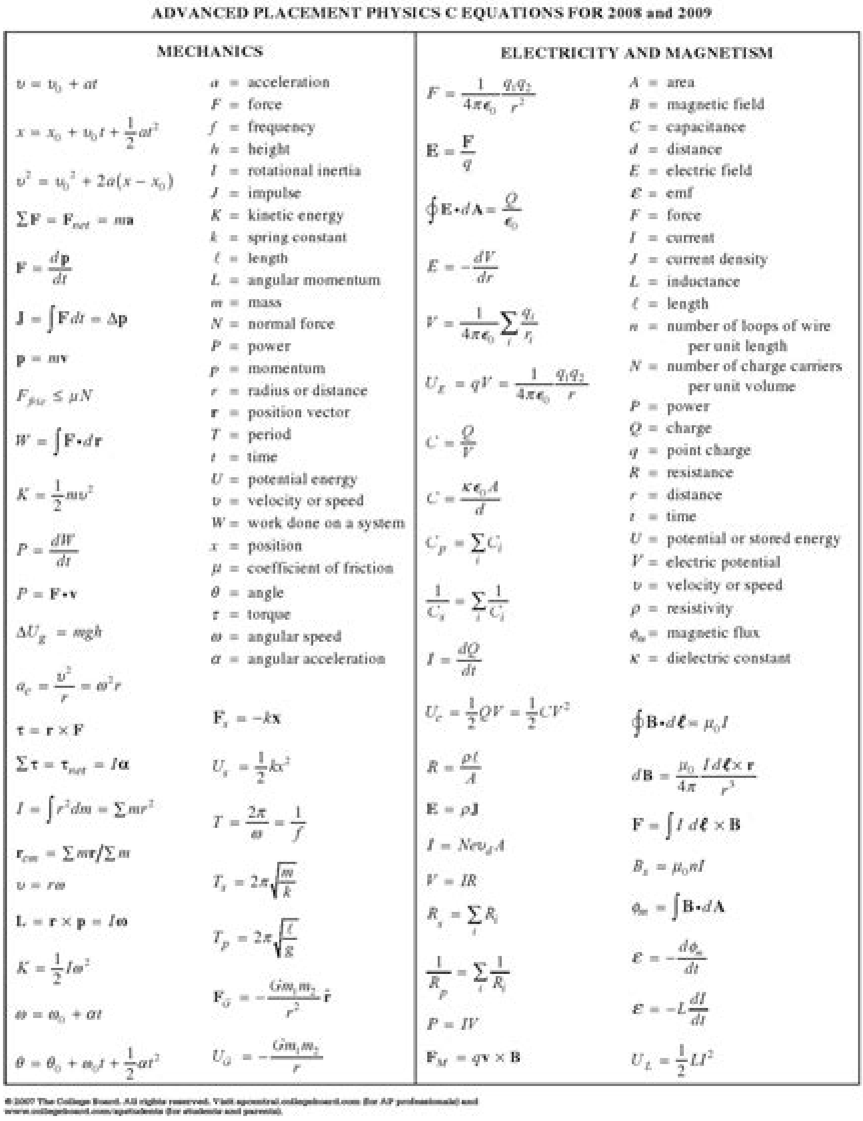
All Basic Formulas Of Physics



ADVANCED PLACEMENT PHYSICS C EQUATIONS FOR 2008 and 2009

MECHANICS

$v = v_0 + at$

$x = x_0 + v_0 t + \frac{1}{2}at^2$

$v^2 = v_0^2 + 2a(x - x_0)$

$\sum \mathbf{F} = \mathbf{F}_{net} = m\mathbf{a}$

$\mathbf{F} = \frac{d\mathbf{p}}{dt}$

$\mathbf{J} = \int \mathbf{F}\,dt = \Delta\mathbf{p}$

$\mathbf{p} = m\mathbf{v}$

$F_{fric} \le \mu N$

$W = \int \mathbf{F} \cdot d\mathbf{r}$

$K = \frac{1}{2}mv^2$

$P = \frac{dW}{dt}$

$P = \mathbf{F} \cdot \mathbf{v}$

$\Delta U_g = mgh$

$a_c = \frac{v^2}{r} = \omega^2 r$

$\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$

$\sum \boldsymbol{\tau} = \boldsymbol{\tau}_{net} = I\boldsymbol{\alpha}$

$I = \int r^2\,dm = \sum mr^2$

$\mathbf{r}_{cm} = \sum m\mathbf{r} / \sum m$

$v = r\omega$

$\mathbf{L} = \mathbf{r} \times \mathbf{p} = I\boldsymbol{\omega}$

$K = \frac{1}{2}I\omega^2$

$\omega = \omega_0 + \alpha t$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

a = acceleration
F = force
f = frequency
h = height
I = rotational inertia
J = impulse
K = kinetic energy
k = spring constant
ℓ = length
L = angular momentum
m = mass
N = normal force
P = power
p = momentum
r = radius or distance
$\mathbf{r}$ = position vector
T = period
t = time
U = potential energy
v = velocity or speed
W = work done on a system
x = position
μ = coefficient of friction
θ = angle
τ = torque
ω = angular speed
α = angular acceleration

$\mathbf{F}_s = -k\mathbf{x}$

$U_s = \frac{1}{2}kx^2$

$T = \frac{2\pi}{\omega} = \frac{1}{f}$

$T_s = 2\pi\sqrt{\frac{m}{k}}$

$T_p = 2\pi\sqrt{\frac{\ell}{g}}$

$\mathbf{F}_G = -\frac{Gm_1m_2}{r^2}\hat{\mathbf{r}}$

$U_G = -\frac{Gm_1m_2}{r}$

ELECTRICITY AND MAGNETISM

$F = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2}$

$\mathbf{E} = \frac{\mathbf{F}}{q}$

$\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$

$E = -\frac{dV}{dr}$

$V = \frac{1}{4\pi\epsilon_0}\sum_i \frac{q_i}{r_i}$

$U_E = qV = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r}$

$C = \frac{Q}{V}$

$C = \frac{\kappa\epsilon_0 A}{d}$

$C_p = \sum_i C_i$

$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$

$I = \frac{dQ}{dt}$

$U_c = \frac{1}{2}QV = \frac{1}{2}CV^2$

$R = \frac{\rho\ell}{A}$

$\mathbf{E} = \rho\mathbf{J}$

$I = Nev_dA$

$V = IR$

$R_s = \sum_i R_i$

$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$

$P = IV$

$\mathbf{F}_M = q\mathbf{v} \times \mathbf{B}$

A = area
B = magnetic field
C = capacitance
d = distance
E = electric field
$\mathcal{E}$ = emf
F = force
I = current
J = current density
L = inductance
ℓ = length
n = number of loops of wire per unit length
N = number of charge carriers per unit volume
P = power
Q = charge
q = point charge
R = resistance
r = distance
t = time
U = potential or stored energy
V = electric potential
v = velocity or speed
ρ = resistivity
ϕ_m = magnetic flux
κ = dielectric constant

$\oint \mathbf{B} \cdot d\boldsymbol{\ell} = \mu_0 I$

$d\mathbf{B} = \frac{\mu_0}{4\pi}\frac{I\,d\boldsymbol{\ell} \times \mathbf{r}}{r^3}$

$\mathbf{F} = \int I\,d\boldsymbol{\ell} \times \mathbf{B}$

$B_s = \mu_0 nI$

$\phi_m = \int \mathbf{B} \cdot d\mathbf{A}$

$\mathcal{E} = -\frac{d\phi_m}{dt}$

$\mathcal{E} = -L\frac{dI}{dt}$

$U_L = \frac{1}{2}LI^2$

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All Basic Formulas of Physics are essential tools that help us understand the fundamental principles governing the natural world. Physics is a vast field that encompasses various topics such as mechanics, thermodynamics, electromagnetism, optics, and more. Each of these areas has its own set of formulas that describe how objects move, interact, and behave under different conditions. This article aims to compile and explain the most important basic formulas in physics, categorized by relevant topics.

1. Mechanics

Mechanics is the branch of physics that deals with the motion of objects and the forces acting upon them. It can be divided into two main categories: kinematics and dynamics.

1.1 Kinematics

Kinematics involves the study of motion without considering the forces that cause it. The basic formulas include:

1. Displacement (s):
$$
s = s_0 + vt + \frac{1}{2}at^2
$$
where:
- s = final displacement
- s_0 = initial displacement
- v = initial velocity
- a = acceleration
- t = time

2. Velocity (v):
$$
v = v_0 + at
$$
where:
- v = final velocity
- v_0 = initial velocity

3. Acceleration (a):
$$
a = \frac{v - v_0}{t}
$$

4. Average Velocity (v_{avg}):
$$
v_{avg} = \frac{s}{t}
$$

1.2 Dynamics

Dynamics studies the forces and their effect on motion. The key formulas include:

1. Newton's Second Law:
$$
F = ma
$$
where:
- F = force
- m = mass
- a = acceleration

2. Weight (W):

$$
W = mg
$$
where:
- g = acceleration due to gravity (approximately $9.81 \, m/s^2$)

3. Frictional Force (f):
$$
f = \mu N
$$
where:
- μ = coefficient of friction
- N = normal force

4. Work (W):
$$
W = Fd \cos(\theta)
$$
where:
- d = displacement
- θ = angle between the force and displacement direction

5. Kinetic Energy (KE):
$$
KE = \frac{1}{2}mv^2
$$

6. Potential Energy (PE):
$$
PE = mgh
$$
where:
- h = height above the ground

2. Thermodynamics

Thermodynamics is the study of heat, energy, and work. The fundamental laws and formulas include:

2.1 Laws of Thermodynamics

1. First Law of Thermodynamics:
$$
\Delta U = Q - W
$$
where:
- ΔU = change in internal energy
- Q = heat added to the system

- \(W\) = work done by the system

2. Efficiency (\(\eta\)):
\[
\eta = \frac{W_{out}}{Q_{in}}
\]
where:
- \(W_{out}\) = work output
- \(Q_{in}\) = heat input

2.2 Ideal Gas Law

The ideal gas law relates pressure, volume, and temperature:
\[
PV = nRT
\]
where:
- \(P\) = pressure
- \(V\) = volume
- \(n\) = number of moles
- \(R\) = ideal gas constant (\(8.314 \, J/(mol \cdot K)\))
- \(T\) = temperature in Kelvin

3. Electromagnetism

Electromagnetism deals with electric charges, electric fields, magnetic fields, and their interactions. Key formulas include:

3.1 Coulomb's Law

Coulomb's law describes the force between two charged objects:
\[
F = k \frac{|q_1 q_2|}{r^2}
\]
where:
- \(F\) = force between charges
- \(k\) = Coulomb's constant (\(8.99 \times 10^9 \, N \cdot m^2/C^2\))
- \(q_1\) and \(q_2\) = charges
- \(r\) = distance between charges

3.2 Ohm's Law

Ohm's law relates voltage, current, and resistance:

$$
V = IR
$$
where:
- V = voltage
- I = current
- R = resistance

3.3 Power in Electrical Circuits

Power (P) in electrical circuits can be expressed as:
$$
P = IV
$$
Alternatively, using Ohm’s law, it can also be written as:
$$
P = I^2R \quad \text{or} \quad P = \frac{V^2}{R}
$$

4. Wave Mechanics

Wave mechanics studies the behavior of waves, including sound and light.

4.1 Wave Speed

The speed of a wave is given by:
$$
v = f\lambda
$$
where:
- v = wave speed
- f = frequency
- λ = wavelength

4.2 Sound Intensity Level

The intensity level of sound in decibels (dB) is calculated as:
$$
L = 10 \log_{10} \left(\frac{I}{I_0} \right)
$$
where:
- L = sound level in dB
- I = intensity of the sound

- I_0 = reference intensity ($10^{-12} \, W/m^2$)

5. Optics

Optics is the study of light and its properties.

5.1 Snell's Law

Snell's law describes the bending of light when entering a different medium:

$$
n_1 \sin(\theta_1) = n_2 \sin(\theta_2)
$$

where:
- n_1 and n_2 = refractive indices of the respective media
- θ_1 and θ_2 = angles of incidence and refraction

5.2 Lens Formula

The lens formula for thin lenses is:

$$
\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}
$$

where:
- f = focal length
- d_o = object distance
- d_i = image distance

6. Conclusion

In summary, the basic formulas of physics serve as a foundation for understanding the laws of nature. They are applicable across various fields, from engineering to environmental science. Mastering these formulas not only aids in problem-solving but also fosters a deeper appreciation for the complexities of the universe. As we continue to explore and learn, these equations will remain critical tools in our scientific endeavors. Whether you are a student, a professional, or simply a curious mind, understanding these essential formulas is key to unlocking the mysteries of the physical world.

Frequently Asked Questions

What is the formula for Newton's second law of motion?

The formula is $F = ma$, where F is the force, m is the mass, and a is the acceleration.

What is the equation for gravitational potential energy?

The formula is $PE = mgh$, where PE is potential energy, m is mass, g is the acceleration due to gravity, and h is height.

How do you calculate kinetic energy?

The formula for kinetic energy is $KE = 1/2\ mv^2$, where KE is kinetic energy, m is mass, and v is velocity.

What is the formula for the conservation of momentum?

The formula is p_initial = p_final, where p is momentum, calculated as $p = mv$ for each object.

What is the equation for Hooke's Law?

The formula is $F = -kx$, where F is the force exerted by the spring, k is the spring constant, and x is the displacement from the equilibrium position.

What is the formula for work done?

The formula is $W = Fd\cos(\theta)$, where W is work, F is the force applied, d is the distance moved, and θ is the angle between the force and the direction of movement.

How do you calculate the frequency of a wave?

The formula is $f = 1/T$, where f is frequency and T is the period of the wave.

What is the formula for the electric force between two charges?

The formula is $F = k(q_1q_2/r^2)$, where F is the electric force, k is Coulomb's constant, q_1 and q_2 are the charges, and r is the distance between the charges.

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