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Physics Equations & Answers (Quick Study Academic)

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PHYSICS EQUATIONS & ANSWERS

Essential Tool for Physics Learns, 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 | Kilogram - kg |
| Temperature | T | Kelvin - K |
| Time | t | Second - s |
| Theory Constant | c | Angstrom - Å (10 ⁻¹⁰ m) |

Derived Units

| Symbol | Unit |
|---------------------------|---|
| Acceleration | a m/s ² |
| Ang. Accel. | α radian/s ² |
| Ang. Momentum | L kg m ² /s |
| Ang. Velocity | ω radian/s |
| Angle | θ rad |
| Capacitance | C Farad F (C ² /V) |
| Charge | Q, q Coulomb C (A·s) |
| Electricity | E Volt V |
| Electricity | ϕ Joule J |
| Electric Field | E Volt/m |
| Electric Flux | Φ_E V·m |
| Electromotive Force (EMF) | \mathcal{E} Volt - V |
| Energy | E, U, K, W Joule (kg m ² /s ²) |
| Energy | Q Cal |
| Force | F Newton - N (kg m/s ²) |
| Frequency | f, ν Hertz - Hz (cycles/s) |
| Heat | Q Joule - J |
| Magnetic Field | B Tesla (Wb/m ²) |
| Magnetic Flux | Φ_B Weber (kg m ² /s ² A) |
| Momentum | p kg m/s |
| Power | P Watts - W (J/s) |
| Pressure | P Pascal - Pa (N/m ²) |
| Resistance | R Ohm (Ω) (V/A) |
| Temperature | T K |
| Velocity | v 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_B | 1.38×10^{-23} J K ⁻¹ |
| Gravitation Constant | G | 6.67×10^{-11} m ³ kg ⁻¹ s ⁻² |
| Permeability of Space | μ_0 | $4\pi \times 10^{-7}$ N/A ² |
| Permittivity of Space | ϵ_0 | 8.85×10^{-12} F/m |

C. Conversion Factors and Alternative Units

| Unit | Equation |
|----------|------------------------------------|
| 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: Directed distance (characterized by (x, y, z) components)

a. Unit vectors: \hat{i} along x, \hat{j} along y, \hat{k} along z

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

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

2. Addition of vectors A & B , add components

$A = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$, $B = B_x \hat{i} + B_y \hat{j} + B_z \hat{k}$

Sample Addition and Length Calculations:

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

$A + B = (3+2)\hat{i} + (4+1)\hat{j} = 5\hat{i} + 5\hat{j}$

$|A+B| = \sqrt{5^2 + 5^2} = 7.07$

$A - B = (3-2)\hat{i} + (4-1)\hat{j} = \hat{i} + 3\hat{j}$

$|A-B| = \sqrt{1^2 + 3^2} = 3.16$

$A \cdot B = (3)(2) + (4)(1) = 10$

$|A \cdot B| = \sqrt{10^2} = 10$

$\cos \theta = \frac{A \cdot B}{|A||B|} = \frac{10}{5 \cdot 5} = 0.4$

$\theta = \cos^{-1}(0.4) = 66.4^\circ$

3. Multiply A & B

a. Dot or scalar product: $A \cdot B = |A||B|\cos \theta$

$A = 3\hat{i} + 4\hat{j}$, $B = 2\hat{i} + 1\hat{j}$

$A \cdot B = (3)(2) + (4)(1) = 10$

$|A| = \sqrt{3^2 + 4^2} = 5$, $|B| = \sqrt{2^2 + 1^2} = 2.24$

$\cos \theta = \frac{10}{5 \cdot 2.24} = 0.89$

$\theta = \cos^{-1}(0.89) = 27^\circ$

b. Cross or vector product: $A \times B = |A||B|\sin \theta \hat{n}$

$A = 3\hat{i} + 4\hat{j}$, $B = 2\hat{i} + 1\hat{j}$

$A \times B = (3)(1) - (4)(2) = -5\hat{k}$

$|A \times B| = \sqrt{(-5)^2} = 5$

$\sin \theta = \frac{5}{5 \cdot 2.24} = 0.447$

$\theta = \sin^{-1}(0.447) = 26.6^\circ$

4. Trigonometry

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

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

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

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

5. Area of circle: πr^2

6. Circumference of circle: $2\pi r$

7. Area of sector: $\frac{1}{2}r^2 \theta$

8. Length of arc: $r\theta$

9. Area of segment: $\frac{1}{2}r^2(\theta - \sin \theta)$

10. Area of annulus: $\pi(R^2 - r^2)$

11. Area of sphere: $4\pi r^2$

12. Volume of sphere: $\frac{4}{3}\pi r^3$

13. Volume of cylinder: $\pi r^2 h$

14. Volume of cone: $\frac{1}{3}\pi r^2 h$

15. Volume of frustum: $\frac{1}{3}\pi h(R^2 + Rr + r^2)$

16. Volume of rectangular prism: $V = lwh$

17. Volume of rectangular box: $V = lwh$

18. Volume of rectangular prism: $V = lwh$

19. Volume of rectangular prism: $V = lwh$

20. Volume of rectangular prism: $V = lwh$



Synopsis

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

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