1. For a polynomial $P(x) = ax^3 + bx^2 + cx + d$
$\alpha + \beta + \gamma = -b/a$
$\alpha * \beta * \gamma = c/a$
where α, β, γ are the roots of the polynomial.

2. For a polynomial $P(x) = ax^2 + bx + c$
$$\alpha = \frac{-b + \sqrt{b^2 - 4 * a * c}}{2 * a}$$
$$\beta = \frac{-b - \sqrt{b^2 - 4 * a * c}}{2 * a}$$
where α, β are the roots of the polynomial.

3. $1^3 + 2^3 + 3^3 + \ldots + n^3 = [\frac{n*(n+1)}{2}]^2$

4. $1^2 + 2^2 + 3^2 + \ldots + n^2 = \frac{n*(n+1)*(2n+1)}{6}$

5. For a arithmetic progression
$a, a + d, a + 2d, a + 3d \ldots$
$T(n) = a + (n - 1) * d$
$S(n) = \frac{n}{2}[2a + (n - 1)d]$

6)For a geometric progression
$a, ar, ar^2, ar^3 \ldots$
$S(n) = a(\frac{r^n - 1}{r - 1})$
$S(\infty) = \frac{a}{1-r}$ where $[-1 < r < 1]$

7)Bertland Ballot's Theorem problem -
"In an election where candidate a receives p votes and b receives q votes with p>q, what is the probability that a will be strictly ahead of b throughout the count"
Ans - $\frac{p-q}{p+q}$
And if ties are allowed then
Ans - $\frac{p-q+1}{p+1}$
8) $(\frac{A}{B})\%mod = (A\%mod * x\%mod)\%mod$
where x is the modular multiplicative inverse of B under mod

9)Fermat's little theorem
$a^{m-2} \equiv a^{-1} \%mod$
when mod is prime
10) $E_p(n!)$: Exponent of p in $n!$ where p is a prime
$E_p(n!) = \lfloor\frac{n}{p}\rfloor + \lfloor\frac{n}{p^2}\rfloor + \lfloor\frac{n}{p^3}\rfloor + \lfloor\frac{n}{p^4}\rfloor + \ldots$

11. let N be a natural number
$N = p_1^{\alpha_1} * p_2^{\alpha_2} * p_3^{\alpha_3} \ldots$

Then total number of divisors =
$(\alpha_1 + 1) * (\alpha_2 + 1) * (\alpha_3 + 1) *...$

Sum of divisors = $(\frac{p_1^{\alpha_1+1}-1}{p_1-1}) * (\frac{p_2^{\alpha_2+1}-1}{p_2-1}) * (\frac{p_3^{\alpha_3+1}-1}{p_3-1})...$
Product of divisors = $n^{\frac{(\alpha_1+1)(\alpha_2+1)\times\cdots\times(\alpha_m+1)}{2}}$
If n is perfect square then multiply it by $\sqrt{x}$ in case of product of divisor

12 $a^b \% mod = a^{b\%(mod-1)} \% mod$ when mod is prime

13 $a^b \% mod = a^{b\%\phi(mod)} \% mod$ when mod is not prime
where $\phi(mod)$ = Euler totient function of mod

14 Derangement of N elements
$$D_n = n!\,(1 - \frac{1}{1!} + - \frac{1}{2!} + (-1)^n \frac{1}{n!})$$

15 If m and n are two co-prime numbers then the biggest number which can not be represented as $(am + bn)$ for non negative integer m and n is $mn - m - n$

16 Euler Totient function($\phi(n)$) :Number of numbers which are coprime with n in range of $[1, n]$

$$\phi(n) = n(1 - \frac{1}{p_1})(1 - \frac{1}{p_2})(1 - \frac{1}{p_3})$$
where $n = p_1^{\alpha_1} * p_2^{\alpha_2} * p_3^{\alpha_3}...$

15 Centroid of a triangle $(\frac{x_1+x_2+x_3}{3}, \frac{y_1+y_2+y_3}{3})$

16 Incentre $(\frac{ax_1+bx_2+cx_3}{a+b+c}, \frac{ay_1+by_2+cy_3}{a+b+c})$

17 Area of triangle $\frac{1}{2}[x_1 * (y_2 - y_3) + x_2 * (y_3 - y_1) + x_3 * (y_1 - y_2)]$

18 Angle between two lines $\tan\,\theta = |\frac{m_1-m_2}{1+m_1*m_2}|$

19 Distance of a point from a line
$$|\frac{ax_1 + by_1 + c}{\sqrt{a^2 + b^2}}|$$

20 Image of a point on a line
$$\frac{x - x_1}{a} = \frac{y - y_1}{b} = -2 * \frac{ax_1 + by_1 + c}{a^2 + b^2}$$

21 Distance between parallel lines
$$\frac{|c_1 - c_2|}{\sqrt{a^2 + b^2}}$$

22 For a simple polygon pick's theorem states that
$A = I + \frac{B}{2} - 1$
A = Area of simple polygon
B = Number of points on its boundary
I = be the number of integer points striclty inside the polygon

23 For a line from (a, b) to (c, d)
the number of lattice points on it is $gcd(c - a, d - b) + 1$

24 A circle with radius r and a central angle α in degrees has the corresponding chord with length
$sqrt(2 \times r^2 \times (1 - cos(\alpha)))$

25 A triangle with 3 sides: a, b, c and semi-perimeter s has an area
$A = \sqrt{s \times (s - a) \times (s - b) \times (s - c)}$.

26 A triangle with 3 sides: a, b, c and area A has an circumscribed circle (circumcircle) with radius
$R = a \times b \times c/(4 \times A)$.