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Physics Equations & Answers (Quick Study Academic)

Quick Study Academic **PHYSICS EQUATIONS & ANSWERS**

Essential Tool for Physics Learners, Concepts, Variables and Equations Including: Sample Problems, Common Pitfalls, and Helpful Hints

BASICS

A. Units for Physical Quantities

Base Units	Symbol	Unit
Length	L	Meter - m
Mass	m, M	Kilogram - kg
Temperature	T	Kelvin - K
Time	t	Second - s
Theory Constant	T	Angstrom - Å (10 ⁻¹⁰ m)

Derived Units

Symbol	Unit	
Acceleration	a	m/s ²
Ang. Area	A	radian ²
Ang. Momentum	L	kg m ² /s
Ang. Velocity	ω	radian/s
Angle	θ, φ	radian
Capacitance	C	Farad F (C ² /V)
Charge	Q, q, e	Coulomb C (A·s)
Density	ρ	kg/m ³
Displacement	s, Δs	meter - m
Electric Field	E	V/m
Electric Flux	Φ _E	V·m
Electromotive Force (EMF)	ℰ	Volt - V
Energy	E, U, K, Δ	Joule (kg m ² /s ²)
Force	F	Newton - N (kg m/s ²)
Frequency	f, ν	Hertz - Hz (cycles/s)
Heat	Q	Joule - J
Magnetic Field	B	Tesla (N/A·m)
Magnetic Flux	Φ _B	Weber (kg m ² /s ² ·A)
Momentum	p	kg m/s
Power	P	Wattage W (J/s)
Pressure	P, p	Pascal - Pa (N/m ²)
Resistance	R	Ohm Ω (V/A)
Speed	v	m/s
Velocity	u	m/s
Volume	V	m ³
Wavelength	λ	meter - m
Work	W	Joule - J (N·m)

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	6.022 × 10 ²³ mol ⁻¹
Elementary charge	e	1.602 × 10 ⁻¹⁹ C
Faraday constant	F	96,485 C/mol
Speed of light	c	3 × 10 ⁸ m/s
Molar Gas Constant	R	8.314 J mol ⁻¹ K ⁻¹
Boltzmann Constant	k	1.38 × 10 ⁻²³ J K ⁻¹
Gravitation Constant	G	6.67 × 10 ⁻¹¹ m ² kg ⁻¹ s ⁻²
Permeability of Space	μ ₀	4π × 10 ⁻⁷ N/A ²
Permittivity of Space	ε ₀	8.85 × 10 ⁻¹² F/m

C. Conversion Factors and alternate units

Unit	Description
Angle	1 radian = 57.3°
Energy	1 eV = 1.602 × 10 ⁻¹⁹ J
Force	1 dyne = 10 ⁻⁵ N
Volume	1 L = 1 dm ³
Pressure	1 bar = 10 ⁵ Pa
Length	1 Å = 10 ⁻¹⁰ m

MATHEMATICAL CONCEPTS

1. Vector Algebra

1. Vector: Three-dimensional (x, y, z) components

2. Unit vectors: i, j, k along x, y, z

3. Vector: $\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$

4. Length of $\vec{A} = \sqrt{A_x^2 + A_y^2 + A_z^2}$

5. Addition of vectors: $\vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j} + (A_z + B_z)\hat{k}$

6. Sample Addition and Length Calculations

$\vec{A} = 3\hat{i} + 4\hat{j}$, $\vec{B} = 2\hat{i} + 3\hat{j} + 5\hat{k}$

$\vec{A} + \vec{B} = 5\hat{i} + 7\hat{j} + 5\hat{k}$

$|\vec{A} + \vec{B}| = \sqrt{5^2 + 7^2 + 5^2} = \sqrt{75} = 8.66$

7. Note: $|\vec{A} + \vec{B}| \neq |\vec{A}| + |\vec{B}|$

8. This is scalar product: $\vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}|\cos\theta$

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

10. Sample: $\vec{A} = 3\hat{i} + 4\hat{j}$, $\vec{B} = 2\hat{i} + 3\hat{j} + 5\hat{k}$

$\vec{A} \cdot \vec{B} = 3(2) + 4(3) + 0(5) = 6 + 12 = 18$

$|\vec{A}| = \sqrt{3^2 + 4^2} = 5$, $|\vec{B}| = \sqrt{2^2 + 3^2 + 5^2} = 5.9$

$18 = 5(5.9)\cos\theta \Rightarrow \cos\theta = \frac{18}{29.5} = 0.61$

$\theta = \cos^{-1}(0.61) = 52.3^\circ$

11. Scalar Product

$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$

$\vec{A} = 3\hat{i} + 4\hat{j}$, $\vec{B} = 2\hat{i} + 3\hat{j} + 5\hat{k}$

$\vec{A} \cdot \vec{B} = 3(2) + 4(3) + 0(5) = 18$

12. Sample: Vector Product

$\vec{A} = 3\hat{i} + 4\hat{j}$, $\vec{B} = 2\hat{i} + 3\hat{j}$

$\vec{A} \times \vec{B} = (3\hat{i} + 4\hat{j}) \times (2\hat{i} + 3\hat{j})$

$= 3(3)\hat{k} - 4(2)\hat{k} = 9\hat{k} - 8\hat{k} = \hat{k}$

$|\vec{A} \times \vec{B}| = 1$

$\theta = \sin^{-1}\left(\frac{1}{5 \times 5.9}\right) = \sin^{-1}\left(\frac{1}{29.5}\right) = 1.9^\circ$

13. Right-hand rule gives the orientation of vector $\vec{A} \times \vec{B}$

14. Trigonometry

1. Basic relations for a triangle: $\sin A = \frac{a}{c}$, $\cos A = \frac{b}{c}$, $\tan A = \frac{a}{b}$

2. Sum of angles: $A + B + C = 180^\circ$

3. Sine rule: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

4. Cosine rule: $a^2 = b^2 + c^2 - 2bc \cos A$

5. Area of triangle: $\frac{1}{2}bc \sin A$

6. Values of sin, cos, tan

7. Unit circle

8. Area and arc length



Synopsis

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

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