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Physics Equations & Answers (Quick Study Academic)

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ACADEMIC OUTLINE

Quick Study
ACADEMIC

PHYSICS

EQUATIONS & ANSWERS

Essential Tools for Physics Laws, Concepts, Variables and Equations including Sample Problems, Common Pitfalls and Physical Constants

BASICS

A. Units for Physical Quantities

Base Units	Symbol	Unit
Length	L	Meter (m)
Mass	M	Kilogram (kg)
Temperature	T	Kelvin (K)
Time	t	Second (s)
Theory Constant	ϵ	Ampere (A)
Derived Units	Symbol	Unit
Acceleration	a	m/s^2
Ang. Accel.	α	rad/s^2
Ang. Momentum	L	$\text{kg} \cdot \text{m}^2/\text{s}$
Ang. Velocity	ω	rad/s
Angle	θ	radian
Capacitance	C	Farad (F)
Charge	Q	Coulomb (C)
Density	ρ	kg/m^3
Displacement	x	meter (m)
Electric Field	E	V/m
Electric Flux	Φ_E	$\text{N} \cdot \text{m}^2/\text{C}$
Electromotive Force (EMF)	$\mathcal{E}$	Volt (V)
Energy	E	Joule (J)
Entropy	S	J/K
Force	F	Newton (N)
Frequency	f	Hertz (Hz)
Heat	Q	Joule (J)
Magnetic Field	B	Tesla (T)
Magnetic Flux	Φ_B	Weber (Wb)
Momentum	p	$\text{kg} \cdot \text{m/s}$
Power	P	Watt (W)
Pressure	P	Pascal (Pa)
Resistance	R	Ohm (Ω)
Temperature	T	Kelvin (K)
Volume	V	m^3
Wavelength	λ	meter (m)
Work	W	Joule (J)

B. Fundamental Physical Constants

Base Units	Symbol	Unit
Mass of electron	m_e	9.11×10^{-31} kg
Mass of proton	m_p	1.67×10^{-27} kg
Avogadro Constant	N_A	$6.02 \times 10^{23} \text{ mol}^{-1}$
Elementary charge	e	$1.602 \times 10^{-19} \text{ C}$
Faraday constant	F	$96,485 \text{ C/mol}$
Speed of light	c	$3 \times 10^8 \text{ m/s}$
Molar Gas Constant	R	$8.314 \text{ J/mol} \cdot \text{K}$
Boltzmann Constant	k	$1.38 \times 10^{-23} \text{ J/K}$
Gravitational Constant	G	$6.67 \times 10^{-11} \text{ m}^3/\text{kg} \cdot \text{s}^2$
Permittivity of Space	ϵ_0	$8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$
Permeability of Space	μ_0	$4\pi \times 10^{-7} \text{ N/A}^2$

C. Conversion Factors and Approximate Values

Unit	Description
Angle	$1 \text{ radian} = 180^\circ / \pi$
Energy	$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$
Force	$1 \text{ N} = 1 \text{ kg} \cdot \text{m/s}^2$
Volume	$1 \text{ L} = 10^{-3} \text{ m}^3$
Pressure	$1 \text{ Pa} = 1 \text{ N/m}^2$
Length	$1 \text{ \AA} = 10^{-10} \text{ m}$

MATHEMATICAL CONCEPTS

A. Vector Algebra

1. **Vector** - Directional characteristic (along x, y, z) components $\hat{i}, \hat{j}, \hat{k}$
2. **Scalar** - Directionless (along x, y, z) components $\hat{i}, \hat{j}, \hat{k}$
3. **Vector** $\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$
4. **Length of $\vec{A}$** $|\vec{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$
5. **Addition of vectors $\vec{A}$ and $\vec{B}$** add components $\vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j} + (A_z + B_z)\hat{k}$
6. **Sample Addition and Length Calculations:**
 $\vec{A} = 3\hat{i} + 4\hat{j}$
 $|\vec{A}| = \sqrt{3^2 + 4^2} = 5$
 $\vec{B} = 2\hat{i} + 3\hat{j}$
 $|\vec{B}| = \sqrt{2^2 + 3^2} = \sqrt{13}$
 $\vec{A} + \vec{B} = 5\hat{i} + 7\hat{j}$
 $|\vec{A} + \vec{B}| = \sqrt{5^2 + 7^2} = \sqrt{74}$

Note: $|\vec{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$

3. Multiply $\vec{A}$ and $\vec{B}$

- a. **Dot or scalar product:** $\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta$
- b. **Cross product:** $\vec{A} \times \vec{B} = |\vec{A}| |\vec{B}| \sin \theta \hat{n}$

Note: θ is the angle between $\vec{A}$ and $\vec{B}$

a. $\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta$

b. $\vec{A} \times \vec{B} = |\vec{A}| |\vec{B}| \sin \theta \hat{n}$

c. $\vec{A} \cdot \vec{A} = |\vec{A}|^2$

d. $\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta$

e. $\vec{A} \times \vec{B} = |\vec{A}| |\vec{B}| \sin \theta \hat{n}$

f. $\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta$

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Synopsis

Essential tool for physics laws, concepts, variables and equations, including sample problems, common pitfalls and helpful hints.

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