SOME IMPORTANT MATHEMATICAL FORMULAE

Circle : Area = πr^2; Circumference = $2\pi r$.
Square : Area = x^2; Perimeter = $4x$.
Rectangle: Area = xy; Perimeter = $2(x+y)$.
Triangle : Area = $\frac{1}{2}$(base)(height); Perimeter = $a+b+c$.

Area of equilateral triangle = $\frac{\sqrt{3}}{4}a^2$.

Sphere : Surface Area = $4\pi r^2$; Volume = $\frac{4}{3}\pi r^3$.
Cube : Surface Area = $6a^2$; Volume = a^3.
Cone : Curved Surface Area = πrl; Volume = $\frac{1}{3}\pi r^2 h$

Total surface area = . $\pi r l + \pi r^2$

Cuboid : Total surface area = $2(ab + bh + lh)$; Volume = lbh.
Cylinder : Curved surface area = $2\pi rh$; Volume = $\pi r^2 h$

Total surface area (open) = $2\pi rh$;
Total surface area (closed) = $2\pi rh + 2\pi r^2$.

SOME BASIC ALGEBRAIC FORMULAE:

1. $(a + b)^2 = a^2 + 2ab + b^2$.
2. $(a - b)^2 = a^2 - 2ab + b^2$.
3. $(a + b)^3 = a^3 + b^3 + 3ab(a + b)$.
4. $(a - b)^3 = a^3 - b^3 - 3ab(a - b)$.
5. $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$.
6. $(a + b + c)^3 = a^3 + b^3 + c^3 + 3a^2b + 3a^2c + 3b^2c + 3b^2a + 3c^2a + 3c^2a + 6abc$.
7. $a^2 - b^2 = (a + b)(a - b)$.
8. $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$.
9. $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$.
10. $(a + b)^2 + (a - b)^2 = 4ab$.
11. $(a + b)^2 - (a - b)^2 = 2(a^2 + b^2)$.
12. If $a + b + c = 0$, then $a^3 + b^3 + c^3 = 3abc$.

INDICES AND SURDS

1. $a^m \; a^n = a^{m+n}$ 2. $\frac{a^m}{a^n} = a^{m-n}$. 3. $(a^m)^n = a^{mn}$. 4. $(ab)^m = a^m b^m$.

5. $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$. 6. $a^0 = 1, \quad a \neq 0$. 7. $a^{-m} = \frac{1}{a^m}$. 8. $a^x = a^y \Rightarrow x = y$

9. $a^x = b^x \Rightarrow a = b$ 10. $\sqrt{a \pm 2\sqrt{b}} = \sqrt{x} \pm \sqrt{y}$, where $x + y = a$ and $xy = b$.

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LOGARITHMS

$a^x = m \Rightarrow \log_a m = x$ ($a > 0$ and $a \neq 1$)

1. $\log_a mn = \log m + \log n$.
2. $\log_a \left(\frac{m}{n}\right) = \log m - \log n$.
3. $\log_a m^n = n \log m$.
4. $\log_b a = \frac{\log a}{\log b}$.
5. $\log_a a = 1$.
6. $\log_a 1 = 0$.
7. $\log_b a = \frac{1}{\log_a b}$.
8. $\log_a 1 = 0$.
9. $\log (m+n) \neq \log m + \log n$.
10. $e^{\log x} = x$.
11. $\log_a a^x = x$.

PROGRESSIONS

ARITHMETIC PROGRESSION

a, a + d, a+2d,-----------------------------are in A.P.

n^{th} term, $T_n = a + (n-1)d$.

Sum to n terms, $S_n = \frac{n}{2}\left[2a + (n-1)d\right]$.

If a, b, c are in A.P, then $2b = a + c$.

GEOMETRIC PROGRESSION

a, ar, ar^2 ,--------------------------- are in G.P.

Sum to n terms, $S_n = \frac{a(1-r^n)}{1-r}$ if $r < 1$ and $S_n = \frac{a(r^n-1)}{r-1}$ if $r > 1$.

Sum to infinite terms of G.P, $S_\infty = \frac{a}{1-r}$.

If a, b, c are in A.P, then $b^2 = ac$.

HARMONIC PROGRESSION

Reciprocals of the terms of A.P are in H.P

$\frac{1}{a}, \frac{1}{a+d}, \frac{1}{a+2d}$, ----------------- are in H.P

If a, b, c are in H.P, then $b = \frac{2ac}{a+c}$.

MATHEMATICAL INDUCTION

$1 + 2 + 3 + \text{-----------------} + n = \sum n = \frac{n(n+1)}{2}$.

$1^2 + 2^2 + 3^2 + \text{-----------------} + n^2 = \sum n^2 = \frac{n(n+1)(2n+1)}{6}$.

$1^3+2^3+3^3+$ ----------------+ $n^3 = \sum n^3 = \frac{n^2(n+1)^2}{4}$.

PERMUTATIONS AND COMBINATION

$n\,P_r = \frac{n!}{(n-r)!}$.

$nC_r = \frac{n!}{r!(n-r)!}$.

$n! = 1.2\ 3.$--------n.

$nC_r = nC_{n-r}$.

$nC_r + nC_{r-1} = (n+1)\,C_r$.

$(m+n)C_r = \frac{(m+n)!}{m!n!}$.

BINOMIAL THEOREM

$(x+a)^n = x^n + nC_1\,x^{n-1}\,a + nC_2\,x^{n-2}\,a^2 + nC_3\,x^{n-3}\,a^3 +$------------+ $nC_n\,a^n$.

n^{th} term, $T_{r+1} = nC_r\,x^{n-r}\,a^r$.

PARTIAL FRACTIONS

$\frac{f(x)}{g(x)}$ is a proper fraction if the deg (g(x)) > deg (f(x)).

$\frac{f(x)}{g(x)}$ is a improper fraction if the deg (g(x)) $\leq$ deg (f(x)).

1. Linear non- repeated factors
   $\frac{f(x)}{(ax+b)(cx+d)} = \frac{A}{ax+b} + \frac{B}{(cx+d)}$.
2. Linear repeated factors
   $\frac{f(x)}{(ax+b)(cx+d)^2} = \frac{A}{ax+b} + \frac{B}{(cx+d)} + \frac{C}{(cx+d)^2}$.
3. Non-linear(quadratic which can not be factorized)
   $\frac{f(x)}{(ax^2+b)(cx^2+d)} = \frac{Ax+B}{ax^2+b} + \frac{Cx+D}{(cx^2+d)}$.

ANALYTICAL GEOMETRY

1. Distance between the two points (x_1, y_1) and (x_2, y_2) in the plane is
   $\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$ OR $\sqrt{(x_1-x_2)^2+(y_1-y_2)^2}$.
2. Section formula
   $\left(\frac{mx_2+nx_1}{m+n}, \frac{my_2+ny_1}{m+n}\right)$ (for internal division),
   $\left(\frac{mx_2-nx_1}{m-n}, \frac{my_2-ny_1}{m-n}\right)$ (for external division).

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3. Mid point formula

$$\left(\frac{x_1+x_2}{2},\frac{y_1+y_2}{2}\right).$$

4. Centriod formula

$$\left(\frac{x_1+x_2+x_3}{3},\frac{y_1+y_2+y_3}{3}\right).$$

5. Area of triangle when their vertices are given,

$$\frac{1}{2}\sum x_1(y_2-y_3)$$

$$=\frac{1}{2}[\,x_1(y_2-y_3)+x_2(y_3-y_1)+x_3(y_1-y_2)]$$

STRAIGHT LINE

Slope (or Gradient) of a line = tangent of an inclination = tanθ.
Slope of a X- axis = 0
Slope of a line parallel to X-axis = 0
Slope of a Y- axis = ∞
Slope of a line parallel to Y-axis = ∞
Slope of a line joining (x_1, x_2) and (y_1, y_2) = $\frac{y_2-y_1}{x_2-x_1}$.

If two lines are parallel, then their slopes are equal ($m_1= m_2$)

If two lines are perpendicular, then their product of slopes is -1 ($m_1\ \ m_2 = -1$)

EQUATIONS OF STRAIGHT LINE

1. $y = mx + c$ (slope-intercept form)
   $y - y_1 = m(x-x_1)$ (point-slope form)
   $y-y_1=\frac{y_2-y_1}{x_2-x_1}(x-x_1)$ (two point form)
   $\frac{x}{a}+\frac{y}{b}=1$ (intercept form)
   $x\cos\alpha + y\sin\alpha = P$ (normal form)

Equation of a straight line in the general form is $\mathbf{ax^2 + bx + c = 0}$

Slope of $ax^2 + bx + c = 0$ is $-\left(\frac{a}{b}\right)$

2. Angle between two straight lines is given by, tanθ = $\left|\frac{m_1-m_2}{1+m_1m_2}\right|$

   Length of the perpendicular from a point (x_1,x_2) and the straight line $ax^2 + bx + c = 0$ is $\left|\frac{ax_1+by_1+c}{\sqrt{a^2+b^2}}\right|$

Equation of a straight line passing through intersection of two lines $a_1x^2 + b_1x + c_1 = 0$ and $a_2x^2 + b_2x + c_2 = 0$ is $a_1x^2 + b_1x + c_1 + K(a_2x^2 + b_2x + c_2) = 0$, where K is any constant.

Two lines meeting a point are called intersecting lines.

More than two lines meeting a point are called concurrent lines.

Equation of bisector of angle between the lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ is $\frac{a_1x + b_1y + c_1}{\sqrt{a_1^2 + b_1^2}} = \pm \frac{a_2x + b_2y_2 + c_2}{\sqrt{a_2^2 + b_2^2}}$

PAIR OF STRAIGHT LINES

1. An equation $ax^2 + 2hxy + by^2 = 0$, represents a pair of lines passing through origin generally called as homogeneous equation of degree2 in x and y and angle between these is given by $\tan\theta = \left|\frac{2\sqrt{h^2 - ab}}{a + b}\right|$.

   $ax^2 + 2hxy + by^2 = 0$, represents a pair of coincident lines, if $h^2 = ab$ and the same represents a pair of perpendicular lines, if $a + b = 0$.

   If m_1 and m_2 are the slopes of the lines $ax^2 + 2hxy + by^2 = 0$,then $m_1 + m_2 = -\frac{2h}{b}$ and $m_1 \; m_2 = \frac{a}{b}$.

2. An equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ is called second general second order equation represents a pair of lines if it satisfies the the condition $abc + 2fgh - af^2 - bg^2 - ch^2 = 0$.

   The angle between the lines $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ is given by $\tan\theta = \left|\frac{2\sqrt{h^2 - ab}}{a + b}\right|$.

   $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, represents a pair of parallel lines, if $h^2 = ab$ and $af^2 = bg^2$ and the distance between the parallel lines is $\left|\frac{2\sqrt{g^2 - ac}}{a(a + b)}\right|$.

   $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, represents a pair of perpendicular lines ,if $a + b = 0$.

TRIGNOMETRY

Area of a sector of a circle = $\frac{1}{2}r^2\theta$.

Arc length, S = $r\,\theta$.

$\sin\theta = \frac{\text{opp}}{\text{hyp}}$, $\cos\theta = \frac{\text{adj}}{\text{hyp}}$, $\tan\theta = \frac{\text{opp}}{\text{adj}}$, $\cot\theta = \frac{\text{adj}}{\text{opp}}$, $\sec\theta = \frac{\text{hyp}}{\text{adj}}$, $\text{cosec}\theta = \frac{\text{hyp}}{\text{opp}}$.

$\text{Sin}\theta = \frac{1}{\text{cosec}\,\theta}$ or $\text{cosec}\theta = \frac{1}{\sin\theta}$, $\cos\theta = \frac{1}{\sec\theta}$ or $\sec\theta = \frac{1}{\cos\theta}$,

$\tan\theta = \frac{1}{\cot\theta}$ or $\cot\theta = \frac{1}{\tan\theta}$, $\tan\theta = \frac{\sin\theta}{\cos\theta}$, $\cot\theta = \frac{\cos\theta}{\sin\theta}$.

$\sin^2\theta + \cos^2\theta = 1; \Rightarrow \sin^2\theta = 1 - \cos^2\theta;\ \cos^2\theta = 1 - \sin^2\theta;$

$\sec^2\theta - \tan^2\theta = 1; \Rightarrow \sec^2\theta = 1 + \tan^2\theta;\ \tan^2\theta = \sec^2\theta - 1;$

$\text{cosec}^2\theta - \cot^2\theta = 1; \Rightarrow \text{cosec}^2\theta = 1 + \cot^2\theta;\ \cot^2\theta = \text{cosec}^2\theta - 1.$

STANDARD ANGLES

	0^0 or 0	30^0 or $\frac{\pi}{6}$	45^0 or $\frac{\pi}{4}$	60^0 or $\frac{\pi}{3}$	90^0 or $\frac{\pi}{2}$	15^0 or $\frac{\pi}{12}$	75^0 or $\frac{5\pi}{12}$
Sin	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1	$\frac{\sqrt{3}-1}{2\sqrt{2}}$	$\frac{\sqrt{3}+1}{2\sqrt{2}}$
Cos	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0	$\frac{\sqrt{3}+1}{2\sqrt{2}}$	$\frac{\sqrt{3}-1}{2\sqrt{2}}$
Tan	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	∞	$\frac{\sqrt{3}-1}{\sqrt{3}+1}$	$\frac{\sqrt{3}+1}{\sqrt{3}-1}$
Cot	∞	$\sqrt{3}$	1	$\frac{1}{\sqrt{3}}$	0	$\frac{\sqrt{3}+1}{\sqrt{3}-1}$	$\frac{\sqrt{3}-1}{\sqrt{3}+1}$
Sec	1	$\frac{2}{\sqrt{3}}$	$\sqrt{2}$	1	∞	$\frac{2\sqrt{2}}{\sqrt{3}+1}$	$\frac{2\sqrt{2}}{\sqrt{3}-1}$
Cosec	∞	2	$\sqrt{2}$	$\frac{2}{\sqrt{3}}$	1	$\frac{2\sqrt{2}}{\sqrt{3}-1}$	$\frac{2\sqrt{2}}{\sqrt{3}+1}$

ALLIED ANGLES

Trigonometric functions of angles which are in the 2nd, 3rd and 4th quadrants can be obtained as follows :

If the transformation begins at 90^0 or 270^0, the trigonometric functions changes as

sin $\leftrightarrow$ cos
tan $\leftrightarrow$ cot
sec $\leftrightarrow$ cosec

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where as the transformation begins at 180^0 or 360^0, the same trigonometric functions will be retained, however the signs (+ or -) of the functions decides ASTC rule.

COMPOUND ANGLES

Sin(A+B)=sinAcosB+cosAsinB.

Sin(A-B)= sinAcosB-cosAsinB.

Cos(A+B)=cosAcosB-sinAsinB.

Cos(A-B)=cosAcosB+sinAsinB.

tan(A+B)= $\dfrac{\tan A+\tan B}{1-\tan A\tan B}$

tan(A-B)= $\dfrac{\tan A-\tan B}{1+\tan A\tan B}$

$\tan\left(\dfrac{\pi}{4}+A\right)=\dfrac{1+\tan A}{1-\tan A}$

$\tan\left(\dfrac{\pi}{4}-A\right)=\dfrac{1-\tan A}{1+\tan A}$

tan(A+B+C)= $\dfrac{\tan A+\tan B+\tan C-\tan A\tan B\tan C}{1-(\tan A\tan B+\tan B\tan C+\tan C\tan A)}$

sin(A+B) sin(A-B)= $\sin^2 A-\sin^2 B=\cos^2 B-\cos^2 A$

cos(A+B) cos(A-B)= $\cos^2 A-\sin^2 B$

MULTIPLE ANGLES

1.sin 2A=2 sinA cosA. 2. sin 2A= $\dfrac{2\tan A}{1+\tan^2 A}$.

3.cos 2A = $\cos^2 A-\sin^2 A$

=1-2 $\sin^2 A$.

= $2\cos^2 A-1$

= $\dfrac{1-\tan^2 A}{1+\tan^2 A}$

4. tan 2A= $\dfrac{2\tan A}{1-\tan^2 A}$, 5. 1+cos 2A= $2\cos^2 A$, 6. $\cos^2 A=\dfrac{1}{2}(1+\cos 2A)$.

7. 1-cos 2A= $2\sin^2 A$, 8. $\sin^2 A=\dfrac{1}{2}(1-\cos 2A)$, 9.1+sin 2A= $(\sin A+\cos A)^2$,

10. 1-sin 2A= $(\cos A-\sin A)^2=(\sin A-\cos A)^2$, 11.cos 3A= $4\cos^3 A-3\cos A$,

12. sin 3A= $3\sin A-4\sin^3 A$, 13.tan 3A= $\dfrac{3\tan A-\tan^3 A}{1-3\tan^2 A}$.

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HALF ANGLE FORMULAE

1) $\sin\theta = 2\sin\frac{\theta}{2}\cos\frac{\theta}{2}$. 2) $\sin\theta = \dfrac{2\tan\left(\frac{\theta}{2}\right)}{1+\tan^2\left(\frac{\theta}{2}\right)}$. 3) $\cos\theta = \cos^2\frac{\theta}{2} - \sin^2\frac{\theta}{2}$.

4) $\cos\theta = 1 - 2\sin^2\frac{\theta}{2}$. 5) $\cos\theta = 2\cos^2\frac{\theta}{2} - 1$. 6) $\cos\theta = \dfrac{1-\tan^2\left(\frac{\theta}{2}\right)}{1+\tan^2\left(\frac{\theta}{2}\right)}$.

7) $\tan\theta = \dfrac{2\tan\left(\frac{\theta}{2}\right)}{1-\tan^2\left(\frac{\theta}{2}\right)}$. 8) $1+\cos\theta = 2\cos^2\frac{\theta}{2}$. 9) $1-\cos\theta = 2\sin^2\frac{\theta}{2}$.

PRODUCT TO SUM

2 sinA cosB = sin(A+B) + sin(A-B).
2 cosA sinB = sin(A+B) – sin(A-B).
2 cosA cosB = cos(A+B) + cos(A-B).
2 sinA sinB = cos(A+B) – cos(A-B).

SUM TO PRODUCT

Sin C + sin D $= 2\sin\left(\dfrac{C+D}{2}\right)\cos\left(\dfrac{C-D}{2}\right)$.

Sin C –sin D $= 2\cos\left(\dfrac{C+D}{2}\right)\sin\left(\dfrac{C-D}{2}\right)$.

Cos C + cos D $= 2\cos\left(\dfrac{C+D}{2}\right)\cos\left(\dfrac{C-D}{2}\right)$.

Cos C- cos D $= -2\sin\left(\dfrac{C+D}{2}\right)\sin\left(\dfrac{C-D}{2}\right)$

OR

Cos C- cos D = $2\sin\left(\dfrac{D+C}{2}\right)\sin\left(\dfrac{D-C}{2}\right)$

PROPERTIES AND SOLUTIONS OF TRIANGLE

Sine Rule: $\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C} = 2R$, where R is the circum radius of the triangle.

Cosine Rule: $a^2 = b^2 + c^2 - 2bc\cos A$ or $\cos A = \dfrac{b^2+c^2-a^2}{2bc}$,

$$b^2 = a^2 + c^2 - 2ac\cos B \text{ or } \cos B = \frac{a^2+c^2-b^2}{2ac},$$

$$c^2 = a^2 + b^2 - 2ab\cos C \text{ or } \cos C = \frac{a^2+b^2-c^2}{2ab}.$$

Projection Rule: $a = b\cos C + c\cos B$

$b = c\cos A + a\cos C$

$c = a\cos B + b\cos A$

Tangents Rule:

$$\tan\left(\frac{B-C}{2}\right) = \frac{b-c}{b+c}\cot\left(\frac{A}{2}\right),$$

$$\tan\left(\frac{C-A}{2}\right) = \frac{c-a}{c+a}\cot\left(\frac{B}{2}\right),$$

$$\tan\left(\frac{A-B}{2}\right) = \frac{a-b}{a+b}\cot\left(\frac{C}{2}\right).$$

Half angle formula:

$$\sin\left(\frac{A}{2}\right) = \sqrt{\frac{(s-b)(s-c)}{bc}},\ \cos\left(\frac{A}{2}\right) = \sqrt{\frac{s(s-a)}{bc}},\ \tan\left(\frac{A}{2}\right) = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}.$$

$$\sin\left(\frac{B}{2}\right) = \sqrt{\frac{(s-a)(s-c)}{ac}},\ \cos\left(\frac{B}{2}\right) = \sqrt{\frac{s(s-b)}{ac}},\ \tan\left(\frac{B}{2}\right) = \sqrt{\frac{(s-a)(s-c)}{s(s-b)}}.$$

$$\sin\left(\frac{C}{2}\right) = \sqrt{\frac{(s-a)(s-b)}{ab}},\ \cos\left(\frac{C}{2}\right) = \sqrt{\frac{s(s-c)}{ab}},\ \tan\left(\frac{C}{2}\right) = \sqrt{\frac{(s-a)(s-b)}{s(s-c)}}.$$

Area of triangle ABC = $\sqrt{s(s-a)(s-b)(s-c)}$,

Area of triangle ABC = $\frac{1}{2}bc\sin A = \frac{1}{2}ac\sin B = \frac{1}{2}ab\sin C$.

LIMITS

1. If $f(-x) = f(x)$, then $f(x)$ is called **Even Function**
2. If $f(-x) = -f(x)$, then $f(x)$ is called **Odd Function**
3. If P is the smallest $+\text{ve}$ real number such that if $f(x+P) = f(x)$, then $f(x)$ is called a **periodic function** with period P.
4. Right Hand Limit (RHL) = $\lim_{x\to a+}\left(f(x)\right) = \lim_{h\to 0}\left(f(a+h)\right)$

Left Hand Limit (LHL) = $\lim_{x\to a-}\left(f(x)\right) = \lim_{h\to 0}\left(f(a-h)\right)$

If RHL=LHL then $\lim_{x\to a}\left(f(x)\right)$ exists and

$\lim_{x\to a}\left(f(x)\right)$ = RHL=LHL

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5. $\underset{n\to\infty}{Lt}\ \frac{1}{n^p}=0$, if $p>0$ and $\underset{n\to\infty}{Lt}\ n^p=\infty$ if $p>0$

6. $\underset{x\to 0}{Lt}\ \frac{\sin x}{x}=\underset{x\to 0}{Lt}\ \frac{\tan x}{x}(x \text{ in radians})=\underset{x\to 0}{Lt}\ \frac{x}{\sin x}=\underset{x\to 0}{Lt}\ \frac{x}{\tan x}=1$

7. $\underset{x\to 0}{Lt}\ \frac{\sin x^0}{x}=\underset{x\to 0}{Lt}\ \frac{\tan x^0}{x}=\frac{\pi}{180}$

8. $\underset{x\to \frac{\pi}{2}}{Lt}\ \frac{\sin x}{x}=\frac{2}{\pi}$

9. $\lim\limits_{x\to 0}\frac{\sin^{-1}x}{x}=1=\lim\limits_{x\to 0}\frac{\tan^{-1}x}{x}$

10. $\lim\limits_{x\to a}\frac{x^n-a^n}{x-a}=na^{n-1}$, where n is an **integer** or a **fraction**.

11. $\lim\limits_{x\to 0}\frac{a^x-1}{x}=\log a,\qquad \lim\limits_{x\to 0}\frac{e^x-1}{x}=\log e=1$

12. $\lim\limits_{x\to\infty}\left(1+\frac{1}{n}\right)^n=e,\qquad \lim\limits_{x\to 0}(1+n)^{\frac{1}{n}}=e$

13. $\lim\limits_{x\to a}\left[kf(x)\right]=k\lim\limits_{x\to a}f(x)$

14. $\lim\limits_{x\to a}\left[f(x)\pm g(x)\right]=\lim\limits_{x\to a}f(x)\pm\lim\limits_{x\to a}g(x)$

15. $\lim\limits_{x\to a}f(x).g(x)=\lim\limits_{x\to a}f(x).\lim\limits_{x\to a}g(x)$

$$\lim_{x\to a}\left(\frac{f(x)}{g(x)}\right)=\frac{\lim\limits_{x\to a}f(x)}{\lim\limits_{x\to a}g(x)}\quad \textit{provided}\ \lim_{x\to a}g(x)\neq 0$$

16. A function $f(x)$ is said to be **continuous** at the point $x=a$ if

(i) $\lim\limits_{x\to a}f(x)$ exists (ii) $f(a)$ is defined (iii) $\lim\limits_{x\to a}f(x)=f(a)$

17. A function $f(x)$ is said to be **discontinuous or not continuous** at $x=a$ if

(i) $f(x)$ is not defined at $x=a$ (ii) $\lim\limits_{x\to a}f(x)$ does not exist at $x=a$

(iii) $\lim\limits_{x\to a+0}f(x)\neq\lim\limits_{x\to a-0}f(x)\neq f(a)$

18. If two functions $f(x)$ and $g(x)$ are continuous then $f(x)+g(x)$ is continuous

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