



# IIT JEE Formulas

## Maths Formulas

### Part 1

#### Circle Formula

The formula for circle are as stated below

Description	Formula
<b>Area of a Circle</b>	<ul style="list-style-type: none"><li>In terms of radius: <math>\pi r^2</math></li><li>In terms of diameter: <math>\frac{\pi}{4} \times d^2</math></li></ul>
<b>Surface Area of a Circle</b>	$\pi r^2$
<b>General Equation of a Circle</b>	The general equation of a circle with coordinates of a centre $(h, k)$ , and radius $r$ is given as: $\sqrt{(x - h)^2 + (y - k)^2} = r$
<b>Standard Equation of a Circle</b>	The Standard equation of a circle with centre $(a, b)$ , and radius $r$ is given as: $(x - a)^2 + (y - b)^2 = r^2$
<b>Diameter of a Circle</b>	$2 \times \text{radius}$
<b>Circumference of a Circle</b>	$2\pi r$
<b>Intercepts made by Circle</b>	$x^2 + y^2 + 2gx + 2fy + c = 0$ <ul style="list-style-type: none"><li>i. On <math>x</math> -axis: <math>2\sqrt{g^2 - c}</math></li><li>ii. On <math>y</math> -axis: <math>2\sqrt{f^2 - c}</math></li></ul>
<b>Parametric Equations of a Circle</b>	$x = h + r\cos \theta ; y = k + r\sin \theta$
<b>Tangent</b>	<ul style="list-style-type: none"><li><b>Slope form:</b> <math>y = mx \pm a\sqrt{1 + m^2}</math></li><li><b>Point form:</b> <math>xx_1 + yy_1 = a^2</math> or <math>T = 0</math></li><li><b>Parametric form:</b> <math>x\cos \alpha + y\sin \alpha = a</math></li></ul>
<b>Pair of Tangents from a Point:</b>	$SS_1 = T^2$



<b>Length of a Tangent</b>	$\sqrt{S_1}$
<b>Director Circle</b>	$x^2 + y^2 = 2a^2$ for $x^2 + y^2 = a^2$
<b>Chord of Contact</b>	$T = 0$ <ul style="list-style-type: none"> <li>i. Length of chord of contact = <math>\frac{2LR}{\sqrt{R^2+L^2}}</math></li> <li>ii. Area of the triangle formed by the pair of the tangents and its chord of contact = <math>\frac{RL^3}{R^2+L^2}</math></li> <li>iii. Tangent of the angle between the pair of tangents from <math>(x_1, y_1) = \left( \frac{2RL}{L^2-R^2}, 0 \right)</math></li> <li>iv. Equation of the circle circumscribing the triangle <math>PT_1, T_2</math> is:  <math display="block">(x - x_1)(x + g) + (y - y_1)(y + f) = 0</math> </li> </ul>
<b>Condition of orthogonality of Two Circles</b>	$2g_1g_2 + 2f_1f_2 = c_1 + c_2$
<b>Radical Axis</b>	$S_1 - S_2 = 0$ i.e. $2(g_1 - g_2)x + 2(f_1 - f_2)y + (c_1 - c_2) = 0$ .
<b>Family of Circles</b>	$S_1 + KS_2 = 0, S + KL = 0$

## Quadratic Equation Formula

The formula for quadratic equation are as stated below

Description	Formula
<b>General form of Quadratic Equation</b>	$ax^2 + bx + c = 0$ ; where $a, b, c$ are constants and $a \neq 0$ .
<b>Roots of equations</b>	$\alpha = \frac{-b+\sqrt{b^2-4ac}}{2a}, \beta = \frac{-b-\sqrt{b^2-4ac}}{2a}$
<b>Sum and Product of Roots</b>	If $\alpha$ and $\beta$ are the roots of the quadratic equation $ax^2 + bx + c = 0$ , then $\text{Sum of roots, } \alpha + \beta = -\frac{b}{a}$ $\text{Product of roots, } \alpha\beta = \frac{c}{a}$
<b>Discriminant of Quadratic equation</b>	The Discriminant of the quadratic equation $ax^2 + bx + c = 0$ is given by $D = b^2 - 4ac$ .
<b>Nature of Roots</b>	<ul style="list-style-type: none"> <li>• If <math>D = 0</math>, the roots are real and equal <math>\alpha = \beta = -\frac{b}{2a}</math>.</li> </ul>



	<ul style="list-style-type: none"><li>• If <math>D \neq 0</math>, The roots are real and unequal.</li><li>• If <math>D &lt; 0</math>, the roots are imaginary and unequal.</li><li>• If <math>D &gt; 0</math> and D is a perfect square, the roots are rational and unequal.</li><li>• If <math>D &gt; 0</math> and D is not a perfect square, the roots are irrational and unequal.</li></ul>
<b>Formation of Quadratic Equation with given roots</b>	If $\alpha$ and $\beta$ are the roots of the quadratic equation, then $(x - \alpha)(x - \beta) = 0; x^2 - (\alpha + \beta)x + \alpha\beta = 0;$ • $x^2 - (\text{Sum of roots})x + \text{product of roots} = 0$
<b>Common Roots</b>	<ul style="list-style-type: none"><li>• If two quadratic equations <math>a_1x^2 + b_1x + c_1 = 0</math> &amp; <math>a_2x^2 + b_2x + c_2 = 0</math> have both roots common, then <math display="block">\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}.</math></li><li>• If only one root <math>\alpha</math> is common, then <math display="block">\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}</math></li></ul>
<b>Range of Quadratic Expression</b> $f(x) = ax^2 + bx + c$ in restricted domain $x \in [x_1, x_2]$	<ul style="list-style-type: none"><li>• If <math>-\frac{b}{2a}</math> not belong to <math>[x_1, x_2]</math> then, <math>f(x) \in \left[ f(x_1), f(x_2) \right], \max\{f(x_1), f(x_2)\}</math></li><li>• If <math>-\frac{b}{2a} \in [x_1, x_2]</math> then, <math>f(x) \in \left[ f(x_1), f(x_2), -\frac{D}{4a} \right], \max\{f(x_1), f(x_2), -\frac{D}{4a}\}</math></li></ul>
<b>Roots under special cases</b>	Consider the quadratic equation $ax^2 + bx + c = 0$ <ul style="list-style-type: none"><li>• If <math>c = 0</math>, then one root is zero. Other root is <math>-\frac{b}{a}</math>.</li><li>• If <math>b = 0</math> The roots are equal but in opposite signs.</li><li>• If <math>b = c = 0</math>, then both roots are zero.</li><li>• If <math>a = c</math>, then the roots are reciprocal to each other.</li><li>• If <math>a + b + c = 0</math>, then one root is 1 and the second root is <math>-\frac{c}{a}</math>.</li><li>• If <math>a = b = c = 0</math>, then the equation will become an identity and will satisfy every value of <math>x</math>.</li></ul>
<b>Graph of Quadratic equation</b>	The graph of a quadratic equation $ax^2 + bx + c = 0$ is a parabola. <ul style="list-style-type: none"><li>• If <math>a &gt; 0</math>, then the graph of a quadratic equation will be concave upwards.</li><li>• If <math>a &lt; 0</math>, then the graph of a quadratic equation will be concave downwards.</li></ul>



<b>Maximum and Minimum value</b>	Consider the quadratic expression $ax^2 + bx + c = 0$ <ul style="list-style-type: none"> <li>If <math>a &lt; 0</math>, then the expression has the greatest value at <math>x = -\frac{b}{2a}</math>. The maximum value is <math>-\frac{D}{4a}</math>.</li> <li>If <math>a &gt; 0</math>, then the expression has the least value at <math>x = -\frac{b}{2a}</math>. The minimum value is <math>-\frac{D}{4a}</math>.</li> </ul>
<b>Quadratic Expression in Two Variables</b>	The general form of a quadratic equation in two variables $x$ and $y$ is $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ . To solve the expression into two linear rational factors, the condition is $\Delta = 0$ $\begin{bmatrix} a & h & g \end{bmatrix}$ $\Delta = [h \ b \ f] = 0$ $\begin{bmatrix} g & f & c \end{bmatrix}$ $abc + 2fgh - af^2 - bg^2 - ch^2 = 0$ 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
<b>Binomial Theorem for positive Integral Index</b>	$(x + a)^n = {}^n C_0 x^n a^0 + {}^n C_1 x^{n-1} a + {}^n C_2 x^{n-2} a^2 + \dots + {}^n C_{r-1} x^{n-r} a^{r-1} + \dots + {}^n C_n x a^n$ General terms = $T_{r+1} = {}^n C_{r-1} x^{n-r} a^r$
<b>Deductions of Binomial Theorem</b>	<ul style="list-style-type: none"> <li><math>(1 + x)^n = {}^n C_0 + {}^n C_1 x + {}^n C_2 x^2 + {}^n C_3 x^3 + \dots + {}^n C_{r-1} x^{r-1} + \dots + {}^n C_n x^n</math> which is the standard form of binomial expansion. General Term= <math>(r + 1)^{th}</math> term: <math>T_{r+1} = {}^n C_r x^r</math> <math display="block">x^r = \frac{n(n-1)(n-2)\dots(n-r+1)}{r!} x^r</math></li> <li><math>(1 - x)^n = {}^n C_0 - {}^n C_1 x + {}^n C_2 x^2 - {}^n C_3 x^3 + \dots + (-1)^r {}^n C_r x^r + \dots + (-1)^n {}^n C_n x^n</math> General Term= <math>(r + 1)^{th}</math> term: <math>T_{r+1} = (-1)^r {}^n C_r x^r</math> <math display="block">x^r = \frac{n(n-1)(n-2)\dots(n-r+1)}{r!} x^r</math></li> </ul>
<b>Middle Term in the expansion of <math>(x + a)^n</math></b>	<ul style="list-style-type: none"> <li>If <math>n</math> is even then middle term = <math>\left(\frac{n}{2} + 1\right)^{th}</math> term.</li> <li>If <math>n</math> is odd then middle terms are <math>\left(\frac{n+1}{2}\right)^{th}</math> and <math>\left(\frac{n+3}{2}\right)^{th}</math> term.</li> <li>Binomial coefficients of middle term is the greatest Binomial coefficients</li> </ul>



<b>To determine a particular term in the expansion</b>	<p>In the expansion of <math>\left(x^\alpha \pm \frac{1}{x^\beta}\right)^n</math>, if <math>x^m</math> occurs in <math>T_{r+1}</math>, then <math>r</math> is given by <math>n\alpha - r(\alpha + \beta) = m \Rightarrow r = \frac{n\alpha - m}{\alpha + \beta}</math> and the term which is independent of <math>x</math> then <math>n\alpha - r(\alpha + \beta) = 0 \Rightarrow r = \frac{n\alpha}{\alpha + \beta}</math>.</p>
<b>To find a term from the end in the expansion of <math>(x + a)^n</math></b>	$T_r(E) = T_{n-r+2}(B)$
<b>Binomial Coefficients and their properties</b>	<p>In the expansion of <math>(1 + x)^n = C_0 + C_1 x + C_2 x^2 + \dots + C_r x^r + \dots + C_n x^n</math>  Where <math>C_0 = 1</math>, <math>C_1 = n</math>, <math>C_2 = \frac{n(n-1)}{2!}</math></p> <p>i. <math>C_0 + C_1 + C_2 + \dots + C_n = 2^n</math></p> <p>ii. <math>C_0 - C_1 + C_2 - C_3 + \dots = 0</math></p> <p>iii. <math>C_0 + C_2 + \dots = C_1 + C_3 + \dots = 2^{n-1}</math></p> <p>iv. <math>C_0^2 + C_1^2 + C_2^2 + \dots + C_n^2 = \frac{2n!}{n!n!}</math></p> <p>v. <math>C_0 + \frac{C_1}{2} + \frac{C_2}{3} + \dots + \frac{C_n}{n+1} = \frac{2^{n+1}-1}{n+1}</math></p> <p>vi. <math>C_0 - \frac{C_1}{2} + \frac{C_2}{3} - \frac{C_3}{4} + \dots + \frac{(-1)^n C_n}{n+1} = \frac{1}{n+1}</math></p>
<b>Greatest term in the expansion of <math>(x + a)^n</math>:</b>	<ul style="list-style-type: none"> <li>The term in the expansion of <math>(x + a)^n</math> of greatest coefficients  <math>= \{T_{\frac{(n+2)}{2}}, \text{ when } n \text{ is even } T_{\frac{(n+1)}{2}}, T_{\frac{(n+3)}{2}}</math>  <math>\text{when } n \text{ is odd}</math></li> <li>The greatest term  <math>= \{T_p, T_{p+1}, \text{ when } \frac{(n+1)a}{x+a} = p \in \mathbb{Z} T_{q+1},</math>  <math>\text{When } \frac{(n+1)a}{x+1} \text{ not belong to } \mathbb{Z} \text{ and } q &lt; \frac{(n+1)a}{x+a} &lt; q + 1</math></li> </ul>
<b>Multinomial Expansion</b>	<p>If <math>n \in \mathbb{N}</math> then the general terms of multinomial expansion</p> $(x_1 + x_2 + x_3 + \dots + x_k)^n \text{ is } \sum_{r_1+r_2+\dots+r_k=n} \frac{n!}{r_1!r_2!\dots r_k!} x_1^{r_1} \cdot x_2^{r_2} \dots x_k^{r_k}$



<b>Binomial Theorem for Negative Integer Or Fractional Indices</b>	$(1 + x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \dots$ $+ \frac{n(n-1)(n-2)\dots(n-r+1)}{r!}x^r + \dots,  x  < 1$ $T_{r+1} = \frac{n(n-1)(n-2)\dots(n-r+1)}{r!}x^r$
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## Part 2

### Vectors Formula

The formula for vectors are as stated below

Description	Formula
<b>Position Vector of a Point</b>	If $\vec{a}$ and $\vec{b}$ are positive vectors of two points A and B, then $\vec{AB} = \vec{b} - \vec{a}$ <ul style="list-style-type: none"> <li><b>Distance Formula:</b> Distance between the two points <math>A(\vec{a})</math> and <math>B(\vec{b})</math> is  <math display="block">AB =  \vec{a} - \vec{b} .</math></li> <li><b>Section Formula:</b> <math>\vec{r} = \frac{\vec{a} + m\vec{b}}{m+n}</math>, Midpoint of <math>AB = \frac{\vec{a} + \vec{b}}{2}</math></li> </ul>
<b>Scalar Product of Two vectors</b>	$\vec{a} \cdot \vec{b} =  \vec{a}   \vec{b}  \cos \theta$ , where $ \vec{a} $ , $ \vec{b} $ are the magnitude of $\vec{a}$ and $\vec{b}$ respectively and $\theta$ is the angle between $\vec{a}$ and $\vec{b}$ <ul style="list-style-type: none"> <li><math>i \cdot i = j \cdot j = k \cdot k = 1</math>; <math>i \cdot j = j \cdot k = k \cdot i = 0</math>, projection of <math>\vec{a}</math> on <math>\vec{b} = \frac{\vec{a} \cdot \vec{b}}{ \vec{b} }</math>.</li> <li>If <math>\vec{a} = a_1\vec{i} + a_2\vec{j} + a_3\vec{k}</math> &amp; <math>\vec{b} = b_1\vec{i} + b_2\vec{j} + b_3\vec{k}</math> then  <math display="block">\vec{a} \cdot \vec{b} = a_1b_1 + a_2b_2 + a_3b_3</math>.</li> <li>The angle <math>\phi</math> between <math>\vec{a}</math> &amp; <math>\vec{b}</math> is given by  <math display="block">\phi = \cos^{-1} \frac{\vec{a} \cdot \vec{b}}{ \vec{a}   \vec{b} }, 0 \leq \phi \leq \pi</math>.</li> <li><math>\vec{a} \cdot \vec{b} = 0 \Leftrightarrow \vec{a}</math> Perpendicular to <math>\vec{b}</math> (<math>\vec{a} \neq 0, \vec{b} \neq 0</math>).</li> </ul>



<b>Vector Product of Two vectors</b>	<ul style="list-style-type: none"> <li>If <math>\vec{a}</math> &amp; <math>\vec{b}</math> are two vectors and <math>\theta</math> is the angle between them then</li> <li><math>\vec{a} \times \vec{b} =  \vec{a}   \vec{b}  \sin \theta \hat{n}</math>, where <math>\hat{n}</math> is the unit vector perpendicular to both <math>\vec{a}</math> &amp; <math>\vec{b}</math> such that <math>\vec{a}, \vec{b}</math> &amp; <math>\hat{n}</math> form a right handed screw system.</li> <li>Geometrically <math> \vec{a} \times \vec{b} </math> = area of the parallelogram whose two adjacents sides are represented by <math>\vec{a}</math> &amp; <math>\vec{b}</math>.</li> <li><math>\hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = 0</math>; <math>\hat{i} \times \hat{j} = \hat{k}</math>, <math>\hat{j} \times \hat{k} = \hat{i}</math>, <math>\hat{k} \times \hat{i} = \hat{j}</math></li> <li>If <math>\vec{a} = a_1 \hat{i} + a_2 \hat{j} + a_3 \hat{k}</math> &amp; <math>\vec{b} = b_1 \hat{i} + b_2 \hat{j} + b_3 \hat{k}</math> then</li> </ul> $\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$ <ul style="list-style-type: none"> <li><math>\vec{a} \times \vec{b} = \vec{0} \Leftrightarrow \vec{a}</math> and <math>\vec{b}</math> are parallel (collinear) (<math>\vec{a} \neq 0, \vec{b} \neq 0</math>) i.e. <math>\vec{a} = K \vec{b}</math> where <math>K</math> is a scalar.</li> <li>Unit vector perpendicular to the plane of <math>\vec{a}</math> &amp; <math>\vec{b}</math> is <math>\hat{n} = \pm \frac{\vec{a} \times \vec{b}}{ \vec{a} \times \vec{b} }</math>.</li> <li>If <math>\vec{a}, \vec{b}</math> &amp; <math>\vec{c}</math> are the position vectors of 3 points A, B &amp; C then the vector area of triangle <math>ABC = \frac{1}{2} [\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}]</math>. The points A, B &amp; C are collinear if <ul style="list-style-type: none"> <li><math>\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a} = \vec{0}</math></li> </ul> </li> <li>Area of any quadrilateral whose diagonal vectors are <math>\vec{d}_1</math> &amp; <math>\vec{d}_2</math> is given by <math>\frac{1}{2}  \vec{d}_1 \times \vec{d}_2 </math>.</li> <li>Lagrange's Identity:</li> </ul> $(\vec{a} \times \vec{b})^2 =  \vec{a} ^2  \vec{b} ^2 - (\vec{a} \cdot \vec{b})^2 = [(\vec{a} \times \vec{a}) (\vec{a} \times \vec{b}) (\vec{b} \times \vec{a}) (\vec{b} \times \vec{b})]$
<b>Scalar Triple Product</b>	<ul style="list-style-type: none"> <li>The scalar triple product of three vectors <math>\vec{a}, \vec{b}</math> &amp; <math>\vec{c}</math> is defined as:  <math display="block">\vec{a} \times \vec{b} \cdot \vec{c} =  \vec{a}   \vec{b}   \vec{c}  \sin \theta \sin \phi \cos \psi</math> </li> <li>Volume of tetrahedron <math>V = \frac{1}{6}  \vec{a} \cdot \vec{b} \cdot \vec{c} </math></li> <li>In a scalar triple product the position of dot and cross can be interchanged i.e.</li> </ul>



	$\vec{a} \cdot (\vec{b} \times \vec{c}) = (\vec{a} \times \vec{b}) \cdot \vec{c}$ Or $[\vec{a} \vec{b} \vec{c}] = [\vec{b} \vec{c} \vec{a}] = [\vec{c} \vec{a} \vec{b}]$ $\vec{a} \cdot (\vec{b} \times \vec{c}) = -\vec{a} \cdot (\vec{c} \times \vec{b})$ i.e. $[\vec{a} \vec{b} \vec{c}] = -[\vec{a} \vec{c} \vec{b}]$ <ul style="list-style-type: none"> <li>If <math>\vec{a} = a_1 \vec{i} + a_2 \vec{j} + a_3 \vec{k}</math>; <math>\vec{b} = b_1 \vec{i} + b_2 \vec{j} + b_3 \vec{k}</math> &amp;  <math>\vec{c} = c_1 \vec{i} + c_2 \vec{j} + c_3 \vec{k}</math> then</li> </ul> $[\vec{a} \cdot \vec{b} \cdot \vec{c}] = \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix}$ <ul style="list-style-type: none"> <li>If <math>\vec{a}, \vec{b}, \vec{c}</math> are coplanar <math>\Leftrightarrow [\vec{a} \vec{b} \vec{c}] = 0</math>.</li> <li>Volume of tetrahedron OABC with O as origin &amp; A(<math>\vec{a}</math>), B(<math>\vec{b}</math>) and C(<math>\vec{c}</math>) be the vertices <math>= \left  \frac{1}{6} [\vec{a} \vec{b} \vec{c}] \right </math>.</li> <li>The position vector of the centroid of a tetrahedron if the pv's of its vertices are <math>\vec{a}, \vec{b}, \vec{c}</math> &amp; <math>\vec{d}</math> are given by <math>\frac{1}{4}[\vec{a} + \vec{b} + \vec{c} + \vec{d}]</math>.</li> <li>•</li> </ul>
<b>Vector Triple Product</b>	$\vec{a} \times (\vec{b} \times \vec{c}) = (\vec{a} \cdot \vec{c})\vec{b} - (\vec{a} \cdot \vec{b})\vec{c}$ , $(\vec{a} \times \vec{b}) \times \vec{c} = (\vec{a} \cdot \vec{c})\vec{b} - (\vec{b} \cdot \vec{c})\vec{a}$ <b>In general:</b> $(\vec{a} \times \vec{b}) \times \vec{c} \neq \vec{a} \times (\vec{b} \times \vec{c})$

## Parabola Formula

The formula for parabola are as stated below

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



	$\frac{4}{m^2} (\sqrt{a(1 + m^2)}(a - mc))$
<b>Tangents to the parabola</b> $y^2 = 4ax$	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 $(\frac{a}{m^2}, \frac{2a}{m})$
<b>Normal to the parabola</b> $y^2 = 4ax$	Normal to the parabola $y^2 = 4ax$ is given as $y - y_1 = \frac{-y_1}{2a}(x - x_1)$ at $(x_1, y_1)$
<b>A chord with a given middle point</b>	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
<b>Definite Integral as Limit Sum</b>	$\int_a^b f(x)dx = \sum_{r=1}^n hf(a + rh)$ Here $h = \frac{b-a}{n}$ is the length of each subinterval
<b>Definite Integral Formula Using the Fundamental theorem of calculus</b>	$\int_a^b f(x)dx = F(b) - F(a), \text{ where } F'(x) = f(x)$
<b>Properties of Definite Integral</b>	<ul style="list-style-type: none"> <li>• <math>\int_a^b f(x).dx = \int_a^b f(t).dt</math></li> <li>• <math>\int_a^b f(x).dx = - \int_b^a f(x).dx</math></li> <li>• <math>\int_a^b cf(x).dx = c \int_a^b f(x).dx</math></li> <li>• <math>\int_a^b f(x) \pm g(x).dx = \int_a^b f(x).dx \pm \int_a^b g(x).dx</math></li> <li>• <math>\int_a^b f(x).dx = \int_a^c f(x).dx + \int_c^b f(x).dx</math></li> <li>• <math>\int_a^b f(x).dx = \int_a^{a+b} f(a+b-x).dx</math></li> </ul>



	<ul style="list-style-type: none"><li>• <math>\int_0^a f(x) \cdot dx = \int_0^a f(a - x) \cdot dt</math> This is a formula derived from the above formula.</li><li>• <math>\int_0^{2a} f(x) \cdot dx = 2 \int_0^a f(x) \cdot dx</math> if <math>f(2a - x) = f(x)</math></li><li>• <math>\int_0^{2a} f(x) \cdot dx = 0</math> if <math>f(2a - x) = -f(x)</math></li><li>• <math>\int_{-a}^a f(x) \cdot dx = 2 \int_0^a f(x) \cdot dx</math> if <math>f(x)</math> is an even function (i.e., <math>f(-x) = f(x)</math>).</li><li>• <math>\int_{-a}^a f(x) \cdot dx = 0</math> if <math>f(x)</math> is an odd function (i.e., <math>f(-x) = -f(x)</math>).</li></ul>
<b>Definite Integrals involving Rational irrational Expression</b> or	<ul style="list-style-type: none"><li>• <math>\int_a^\infty \frac{dx}{x^2 + a^2} = \frac{\pi}{2a}</math></li><li>• <math>\int_a^\infty \frac{x^m dx}{x^n + a^n} = \frac{\pi a^{m-n+1}}{n^{\frac{(m+1)\pi}{n}}}, 0 &lt; m + 1 &lt; n</math></li><li>• <math>\int_a^\infty \frac{x^{p-1} dx}{1+x} = \frac{\pi}{\sin(\sin(p\pi))}, 0 &lt; p &lt; 1</math></li><li>• <math>\int_a^\infty \frac{dx}{\sqrt{a^2 - x^2}} = \frac{\pi}{2}</math></li><li>• <math>\int_a^\infty \sqrt{a^2 - x^2} dx = \frac{\pi a^2}{4}</math></li><li>• </li></ul>
<b>Definite Integrals involving Trigonometric Functions</b>	<ul style="list-style-type: none"><li>• <math>\int_0^\pi mx \cos nx dx = \begin{cases} 0 &amp; \text{if } m \neq n \\ \frac{\pi}{2} &amp; \text{if } m = n \end{cases} \quad m, n \quad \text{positive integers}</math></li><li>• <math>\int_0^\pi mx \cos nx dx = \begin{cases} 0 &amp; \text{if } m \neq n \\ \frac{\pi}{2} &amp; \text{if } m = n \end{cases} \quad m, n \quad \text{positive integers}</math></li><li>• <math>\int_0^\pi mx \cos nx dx = \begin{cases} 0 &amp; \text{if } m + n \text{ even} \\ \frac{2m}{m^2 - n^2} &amp; \text{if } m = n \end{cases} \quad \text{integers}</math></li></ul>



	<ul style="list-style-type: none"> <li><math>\int_0^{\frac{\pi}{2}} x dx = \int_0^{\frac{\pi}{2}} dx = \frac{\pi}{4}</math></li> <li><math>\int_0^{\frac{\pi}{2}} x dx = \int_0^{\frac{\pi}{2}} dx = \frac{1.3.5....2m-1}{2.4.6....2m} \cdot \frac{\pi}{2}, m = 1, 2, ...</math></li> <li><math>\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, ...</math></li> <li>•</li> </ul>
If $f(x)$ is a periodic function with period T	<ul style="list-style-type: none"> <li><math>\int_0^{nT} f(x)dx = n \int_0^T f(x)dx, n \in \mathbb{Z}, \int_a^{a+nT} f(x)dx = n \int_0^T f(x)dx, n \in \mathbb{Z}</math></li> <li><math>\int_{mT}^{nT} f(x)dx = (n - m) \int_0^T f(x)dx, m, n \in \mathbb{Z}, \int_{nT}^{a+nT} f(x)dx = \int_0^a f(x)dx</math></li> <li><math>\int_{a+nT}^{b+nT} f(x)dx = \int_a^b f(x)dx, n \in \mathbb{Z}, a, b \in \mathbb{R}</math></li> <li>•</li> </ul>

## Ellipse Formula

The formula for ellipse are as stated below

Description	Formula
Standard Equation	$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, \text{ where } a > b \text{ & } b^2 = a^2(1 - e^2)$ <ul style="list-style-type: none"> <li>Eccentricity: <math>e = \sqrt{1 - \frac{b^2}{a^2}}, (0 &lt; e &lt; 1)</math>, Directrices: <math>x = \pm \frac{a}{e}</math></li> <li>Foci: <math>S = (\pm a e, 0)</math>. Length of major axes = <math>2a</math> and minor axes = <math>2b</math></li> <li>Vertices: <math>A' = (-a, 0)</math> &amp; <math>A = (a, 0)</math>.</li> <li>Latus Rectum: <math>= \frac{2b^2}{a} = 2a(1 - e^2)</math></li> </ul>



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; $\frac{x_1^2}{a^2} + \frac{y_1^2}{b^2} - 1 > 0 \text{ or } = 0.$
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 $>$ $a^2 m^2 + b^2$ .
Tangents	<ul style="list-style-type: none"> <li>Slope form: <math>y = mx \pm \sqrt{a^2 m^2 + b^2}</math>, point form: <math display="block">\frac{xx_1}{a^2} + \frac{yy_1}{b^2} = 1</math></li> <li>Parametric form: <math>\frac{x \cos \theta}{a} + \frac{y \sin \theta}{b} = 1</math></li> </ul>
Normal	$\frac{a^2 x}{x_1} - \frac{b^2 y}{y_1} = a^2 - b^2, ax \sec \theta - by \cosec \theta = (a^2 - b^2),$ $y = mx - \frac{(a^2 - b^2)m}{\sqrt{a^2 + b^2} m^2}$
Director Circle	$x^2 + y^2 = a^2 + b^2$

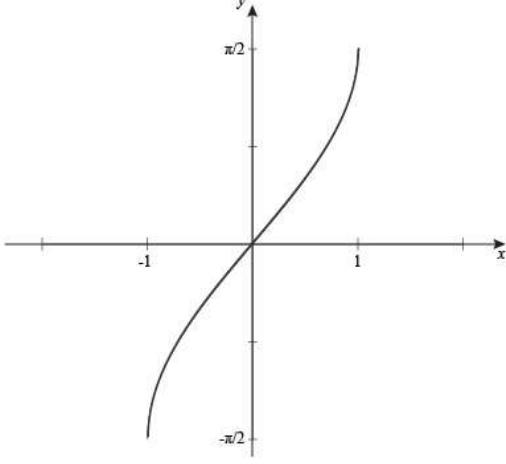
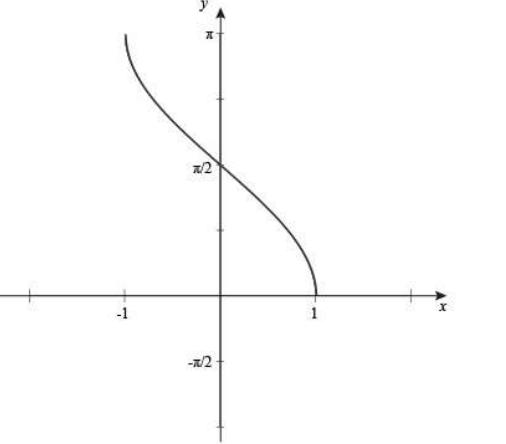
### Part 3

## Inverse Trigonometric Functions Formula

The formula for inverse trigonometric functions are as stated below

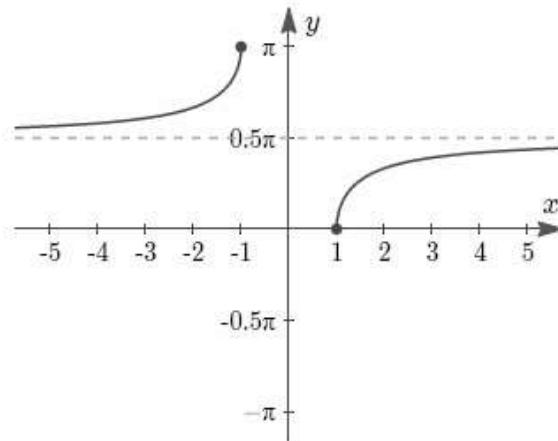
Description	Formula
Arcsine Function	Arcsine function is an inverse of sine function which is denoted by $\sin^{-1}$ The formula for arcsin is given as $\sin^{-1}(-x) = -\sin^{-1}(x), x \in [-1, 1]$



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



	<p>Differentiation of <math>\tan^{-1}(x)</math> is <math>\frac{1}{1+x^2}</math></p>
Arc cotangent (Arc cot) Function	<p>Arc cotangent function is an inverse of cotangent function which is denoted by <math>\cot^{-1}</math></p> $\cot^{-1}(-x) = \pi - \cot^{-1}(x), x \in R$ <p>Domain of Arc cotangent is <math>-\infty \leq x \leq \infty</math></p> <p>Range of Arc cotangent is <math>0 \leq y \leq \pi</math></p> <p>Differentiation of <math>\cot^{-1}(x)</math> is <math>\frac{-1}{1+x^2}</math></p>
Arc secant Function	<p>Arc secant function is an inverse of cosine function which is denoted by <math>\sec^{-1}</math></p> $\sec^{-1}(-x) = \pi - \sec^{-1}(x),  x  \geq 1$ <p>Domain of Arc secant is <math>-\infty \leq x \leq -1 \text{ or } 1 \leq x \leq \infty</math></p> <p>Range of Arc secant is <math>0 \leq y \leq \pi, y \neq \frac{\pi}{2}</math></p>



Differentiation of  $\sec^{-1}(x)$  is  $\frac{-1}{|x|\sqrt{x^2-1}}$

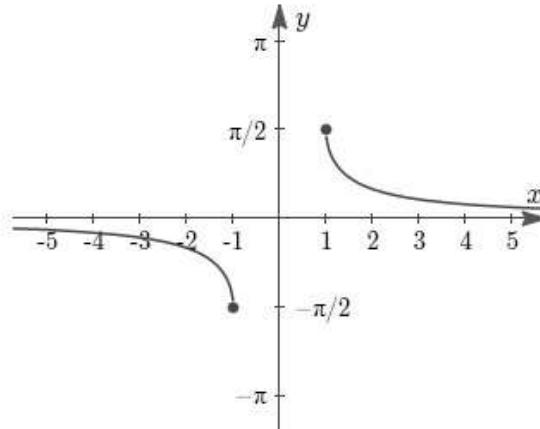
#### Arc cosecant Function

Arc cosecant function is an inverse of sine function which is denoted by  $\text{cosec}^{-1}$

$$\text{cosec}^{-1}(-x) = -\text{cosec}^{-1}(x), x \geq 1$$

Domain of Arc cosecant is  $-\infty \leq x \leq -1$  or  $1 \leq x \leq \infty$

Range of Arc cosecant is  $-\frac{\pi}{2} \leq y \leq \frac{\pi}{2}, y \neq 0$



Differentiation of  $\text{cosec}^{-1}(x)$  is  $\frac{1}{|x|\sqrt{x^2-1}}$

## Straight Line Formula

The formula for straight line are as stated below

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



	In center $I\left(\frac{ax_1+bx_2+cx_3}{a+b+c}, \frac{ay_1+by_2+cy_3}{a+b+c}\right)$ Excentre $I_1\left(\frac{-a_x+bx_2+cx_3}{-a+b+c}, \frac{-ay_1+by_2+cy_3}{-a+b+c}\right)$
<b>Area of Triangle</b>	$\Delta ABC = \frac{1}{2} \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$
<b>Slope formula</b>	Line Joining two points $(x_1, y_1)$ & $(x_2, y_2)$ $m = \frac{y_1 - y_2}{x_1 - x_2}$
<b>Condition of collinearity of three points</b>	$ x_1 y_1 1 x_2 y_2 1 x_3 y_3 1  = 0$
<b>Angle between two straight lines</b>	$\tan \theta = \left  \frac{m_1 - m_2}{1 + m_1 m_2} \right $
<b>Bisector of the angles between two lines</b>	$\frac{ax+by+c}{\sqrt{a^2+b^2}} = \pm \frac{(a x +b y +c)}{\sqrt{ a ^2+ b ^2}}$
<b>Condition of Concurrency</b>	For three lines $a_1 x + a_2 y + c_1 = 0, i = 123$ is $ a_1 b_1 c_1 a_2 b_2 c_2 a_3 b_3 c_3  = 0$
<b>A pair of straight lines through origin</b>	$ax^2 + 2hxy + by^2 = 0$ If $\theta$ is the acute angle between the pair of straight lines, then $\tan \theta = \left  \frac{2\sqrt{(h^2-ab)}}{a+b} \right $
<b>Two Lines:</b>	$ax + bx + c = 0$ and $ax + by + c' = 0$ 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 $aa' + bb' = 0$
<b>A point and line</b>	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

<b>If f &amp; g are functions of x such that <math>\dot{g}(x) = f(x)</math> then,</b>	$\int f(x)dx = g(x) + c \Leftrightarrow \frac{d}{dx}\{g(x) + c\} = f(x)$ <p>Here, c is called the constant of integration</p>
<b>Standard Formula:</b>	<ul style="list-style-type: none"><li>• <math>\int (ax + b)^n dx = \frac{(ax+b)^{n+1}}{a(n+1)} + c, n \neq -1</math></li><li>• <math>\int \frac{dx}{ax+b} = \frac{1}{a} \ln ax + b  + c</math></li><li>• <math>\int e^{ax+b} dx = \frac{1}{a} e^{ax+b} + c</math></li><li>• <math>\int a^{px+q} dx = \frac{1}{p} \frac{a^{px+q}}{\ln \ln a} + c, \text{ Here } a &gt; 0</math></li><li>• <math>\int \sin(ax + b) dx = -\frac{1}{a} \cos \cos(ax + b) + c</math></li><li>• <math>\int \cos(ax + b) dx = \frac{1}{a} \sin \sin(ax + b) + c</math></li><li>• <math>\int \tan(ax + b) dx = \frac{1}{a} \ln \sec \sec(ax + b)  + c</math></li><li>• <math>\int \cot(ax + b) dx = \frac{1}{a} \ln \sin \sin(ax + b)  + c</math></li><li>• <math>\int (ax + b) dx = \frac{1}{a} \tan(ax + b) + c</math></li><li>• <math>\int (ax + b) dx = -\frac{1}{a} \cot(ax + b) + c</math></li><li>• <math>\int dx = \ln(\sec x + \tan x) + c</math></li></ul> <p>or <math>\int dx = \ln \tan\left(\frac{\pi}{4} + \frac{x}{2}\right) + c</math></p>



	<ul style="list-style-type: none"> <li><math>\int dx = \ln(x + \cot x) + c</math> or <math>\int dx = \ln \tan \frac{x}{2} + c</math></li> <li><math>\int \frac{dx}{\sqrt{a^2 - x^2}} = \frac{x}{a} + c</math></li> <li><math>\int \frac{dx}{a^2 + x^2} = -\frac{1}{a} \frac{x}{a} + c</math></li> <li><math>\int \frac{dx}{ x  \sqrt{x^2 + a^2}} = -\frac{1}{a} \frac{x}{a} + c</math></li> <li><math>\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln \left[ x + \sqrt{x^2 + a^2} \right] + c</math></li> <li><math>\int \frac{dx}{\sqrt{x^2 - a^2}} = \ln \left[ x + \sqrt{x^2 - a^2} \right] + c</math></li> <li><math>\int \frac{dx}{a^2 - x^2} = \frac{1}{2a} \ln \left  \frac{a+x}{a-x} \right  + c</math></li> <li><math>\int \frac{dx}{x^2 - a^2} = \frac{1}{2a} \ln \left  \frac{x-a}{x+a} \right  + c</math></li> <li><math>\int \sqrt{a^2 - x^2} dx = \frac{x}{2} \sqrt{x^2 + a^2} + \frac{a^2}{2} \frac{x}{a} + c</math></li> <li><math>\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</math></li> <li><math>\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</math></li> </ul>
<b>Integration by substitutions</b>	If we substitute $f(x) = t$ , then $f'(x)dx = dt$
<b>Integration by part</b>	$\int (f(x)g(x))dx = f(x) \int (g(x))dx - \int \left( \frac{d}{dx}(f(x)) \int (g(x))dx \right) dx$



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

## Application of Derivatives Formula

The formula for application of derivatives are as stated below

Description	Formula
<b>Equation of tangent and normal</b>	<ul style="list-style-type: none"> <li>Tangent at <math>(x_1, y_1)</math> is given by <math>(y - y_1) = f'(x_1)(x - x_1)</math>, here the <math>f'(x_1)</math> should be real</li> <li>And normal at <math>(x_1, y_1)</math> is given by <math>(y - y_1) = -\frac{1}{f'(x_1)}(x - x_1)</math>, here the <math>f'(x_1)</math> should be non-zero and real.</li> </ul>
<b>Tangent from an external point</b>	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. $f'(h) = \frac{f(h)-b}{h-a}$



	<p>And equation of the tangent is</p> $y - b = \frac{f(h)-b}{h-a}(x - a)$
<b>Length of tangent, normal, subtangent, subnormal</b>	<ul style="list-style-type: none"> <li>• <math>PT =  k  \sqrt{1 + \frac{1}{m^2}}</math> is the length of the tangent</li> <li>• <math>PN =  k  \sqrt{1 + m^2}</math> is the length of normal</li> <li>• <math>TM = \left  \frac{k}{m} \right </math> is the length of the subtangent</li> <li>• <math>MN =  km </math> is the length of subnormal</li> </ul>
<b>Angle between the curves</b>	<p>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,</p> $\tan \theta = \left  \frac{m_1 - m_2}{1 + m_1 m_2} \right $
<b>Rolle's Theorem:</b>	<p>If a function <math>f</math> defined on <math>[a, b]</math> is</p> <ul style="list-style-type: none"> <li>• continuous on <math>[a, b]</math></li> <li>• derivable on <math>(a, b)</math> and</li> <li>• <math>f(a) = f(b)</math>,</li> <li>• then there exists at least one real number <math>c</math> between <math>a</math> and <math>b</math> (<math>a &lt; c &lt; b</math>) such that <math>f'(c) = 0</math></li> </ul>
<b>Lagrange's Mean Value Theorem (LMVT):</b>	<p>If a function <math>f</math> defined on <math>[a, b]</math> is</p> <p>(i) Continuous on <math>[a, b]</math> and      (ii) derivable on <math>(a, b)</math></p> <p>then there exists at least one real numbers between <math>a</math> and <math>b</math> (<math>a &lt; c &lt; b</math>) such that</p> $\frac{f(b) - f(a)}{b - a} = f'(c)$
<b>Formulae of Mensuration</b>	<ul style="list-style-type: none"> <li>• Volume of a cuboid = <math>lbh</math></li> <li>• Surface area of cuboid = <math>2(lb + bh + hl)</math></li> <li>• Volume of cube = <math>a^3</math></li> <li>• Surface area of cube = <math>6a^2</math></li> <li>• Volume of a cone = <math>\frac{1}{3}\pi r^2 h</math></li> </ul>



	<ul style="list-style-type: none"><li>• Curved surface area of cone = <math>\pi r l</math> (<math>l</math> = slant height)</li><li>• Curved surface area of a cylinder = <math>2\pi r h</math></li><li>• Total surface area of a cylinder = <math>2\pi r h + 2\pi r^2</math></li><li>• Volume of a sphere = <math>\frac{4}{3}\pi r^3</math></li><li>• Surface area of a sphere = <math>4\pi r^2</math></li><li>• Area of a circular sector = <math>\frac{1}{2}r^2\theta</math>, here <math>\theta</math> is in radian</li><li>• Volume of a prism = (area of the base) <math>\times</math> (height)</li><li>• Lateral surface area of a prism <math>= (\text{perimeter of the base}) \times (\text{height})</math></li><li>• Total surface area of a prism <math>= (\text{lateral surface area}) \times 2(\text{area of the base})</math></li><li>• Volume of a pyramid = <math>\frac{1}{3}(\text{area of the base}) \times (\text{height})</math></li><li>• Curved surface area of a pyramid <math>= \frac{1}{2}(\text{perimeter of the base}) \times (\text{slant height})</math></li></ul>
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#### Part 4

### Sequence & Series

The formula for sequence and series are as stated below

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



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.	<ul style="list-style-type: none"><li>If <math>a, b, c</math> are in A. P. <math>\Rightarrow 2b = a + c</math> &amp; if <math>a, b, c, d</math> are in A. P. <math>\Rightarrow a + d = b + c</math></li><li>Sum of the terms of an A.P. equidistant from the beginning &amp; end = sum of first &amp; last term.</li></ul>
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 & $a, A_1, A_2, \dots, A_n, b$ are in A.P. then $A_1, A_2, \dots, A_n$ are the $n$ A.M.'s between $a$ & $b$ . $A_1 = a + \frac{b-a}{n+1}$ $A_2 = a + \frac{2(b-a)}{n+1}, \dots, A_n = a + \frac{n(b-a)}{n+1}$ $\sum_{r=1}^n A_r = nA$ where $A$ is the single A.M. between $a$ & $b$ .
Geometric Progression	$a, ar, ar^2, ar^3, ar^4, \dots$ , is a G.P. with $a$ as the first term & $r$ as a common ratio. <ul style="list-style-type: none"><li><math>n^{th}</math> term <math>= ar^{n-1}</math></li><li>Sum of the first <math>n</math> terms i.e., <math display="block">S_n = \begin{cases} \frac{a(r^n-1)}{r-1}, &amp; r \neq 1 \\ na, &amp; r = 1 \end{cases}</math></li></ul>
Harmonic Mean	<ul style="list-style-type: none"><li>If <math>a, b, c</math> are in H.P., <math>b</math> is the H.M. between <math>a</math> &amp; <math>c</math>, then <math>b = \frac{2ac}{a+c}</math></li><li>H.M. of <math>a_1, a_2, \dots, a_n</math> is given by <math display="block">\frac{1}{H} = \frac{1}{n} \left[ \frac{1}{a_1} + \frac{1}{a_2} + \dots + \frac{1}{a_n} \right]</math></li></ul>
Relation between means:	$G^2 = AH$ , $A. M. \geq G. M. \geq H. M.$ <ul style="list-style-type: none"><li><math>A. M. = G. M. = H. M.</math> if <math>a_1 = a_2 = a_3 = \dots = a_n</math></li></ul>
Important Results	<ul style="list-style-type: none"><li><math display="block">\sum_{r=1}^n (a_r \pm b_r) = \sum_{r=1}^n a_r \pm \sum_{r=1}^n b_r</math></li></ul>



	<ul style="list-style-type: none"> <li>• <math>\sum_{r=1}^n k a_r = k \sum_{r=1}^n a_r</math></li> <li>• <math>\sum_{r=1}^n k = nk</math> where <math>k</math> is constant</li> <li>• <math>\sum_{r=1}^n r = 1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}</math></li> <li>• <math>\sum_{r=1}^n r^2 = 1^2 + 2^2 + 3^2 + \dots + n^2 = \frac{n(n+1)(2n+1)}{6}</math></li> <li>• <math>\sum_{r=1}^n r^3 = 1^3 + 2^3 + 3^3 + \dots + n^3 = \frac{n^2(n+1)^2}{4}</math></li> </ul>
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## Hyperbola Formula

The formula for hyperbola are as stated below

Description	Formula
Standard Equation	$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \text{ where } b^2 = a^2(e^2 - 1)$ Foci: $S \equiv (\pm ae, 0)$ Directrices: $x = \pm \frac{a}{e}$ Vertices: $A \equiv (\pm a, 0)$ Latus Rectum $l = \frac{2b^2}{a} = 2a(e^2 - 1)$
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	$x = a \sec \theta$ and $y = b \tan \theta$
Position of A point w.r.t hyperbola	$S_1 \equiv \frac{x_1^2}{a^2} - \frac{y_1^2}{b^2} - 1 \geq 0 \text{ or } < 0$ According to the point $(x_1, y_1)$ lies inside on or outside the curve
Tangents	Slope form: $y = mx \pm \sqrt{a^2 m^2 - b^2}$ Point Form: at the point $(x_1, y_1)$ is $\frac{xx_1}{a^2} - \frac{yy_1}{b^2} = 1$ Parametric form: $\frac{x \sec \theta}{a} - \frac{y \tan \theta}{b} = 1$



Normal:	<ul style="list-style-type: none"><li>At the point <math>P(x_1, y_1)</math> is <math>\frac{a^2 x}{x_1} + \frac{b^2 y}{y_1} = a^2 + b^2 = a^2 e^2</math></li><li>At the point <math>P(a \sec \sec \theta, b \tan \tan \theta)</math> is <math>\frac{ax}{\sec \sec \theta} + \frac{by}{\tan \tan \theta} = a^2 + b^2 = a^2 e^2</math></li><li>Equation of normal in term of its slope <math>m</math> is <math>y = mx \pm \frac{(a^2 + b^2)m}{\sqrt{a^2 - b^2 m^2}}</math></li></ul>
Asymptotes	$\frac{x}{a} + \frac{y}{b} = 0$ and $\frac{x}{a} - \frac{y}{b} = 0$ Pair of asymptotes: $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 0$ <ul style="list-style-type: none"><li>•</li></ul>
Rectangular Or Equilateral Hyperbola	<ul style="list-style-type: none"><li><math>xy = c^2</math> eccentricity is <math>\sqrt{2}</math></li><li>Vertices: <math>(\pm c, \pm c)</math></li><li>Foci: <math>\pm \sqrt{2}c, \pm \sqrt{2}c</math></li><li>Directrices: <math>x + y = \pm \sqrt{2}c</math></li><li>Latus Rectum <math>l = 2\sqrt{2}c = T.A. = C.A.</math></li><li>Parametric equation <math>x = ct, y = \frac{c}{t}, t \in R - \{0\}</math></li><li>Equation of the tangent at <math>P(x_1, y_1) = \frac{x}{x_1} + \frac{y}{y_1} = 2</math></li><li>Equation of the tangent at <math>P(t) = \frac{x}{t} + ty = 2c</math></li><li>Equation of the normal at <math>P(t) = xt^3 - yt = c(t^4 - 1)</math></li><li>Chord with a given middle point as <math>(h, k) = kx + hy = 2hk</math></li></ul>



# Physics Formulas

## Part 1

### Uniform Circular Motion Formula

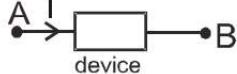
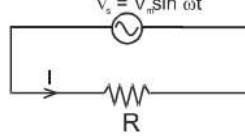
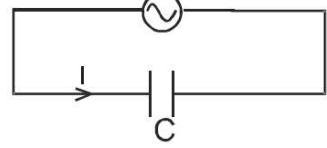
The formula for uniform circular motion are as stated below

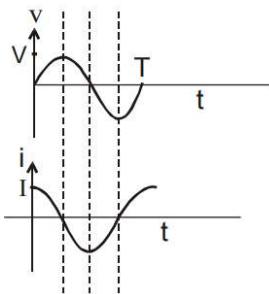
Description	Formula
The formula for Angular Distance is	$\Delta\theta = \omega \Delta t$ , Where t is time, $\omega$ is angular speed and $\theta$ is angular distance.
The formula for linear velocity is given by	$v = R\omega$ Where speed and R is radius and $\omega$ is angular speed.
The formula for 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 $\omega$ is angular speed $A_c = 4\pi^2 v^2 R$ Where R is the radius and v 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	$N = mg \cos\theta + \frac{mv^2}{r}$



<b>Normal reaction on a convex bridge</b>	$N = mg\cos\theta - \frac{mv^2}{r}$
<b>Skidding of vehicle on a level road</b>	$V_{safe} \leq \sqrt{\mu gr}$
<b>Skidding of an object on a rotating platform</b>	$\omega_{max} = \sqrt{\frac{\mu g}{r}}$
<b>Bending of Cyclist</b>	$\tan \theta = \frac{v^2}{rg}$
<b>Banking of road without friction</b>	$\tan \theta = \frac{v^2}{rg}$
<b>Banking of Road with friction</b>	$\frac{V^2}{rg} = \frac{\mu + \tan \theta}{1 - \mu \tan \theta}$
<b>Maximum also minimum safe speed on a banked frictional road</b>	$V_{max} = \left[ \left( \frac{rg(\mu + \tan \theta)}{1 - \mu \tan \theta} \right) \right]^{\frac{1}{2}}$ $V_{min} = \left[ \left( \frac{rg(\tan \theta - \mu)}{1 + \mu \tan \theta} \right) \right]^{\frac{1}{2}}$
<b>Alternating Current Formula</b>	
The formula for alternating current are as stated below	
Description	Formula
<b>AC and DC current</b>	 
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).	



<b>Root Mean square Value</b>	Root mean square of a function from $t_1$ and $t_2$ is defined as $f_{rms} = \sqrt{\frac{\int_{t_1}^{t_2} f(t)^2 dt}{t_2 - t_1}}$
<b>Power consumption in AC Circuit</b>	Average power consumed in a cycle $= \frac{1}{T} \int_0^{\frac{2\pi}{\omega}} P dt = \frac{1}{2} V_m I_m \cos\phi$ <p style="text-align: center;"></p> $= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} \cdot \cos\phi = V_{rms} I_{rms} \cos\phi$ <p><math>\cos\phi</math> is known as the Power Factor.</p>
<b>Impedance</b>	$Z = \frac{V_m}{I_m} = \frac{V_{rms}}{I_{rms}}$ <p><math>L</math> is called inductive reactance and is denoted by <math>X_L</math>. <math>\frac{1}{\omega C}</math> is called capacitive reactance and is denoted by <math>X_c</math>.</p>
<b>Purely Resistive Circuit</b>	$V_s = V_m \sin \omega t$ <p style="text-align: center;"></p> $I = \frac{V_s}{R} = \frac{V_m \sin \omega t}{R} = I_m \sin \omega t$ $I_m = \frac{V_m}{R}$ $I_{rms} = \frac{V_{rms}}{R}$ $\langle p \rangle = V_{rms} I_{rms} \cos\phi = \frac{V_{rms}^2}{R}$
<b>Purely Capacitive Circuit</b>	$V_s = V_m \sin \omega t$ <p style="text-align: center;"></p> $I = \frac{\frac{V_m}{1}}{\omega C} \cos \omega t$ $= \frac{V_m}{X_c} \cos \omega t = I_m \cos \omega t$ <p><math>X_c = \frac{1}{\omega C}</math> And is called capacitive reactance.</p>



$I_c$  Leads by  $V_c$  by  $\frac{\pi}{2}$ , Diagrammatically it is represented as

$$\begin{array}{c} \rightarrow \\ \downarrow \\ I_m \\ V_m \end{array}$$

Since,  $\phi = 90^\circ$ ,  $\langle p \rangle = V_{rms} I_{rms} \cos\phi = 0$

## Ampere's Circuital Law

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

Description	Formula
Ampere's circuital law	$\int B \cdot dl = \mu_0 I$ <p>Here <math>\mu_0</math> = permeability of free space = <math>4\pi \times 10^{-15} NA^{-2}</math>  <math>B</math> = Magnetic field  <math>I</math> = enclosed electric current by the path</p>
Ampere's law (integral form)	$\int B \cdot ds = \mu_0 I_{enclosed}$ <p><math>I_{enclosed}</math> = enclosed current by the surface</p>
Field of a current-carrying wire:	$B = \frac{\mu_0 I}{2\pi r}$
Field of a solenoid	$BL = \mu_0 N I$ <p>Here <math>N</math>: number of turns in the solenoid</p>
Field inside a thick wire	$\int B \cdot ds = \mu_0 I$ <p>And</p> $B = \mu_0 I \frac{r}{2\pi R^2}$
Field of the toroid	$B = \frac{\mu_0 NI}{2\pi r}$



<b>Force between two parallel current carrying wires</b>	$F_{\frac{A}{B}} = \frac{\mu_0 I_A I_B}{(2\pi r)}$ $I_{A, B}$ = Current carrying by wires A and B
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## Capacitance Formula

The formula for capacitance are as stated below

Description	Formula
<b>Capacitance of a parallel plate capacitor in terms of charge and potential difference</b>	$C = \frac{Q}{V}$ Here, C is the capacitance of the capacitor, Q is the charge stored and V is the potential difference between the plates.
<b>Capacitance of a parallel plate capacitor in terms of surface area and distance between the plates</b>	$C = \frac{\epsilon_0 A}{d}$ Here, $\epsilon_0$ is the permittivity of free space and its value is $8.854 \times 10^{-12} m^{-3} kg^{-1} s^4 A^2$ , A is the surface area of the plates and d is the distance between the plates.
<b>Capacitance of a spherical capacitor derivation</b>	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: $\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$ $E(4\pi r^2) = \frac{Q}{\epsilon_0}$ $E = \frac{Q}{4\pi\epsilon_0 r^2}$ $V = \frac{Q}{4\pi\epsilon_0 r}$
<b>The potential difference between the plates</b>	$V_{ab} = V_a - V_b = \frac{Q}{4\pi\epsilon_0} \left( \frac{1}{r_a} - \frac{1}{r_b} \right)$ $= \frac{Q}{4\pi\epsilon_0} \frac{r_b - r_a}{r_a r_b}$ Therefore, the capacitance will be: $C = \frac{Q}{V_{ab}} = 4\pi\epsilon_0 \frac{r_a r_b}{r_b - r_a}$



<b>Energy stored in capacitor</b>	<ul style="list-style-type: none"><li>• <math>U = \frac{1}{2}CV^2</math></li><li>• <math>U = \frac{Q^2}{2C}</math></li><li>• <math>U = \frac{QV}{2}</math></li></ul> <p>Here, U is the energy, C is the capacitance, V is the potential difference and Q is the charge stored.</p>
<b>Energy density of capacitor</b>	$Energy\ density = \frac{1}{2}\epsilon_0\epsilon_r E^2$ In vacuum: $Energy\ density = \frac{1}{2}\epsilon_0 E^2$ Here, $\epsilon_0$ is the permittivity of free space, $\epsilon_r$ is the relative permittivity and E is the electric field.
<b>Capacitance per unit length of a cylindrical capacitor</b>	$Capacitance\ per\ unit\ length = \frac{2\pi\epsilon_0}{\ln\left(\frac{b}{a}\right)}$ Here, $\epsilon_0$ is the permittivity of free space, b is the radius of outer cylinder and a is the radius of inner cylinder.
<b>Electric field intensity</b>	<p>The formula for electric field intensity between the plates is given as:</p> $E = \frac{\sigma}{\epsilon_0} = \frac{V}{d}$ <p>Here, <math>\sigma</math> is the surface charge density, V is the potential difference and d is the distance between plates.</p>
<b>Redistribution of charge when two charged capacitors are connected in parallel</b>	<p>Let us assume a capacitor with capacitance <math>C_1</math> with initial charge <math>Q_1</math> and capacitor with capacitance <math>C_2</math> with initial charge <math>Q_2</math>.</p> <p>The final charge on capacitor with capacitance <math>C_1</math> will be:</p> $Q'_1 = \frac{C_1}{C_1+C_2} (Q_1 + Q_2)$ <p>final charge on capacitor with capacitance <math>C_2</math> will be:</p> $Q'_2 = \frac{C_2}{C_1+C_2} (Q_1 + Q_2)$
<b>Equivalent capacitance when capacitors are connected in series</b>	$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots + \frac{1}{C_n}$ <p>Here, <math>C_{eq}</math> is the equivalent capacitance and <math>C_1, C_2, C_3</math> are the capacitance of the capacitors.</p>



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

## Part 2

### Centre of Mass Formula

The formula for centre of mass are as stated below

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



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



<b>Centre of mass of a hollow circular cone</b>	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.
<h2>Circular Motion</h2>	
The formula for circular motion are as stated below	
Description	Formula
<b>Average angular velocity</b>	$\omega_{average} = \frac{\theta_2 - \theta_1}{t_2 - t_1}$ Here, $\theta_2$ is the angle at time $t_2$ , and $\theta_1$ is the angle at time $t_1$ .
<b>Average angular acceleration</b>	$\alpha_{av} = \frac{\omega_2 - \omega_1}{t_2 - t_1}$ Here, $\omega_2$ is the angular frequency at time $t_2$ and $\omega_1$ is the angular frequency at time $t_1$ .
<b>Tangential acceleration</b>	$a_t = \frac{dV}{dt}$ 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 $dt$ .
<b>Centripetal acceleration</b>	$a_c = \frac{v^2}{r}$ or $a_c = \omega^2 r$ Here, v is the linear velocity, r is the radius and $\omega$ is the angular frequency.
<b>Normal reaction on a body moving on a concave bridge</b>	$N = mg \cos \theta + \frac{mv^2}{r}$ Here, m is the mass, g is the gravitational acceleration, $\theta$ is the angle, v is the linear velocity and r is the radius of the bridge.
<b>Normal reaction on a convex bridge</b>	$N = mg \cos \theta - \frac{mv^2}{r}$ Here, m is the mass, g is the gravitational acceleration, $\theta$ is the angle, v is the linear velocity and r is the radius.
<b>Safe velocity of a vehicle on a level road</b>	$v_{safe} \leq \sqrt{\mu gr}$ Here, $v_{safe}$ is the safe velocity, $\mu$ is the coefficient of friction, g is the gravitational acceleration and r is the radius.



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

## De Broglie Wavelength Formula

The formula for de broglie wavelength are as stated below

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



	Paschim series: $n_1 = 3; n_2 = 4, 5, 6, \dots$
<b>Minimum wavelength for x rays</b>	$\lambda_{min} = \frac{hc}{eV_0}$ Or $\lambda_{min} = \frac{12400}{V_0} \times 10^{-10} m$ here, $\lambda_{min}$ 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.
<b>Radius of nucleus</b>	$R = R_0 A^{1/3}$ Here, R is the radius of the atom, $R_0$ is a constant whose value is $1.1 \times 10^{-15} m$ , A is the mass number of the atom.
<b>Number of nuclei during a radioactive decay</b>	$N = N_0 e^{-\lambda t}$ here, N is the number of nuclei at time t, $N_0$ is the initial number of nucleus and $\lambda$ is the decay constant.
<b>Half-life of a radioactive sample</b>	$T_{1/2} = \frac{0.693}{\lambda}$ Here, $T_{1/2}$ is the half-life period and $\lambda$ is the decay constant.
<b>Average life</b>	$T_{av} = \frac{T_{1/2}}{0.693}$ 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
<b>Formula for current</b>	<ul style="list-style-type: none"> <li>• <math>I = \frac{\Delta q}{\Delta t}</math></li> <li>• <math>I = \frac{\Delta q}{\Delta t} = \frac{dq}{dt}</math></li> </ul> <p>Here, <math>\Delta q</math> is the charge flown through the circuit and <math>\Delta t</math> is the time in which the charge has flown.</p>
<b>Electric current in a conductor(wire)</b>	$I = nAeV_d$ $v_d = \frac{\lambda}{\tau}$



	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, $\lambda$ is the linear charge density and $\tau$ is the relaxation time.
<b>Potential difference using ohm's law</b>	$V = IR$ Here, $V$ is the potential difference, $I$ is the current flowing through the conductor and $R$ is the resistance offered by the conductor.
<b>Resistance in terms of resistivity</b>	$R = \frac{\rho l}{A}$ Here, $\rho$ 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.
<b>Change in resistance due to temperature</b>	$R = R_0(1 + \alpha\Delta T)$ Here, $R$ is the resistance, $R_0$ is the initial temperature, $\alpha$ is the temperature coefficient of the resistivity and $\Delta T$ is the change in temperature.
<b>Electric power</b>	$P = VI$ Here, $P$ is the power, $V$ is the potential difference and $I$ is the current. Also, $P = I^2 R$ $P = \frac{V^2}{R}$
<b>Heat energy released due to current</b>	$H = VIt$ also $H = I^2 Rt$ $H = \frac{V^2}{R} t$ 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.
<b>Equivalent resistance when resistors are connected in series</b>	$R_{eq} = R_1 + R_2 + R_3 + \dots + R_n$ Here, $R_{eq}$ is the equivalent resistance, $R_1, R_2, R_3$ are the resistance of the resistors.
<b>Equivalent resistance when</b>	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_n}$



resistors are connected in parallel	
Potential difference when cells are connected in parallel	$E_{eq} = \frac{\left( \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} + \frac{\varepsilon_3}{r_3} + \dots + \frac{\varepsilon_n}{r_n} \right)}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \dots + \frac{1}{r_n}}$ <p>Here, <math>\varepsilon_1, \varepsilon_2, \varepsilon_3</math> are the emf of the cells and <math>r_1, r_2, r_3</math> are the internal resistance of the cells.</p>
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: $S = \frac{I_g R_g}{I}$ <p>Here, <math>S</math> is the value of shunt resistance, <math>I_g</math> is the current through galvanometer, <math>R_g</math> is the resistance of the galvanometer and <math>I</math> is the maximum current to be measured.</p>
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: $R_s = \frac{V}{I_g} - R_g$ <p>Here, <math>V</math> is the maximum potential difference to be measured, <math>I_g</math> is the current through galvanometer and <math>R_g</math> is the resistance of the galvanometer.</p>

## 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,



	$i = \text{current},$ $R = \frac{\rho l}{A} = \frac{\rho l}{\pi r^2}$ Where, $R$ – Resistance of the wire; $\rho$ – Resistivity, $l$ – length of the wire, $A$ – area of cross section of the wire
<b>Variation of resistance with the temperature</b>	$R_T = R_0[1 + \alpha(t)]$ $\rightarrow \alpha = \frac{R_t - R_0}{R_0(t)} t^\circ C$ $\alpha = \frac{(R_1 - R_2)}{R_1(t_2 - t_1)} t^\circ C$ Here, $R$ = resistance at temperature $t^\circ C$ $R_0$ = resistance at temperature $0^\circ C$ $\alpha$ = temperature coefficient of resistance
<b>Conductivity</b>	Reciprocal of resistivity. $\sigma = \frac{1}{\rho}$ Where - $\sigma$ -conductivity, $\rho$ -resistivity
<b>Terminal voltage</b>	<b>Case-1: When battery is delivering current</b> $V = E - ir$ 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.  <b>Case 2: when battery is charging</b> $V = E + ir$
<b>Kirchhoff's laws</b>	<b>Kirchhoff's First law:</b> $\sum i = 0$ at any junction.  <b>Kirchhoff's second law:</b> $\sum iR = 0$ in a closed circuit.
<b>Metre Bridge</b>	$1. \frac{x}{R} = \frac{l_1}{l_2} \Rightarrow \frac{x}{R} = \frac{l_1}{(100-l_1)}$ 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 $\rho$ -Resistivity of the wire, $x$ -resistance of wire, $A$ - area of cross section of the wire, $l$ -length of the wire.
<b>Potentio Meter</b>	<b>Emf of cell in the secondary circuit</b> $E_s = I\rho l$



	<p>1. Comparison of emf's of two cells: <math>\frac{E_1}{E_2} = \frac{l_1}{l_2}</math> Where <math>E_1</math> and <math>E_2</math> -emf of the first and second cell, <math>l_1</math> and <math>l_2</math> - the balancing lengths of individual cells respectively.</p> <p>2. <math>r = \frac{R(l_1 - l_2)}{l_2}</math></p>
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## Electromagnetic Induction Formula

The formula for electromagnetic induction are as stated below

Description	Formula
Magnetic Flux	<p>The magnetic flux through a plane of area <math>dA</math> placed in a uniform magnetic field <math>B</math> is given as</p> $\phi = \int \vec{B} \cdot d\vec{A}$ <p>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</p>
Electromagnetic Induction: Faraday's Law	<p><b>First Law:</b> 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.</p> <p><b>Second Law:</b> According to this law, the induced emf is equal to the negative rate of change of flux through the circuit.</p> $E = -\frac{d\phi}{dt}$
Lenz's Law	<p>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,</p> $E = -N\left(\frac{d\phi}{dt}\right)$
Induced emf	<p>Induced emf is given as</p> $E = -N\left(\frac{d\phi}{dt}\right)$ $E = -N\left(\frac{\phi_1 - \phi_2}{t}\right)$
Induced Current	<p>Induced Current is given as</p> $I = \frac{E}{R} = \frac{N}{R} \left(\frac{d\phi}{dt}\right) = \frac{N}{R} \left(\frac{\phi_1 - \phi_2}{t}\right)$
Self - Induction	<p>Change in the strength of flow of current is opposed by a characteristic of a coil is known as self-inductance.</p> <p>It is given as <math>\phi = LI</math></p> <p>Here, <math>L</math> = coefficient of self - inductance</p> <p>Magnetic flux rate of change in the coil is given as</p> $\frac{d\phi}{dt} = L \frac{dl}{dt} = -E$
Mutual - Induction	<p>Mutual – Induction is given as</p> $e_2 = \frac{d(N_2 \phi_2)}{dt} = M \frac{dl_1}{dt}$



	Therefore, $M = \frac{\mu_0 N_1 N_2 A}{l}$
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## 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	<b>First Law:</b> 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. <b>Second Law:</b> 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, $E = - N \left( \frac{d\phi}{dt} \right)$
Induced emf	Induced emf is given as $E = - N \left( \frac{d\phi}{dt} \right)$ $E = - N \left( \frac{\phi_1 - \phi_2}{t} \right)$
Induced Current	Induced Current is given as $I = \frac{E}{R} = \frac{N}{R} \left( \frac{d\phi}{dt} \right) = \frac{N}{R} \left( \frac{\phi_1 - \phi_2}{t} \right)$
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, $M = \frac{\mu_0 N_1 N_2 A}{l}$
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## Electromagnetic Waves

The formula for electromagnetic waves are as stated below

Description	Formula
<b>Gauss's law for electricity</b>	$\oint E \cdot dA = \frac{Q}{\epsilon_0}$ Here, E is the electric field, A is the area, Q is the charge and $\epsilon_0$ is the permittivity of free space.
<b>Gauss's law for magnetism</b>	$\oint B \cdot dA = 0$ B is the magnetic field and A is the area.
<b>Faraday's law</b>	$\oint E \cdot dl = - \frac{d\Phi_B}{dt}$ Here, E is the electric field, l is the length of the conductor, $\Phi_B$ is the magnetic flux and t is the time.
<b>Ampere- Maxwell law</b>	$\oint B \cdot dl = \mu_0 i + \mu_0 \epsilon_0 \frac{d\Phi_B}{dt}$ Here, B is the magnetic field, l is the length of the conductor, $\mu_0$ is permeability of free space, i is the current flowing through the conductor, $\epsilon_0$ is the permittivity of free space, $\Phi_B$ is the magnetic flux and t is the time.
<b>Speed of light in vacuum</b>	$c = 1/\sqrt{\mu_0 \epsilon_0}$

## Electrostatics Formula

The formula for electrostatics are as stated below

Description	Formula
<b>Electrostatic force between two-point charges</b>	$\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{ \vec{r} ^2} \hat{r}$



	Here, $\epsilon_0$ is the permittivity of free space, $q_1, q_2$ are the point charges and $r$ is the distance between the charges.
<b>Electric field</b>	$\vec{E} = \frac{\vec{F}}{q_0}$ Here, $\vec{F}$ is the electrostatic force experienced by test charge $q_0$ .
<b>Electric field due to a uniformly charged ring</b>	$E_{axis} = \frac{KQx}{(R^2+x^2)^{\frac{3}{2}}}$ 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.
<b>Electric field due to a uniformly charged disc</b>	$E = \frac{\sigma}{2\epsilon_0} \left[ 1 - \frac{x}{\sqrt{R^2+x^2}} \right]$ Here, $\sigma$ is the surface charge density, $\epsilon_0$ 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.
<b>Work done by external force</b>	The work done by an external force in bringing a charge $q$ from potential $V_B$ to $V_A$ is: $W = q(V_A - V_B)$
<b>Electrostatic potential energy</b>	$U = qV$ Here, $q$ is the charge and $V$ is the potential.
<b>Electrostatic energy</b>	$U = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r}$ here $q_1, q_2$ are the charges and $r$ is the distance between the charges.
<b>Electric potential at a point due to a point charge</b>	$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$
<b>Dipole moment</b>	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.
<b>Potential at a point due to dipole</b>	The potential at a point due to a dipole is given as: $V = \frac{1}{4\pi\epsilon_0} \frac{p \cos \theta}{r^2}$ Here, $p$ is the dipole moment and $\theta$ 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.
<b>Torque experienced by dipole due to electric field</b>	$\vec{\tau} = \vec{p} \times \vec{E}$ 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
<b>Force due to kinetic friction</b>	<p>The formula for calculating the force due to kinetic friction is:</p> $F_k = \mu_k R$ <p>here, <math>F_k</math> is the force due to kinetic friction, <math>\mu_k</math> is the coefficient of kinetic friction and R is the normal reaction force on the body on which the force is acting.</p> <p>If the body is lying on levelled plane, then the normal force is given as:</p> $R = mg$ <p>Here m is the mass and g is the gravitational acceleration.</p> <p>When the body is lying on a plane that is at some angle <math>\theta</math> with the horizontal then the normal reaction force on the body is given as:</p> $R = mg \cos \theta$
<b>Force due to static friction</b>	<p>The formula for calculating the force due to static friction is:</p> $F_s = \mu_s R$ <p>here, <math>F_s</math> is the force due to static friction, <math>\mu_s</math> is the coefficient of static friction and R is the normal reaction force on the body.</p>

## Part 5

## Linear Momentum Formula

The formula for linear momentum are as stated below

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



Conservation of momentum	$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$ Where P = Momentum, m = Mass and u,v= velocity
Elastic Collision	$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ Where i = initial and f = final
Inelastic collision	$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2)v_{2f}$
Force (from Newton's second law)	$F = m \times a$ $F_{net} = \frac{dp}{dt}$
Momentum in terms of kinetic energy	$p = mv$ $p^2 = m^2 v^2$ $p^2 = 2m(\frac{1}{2}mv^2)$ $p^2 = 2mK$ Here, K = kinetic energy
Dimensional Formula of Momentum	$[M^1 L^1 T^{-1}]$

## 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. <b>Snell's law</b> According to the Snell's law $\frac{\sin i}{\sin r} = \text{constant}$ 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



<b>Lateral Shift</b>	<p>Lateral Shift is given as</p> $\text{lateral shift} = t \frac{\sin(i-r)}{\cos r}$
<b>Normal shift on a single surface</b>	The normal shift on a single surface is given as $\text{Normal shift} = t(1 - \frac{1}{n})$
<b>Relation between refractive index and critical angle</b>	The relation between refractive index and critical angle is given as $n = \frac{1}{\sin c}$
<b>Refraction through a prism</b>	<p>The refractive index of a prism is given as</p> $n = \frac{\sin(a + \frac{\delta}{2})}{\sin \frac{A}{2}}$
<b>Lens maker formula for thin lenses</b>	Lens maker formula for thin lenses is given as $\frac{1}{f} = (n - 1) \left[ \frac{1}{R_1} - \frac{1}{R_2} \right]$
<b>Power of lens</b>	Power of lens is given as $P = \frac{1}{f}$
<b>Equivalent focal length of combination of two thin lenses</b>	$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$
<b>Heat And Thermodynamics Formula</b>	
The formula for heat and thermodynamics are as stated below	
Description	Formula
Kirchhoff's Law	$\frac{\text{Emissive power of body}}{\text{Absorptive power of body}} = \text{Emissive power of black body}$



<b>Conduction</b>	Rate of flow of heat in conduction is determined as $\frac{dQ}{dt} = -KA \frac{dT}{dx}$ <ul style="list-style-type: none"><li>● K = thermal conductivity</li><li>● A = area of cross-section</li><li>● dx = thickness</li><li>● dT = temperature difference</li></ul>
<b>Newton's law of cooling</b>	$\frac{d\theta}{dt} = (\theta - \theta_0)$ <ul style="list-style-type: none"><li>● Here,</li><li>● <math>\theta</math> and <math>\theta_0</math> = temperature corresponding to object and surroundings.</li></ul>
<b>Temperature scales</b>	$F = 32 + \frac{9}{5} \times C$ $K = C + 273.16$ <ul style="list-style-type: none"><li>● F = Fahrenheit scale</li><li>● C = Celsius scale</li><li>● K = Kelvin scale</li></ul>
<b>Ideal Gas equation</b>	$PV = nRT$ <ul style="list-style-type: none"><li>● Here,</li><li>● n = number of moles</li><li>● P = pressure</li><li>● V = Volume</li><li>● T = Temperature</li></ul>
<b>Van der Waals equation</b>	$(p + a(\frac{n}{V})^2)(V - nb) = nRT$ <ul style="list-style-type: none"><li>● <math>a(\frac{n}{V})^2</math> = correction factor for intermolecular forces</li><li>● nb = correction factor for molecule size</li><li>● n = number of moles</li><li>● T = Temperature</li><li>● V = Volume</li><li>● p = pressure</li></ul>
<b>Thermal expansion</b>	Linear Expansion $L = L_0(1 + \alpha \Delta T)$



	<p><b>Area Expansion</b></p> $A = A_0(1 + \beta\Delta T)$ <p><b>Volume Expansion</b></p> $V = V(1 + \gamma\Delta T)$
<b>Relation between <math>\alpha</math>, <math>\beta</math> and <math>\gamma</math> for the isotropic solid</b>	$\frac{\alpha}{1} = \frac{\beta}{2} = \frac{\gamma}{3}$
<b>Stefan-Boltzmann's law</b>	$u = \sigma AT^4$ (Perfect black body) $u = e\sigma AT^4$ (Not a perfect black body) <ul style="list-style-type: none"><li>• here,</li><li>• <math>\sigma</math> = Stefan's constant = <math>5.67 \times 10^{-8}</math> watt / <math>m^2 K^4</math></li><li>• <math>\frac{u}{A}</math> = energy flux</li><li>• <math>e</math> = emissivity</li></ul>
<b>Thermal resistance to conduction</b>	Thermal resistance is given as $R = \frac{L}{KA}$ <ul style="list-style-type: none"><li>• <math>K</math> = material's conductivity</li><li>• <math>L</math> = plane thickness</li><li>• <math>A</math> = plane area</li></ul>

## Hooke's Law Formula

The formula for Hooke's law are as stated below

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



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

## Inductance Formula

The formula for inductance are as stated below

Description	Formula
Inductance	$L=\mu N^2 A/l$ Where $L$ - inductance in Henry(H) $\mu$ - 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



	$\phi = \int \vec{B} \cdot d\vec{A}$ <p>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</p>
<b>Induced Current</b>	<p>Induced Current is given as</p> $I = \frac{E}{R} = \frac{N}{R} \left( \frac{d\phi}{dt} \right) = \frac{N}{R} \left( \frac{\phi_1 - \phi_2}{t} \right)$
<b>Mutual - Induction</b>	<p>Mutual – Induction is given as</p> $e_2 = \frac{d(N_2 \phi_2)}{dt} = M \frac{dl_1}{dt}$ <p>Therefore,</p> $M = \frac{\mu_0 N_1 N_2 A}{l}$

## Part 6

### Faraday's Law Formula

The formula for Faraday's law are as stated below

Description	Formula
<b>Faraday's first law</b>	<p>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.</p>
<b>Faraday's second law</b>	<ol style="list-style-type: none"> <li>It states that the emf induced in a conductor is equivalent to the rate at which the flux is linked to the circuit changes.  <math display="block">\varepsilon = -d\phi/dt</math> <p>Where, <math>\varepsilon</math> = the emf or electromotive force  <math>\phi</math> = the magnetic flux</p> </li> <li>If there are N number of turns in the coil then the total magnetic induction in a coil is represented as</li> </ol>



	$\varepsilon = -N \frac{d\phi}{dt}$
<b>Magnetic flux</b>	It is the integral (sum) of all of the magnetic fields passing through infinitesimal area elements $dA$ . $\Phi_B = \int \vec{B} \cdot d\vec{A}$
<b>The magnetic flux through a surface</b>	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 $\Phi_B = B \cdot A = BA \cos\theta$
<b>Lenz's Law</b>	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, $E = -N \left( \frac{d\phi}{dt} \right)$
<b>Induced emf</b>	Induced emf is given as $E = -N \left( \frac{d\phi}{dt} \right)$ $E = -N \left( \frac{\phi_1 - \phi_2}{t} \right)$
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
<b>Pressure</b>	$P = \frac{F}{A}$ 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.
<b>Angle made by liquid surface when the container experiences an acceleration</b>	$\tan \theta = \frac{a_0}{g}$ here, $\theta$ 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.
<b>Continuity equation</b>	According to the equation of continuity, the product of velocity and the area of cross section at any section in a tube is constant.



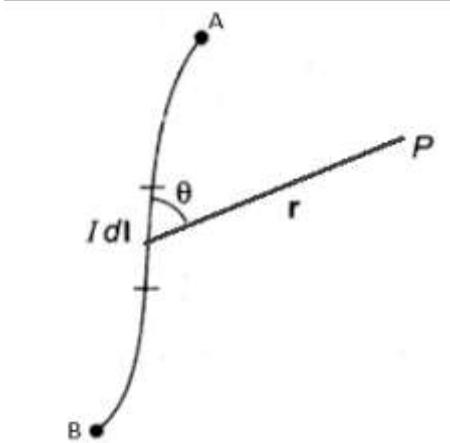
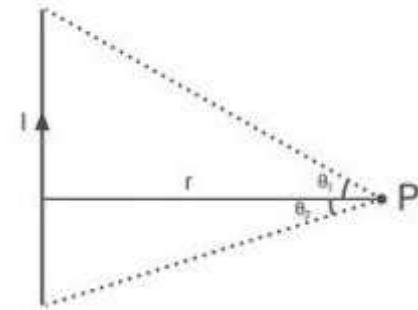
	$a_1 v_1 = a_2 v_2$ here, $a_1 v_1$ are the area of cross section and velocity of fluid at section 1 and $a_2 v_2$ are the area of cross section and velocity of the fluid at section 2.
<b>Bernoulli's equation</b>	According to Bernoulli's equation the total energy of liquid flowing through a tube is constant throughout the tube. $\frac{P}{\rho g} + \frac{v^2}{2g} + Z = \text{constant}$ Here, $P$ is the pressure, $\rho$ 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.
<b>Speed of efflux</b>	$v = \sqrt{\frac{2gh}{1 - \frac{A_2^2}{A_1^2}}}$ 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.
<b>Stress</b>	$\sigma = \frac{F}{A}$ here, $\sigma$ is the stress, $F$ is the force and $A$ is the area.
<b>Strain</b>	$\epsilon = \frac{\Delta L}{L}$ here, $\epsilon$ is the strain, $\Delta L$ is the change in length, and $L$ is the initial length.
<b>Young's modulus</b>	$E = \frac{\sigma}{\epsilon}$ 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 $\Delta L$ is the change in length.
<b>Stoke's law</b>	$F = 6\pi\eta r v$ Here, $F$ is the drag experienced by the sphere, $r$ is the radius of the sphere, $\eta$ is the viscosity of the fluid and $v$ is the velocity of the sphere.
<b>Terminal velocity</b>	$v = \frac{2}{9} \left( \frac{r^2 (\rho - \sigma) g}{\eta} \right)$



	Here, $r$ is the radius of the sphere, $\rho$ is the density of the sphere, $\sigma$ is the density of the fluid, $g$ is the gravitational acceleration and $\eta$ is the viscosity of the fluid.
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## 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 $\vec{B} = \frac{\mu_0 q (\vec{v} \times \vec{r})}{4\pi r^3}$ $\mu_0$ = 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	 <p>The magnetic field due to a straight wire is given as</p> $B = \frac{\mu_0 I}{4\pi r} (\sin \theta_1 + \sin \theta_2)$



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



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	$B = \frac{\mu_0 M}{4\pi r^3}$
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	$\oint E \cdot da = \frac{Q}{\epsilon_0}$
Gauss's Law for Magnetism	$\oint B \cdot dA = 0$
Faraday's Law	$\oint E \cdot dl = -\frac{d\phi_E}{dt}$
Ampere-Maxwell Law	$\oint B \cdot dl = \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$
Speed of Light in Vacuum	$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$



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	$k = \frac{2\pi}{\lambda} = \frac{\omega}{v} (\text{rad m}^{-1})$
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 $T = \text{Tension}$ $\mu = \text{mass per unit length}$
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 $\rho$ is the density of medium
Loudness of Sound	$10 (\frac{I}{I_0}) dB$
Intensity at a distance r from a point Source	$I = \frac{P}{4\pi r^2}$
Interference of Sound Wave	$P_1 = P_{m1} \sin(\omega t - kx_1 + \theta_1)$ $P_2 = P_{m2} \sin(\omega t - kx_2 + \theta_2)$ The Result is the sum of all the pressure. $P_0 = \sqrt{p_{m_1}^2 + p_{m_2}^2 + 2p_{m_1}p_{m_2} \cos\phi}$
For constructive Interference	$\phi = 2\pi n$ then, $\Rightarrow P_o = P_{m_1} + P_{m_2}$
For destructive interference	$\phi = (2n + 1)\pi$ and $\Rightarrow P_o =  P_{m_1} - P_{m_2} $
Close Organ Pipe	$f = \frac{v}{4l}, \frac{3v}{4l}, \frac{5v}{4l}, \dots, \frac{(2n+1)v}{4l}$
Open organ pipe	$f = \frac{v}{2l}, \frac{2v}{2l}, \dots, \frac{nV}{2l}$
Beats	Beats Frequency = $f_1 - f_2$
Doppler's Law	The Observed Frequency, $\dot{f} = f \left( \frac{v - v_0}{v - v_s} \right)$ Apparent Wavelength, $\dot{\lambda} = \lambda \left( \frac{v - v_s}{v} \right)$

## Wave Optics Formula

The formula for wave optics are as stated below

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



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



<b>Diffraction grating: maximum (bright stripes)</b>	$ds\sin\theta = k\lambda$ d is the lattice constant $\theta$ is the diffraction angle $\lambda$ is the wavelength
<b>Diffraction grating (dark stripes)</b>	$ds\sin\theta = (K + 1/2)\lambda$ d is the lattice constant $\phi$ is the diffraction angle $\lambda$ is the wavelength

## Work Power and Energy Formula

The formula for work power energy are as stated below

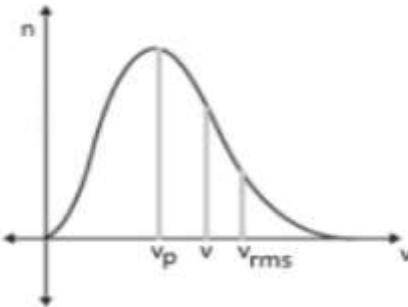
Description	Formula
<b>Work done is given by</b>	$W = F \times d$ F is the force d is the displacement
<b>Kinetic Energy</b>	$K.E = \frac{1}{2}mv^2$ m is the mass of the body. v is the velocity of the body
<b>Potential Energy</b>	$P.E = mgh$ m is the mass of the body in kg h is the height of the body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



<b>Work-Energy theorem</b>	$W_{net} = \Delta K$ <p>Where</p> <p><math>W_{net}</math> is the sum of all forces acting on the object</p> <p><math>\Delta K</math> is the change of kinetic energy</p>
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## Kinetic Theory Formula

The formula for kinetic theory are as stated below

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



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	$p = \frac{1}{3} \rho v_{rms}^2$
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	$k_B = \frac{nR}{N}$ <ul style="list-style-type: none"><li>• <math>k_B</math> is the Boltzmann's Constant</li><li>• R is the gas Constant</li><li>• n is the Number of Moles</li><li>• N is the Number of Particles in one mole (the Avogadro number)</li></ul>
Total Translational K.E of Gas	$K.E = \left(\frac{3}{2}\right)nRT$ <ul style="list-style-type: none"><li>• n is the number of moles</li><li>• R is the Universal gas Constant</li><li>• T is the absolute Temperature</li></ul>
Maxwell Distribution Law	$V_{rms} > V > V_p$ <ul style="list-style-type: none"><li>• <math>V_{rms}</math> is the RMS speed</li><li>• V is the Average Speed.</li></ul>



	<ul style="list-style-type: none"><li>• <math>V_p</math> is the most probable speed</li></ul>
RMS Speed ( $V_{rms}$ )	$V_{rms} = \sqrt{\frac{8kt}{m}} = \sqrt{\frac{3RT}{M}}$ <ul style="list-style-type: none"><li>• R is the universal gas constant.</li><li>• T is the absolute temperature.</li><li>• M is the molar mass.</li></ul>
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	$P = \frac{1}{3} V_{rms}^2$ <ul style="list-style-type: none"><li>• P is the density of molecules</li></ul>
Equipartition of Energy	$K = \frac{1}{2} K_B T \text{ for each degree of freedom}$ $K = \left(\frac{f}{2}\right) K_B T \text{ for molecules having } f \text{ degrees of freedom}$ <ul style="list-style-type: none"><li>• <math>K_B</math> is the Boltzmann's Constant</li><li>• T is the Temperature of the gas</li></ul>
Internal Energy	$U = \left(\frac{f}{2}\right) nRT$ <ul style="list-style-type: none"><li>• For n moles of an ideal Gas.</li></ul>



## Part 8

### **Lenz's Law Formula**

The formula for Lenz's law are as stated below

Description	Formula
Magnetic Flux	<p>The magnetic flux through a plane of area <math>dA</math> placed in a uniform magnetic field <math>B</math> is given as</p> $\phi = B \cdot dA$ <p>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.</p>
Lenz's Law	<p>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,</p> $E = -N(d\phi/dt)$
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 $e_2 = (d(N_2 \phi_2)/dt) = M (di_1)/dt$ 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 ( $\Delta H$ )	<ul style="list-style-type: none"><li>At isobaric condition: When <math>\Delta p=0</math>; <math>\Delta H = C_p (T_2 - T_1)</math></li><li>At isochoric condition: When <math>\Delta V=0</math>; <math>\Delta H = Q_V + V\Delta p</math></li><li>At isothermal condition: When <math>\Delta T=0</math>; <math>\Delta H = 0</math></li><li>At Adiabatic condition: When <math>Q=0</math>; <math>\Delta H = C_p (T_2 - T_1)</math></li></ul>
Enthalpy change of a reaction	$\begin{aligned}\Delta H_{reaction} &= H_{product} - H_{reactants} \\ \Delta H^\circ &= H^\circ_{products} - H^\circ_{reactants} \\ &= \text{positive } \Delta H - \text{endothermic} \\ &= \text{negative } \Delta H - \text{exothermic}\end{aligned}$
Enthalpy of Reaction from Enthalpies of Formation	The enthalpy of reaction can be given as:- $\Delta H^\circ_r = \sum v_B \Delta H^\circ_{f,products} - \sum v_B \Delta H^\circ_{f,reactants}$ $v_B$ is the stoichiometric coefficient
Estimation of Enthalpy of a reaction from bond Enthalpies	$H = \text{Enthalpy required to break reactants into gaseous atoms} - \text{Enthalpy released to form products from the gasesous atoms}$
Resonance energy	$\begin{aligned}\Delta H^\circ_{resonance} &= \Delta H^\circ_{f,experimental} - \Delta H^\circ_{f,calculated} \\ \Delta H^\circ_{resonance} &= \Delta H^\circ_{c,calculated} - \Delta H^\circ_{f,experimental}\end{aligned}$



<h2>Entropy Formula</h2>	
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 $\Delta S_{rxn}$ by using a table of standard entropy values	$\Delta S_{rxn} = \sum \Delta S_{products} - \sum \Delta S_{reactants}$ $\Delta S_{rxn}$ – refers to the standard entropy values $\sum \Delta S_{products}$ = refers to the sum of the $\Delta S_{products}$ $\sum \Delta S_{reactants}$ – refers to the sum of the $\Delta S_{reactants}$
Gibbs free energy	$G_{system} = H_{system} - TS_{system}$
<h2>Atomic Mass Formula</h2>	
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	$RAM = \frac{\text{Mass of one atom of an element}}{\frac{1}{2} \times \text{mass of one carbon atom}}$
Specific gravity	$\text{Specific gravity} = \frac{\text{density of the substance}}{\text{density of water at } 4^\circ\text{C}}$
Absolute density	$\text{Absolute density} = \frac{\text{Molar mass of the gas}}{\text{Molar volume of the gas}}$ $\rho = \frac{PM}{RT}$
Vapor density	$V.D. = \frac{d_{gas}}{d_{H_2}} = \frac{\frac{PM_{gas}}{RT}}{\frac{PM_{H_2}}{RT}} = \frac{M_{gas}}{M_{H_2}} = \frac{M_{gas}}{2}$



	$\therefore M_{gas} = 2 V.D.$
Molarity	$M = \frac{w \times 1000}{(Mol. wt of solute) \times V_{in\ ml}}$
Molality	$m = \frac{\text{number of moles of solute}}{\text{mass of solvent in gram}} \times 1000 = \frac{1000 \times w_1}{M_1 \times w_2}$
Mole fraction	<ul style="list-style-type: none"> <li><i>Mole fraction of solution</i> (<math>x_1</math>) = <math>\frac{n}{n+N}</math></li> <li><i>Mole fraction of solvent</i> (<math>x_2</math>) = <math>\frac{N}{n+N}</math></li> </ul> $x_1 + x_2 = 1$
% Calculation:	<ul style="list-style-type: none"> <li><math>\% w/w = \frac{\text{mass of solute in gm}}{\text{mass of solution in gm}} \times 100</math></li> <li><math>\% w/v = \frac{\text{mass of solute in gm}}{\text{Volume of solution in ml}} \times 100</math></li> <li><math>\% v/v = \frac{\text{Volume of solute in ml}}{\text{Volume of solution}} \times 100</math></li> <li>•</li> </ul>
Derived conversion	<ul style="list-style-type: none"> <li>Mole fraction of solute into molarity of solution <math display="block">M = \frac{x_2 \rho \times 1000}{x_1 M_1 + M_2 x_2}</math></li> <li>Molarity into mole fraction <math display="block">x_2 = \frac{MM_1 \times 1000}{\rho \times 1000 - MM_2}</math></li> <li>Mole fraction into molality <math display="block">m = \frac{x_2 \times 1000}{x_1 M_1}</math></li> <li>Molality into mole fraction <math display="block">x_2 = \frac{mM_1}{1000 + mM_1}</math></li> <li>Molality into molarity <math display="block">M = \frac{m \rho \times 1000}{1000 + mM_2}</math></li> <li>Molarity into molality <math display="block">m = \frac{M \times 1000}{1000 \rho - MM_2}</math></li> </ul> <p>Here <math>M_1</math> and <math>M_2</math> are molar masses of solvent and solute  <math>\rho</math> is density of solution  <math>M</math> is molarity  <math>m</math> is molality  <math>x_1</math> is mole fraction of solvent  <math>x_2</math> is mole fraction of solute</p>
Average atomic mass	$A_x = \frac{a_1 x_1 + a_2 x_2 + \dots + a_n x_n}{100}$
Mean molar mass	$M_{avg} = \frac{M_1 n_1 + M_2 n_2 + \dots + M_n n_n}{n_1 + n_2 + \dots + n_n}$



Normality	<ul style="list-style-type: none"> <li><math>N = \frac{\text{Number of equivalents of solute}}{\text{Volume of solution}}</math></li> <li><math>N = \text{Molarity} \times v.f</math></li> </ul>
At equivalence point	<ul style="list-style-type: none"> <li><math>N_1 V_1 = N_2 V_2</math></li> <li><math>n_1 M_1 V_1 = n_2 M_2 V_2</math></li> <li>▪</li> </ul>
Oxidation Number	$\text{Oxidation Number} = \text{number of electrons in the valence shell} - \text{number of electrons left after bonding}$
Equivalent weight	$E = \frac{\text{Atomic weight}}{\text{Valency factor}}$
Concept of number of equivalents	<ul style="list-style-type: none"> <li>No. of equivalents of solute = <math>\frac{Wt}{\text{Eq. wt.}} = \frac{W}{E} = \frac{W}{M/n}</math></li> <li>No. of equivalents of solute = No. of moles of solute <math>\times v.f.</math></li> </ul>
Measurement of Hardness	<ul style="list-style-type: none"> <li><math>\text{Hardness} = \frac{\text{mass of } CaCO_3}{\text{Total mass of water}} \times 10^6</math></li> </ul>

## Atomic Structure Formula

The formula for atomic structure are as stated below

Description	Formula
Planck's Quantum Theory	Energy of one photon = $h\nu = \frac{hc}{\lambda}$
Photoelectric effect:	$h\nu = h\nu_0 + \frac{1}{2}m_e v^2$
Bohr's Model for Hydrogen like atoms	<ul style="list-style-type: none"> <li><math>mvr = n = \frac{h}{2\pi}</math></li> <li><math>E_n = -\frac{E_1}{n^2} Z^2 = -2.178 \times 10^{-18} \frac{Z^2}{n^2} J/\text{atom} = -13.6 \frac{Z^2}{n^2} eV</math></li> <li><math>E_1 = \frac{-2\pi^2 me^4}{n^2}</math></li> <li><math>r_n = \frac{n^2}{Z} \times \frac{h^2}{4\pi^2 e^2 m} = \frac{0.529 \times n^2}{Z} \text{ Å}</math></li> <li><math>v = \frac{2\pi z e^2}{nh} = \frac{2.18 \times 10^6 \times Z}{n} \text{ m/s}</math></li> </ul>
De-Broglie wavelength	$\lambda = \frac{h}{mc} = \frac{h}{p} \text{ (For photon)}$
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	$E = nhv$ Where n is the number of photons emitted h is the Planck's constant v is the frequency
Heisenberg's uncertainty principle	<ul style="list-style-type: none"><li>• <math>\Delta x \cdot \Delta p &gt; \frac{h}{4\pi}</math></li><li>• <math>m \Delta x \cdot \Delta v \geq \frac{h}{4\pi}</math></li><li>• <math>\Delta x \cdot \Delta v \geq \frac{h}{4\pi m}</math></li></ul>
Quantum Number	<ul style="list-style-type: none"><li>• Principle quantum number - (<math>n = 1, 2, 3, 4, 5 \dots \infty</math>)</li><li>• Orbital angular momentum of electron in any orbit = <math>\frac{nh}{2\pi}</math></li><li>• Azimuthal quantum number (<math>l</math>) = 0, 1, 2, 3, ...(<math>n - 1</math>)</li><li>• Magnetic quantum number (<math>m</math>) = -l, ..., -1, 0, 1, ..., +l</li><li>• Spin quantum number (<math>s</math>) = +½, -½</li><li>• Number of orbitals in subshell = <math>2l + 1</math></li><li>• Maximum number of electrons in particular subshell = <math>2(2l + 1)</math></li><li>• Orbital angular momentum <math>L = \frac{h}{2\pi} \sqrt{l(l + 1)} = \hbar \sqrt{l(l + 1)}</math></li><li>• <math>\hbar = \frac{h}{2\pi}</math></li></ul>

## 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	$\Delta Tb = Kbm$ $m = 1000 \times w_2 / w_1 \times M_2$ $\Delta Tb = Kb \times 1000 \times w_2 / w_1 \times M_2$
When depression of freezing point is given	$\Delta Tf = Kfm$ $\Delta Tf = Kf \times 1000 \times w_2 / w_1 \times M_2$



Molarity	$M = \frac{w \times 1000}{(Mol. wt of solute) \times V_{in\ ml}}$
Molality	$m = \frac{\text{number of moles of solute}}{\text{mass of solvent in gram}} \times 1000 = \frac{1000 \times w_1}{M_1 \times w_2}$
Average atomic mass	$A_x = \frac{a_1 x_1 + a_2 x_2 + \dots + a_n x_n}{100}$
Mean molar mass	$M_{avg} = \frac{M_1 n_1 + M_2 n_2 + \dots + M_n n_n}{n_1 + n_2 + \dots + n_n}$

## Stoichiometry Formula

The formula for stoichiometry are as stated below

Description	Formulas
Relative atomic mass	$\text{Relative atomic mass (R.A.M)} = \frac{\text{Mass of one atom of an element}}{\frac{1}{12} \times \text{mass of one Carbon atom}} = \text{Total number of protons in the nucleus}$
Density	$\text{Specific gravity} = \frac{\text{density of the substance}}{\text{density of water at } 4^\circ\text{C}}$
For Gases:	$\text{Absolute density} \left( \frac{\text{mass}}{\text{volume}} \right) = \frac{\text{Molar mass of the gas}}{\text{Molar Volume of the gas}}$ $\Rightarrow \rho = \frac{PM}{RT}$ $\text{Vapor density } V.D. = \frac{d_{gas}}{d_{H_2}} = \frac{PM_{gas}}{PM_{H_2}} = \frac{M_{gas}}{M_{H_2}}$ $M_{gas} = 2 V.D$
Molarity (M):	$\text{Molarity}(M) = \frac{w \times 1000}{(Mol. wt of Solute) \times V_{in\ ml}}$
Molality (m):	$\text{Molality} = \frac{\text{number of moles of solute}}{\text{mass of solvent in gram}} \times 1000 = 1000 \frac{W_1}{M_1 W_2}$
% Calculation	$\% \frac{w}{w} = \frac{\text{mass of solute in gm}}{\text{mass of solution in gm}} \times 100$ $\% \frac{w}{v} = \frac{\text{Mass of solute in gm}}{\text{Volume of solution in ml}} \times 100$ $\% \frac{v}{v} = \frac{\text{Volume of solute in ml}}{\text{Volume of solution}} \times 100$
Average/ Mean atomic mass:	$A_x = \frac{a_1 x_1 + a_2 x_2 + \dots + a_n x_n}{100}$
Mean molar mass or molecular Mass	$M_{avg} = \frac{n_1 M_1 + n_2 M_2 + \dots + n_n M_n}{n_1 + n_2 + \dots + n_n}$
Normality (N)	$\text{Normality}(N) = \frac{\text{Number of equivalents of solute}}{\text{Volume of Sodium (in liters)}}$



Measurement of Hardness	$\text{Hardness in ppm} = \frac{\text{mass of } CaCO_3}{\text{Total Mass of water}} \times 10^6$
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 $\rho$ 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	<pre>     graph TD       Number -- "x N_A" --&gt; Mole       Number -- "x N_A" --&gt; Volume[Volume at STP]       Mole -- "x 22.4 l" --&gt; Volume       Mole -- "x 22.4 l" --&gt; Mass[Mass]       Mass -- "x mol. wt." --&gt; Mole       Mass -- "x At. wt." --&gt; Mole     </pre>

## Part 2

### Thermodynamics Formulas

The formula for thermodynamics are as stated below

Description	Formula
Various processes in Thermodynamic	Isothermal process: $T = \text{constant}$ $dT = 0$ $\Delta T = 0$ Isochoric process: $V = \text{constant}$ $dV = 0$ $\Delta V = 0$ Isobaric process: $P = \text{constant}$ $dP = 0$



	$\Delta P = 0$ 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	<ul style="list-style-type: none"> <li><b>1<sup>st</sup> law of Thermodynamics</b>  <math>\Delta U = (U_2 - U_1) = q + w</math></li> <li><b>2<sup>nd</sup> law of Thermodynamics</b>  <math>\Delta S_{universe} = \Delta S_{system} + \Delta S_{surrounding} &gt; 0</math>  <b>This equation is for spontaneous processes.</b></li> <li><b>3<sup>rd</sup> law of Thermodynamics</b>  <math>S - S_0 = k_B \ln \Omega</math>  <math>S</math> is the entropy of the system.  <math>S_0</math> is the initial entropy.  <math>k_B</math> denotes the Boltzmann constant.  <math>\Omega</math> refers to the total number of microstates that are consistent with the system's macroscopic configuration.</li> </ul>
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	$C = \frac{\Delta q}{n\Delta T} = \frac{dq}{ndT}$ $C_p = \frac{\gamma R}{\gamma - 1}$ $C_v = \frac{R}{\gamma - 1}$
Specific heat capacity	$S = \frac{\Delta q}{m\Delta T} = \frac{dq}{mdT}$
Application of 1 <sup>st</sup> Law of Thermodynamics	$\Delta U = \Delta Q + \Delta W$ $\Rightarrow \Delta W = -P \Delta V$ ( $\therefore \Delta U = \Delta Q - P \Delta V$ )
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	$W = P(V_f - V_i)$
Adiabatic reversible expansion	$T_2 V_2^{\gamma-1} = T_1 V_1^{\gamma-1}$
Reversible work	$W = \frac{P_2 V_2 - P_1 V_1}{\gamma-1} = \frac{nR(T_2 - T_1)}{\gamma-1}$
Irreversible Work	$W = \frac{P_2 V_2 - P_1 V_1}{\gamma-1} = \frac{nR(T_2 - T_1)}{\gamma-1} = nC_v(T_2 - T_1) = -P_{ext}(V_2 - V_1)$



	Use $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
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## 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	<i>At constant temperature,</i> $V \propto \frac{1}{P}$ $P_1 V_1 = P_2 V_2$
Charles Law	<i>At constant pressure,</i> $V \propto T$ Or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
Gay-Lussac's Law	<i>At constant Volume,</i> $P \propto T$ $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ 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:	$P_1 = \frac{n_1 RT}{V}, P_2 = \frac{n_2 RT}{V}$ Total Pressure = $P_1 + P_2 + \dots$ Partial pressure = Mole fraction $\times$ Total Pressure
Average Molecular mass of gaseous mixture	$M_{mix} = \frac{\text{Total mass of mixture}}{\text{Total no. of moles in mixture}} = \frac{n_1 M_1 + n_2 M_2 + n_3 M_3}{n_1 + n_2 + n_3}$
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	$\left( P + \frac{an^2}{v^2} \right) (v - nb) = nRT$ <p style="text-align: center;">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</p>
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	<p><b>Root mean Square speed</b></p> $U_{rms} = \sqrt{\frac{3RT}{M}}$ Molar mass be in kg/mole <p><b>Average speed</b></p> $U_{avg} = U_1 + U_2 + U_3 + \dots U_N$ $U_{avg} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8KT}{\pi m}}$ K is Boltzmann Constant <p><b>Most Probable Speed</b></p> $U_{MPS} = \sqrt{\frac{2RT}{M}} = \sqrt{\frac{2KT}{m}}$
<b>Chemical Equilibrium Formula</b>	
The formula for chemical equilibrium are as stated below	
Description	Formula
At Equilibrium:	$\text{Rate of forward reaction} = \text{rate of backward reaction}$ $\Delta G = 0$ $Q = K_{eq}$
Equilibrium constant (K):	$K = \frac{\text{rate constant of forward reaction}}{\text{rate constant of backward reaction}} = \frac{K_f}{K_b}$



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 $K_p$ & $K_c$ :	$K_p = K_c \cdot (RT)^{\Delta n}$
Relation between $K_p$ & $K_x$ :	$K_p = K_x (P)^{\Delta n}$ $\log \log \frac{K_2}{K_1} = \frac{\Delta H}{2.303 R} \left[ \frac{1}{T_1} - \frac{1}{T_2} \right]$ <p>Here <math>\Delta H</math> = Enthalpy of reaction</p>
between equilibrium constant & standard free energy change	$\Delta G^\circ = - 2.303 RT \log K$
Reaction Quotient(Q):	$Q = \frac{[C]^c [D]^d}{[A]^a [B]^b}$
Degree of Dissociation ( $\alpha$ ):	$\alpha = \frac{\text{number of moles dissociated}}{\text{initial number of moles taken}}$
Vapor Pressure of Liquid:	$\text{Relative Humidity} = \frac{\text{Partial pressure of } H_2O \text{ vapors}}{\text{Vapor pressure of } H_2O \text{ at the temperature}}$
Thermodynamics of Equilibrium:	$\Delta G = \Delta G^\circ + 2.303 RT Q$
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:	<ul style="list-style-type: none"> <li>Dissociation constant of weak acid (<math>K_a</math>),</li> </ul>



	$K_a = \frac{[H^+][A^-]}{HA} = \frac{C\alpha[C\alpha]}{C(1-\alpha)} = \frac{C\alpha^2}{1-\alpha}$ <ul style="list-style-type: none"> <li>If <math>\alpha \ll 1</math>, then <math>1 - \alpha \approx 1</math> or <math>K_a = C\alpha^2</math></li> </ul> $\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{K_a \times V}$ <ul style="list-style-type: none"> <li>Similarly for a weak base,</li> </ul> $\alpha = \sqrt{\frac{K_b}{C}}$ <p>Higher the value of <math>K_a/K_b</math>, stronger is the acid/base</p>
Acidity and pH scale	<ul style="list-style-type: none"> <li><math>pH = -\log a_{H^+}</math> Here <math>a_{H^+}</math> is the activity of <math>H^+</math> ions = molar concentration for dilute solution</li> <li><math>pH = -\log [H^+] \quad [H^+] = 10^{-pH}</math></li> <li><math>pOH = -\log [OH^-] \quad [OH^-] = 10^{-pOH}</math></li> <li><math>pKa = -\log K_a \quad K_a = 10^{pKa}</math></li> <li><math>pKb = -\log K_b \quad K_b = 10^{-pKb}</math></li> <li>•</li> </ul>
pH Calculations of Different Types of Solutions:	<ul style="list-style-type: none"> <li><b>Strong acid solution:</b> If concentration is greater than <math>10^{-6} M</math> In this case <math>H^+</math> ions coming from water can be neglected, If concentration is less than <math>10^{-6} M</math> In this case <math>H^+</math> ions coming from water cannot be neglected</li> <li><b>Strong base solution:</b> Using similar method as in part (a) calculate first <math>[OH^-]</math> and then use <math>[H^+] \times [OH^-] = 10^{-14}</math></li> <li>•</li> </ul>
pH of mixture of two strong acids:	<ul style="list-style-type: none"> <li>Number of <math>H^+</math> ions from I-solution = <math>N_1 V_1</math></li> <li>Number of <math>H^+</math> ions from II-solution = <math>N_2 V_2</math></li> <li><math display="block">[H^+] = N = \frac{N_1 V_1 + N_2 V_2}{V_1 + V_2}</math></li> <li>•</li> </ul>
pH of mixture of two strong bases:	$[OH^-] = N = \frac{N_1 V_1 + N_2 V_2}{V_1 + V_2}$ <li>•</li>
pH of mixture of a strong acid and a strong base:	<ul style="list-style-type: none"> <li>if <math>N_1 V_1 &gt; N_2 V_2</math>, then the solution will be acidic in nature. So,</li> </ul> $[H^+] = N = \frac{N_1 V_1 - N_2 V_2}{V_1 + V_2}$



	<ul style="list-style-type: none"> <li>If <math>N_2V_2 &gt; N_1V_1</math>, then the solution will be basic in nature.</li> </ul> <p>So,</p> $[OH^-] = N = \frac{N_2V_2 - N_1V_1}{V_1 + V_2}$
pH of a weak acid(monoprotic) solution:	$K_a = \frac{[H^+][OH^-]}{[HA]} = \frac{C\alpha^2}{1-\alpha}$ <p>If <math>\alpha \ll 1 \Rightarrow (1 - \alpha) \approx 1</math></p> $K_a \approx C\alpha^2$ $\alpha = \sqrt{\frac{K_a}{C}}$ <p>Here <math>\alpha &lt; 0.1</math> or 10%</p>
Relative Strength of two acids:	$\frac{[H^+] \text{ furnished by I acid}}{[H^+] \text{ furnished by II acid}} = \frac{c_1\alpha_1}{c_2\alpha_2} = \sqrt{\frac{k_{a_1} c_1}{k_{a_2} c_2}}$
Hydrolysis of polyvalent anions or cations	<p>For <math>[Na_3PO_4] = C</math></p> $K_{a1} \times K_{h3} = K_w$ $K_{a2} \times K_{h2} = K_w$ $K_{a3} \times K_{h1} = K_w$ <p>Generally, pH is calculated only using the first step hydrolysis</p> $K_{h1} = \frac{Ch^2}{1-h} \approx Ch^2$ $h = \sqrt{\frac{K_{h1}}{C}} \Rightarrow [OH^-] = ch = \sqrt{K_{h1} \times C} \Rightarrow [H^+] = \sqrt{\frac{K_w \times K_{a3}}{C}}$ $\therefore pH = \frac{1}{2} [pK_w + pK_{a3} + \log \log C]$
Buffer Solution:	<ul style="list-style-type: none"> <li>Acidic Buffer: e.g., <math>CH_3COOH</math> and <math>CH_3COONa</math> (weak acid and salt of its conjugate base)</li> </ul> $pH = pK_a + \log \log \frac{[\text{salt}]}{[\text{acid}]}$ <ul style="list-style-type: none"> <li>Basic Buffer: e.g., <math>NH_4OH + NH_4Cl</math> (weak base and salt of its conjugate acid)</li> </ul> $pOH = pK_b + \log \log \frac{[\text{salt}]}{[\text{base}]}$
Solubility Product:	$K_{sp} = (xs)^x (ys)^y = x^x \cdot y^y \cdot (s)^{x+y}$ <ul style="list-style-type: none"> <li></li> </ul>
<b>Charles's Law</b>	
The formula for Charles's law are as stated below	



Description	Formulas
Charles' law is expressed as	$V \propto T$ 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	$V \propto T$ $\frac{V}{T} = \text{constant} = k$ $\frac{V_1}{T_1} = k \quad \dots \quad (I)$ and $\frac{V_2}{T_2} = k \quad \dots \quad (II)$ 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	$PV = nRT$ $PV = \frac{w}{m}RT \text{ Or } Pm = dRT$
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	$V = V_1 + V_2 + V_3 + \dots + Vn$

### Part 3

## Electrochemistry Formula

The formula for electrochemistry are as stated below



Description	Formula
Gibbs Free energy change	<ul style="list-style-type: none"> <li>• <math>\Delta G = - nFE_{cell}</math></li> <li>• <math>\Delta G^0 = - nFE_{cell}^0</math></li> </ul>
Nernst Equation	<p style="text-align: center;"><u>Effect of concentration and temp on emf of cell</u> where <math>Q</math> is reaction quotient</p> $\Delta G = \Delta G^0 + RT \ln Q$ $\Delta G^0 = - RT \ln K_{eq}$ $E_{cell} = E_{cell}^0 - \frac{RT}{nF} \ln Q$ $E_{cell} = E_{cell}^0 - \frac{2.303RT}{nF} \log Q$ $E_{cell} = E_{cell}^0 - \frac{0.0591}{n} \log Q$ <ul style="list-style-type: none"> <li>• At chemical equilibrium</li> </ul> $\Delta G = 0; \quad E_{cell} = 0$ $\log K_{eq} = \frac{nE_{cell}^0}{0.0591}$ $E_{cell}^0 = \frac{0.0591}{n} \log K_{eq}$ <ul style="list-style-type: none"> <li>• For an electrode:</li> </ul> $E_{M^{n+}/M} = E_{M^{n+}/M}^0 - \frac{2.303RT}{nF} \log 1/[M^{n+}]$
Concentration Cell	$E_{cell}^0 = 0$ <ul style="list-style-type: none"> <li>• <b>Electrolyte Concentration cell</b> (e.g., <math>Zn(s)/Zn^{2+}(c_1) \parallel Zn^{2+}(c_2)/Zn(s)</math>):</li> </ul> $E = \frac{0.0591}{2} \log \frac{c_2}{c_1}$ <ul style="list-style-type: none"> <li>• <b>Electrode Concentration Cell</b> (e.g., <math>Pt, H_2(P_1 \text{ atm})/H^+(1 M) / H_2(P_2 \text{ atm})/Pt</math>):</li> </ul> $E = \frac{0.0591}{2} \log \frac{P_1}{P_2}$



Faraday's law of electrolysis:	<ul style="list-style-type: none"><li><b>First law:</b> The amount of chemical reaction (w) is proportional to the quantity of electricity passed (q) through the electrolyte. <math>w \propto q</math> <math>w = zq</math> <math>w = Z</math> Here <math>Z</math> is Electrochemical equivalent of substance</li><li><b>Second law:</b> <math>W \propto E</math> <math>\frac{W}{E} = \text{constant}</math> <math display="block">\frac{W_1}{E_1} = \frac{W_2}{E_2} = \dots = \frac{W_n}{E_n}</math> <math display="block">\frac{W}{E} = \frac{i \times t \times \text{current efficiency factor}}{96500}</math> <math display="block">\text{current efficiency} = \frac{\text{actual mass deposited}}{\text{Theoretical mass deposited}} \times 100</math></li></ul>
Conductance:	<ul style="list-style-type: none"><li><math>\text{Conductance} = \frac{1}{\text{Resistance}}</math></li><li>Specific conductance or conductivity: <math>K = \frac{1}{\rho}</math> Here, <math>K</math> is specific conductance</li><li>Equivalent conductance: <math>\lambda_E = \frac{K \times 1000}{\text{Normality}}</math></li><li>Molar conductance: <math>\lambda_m = \frac{K \times 1000}{\text{Molarity}}</math></li><li>Specific conductance = conductance <math>\times \frac{l}{a}</math></li></ul>
Application of Kohlrausch law	<ul style="list-style-type: none"><li>Calculation of <math>\lambda_M^0</math> of weak electrolytes: <math display="block">\lambda_M^0 (\text{CH}_3\text{COOH}) = \lambda_M^0 (\text{CH}_3\text{COONa}) + \lambda_M^0 (\text{HCl}) - \lambda_M^0 (\text{NaCl})</math></li><li>To calculate degree of dissociation of a weak electrolyte <math display="block">\alpha = \frac{\lambda_m^c}{\lambda_m^0}; \quad K_{eq} = \frac{c\alpha^2}{1-\alpha}</math></li></ul>



	<ul style="list-style-type: none"><li>Solubility of sparingly soluble salt &amp; their <math>K_{sp}</math></li></ul> $\lambda_M^c = \lambda_M^\infty = k \times \frac{1000}{solubility}$ $K_{sp} = S^2$ <ul style="list-style-type: none"><li>Transport Number:</li></ul> $t_c = \left[ \frac{\mu_c}{\mu_c + \mu_a} \right], \quad t_a = \left[ \frac{\mu_a}{\mu_a + \mu_c} \right]$ <ul style="list-style-type: none"><li>Here <math>t_c</math> is Transport Number of cation and <math>t_a</math> is the transport number of anion.</li></ul>
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## 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	<p>Ideal gas law combines three laws:</p> <ul style="list-style-type: none"><li>Boyle's Law: <math>V \propto 1/P</math></li><li>Charles' Law: <math>V \propto T</math></li><li>Avogadro's Law: <math>V \propto n</math></li></ul> <p>Combining these above three Equation we get</p> $V \propto \frac{nT}{P}$ <p>The above equation shows that volume is proportional to the number moles and the temperature while inversely proportional to the pressure.</p> <p>This expression can be rewritten as follows:</p> $V = \frac{RnT}{P}$ <p>Multiplying both sides of the equation by P to Clear off the fraction, We get</p> $PV = nRT$ <p>The Above equation is known as the ideal Gas Equation.</p>
Molar Form of $PV = nRT$	$n = \frac{m}{M}$ , m= total mass of the gas, M=Molar mass



	$\text{Density } \rho = \frac{m}{V},$ $pV = \frac{m}{M}RT ,$ $p = \frac{m RT}{V M} , \quad p = \rho \frac{R}{M}T$
Combined Gas law can be Stated as	$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
If we want to use $N$ number of molecules instead of $n$ moles, we can write the ideal gas law as	$PV = Nk_b T$
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	$Q_s = -D_s ds/dx$ <p>Where <math>Q_s</math> is the rate of movement of matter, momentum or energy through a unit normal area. — <math>D_s</math> is the diffusion coefficient. <math>ds/dx</math> is the gradient of mass,momentum or energy in the medium.</p>
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	$\lambda = h/mv,$ Where $\lambda$ 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	<ul style="list-style-type: none"><li>Plank's quantum theory relates the energy of an electromagnetic wave to its wavelength or frequency. <math display="block">E = h\nu = \frac{hc}{\lambda} \dots\dots (1)</math></li></ul> <p>Einstein related the energy of particle matter to its mass and Velocity, as</p> $E = mc^2 \dots\dots (2)$ <p>As the Smaller particle exhibits dual nature, and energy being the same, de Broglie Equation as</p> $E = \frac{hc}{\lambda} = mv^2 \quad \text{then, } \frac{h}{\lambda} = mv$ <p>This is the momentum of a particle with its wavelength and this equation is known as De-Broglie's Equation.</p>
De-Broglie's Wavelength	$\lambda = \frac{h}{mv} = \frac{h}{\text{momentum}} = \frac{h}{p}$ <ul style="list-style-type: none"><li></li></ul>
Relation between de Broglie Equation and Bohr's Hypothesis of Atom:	$mv = \frac{nh}{2\pi r} \quad \text{or} \quad mvr = n \times \left(\frac{h}{2\pi}\right)$
Thermal De-Broglie Wavelength	The thermal de Broglie wavelength ( $\lambda_{th}$ ) is approximately the average de Broglie wavelength of the gas particles in an ideal gas at the specified temperature.



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