

√ Algebra

- ✓ **Quadratic formula:** when $ax^2 + bx + c = 0$, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
- ✓ **Vieta's formulas, quadratic:** for $ax^2 + bx + c = 0$ with roots r_1, r_2
 - $r_1 + r_2 = -\frac{b}{a}$
 - $r_1 r_2 = \frac{c}{a}$
- ✓ **Vieta's formulas, cubic:** for $P(x) = ax^3 + bx^2 + cx + d$
 - $r_1 + r_2 + r_3 = -\frac{b}{a}$
 - $r_1 r_2 + r_1 r_3 + r_2 r_3 = \frac{c}{a}$
 - $r_1 r_2 r_3 = -\frac{d}{a}$
- ✓ **Vieta's formulas, higher degree:** for $P(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0$
 - $r_1 + r_2 + \dots + r_n = -\frac{a_{n-1}}{a_n}$
 - $r_1 r_2 \dots r_n = (-1)^n \frac{a_0}{a_n}$
- ✓ **Newton sums:** for $f(x) = x^n + a_1 x^{n-1} + a_2 x^{n-2} + \dots + a_n$, with P_k the sum of the roots' k th powers
 - $P_1 + a_1 = 0$
 - $P_2 + a_1 P_1 + 2a_2 = 0$
 - $P_3 + a_1 P_2 + a_2 P_1 + 3a_3 = 0$
 - $P_4 + a_1 P_3 + a_2 P_2 + a_3 P_1 + 4a_4 = 0$
- ✓ **Work-rate formula:** work = rate $\times$ time
- ✓ **Euler's formula:** $e^{i\theta} = \cos \theta + i \sin \theta$

Number theory

- ✓ **Fermat's little theorem:** for a prime p that does not divide a , $a^{p-1} \equiv 1 \pmod{p}$
- ✓ **Euler's theorem:** for a and n coprime, $a^{\varphi(n)} \equiv 1 \pmod{n}$, where $\varphi(n)$ counts the positive integers up to n sharing no prime factor with n
- ✓ **Sum of squares:** $\sum_{k=1}^n k^2 = 1^2 + 2^2 + \dots + n^2 = \frac{n(n+1)(2n+1)}{6}$
- ✓ **Sum of cubes:** $\sum_{k=1}^n k^3 = 1^3 + 2^3 + \dots + n^3 = \left(\frac{n(n+1)}{2}\right)^2$

🎲 Counting and probability

- ✓ **Permutations:** $P(n, k) = \frac{n!}{(n-k)!}$
- ✓ **Combinations:** $\binom{n}{k} = \frac{n!}{k!(n-k)!}$
- ✓ **Binomial theorem,** in algebra and counting alike: $(a+b)^n = \sum_{k=0}^n \binom{n}{k} a^{n-k} b^k$