How to Understand Any Physics Equation

Case Study: Newton's Second Law

By SpideyPhysics

1. Name the Equation

Knowing what you're looking at helps your brain categorize information.
F = ma → *Newton's Second Law*

2. Define Every Symbol (use Units)

Write what each letter means and include its standard unit:

F = Force → [Newtons, N]
m = Mass → [kilograms, kg]
a = Acceleration → [meters/second^2, m/s^2]

Tip: Units help anchor understanding — don't skip them.

3. Expand the Equation

Understand how Newton's Second Law can be expanded to describe more complex physical situations.

a) Expand the Left Side: Net Force

When multiple forces act on an object, they combine to form a net force:

$$\sum F = ma$$

Examples of how multiple forces combine:

- Tension – Weight = ma
- Thrust – Drag – Gravity = ma

b) Specify the Types of Forces

Each term in the net force can represent a specific kind of interaction:

- Friction: $F_k = \mu N$
- Spring: $F = -kx$
- Electric: $F = qE$
- Gravity (near Earth): $F = mg$
- Universal Gravitation: $F = \frac{Gm_1m_2}{r^2}$

c) Expand the Right Side: Acceleration

Acceleration is the rate of change of velocity — and velocity is the rate of change of position:

$$F = m \cdot \frac{dv}{dt} = m \cdot \frac{d^2x}{dt^2}$$

This links Newton's law to calculus and shows how motion is governed by differential equations.

d) Recognize Time Dependence

In physics, quantities like position, velocity, and acceleration often depend on time:

- $x(t)$ = position as a function of time
- $v(t)$ = velocity as a function of time
- $a(t)$ = acceleration as a function of time

Sometimes, other variables (like force or mass) may also depend on time or position. Recognizing this helps when analyzing more complex systems.

Apply to Any Equation

Next time you see an equation like $V = IR$ or $W = Fd\cos\theta$, ask:

- What does it describe?
- What do the symbols mean?
- Are there alternate forms?
- Are the variables time-dependent?

Key Takeaway

Don't just memorize — deconstruct. Every equation is a story. Learn to read it.

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Try It Yourself!

Apply the same process to a new equation

Equation: $W = Fd\cos\theta$

1. Name the Equation

2. Define Every Symbol (with Units)

- $W =$ _____
- $F =$ _____
- $d =$ _____
- $\theta =$ _____

3. Expand the Equation

4. Extra Notes

Bonus: Apply the same method to $V = IR$ or $KE = \frac{1}{2}mv^2$ You're now thinking like a physicist!