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Physics (Quick Study Academic)

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PHYSICS

WHAT IS PHYSICS ALL ABOUT?

Physics seeks to understand the natural phenomena that occur in our universe; a description of a natural phenomenon uses many specific terms, definitions and mathematical equations.

Solving Problems in Physics
In physics, we use the SI units (International System) for data and calculations.

| Base Quantity | Symbol | Unit |
|------------------|-------------|------------------|
| Length | Δ, s | Meter - m |
| Mass | m, M | Kilogram - kg |
| Temperature | T | Kelvin - K |
| Time | t | Second - s |
| Electric Current | I | Ampere - A (C/s) |

Other physical quantities are derived from these basic units. Prefixes denote fractions or multiples of units; many variable symbols are Greek letters.

Math Skills: Many physical concepts are only understood with the use of algebra, statistics, trigonometry and calculus.

CLASSICAL MECHANICS

A. Kinematics of Newtonian Mechanics

The position of a body is given by an equation of motion with position, velocity and acceleration as variables; mass is the measure of the amount of matter; the standard unit for mass is kg, 1 kg = 1000 g; inertia is a property of matter, and as such, it resists change.

1. Motion along a straight line is called **rectilinear**; the equation of motion describes the position of the particle and velocity for elapsed time, t .

a. **Velocity (v)**: The rate of change of the displacement (x) with time (t): $v = \frac{dx}{dt}$.

b. **Acceleration (a)**: The rate of change of the velocity with time: $a = \frac{dv}{dt}$.

a & b are vectors, with magnitude and direction.

c. Speed is the absolute value of the velocity; scalar with the same units as velocity.

2. Equations of Motion for One Dimension (1-D):
Equations of motion describe the future position (x) and velocity (v) of a body in terms of the initial velocity (v_0), position (x_0) and acceleration (a):

a. For constant acceleration, the position is related to the time and acceleration by the following equation of motion: $x(t) = x_0 + v_0 t + \frac{1}{2} a t^2$.

b. For constant acceleration, the velocity vs. time is given by the following: $v(t) = v_0 + a t$.

c. If the acceleration is a function of time, the equation must be solved using $a = a(t)$.

1. Newton's 1st Law

A body remains at rest or in motion unless influenced by a force.

2. Newton's 2nd Law

Force and acceleration determine the motion of a body and predict future position and velocity: $F = m a$. OR $\Sigma F = m a$.

3. Newton's 3rd Law

Every action is countered by an opposing action.

E. Types of Forces

1. A body force acts on the entire body, with the force acting at the center of mass.

a. A gravitational force, F_g , pulls an object toward the center of the Earth: $F_g = m g$.

b. Weight = F_g ; gravitational force.

c. Mass is a measure of the quantity of material, independent of g and other forces.

2. Surface forces act on the body's surface.

a. Friction, F_f , is proportional to the force normal to the part of the body in contact with a surface: $F_f = F_n \mu$.

b. Static friction resists the movement of a body.

c. Dynamic friction slows the motion of a body.

For an object on a horizontal plane:
 $F_f \leq \mu F_n$; μ is μ_s or μ_k
Net force = $F - F_f$.

F. Circular Motion

1. Motion along a circular path uses polar coordinates (r, θ).

2. Key Variables:

| Symbol | Unit | Description |
|----------|----------------------------|--|
| r | Meter | The distance from the rotation center (center of mass) |
| θ | Radian | The angle between r and the (x) axis |
| ω | Radian/second | The angular velocity |
| α | Radian/second ² | The angular acceleration |
| s | Meter | The circular motion arc: $s = R \theta$ (θ in rad) |

3. Tangential acceleration & velocity: $v_t = r \omega$, $a_t = r \alpha$; v and a along the path of the motion are.

4. Centripetal acceleration: $a_c = \frac{v^2}{r}$; a_c is directed toward the rotational center.

a. The centripetal force keeps the body in circular motion with a tangential acceleration and velocity.

G. Kinetic Energy & Work

1. Kinetic energy, K , kinetic energy is the energy of motion; mass, m , and velocity, v : $K = \frac{1}{2} m v^2$.
The SI energy unit is the Joule (J): $1 J = 1 kg \cdot m^2/s^2$.

2. Momentum, p , momentum is a property of motion, defined as the product of mass and velocity: $p = m v$.

3. Work (W): Work is a force acting on a body moving a distance; for a general force, F , and a body moving a path, s : $W = \int F ds$.

For a constant force, work is the scalar product of the two vectors: force, F , and path, s :
 $W = F s \cos(\theta) = F s \cos \theta$.

4. Power (P): Power is energy expended per unit time: $P = \frac{dW}{dt}$, $1 W = 1 J/s$.

Work = $\int P dt$.

The SI unit for power is the Watt (W):
 $1 W = 1 Joule/second = 1 J/s$.

Work for a constant output of power:
 $W = P t$.

H. Potential Energy & Energy Conservation

1. The total energy of a body, E , is the sum of kinetic, K , and potential energy, U : $E = K + U$.

2. Potential energy arises from the interaction with a potential from an external force.

Potential energy is energy of position (U); the form of U depends on the force producing the potential.

Gravitational: $U(g) = m g h$
Electrostatic: $U(e) = \frac{q_1 q_2}{4 \pi \epsilon_0 r}$.

If there are no other forces acting on the system, E is constant and the system is called conservative.

I. Collisions & Linear Momentum

1. Types of Collisions:
a. Elastic: conserve energy
b. Inelastic: energy is lost as heat or deformation.

2. Relative Motion & Frames of Reference:
Relative motion & frames of reference with velocity v in frame S ; in frame S' the velocity is v' ; if u is the velocity of frame S' relative to S , then:
 $v = v' + u$.

3. Elastic Collision:
Conserve Kinetic Energy: $\Sigma \frac{1}{2} m v_i^2 = \Sigma \frac{1}{2} m v_f^2$
Conserve Momentum: $\Sigma m v_i = \Sigma m v_f$.

4. Impulse is a force acting over time:
Impulse = $\int F dt$ or $F \Delta t$.
Impulse is also the momentum change: $P_f - P_i$.



Synopsis

Reference and outline to concepts in physics.

Book Information

Series: Quickstudy: Academic

Pamphlet: 6 pages

Publisher: QuickStudy; Lam Crds edition (January 1, 2007)

Language: English

ISBN-10: 1423203100

ISBN-13: 978-1423203100

Product Dimensions: 8.5 x 11 x 0.1 inches

Shipping Weight: 1.6 ounces (View shipping rates and policies)

Average Customer Review: 4.3 out of 5 stars [See all reviews](#) (31 customer reviews)

Best Sellers Rank: #27,762 in Books (See Top 100 in Books) #7 in [Books > Science & Math > Physics > Dynamics > Thermodynamics](#) #18 in [Books > Science & Math > Reference](#) #69 in [Books > Textbooks > Science & Mathematics > Physics](#)

Customer Reviews

This chart has errors in some of the equations. Equations listed for magnetic force (such as $F = qv \times B$) that should have a cross product have a dot product instead. I was disappointed to find this because it means this product is not properly refined and therefore useless to me as a student. I really like it otherwise, as it covers all the stuff seen in standard sophomore level physics classes.

BarCharts are a great little reference. I would not recommend them as a study aid, but as a quick reference, they are great! I have used them for Chem, Physics, Electronics and Math. They are great for what they are.

Mine may be a different edition because there is a cross product in the magnetic force formula, but I am missing a dot in the definition of magnetic flux and the magnetic field of a long conducting wire (for the Biot-Savart Law sample) is incorrect. It shows division by 4π when it should be 2π . I would recommend students using these guides double check the formulas with their textbooks the first time they use them.

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I love these. My kids use them for AP classes. It is really helpful. This is for class next year but the ones i have gotten in the past have been very beneficial.

Good tool. A bit of an overkill for me. Not by any fault to the study guide, it was simply far more than I needed for a calculus based first year physics class.

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