IIT JEE Formulas

Maths Formulas

Part 1

Circle Formula

The formula for circle are as stated below

Description	Formula
Area of a Circle	- In terms of radius: πr^2 - In terms of diameter: $\frac{\pi}{4} \times d^2$
Surface Area of a Circle	πr^2
General Equation of a Circle	The general equation of a circle with coordinates of a centre(h, k), and radius r is given as: $\sqrt{(x-h)^2 + (y-k)^2} = r$
Standard Equation of a Circle	The Standard equation of a circle with centre (a, b), and radius r is given as: $(x-a)^2 + (y-b)^2 = r^2$
Diameter of a Circle	2 × radius
Circumference of a Circle	$2\pi r$
Intercepts made by Circle	$x^2 + y^2 + 2gx + 2fy + c = 0$ i. On x −axis: $2\sqrt{g^2 - c}$ ii. On y −axis: $2\sqrt{f^2 - c}$
Parametric Equations of a Circle	$x = h + r\cos\theta\,;\, y = k + r\sin\theta$
Tangent	- **Slope form**: $y = mx \pm a\sqrt{1 + m^2}$ - **Point form:** $xx_1 + yy_1 = a^2$ or $T = 0$ - **Parametric form:** $x\cos\alpha + y\sin\alpha = a$
Pair of Tangents from a Point:	$SS_1 = T^2$

Length of a Tangent	$\sqrt{S_1}$
Director Circle	$x^2 + y^2 = 2a^2$ for $x^2 + y^2 = a^2$
Chord of Contact	$T = 0$ i. Length of chord of contact= $\frac{2LR}{\sqrt{R^2+L^2}}$ ii. Area of the triangle formed by the pair of the tangents and its chord of contact = $\frac{RL^3}{R^2+L^2}$ iii. Tangent of the angle between the pair of tangents from $(x_1, y_1) = \left(\frac{2RL}{L^2-R^2}\right)$ iv. Equation of the circle circumscribing the triangle PT_1, T_2 is: $(x - x_1)(x + g) + (y - y_1)(y + f) = 0$
Condition of orthogonality of Two Circles	$2g_1g_2 + 2f_1f_2 = c_1 + c_2$
Radical Axis	$S_1 - S_2 = 0$ i.e. $2(g_1 - g_2)x + 2(f_1 - f_2)y + (c_1 - c_2) = 0.$
Family of Circles	$S_1 + KS_2 = 0, \ S + KL = 0$

Quadratic Equation Formula

The formula for quadratic equation are as stated below

Description	Formula
General form of Quadratic Equation	$ax^2 + bx + c = 0$; where a, b, c are constants and $a \neq 0$.
Roots of equations	$\alpha = \frac{-b+\sqrt{b^2-4ac}}{2a}, \ \beta = \frac{-b-\sqrt{b^2-4ac}}{2a}$
Sum and Product of Roots	If α and β are the roots of the quadratic equation $ax^2 + bx + c = 0$, then Sum of roots, $\alpha + \beta = -\frac{b}{a}$ Product of roots, $\alpha\beta = \frac{c}{a}$
Discriminant of Quadratic equation	The Discriminant of the quadratic equation $ax^2 + bx + c = 0$ is given by $D = b^2 - 4ac$.
Nature of Roots	● If $D = 0$, the roots are real and equal $\alpha = \beta = -\frac{b}{2a}$.

	- If $D\neq0$, The roots are real and unequal. - If $D < 0$, the roots are imaginary and unequal. - If $D > 0$ and D is a perfect square, the roots are rational and unequal. - If $D > 0$ and D is not a perfect square, the roots are irrational and unequal.
Formation of Quadratic Equation with given roots	If α and β are the roots of the quadratic equation, then $(x - \alpha)(x - \beta) = 0;\ x^2 - (\alpha + \beta)x + \alpha\beta = 0;$ - $x^2 - (Sum\ of\ roots)x +\ product\ of\ roots=0$
Common Roots	- If two quadratic equations $a_1x^2 + b_1x + c_1 = 0$ & $a_2x^2 + b_2x + c_2 = 0$ have both roots common, then $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$. - If only one root α is common, then $\alpha = \frac{c_1a_2-c_2a_1}{a_1b_2-a_2b_1} = \frac{b_1c_2-b_2c_1}{c_1a_2-c_2a_1}$
Range of Quadratic Expression $f(x) = ax^2 + bx + c$ **in restricted domain** $x\in[x_1, x_2]$	- If $-\frac{b}{2a}$ not belong to $[x_1, x_2]$ then, $f(x)\in\left[\left\{f\left(x_1\right), f(x_2)\right\},\ max\{f\left(x_1\right), f(x_2)\}\right]$ - If$-\frac{b}{2a}\in[x_1, x_2]$ then, $f(x)\in\left[\left\{f\left(x_1\right), f\left(x_2\right), -\frac{D}{4a}\right\},\ max\{f\left(x_1\right), f\left(x_2\right), -\frac{D}{4a}\}\right]$
Roots under special cases	Consider the quadratic equation $ax^2 + bx + c = 0$ - If $c = 0$, then one root is zero. Other root is$-\frac{b}{a}$. - If $b = 0$The roots are equal but in opposite signs. - If $b = c = 0$, then both roots are zero. - If $a = c$, then the roots are reciprocal to each other. - If $a + b + c = 0$, then one root is 1 and the second root is $\frac{c}{a}$. - If $a = b = c = 0$, then the equation will become an identity and will satisfy every value of x.
Graph of Quadratic equation	The graph of a quadratic equation $ax^2 + bx + c = 0$ is a parabola. - If $a > 0$, then the graph of a quadratic equation will be concave upwards. - If $a < 0$, then the graph of a quadratic equation will be concave downwards.

Maximum and Minimum value	Consider the quadratic expression $ax^2 + bx + c = 0$ - If $a < 0$, then the expression has the greatest value at $x = -\frac{b}{2a}$. The maximum value is $-\frac{D}{4a}$. - If $a > 0$, then the expression has the least value at $x = -\frac{b}{2a}$. The minimum value is $-\frac{D}{4a}$.
Quadratic Expression in Two Variables	The general form of a quadratic equation in two variables x and y is $ax^2 + 2hxy + by^2 + 2gx + 2fy + c$. To solve the expression into two linear rational factors, the condition is $\Delta = 0$ [a h g] Δ= [h b f] =0 [g f c] $abc + 2fgh - af^2 - bg^2 - ch^2 = 0$ And $h^2 - ab > 0$. This is called the Discriminant of the given expression.

Binomial Theorem Formula

Quick formula revision for jee mains and advanced.

Description	Formula
Binomial Theorem for positive Integral Index	$(x + a)^n = {}^{n}C_{0x^{n}a^{0}} + {}^{n}C_{1x^{n-1}a} + {}^{n}C_{2x^{n-2}a^{2}} + \dots + {}^{n}C_{rx^{n-r}a^{r}} + \dots + {}^{n}C_{n}.xa^{n}$ General terms = $T_{r+1} = {}^{n}C_{rx^{n-r}a^{r}}$
Deductions of Binomial Theorem	- $(1 + x)^n = {}^{n}C_{0+}\, {}^{n}C_{1x} + {}^{n}C_{2x^{2}} + {}^{n}C_{3x^{3}} + \dots + {}^{n}C_{rx^{r}} + \dots + {}^{n}C_{nx^{n}}$ which is the standard form of binomial expansion. General Term= $(r + 1)^{th}$ term: $T_{r+1} = {}^{n}C_{r}$ $x^r = \frac{n(n-1)(n-2)......(n-r+1)}{r!}.x^r$ - $(1 - x)^n = {}^{n}C_{0-}\, {}^{n}C_{1x} + {}^{n}C_{2x^{2}} - {}^{n}C_{3x^{3}} + \dots + (-1)^{r}\, {}^{n}C_{rx^{r}} + \dots + (-1)^{n}\, {}^{n}C_{nx^{n}}$ General Term= $(r + 1)^{th}$ term: $T_{r+1} = (-1)^{r}.{}^{n}C_{r}$ $x^r = \frac{n(n-1)(n-2)......(n-r+1)}{r!}.x^r$
Middle Term in the expansion of $(x + a)^n$	- If n is even then middle term $= \left(\frac{n}{2} + 1\right)^{th}$ term. - If n is odd then middle terms are $\left(\frac{n+1}{2}\right)^{th}$ and $\left(\frac{n+3}{2}\right)^{th}$ term. - Binomial coefficients of middle term is the greatest Binomial coefficients

To determine a particular term in the expansion	In the expansion of $\left(x^{\alpha} \pm \frac{1}{x^{\beta}}\right)^{n}$, if x^{m} occurs in T_{r+1}, then r is given by $n\alpha - r(\alpha + \beta) = m => r = \frac{n\alpha - m}{\alpha+\beta}$ and the term which is independent of x then $n\alpha - r(\alpha + \beta) = 0 \ => r = \frac{n\alpha}{\alpha+\beta}$.
To find a term from the end in the expansion of $(x + a)^{n}$	$T_{r}(E) = T_{n-r+2}(B)$
Binomial Coefficients and their properties	In the expansion of $(1 + x)^{n} = C_{0} + C_{1}x + C_{2}x^{2} + \dots + C_{r}x^{r} + \dots + C_{n}x^{n}$ Where $C_{0} = 1,\ C_{1} = n,\ C_{2} = \frac{n(n-1)}{2!}$ i. $C_{0} + C_{1} + C_{2} + \dots\dots + C_{n} = 2^{n}$ ii. $C_{0} - C_{1} + C_{2} - C_{3} + \dots\dots = 0$ iii. $C_{0} + C_{2} + \dots\dots = C_{1} + C_{3} + \dots\dots = 2^{n-1}$ iv. $C_{0}^{2} + C_{1}^{2} + C_{2}^{2} + \dots\dots + C_{n}^{2} = \frac{2n!}{n!n!}$ v. $C_{0} + \frac{C_{1}}{2} + \frac{C_{2}}{3} + \dots\dots + \frac{C_{n}}{n+1} = \frac{2^{n+1}-1}{n+1}$ vi. $C_{0} - \frac{C_{1}}{2} + \frac{C_{2}}{3} - \frac{C_{3}}{4} + \dots\dots + \frac{(-1)^{n}.C_{n}}{n+1} = \frac{1}{n+1}$
Greatest term in the expansion of $(x + a)^{n}$**:**	- The term in the expansion of $(x + a)^{n}$ of greatest coefficients $= \{T_{\frac{(n+2)}{2}}, \quad when\ n\ is\ even\ T_{\frac{(n+1)}{2}},\ T_{\frac{(n+3)}{2}}$ $when\ is\ is\ odd$ - The greatest term $= \{T_{p},\ T_{p+1},\ when\ \frac{(n+1)a}{x+a} = p \in Z\ T_{q+1},$ $When\ \frac{(n+1)a}{x+1}\ nnot\ belong\ to\ Z\ and\ q < \frac{(n+1)a}{x+a} < q + 1$
Multinomial Expansion	If $n \in N$ then the general terms of multinomial expansion $\left(x_{1} + x_{2} + x_{3} + \dots + x_{k}\right)^{n}$ is $\sum_{r_{1}+r_{2}+\dots+r_{k}=n} \frac{n!}{r_{1}!r_{2}!\dots r_{k}!} x_{1}^{r1}.x_{2}^{r2} \dots x_{k}^{r_{k}}$

Binomial Theorem for Negative Integer Or Fractional Indices	$(1 + x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + ...$ $+ \frac{n(n-1)(n-2).......(n-r+1)}{r!}x^r + ..., \lvert x \rvert < 1$ $T_{r+1} = \frac{n(n-1)(n-2).......(n-r+1)}{r!}x^r$

Part 2

Vectors Formula

The formula for vectors are as stated below

Description	Formula
Position Vector of a Point	If $\vec{a}$ and $\vec{b}$ are positive vectors of two points A and B, then $\vec{AB} = \vec{b} - \vec{a}$ • **Distance Formula:** Distance between the two points $A(\vec{a})$ and $B(\vec{b})$ is $AB = \lvert \vec{a} - \vec{b} \rvert$. • **Section Formula:** $\vec{r} = \frac{n\vec{a}+m\vec{b}}{m+n}$, Midpoint of $AB = \frac{\vec{a}+\vec{b}}{2}$
Scalar Product of Two vectors	$\vec{a}.\vec{b} = \lvert \vec{a} \rvert \lvert \vec{b} \rvert cos\,\theta$, where $\lvert \vec{a} \rvert$, $\lvert \vec{b} \rvert$ are the magnitude of $\vec{a}$ and $\vec{b}$ respectively and θ is the angle between $\vec{a}$ and $\vec{b}$ • $i.i = j.j = k.k = 1;\ i.j = j.k = k.i = 0$, projection of $\vec{a}$ on $\vec{b} = \frac{\vec{a}.\vec{b}}{\lvert \vec{b} \rvert}$. • If $\vec{a} = a_1 i + a_2 j + a_3 k$ & $\vec{b} = b_1 i + b_2 j + b_3 k$ then $\vec{a}.\vec{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$. • The angle ∅ between $\vec{a}$ & $\vec{b}$ is given by $\emptyset = cos^{-1}\frac{\vec{a}.\vec{b}}{\lvert \vec{a} \rvert \lvert \vec{b} \rvert}$, $0 \le \emptyset \le \pi$. • $\vec{a}.\vec{b} = 0 \Leftrightarrow \vec{a}$ Perpendicular to $\vec{b}$ $(a \neq 0, \vec{b} \neq 0)$.

Vector Product of Two vectors	• If $\vec{a}$ & $\vec{b}$ are two vectors and θ is the angle between them then • $\vec{a}\times\vec{b}=\lvert\vec{a}\rvert\lvert\vec{b}\rvert sin\,\theta\,\hat{n}$, where $\hat{n}$ is the unit vector perpendicular to both $\vec{a}$ & $\vec{b}$ such that $\vec{a},\vec{b}$& $\hat{n}$ form a right handed screw system. • Geometrically $\lvert\vec{a}\times\vec{b}\rvert$ =area of the parallelogram whose two adjacents sides are represented by $\vec{a}$ & $\vec{b}$. • $\hat{i}\times\hat{i}=\hat{j}\times\hat{j}=\hat{k}\times\hat{k}=0;\ \hat{i}\times\hat{j}=\hat{k},\ \hat{j}\times\hat{k}=\hat{i},\ \hat{k}\times\hat{i}=\hat{j}$ • If $\vec{a}=a_1\hat{i}+a_2\hat{j}+a_3\hat{k}$ & $\vec{b}=b_1\hat{i}+b_2\hat{j}+b_3\hat{k}$ then $\vec{a}\times\vec{b}=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\a_1&a_2&a_3\\b_1&b_2&b_3\end{vmatrix}$ • $\vec{a}\times\vec{b}=\vec{o}\leftrightarrow\vec{a}$ and $\vec{b}$ are parallel (collinear) ($\vec{a}\neq0,\ \vec{b}\neq0$) i.e. $\vec{a}=K\vec{b}$ where K is a scalar. • Unit vector perpendicular to the plane of $\vec{a}$ & $\vec{b}$ is $\hat{n}=\pm\frac{\vec{a}\times\vec{b}}{\lvert\vec{a}\times\vec{b}\rvert}$. • If $\vec{a},\vec{b}$ & $\vec{c}$ are the position vectors of 3 points A, B & C then the vector area of triangle $ABC=\frac{1}{2}[\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a}]$. The points A, B & C are collinear if ▪ $\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a}=\vec{0}$ • Area of any quadrilateral whose diagonal vectors are $\vec{d}_1$ & $\vec{d}_2$ is given by $\frac{1}{2}\lvert\vec{d}_1\times\vec{d}_2\rvert$. • Lagrange'sIdentity: $(\vec{a}\times\vec{b})^2=\lvert\vec{a}\rvert^2\lvert\vec{b}\rvert^2-(\vec{a}.\vec{b})^2=[(\vec{a}\times\vec{a})(\vec{a}\times\vec{b})(\vec{b}\times\vec{a})(\vec{b}$
Scalar Triple Product	• The scalar triple product of three vectors $\vec{a},\vec{b}$ & $\vec{c}$ is defined as: $\vec{a}\times\vec{b}.\vec{c}=\lvert\vec{a}\rvert\lvert\vec{b}\rvert\lvert\vec{c}\rvert\sin sin\,\theta\ \cos cos\,\emptyset$ • Volume of tetrahedron $V=[\vec{a}.\vec{b}.\vec{c}]$ • In a scalar triple product the position of dot and cross can be interchanged i.e.

	$\vec{a}.(\vec{b}\times\vec{c}) = (\vec{a}\times\vec{b}).\vec{c}$ Or $[\vec{a}\,\vec{b}\,\vec{c}] = [\vec{b}\,\vec{c}\,\vec{a}] = [\vec{c}\,\vec{a}\,\vec{b}]$ $\vec{a}.(\vec{b}\times\vec{c}) =- \vec{a}.(\vec{c}\times\vec{b})$ i.e. $[\vec{a}\,\vec{b}\,\vec{c}] =- [\vec{a}\,\vec{c}\,\vec{b}]$ ● If $\vec{a} = a_1 i + a_2 j + a_3 k$; $\vec{b} = b_1 i + b_2 j + b_3 k$ & $\vec{c} = c_1 i + c_2 j + c_3 k$ then $[\vec{a}.\vec{b}.\vec{c}] = \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix}$ ● If $\vec{a}, \vec{b}, \vec{c}$ are coplanar↔ $[\vec{a}\,\vec{b}\,\vec{c}] = 0.$ ● Volume of tetrahedron OABC with O as origin & A($\vec{a}$), B($\vec{b}$) and C($\vec{c}$) be the vertices $= \left\|\frac{1}{6}[\vec{a}\,\vec{b}\,\vec{c}]\right\|.$ ● The position vector of the centroid of a tetrahedron if the pv's of its vertices are $\vec{a}, \vec{b}, \vec{c}$ & $\vec{d}$ are given by $\frac{1}{4}[\vec{a} + \vec{b} + \vec{c} + \vec{d}]$. ●
Vector Triple Product	$\vec{a}\times(\vec{b}\times\vec{c}) = (\vec{a}.\vec{c})\vec{b} - (\vec{a}.\vec{b})\vec{c},$ $(\vec{a}\times\vec{b})\times\vec{c} = (\vec{a}.\vec{c})\vec{b} - (\vec{b}.\vec{c})\,\vec{a}$ **In general:** $(\vec{a}\times\vec{b})\times\vec{c} \neq \vec{a}\times(\vec{b}\times\vec{c})$

Parabola Formula

The formula for parabola are as stated below

Description	Formula
Equation of standard parabola:	The equation of parabola with focus at $(a, 0)$, $a > 0$ and directrix $x = -a$ is given as $y^2 = 4ax$ When vertex is (0, 0) then axis is given as $y = 0$ Length of latus rectum is equals to $4a$ Ends of the latus rectum are L(a, 2a) and L'(a, -2a).
Parametric representation	The point (x, y_1) lies outside, on or inside the parabola which is given as $y = 4ax$ Therefore, equation of parabola now becomes, $y_1^2 - 4ax \geq 0$ Or $y_1^2 - 4ax < 0$
Line and a parabola	Length of the chord intercepted by the parabola $y^2 = 4ax$ on the line $y = mx + c$ is given as

	$\frac{4}{m^2}(\sqrt{a\left(1+m^2\right)(a-mc)}$
Tangents to the parabola	Tangent of the parabola $y^2 = 4ax$ is given as T = 0 $y = mx + \frac{a}{m}$, $m \neq 0$ is the tangent of parabola $y^2 = 4ax$ at $\left(\frac{a}{m^2}, \frac{2a}{m}\right)$
Normal to the parabola $y^2 = 4ax$	Normal to the parabola $y^2 = 4ax$ is given as $y - y_1 = \frac{-y_1}{2a}\left(x - x_1\right)$ at $\left(x_1, y_1\right)$
A chord with a given middle point	The equation of the chord of parabola $y^2 = 4ax$ with midpoint (x_1, y_1) is given as $T = S_1$. Here, $S_1 = y_1 - 4ax$

Definite Integration Formula

The formula for definite integration are as stated below

Description	Formula
Definite Integral as Limit Sum	$\int_a^b f(x)dx = \sum_{r=1}^{n} hf(a + rh)$ Here $h = \frac{b-a}{n}$ is the length of each subinterval
Definite Integral Formula Using the Fundamental theorem of calculus	$\int_a^b f(x)dx = F(b) - F(a)$, where $F^{'}(x) = f(x)$
Properties of Definite Integral	• $\int_a^b f(x).dx = \int_a^b f(t).dt$ • $\int_a^b f(x).dx = -\int_b^a f(x).dx$ • $\int_a^b cf(x).dx = c\int_a^b f(x).dx$ • $\int_a^b f(x) \pm g(x).dx = \int_a^b f(x).dx \pm \int_a^b g(x).dx$ • $\int_a^b f(x).dx = \int_a^c f(x).dx + \int_c^b f(x).dx$ • $\int_a^b f(x).dx = \int_a^b f(a + b - x).dx$

	• $\int_{0}^{a} f(x).dx = \int_{0}^{a} f(a-x).dt$ This is a formula derived from the above formula. • $\int_{0}^{2a} f(x).dx = 2\int_{0}^{a} f(x).dx$ if $f(2a-x) = f(x)$ • $\int_{0}^{2a} f(x).dx = 0$ if $f(2a-x) =- f(x)$ • $\int_{-a}^{a} f(x).dx = 2\int_{0}^{a} f(x).dx$ if $f(x)$ is an even function (i.e., $f(-x) = f(x)$). • $\int_{-a}^{a} f(x).dx = 0$ if $f(x)$ is an odd function (i.e., $f(-x) =- f(x)$).
Definite Integrals involving Rational or irrational Expression	• $\int_{a}^{\infty} \frac{dx}{x^2+a^2} = \frac{\pi}{2a}$ • $\int_{a}^{\infty} \frac{x^m dx}{x^n+a^n} = \frac{\pi a^{m-n+1}}{n\frac{(m+1)\pi}{n})}, \ 0 < m+1 < n$ • $\int_{a}^{\infty} \frac{x^{p-1} dx}{1+x} = \frac{\pi}{\sin sin\,(p\pi)}, \ 0 < p < 1$ • $\int_{a}^{\infty} \frac{dx}{\sqrt{a^2-x^2}} = \frac{\pi}{2}$ • $\int_{a}^{\infty} \sqrt{a^2 - x^2} dx = \frac{\pi a^2}{4}$ •
Definite Integrals involving Trigonometric Functions	• $\int_{0}^{\pi} mx\,)nx\,)dx = \{0 \ if \ m \neq n \ \frac{\pi}{2} \ if \ m = n \quad m, n$ positive integers • $\int_{0}^{\pi} mx\,)nx\,)dx = \{\,0 \ if \ m \neq n \ \frac{\pi}{2} \ if \ m = n \quad m, n$ positive integers • $\int_{0}^{\pi} mx\,)nx\,)dx = \{\,0 \quad if \ m + n \ \ even \frac{2m}{m^2-n^2} \ \ if \ m = n$ integers

	• $\int_{0}^{\frac{\pi}{2}} x\,dx = \int_{0}^{\frac{\pi}{2}} x\,dx = \frac{\pi}{4}$ • $\int_{0}^{\frac{\pi}{2}} x\,dx = \int_{0}^{\frac{\pi}{2}} dx = \frac{1.3.5.......2m-1}{2.4.6......2m}.\frac{\pi}{2}, \; m = 1, 2, ...$ • $\int_{0}^{\frac{\pi}{2}} x\,dx = \int_{0}^{\frac{\pi}{2}} dx = \frac{2.4.6....2m}{1.3.5...2m+1}, \; m = 1, 2, ...$ •
If $f(x)$ is a periodic function with period T	• $\int_{0}^{nT} f(x)dx = n\int_{0}^{T} f(x)dx, \; n\in z, \quad \int_{a}^{a+nT} f(x)dx = n\int_{0}^{T} f(x)dx, \; n\in z$ • $\int_{mT}^{nT} f(x)dx = (n - m)\int_{0}^{T} f(x)dx, \; m, n\in z, \quad \int_{nT}^{a+nT} f(x)dx = \int_{0}^{a} f($ • $\int_{a+nT}^{b+nT} f(x)dx = \int_{a}^{a} f(x)dx, \; n\in z, \quad a, b\in R$ •
Leibniz Theorem	If $F(x) = \int_{g(x)}^{h(x)} f(t)dt$, then $\frac{dF(x)}{dx} = h'(x)f(h(x)) - g'(x)f(g(x))$

Ellipse Formula

The formula for ellipse are as stated below

Description	Formula
Standard Equation	$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, where $a >$ & $b^2 = a^2(1 - e^2)$ • Eccentricity: $e = \sqrt{1 - \frac{b^2}{a^2}}$,$(0 < e < 1)$, Directrices: $x = \pm\frac{a}{e}$ • Foci: $S = (\pm a\,e, 0)$. Length of major axes = $2a$ and minor axes = $2b$ • Vertices: $A' = (-\,a, 0)$ & $A = (a, 0)$. • Latus Rectum: = $\frac{2b^2}{a} = 2a(1 - e^2)$

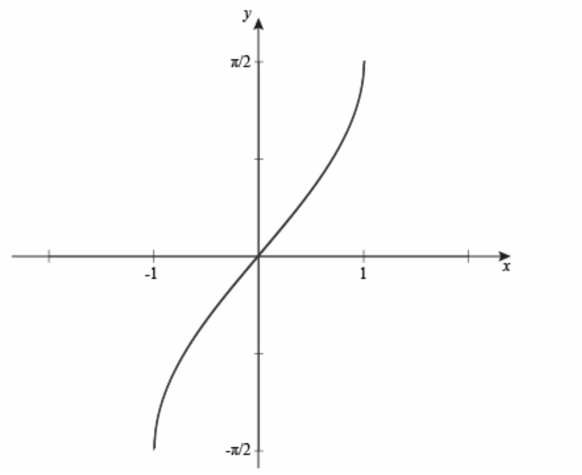
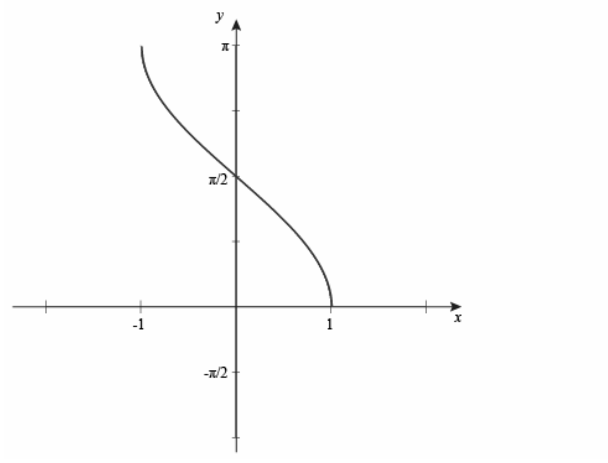
Auxiliary circle	$x^2 + y^2 = a^2$
Parametric Representation	$x = a\cos\theta$ & $y = b\sin\theta$
Position of a Point w.r.t. an Ellipse	The point P(x_1, y_1) lies outside, inside or on the ellipse according as; $\frac{x_1^2}{a^2} + \frac{y_1^2}{b^2} - 1 >< or = 0.$
Line and an Ellipse	The line $y = mx + c$ meets the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ in two points real, coincident or imaginary according as c^2 is < =or > $a^2m^2 + b^2$.
Tangents	● Slope form: $y = mx \pm \sqrt{a^2m^2 + b^2}$, point form: $\frac{xx_1}{a^2} + \frac{yy_1}{b^2} = 1$ ● Parametric form: $\frac{x\cos\theta}{a} + \frac{y\sin\theta}{b} = 1$
Normal	$\frac{a^2x}{x_1} - \frac{b^2y}{y_1} = a^2 - b^2$, $ax.\sec\theta - by.\mathrm{cosec}\theta = \left(a^2 - b^2\right)$, $y = mx - \frac{(a^2-b^2)m}{\sqrt{a^2+b^2m^2}}$
Director Circle	$x^2 + y^2 = a^2 + b^2$

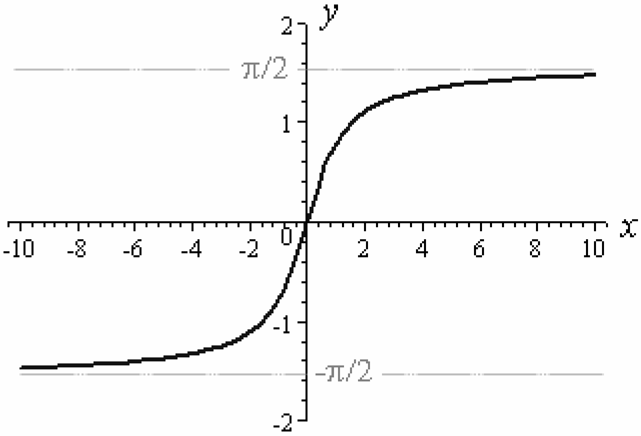
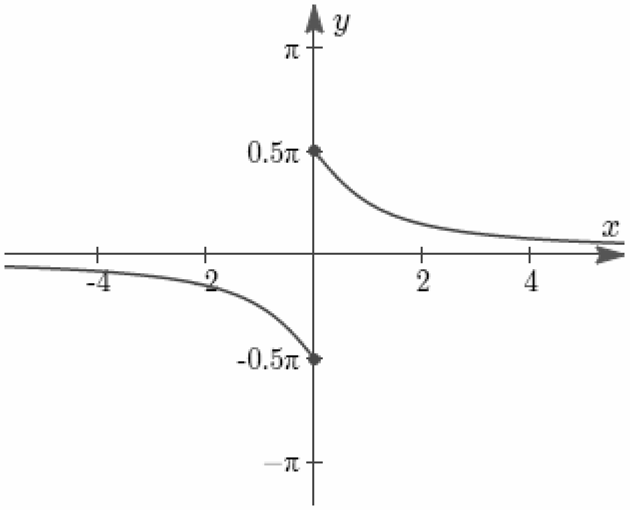
Part 3

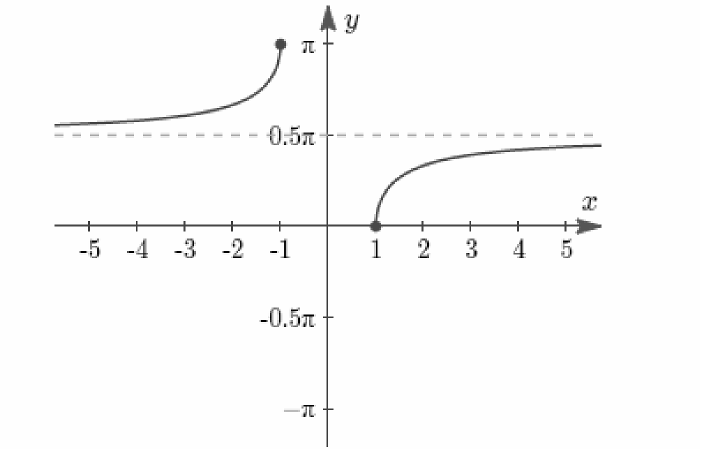
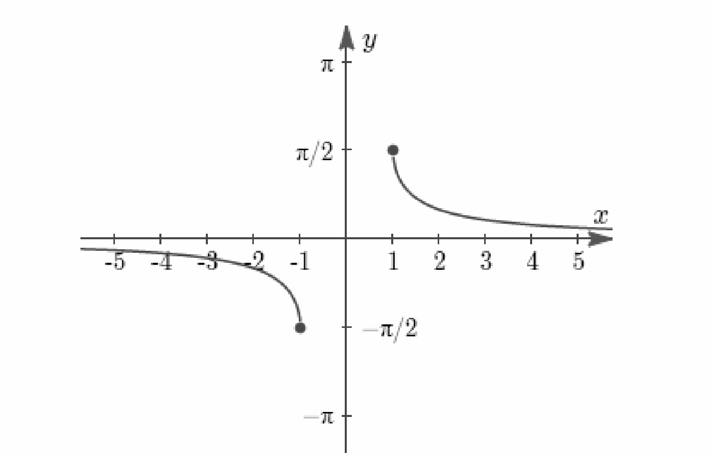
Inverse Trigonometric Functions Formula

The formula for inverse trigonometric functions are as stated below

Description	Formula
Arcsine Function	Arcsine function is an inverse of sine function which is denoted by $\sin^{-1}$ The formula for arcsin is given as $\sin^{-1}(-x) = -\sin^{-1}(x),\ x \in [-1, 1]$

	Domain of arcsin is $-1\leq x\leq 1$ Range of arcsin is $-\frac{\pi}{2}\leq y\leq\frac{\pi}{2}$  Differentiation of $sin^{-1}(x)$ is $\frac{1}{\sqrt{1-x^{2}}}$
Arccosine Function	Arccosine function is an inverse of cosine function which is denoted by cos^{-1} $cos^{-1}(-x) = \pi - cos^{-1}(x),\ x\in[-1,\ 1]$ Domain of arccos is $-1\leq x\leq 1$ Range of arccos is $0\leq y\leq\pi$  Differentiation of $cos^{-1}(x)$ is $-\frac{1}{\sqrt{1-x^{2}}}$
Arctangent Function	Arctangent function is an inverse of tangent function which is denoted by tan^{-1} $tan^{-1}(-x) = -tan^{-1}(x),\ x\in R$ Domain of Arctangent is $-\infty\leq x\leq\infty$ Range of Arctangent is $-\frac{\pi}{2}\leq y\leq\frac{\pi}{2}$

	 Differentiation of $tan^{-1}(x)$ is $\frac{1}{1+x^2}$
Arc cotangent (Arc cot) Function	Arc cotangent function is an inverse of cotangent function which is denoted by cot^{-1} $cot^{-1}(-x) = \pi - cot^{-1}(x),\ x \in R$ Domain of Arc cotangent is $-\infty \le x \le \infty$ Range of Arc cotangent is $0 \le y \le \pi$  Differentiation of $cot^{-1}(x)$ is $\frac{-1}{1+x^2}$
Arc secant Function	Arc secant function is an inverse of cosine function which is denoted by cot^{-1} $sec^{-1}(-x) = \pi - sec^{-1}(x),\ \lvert x \rvert \ge 1$ Domain of Arc secant is $-\infty \le x \le -1\ or\ 1 - \infty \le x \le -\infty$ Range of Arc secant is $0 \le y \le \pi,\ y \ne \frac{\pi}{2}$

	 Differentiation of $sec^{-1}(x)$ is $\frac{-1}{\lvert x\rvert\sqrt{x^2-1}}$
Arc cosecant Function	Arc cosecant function is an inverse of sine function which is denoted by $cosec^{-1}$ $cosec^{-1}(-x) = -cosec^{-1}(x),\ x\geq 1$ Domain of Arc cosecant is $-\infty\leq x\leq -1\ or\ 1-\infty\leq x\leq -\infty$ Range of Arc cosecant is $-\frac{\pi}{2}\leq y\leq\frac{\pi}{2},\ y\neq 0$  Differentiation of $cosec^{-1}(x)$ is $\frac{1}{\lvert x\rvert\sqrt{x^2-1}}$

Straight Line Formula

The formula for straight line are as stated below

Description	Formulas
Distance Formula	$d = \sqrt{\left(x_1 - x_2\right)^2 - \left(y_1 - y_2\right)^2}$
Section Formula	$x = \frac{mx_2 \pm nx_1}{m \pm n};\ y = \frac{my_2 \pm ny_1}{m \pm n}$
Centroid, Incentre and Excenter	Centroid $G\left(\frac{x_1+x_2+x_3}{3}, \frac{y_1+y_2+y_3}{3}\right)$

	In center $I(\frac{ax_1+bx_2+cx_3}{a+b+c}, \frac{ay_1+by_2+cy_3}{a+b+c})$ Excentre $I_1\left(\frac{-a_x+bx_2+cx_3}{-a+b+c}, \frac{-ay_1+by_2+cy_3}{-a+b+c}\right)$
Area of Triangle	$\Delta\, ABC = \frac{1}{2}\left\|x_1\; y_1\; 1\; x_2\; y_2\; 1\; x_3\; y_3\; 1\right\|$
Slope formula	Line Joining two points $(x_1 y_1)\&(x_2 y_2)$ $m = \frac{y_1-y_2}{x_1-x_2}$
Condition of collinearity of three points	$\left\|x_1\; y_1\; 1\; x_2\; y_2\; 1\; x_3\; y_3\; 1\right\| = 0$
Angle between two straight lines	$tan\theta = \left\|\frac{m_1-m_2}{1+m_1m_2}\right\|$
Bisector of the angles between two lines	$\frac{ax+by+c}{\sqrt{a^2+b^2}} = \pm\frac{(a^{\|}x+b^{\|}y+c^{\|})}{\sqrt{a^{'2}+b^{'2}}}$
Condition of Concurrency	For three lines $a_1x + a_2y + c_1 = 0, i = 123$ is $\left\|a_1\; b_1\; c_1\; a_2\; b_2\; c_2\; a_3\; b_3\; c_3\right\| = 0$
A pair of straight lines through origin	$ax^2 + 2hxy + by^2 = 0$ If θ is the acute angle between the pair of straight lines, then $tan\theta$ $= \left\|\frac{2\sqrt{(h^2-ab)}}{a+b}\right\|$
Two Lines:	$ax + bx + c = 0\; and\; a^{'}x + b^{'}y + c^{'} = 0$ Two lines a. Parallel if $\frac{a}{a^{'}} = \frac{b}{b'} \neq \frac{c}{c'}$ b. Distance between two parallel lines= $\left\|\frac{C_1-C_2}{\sqrt{a^2+b^2}}\right\|$ c. Perpendicular: $if\; aa^{'} + bb^{'} = 0$
A point and line	a. Distance between point and line= $\left\|\frac{ax_1+by_1+c}{\sqrt{a^2+b^2}}\right\|$ b. Reflection of a point about a line: $\frac{x-x_1}{a} = \frac{y-y_1}{b} =- 2\frac{ax_1+by_1+c}{a^2+b^2}$ c. Foot of the perpendicular from a point on the line is $\frac{x-x_1}{a} = \frac{y-y_1}{b} =- \frac{ax_1+by_1+c}{a^2+b^2}$

Indefinite Integration formula

The formula for indefinite integration are as stated below

If f & g are functions of x such that $g'(x) = f(x)$ **then,**	$\int f(x)dx = g(x) + c \Leftrightarrow \frac{d}{dx}\{g(x) + c\} = f(x)$ Here, c is called the constant of integration
Standard Formula:	• $\int (ax + b)^n\, dx = \frac{(ax+b)^{n+1}}{a(n+1)} + c,\ n \neq -1$ • $\int \frac{dx}{ax+b} = \frac{1}{a}\ln ln\,(ax + b) + c$ • $\int e^{ax+b}dx = \frac{1}{a}e^{ax+b} + c$ • $\int a^{px+q}dx = \frac{1}{P}\frac{a^{px+q}}{\ln ln\, a} + c$, Here $a > 0$ • $\int sin\,(ax + b)dx = -\frac{1}{a}\cos cos\,(ax + b) + c$ • $\int cos\,(ax + b)dx = \frac{1}{a}\sin sin\,(ax + b) + c$ • $\int tan\,(ax + b)dx = \frac{1}{a}\ln ln\ \sec sec\,(ax + b) + c$ • $\int cot\,(ax + b)dx = \frac{1}{a}\ln ln\ \sin sin\,(ax + b) + c$ • $\int(ax + b)dx = \frac{1}{a}tan\,(ax + b) + c$ • $\int(ax + b)dx = -\frac{1}{a}cot\,(ax + b) + c$ • $\int dx = ln\,(sec\,x + tan\,x) + c$ or $\int dx = ln\,tan\left(\frac{\pi}{4} + \frac{x}{2}\right) + c$

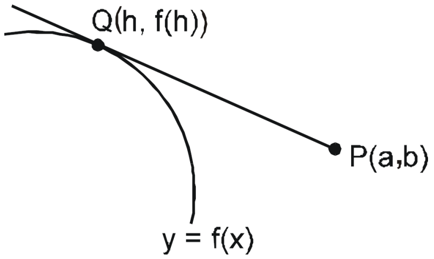
	• $\int dx = ln\,(x + cot\,x) + c$ or $\int dx = ln\,tan\,\frac{x}{2} + c$ or $\int dx = ln\,(cosec\,x + cot\,x) + c$ • $\int \frac{dx}{\sqrt{a^2-x^2}} = \frac{x}{a} + c$ • $\int \frac{dx}{a^2+x^2} =- \frac{1}{a}\frac{x}{a} + c$ • $\int \frac{dx}{\lvert x\rvert\sqrt{x^2+a^2}} =- \frac{1}{a}\frac{x}{a} + c$ • $\int \frac{dx}{\sqrt{x^2+a^2}} = ln\left[x + \sqrt{x^2 + a^2}\right] + c$ • $\int \frac{dx}{\sqrt{x^2-a^2}} = ln\left[x + \sqrt{x^2 - a^2}\right] + c$ • $\int \frac{dx}{a^2-x^2} = \frac{1}{2a} ln\left\lvert\frac{a+x}{a-x}\right\rvert + c$ • $\int \frac{dx}{x^2-a^2} = \frac{1}{2a} ln\left\lvert\frac{x-a}{x+a}\right\rvert + c$ • $\int \sqrt{a^2 - x^2}dx = \frac{x}{2}\sqrt{x^2 + a^2} + \frac{a^2}{2}\frac{x}{a} + c$ • $\int \sqrt{x^2 + a^2}dx = \frac{x}{2}\sqrt{x^2 + a^2} + \frac{a^2}{2} ln\left(\frac{x+\sqrt{x^2+a^2}}{a}\right) + c$ • $\int \sqrt{x^2 - a^2}dx = \frac{x}{2}\sqrt{x^2 - a^2} - \frac{a^2}{2} ln\left(\frac{x+\sqrt{x^2-a^2}}{a}\right) + c$
Integration by substitutions	If we substitute $f(x) = t$, then $f'(x)dx = dt$
Integration by part	$\int(f(x)g(x))dx = f(x)\int(g(x))dx - \int\left(\frac{d}{dx}(f(x))\int(g(x))dx\right)dx$

Integration of type	$\int \frac{dx}{ax^2+bx+c}, \int \frac{dx}{\sqrt{ax^2+bx+c}}, \int \sqrt{ax^2 + bx + c}dx$ Make the substitute $x + \frac{b}{2a} = t$
Integration of trigonometric **functions**	$\int \frac{dx}{a+bx}\ or \int \frac{dx}{a+bx}\ \ or\ \int \frac{dx}{ax + bsinsin\,x\ coscos\,x + cx}$ Here we put tan $tan\,x\ = t$ $\int \frac{dx}{a+bsinsin\,x}\ or \int dx/(a + b\cos cos\,x\,)\ or \int \frac{dx}{a+bsinsin\,x + ccoscos\,x}$ Here we put tan $tan\,\frac{x}{2}\ = t$
Integration of type	$\int \frac{x^2+1}{x^4+Kx^2+1}dx$ Here k is any constant So, we divide numerator and denominator by x^2 and put $x \mp \frac{1}{x} = t$

Application of Derivatives Formula

The formula for application of derivatives are as stated below

Description	Formula
Equation of tangent and normal	● Tangent at (x_1, y_1) is given by $\left(y - y_1\right) = f'\left(x_1\right)\left(x - x_1\right)$, here the $f'(x_1)$ should be real ● And normal at (x_1, y_1) is given by $\left(y - y_1\right) =- \frac{1}{f'\left(x_1\right)}(x - x_1)$, here the $f'\left(x_1\right)$ should be non-zero and real.
Tangent from an external point	Given a point $P(a,\ b)$ which does not lie on the curve $y\ =\ f(x)$, then the equation of possible tangents to the curve $y\ =\ f(x)$, passing through $(a,\ b)$ can be found by solving for the point of contact Q. $f'(h) = \frac{f(h)-b}{h-a}$

	 And equation of the tangent is $y - b = \frac{f(h)-b}{h-a}(x - a)$
Length of tangent, normal, subtangent, subnormal	- $PT = \|k\|\sqrt{1 + \frac{1}{m^2}}$ is the length of the tangent - $PN = \|k\|\sqrt{1 + m^2}$ is the length of normal - $TM = \left\|\frac{k}{m}\right\|$ is the length of the subtangent - $MN = \|km\|$ is the length of subnormal
Angle between the curves	Angle between two intersecting curves is defined as the acute angle between their tangents (or normal) at the point of intersection of two curves. So, $\tan tan\,\theta = \left\|\frac{m_1-m_2}{1+m_1m_2}\right\|$
Rolle's Theorem:	If a function f defined on [a, b] is - continuous on [a, b] - derivable on (a, b) and - f(a) = f(b), - then there exists at least one real number c between a and b (a < c < b) such that f'(c) = 0
Lagrange's Mean Value Theorem (LMVT):	If a function f defined on [a, b] is (i) Continuous on [a, b] and (ii) derivable on (a, b) then there exists at least one real numbers between a and b (a < c < b) such that $\frac{f(b)-f(a)}{b-a} = f'(c)$
Formulae of Mensuration	- Volume of a cuboid $= lbh$ - Surface area of cuboid $= 2(lb + bh + hl)$ - Volume of cube $= a^3$ - Surface area of cube $= 6a^2$ - Volume of a cone $= \frac{1}{3}\pi r^2 h$

	● Curved surface area of cone $= \pi rl\ (l = slant\ height)$ ● Curved surface area of a cylinder $= 2\pi rh$ ● Total surface area of a cylinder $= 2\pi rh + 2\pi r^2$ ● Volume of a sphere $= \frac{4}{3}\pi r^3$ ● Surface area of a sphere $= 4\pi r^2$ ● Area of a circular sector $= \frac{1}{2}r^2\theta$, here θ is in radian ● Volume of a prism $= (area\ of\ the\ base)\times(height)$ ● Lateral surface area of a prism $= (perimeter\ of\ the\ base) \times (height)$ ● Total surface area of a prism $= (lateral\ surface\ area)\times 2(area\ of\ the\ base)$ ● Volume of a pyramid $= \frac{1}{3}(area\ of\ the\ base)\times(height)$ ● Curved surface area of a pyramid $= \frac{1}{2}(perimeter\ of\ the\ base)\times(slant\ height)$

Part 4

Sequence & Series

The formula for sequence and series are as stated below

Description	Formula
An arithmetic progression (A. P)	$a,\ a + d,\ a + 2d,\ ...,\ a + (n - 1)d$ is an A. P. Let a be the first term and d be the common difference of an A. P., then n^{th} term $= t_n = a + (n - 1)d$

The sum of first n terms of A. P.	$S_n = \frac{n}{2}[2a + (n - 1)d] = \frac{n}{2}[a + l]$ r^{th} term of an A. P. when sum of first r terms is given is $t_r = S_r - S_r - 1$
Properties of A. P.	● If a, b, c are in A. P. ⇒$2b = a + c$ & if a, b, c, d are in A. P. ⇒$a + d = b + c$ ● Sum of the terms of an A.P. equidistant from the beginning & end = sum of first & last term.
Arithmetic Mean	If three terms are in A.P. then the middle term is called the A.M. between the other two, so if a, b, c are in A.P., b is A.M. of a & c. n – Arithmetic Means between two number If a, b are any two given numbers & $a,\ A_1,\ A_2, \ldots,\ A_n,\ b$ are in A.P. then $A_1,\ A_2, \ldots\ A_n$ are the n A.M.'s between a & b. $A_1 = a + \frac{b-a}{n+1}$ $A_2 = a + \frac{2(b-a)}{n+1}, \ldots, A_n = a + \frac{n(b-a)}{n+1}$ $\sum_{r=1}^{n} A_r = nA$ where A is the single A.M. between a & b.
Geometric Progression	$a, ar, ar^2, ar^3, ar^4, \ldots,$ is a G.P. with a as the first term & r as a common ratio. ● n^{th} term $= ar^{n-1}$ ● Sum of the first n terms i.e., $S_n = \{\frac{a(r^n-1)}{r-1},\quad r\neq 1\ na,\qquad r = 1$
Harmonic Mean	● If a, b, c are in H.P., b is the H.M. between a & c, then $b = \frac{2ac}{a+c}$ ● H.M. of $a_1,\ a_2 \ldots a_n$ is given by $\frac{1}{H} = \frac{1}{n}\left[\frac{1}{a_1} + \frac{1}{a_2} + \ldots + \frac{1}{a_n}\right]$
Relation between means:	$G^2 = AH,\quad A.M. \geq G.M. \geq H.M.$ ● $A.M. = G.M. = H.M.$ if $a_1 = a_2 = a_3 = \ldots = a_n$
Important Results	● $\sum_{r-1}^{n}(a_r \pm b_r) = \sum_{r-1}^{n} a_r \pm \sum_{r-1}^{n} b_r$

	$\sum_{r-1}^{n} k\, a_r = k \sum_{r-1}^{n} a_r$ $\sum_{r-1}^{n} k = nk$ where k is constant $\sum_{r-1}^{n} r = 1 + 2 + 3 + \ldots + n = \frac{n(n+1)}{2}$ $\sum_{r-1}^{n} r^2 = 1^2 + 2^2 + 3^2 + \ldots + n^2 = \frac{n(n+1)(2n+1)}{6}$ $\sum_{r-1}^{n} r^3 = 1^3 + 2^3 + 3^3 + \ldots + n^3 = \frac{n^2(n+1)^2}{4}$

Hyperbola Formula

The formula for hyperbola are as stated below

Description	Formula
Standard Equation	$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ where $b^2 = a^2\left(e^2 - 1\right)$ Foci: $S \equiv (\pm ae, 0)$ Directrices: $x = \pm\frac{a}{e}$ Vertices: $A \equiv (\pm a, 0)$ Latus Rectum $l = \frac{2b^2}{a} = 2a\left(e^2 - 1\right)$
Conjugate Hyperbola	$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ Are conjugate hyperbolas of each
Auxiliary Circle	$x^2 + y^2 = a^2$
Parametric Representation	$x = a \sec sec\, \theta$ and $y = b \tan tan\, \theta$
Position of A point w.r.t hyperbola	$s_1 \equiv \frac{x_1^2}{a^2} - \frac{y_1^2}{b^2} - 1 \geq or < 0$ According to the point $\left(x_1, y_1\right)$ lies inside on or outside the curve
Tangents	Slope form: $y = mx \pm \sqrt{a^2m^2 - b^2}$ Point Form: at the point $\left(x_1,\ y_1\right)$ is $\frac{xx_1}{a^2} - \frac{yy_1}{b^2} = 1$ Parametric form: $\frac{xsecsec\, \theta}{a} - \frac{ytantan\, \theta}{b} = 1$

Normal:	• At the point $P(x_1, y_1)$ is $\frac{a^2x}{x_1} + \frac{b^2y}{y_1} = a^2 + b^2 = a^2e^2$ • At the point $P(a \sec sec\,\theta,\ b \tan tan\,\theta)$ is $\frac{ax}{\mathrm{secsec}\,\theta} + \frac{by}{\mathrm{tantan}\,\theta} = a^2 + b^2 = a^2e^2$ • Equation of normal in term of its slope m is $y = mx \pm \frac{(a^2+b^2)m}{\sqrt{a^2-b^2m^2}}$
Asymptotes	$\frac{x}{a} + \frac{y}{b} = 0$ and $\frac{x}{a} - \frac{y}{b} = 0$ Pair of asymptotes: $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 0$ •
Rectangular Or Equilateral Hyperbola	• $xy = c^2$ eccentricity is $\sqrt{2}$ • Vertices: $(\pm c \pm c)$ • Foci: $\pm\sqrt{2}c, \pm\sqrt{2}c$ • Directrices: $x + y = \pm\sqrt{2}c$ • Latus Rectum $l = 2\sqrt{2}c = T.A. = C.A.$ • Parametric equation $x = ct, y = \frac{c}{t}, t\epsilon R - \{0\}$ • Equation of the tangent at $P(x_1, y_1) = \frac{x}{x_1} + \frac{y}{y_1} = 2$ • Equation of the tangent at $P(t) = \frac{x}{t} + ty = 2c$ • Equation of the normal at $P(t) = xt^3 - yt = c(t^4 - 1)$ • Chord with a given middle point as $(h, k) = kx + hy = 2hk$

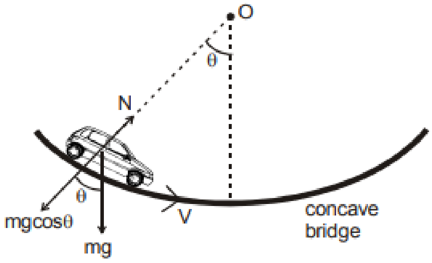
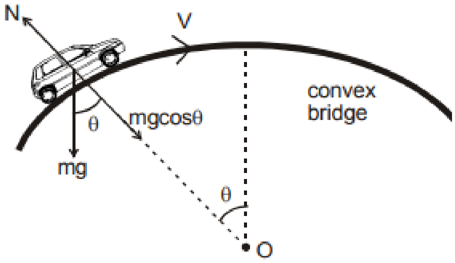
Physics Formulas

Part 1

Uniform Circular Motion Formula

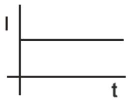
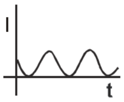
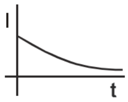
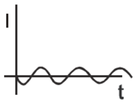
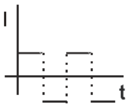
The formula for uniform circular motion are as stated below

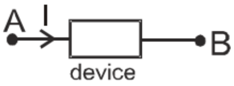
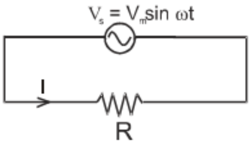
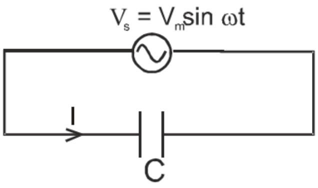
Description	Formula
The formula for Angular Distance is	$\Delta\theta = \omega\,\Delta t,$ Where t is time, ω is angular speed and θ is angular distance.
The formula for linear velocity is given by	$v = R\omega$ Where speed and R is radius and ω is angular speed.
The formula for Centripetal Acceleration is given by	$A_c = v^2/R,$ Where R is the radius and v is the velocity. $A_c = \omega^2 R$ Where R is the radius and ω is angular speed $Ac = 4\pi^2 \nu^2 R$ Where R is the radius and ν is the frequency
Average Angular Velocity	$\omega_{av} = \frac{\theta_2 - \theta_1}{t_2 - t_1} = \frac{\Delta\theta}{\Delta t}$
Instantaneous angular Velocity	$\omega = \frac{d\theta}{dt}$
Average Angular acceleration	$\alpha_{av} = \frac{\omega_2 - \omega_1}{t_2 - t_1} = \frac{\Delta\omega}{\Delta t}$
Instantaneous angular acceleration	$\alpha = \frac{d\omega}{dt} = \omega\frac{d\omega}{d\theta}$
Relation between speed and angular velocity	$v = r\omega \ and \ \vec{v} = \vec{\omega} \times \vec{r}$
Tangential acceleration	$a_t = \frac{dV}{dt} = r\frac{d\omega}{dt} = \omega\frac{dr}{dt}$
Radial or normal or centripetal acceleration	$a_r = \frac{V^2}{r} = \omega^2 r$
Angular Acceleration	$\vec{\alpha} = \frac{d\vec{\omega}}{dt}\ (Non - uniform\ motion)$
Normal reaction of road on a concave bridge	$N = mg\cos\theta + \frac{mv^2}{r}$

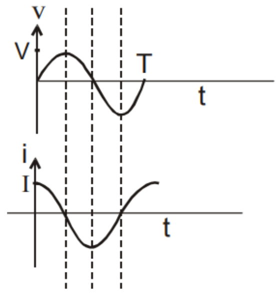
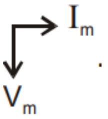
	
Normal reaction on a convex bridge	$N = mgcos\theta - \frac{mv^2}{r}$ 
Skidding of vehicle on a level road	$V_{safe} \leq \sqrt{\mu g r}$
Skidding of an object on a rotating platform	$\omega_{max} = \sqrt{\frac{\mu g}{r}}$
Bending of Cyclist	$tan\,\theta = \frac{v^2}{rg}$
Banking of road without friction	$tan\,\theta = \frac{v^2}{rg}$
Banking of Road with friction	$\frac{V^2}{rg} = \frac{\mu + tan\theta}{1 - \mu\,tan\,\theta}$
Maximum also minimum safe speed on a banked frictional road	$V_{max} = \left[\left(\frac{rg(\mu + tan\theta)}{1 - \mu\,tan\,\theta}\right)\right]^{\frac{1}{2}}$ $V_{min} = \left[\left(\frac{rg(tan\theta - \mu)}{1 + \mu tan\theta}\right)\right]^{\frac{1}{2}}$

Alternating Current Formula

The formula for alternating current are as stated below

Description	Formula
AC and DC current	 constant dc  periodic dc  variable dc  ac  ac A current that changes its direction periodically is called alternating current (AC). If a current maintains its direction constant it is called direct current (DC).

Root Mean square Value	Root mean square of a function from t_1 and t_2 is defined as $$f_{rms} = \sqrt{\frac{\int_{t_1}^{t_2} f(t)^2 dt}{t_2-t_1}}$$
Power consumption in AC Circuit	Average power consumed in a cycle $$= \frac{1}{T}\int_0^{\frac{2\pi}{\omega}} \frac{Pdt}{\frac{2\pi}{\omega}} = \frac{1}{2}V_m I_m cos\phi$$  $$= \frac{V_m}{\sqrt{2}} . \frac{I_m}{\sqrt{2}} . cos\phi = V_{rms} I_{rms} cos\phi$$ $cos\phi$ Is known as the Power Factor.
Impedance	$$z = \frac{V_m}{I_m} = \frac{V_{rms}}{I_{rms}}$$ L Is called inductive reactance and is denoted by X_L. $\frac{1}{\omega\ C}$ Is called capacitive reactance and is denoted by X_c.
Purely Resistive Circuit	 $$I = \frac{V_S}{R} = \frac{V_m sin\omega t}{R} = I_m sin\omega t$$ $$I_m = \frac{V_m}{R}$$ $$I_{rms} = \frac{V_{rms}}{R}$$ $$< p >= V_{rms} I_{rms} cos\phi = \frac{V_{rms}^2}{R}$$
Purely Capacitive Circuit	 $$I = \frac{V_m}{\frac{1}{\omega c}} cos\omega t$$ $$= \frac{V_m}{X_c} cos\ \omega t = I_m cos\omega t$$ $X_c = \frac{1}{\omega C}$ And is called capacitive reactance.

	 I_c Leads by V_c by $\frac{\pi}{2}$, Diagrammatically it is represented as  Since, $\phi=90^0$, $< p >= V_{rms} I_{rms} cos\phi = 0$

Ampere’s Circuital Law

The formula for Ampere’s circuital law are as stated below

Description	Formula
Ampere’s circuital law	$\int B.dl = \mu_o I$ Here μ_o= permeability of free space=$4\pi\times10^{-15} NA^{-2}$ B = Magnetic field I = enclosed electric current by the path
Ampere’s law (integral form)	$\int B.ds = \mu_o I_{enclosed}$ $I_{enclosed}$= enclosed current by the surface
Field of a current-carrying wire:	$B = \frac{\mu_o I}{2\pi r}$
Field of a solenoid	$BL = \mu_o NI$ Here N: number of turns in the solenoid
Field inside a thick wire	$\int B.ds = \mu_o I$ And $B = \mu_o I \frac{r}{2\pi R^2}$
Field of the toroid	$B = \frac{\mu_o NI}{2\pi r}$

Force between two parallel current carrying wires	$F_{\frac{A}{B}} = \frac{\mu_\circ I_A I_B}{(2\pi r)}$ $I_{A,} I_B$ = Current carrying by wires A and B

Capacitance Formula

The formula for capacitance are as stated below

Description	Formula
Capacitance of a parallel plate capacitor in terms of charge and potential difference	$C = \frac{Q}{V}$ Here, C is the capacitance of the capacitor, Q is the charge stored and V is the potential difference between the plates.
Capacitance of a parallel plate capacitor in terms of surface area and distance between the plates	$C = \frac{\varepsilon_0 A}{d}$ Here, ε_0 is the permittivity of free space and its value is $8.854\times10^{-12} m^{-3} kg^{-1} s^{4} A^{2}$, A is the surface area of the plates and d is the distance between the plates.
Capacitance of a spherical capacitor derivation	To find the formula for capacitance of a spherical capacitor we will use the gauss's law. Let the charge on the spherical surface be Q, the radius of smaller sphere be r_a and radius of the bigger sphere be r_b. Using gauss's law, we can write: $\oint \vec{E}\cdot d\vec{A} = \frac{Q}{\varepsilon_0}$ $E\left(4\pi r^2\right) = \frac{Q}{\varepsilon_0}$ $E = \frac{Q}{4\pi\varepsilon_0 r^2}$ $V = \frac{Q}{4\pi\varepsilon_0 r}$
The potential difference between the plates	$V_{ab} = V_a - V_b = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r_a} - \frac{1}{r_b}\right)$ $= \frac{Q}{4\pi\varepsilon_0}\frac{r_b - r_a}{r_a r_b}$ Therefore, the capacitance will be: $C = \frac{Q}{V_{ab}} = 4\pi\varepsilon_0 \frac{r_a r_b}{r_b - r_a}$

Energy stored in capacitor	• $U = \frac{1}{2}CV^2$ • $U = \frac{Q^2}{2C}$ • $U = \frac{QV}{2}$ Here, U is the energy, C is the capacitance, V is the potential difference and Q is the charge stored.
Energy density of capacitor	$Energy\ density = \frac{1}{2}\varepsilon_0\varepsilon_r E^2$ In vacuum: $Energy\ density = \frac{1}{2}\varepsilon_0 E^2$ Here, ε_0 is the permittivity of free space, ε_r is the relative permittivity and E is the electric field.
Capacitance per unit length of a cylindrical capacitor	$Capacitance\ per\ unit\ length = \frac{2\pi\varepsilon_0}{ln\left(\frac{b}{a}\right)}$ Here, ε_0 is the permittivity of free space, b is the radius of outer cylinder and a is the radius of inner cylinder.
Electric field intensity	The formula for electric field intensity between the plates is given as: $E = \frac{\sigma}{\varepsilon_0} = \frac{V}{d}$ Here, σ is the surface charge density, V is the potential difference and d is the distance between plates.
Redistribution of charge when two charged capacitors are connected in parallel	Let us assume a capacitor with capacitance C_1 with initial charge Q_1 and capacitor with capacitance C_2 with initial charge Q_2. The final charge on capacitor with capacitance C_1 will be: $Q'_1 = \frac{C_1}{C_1+C_2}\left(Q_1 + Q_2\right)$ final charge on capacitor with capacitance C_2 will be: $Q'_2 = \frac{C_2}{C_1+C_2}\left(Q_1 + Q_2\right)$
Equivalent capacitance when capacitors are connected in series	$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots + \frac{1}{C_n}$ Here, C_{eq} is the equivalent capacitance and C_1, C_2, C_3 are the capacitance of the capacitors.

Equivalent capacitance of the capacitors connected in parallel	$C_{eq} = C_1 + C_2 + C_3 + \ldots C_n$
Charging of capacitor	$q = q_0\left(1 - e^{-\frac{t}{\tau}}\right)$ Here, q is the charge on the capacitor at time t, τ is the time constant and q_0 is the charge on the capacitor at steady state.
Discharging of capacitor	$q = q_0 e^{-\frac{t}{\tau}}$ Here, q is the charge on the capacitor at time t, τ is the time constant and q_0 is the charge on the capacitor at steady state.

Part 2

Centre of Mass Formula

The formula for centre of mass are as stated below

Description	Formula
Centre of mass of a system with n number of masses situated on a line at different positions	The centre of mass of the system will be: $\vec{r}_{cm} = \frac{\left(m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3 + \ldots + m_n\vec{r}_n\right)}{m_1 + m_2 + m_3 + \ldots + m_n}$ here, m_1, m_2, m_3 are the masses situated at $\vec{r}_1, \vec{r}_2, \vec{r}_3$ respectively.
Centre of mass of a system with n number of masses situated on a 2D plane	Let the masses m_1, m_2, m_3, m_n be placed at coordinates $\left(x_1, y_1\right), \left(x_2, y_2\right), \left(x_3, y_3\right), \left(x_n, y_n\right)$ So, we will find the centre of mass for x and y axis respectively using the formula: $r_x = \frac{m_1x_1 + m_2x_2 + m_3x_3 + \ldots + m_nx_n}{m_1 + m_2 + m_3 + \ldots + m_n}$ $r_y = \frac{m_1y_1 + m_2y_2 + m_3y_3 + \ldots + m_ny_n}{m_1 + m_2 + m_3 + \ldots + m_n}$

	The centre of mass of the system will be: $\left(r_x, r_y\right)$.
Centre of mass of a rectangular plate	The centre of mass of a uniform rectangular plate of length L and breadth B is given as: $r_x = \frac{B}{2}$ $r_y = \frac{L}{2}$
Centre of mass of a triangular plate	The centre of mass of a uniform triangular plate is given by the formula: $r_c = \frac{h}{3}$ Where, h is the height of the plate.
Centre of mass of a semi-circular ring	The centre of mass of a semi-circular ring is given as: $r_y = \frac{2R}{\pi}$ $r_x = 0$ Here, R is the radius of the semi- Circle.
Centre of mass of a semi-circular disc	The centre of mass of a semi-circular disc is given as: $r_y = \frac{4R}{3\pi}$ $r_x = 0$ Here, R is the radius of the semi- Circle.
Centre of mass of a hemispherical shell	The centre of mass of a hemispherical shell is given as: $r_y = \frac{R}{2}$ $r_x = 0$ Here, R is the radius of the semi- Circle.
Centre of mass of a solid hemisphere	The centre of mass of a solid hemisphere is given as: $r_y = \frac{3R}{8}$ $r_x = 0$ Here, R is the radius of the hemisphere.
Centre of mass of a circular cone	The centre of mass of a circular cone is given as: $r_y = \frac{h}{4}$ Here, h is the height of the cone.

Centre of mass of a hollow circular cone	The centre of mass of a hollow circular cone is given as: $$r_y = \frac{h}{3}$$ Here, h is the height of the cone.

Circular Motion

The formula for circular motion are as stated below

Description	Formula
Average angular velocity	$\omega_{average} = \frac{\theta_2 - \theta_1}{t_2 - t_1}$ Here, θ_2 is the angle at time t_1, and θ_1 is the angle at time t_1.
Average angular acceleration	$\alpha_{av} = \frac{\omega_2 - \omega_1}{t_2 - t_1}$ Here, ω_2 is the angular frequency at time t_2 and ω_1 is the angular frequency at time t_1.
Tangential acceleration	$a_t = \frac{dV}{dt}$ Here dV is the change in velocity over time dt. $a_t = r\frac{d\omega}{dt}$ Here, r is the radius, $d\omega$ is the change in angular frequency over time dt.
Centripetal acceleration	$a_c = \frac{v^2}{r}$ or $a_c = \omega^2 r$ Here, v is the linear velocity, r is the radius and ω is the angular frequency.
Normal reaction on a body moving on a concave bridge	$N = mg \cos\cos\theta + \frac{mv^2}{r}$ Here, m is the mass, g is the gravitational acceleration, θ is the angle, v is the linear velocity and r is the radius of the bridge.
Normal reaction on a convex bridge	$N = mg \cos\cos\theta - \frac{mv^2}{r}$ Here, m is the mass, g is the gravitational acceleration, θ is the angle, v is the linear velocity and r is the radius.
Safe velocity of a vehicle on a level road	$v_{safe} \le \sqrt{\mu g r}$ Here, v_{safe} is the safe velocity, μ is the coefficient of friction, g is the gravitational acceleration and r is the radius.

Banking angle	$\tan\theta = \frac{v^2}{rg}$ Here, θ is the banking angle, v is the linear velocity, r is the radius of the curve and g is the gravitational acceleration.
Centrifugal force	$f = m\omega^2 r$ Here, f is the centrifugal force, m is the mass, ω is the angular velocity and r is the radius.
Conical pendulum	$T = 2\pi\sqrt{\frac{L\cos\theta}{g}}$ Here, L is the length of the pendulum, θ is the angle made by the string with the vertical and g is the gravitational acceleration.

De Broglie Wavelength Formula

The formula for de broglie wavelength are as stated below

Description	Formula
De Broglie wavelength	$\lambda = \frac{h}{mv}$ Or $\lambda = \frac{h}{\sqrt{2mKE}}$ Here, λ is the de Broglie wavelength, h is the Plank's constant, m is the mass, v is the velocity, KE is the kinetic energy.
Radius of electron in hydrogen like atoms	$r_n = \frac{n^2}{Z}a_0$ Here, r_n is the radius of nth orbit, a_0 is a constant whose value is $0.529\times10^{-10}m$ and z is the atomic number.
Speed of electron in hydrogen like atoms	$v_n = \frac{Z}{n}v_0$ Here, Z is the atomic number, n is the orbit and v_0 is a constant whose value is $2.19\times10^{6}m/s$.
Energy in nth orbit	$E_n = E_1 \cdot \frac{Z^2}{n^2}$ Here, E_n is energy of the nth orbit, E_1 is the energy of the 1st orbit and its value is $-13.6\ eV$, Z is the atomic number and n is the number orbit.
Wavelength corresponding to spectral lines	$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ Here, λ is the wavelength, R is the Rydberg constant and its value is $1.097\times10^{7}m^{-1}$. Values of n for different series. Lyman series: $n_1 = 1;\ n_2 = 2, 3, 4, \ldots$ Balmer series: $n_1 = 2;\ n_2 = 3, 4, 5, \ldots$

	Paschim series:$n_1 = 3; n_2 = 4, 5, 6, ...$
Minimum wavelength for x rays	$\lambda_{min} = \frac{hc}{eV_0}$ Or $\lambda_{min} = \frac{12400}{V_0} \times 10^{-10}m$ here, λ_{min} is the minimum wavelength, h is the plank’s constant, c is the speed of light, e is the charge of an electron and V_0 is the accelerating voltage.
Radius of nucleus	$R = R_0A^{1/3}$ Here, R is the radius of the atom, R_0 is a constant whose value is $1.1\times10^{-15}m$, A is the mass number of the atom.
Number of nuclei during a radioactive decay	$N = N_0e^{-\lambda t}$ here, N is the number of nuclei at time t, N_0 is the initial number of nucleus and λ is the decay constant.
Half-life of a radioactive sample	$T_{1/2} = \frac{0.693}{\lambda}$ Here, $T_{1/2}$ is the half-life period and λ is the decay constant.
Average life	$T_{av} = \frac{T_{\frac{1}{2}}}{0.693}$ here, T_{av} is the average life and $T_{1/2}$ is the half- life period.

Part 3

Current Electricity

The formula for current electricity are as stated below

Description	Formula
Formula for current	• $I = \frac{\Delta q}{\Delta t}$ • $I = \frac{\Delta q}{\Delta t} = \frac{dq}{dt}$ Here, Δq is the charge flown through the circuit and Δt is the time in which the charge has flown.
Electric current in a conductor(wire)	$I = nAeV_d$ $v_d = \frac{\lambda}{\tau}$

	Here, n is the number of free electrons, A is the area of conductor, e is the charge of an electron, V_d is the drift velocity, λ is the linear charge density and τ is the relaxation time.
Potential difference using ohm's law	$V = IR$ Here, V is the potential difference, I is the current flowing through the conductor and R is the resistance offered by the conductor.
Resistance in terms of resistivity	$R = \frac{\rho l}{A}$ Here, ρ is the resistivity of the material of the conductor, l is the length of the conductor and A is the area of cross section of the conductor.
Change in resistance due to temperature	$R = R_0(1 + \alpha\Delta T)$ Here, R is the resistance, R_0 is the initial temperature, α is the temperature coefficient of the resistivity and ΔT is the change in temperature.
Electric power	$P = VI$ Here, P is the power, V is the potential difference and I is the current. Also, $P = I^2R$ $P = \frac{V^2}{R}$
Heat energy released due to current	$H = VIt$ also $H = I^2Rt$ $H = \frac{V^2}{R}t$ Here, H is the heat released in joules, V is the potential difference, R is the resistance, I is the current and t is the total time the current was flowing through the conductor.
Equivalent resistance when resistors are connected in series	$R_{eq} = R_1 + R_2 + R_3 + \ldots + R_n$ Here, R_{eq} is the equivalent resistance, R_1, R_2, R_3 are the resistance of the resistors.
Equivalent resistance when	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_n}$

resistors are connected in parallel	
Potential difference when cells are connected in parallel	$E_{eq} = \frac{\left(\frac{\varepsilon_1}{r_1}+\frac{\varepsilon_2}{r_2}+\frac{\varepsilon_3}{r_3}+...+\frac{\varepsilon_n}{r_n}\right)}{\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{r_3}+...+\frac{1}{r_n}}$ Here, $\varepsilon_1, \varepsilon_2, \varepsilon_3$ are the emf of the cells and r_1, r_2, r_3 are the internal resistance of the cells.
Ammeter using galvanometer	To measure the maximum current I using a galvanometer, we need to connect a shunt resistance in parallel with the galvanometer. The value of the resistance is calculated as: $S = \frac{I_g R_g}{I}$ Here, S is the value of shunt resistance, I_g is the current through galvanometer, R_g is the resistance of the galvanometer and I is the maximum current to be measured.
Voltmeter using galvanometer	To measure a potential difference using a galvanometer, we need to connect a series resistance with it. The value of the resistance that needs to be connected is: $R_s = \frac{V}{I_g} - R_g$ Here, V is the maximum potential difference to be measured, I_g is the current through galvanometer and R_g is the resistance of the galvanometer.

Electric Current Formula

The formula for electric current are as stated below

Description	Formula
Electric current	$I = q/t = ne/t$ Where I= strength of current; q-charge; t- time
Resistance	$R = \frac{V}{i}$ and $Conductance\ G = \frac{I}{R}$ Where $V - potential\ difference,$

	$i\ -\ current,$ $R\ = \frac{\rho l}{A} = \frac{\rho l}{\pi r^2}$ Where , $R\ -\ Resistance\ fo\ the\ wire;$ $\rho\ -\ Resistivity$, $l\ -\ length\ of\ the\ wire,$ $A\ -\ area\ of\ cross\ section\ of\ the\ wire$
Variation of resistance with the temperature	$R_T\ = R_\circ[1\ +\ \alpha(t)]$ $\rightarrow \alpha\ = \frac{R_{t-}R_\circ}{R_\circ(t)} l ^\circ C$ $\alpha\ = \frac{\left(R_1 - R_2\right)}{R_1\left(t_2 - t_1\right)} l\ ^\circ C$ Here, R = resistance at temperature $t ^\circ C$ $R_\circ$ = resistance at temperature $0 ^\circ C$ α = temperature coefficient of resistance
Conductivity	Reciprocal of resistivity. $\sigma\ = \frac{1}{\rho}$ Where - σ -conductivity, ρ -resistivity
Terminal voltage	**Case-1: When battery is delivering current** $V\ =\ E\ -\ ir\ or\ i\ = \frac{E}{R+r}$ Where V -terminal P.d, E - emf of the cell, r -internal resistance of the cell, $R\ -$ external resistance. **Case 2: when battery is charging** $V\ =\ E\ +\ ir$
Kirchhoff's laws	**Kirchhoff's First laws**: $\sum i\ =\ 0$ at any junction. **Kirchhoff's second law**: $\sum iR\ =\ 0$ in a closed circuit.
Metre Bridge	1. $\frac{x}{R} = \frac{l_1}{l_2} \Rightarrow \frac{x}{R} = \frac{l_1}{\left(100 - l_1\right)}$ Where x - unknown resistance of given wire, R-resistance in the resistance box, l_1-balancing length from left end of the bridge to Jockey. 2. $\rho\ = \frac{xA}{l} = x\frac{\pi r^2}{l}$ Where ρ -Resistivity of the wire, x -resistance of wire, A - area of cross section of the wire, l -length of the wire.
Potentio Meter	**Emf of cell in the secondary circuit** $E_s\ =\ I\rho l$

	1. Comparison of emf's of two cells: $\frac{E_1}{E_2} = \frac{l_1}{l_2}$ Where E_1 and E_2-emf of the first and second cell, l_1 and l_2- the balancing lengths of individual cells respectively. 2. $r = \frac{R(l_1 - l_2)}{l_2}$

Electromagnetic Induction Formula

The formula for electromagnetic induction are as stated below

Description	Formula
Magnetic Flux	The magnetic flux through a plane of area dA placed in a uniform magnetic field B is given as $\phi = \int \vec{B} \cdot d\vec{A}$ When the surface is closed, then magnetic flux will be zero. This is due to magnetic lines of force are closed lines and free magnetic poles is not exist
Electromagnetic Induction: Faraday's Law	**First Law**: Whenever magnetic flux linked with a circuit changes with time, an induced emf is generated in the circuit that lasts as long as the change in magnetic flux continues. **Second Law:** According to this law, the induced emf is equal to the negative rate of change of flux through the circuit. $E = -\frac{d\phi}{dt}$
Lenz's Law	The direction of induced emf or current in the circuit is in such a way that it opposes the cause due to which it is produced. Therefore, $E = -N(\frac{d\phi}{dt})$
Induced emf	Induced emf is given as $E = -N(\frac{d\phi}{dt})$ $E = -N(\frac{\phi_1 - \phi_2}{t})$
Induced Current	Induced Current is given as $I = \frac{E}{R} = \frac{N}{R}(\frac{d\phi}{dt}) = \frac{N}{R}(\frac{\phi_1 - \phi_2}{t})$
Self - Induction	Change in the strength of flow of current is opposed by a characteristic of a coil is known as self-inductance. It is given as $\phi = LI$ Here, L = coefficient of self - inductance Magnetic flux rate of change in the coil is given as $\frac{d\phi}{dt} = L\frac{dl}{dt} = -E$
Mutual - Induction	Mutual – Induction is given as $e_2 = \frac{d(N_2\phi_2}{dt} = M\frac{dl_1}{dt}$

	Therefore, $M = \frac{\mu_0 N_1 N_2 A}{l}$

Part 4

Electromagnetic Induction Formula

The formula for electromagnetic induction are as stated below

Description	**Formula**
Magnetic Flux	The magnetic flux through a plane of area dA placed in a uniform magnetic field B is given as $\phi = \int \vec{B} \cdot d\vec{A}$ When the surface is closed, then magnetic flux will be zero. This is due to magnetic lines of force are closed lines and free magnetic poles is not exist
Electromagnetic Induction: Faraday’s Law	**First Law**: Whenever magnetic flux linked with a circuit changes with time, an induced emf is generated in the circuit that lasts as long as the change in magnetic flux continues. **Second Law:** According to this law, the induced emf is equal to the negative rate of change of flux through the circuit. $E = -\frac{d\phi}{dt}$
Lenz’s Law	The direction of induced emf or current in the circuit is in such a way that it opposes the cause due to which it is produced. Therefore, $E = -N(\frac{d\phi}{dt})$
Induced emf	Induced emf is given as $E = -N(\frac{d\phi}{dt})$ $E = -N(\frac{\phi_1 - \phi_2}{t})$
Induced Current	Induced Current is given as $I = \frac{E}{R} = \frac{N}{R}(\frac{d\phi}{dt}) = \frac{N}{R}(\frac{\phi_1 - \phi_2}{t})$
Self - Induction	Change in the strength of flow of current is opposed by a characteristic of a coil is known as self-inductance. It is given as $\phi = LI$ Here, L = coefficient of self - inductance Magnetic flux rate of change in the coil is given as $\frac{d\phi}{dt} = L\frac{dl}{dt} = -E$
Mutual - Induction	Mutual – Induction is given as $e_2 = \frac{d(N_2\phi_2)}{dt} = M\frac{dl_1}{dt}$

	Therefore, $M = \frac{\mu_0 N_1 N_2 A}{l}$

Electromagnetic Waves

The formula for electromagnetic waves are as stated below

Description	Formula
Gauss's law for electricity	$\oint E \cdot dA = \frac{Q}{\varepsilon_0}$ Here, E is the electric field, A is the area, Q is the charge and ε_0 is the permittivity of free space.
Gauss's law for magnetism	$\oint B \cdot dA = 0$ B is the magnetic field and A is the area.
Faraday's law	$\oint E \cdot dl = -\frac{d\Phi_B}{dt}$ Here, E is the electric field, l is the length of the conductor, Φ_B is the magnetic flux and t is the time.
Ampere- Maxwell law	$\oint B \cdot dl = \mu_0 i + \mu_0 \varepsilon_0 \frac{d\Phi_B}{dt}$ Here, B is the magnetic field, l is the length of the conductor, μ_0 is permeability of free space, i is the current flowing through the conductor, ε_0 is the permittivity of free space, Φ_B is the magnetic flux and t is the time.
Speed of light in vacuum	$c = 1/\sqrt{\mu_0 \varepsilon_0}$

Electrostatics Formula

The formula for electrostatistics are as stated below

Description	Formula
Electrostatic force between two-point charges	$\vec{F} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{\lvert \vec{r} \rvert^2}\hat{r}$

	Here, ε_0 is the permittivity of free space, $q_1\, q_2$ are the point charges and r is the distance between the charges.
Electric field	$\vec{E} = \frac{\vec{F}}{q_0}$ Here, $\vec{F}$ is the electrostatic force experienced by test charge q_0.
Electric field due to a uniformly charged ring	$E_{axis} = \frac{KQx}{\left(R^2+x^2\right)^{\frac{3}{2}}}$ Here, K is the relative permeability, Q is the charge on the ring, x is the perpendicular distance from the ring to the point at which the electric field is to be calculated and R is the radius of the ring.
Electric field due to a uniformly charged disc	$E = \frac{\sigma}{2\varepsilon_0}\left[1 - \frac{x}{\sqrt{R^2+x^2}}\right]$ Here, σ is the surface charge density, ε_0 is the permittivity of free space, x is the perpendicular distance from the centre of the disk and R is the radius of the disk.
Work done by external force	The work done by an external force in bringing a charge q from potential V_B to V_A is: $W = q\left(V_A - V_B\right)$
Electrostatic potential energy	$U = qV$ Here, q is the charge and V is the potential.
Electrostatic energy	$U = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r}$ here q_1q_2 are the charges and r is the distance between the charges.
Electric potential at a point due to a point charge	$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$
Dipole moment	The formula for calculating electric dipole moment is $\vec{p} = q\vec{d}$ Here q is the magnitude of the charge and d is the distance between the charges.
Potential at a point due to dipole	The potential at a point due to a dipole is given as: $V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}$ Here, p is the dipole moment and θ is the angle made by the line joining the point and the centre of the dipole with the line joining the charges and r is the distance from the point at which the potential is to be calculated and the line joining the charges.
Torque experienced by dipole due to electric field	$\vec{\tau} = \vec{p} \times \vec{E}$ here, $\vec{p}$ is the dipole moment and $\vec{E}$ is the electric field.

Friction Formula

The formula for friction are as stated below

Description	Formula
Force due to kinetic friction	The formula for calculating the force due to kinetic friction is: $F_k = \mu_k R$ here, F_k is the force due to kinetic friction, μ_k is the coefficient of kinetic friction and R is the normal reaction force on the body on which the force is acting. If the body is lying on levelled plane, then the normal force is given as: $R = mg$ Here m is the mass and g is the gravitational acceleration. When the body is lying on a plane that is at some angle θ with the horizontal then the normal reaction force on the body is given as: $R = mg\cos\theta$
Force due to static friction	The formula for calculating the force due to static friction is: $F_s = \mu_s R$ here, F_s is the force due to static friction, μ_s is the coefficient of static friction and R is the normal reaction force on the body.

Part 5

Linear Momentum Formula

The formula for linear momentum are as stated below

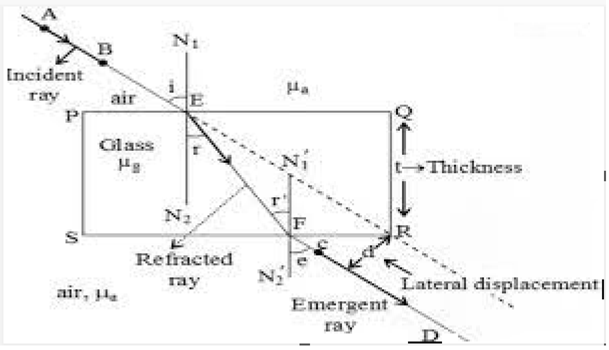
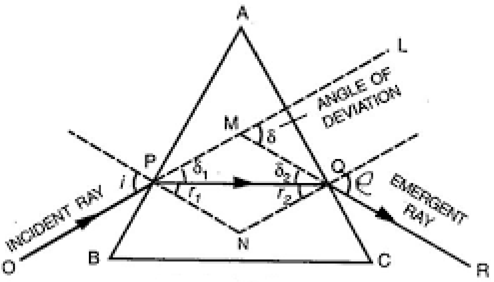
Description	Formula
Linear Momentum	$p = mv$ p is linear momentum, m is mass and v is velocity

Conservation of momentum	$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ Where P = Momentum, m = Mass and u,v= velocity
Elastic Collision	$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ Where i = initial and f = final
Inelastic collision	$m_1v_{1i} + m_2v_{2i} = \left(m_1 + m_2\right)v_{2f}$
Force (from Newton’s second law)	$F = m\times a$ $F_{net} = \frac{dp}{dt}$
Momentum in terms of kinetic energy	$p = mv$ $p^2 = m^2v^2$ $p^2 = 2m(\frac{1}{2}mv^2)$ $p^2 = 2mK$ Here, K = kinetic energy
Dimensional Formula of Momentum	$[M^1L^1T^{-1}]$

Geometrical Optics Formula

The formula for geometrical optics are as stated below

Description	Formula
Laws of Reflection of light	The incident ray, refracted ray, and normal always lie on the same plane. **Snell’s law** According to the Snell’s law $\frac{\sin i}{\sin r} = constant$ Here, i = angle of incidence r = angle of reflection
Relative refractive index	The Relative refractive index is given as $n = \frac{c}{v}$ here, n = refractive index c = speed of light in vacuum v = speed of light in medium

Lateral Shift	 Lateral Shift is given as $lateral\ shift = t\frac{\sin(i-r)}{\cos r}$
Normal shift on a single surface	The normal shift on a single surface is given as $Normal\ shift = t(1 - \frac{1}{n})$
Relation between refractive index and critical angle	The relation between refractive index and critical angle is given as $n = \frac{1}{\sin c}$
Refraction through a prism	 The refractive index of a prism is given as $n = \frac{\sin\left(a+\frac{\delta}{2}\right)}{\sin\frac{A}{2}}$
Lens maker formula for thin lenses	Lens maker formula for thin lenses is given as $\frac{1}{f} = (n - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$
Power of lens	Power of lens is given as $P = \frac{1}{f}$
Equivalent focal length of combination of two thin lenses	$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

Heat And Thermodynamics Formula

The formula for heat and thermodynamics are as stated below

Description	Formula
Kirchhoff's Law	$\frac{Emissive\ power\ of\ body}{Absorptive\ power\ of\ body} = Emissive\ power\ of\ black\ body$

Conduction	Rate of flow of heat in conduction is determined as $\frac{dQ}{dt} =- KA\frac{dT}{dx}$ • K = thermal conductivity • A = area of cross-section • dx = thickness • dT = temperature difference
Newton's law of cooling	$\frac{d\theta}{dt} = (\theta - \theta_0)$ • Here, • $\theta\ and\ \theta_0$ = temperature corresponding to object and surroundings.
Temperature scales	$F = 32 + \frac{9}{5}\times C$ $K = C + 273.16$ • F = Fahrenheit scale • C = Celsius scale • K = Kelvin scale
Ideal Gas equation	$PV = nRT$ • Here, • n = number of moles • P = pressure • V = Volume • T = Temperature
Van der Waals equation	$(p + a(\frac{n}{V})^2)(V - nb) = nRT$ • $a(\frac{n}{V})^2$ = correction factor for intermolecular forces • nb = correction factor for molecule size • n = number of moles • T = Temperature • V = Volume • p = pressure
Thermal expansion	**Linear Expansion** $L = L_0(1 + \alpha\Delta T)$

	Area Expansion $A = A_0(1 + \beta\Delta T)$ **Volume Expansion** $V = V(1 + \gamma\Delta T)$
Relation between α, β and γ for the isotropic solid	$\frac{\alpha}{1} = \frac{\beta}{2} = \frac{\gamma}{3}$
Stefan-Boltzmann's law	$u = \sigma A T^4$ (Perfect black body) $u = e\sigma A T^4$ (Not a perfect black body) ● here, ● σ = Stefan's constant = $5.67\times10^{-8}\ watt / m^2K^4$ ● $\frac{u}{A}$ = energy flux ● e = emissivity
Thermal resistance to conduction	Thermal resistance is given as $R = \frac{L}{KA}$ ● K = material's conductivity ● L = plane thickness ● A = plane area

Hooke's Law Formula

The formula for Hooke's law are as stated below

Description	Formula
Formula for Hooke's Law	$F =- kx$ Where F = force, k = constant and x = displacement Note: Hooke's law can be expressed in the form of stress and strain.
According to Hooke's law	$Stress \propto Strain$ That is, $Stress = K\times Strain$ Where K is the proportionality constant
Formula for Stress	$Stress\ (\sigma) = F/A$ Where,

	F is the restoring force, and A is the cross-section area
Formula for Strain	$Strain\ (\varepsilon) = \Delta L/L$ Where, ΔL= Change in length and L = original length
SI unit of Stress	N/m^2
Young’s Modulus (Y)	$Y = \frac{Tensile\ stress}{Tensile\ Strain}$ $Y = \frac{F_l/A}{\Delta l/l}$
Shear Modulus	$Y = \frac{Shearing\ stress}{Shearing\ Strain}$ $Y = \frac{F_l/A}{\Delta x/h}$

Inductance Formula

The formula for inductance are as stated below

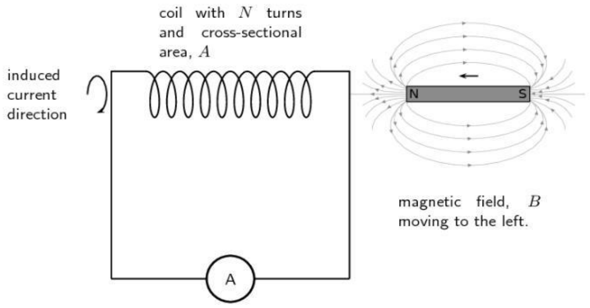
Description	Formula
Inductance	$L=\mu N^2A/l$ Where L - inductance in Henry(H) μ - permeability $(Wb/A.m)$ N - number of turns in the coil A - area encircled by the coil l -length of coil(m)
Induced voltage in a coil (V)	The voltage induced in a coil (V) with an inductance of L is given by $V=L\ di/dt$ Where, V = voltage(volts) L - inductance value(H) i -the current is(A) t -time taken (s)
Reactance of inductance	The reactance of inductance is given by: $X=2\pi fL$ Where, Reactance is X in ohm The frequency if f in Hz Inductance is L in Henry(H)
Magnetic Flux	The magnetic flux through a plane of area dA placed in a uniform magnetic field B is given as

	$$\phi = \int \vec{B}\cdot d\vec{A}$$ When the surface is closed, then magnetic flux will be zero. This is due to magnetic lines of force are closed lines and free magnetic poles is not exist
Induced Current	Induced Current is given as $$I = \frac{E}{R} = \frac{N}{R}\left(\frac{d\phi}{dt}\right) = \frac{N}{R}\left(\frac{\phi_1 - \phi_2}{t}\right)$$
Mutual - Induction	Mutual – Induction is given as $$e_2 = \frac{d(N_2\phi_2}{dt} = M\frac{dl_1}{dt}$$ Therefore, $$M = \frac{\mu_0 N_1 N_2 A}{l}$$

Part 6

Faraday’s Law Formula

The formula for Faraday’s law are as stated below

Description	Formula
Faraday’s first law	The first law of Faraday’s electromagnetic induction explains that when a wire is kept in a field that experiences a constant change in its magnetic field, then an electromagnetic field is developed. This phenomenon of development of the electromagnetic field is called an induced emf. 
Faraday’s second law	1. It states that the emf induced in a conductor is equivalent to the rate at which the flux is linked to the circuit changes. $$\varepsilon = -d\phi/dt$$ Where, ε = the emf or electromotive force ϕ = the magnetic flux 2. If there are N number of turns in the coil then the total magnetic induction in a coil is represented as

	$\varepsilon = -N\, d\phi/dt$
Magnetic flux	It is the integral (sum) of all of the magnetic fields passing through infinitesimal area elements dA. $\Phi_B = \int \vec{B}\cdot d\vec{A}$
The magnetic flux through a surface	The component of the magnetic field passing through that surface. The magnetic flux through some surface is proportional to the number of field lines passing through that surface. The magnetic flux passing through a surface of vector area A is $\Phi_B = B \cdot A = BA\cos\theta$
Lenz's Law	The direction of induced emf or current in the circuit is in such a way that it opposes the cause due to which it is produced. Therefore, $E = -N\left(\frac{d\phi}{dt}\right)$
Induced emf	Induced emf is given as $E = -N(\frac{d\phi}{dt})$ $E = -N(\frac{\phi_1 - \phi_2}{t})$
Magnetic Flux	The magnetic flux through a plane of area dA placed in a uniform magnetic field B is given as $\phi = \int \vec{B}\cdot d\vec{A}$

Fluid mechanics & Properties of Matter Formula

The formula for fluid mechanics and properties of matter are as stated below

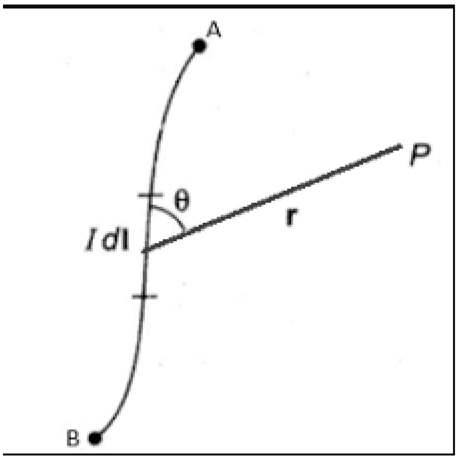
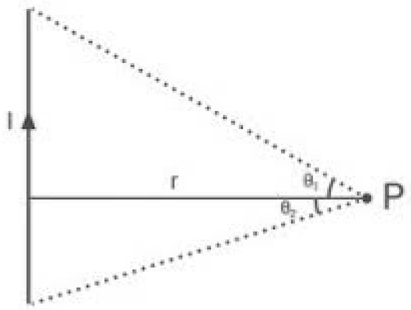
Description	Formula
Pressure	$P = \frac{F}{A}$ For hydraulic press: $F = \frac{A}{a} f$ Here, P is the pressure, F is the force applied on bigger piston with area A and f is the force on the smaller piston with area a.
Angle made by liquid surface when the container experiences an acceleration	$\tan\theta = \frac{a_0}{g}$ here, θ is the angle made by the liquid surface with the horizontal, a_0 is the acceleration of the container and g is the gravitational acceleration.
Continuity equation	According to the equation of continuity, the product of velocity and the area of cross section at any section in a tube is constant.

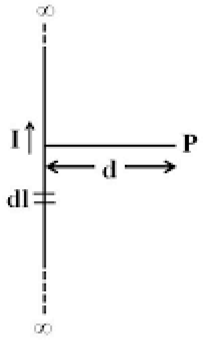
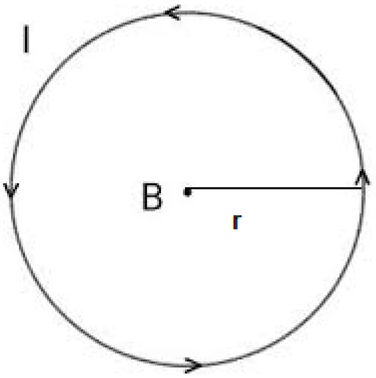
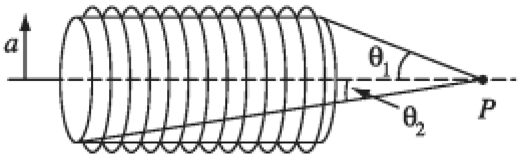
	$a_1 v_1 = a_2 v_2$ here, a_1 v_1 are the area of cross section and velocity of fluid at section 1 and a_2 v_2 are the area of cross section and velocity of the fluid at section 2.
Bernoulli's equation	According to Bernoulli's equation the total energy of liquid flowing through a tube is constant throughout the tube. $\frac{P}{\rho g} + \frac{v^2}{2g} + Z = constant$ Here, P is the pressure, ρ is the density of the fluid, g is the gravitational acceleration, v is the velocity of the fluid and Z is the potential head. The term $\left(\frac{P}{\rho g}\right)$ is called pressure head, $\left(\frac{v^2}{2g}\right)$ is called velocity or kinetic head and Z is called the potential head.
Speed of efflux	$v = \sqrt{\frac{2gh}{1-\frac{A_2^2}{A_1^2}}}$ Here, v is the velocity, g is the gravitational acceleration, h is the height, A_2 is the area of hole and A_1 is the area of the vessel.
Stress	$\sigma = \frac{F}{A}$ here, σ is the stress, F is the force and A is the area.
Strain	$\varepsilon = \frac{\Delta L}{L}$ here, ε is the strain, ΔL is the change in length, and L is the initial length.
Young's modulus	$E = \frac{\sigma}{\varepsilon}$ Or $E = \frac{FL}{A\Delta L}$ here, E is the young's modulus, F is the force, L is the initial length, A is the area of cross section and ΔL is the change in length.
Stoke's law	$F = 6\pi\eta r v$ Here, F is the drag experienced by the sphere, r is the radius of the sphere, η is the viscosity of the fluid and v is the velocity of the sphere.
Terminal velocity	$v = \frac{2}{9}\left(\frac{r^2(\rho-\sigma)g}{\eta}\right)$

	Here, r is the radius of the sphere, ρ is the density of the sphere, σ is the density of the fluid, g is the gravitational acceleration and η is the viscosity of the fluid.

Magnetic Effect of Current Formula

The formula for magnetic effect of current are as stated below

Description	Formula
Magnetic field due to a moving point charge	Magnetic field due to a moving point charge is given as $\vec{B} = \frac{\mu_0 q(\vec{v}\times\vec{r})}{4\pi r^3}$ μ_0 = permeability of free space
Biot Savart's Law	 $dB \propto \frac{I\cdot dl\cdot \sin\theta}{r^2}$
Magnetic field due to a straight wire	 The magnetic field due to a straight wire is given as $B = \frac{\mu_0 I}{4\pi r}(\sin\theta_1 + \sin\theta_2)$

Magnetic field due to an infinite straight line	 $B = \frac{\mu_0 I}{2\pi r}$
Magnetic field due to a circular loop	 At Axis $\frac{\mu_0 (NIR^2)}{2(R^2+x^2)^{3/2}}$ At centre $B = \frac{\mu_0 NI}{2r}$
Magnetic field on the axis of a solenoid	 $B = \frac{\mu_0 NI}{2}\left(cos\theta_1 - cos\theta_2\right)$
Ampere's Law	$\oint \vec{B} \bullet \vec{dl} = \mu_0 l$
Magnetic field due to a long cylinder	$B = 0,\ r < R$ And $B = \frac{\mu_0 NI}{2r},\ r \geq R$
Magnetic force acting on a moving point Charge	$\vec{F} = q\left(\vec{v} \times \vec{B}\right)$
Magnetic force acting on a current-carrying	$\vec{F} = I\left(\vec{l} \times \vec{B}\right)$

Magnetic Moment of a current carrying loop	$M = NIA$
The torque acting on a loop	$\vec{\tau} = \vec{M} \times \vec{B}$
Magnetic field due to single pole	$B = \frac{\mu_0 m}{2\pi r^2}$
Magnetic field on the axis of the magnet	$B = \frac{\mu_0 2M}{4\pi r^3}$
Magnetic field on the equatorial axis of the magnet	$B = \frac{\mu_0 M}{4\pi r^3}$
Magnetic field at the point P of the magnet	$B = \frac{\mu_0 M}{4\pi r^3} [\sqrt{(1 + cos^2 \theta)}]$

Part 7

Wave Formula Part 1

Electromagnetic wave equations are given as below

Description	**Formula**
Gauss's Law for electricity	$\oint E.da = \frac{Q}{\epsilon_0}$
Gauss's Law for Magnetism	$\oint B.dA = 0$
Faraday's Law	$\oint E.dl =- \frac{d\phi}{dt}$
Ampere-Maxwell Law	$\oint B.dl = \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$
Speed of Light in Vacuum	$c = \frac{1}{\sqrt{\mu_0 \epsilon_o}}$

Speed of light in medium	$v = \frac{1}{\sqrt{\mu\epsilon}}$
Relation between Electric and Magnetic field	$\frac{E_0}{B_0} = c$

Wave Formula 2

The formula for wave are as stated below

Description	Formula
General Equation of Wave Motion	$\frac{\partial^2 y}{\partial t^2} = v^2 \frac{\partial^2 y}{\partial x^2}$
Wave number	$k = \frac{2\pi}{\lambda} = \frac{\omega}{v} (rad\, m^{-1})$
Phase of a Wave	It is the difference in phases of two particles at any time t. $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$
Speed of Transverse Wave Along a String / Wire	$v = \sqrt{\frac{T}{\mu}} where\ T = Tension$ $\mu = mass\ per\ unit\ length$
Power Transmitted Along The String By a Sine Wave	Average Power (P) $P = 2\pi^2 f^2 A^2 \mu v$ v =velocity Intensity $I = \frac{P}{S} = 2\pi^2 f^2 A^2 \rho v$
Longitudinal Displacement of Sound Wave	$\epsilon = A\, sin(\omega t - kx)$
Pressure Excess during travelling sound wave	$P_{ex} =- B\frac{\partial\epsilon}{\partial x}$ $= (B)\ Cos\ (\omega t - kx)$ Where B is the Bulk Modulus P_{ex} is the excess pressure

Speed of Sound	$C = \sqrt{\frac{E}{\rho}}$ Here, E is elastic modulus ρ is the density of medium
Loudness of Sound	$10\left(\frac{I}{I_0}\right) dB$
Intensity at a distance r from a point Source	$I = \frac{P}{4\pi r^2}$
Interference of Sound Wave	$P_1 = P_{m1} Sin\left(\omega t - kx_1 + \theta_1\right)$ $P_2 = P_{m2} Sin(\omega t - kx_2 + \theta_2)$ The Result is the sum of all the pressure. $P_0 = \sqrt{p_{m_1}^2 + p_{m_2}^2 + 2p_{m_1} P_{m2} cos\phi}$
For constructive Interference	$\phi = 2\pi n\ then, => P_o = P_{m_1} + P_{m_2}$
For destructive interference	$\phi = (2n + 1)\pi\ and\ => P_o = \lvert P_{m_1} - P_{m_2} \rvert$
Close Organ Pipe	$f = \frac{v}{4l}, \frac{3v}{4l}, \frac{5v}{4l}, ... \frac{(2n+1)v}{4l}$
Open organ pipe	$f = \frac{v}{2l}, \frac{2v}{2l}, ... \frac{nV}{2l}$
Beats	Beats Frequency=$f_1 - f_2$
Doppler's Law	The Observed Frequency, $f' = f\left(\frac{v - v_0}{v - v_s}\right)$ Apparent Wavelength, $\lambda' = \lambda(\frac{v - v_s}{v})$

Wave Optics Formula

The formula for wave optics are as stated below

Description	Formula
The path difference of	$\Delta d = d_2 - d_1$ Δd is the path difference

two coherent Waves	
The Path difference of two coherent waves: Interference Maximum	$\Delta d = k.\lambda$ Δd is path difference λ is the wavelength
The path difference of two coherent waves: Interference Minimum	$\Delta d = \frac{(2.k+1).\lambda}{2}$ Δd is path difference λ is the wave length
Thin-film interference: Constructive (maximum)	$2ntcos\, r = (n + 1/2)\lambda$ t is film thickness n is refractive index r is refraction angle λ is wave length
Thin-Film interference: destructive (minimum)	$2ntcosr = n\lambda.$ t is film thickness n is refractive index r is refraction angle λ is wave length
Radii of Newton's Ring	$r = \sqrt{k.R.\lambda}$ or $r = \frac{\sqrt{((2.k+1).R.\lambda)}}{2}$ r is the radius R is the radius of curvature λ is the wavelength
Light Diffraction	$l = \frac{d^2}{4.\lambda}$ l is the distance from obstacle d is the obstacle size λ is wavelength

Diffraction grating: maximum (bright stripes)	$d sin\theta = k\lambda$ d is the lattice constant θ is the diffraction angle λ is the wavelength
Diffraction grating (dark stripes)	$d sin\theta = (K + 1/2)\lambda$ d is the lattice constant ϕ is the diffraction angle λ is the wavelength

Work Power and Energy Formula

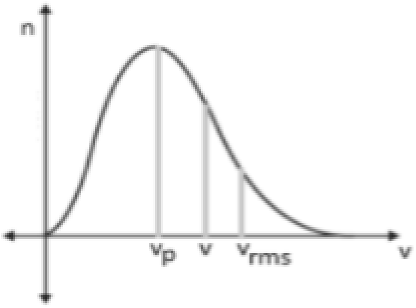
The formula for work power energy are as stated below

Description	Formula
Work done is given by	$W = F\times d$ F is the force d is the displacement
Kinetic Energy	$K.E = \frac{1}{2}mv^2$ m is the mass of the body. v is the velocity of the body
Potential Energy	$P.E = mgh$ m is the mass of the body in kg h is the height of the body in meters g is the acceleration due to gravity
Power	$P = \frac{W}{t}$ W is the work done by the body t is the time $P = \frac{\vec{F}.\vec{ds}}{dt} = \vec{F}.\vec{V}$
Conservative Forces	$F =- \frac{du}{dr}$

Work-Energy theorem	$W_{net} = \Delta K$ Where W_{net} is the sum of all forces acting on the object ΔK is the change of kinetic energy

Kinetic Theory Formula

The formula for kinetic theory are as stated below

Description	Formula
Boltzmann's Constant	$k_B = \frac{nR}{N}$ k_B = Boltzmann's constant R = gas constant n = number of moles N = number of particles in one mole
Total translational Kinetic Energy of Gas	$K.E = \frac{3}{2}(nRT)$ R = gas constant n = number of moles T = absolute temperature
Maxwell distribution law	 $V_{rms} > V > V_p$ V_{rms} = RMS speed V_p = most probable speed V = average speed
RMS Speed	$V_{rms} = \sqrt{\frac{3kt}{m}} = \sqrt{\frac{3Rt}{M}}$ R = universal gas constant T = absolute temperature M = molar mass

Average Speed	$\vec{v} = \sqrt{\frac{8kt}{\pi m}} = \sqrt{\frac{8Rt}{\pi M}}$
Most probable speed	$v_p = \sqrt{\frac{2kt}{m}} = \sqrt{\frac{2Rt}{M}}$
Pressure of ideal gas	$p = \frac{1}{3} \rho v^2_{rms}$
Equipartition of energy	For each degree of freedom $K = \frac{1}{2} k_B T$ For f degree of freedom $K = \frac{f}{2} k_B T$ k_B = Boltzmann's constant T = temperature of gas
Internal Energy	For n moles of an ideal gas, internal energy is given as $U = \frac{f}{2} (nRT)$

Kinetic Theory of Gases Formula

The formula for kinetic theory of gases are as stated below

Description	Formula
Boltzmann's Constant	$k_B = \frac{nR}{N}$ • k_B is the Boltzmann's Constant • R is the gas Constant • n is the Number of Moles • N is the Number of Particles in one mole (the Avogadro number)
Total Translational K.E of Gas	$K.E = \left(\frac{3}{2}\right) nRT$ • n is the number of moles • R is the Universal gas Constant • T is the absolute Temperature
Maxwell Distribution Law	$V_{rms} > V > Vp$ • V_{rms} is the RMS speed • V is the Average Speed.

	● Vp is the most probable speed
RMS Speed (V_{rms})	$V_{rms} = \sqrt{\frac{8kt}{m}} = \sqrt{\frac{3RT}{M}}$ ● R is the universal gas constant. ● T is the absolute temperature. ● M is the molar mass.
Average Speed	$\vec{v} = \sqrt{\frac{8kt}{\pi m}} = \sqrt{\frac{8RT}{\pi M}}$
Most Probable Speed (V_p)	$V_p = \sqrt{\frac{2kt}{m}} = \sqrt{\frac{2RT}{M}}$
The Pressure of Ideal Gas	$P = \frac{1}{3}V^2_{rms}$ ● P is the density of molecules
Equipartition of Energy	$K = \frac{1}{2}K_B T$ for each degree of freedom K=$\left(\frac{f}{2}\right)K_B T$ for molecules having f degrees of freedom ● K_B is the Boltzmann's Constant ● T is the Temperature of the gas
Internal Energy	$U = \left(\frac{f}{2}\right)nRT$ ● For n moles of an ideal Gas.

Part 8

Lenz's Law Formula The formula for Lenz's law are as stated below	
Description	**Formula**
Magnetic Flux	The magnetic flux through a plane of area dA placed in a uniform magnetic field B is given as $\phi = B \cdot dA$ When the surface is closed, then magnetic flux will be zero. This is due to magnetic lines of force are closed lines and free magnetic poles is not exist.
Lenz's Law	The direction of induced emf or current in the circuit is in such a way that it opposes the cause due to which it is produced. Therefore, $E = -N(d\phi/dt)$
Induced emf	Induced emf is given as

	$E = -N(d\phi/dt)$ $E = -N((\phi_1 - \phi_2)/t)$
Induced Current	Induced Current is given as $I = E/R = N/R(d\phi/dt) = N/R((\phi_1 - \phi_2)/t)$
Self – Induction	Change in the strength of flow of current is opposed by a characteristic of a coil is known as self-inductance. It is given as $\phi = LI$ Here, L = coefficient of self – inductance Magnetic flux rate of change in the coil is given as $d\phi/dt = LdI/dt = -E$
Mutual – Induction	Mutual – Induction is given as $e2 = (d(N_2\ \phi_2)/dt = M\ (dI_1)/dt$ Therefore, $M = (\mu_0\ N_1 N_2 A)/l$

Chemistry Formulas

Part 1

Enthalpy Formula

The formula for enthalpy are as stated below

Description	Formula
Enthalpy	H = U + pV U = Internal energy of system p = Pressure of system V = Volume of system
For change in Enthalpy (ΔH)	● At isobaric condition: When Δp=0; ΔH= $C_P(T_2 - T_1)$ ● At isochoric condition: When ΔV=0; ΔH= $Q_V + V\Delta p$ ● At isothermal condition: When ΔT=0; ΔH= 0 ● At Adiabatic condition: When Q=0; ΔH = $C_P(T_2 - T_1)$
Enthalpy change of a reaction	$\Delta H_{reaction} = H_{product} - H_{reactants}$ $\Delta H° = H°_{products} - H°_{reactants}$ $= positive\ \Delta H\ - endothermic$ $= negative\ \Delta H\ - exothermic$
Enthalpy of Reaction from Enthalpies of Formation	The enthalpy of reaction can be given as:- $\Delta H°_r = \sum v_B \Delta H°_{f,products} - \sum v_B \Delta H°_{f,reactants}$ v_B is the stoichiometric coefficient
Estimation of Enthalpy of a reaction from bond Enthalpies	$H = Enthalpy\ required\ to\ break\ reactants\ into\ gaseous\ atoms\ -$ $Enthalpy\ released\ to\ form\ products\ from\ the\ gasesous\ atoms$
Resonance energy	$\Delta H°_{resonance} = \Delta H°_{f,experimental} - \Delta H°_{f,\ calculated}$ $\Delta H°_{resonance} = \Delta H°_{c,\ calculated} - \Delta H°_{f,experimental}$

Entropy Formula

The formula for entropy are as stated below

Description	Formula
Entropy	$\Delta S_{system} = \int_{A}^{B} \frac{dq_{rev}}{T}$
Entropy calculation for an ideal gas	$\Delta S_{system} = nc_v ln \frac{T_2}{T_1} + nR.ln \frac{V_2}{V_1}$ *Also* $\Delta S_{system} = nc_P ln \frac{T_2}{T_1} + nR.ln \frac{V_2}{V_1}$
if the reaction of the process is known then we can find ΔS_{rxn} by using a table of standard entropy values	$\Delta S_{rxn} = \sum \Delta S_{products} - \sum \Delta S_{reactants}$ ΔS_{rxn} – refers to the standard entropy values $\Sigma\Delta Sproducts$ = refers to the sum of the $\Delta Sproducts$ $\Sigma\Delta reactants$ – refers to the sum of the $\Delta Sreactants$
Gibbs free energy	$G_{system} = H_{system} - TS_{system}$

Atomic Mass Formula

The formula for atomic mass are as stated below

Description	Formula
Atomic Mass	Atomic Mass = Mass of protons + Mass of neutrons + Mass of electrons
Mass Number	Mass number = no. of protons + no. of neutrons
Relative atomic mass	$RAM = \frac{Mass\ of\ one\ atom\ of\ an\ element}{\frac{1}{2} \times mass\ of\ one\ carbon\ atom}$
Specific gravity	$Specific\ gravity = \frac{density\ of\ the\ substance}{density\ of\ water\ at\ 4°C}$
Absolute density	$Absolute\ density = \frac{Molar\ mass\ of\ the\ gas}{Molar\ volume\ of\ the\ gas}$ $\rho = \frac{PM}{RT}$
Vapor density	$V.D. = \frac{d_{gas}}{d_{H_2}} = \frac{PM_{\frac{gas}{RT}}}{PM_{\frac{H_2}{RT}}} = \frac{M_{gas}}{M_{H_2}} = \frac{M_{gas}}{2}$

	$\therefore M_{gas} = 2\,V.D.$
Molarity	$M = \frac{w\times 1000}{(Mol.\ wt\ of\ solute)\times V_{in\ ml}}$
Molality	$m = \frac{number\ of\ moles\ of\ solute}{mass\ of\ solvent\ in\ gram}\times 1000 = \frac{1000\times w_1}{M_1\times w_2}$
Mole fraction	• $Mole\ fraction\ of\ solution\left(x_1\right) = \frac{n}{n+N}$ • $Mole\ fraction\ of\ solvent\left(x_2\right) = \frac{N}{n+N}$ $x_1 + x_2 = 1$
% Calculation:	• $\%\ w/w = \frac{mass\ of\ solute\ in\ gm}{mass\ of\ solution\ in\ gm}\times 100$ • $\%\ w/v = \frac{mass\ of\ solute\ in\ gm}{Volume\ of\ solution\ in\ ml}\times 100$ • $\%\ v/v = \frac{Volume\ of\ solute\ in\ ml}{Volume\ of\ solution}\times 100$ •
Derived conversion	• Mole fraction of solute into molarity of solution $M = \frac{x_2\rho\times 1000}{x_1M_1+M_2x_2}$ • Molarity into mole fraction $x_2 = \frac{MM_1\times 1000}{\rho\times 1000-MM_2}$ • Mole fraction into molality $m = \frac{x_2\times 1000}{x_1M_1}$ • Molality into mole fraction $x_2 = \frac{mM_1}{1000+mM_1}$ • Molality into molarity $M = \frac{m\rho\times 1000}{1000+mM_2}$ • Molarity into molality $m = \frac{M\times 1000}{1000\rho-MM_2}$ Here M_1 and M_2 are molar masses of solvent and solute ρ is density of solution M is molarity m is molality x_1 is mole fraction of solvent x_2 is mole fraction of solute
Average atomic mass	$A_x = \frac{a_1x_1 + a_2x_2 + ...+ a_nx_n}{100}$
Mean molar mass	$M_{avg} = \frac{M_1n_1 + M_2n_2 + ...M_nn_n}{n_1+n_2+....n_n}$

Normality	- $N = \frac{Number\ of\ equivalents\ of\ solute}{Volume\ of\ solution}$ - $N = Molarity \times v.f$
At equivalence point	- $N_1V_1 = N_2V_2$ - $n_1M_1V_1 = n_2M_2V_2$
Oxidation Number	$Oxidation\ Number = number\ of\ electrons\ in\ the\ valence\ shell - number\ of\ electrons\ left\ after\ bonding$
Equivalent weight	$E = \frac{Atomic\ weight}{Valency\ factor}$
Concept of number of equivalents	- No. of equivalents of solute = $\frac{Wt}{Eq.\ wt.} = \frac{W}{E} = \frac{W}{M/n}$ - No. of equivalents of solute = No. of moles of solute ×v.f.
Measurement of Hardness	- $Hardness = \frac{mass\ of\ CaCO_3}{Total\ mass\ of\ water} \times 10^6$

Atomic Structure Formula

The formula for atomic structure are as stated below

Description	Formula
Planck's Quantum Theory	Energy of one photon = $hv = \frac{hc}{\lambda}$
Photoelectric effect:	$hv = hv_0 + \frac{1}{2}m_e v^2$
Bohr's Model for Hydrogen like atoms	- $mvr = n = \frac{h}{2\pi}$ - $E_n = -\frac{E_1}{n^2}z^2 = -2.178\times10^{-18}\frac{z^2}{n^2}\ J/atom = -13.6\frac{z^2}{n^2}eV$ - $E_1 = \frac{-2\pi^2me^4}{n^2}$ - $r_n = \frac{n^2}{Z} \times \frac{h^2}{4\pi^2e^2m} = \frac{0.529\times n^2}{Z}\ \overset{\circ}{A}$ - $v = \frac{2\pi ze^2}{nh} = \frac{2.18\times10^6\times z}{n}\ m/s$
De-Broglie wavelength	$\lambda = \frac{h}{mc} = \frac{h}{p}$ (For photon)
Wavelength of emitted photon	$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

Number of photons emitted by a sample of H atom	$E = nh\nu$ Where n is the number of photons emitted h is the Planck's constant ν is the frequency
Heisenberg's uncertainty principle	• $\Delta x.\Delta p > \frac{h}{4\pi}$ • $m\Delta x.\Delta v \geq \frac{h}{4\pi}$ • $\Delta x.\Delta v \geq \frac{h}{4\pi m}$
Quantum Number	• Principle quantum number - $(n = 1, 2, 3, 4, 5 ... \infty)$ • Orbital angular momentum of electron in any orbit $= \frac{nh}{2\pi}$ • Azimuthal quantum number $(l) = 0, 1, 2, 3, ...(n - 1)$ • Magnetic quantum number (m)=-l,…..-1,0,1…..+l • Spin quantum number (s)=+½ , -½ • Number of orbitals in subshell $= 2l + 1$ • Maximum number of electrons in particular subshell $= 2(2l + 1)$ • Orbital angular momentum $L = \frac{h}{2\pi}\sqrt{l(l + 1)} = \hbar\sqrt{l(l + 1)}$ • $\hbar = \frac{h}{2\pi}$

Molar Mass Formula

The formula for molar mass are as stated below

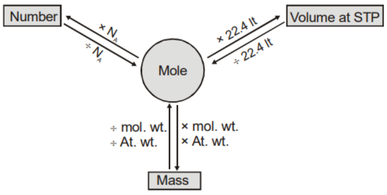
Description	Formula
Molar mass	M= $\frac{m}{n}$ M is the molar mass, m is the mass of a substance (in grams), n is the number of moles of a substance.
Molar mass of an element	Molar mass = Molar mass constant × Relative atomic mass
molar mass from colligative properties data	M = $\frac{\Delta T_f}{K_f}$
When elevation of boiling point is given	$\Delta Tb = Kbm$ m= 1000 ×w2 / w1 × M2 $\Delta Tb = Kb\times$ 1000 ×w2 / w1 × M2
When depression of freezing point is given	$\Delta Tf = Kfm$ $\Delta Tf = Kf\times$ 1000 ×w2 / w1 × M2

Molarity	$M = \frac{w\times1000}{(\text{Mol. wt of solute})\times V_{\text{in ml}}}$
Molality	$m = \frac{\text{number of moles of solute}}{\text{mass of solvent in gram}}\times1000 = \frac{1000\times w_1}{M_1\times w_2}$
Average atomic mass	$A_x = \frac{a_1x_1 + a_2x_2 + \ldots\ldots + a_nx_n}{100}$
Mean molar mass	$M_{avg} = \frac{M_1n_1 + M_2n_2 + \ldots..M_nn_n}{n_1+n_2+\ldots.n_n}$

Stoichiometry Formula

The formula for stoichiometry are as stated below

Description	Formulas
Relative atomic mass	$\text{Relative atomic mass (R. A. M)} = \frac{\text{Mass of one atom of an element}}{\frac{1}{12}\times\text{mass of one Carbon atom}} = \text{Total number of}$
Density	$\text{Specific gravity} = \frac{\text{density of the substance}}{\text{density of water at } 4^0C}$
For Gases:	$\text{Absolute density}\left(\frac{\text{mass}}{\text{volume}}\right) = \frac{\text{Molar mass of the gas}}{\text{Molar Volume of the gas}}$ $=> \rho = \frac{PM}{RT}$ $\text{Vapor density } V.D.. = \frac{d_{gas}}{d_{H_2}} = \frac{PM_{\frac{gas}{RT}}}{PM_{H_{\frac{2}{Rt}}}} = \frac{M_{gas}}{M_{H_2}}$ $M_{gas} = 2\,V.D$
Molarity (M):	$\text{Molarity}(M) = \frac{w\times1000}{(\text{Mol. wt of Solute})\times V_{\text{in ml}}}$
Molality (m):	$\text{Molality} = \frac{\text{number of moles of solute}}{\text{mass of solvent in gram}}\times1000 = 1000\frac{W_1}{M_1W_2}$
% Calculation	$\%\frac{w}{w} = \frac{\text{mass of solute in gm}}{\text{mass of solution in gm}}\times100$ $\%\frac{w}{v} = \frac{\text{Mass of solute in gm}}{\text{Volume of solution in ml}}\times100$ $\%\frac{v}{v} = \frac{\text{Volume of solute in ml}}{\text{Volume of solution}}\times100$
Average/ Mean atomic mass:	$A_x = \frac{a_1x_1+a_2x_2+\ldots+a_nX_n}{100}$
Mean molar mass or molecular Mass	$M_{avg} = \frac{n_1M_1+n_2M_2+\ldots n_nM_n}{n_1+n_2+n_3+\ldots n_n}$
Normality (N)	$\text{Normality}(N) = \frac{\text{Number of equivalents of solute}}{\text{Volume of Sodium(in liters)}}$

Measurement of Hardness	$Hardness\ in\ ppm = \frac{mass\ of\ CaC0_3}{Total\ Mass\ of\ water} \times 10^6$
Molarity in mole Fraction	$x_2 = \frac{MM_1 \times 1000}{\rho \times 1000 - MM_2}$
Mole Fraction into molality	$m = \left(\frac{x_2 \times 1000}{x_1 M_1}\right)$
Molality into mole fraction	$x_2 = \frac{mM_1}{1000 + mM_1}$
Molality into molarity	$M = \frac{m\rho \times 1000}{1000 + mM_2}$
Relation between molarity and molality	$m = \frac{M \times 1000}{1000\rho - MM_1}$ Where ρ is the density of solution in (gm/mL). M_1 is molecular weight of solute m is the molality and M is the molarity
Y-Map	

Part 2

Thermodynamics Formulas

The formula for thermodynamics are as stated below

Description	Formula
Various processes in Thermodynamic	Isothermal process: T = constant dT = 0 ΔT = 0 Isochoric process: V = constant dV = 0 ΔV = 0 Isobaric process: P = constant dP = 0

	$\Delta P = 0$ Adiabatic process: q = 0 or the heat exchange with surrounding is zero
Sign convention	When work is done on the system: Positive When work is done by the system: Negative
Laws of Thermodynamics	- **1st law of Thermodynamics** $\Delta U = (U_2 - U_1) = q + w$ - **2nd law of Thermodynamics** $\Delta S_{universe} = \Delta S_{system} + \Delta S_{surrounding} > 0$ **This equation is for spontaneous processes.** - **3rd law of Thermodynamics** $S - S_0 = k_B \ln \Omega$ S is the entropy of the system. S_0 is the initial entropy. k_B denotes the Boltzmann constant. Ω refers to the total number of microstates that are consistent with the system's macroscopic configuration.
Law of Equipartition Energy	$U = \frac{f}{2} nRT$ $\Delta E = \frac{f}{2} nR(\Delta T)$ Where, f is degrees of freedom for that gas.
Total heat capacity	$C_T = \frac{\Delta q}{\Delta T} = \frac{dq}{dT}$
Molar heat capacity	$C = \frac{\Delta q}{n\Delta T} = \frac{dq}{ndT}$ $C_p = \frac{\gamma R}{\gamma - 1}$ $\quad C_v = \frac{R}{\gamma - 1}$
Specific heat capacity	$S = \frac{\Delta q}{m\Delta T} = \frac{dq}{mdT}$
Application of 1st Law of Thermodynamics	$\Delta U = \Delta Q + \Delta W$ $\Rightarrow \Delta W = - P \Delta V \quad (\therefore \Delta U = \Delta Q - P \Delta V)$
Isothermal Reversible expansion/compression of an ideal gas	$W = - nRT ln\left(\frac{V_f}{V_i}\right)$
Reversible/irreversible isochoric processes	Since $dV = 0$ So, $dW = - P_{ext}. dV = 0$
Reversible isobaric process	$W = P\left(V_f - V_i\right)$
Adiabatic reversible expansion	$T_2 V_2^{\gamma - 1} = T_1 V_1^{\gamma - 1}$
Reversible work	$W = \frac{P_2V_2 - P_1V_1}{\gamma - 1} = \frac{nR\left(T_2 - T_1\right)}{\gamma - 1}$
Irreversible Work	$W = \frac{P_2V_2 - P_1V_1}{\gamma - 1} = \frac{nR\left(T_2 - T_1\right)}{\gamma - 1} = nC_v\left(T_2 - T_1\right) = - P_{ext}\left(V_2 - V_1\right)$

	Use $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Gaseous State Formula

The formula for gaseous state are as stated below

Description	Formula
Temperature conversion from Celsius to Kelvin	$\frac{C-0}{100-0} = \frac{K-273}{373-273}$
Temperature conversion from Kelvin to Fahrenheit	$\frac{K-273}{373-273} = \frac{F-32}{212-32}$
Boyle's Law and Measurement of pressure	$At\ constant\ temperature,$ $V \propto \frac{1}{P}$ $P_1V_1 = P_2V_2$
Charles Law	At constant pressure, $V \propto T\ Or \frac{V_1}{T_1} = \frac{V_2}{T_2}$
Gay-Lussac's Law	At constant Volume, $P \propto T\ \ \frac{P_1}{T_1} = \frac{P_2}{T_2}$ Temp on absolute Scale
Ideal gas Equation	$PV = nRT$ $PV = \frac{w}{m}RT\ or\ P = \frac{d}{m}RT\ or\ Pm = dRT$
Dalton's Law of Partial Pressure:	$P_1 = \frac{n_1RT}{V}, P_2 = \frac{n_2RT}{V}$ Total Pressure=$P_1 + P_2 + \ldots$ $Partial\ pressure = Mole\ fraction \times Total\ Pressure$
Average Molecular mass of gaseous mixture	$M_{mix} = \frac{Total\ mass\ of\ mixture}{Total\ no.\ of\ moles\ in\ mixture} = \frac{n_1M_1+n_2M_2+n_3M_3}{n_1+n_2+n_3}$
Graham's Law	Rate of Diffusion $r \propto \frac{1}{\sqrt{d}}$; d= density of gas

	$\frac{r_1}{r_2} = \frac{\sqrt{d_2}}{\sqrt{d_1}} = \frac{\sqrt{M_2}}{\sqrt{M_1}} = \sqrt{\frac{V.D_2}{V.D_1}}$
Van der wall’s Equation	$\left(P + \frac{an^2}{v^2}\right)(v - nb) = nRT$ Where ‘P’ is the pressure ‘a’ and ‘b’ are the gas constants ‘V’ is the molar volume ‘R’ is the universal gas constant ‘T’ is the temperature ‘n’ is the number of moles
Relation between molar volume (V) and gas constant (b)	$V_c = 3b$
Relation between Pressure (P) and gas constant (a) and (b)	$P_c = \frac{a}{27b^2}$
Relation between temperature (T) and gas constant (b)	$T_c = \frac{8a}{27Rb}$
Kinetic Theory of Gases	**Root mean Square speed** $U_{rms} = \sqrt{\frac{3RT}{M}}$ Molar mass be in kg/mole **Average speed** $U_{avg} = U_1 + U_2 + U_3 + ...U_N$ $U_{avg} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8KT}{\pi m}}$ K is Boltzmann Constant **Most Probable Speed** $U_{MPS} = \sqrt{\frac{2RT}{M}} = \sqrt{\frac{2KT}{m}}$

Chemical Equilibrium Formula

The formula for chemical equilibrium are as stated below

Description	Formula
At Equilibrium:	$Rate\ of\ forward\ reaction = rate\ of\ backward\ reaction$ $\Delta G = 0$ $Q = K_{eq}$
Equilibrium constant (K):	$K = \frac{rate\ constant\ of\ forward\ reaction}{rate\ constant\ of\ backward\ reaction} = \frac{K_f}{K_b}$

Equilibrium constant in terms of concentration (K_c):	$\frac{K_f}{K_b} = K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$
Equilibrium constant in terms of partial pressure (K_p):	$K_p = \frac{[P_C]^c[P_D]^d}{[P_A]^a[P_B]^b}$
Equilibrium constant in terms of mole fraction (K_x):	$K_x = \frac{X_C^c X_D^d}{X_A^a X_B^b}$
Relation between K_p & K_c:	$K_p = K_c.(RT)^{\Delta n}$
Relation between K_p & K_x:	$K_p = K_x(P)^{\Delta n}$ $\log log \frac{K_2}{K_1} = \frac{\Delta H}{2.303\, R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$ Here ΔH = Enthalpy of reaction
between equilibrium constant & standard free energy change	$\Delta G^{\circ} =- 2.303\, RTlog = K$
Reaction Quotient(Q):	$Q = \frac{[C]^c[D]^d}{[A]^a[B]^b}$
Degree of Dissociation (α):	$\alpha = \frac{number\ of\ moles\ dissociated}{initial\ number\ of\ moles\ taken}$
Vapor Pressure of Liquid:	$Relative\ Humidity = \frac{Partial\ pressure\ of\ H_2O\ vapors}{Vapor\ pressure\ of\ H_2O\ at\ the\ temperature}$
Thermodynamics of Equilibrium:	$\Delta G = \Delta G^{\circ} + 2.303\, RTQ$
Van't Hoff equation	$\log log \frac{K_1}{K_2} = \frac{\Delta H^{\circ}}{2.303\, R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$

Ionic Equilibrium Formula

The formula for ionic equilibrium are as stated below

Description	**Formula**
Ostwald Dilution Law:	● Dissociation constant of weak acid (K_a),

	$K_a = \frac{[H^+][A^-]}{HA} = \frac{[C\alpha][C\alpha]}{C(1-\alpha)} = \frac{C\alpha^2}{1-\alpha}$ • If $\alpha \ll 1$, then $1 - \alpha \cong 1$ or $K_a = c\alpha^2$ $\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{K_a \times V}$ • Similarly for a weak base, $\alpha = \sqrt{\frac{K_b}{C}}$ Higher the value of K_a/K_b, stronger is the acid/base
Acidity and pH scale	• $pH =- \log a_{H^+}$ Here a_{H^+} is the activity of H^+ ions = molar concentration for dilute solution • $pH =- \log \left[H^+\right]$ $\quad \left[H^+\right] = 10^{-pH}$ • $pOH =- \log\left[OH^-\right]$ $\quad [OH\ -] = 10^{-pOH}$ • $pKa =- \log Ka$ $\quad Ka = 10^{pKa}$ • $pKb =- \log\ Kb$ $\quad Kb = 10^{-pKb}$ •
pH Calculations of Different Types of Solutions:	• **Strong acid solution:** If concentration is greater than $10^{-6}\ M$ In this case H^+ ions coming from water can be neglected, If concentration is less than $10^{-6}\ M$ In this case H^+ ions coming from water cannot be neglected • **Strong base solution:** Using similar method as in part (a) calculate first $[OH^-]$ and then use $[H^+] \times [OH^-] = 10^{-14}$ •
pH of mixture of two strong acids:	• Number of H+ ions from I-solution = N_1V_1 • Number of H+ ions from II-solution = N_2V_2 $\left[H^+\right] = N = \frac{N_1V_1+N_2V_2}{V_1+V_2}$ •
pH of mixture of two strong bases:	$\left[OH^-\right] = N = \frac{N_1V_1+N_2V_2}{V_1+V_2}$ •
pH of mixture of a strong acid and a strong base:	• if $N_1V_1 > N_2V_2$, then the solution will be acidic in nature. So, $\left[H^+\right] = N = \frac{N_1V_1-N_2V_2}{V_1+V_2}$

	● If $N_2V_2 > N_1V_1$, then the solution will be basic in nature. So, $\left[OH^-\right] = N = \frac{N_2V_2-N_1V_1}{V_1+V_2}$
pH of a weak acid(monoprotic) solution:	$K_a = \frac{[H^+][OH]^-}{[HA]} = \frac{C\alpha^2}{1-\alpha}$ If $\alpha \ll 1 \Rightarrow (1-\alpha) \approx 1$ $K_a \approx C\alpha^2$ $\alpha = \sqrt{\frac{K_a}{C}}$ Here $\alpha < 0.1 \; or \; 10\%$
Relative Strength of two acids:	$\frac{[H^+] furnished \; by \; I \; acid}{[H^+] furnished \; by \; II \; acid} = \frac{c_1\alpha_1}{c_2\alpha_2} = \sqrt{\frac{k_{a_1}c_1}{k_{a_2}c_2}}$
Hydrolysis of polyvalent anions or cations	For $\left[Na_3PO_4\right] = C$ $K_{a1} \times K_{h3} = K_w$ $K_{a2} \times K_{h2} = K_w$ $K_{a3} \times K_{h1} = K_w$ Generally, pH is calculated only using the first step hydrolysis $K_{h1} = \frac{Ch^2}{1-h} \approx Ch^2$ $h = \sqrt{\frac{K_{h1}}{c}} \Rightarrow \left[OH^-\right] = ch = \sqrt{K_{h1} \times c} \Rightarrow \left[H^+\right] = \sqrt{\frac{K_w \times K_{a3}}{C}}$ $\therefore pH = \frac{1}{2}\left[pK_w + pK_{a3} + \log log \; C\right]$
Buffer Solution:	● Acidic Buffer: e.g., CH_3COOH and CH_3COONa (weak acid and salt of its conjugate base) $pH - pK_a + \log log \frac{[salt]}{[Acid]}$ ● Basic Buffer: e.g., $NH_4OH + NH_4Cl$ (weak base and salt of its conjugate acid) $pOH = pK_b + \log log \frac{[Salt]}{[Base]}$
Solubility Product:	$K_{sp} = (xs)^x(ys)^y = x^x.y^y.(s)^{x+y}$ ●

Charles's Law

The formula for Charle’s law are as stated below

Description	Formulas
Charles' law is expressed as	$V \alpha T$ or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$, Where V_1 and V_2 are initial and final volume and T_1 and T_2 are initial and final temperatures.
Derivation of Charles' law	$V \alpha T$ $\frac{V}{T} = constant = k$ $\frac{V_1}{T_1} = k ------ (I)$ and $\frac{V_2}{T_2} = k ------ (II)$ Where V_1 and T_1 are initial volume and temperature and V_2 and T_2 are the final volume and temperature. Equating equations (I) and (II), $\frac{V_1}{T_1} = \frac{V_2}{T_2} = k$ Hence, we can generalize the formula and write it as: $\frac{(V_1)}{(T_1)} = \frac{(V_2)}{(T_2)}$
Gay-Lussac's Law	At constant volume, $P \propto T$ $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
Ideal gas Equation	$PV = nRT$ $PV = \frac{w}{m} RT \; Or \; Pm = dRT$
Boyle's Law	At Constant Temperature $V \propto \frac{1}{P}$ $P_1 V_1 = P_2 V_2$
Amagat's Law of partial volume	$V = V_1 + V_2 + V_3 + \ldots Vn$

Part 3

Electrochemistry Formula

The formula for electrochemistry are as stated below

Description	Formula
Gibbs Free energy change	● $\Delta G =- nFE_{cell}$ ● $\Delta G^0 =- nFE^0_{cell}$
Nernst Equation	$\frac{Effect\ of\ concentration\ and\ temp\ on\ emf\ of\ cell}{where\ Q\ is\ reaction\ quotient}$ $\Delta G = \Delta G^0 + RTln\,Q$ $\Delta G^0 =- RTln\,K_{eq}$ $E_{cell} = E^0_{cell} - \frac{RT}{nF} ln\,Q$ $E_{cell} = E^0_{cell} - \frac{2.303RT}{nF} log\,Q$ $E_{cell} = E^0_{cell} - \frac{0.0591}{n} log\,Q$ ● At chemical equilibrium $\Delta G = 0; \qquad E_{cell} = 0$ $\log\ K_{eq} = \frac{nE^0_{cell}}{0.0591}$ $E^0_{cell} = \frac{0.0591}{n} log\,K_{eq}$ ● For an electrode: $E_{M^{n+}/M} = E^0_{M^{n+}/M} - \frac{2.303RT}{nF} log\,1/[M^{n+}]$
Concentration Cell	$E°_{cell} = 0$ ● **Electrolyte Concentration cell** (eg., $Zn(s)/Zn^{2+}(c_1)\|\|Zn^{2+}(c_2)/Zn(s)$): $E = \frac{0.0591}{2} log\,\frac{C_2}{C_1}$ ● **Electrode Concentration Cell** (e.g., $Pt,\ H_2(P_1\,atm)/H^+(1\ M)\ /H_2(P_2\,atm)/Pt$): $E = \frac{0.0591}{2} log\,\frac{P_1}{P_2}$

Faraday’s law of electrolysis:	• **First law:** The amount of chemical reaction (w) is proportional to the quantity of electricity passed (q) through the electrolyte. $w \propto q$ $w = zq$ $w = Z$ Here Z is Electrochemical equivalent of substance • **Second law:** $W \propto E$ $\frac{W}{E} = constant$ $\frac{W_1}{E_1} = \frac{W_2}{E_2} = \ldots = \frac{W_n}{E_n}$ $\frac{W}{E} = \frac{i \times t \times current\ efficiency\ factor}{96500}$ $current\ efficiency = \frac{actual\ mass\ deposited}{Theoretical\ mass\ deposited} \times 100$
Conductance:	• $Conductance = \frac{1}{Resistance}$ • Specific conductance or conductivity: $K = \frac{1}{\rho}$ Here, K is specific conductance • Equivalent conductance: $\lambda_E = \frac{K \times 1000}{Normality}$ • Molar conductance: $\lambda_m = \frac{K \times 1000}{Molarity}$ • $Specific\ conductance = conductance \times \frac{l}{a}$
Application of Kohlrausch law	• Calculation of λ_M^0 of weak electrolytes: $\lambda^0_{M\ (CH_3COOHI)} = \lambda^0_{M\ (CH_3COONa)} + \lambda^0_{M\ (HCl)} - \lambda^0_{M\ (NaCl)}$ • To calculate degree of dissociation of a weak electrolyte $\alpha = \frac{\lambda^c_m}{\lambda^0_m}; \quad K_{eq} = \frac{c\alpha^2}{1-\alpha}$

	- Solubility of sparingly soluble salt & their K_{sp} $\lambda^{c}_{M} = \lambda^{\infty}_{M} = k \times \frac{1000}{solubility}$ $K_{sp} = S^{2}$ - Transport Number: $t_c = \left[\frac{\mu_c}{\mu_c+\mu_a}\right]$, $t_a = \left[\frac{\mu_a}{\mu_a+\mu_c}\right]$ - Here t_c is Transport Number of cation and t_a is the transport number of anion.

Ideal Gas Equation Formula

The formula for ideal gas are as stated below

Description	Formula
Ideal gas law is expressed as:	**PV=nRT** where, P is the pressure V is the volume n is the amount of substance R is the ideal gas constant.
Derivation of Ideal gas law	Ideal gas law combines three laws: - Boyle's Law: $V \propto 1/P$ - Charles' Law: $V \propto T$ - Avogadro's Law: $V \propto n$ Combining these above three Equation we get $V \propto \frac{nT}{P}$ The above equation shows that volume is proportional to the number moles and the temperature while inversely proportional to the pressure. This expression can be rewritten as follows: $V = \frac{RnT}{P}$ Multiplying both sides of the equation by P to Clear off the fraction, We get $PV = nRT$ The Above equation is known as the ideal Gas Equation.
Molar From of $PV = nRT$	$n = \frac{m}{M}$, m= total mass of the gas, M=Molar mass

	$Density\ \rho\ = \frac{m}{V},$ $pV\ = \frac{m}{M}RT\quad ,$ $p\ = \frac{m\ \ RT}{V\ \ M}\ ,\ p\ = \rho\frac{R}{M}T$
Combined Gas law can be Stated as	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
If we want to use *N* number of molecules instead of *n* moles, we can write the ideal gas law as	$PV\ =\ Nk_bT$
The energy possessed by the gas is in the kinetic energy of the molecules of the gas	$E\ = \frac{3}{2}nRT$
Avogadro's Constant	Avogadro's Constant (N_A) is the ratio of the total number of molecules (N) to the total moles (n). $N_A = \frac{N}{n} = \frac{N}{\frac{PV}{RT}}$

Diffusion Formula

The formula for diffusion are as stated below

Description	Formula
Diffusion Formula	$Q_s =- D_s\ ds/dx$ Where Q_s is the rate of movement of matter, momentum or energy through a unit normal area. $-\ D_s$ is the diffusion coefficient. ds/dx is the gradient of mass,momentum or energy in the medium.
Graham's Law	Rate of diffusion $r \propto \frac{1}{\sqrt{d}}$ D= Density of Gas $\frac{r_1}{r_2} = \frac{\sqrt{d_2}}{\sqrt{d_1}} = \frac{\sqrt{M_2}}{\sqrt{M_1}} = \sqrt{\frac{V.D_2}{V.D_1}}$

Van der Waals Equation	$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$
Critical Constant	$V_c = 3b,\ P_c = \frac{a}{27b^2},\ T_c = \frac{8a}{27Rb}$
Graham's Law for comparison between two Gases	$\frac{r_{Gas}A}{r_{Gas}B} = \frac{(M_{Gas\,B})^{\frac{1}{2}}}{(M_{Gas\,A})^{\frac{1}{2}}}$

De-Broglie's Formula

The formula for De-Broglie are as stated below

Description	Formula
The de-Broglie's Equation	**λ = h/mv,** Where λ is wavelength, h is Planck's constant, m is the mass of a particle, moving at a velocity v.
Derivation of De-Broglie's equation	● Plank's quantum theory relates the energy of an electromagnetic wave to its wavelength or frequency. $E = hv = \frac{hc}{\lambda}$ .... (1) Einstein related the energy of particle matter to its mass and Velocity, as $E = mc^2$.......... (2) As the Smaller particle exhibits dual nature, and energy being the same, de Broglie Equation as $E = \frac{hc}{\lambda} = mv^2 \quad then,\ \frac{h}{\lambda} = mv$ This is the momentum of a particle with its wavelength and this equation is known as De-Broglie's Equation.
De-Broglie's Wavelength	$\lambda = \frac{h}{mv} = \frac{h}{momentum} = \frac{h}{p}$ ●
Relation between de Broglie Equation and Bohr's Hypothesis of Atom:	$mv = \frac{nh}{2\Pi r} \quad or \quad mvr = n \times (\frac{h}{2\Pi})$
Thermal De-Broglie Wavelength	The thermal de Broglie wavelength (λth) is approximately the average de Broglie wavelength of the gas particles in an ideal gas at the specified temperature.

	$$\lambda_{th} = \frac{h}{\sqrt{2\pi m k_b T}}$$ where, h = Planck constant, m = mass of a gas particle, k_b = Boltzmann constant, T = temperature of the gas,
De Broglie's in terms of kinetic energy	$$\lambda = \frac{h}{\sqrt{2mK}}$$