61905

Reg. No. | | | | | | | | |

I Semester M.Sc. Degree Examination, March/April - 2025

CHEMISTRY

Mathematics for Chemistry

(CBCS Scheme 2019-20)

Paper : Ch-105

Time : 3 Hours **Maximum Marks : 70**

Instructions to Candidates : **Answer question No.1 and any Five questions of the remaining questions.**

Answer any Ten of the following. **(10×2=20)**

1. a) If $\vec{a}=2\vec{i}+\vec{j}+3\vec{k}$, $\vec{b}=-\vec{i}+2\vec{j}+\vec{k}$ and $\vec{c}=3\vec{i}+\vec{j}+2\vec{k}$ find $\vec{a}.\left(\vec{b}\times\vec{c}\right)$

   b) A helium atom is moving with a velocity of $20i-15j$ m/s. What is its speed?

   c) Evaluate $\vec{i}.\left(\vec{j}\times\vec{k}\right)+\left(\vec{i}\times\vec{k}\right).\vec{j}$

   d) If $A=\begin{bmatrix} 1 & 5 & 6 \\ -6 & 7 & 0 \end{bmatrix}$ and $B=\begin{bmatrix} 1 & -5 & 7 \\ 8 & -7 & 7 \end{bmatrix}$, find A+B and A-B.

   e) Find the derivative of $y=\sqrt{x}+\mathrm{dn}3x.+\mathrm{Cos}(7x)$

   f) Find $\frac{dy}{dx}$ for the function $x=a\,\mathrm{Cos}\,t,\ y=b\sin t$

   g) The ideal gas equation is PV=nRT, find $\left(\frac{\partial T}{\partial P}\right)_v$

   h) In X-ray Crystallography, the Braggs equation is given by $n\lambda=2d\,\mathrm{Sin}\,\theta$ where 'd' is distance between successive layers in a crystal and 'n' is an integer. If 'θ' is the angle through which the X-rays are scattered and 'λ' is the wavelength of the X-rays, what is the rate of change of 'λ' w.r.t. 'θ'

[P.T.O.

i) Find $\int x^2 \log x dx$

j) Integrate $\int \sin Mx$

k) Find the solution of the differential equation $(x+1)dy + (y-1)dx = 0$

l) Two dice are rolled simultaneously. Find the probability of having no doubles.

2. a) Show that four points, $\vec{a}+4\vec{b}-3\vec{c}$, $3\vec{a}+2\vec{b}-5\vec{c}$, $-3\vec{a}+8\vec{b}-5\vec{c}$ and $-3\vec{a}+2\vec{b}+\vec{c}$ are coplanar.

b) Find the volume of the parallelopiped whose. edges are represented by the vectors. $\vec{a} = 2\vec{i} - 3\vec{j} + 4\vec{k}$, $\vec{b} = \vec{i} + 2\vec{j} - \vec{k}$ and $\vec{c} = 3\vec{i} - \vec{j} + 2\vec{k}$ **(5+5)**

3. a) Find the inverse of $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ -3 & 5 & 6 \end{bmatrix}$

b) Solve the following equations by Cramer's method or determinant method.

$x + y + z = 7$

$x + 2y + 3z = 16$

$x + 3y + 4z = 22$ **(5+5)**

4. a) Find $\frac{dy}{dx}$ for the following functions i) $x^4(3x+2)^3$ and ii) $y + \sin y = \cos x$

b) Find the derivative by using Chain rule for the function $y = \left[\cos\left(\sin e^x\right)\right]^2$ **(5+5)**

5. a) The Lennard - Jones potential describes the potential energy 'V' between the helium atoms separated by a distance 'R'. The equation of this function is $V(R) = \frac{A}{R^{12}} - \frac{B}{R^6}$, where A and B are constants. The two particles are at their equilibrium separation when the potential is at a minimum. Find the equilibrium distance 'R'.

b) The probability density function of an electron at a distance 'r' from the centre of the nucleus of the hydrogen atom is $P(r) = \frac{4r^2}{a_0^2} e^{\frac{-2r}{a_0}}$ where a_0 is the Bohr radius which is the most probable maximum distance of an electron from the nucleus. Then show that when $r = a_0$ $P(r)$ is maximum. **(5+5)**

6. a) Evaluate $\int e^x \operatorname{Sin} x dx$

b) Evaluate $\int \frac{x-1}{(x-2)(x-3)} dx$ (5+5)

7. a) Solve $(2ax + by) y dx + (ax + 2by) x dy = 0$

b) Find $\frac{\partial^2 u}{\partial x^2}, \frac{\partial^2 u}{\partial x \partial y}, \frac{\partial^2 u}{\partial y \partial x}, \frac{\partial^2 u}{\partial y^2}$ for the following functions.

i) $u = 2x^2 - 5xy + y^2$ and

ii) $u = x \log y$ (5+5)

8. a) Find the maxima, minima and point of inflexon for the cubic function $y = x^3 - 3x^2 - 144x$

b) Obtain the fourier series of $f(x) = \frac{\pi - x}{2}$ in the interval $0 < x < 2\pi$, Hence, deduce that $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \ldots\ldots\ldots\ldots = \frac{\pi}{4}$

(5+5)