

PHYSICS FORMULAS

2425

Types of Errors:

Personal errors due to bias or mistakes.

Systematic errors due to miscalibration of instruments, personal bias, or reaction time.

Random errors are unknown or unpredictable, such as voltage or temperature fluctuations, vibration, etc.

Accuracy - how close measurement comes to accepted value

Precision - how consistent or repeatable measurements are

Calculation of Errors:

Multiplication: operation: $A = L \times W$
error: $\Delta A = \pm (L \times \Delta W + W \times \Delta L)$

Division: operation: $D = \frac{M}{V}$
error: $\Delta D = \pm \left(\frac{\Delta M}{V} + \frac{M \times \Delta V}{V^2} \right)$

$$g = 9.8 \text{ m/s}^2 = 32 \text{ ft/s}^2$$

$$g_{\text{moon}} = 1.62 \text{ m/s}^2$$

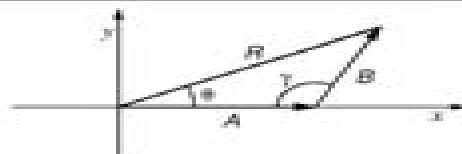
Quadratic Equation:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Law of Cosines:

$$R = \sqrt{A^2 + B^2 - 2AB \cos \gamma}$$

$$\sin \theta = \frac{R}{B \sin \gamma}$$



Newton's Laws:

First Law: Law of Inertia. An object at rest will remain at rest unless acted on by an external force. An object in motion will remain in motion unless . . .

Second Law: $\Sigma F = ma$, $\Sigma \tau = I\alpha$ The sum of external forces on a object is equal to its mass (or inertia for rotational forces) times the acceleration.

Third Law: Every action has an equal and opposite reaction.

Law of Gravity: $F =$ force of attraction exerted on each body
 $F = G \frac{m_1 m_2}{r^2}$ $G =$ gravitational constant 6.67×10^{-11}
 [N · m²/kg] or [m³/kg · s²]
 $r =$ distance between centers [m]

Formulas for Velocity: [units: v , m/s; a , m/s²; x , m; t , s]

$$v = v_0 + at \quad (\text{for constant } a)$$

$$\bar{v} = \frac{v_0 + v}{2} \quad (\text{for constant } a) \text{ average velocity}$$

$$x = v_0 t + \frac{1}{2} at^2 \quad (\text{for constant } a)$$

$$v^2 = v_0^2 + 2ax \quad (\text{for constant } a)$$

Rocket Science: The relationship between velocity and the burning of fuel.

$$v_f - v_i = u \ln \frac{M_i}{M_f} \quad u = \text{speed of the exhaust relative to the rocket [m/s]}$$

Addition of Multiple Vectors:

$$\vec{R} = \vec{A} + \vec{B} + \vec{C} \quad \text{Resultant = Sum of the vectors}$$

$$R_x = A_x + B_x + C_x \quad \text{x-component} \quad A_x = A \cos \theta$$

$$R_y = A_y + B_y + C_y \quad \text{y-component} \quad A_y = A \sin \theta$$

$$R = \sqrt{R_x^2 + R_y^2} \quad \text{Magnitude (length) of } R$$

$$\theta_x = \tan^{-1} \frac{R_y}{R_x} \quad \text{or} \quad \tan \theta_x = \frac{R_y}{R_x} \quad \text{Angle of the resultant}$$

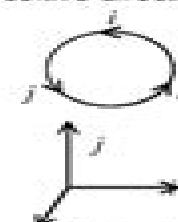
Unit Vectors:

Cross Product or Vector Product:

$$i \times j = k \quad j \times i = -k$$

$$i \times i = 0$$

Positive direction:



Dot Product or Scalar Product:

$$i \cdot j = 0 \quad i \cdot i = 1$$

Velocity is the derivative of position with respect to time:

$$\mathbf{v} = \frac{d}{dt} (x\mathbf{i} + y\mathbf{j} + z\mathbf{k}) = \frac{dx}{dt} \mathbf{i} + \frac{dy}{dt} \mathbf{j} + \frac{dz}{dt} \mathbf{k}$$

Acceleration is the derivative of velocity with respect to time:

$$\mathbf{a} = \frac{d}{dt} (v_x \mathbf{i} + v_y \mathbf{j} + v_z \mathbf{k}) = \frac{dv_x}{dt} \mathbf{i} + \frac{dv_y}{dt} \mathbf{j} + \frac{dv_z}{dt} \mathbf{k}$$

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Table of Contents Modern Physics Cheat Sheet

1. Understanding the eBook Modern Physics Cheat Sheet
 - The Rise of Digital Reading Modern Physics Cheat Sheet
 - Advantages of eBooks Over Traditional Books
2. Identifying Modern Physics Cheat Sheet
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Modern Physics Cheat Sheet
 - User-Friendly Interface
4. Exploring eBook Recommendations from Modern Physics Cheat Sheet
 - Personalized Recommendations
 - Modern Physics Cheat Sheet User Reviews and Ratings
 - Modern Physics Cheat Sheet and Bestseller Lists

5. Accessing Modern Physics Cheat Sheet Free and Paid eBooks
 - Modern Physics Cheat Sheet Public Domain eBooks
 - Modern Physics Cheat Sheet eBook Subscription Services
 - Modern Physics Cheat Sheet Budget-Friendly Options
6. Navigating Modern Physics Cheat Sheet eBook Formats
 - ePub, PDF, MOBI, and More
 - Modern Physics Cheat Sheet Compatibility with Devices
 - Modern Physics Cheat Sheet Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Modern Physics Cheat Sheet
 - Highlighting and Note-Taking Modern Physics Cheat Sheet
 - Interactive Elements Modern Physics Cheat Sheet
8. Staying Engaged with Modern Physics Cheat Sheet
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Modern Physics Cheat Sheet
9. Balancing eBooks and Physical Books Modern Physics Cheat Sheet
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Modern Physics Cheat Sheet
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Modern Physics Cheat Sheet
 - Setting Reading Goals Modern Physics Cheat Sheet
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Modern Physics Cheat Sheet
 - Fact-Checking eBook Content of Modern Physics Cheat Sheet
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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