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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)

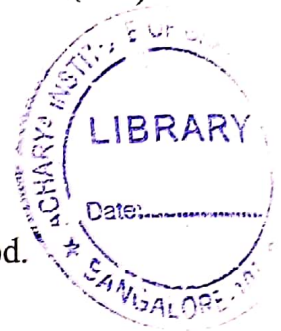
1. a) If $\vec{a} = 2\vec{i} + \vec{j} + 3\vec{k}$, $\vec{b} = -\vec{i} + 2\vec{j} + \vec{k}$ and $\vec{c} = 3\vec{i} + \vec{j} + 2\vec{k}$ find $\vec{a} \cdot (\vec{b} \times \vec{c})$
- b) A helium atom is moving with a velocity of $20\vec{i} - 15\vec{j}$ m/s. What is its speed?
- c) Evaluate $\vec{i} \cdot (\vec{j} \times \vec{k}) + (\vec{i} \times \vec{k}) \cdot \vec{j}$
- 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 $y = \sqrt{x} + \ln 3x + \cos(7x)$
- f) Find $\frac{dy}{dx}$ for the function $x = a \cos t$, $y = b \sin t$
- 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 $n\lambda = 2d \sin \theta$ 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 $y = [\cos(\sin e^x)]^2$ (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 $P(r) = \frac{4r^2}{a_0^3} e^{-\frac{2r}{a_0}}$ 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)





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6. a) Evaluate $\int e^x \sin x dx$

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

7. a) Solve $(2ax + by)ydx + (ax + 2by)xdy = 0$

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 inflexion 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 $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots = \frac{\pi}{4}$

(5+5)

