Equations in Physics

A brief introduction

Your name here *

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Abstract

In physics, there are equations in every field that relate physical quantities to each other and enable calculations. While entire handbooks of equations can summarize many aspects of the subject, they cannot cover everything. Some equations are highly specialized and pertain only to specific areas of study.

1 Classical Mechanics

Classical mechanics is the branch of physics used to describe the motion of macroscopic objects. The concepts it covers, such as *mass, acceleration, and force*, are commonly used and known. This article lists equations from **Newtonian Mechanics.**

1.0.1 Kinematic quantities

- Velocity $v = \frac{dx}{dt}$,
- Acceleration $a = \frac{dv}{dt}$.

1.0.2 Dynamic quantities

- Momentum $p = mv$,
- Force $F = \frac{dp}{dt}$.

1.0.3 Euler's equation for rigid body dynamics

$$I \cdot \alpha + \omega \times (I \cdot \omega) = \tau$$

2 Thermodynamics

This is a *small* summary of common equations and quantities in thermodynamics.

*Institute of Mathematics, University of Wrocław and Wikipedia

2.0.1 Thermal transfer

- Thermal conduction rate $P = \dfrac{dQ}{dt}$,
- thermal intensity $I = \dfrac{dP}{dA}$.

2.0.2 Kinetic theory

- Ideal gas law $pV = nRT$,
- the pressure of an ideal gas $p = \dfrac{1}{3}nm\langle v^2\rangle$.

2.0.3 Entropy

If K_B is the *Boltzmann constant* and Ω denotes the volume of macrostate in the phase space then

$$S = K_B \ln \Omega.$$

3 Maxwell's equations

Maxwell's equations are a set of coupled partial differential equations that form the foundation of classical electromagnetism, classical optics and electric circuits.

3.1 Differential equations

$$\begin{aligned}
\nabla \cdot E &= \frac{\rho}{\varepsilon_0} \\
\nabla \cdot B &= 0 \\
\nabla \times E &= -\frac{\partial B}{\partial t} \\
\nabla \times B &= \mu_0 \left(J + \varepsilon \frac{\partial E}{\partial t} \right)
\end{aligned}$$

3.2 Integral equations

$$\begin{aligned}
\oiint_{\partial\Omega} E \cdot dS &= \frac{1}{\varepsilon_0} \iiint_{\Omega} \rho dV \\
\oiint_{\partial\Omega} B \cdot dS &= 0 \\
\oint_{\partial\Sigma} E \cdot d\ell &= -\frac{d}{dt} \iint_{\Sigma} B \cdot dS \\
\oint_{\partial\Sigma} B \cdot d\ell &= \mu_0 \left(\iint_{\Sigma} J \cdot dS + \varepsilon \frac{d}{dt} \iint_{\Sigma} E \cdot dS \right)
\end{aligned}$$