. If j_A and j_B be current desities and E_A and E_B be the electric field intensities at A and B respectively, then :



(A) $j_A > j_B ; E_A > E_B$ **(B)** $j_A > j_B ; E_A < E_B$

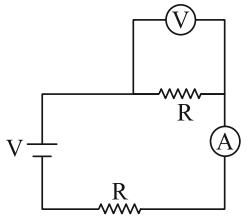
(C) $j_A > j_B ; E_A = E_B$ **(D)** $j_A < j_B ; E_A < E_B$

SPACE FOR ROUGH WORK

13. A charge 'q' is placed at the vertex of a right circular cone, having base radius 'R' and height 'H' such that $H=\frac{3}{4}R$. Then electric flux passing through the circular face of the cone will be:

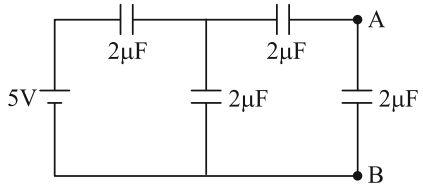
(A) 0 **(B)** $\frac{q}{5\varepsilon_0}$ **(C)** $\frac{q}{10\varepsilon_0}$ **(D)** $\frac{q}{2\varepsilon_0}\left(1-\frac{1}{\sqrt{2}}\right)$

14. In the circuit shown. ammeter and voltmeter are ideal. Readings of ammeter and voltmeter will be:



(A) $\frac{V}{2R},V$ **(B)** $0,V$ **(C)** $0,0$ **(D)** $\frac{V}{2R},\frac{V}{2}$

15. Find the potential difference across AB in the circuit shown.



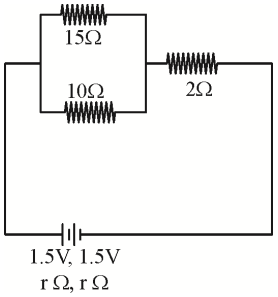
(A) 4V **(B)** 2V **(C)** 1V **(D)** 5V

16. A charge 'q' is distributed uniformly on one side of an equilateral triangle having side length 'ℓ'. Find the magnitude of electric field at centre of the triangle.

(A) 0 **(B)** $\frac{3kq}{\ell^2}$ **(C)** $2\sqrt{3}\frac{kq}{\ell^2}$ **(D)** $\frac{6kq}{\ell^2}$

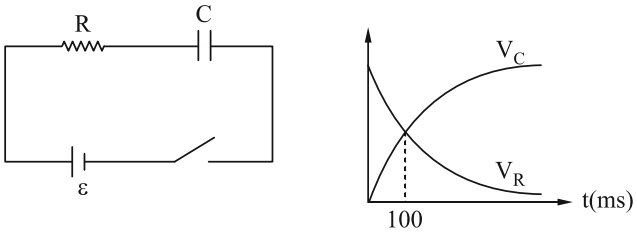
SPACE FOR ROUGH WORK

17. In the given circuit, current in the 10Ω resistance is 0.2A. The internal resistance *r*, of each cell is:



(A) 1Ω **(B)** 0.5Ω **(C)** 0Ω **(D)** 1.5Ω

18. In the RC circuit shown, switch is closed at $t = 0$. Graph showing variation of potential (V_R) across resistor and potential (V_C) across capacitor are given. Time constant of circuit is approximately equal to : [take ln2 = 0.69]

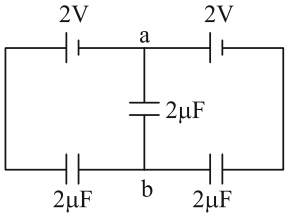


(A) 100 ms **(B)** 145 ms **(C)** 200 ms **(D)** 300 ms

19. A capacitor of capacitance C is initially charged to a potential difference V. Now it is connected to a potential difference of 2V with opposite polarity. The ratio of heat generated to the final energy stored in the capacitor will be:

(A) 1.75 **(B)** 2.25 **(C)** 2.5 **(D)** 0.5

20. Find the potential difference $V_a - V_b$ between the points a and b shown in the figure.



(A) 0 V **(B)** 1 V **(C)** 1.5 V **(D)** 2 V

SPACE FOR ROUGH WORK

SECTION-2

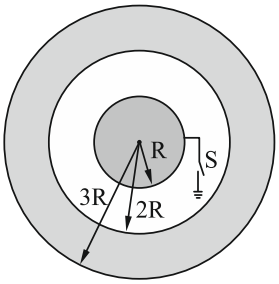
Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted.
The answer to each question should be **rounded off to the nearest integer**.

1. Electric field along x-axis varies as $E=(4-3x^2)V/m$. If potential at $x=2m$ is 5V, then potential at $x=5m$ will be _____ Volt.

2. Resistivity of copper at room temperature is $2\times10^{-8}\,\Omega m$. Density of mobile electrons is $9\times10^{27}/m^3$. The relaxation time for electrons will nearly be 2×10^{-x} sec, find *x*.

3. A 60pF capacitor is fully charged by a 20 V supply. It is then disconnected from the supply and is connected to another uncharged 60 pF capacitor in parallel. The electrostatic energy that is lost in this process by the time the charge is redistributed between them is _____ .(in nJ)

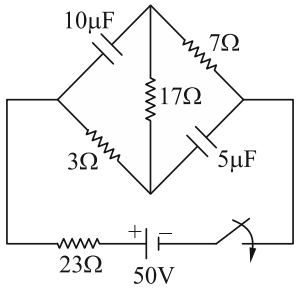
4. An uncharged conducting sphere having radius R is placed concentrically inside a spherical conducting shell of inner and outer radii 2R and 3R as shown in the fiugre. Shell is given a charge –*Q*. After closing switch 'S' charge flow through it is $\frac{nQ}{10}$, find *n*.



5. A galvanometer, having a coil resistance of 50Ω gives full scale deflection for a current of 0.05 A. Find the length (in m) of a resistance wire of area of cross section $2.97\times10^{-2}cm^2$ that can be used to convert the galvanometer in to ammeter which can read a maximum current 5A. (Resitivity of wire $\rho=5\times10^{-7}\,\Omega m$)

SPACE FOR ROUGH WORK

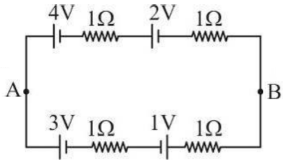
6. The charge (in μC) on $10\mu F$ capacitor in steady state is:



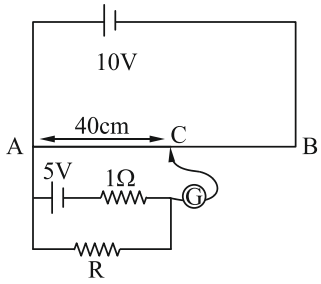
7. A point charge $200\mu C$ is located in x-y plane at the point with position vector $\vec{r}_o = (2\hat{i} + 3\hat{j} + \hat{k})m$. Electric potential at point with position vector $\overrightarrow{r_p} = (8\hat{i} - 5\hat{j} + \hat{k})m$ will be _____kV.

8. The resistance of a wire is 5Ω at $50°C$ and 6Ω at $100°C$. The resistance of the wire at $0°C$ will be_____Ω.

9. The potential difference between the points A and B in the given circuit is _____ (in V).



10. A potentiometer wire AB is 100 cm long and has a total resistance 10Ω. If galvanometer shows zero deflection at position C. Find the value of unknown resistance R in ohm.



SPACE FOR ROUGH WORK

PART II : CHEMISTRY	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. For a zero order reaction $x \longrightarrow y$, time taken for Reactant's concentration to reduce to 75%, 50% and 25% of its initial value is p, q and r respectively. The correct relation is:

(A) p = q = r **(B)** 6p = 3q = 2r **(C)** p = 2q = 3r **(D)** 3p = 2q = r

2. In which of the following pairs, product of electrolysis is same at cathode? (Using inert electrodes)

(A) $CuSO_4(aq)$ and $AgNO_3(aq)$ **(B)** $NaCl(aq)$ and $CuSO_4(aq)$

(C) $Na_2SO_4(aq)$ and $HCl(aq)$ **(D)** $AgNO_3(aq)$ and $Na_2SO_4(aq)$

3. Match the following :

	Column-I		**Column-II**
(i)	Kinetic property	**(p)**	Brownian motion
(ii)	Coagulation	**(q)**	Peptization
(iii)	Preparation of colloid	**(r)**	Dialysis
(iv)	Purification of colloid	**(s)**	Adding oppositely charged ion

(A) (i) – (q), (ii) – (r), (iii) – (s), (iv) – (p) **(B)** (i) – (p), (ii) – (q), (iii) – (s), (iv) – (r)

(C) (i) – (p), (ii) – (s), (iii) – (r), (iv) – (q) **(D)** (i) – (p), (ii) – (s), (iii) – (q), (iv) – (r)

4. Consider a reaction, A + B $\longrightarrow$ Product, the half-life of A was found to be directly proportional to its initial concentration. For B, it was found that the product of its initial concentration and half-life is constant. The overall order of reaction is:

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

SPACE FOR ROUGH WORK

5. Column I lists four cations and Column II lists ionic molar conductivities. The correct match of these two columns is:

	Column – I		Column – II
(i)	$OH^-(aq.)$	**(p)**	38.66 S cm^2mol^{-1}
(ii)	$Li^+(aq.)$	**(q)**	50.11 S cm^2mol^{-1}
(iii)	$Na^+(aq.)$	**(r)**	73.52 S cm^2mol^{-1}
(iv)	$K^+(aq.)$	**(s)**	197.6 S cm^2mol^{-1}

(A) (i) – (s), (ii) – (r), (iii) – (q), (iv) – (p) **(B)** (i) – (s), (ii) – (p), (iii) – (q), (iv) – (r)
(C) (i) – (p), (ii) – (s), (iii) – (r), (iv) – (q) **(D)** (i) – (p), (ii) – (q), (iii) – (r), (iv) – (s)

6. For the elementary reaction,

$2A + 3B \longrightarrow C + 2D$, the incorrect option is :

(A) $\frac{-d[A]}{dt} = \frac{d[D]}{dt}$ **(B)** $\frac{-d[B]}{dt} = \frac{3.d[C]}{dt}$

(C) $\frac{-3d[A]}{dt} = \frac{-2d[B]}{dt}$ **(D)** $\frac{-3d[B]}{dt} = \frac{2.d[D]}{dt}$

7. Consider the following reaction sequence.

$Starch \xrightarrow{x} Maltose \xrightarrow{y} Glucose \xrightarrow{z} Alcohol + CO_2$ x, y, z respectively are :

(A) zymase, maltase, diastase **(B)** diastase, maltase, zymase
(C) diastase, zymase, maltase **(D)** maltase, diastase, zymase

8. **Statement I :** Larger the size of dispersed phase particles, greater is the scattering of light. Hence, more tyndall effect is observed.

Statement II : Larger the difference in refractive indices of dispersed phase and dispersion medium, more is the tyndall effect.

(A) Statement I is correct. Statement II is incorrect.
(B) Statement I is incorrect. Statement II is correct.
(C) Both statement I and II are correct.
(D) Both statement I and II are incorrect.

SPACE FOR ROUGH WORK

9. A galvanic cell undergoes following reaction at 298 K

$MnO_4^- + 8H^+ + 5Fe^{2+} \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$. The EMF of the cell could be increased by:

(A) increasing $\left[Mn^{2+}\right]$ **(B)** decreasing $\left[MnO_4^-\right]$

(C) increasing $\left[Fe^{3+}\right]$ **(D)** decreasing pH

10. Given, $\overset{\infty}{\lambda}_{eq}\left(Ca^{2+}\right) = x\,Scm^2eq^{-1}$

$\overset{\infty}{\lambda}_{eq}\left(PO_4^{3-}\right) = y\,Scm^2eq^{-1}$

Limiting molar conductivity $\left(\overset{\infty}{\lambda}_m\right)$ of $Ca_3\left(PO_4\right)_2\left(S\,cm^2\ mol^{-1}\right)$ is:

(A) (x + y) **(B)** 6 (x + y) **(C)** 3x + 2y **(D)** $\frac{x}{2}+\frac{y}{3}$

11. For the reaction $A + 2B + 3C \longrightarrow$ product, rate law gives the order of reaction 2, 1, 0 with respect to A, B, C respectively. The unit of rate constant is:

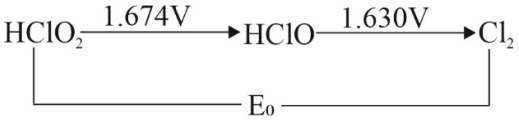
(A) $Mol^{-2}L^2s^{-1}$ **(B)** $Mol^{-1}L\ s^{-1}$ **(C)** $Mol^2L^{-2}s^{-1}$ **(D)** $Mol\ L^{-1}s^{-1}$

12. For a reaction having two reactants A and B, when concentration of A is doubled keeping concentration of B constant, rate of reaction becomes 4 times, when concentration of B is halved, keeping concentration of A constant, rate of reaction remains constant. How many times rate of reaction becomes when volume of container is doubled?

(A) 1/2 **(B)** 1/4 **(C)** 2 **(D)** 4

SPACE FOR ROUGH WORK

13. Given the Latimer diagram in acidic medium $\left(H^+ = 1\ M\right)$



The value of E_0 is:

(A) 3.304 V **(B)** 0.044 V **(C)** 1.718 V **(D)** 1.659 V

14. Graph between which of the following is NOT a straight line?

(A) Reactant's concentration vs. time (zero order)
(B) Half-life vs. initial concentration of reactant (first order)
(C) Rate of reaction vs. concentration of reactant (zero order)
(D) Reactant's concentration vs. time (first order)

15. 3 different electrolytic cells containing equimolar $AgNO_3(aq)$, $CuSO_4(aq)$ and $AuCl_3(aq)$ were connected in series and a current was passed through them for same time duration. Consider the following statements:

(I) Moles of $Ag_{(s)}, Cu_{(s)}, Au_{(s)}$ deposited at respective electrodes is in the ratio 1 : 2 : 3 respectively.

(II) Equivalents of $Ag_{(s)}$, $Cu_{(s)}, Au_{(s)}$ deposited at respective electrodes is in the ratio 1 : 1 : 1 respectively.

(III) After electrolysis, concentration of ions in electrolytic solution varies as

$$\left[Au^{3+}\right] > \left[Cu^{2+}\right] > \left[Ag^{+}\right]$$

Correct Statement(s) are :

(A) (I) and (II) only **(B)** (II) and (III) only
(C) (I) only **(D)** (I), (II) and (III)

16. A student studied amount of nitrogen adsorbed per gram of adsorbent (Iron) at different pressure (bar) and 70 K.

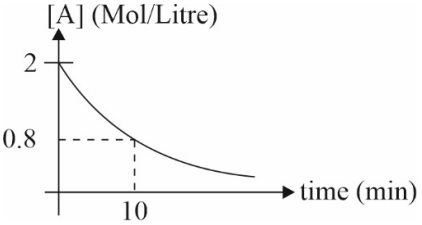
P(bar)	4	25	64
$\frac{x}{m}$	0.2	0.5	0.8

Calculate number of moles of nitrogen adsorbed per gram of adsorbent at pressure 36 bar at 70 K.

(A) 0.02 **(B)** 0.01 **(C)** 0.04 **(D)** 0.05

SPACE FOR ROUGH WORK

17. For the first order reaction $A \longrightarrow B$, the value of rate constant $\left(min^{-1}\right)$ is : $\left[\text{Take } \log\left(\frac{5}{2}\right) = 0.4\right]$



(A) 0.092 **(B)** 0.576 **(C)** 0.040 **(D)** 0.921

18. **Statement I :** Oxidation and reduction reactions occur at anode and cathode, respectively, in electrolytic cell as well as galvanic cell.

Statement II : The sign of anode and cathode are identical in electrolytic as well as galvanic cell.

(A) Statement I is correct. Statement II is correct. Statement II is the correct explanation of Statement I.

(B) Statement I is correct. Statement II is correct. Statement II is NOT the correct explanation of Statement I.

(C) Statement I is correct. Statement II is incorrect.

(D) Statement I is incorrect. Statement II is correct.

19. Identify the incorrect match.

(A) Lyophillic colloid – Gelatin **(B)** Positive colloid – Gold sol

(C) Associated colloid – Soap sol **(D)** Emulsion – Milk

20. Which of the following cell reactions is incorrect?

(A) Dry Cell : Anode : $Zn(s) \longrightarrow Zn^{2+} + 2e^-$

(B) $H_2 - O_2$ Fuel cell : Cathode : $O_2(g) + 2H_2O(l) + 4e^- \longrightarrow 4OH^-(aq.)$

(C) Mercury cell : Cathode : $HgO + H_2O + 2e^- \longrightarrow Hg(l) + 2OH^-$

(D) Lead storage battery : Cathode : $Pb(s) + SO_4^{2-}(aq.) \longrightarrow PbSO_4(s) + 2e^-$

SPACE FOR ROUGH WORK

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted.
The answer to each question should be **rounded off to the nearest integer**.

1. The resistance of 0.01 M potassium hydroxide is found to be 20Ω in a conductivity cell. If the conductivity of the solution is 0.027 $S\,cm^{-1}$, the value cell constant is $\cancel{Z}\ cm^{-1}$. The value of $100\,\cancel{Z}$ is _____ cm^{-1}.

2. By definition of gold number, the amount of protective colloid required to prevent coagulation of 10 ml gold sol against 1 ml 10% NaCl solution. Gold number of a protective colloid is 50. The amount of protective colloid required (in grams) to prevent coagulation of 50 ml of gold sol on addition of 1 ml 10% NaCl solution is 'x' g. The value of 100 'x' is _____.

3. The emf of the cell :
$Pt(s)\,|\,H_2(g)(1\,atm)\,|\,H^+(aq)(0.001\,M)\,||\,H^+(aq)(pH = x)\,|\,H_2(g)(1\,atm)\,|\,Pt(s)$ is 0.12 V at 298 K. The value of x is [Take $\frac{RT}{F} \times 2.303 = 0.06$].

4. For a first order reaction, rate constant is 0.0693 min^{-1}. If $t_{3/4}$ means the time taken for 75% reaction to be complete and $t_{7/8}$ means time taken for 87.5% reaction to be complete, the value of $t_{3/4} + t_{7/8}$ in min is _____ .

5. Upon electrolysis of $aq.Na_2SO_4$, 3.36 litres of gases were produced at STP. The time (in min.) for which a current of 9.65 A having 50 % current efficiency was passed through the cell is _____. [Molar volume at STP = 22.4 L] [Take F = 96500 C/mol]

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6. A vessel having capacity of 5L is filled with a gas having pressure 10 atm at 27°C. Upon addition of 60 g charcoal into the vessel, the pressure of the gas is reduced by 50%. Assuming volume occupied by charcoal is negligible, the mass of gas (in grams) adsorbed per unit gram of charcoal is $\not{Z}$. The value of 10 $\not{Z}$ is _____. [Molar mass of gas = 30 g/mol] [$R = \frac{1}{12}$ atm L $mol^{-1}K^{-1}$]

7. In a reaction $A \longrightarrow B$, the concentration of B was found to be 0.6 M after 10 min. The value of rate constant (k) in $mol\,L^{-1}\,s^{-1}$ is 1×10^{-x}. The value of x is _____ .

8. $E^{\circ}\left(Ag^{+}/Ag\right) = 0.80\ V$

$K_{SP}\left(AgI\right) = 8\times10^{-17}\ Mol^{2}dm^{-6}$ at 298 K

The value of $E^{\circ}\left(I^{-}/AgI/Ag\right)$ is 'x' V.

$\left|\frac{1000\,x}{2}\right|$ is _____. $\left(\text{Take, } \frac{2.303\,RT}{F} = 0.06 \text{ at } 298\ K\right)$ $[\log 8 = 0.9]$

9. Flocculation value of an effective ion is related to its charge as follows :

Flocculation value $\propto \frac{1}{\not{Z}^{6}}$ $(\not{Z} = \text{charge of ion})$

If 100 millimoles of x^{+} are required for coagulation of a sol, the number of millimoles of y^{4+} required for coagulation of same sol is $y\times10^{-3}$. The value of y is _____ .

10. For the reaction $A_{2(g)} \rightleftharpoons 2A_{(g)}$, the energy of activation of backward direction is 60 $kJ\,mol^{-1}$. If $\Delta_f \overset{\circ}{H}\left(A_{2(g)}\right) = 20\ kJ\ mol^{-1}$ and $\Delta_f \overset{\circ}{H}\left(A_{(g)}\right) = 40\ kJ\ mol^{-1}$, the activation energy of forward reaction is x $kJ\,mol^{-1}$. The value of x/10 is _____ .

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PART III : MATHEMATICS	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. If $f:[1,\infty)\to[2,\infty)$ is given by $f(x)=x+\frac{1}{x}$ then $f^{-1}(x)$ equals :

(A) $\frac{x+\sqrt{x^2-4}}{2}$ **(B)** $\frac{x}{1+x^2}$ **(C)** $\frac{x-\sqrt{x^2-4}}{2}$ **(D)** $1+x\sqrt{x^2-4}$

2. The fundamental period of the function $|\sin x|+|\cos x|$ has:

(A) π **(B)** $\frac{\pi}{2}$ **(C)** 2π **(D)** $\frac{\pi}{4}$

3. If $f(x)=\begin{cases}\frac{(1+\cos x)a}{\cos x} & x<\frac{\pi}{2}\\ b & x=\frac{\pi}{2}\\ \frac{e^{-\cos x}-2c}{\sqrt{x-\frac{\pi}{2}}} & x>\frac{\pi}{2}\end{cases}$ is continuous at $x=\frac{\pi}{2}$

Then $a+b+4c=$

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

4. $f(x)=x+|x|$ is continuous for :

(A) $x\in(-\infty,\infty)$ **(B)** $x\in(-\infty,\infty)-\{0\}$

(C) Only $x>0$ **(D)** No value of x

5. $\lim\limits_{x\to 0}\frac{1}{[x]}=$

(A) 1 **(B)** –1 **(C)** 0 **(D)** Does not exist

6. Let $y(x)=(1+x)(1+x^2)(1+x^4)(1+x^8)(1+x^{16})$, then $y'-y''$ at $x=-1$ is equal to:

(A) 976 **(B)** 464 **(C)** 496 **(D)** 944

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7. If f and g are 2 Non-Differentiable functions at $x = a$.

$S_1: f+g$ is always Non-Differentiable at $x = a$.

$S_2: f.g$ is always Non-Differentiable at $x = a$.

(A) S_1 is true and S_2 is false **(B)** S_1 is false and S_2 is true

(C) Both S_1 & S_2 are false. **(D)** Both S_1 & S_2 are true.

8. $\lim\limits_{x\to\infty} x\sin\left(\frac{2}{x}\right)$ is equal to:

(A) ∞ **(B)** 0 **(C)** 2 **(D)** $\frac{1}{2}$

9. If $2f(x)-f\left(\frac{1}{x}\right)=x+\frac{1}{x}, x\neq 0$, then the value of the expression $\frac{f(x)+f\left(\frac{1}{x}\right)}{x+\frac{1}{x}}$ is:

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

10. Find Range of $f(x)=\frac{x-[x]}{1-[x]+x}$

(A) $\left[0,\frac{1}{2}\right]$ **(B)** [0, 1] **(C)** $\left[0,\frac{1}{2}\right)$ **(D)** [0, 1)

11. The function $f(x)=\sin\left(\log\left(x+\sqrt{x^2+1}\right)\right)$ is:

(A) even **(B)** odd **(C)** constant **(D)** Neither Even nor Odd

12. Value of $\sec\left(2\sin^{-1}\frac{\sqrt{63}}{8}\right)$ is:

(A) $-\frac{32}{31}$ **(B)** $-\frac{64}{63}$ **(C)** $\frac{32}{31}$ **(D)** $\frac{64}{63}$

13. A function $f(x)=\begin{cases}1+x, & x\le 2\\ 5-x, & x>2\end{cases}$ is:

(A) Not continuous at $x = 2$

(B) Differentiable at $x = 2$

(C) Continuous but not differentiable at $x = 2$

(D) Continuous and Differentiable Everywhere

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14. If $\tan^{-1} a + \tan^{-1} b = \frac{\pi}{4}$, then point (a, b) lies on a.

(A) Parabola **(B)** Ellipse **(C)** Hyperbola **(D)** Circle

15. Range of the function $f(x) = \cot^{-1}(\sin x + \cos x)$, Where $x \in \left[0, \frac{\pi}{2}\right]$ is:

(A) $\left[\frac{\pi}{4}, \cot^{-1}\sqrt{2}\right]$ **(B)** $\left[\cot^{-1}\sqrt{2}, \frac{\pi}{4}\right]$ **(C)** $\left[\frac{\pi}{4}, 1\right]$ **(D)** $\left[\cot^{-1}\sqrt{2}, 1\right]$

16. S_1: If $f(x)$ is differentiable at $x = a$ then $f'(x)$ is continuous at $x = a$.

S_2: If $f'(x)$ is continuous at $x = a$ then $f(x)$ is differentiable at $x = a$.

(A) S_1 is true and S_2 is false **(B)** S_1 is false and S_2 is true

(C) Both S_1 & S_2 are false. **(D)** Both S_1 & S_2 are true.

17. The value of $\lim\limits_{x \to 0} \frac{e^{ax} - e^{bx}}{x}$ is equal to:

(A) $a + b$ **(B)** $a - b$ **(C)** e^{ab} **(D)** 1

18. Value of $\sum\limits_{r=0}^{n} \tan^{-1}\left(\frac{1}{2^{-r} + 2^{r+1}}\right)$ is:

(A) $\tan^{-1}\left(2^{n+1}\right) - \frac{\pi}{4}$ **(B)** $\frac{\pi}{4}$

(C) $\tan^{-1}\left(2^{n}\right) - \frac{\pi}{4}$ **(D)** $\frac{\pi}{2}$

19. $f(x) = (x-1)(x-2)....(x-2023)$ then $\frac{f'(2024)}{f(2024)} =$, where $f'(x)$ is derivative of $f(x)$.

(A) $\sum\limits_{n=1}^{2023} \frac{1}{n}$ **(B)** $\sum\limits_{n=1}^{2024} \frac{1}{n}$ **(C)** $\prod\limits_{n=1}^{2023} \frac{1}{n}$ **(D)** $\prod\limits_{n=1}^{2024} \frac{1}{n}$

20. Sum of all the real roots to the equation $\tan^{-1}(x) + \tan^{-1}(x+1) + \tan^{-1}(x+2) = 0$ is:

(A) 0 **(B)** –1 **(C)** 1 **(D)** 3

SPACE FOR ROUGH WORK

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted.
The answer to each question should be **rounded off to the nearest integer**.

1. $f: R \to R,\ f(x) = |x-3|\sin|x-3| + \cos|x-3|\ \left|x^2-6x+5\right|$ then no. of points where $f(x)$ is NOT differentiable.

2. If the function $f(x) = \begin{cases} \dfrac{1-\cos x}{x^2}, & \text{for } x \neq 0 \\ k, & \text{for } x = 0 \end{cases}$ is continuous at $x = 0$, then the value of $\dfrac{1}{k}$ is _____.

3. If $2\log_{3/16}|\sin x| \leq 1 - 2\log_{3/16}|\cos x|$ for $x \in [0, \pi]$, then the values of x which satisfy above inequality $\in [a\pi, b\pi] \cup [c\pi, \alpha\pi]$. The value of $6a - 3b + 3c + 6d$ is _____.

4. Let $f: R - \{-2\} \to R$ defined by $f(x) = \dfrac{1+x}{2+x}$ and $g: R \to R$ defined by $g(x) = 2x(1-x)$. If range of $fog(x)$ is $(-\infty, \alpha] \cup (\beta, \infty)$, then $5\alpha + \beta$ is _____.

5. If $f(x) = \sin[\pi]x + \sin[-\pi]x$, where [.] denotes the greatest integer function, then the value of $f(\pi)$ is _____.

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6. $\lim\limits_{n\to\infty}\left(n^3-n^2-1\right)^{\frac{1}{3}}+n\alpha+\beta=0$ then $3(\beta-\alpha)=$

7. If domain of the function $\log_e\left(\frac{6x^2+5x+1}{2x-1}\right)+\cos^{-1}\left(\frac{2x^2-3x+4}{3x-5}\right)$ is $(\alpha,\beta)\cup(\gamma,\delta]$, then $\frac{18}{5}(\alpha^2+\beta^2+\gamma^2+\delta^2)$ is equal to _____.

8. If $x=\sin^{-1}\left(a^6+1\right)+\cos^{-1}\left(a^4+1\right)+\tan^{-1}\left(a^2+1\right)$ then find the value of $\sin\left(x+\frac{\pi}{4}\right)-\cos\left(x+\frac{\pi}{4}\right)$.

9. If m is a root of $x^2+3x+1=0,$ such that the value of $\tan^{-1}(m)+\tan^{-1}\left(\frac{1}{m}\right)$ is $\frac{k\pi}{2}, k\in I$, then find the value of $(k+4)$.

10. The derivative of $f(x)=|x|^3$ at $x=0$ is _____.

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End of 2024-JEE Main - 2