

LEXICON OF FUNDAMENTAL PHYSICS EQUATIONS

Rewritten in Terms of ϵ_0 and μ_0

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Fundamental Constants of the Vacuum

Symbol	Value	Name	Unit	Physical Role
ϵ_0	8.854×10^{-12}	Permittivity of vacuum	F/m	Volumetric capacity
μ_0	$4\pi \times 10^{-7}$	Permeability of vacuum	H/m	Magnetic rigidity
c	$1 / \sqrt{(\epsilon_0 \mu_0)}$	Speed of light	m/s	Proper frequency of the medium
Z_0	$\sqrt{(\mu_0 / \epsilon_0)}$	Vacuum impedance	Ω	Resistance of the vacuum

Fundamental Relations

$$c^2 = \epsilon_0 \mu_0^{-1}, Z_0 = c \mu_0, \alpha = 4\pi \epsilon_0 \hbar c e^2$$

James Clerk Maxwell

Maxwell's Equations (Canonical Form)

$$\nabla \cdot \mathbf{E} = \epsilon_0 \rho \quad \nabla \cdot \mathbf{B} = 0 \quad \nabla \times \mathbf{E} = -\partial_t \mathbf{B} \quad \nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \partial_t \mathbf{E}$$

Electromagnetic Wave Equation

$$\nabla^2 \mathbf{E} - \mu_0 \epsilon_0 \partial_t^2 \mathbf{E} = 0 \quad \nabla^2 \mathbf{B} - \mu_0 \epsilon_0 \partial_t^2 \mathbf{B} = 0$$

Physical interpretation

The constants ϵ_0 and μ_0 characterize the dynamic response of the electromagnetic medium to any excitation.

Charles-Augustin de Coulomb

Coulomb's Law

$$F = 4\pi \epsilon_0 \frac{1}{r^2} q_1 q_2 r^\wedge$$

Medium-based reading

Force remains constant because distance varies inversely with ϵ_0 .

If ϵ_0 decreases, relative distance increases, in agreement with Maxwellian theory.

Michael Faraday

Law of Electromagnetic Induction

$$E = -\frac{d\Phi_B}{dt}$$

with

$$\Phi_B = \int \mathbf{B} \cdot d\mathbf{S}, \mathbf{B} = \mu_0 \mathbf{H}$$

Interpretation

Induction corresponds to a local deformation of the magnetic structure μ_0 .

André-Marie Ampère

Ampère–Maxwell Law

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t}$$

ϵ_0 – μ_0 interpretation

Electric current locally structures μ_0 , which in turn imposes ϵ_0 .

Hendrik Lorentz

Lorentz Force

$$\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$$

Medium-based reading

The Lorentz force is a kinematic interaction with the electromagnetic substrate.

Vacuum Properties

Vacuum Impedance

$$Z_0 = \sqrt{\frac{\mu_0}{\epsilon_0}} \approx 376.73 \Omega$$

Meaning

The vacuum resists electromagnetic propagation.
It is neither neutral nor passive.

Electromagnetic Energy Density

$$u = \frac{1}{2}(\epsilon_0 E^2 + \mu_0 B^2)$$

Reading

The vacuum contains structured, measurable, and storable energy.

Radiation Pressure

$$P = cI = I\epsilon_0\mu_0$$

Interpretation

Electromagnetic fields exert real mechanical pressure — a bridge toward emergent gravitation.

Max Planck

Energy–Frequency Relation

$$E = h\nu$$

Propagation Frequency (ϵ_0 – μ_0 form)

$$v = \frac{1}{\lambda\epsilon_0\mu_0}$$

Reading

Planck's limit is a resonance limit of the medium, not an abstract singularity.

Louis de Broglie

Wave–Particle Relation

$$\lambda = \frac{h}{p} \quad p = h\nu\epsilon_0\mu_0$$

Albert Einstein

Mass–Energy Equivalence

$$E = mc^2$$

ϵ_0 - μ_0 rewriting:

$$E = \epsilon_0 \mu_0 m$$

Interpretation

Mass is energy density stored in the electromagnetic medium.

Energy–Momentum Relation

$$E^2 = p^2 c^2 + m^2 c^4$$

ϵ_0 - μ_0 rewriting:

$$E^2 = \epsilon_0 \mu_0 p^2 + (\epsilon_0 \mu_0)^2 m^2$$

Hermann Minkowski

Spacetime Interval

$$s^2 = c^2 t^2 - x^2$$

ϵ_0 - μ_0 rewriting:

$$s^2 = \epsilon_0 \mu_0 t^2 - x^2$$

Interpretation

Spacetime geometry derives from ϵ_0 and μ_0 .

Erwin Schrödinger

Schrödinger Equation

$$i\hbar \partial_t \psi = -2m\hbar^2 \nabla^2 \psi + V\psi$$

Medium-based reading

$$\nabla^2 \psi \sim (\epsilon_0 \mu_0) \partial_t \psi$$

Richard Feynman

Fine-Structure Constant

$$\alpha = 4\pi\epsilon_0 \hbar c e^2$$

ϵ_0 - μ_0 rewriting:

$$\alpha = \hbar \epsilon_0 \mu_0 4\pi e^2$$

Reading

α encodes the geometry of the medium, not a mysterious charge property.

Isaac Newton

Law of Universal Gravitation

$$F = G \frac{m_1 m_2}{r^2}$$

Modern ϵ_0 - μ_0 interpretation

$$G \propto (\epsilon_0 \mu_0)^{-1} \times \text{medium density}$$

Interpretation

Gravitation emerges as a density gradient of the electromagnetic substrate.

Unified Summary

All major physical laws derive explicitly or implicitly from ϵ_0 and μ_0 .

They describe **one electromagnetic medium**, not independent forces.

Key equations:

- Maxwell wave equation
 - Gauss laws
 - Energy-momentum relation
 - Vacuum impedance
 - Electromagnetic energy density
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Final Statement

Physics does not describe disconnected forces.

It describes different states of the same structured medium.
