Physics

Science Curriculum Framework

Revised 2005

Course Title: Physics
Course/Unit Credit: 1
Teacher Licensure: Physical/Earth Science
Grades: 9-12

Physics

Physics should ground students in the five traditional areas of Physics (Newtonian mechanics, thermodynamics, optics, electricity and magnetism, and quantum mechanics) as well as the nature of science. It should provide the knowledge base needed for many college programs. Students should be expected to use higher-level mathematics and collect and analyze data. Instruction and assessment should include both appropriate technology and the safe use of laboratory equipment. Students should be engaged in hands-on laboratory experiences at least 20% of the instructional time.

Strand	Standard
Motion and Forces	
	1. Students shall understand one-dimensional motion.
	2. Students shall understand two-dimensional motion.
	3. Students shall understand the *dynamics* of rotational equilibrium.
	4. Students shall understand the relationship between work and *energy*.
	5. Students shall understand the law of conservation of momentum.
	6. Students shall understand the concepts of *fluid* mechanics.
Heat and Thermodynamics	
	7. Students shall understand the effects of thermal *energy* on particles and systems.
	8. Students shall apply the two laws of thermodynamics.
Waves and Optics	
	9. Students shall distinguish between *simple harmonic motion* and waves.
	10. Students shall compare and contrast the law of reflection and the law of refraction.
Electricity and Magnetism	
	11. Students shall understand the relationship between *electric forces* and *electric fields*.
	12. Students shall understand the relationship between electric *energy* and *capacitance*.
	13. Students shall understand how magnetism relates to induced and alternating *currents*.
Nuclear Physics	
	14. Students shall understand the concepts of quantum mechanics as they apply to the atomic spectrum.
	15. Students shall understand the process of nuclear decay.
Nature of Science	
	16. Students shall demonstrate an understanding that science is a way of knowing.
	17. Students shall safely design and conduct a scientific inquiry to solve valid problems.
	18. Students shall demonstrate an understanding of historical trends in physics.
	19. Students shall use mathematics, science equipment, and technology as tools to communicate and solve physics problems.
	20. Students shall describe the connections between pure and applied science.
	21. Students shall describe various physics careers and the training required for the selected career.

Strand: Motion and Forces

Standard 1: Students shall understand one-dimensional motion.

MF.1.P.1	Compare and contrast *scalar* and *vector* quantities
MF.1.P.2	Solve problems involving constant and average velocity: $v = \frac{d}{t}$ $v_{ave} = \frac{\Delta d}{\Delta t}$
MF.1.P.3	Apply *kinematic* equations to calculate distance, time, or velocity under conditions of constant *acceleration:* $a = \frac{v}{t}$ $a_{ave} = \frac{\Delta v}{\Delta t}$ $\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$ $v_f = v_i + a\Delta t$ $\Delta x = v_i \Delta t + \frac{1}{2}a(\Delta t)^2$ $v_f^2 = v_i^2 + 2a\Delta x$
MF.1.P.4	Compare graphic representations of motion: d-t v-t a-t
MF.1.P.5	Calculate the *components* of a free falling object at various points in motion: $v_f^2 = v_i^2 + 2a\Delta y$ Where $a = gravity$ (g)

Key: MF.1.P.1 = Motion and Forces. Standard 1. Physics. 1st Student Learning Expectation

Strand: Motion and Forces

Standard 1: Students shall understand one-dimensional motion.

MF.1.P.6	Compare and contrast contact force (e.g., friction) and *field* forces (e.g., *gravitational* force)
MF.1.P.7	Draw free body diagrams of all forces acting upon an object
MF.1.P.8	Calculate the applied forces represented in a free body diagram
MF.1.P.9	Apply Newton's first law of motion to show balanced and unbalanced forces
MF.1.P.10	Apply Newton's second law of motion to solve motion problems that involve constant forces: $F = ma$
MF.1.P.11	Apply Newton's third law of motion to explain action-reaction pairs
MF.1.P.12	Calculate frictional forces (i.e., *kinetic* and static): $\mu_k = \frac{F_k}{F_n}$ $\mu_s = \frac{F_s}{F_n}$
MF.1.P.13	Calculate the *magnitude* of the force of friction: $F_f = \mu F_n$

Key: MF.1.P.9 = Motion and Forces. Standard 1. Physics. 9th Student Learning Expectation

Strand: Motion and Forces

Standard 2: Students shall understand two-dimensional motion.

MF.2.P.1	Calculate the *resultant vector* of a moving object
MF.2.P.2	Resolve two-dimensional *vectors* into their *components:* $d_x = d\cos\theta$ $d_y = d\sin\theta$
MF.2.P.3	Calculate the *magnitude* and direction of a *vector* from its *components:* $d^2 = x^2 + y^2$ $\tan^{-1}\theta = \frac{x}{y}$
MF.2.P.4	Solve two-dimensional problems using balanced forces: $W = \mathrm{T}\sin\theta$ Where $W = weight; \mathrm{T} = tension$
MF.2.P.5	Solve two-dimensional problems using the Pythagorean Theorem or the quadratic formula: $a^2 + b^2 = c^2$ $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
MF.2.P.6	Describe the path of a projectile as a *parabola*
MF.2.P.7	Apply *kinematic* equations to solve problems involving projectile motion of an object launched at an angle: $v_x = v_i \cos\theta =$ constant $\Delta x = v_i(\cos\theta)\Delta t$ $v_{y,f} = v_i(\sin\theta) - g\Delta t$ $v_{y,f}^2 = v_i^2(\sin\theta)^2 - 2g\Delta y$ $\Delta y = v_i(\sin\theta)\Delta t - \frac{1}{2}g(\Delta t)^2$

Key: MF.2.P.1 = Motion and Forces. Standard 2. Physics. 1st Student Learning Expectation

Strand: Motion and Forces

Standard 2: Students shall understand two-dimensional motion.

<table>
<tr><td>MF.2.P.8</td><td>Apply kinematic equations to solve problems involving projectile motion of an object launched with initial horizontal velocity
<table>
<tr><td>$v_{y,f} = -g\Delta t$</td><td>$v_x = v_{x.i} = constant$</td><td></td></tr>
<tr><td>$\therefore v_{y,f}^2 = -2g\Delta y$</td><td>$\therefore \Delta x = v_x \Delta t$</td><td></td></tr>
<tr><td>$\therefore \Delta y = -\frac{1}{2} g(\Delta t)^2$</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>MF.2.P.9</td><td>Calculate rotational motion with a constant force directed toward the center:
$$F_c = \frac{mv^2}{r}$$</td></tr>
<tr><td>MF.2.P.10</td><td>Solve problems in circular motion by using centripetal acceleration:
$$a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$$</td></tr>
</table>

Key: MF.2.P.8 = Motion and Forces. Standard 2. Physics. 8th Student Learning Expectation

Strand: Motion and Forces

Standard 3: Students shall understand the dynamics of rotational equilibrium.

MF.3.P.1	Relate radians to degrees: $\Delta\theta = \frac{\Delta s}{r}$ Where Δs = *arc length; r = radius*
MF.3.P.2	Calculate the *magnitude* of *torque* on an object: $\tau = Fd(\sin\theta)$ Where $\tau = torque$
MF.3.P.3	Calculate angular speed and *angular acceleration:* $\omega_{ave} = \frac{\Delta\theta}{\Delta t}$ $\alpha = \frac{\Delta\omega}{\Delta t}$
MF.3.P.4	Solve problems using *kinematic* equations for angular motion: $\omega_f = \omega_i + \alpha\Delta t$ $\Delta\theta = \omega_i\Delta t + \frac{1}{2}\alpha(\Delta t)^2$ $\omega_f^2 = \omega_i^2 + 2\alpha(\Delta\theta)$ $\Delta\theta = \frac{1}{2}(\omega_i + \omega_f)\Delta t$
MF.3.P.5	Solve problems involving *tangential speed:* $v_t = r\omega$
MF.3.P.6	Solve problems involving *tangential acceleration:* $a_t = r\alpha$
MF.3.P.7	Calculate *centripetal acceleration:* $a_c = \frac{v_t^2}{r}$ $a_c = r\omega^2$
MF.3.P.8	Apply Newton's universal law of gravitation to find the gravitational force between two masses: $F_g = G\frac{m_1 m_2}{r^2}$, Where $G = 6.673\times10^{-11}\frac{N\cdot m^2}{kg^2}$

Key: MF.3.P.1 = Motion and Forces. Standard 3. Physics. 1st Student Learning Expectation

Strand: Motion and Forces

Standard 4: Students shall understand the relationship between work and energy.

MF.4.P.1	Calculate net work done by a constant net force: $W_{net} = F_{net} d \cos\theta$ Where $W_{net} = work$
MF.4.P.2	Solve problems relating kinetic energy and potential energy to the *work-energy theorem:* $W_{net} = \Delta KE$
MF.4.P.3	Solve problems through the application of conservation of mechanical energy: $ME_i = ME_f$ $\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$
MF.4.P.4	Relate the concepts of time and *energy* to power
MF.4.P.5	Prove the relationship of time, *energy* and power through problem solving: $P = \frac{W}{\Delta t}$ $P = Fv$ Where P = power; W = work; F = force; V = velocity; T = time

Key: MF.4.P.1 = Motion and Forces. Standard 4. Physics. 1st Student Learning Expectation

Strand: Motion and Forces

Standard 5: Students shall understand the law of conservation of momentum.

MF.5.P.1	Describe changes in momentum in terms of force and time
MF.5.P.2	Solve problems using the impulse-momentum theorem: $F \Delta t = \Delta p$ or $F\Delta t = mv_f - mv_i$ Where Δp = change in momentum; $F \Delta t$ = *impulse*
MF.5.P.3	Compare total momentum of two objects before and after they interact: $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$
MF.5.P.4	Solve problems for perfectly inelastic and elastic *collisions*: $m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v'_f$ $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ Where v_f is the final velocity

Key: MF.5.P.1 = Motion and Forces. Standard 5. Physics. 1st Student Learning Expectation

Strand: Motion and Forces

Standard 6: Students shall understand the concepts of *fluid* mechanics.

MF.6.P.1	Calibrate the applied buoyant force to determine if the object will sink or float: $F_B = F_{g(displacedfluid)} = m_f g$
MF.6.P.2	Apply Pascal's principle to an enclosed *fluid* system: $P = \frac{F_1}{A_1} = \frac{F_2}{A_2}$ Where $P = pressure$
MF.6.P.3	Apply Bernoulli's equation to solve *fluid*-flow problems: $p + \frac{1}{2}\rho v^2 + \rho gh = constant$ Where ρ = density
MF.6.P.4	Use the ideal gas law to predict the properties of an ideal gas under different conditions

PHYSICS	CHEMISTRY	
$PV = Nk_B T$	$PV = nRT$	
N = number of gas particles	n = number of moles (1mole =6.022x10^{23} particles)	
k_b = Boltzmann's constant (1.38x10^{-23} J/k)	R = Molar gas constant (8.31 J/mole K)	
T = temperature	T = temperature	

Key: MF.6.P.1 = Motion and Forces. Standard 6. Physics. 1st Student Learning Expectation

Strand: Heat and Thermodynamics

Standard 7: Students shall understand the effects of thermal energy on particles and systems.

HT.7.P.1	Perform *specific heat capacity* calculations: $C_p = \frac{Q}{m\Delta T}$
HT.7.P.2	Perform calculations involving *latent heat:* $Q = mL$
HT.7.P.3	Interpret the various sections of a heating curve diagram
HT.7.P.4	Calculate heat energy of the different phase changes of a substance: $Q = mC_p \Delta T$ $Q = mL_f$ $Q = mL_v$ Where L_f = Latent heat of fusion; L_v = Latent heat of vaporization

Key: HT.7.P.1 = Heat and Thermodynamics. Standard 7. Physics. 1st Student Learning Expectation

Strand: Heat and Thermodynamics

Standard 8: Students shall apply the two laws of thermodynamics.

HT.8.P.1	Describe how the first law of thermodynamics is a statement of *energy* conversion
HT.8.P.2	Calculate heat, work, and the change in internal *energy* by applying the first law of thermodynamics: $\Delta U = Q - W$ Where ΔU = *change in system's internal energy*
HT.8.P.3	Calculate the efficiency of a heat engine by using the second law of thermodynamics: $Eff = \frac{W_{net}}{Q_h} = \frac{Q_h - Q_c}{Q_h} = 1 - Q_c$ Where Q_h = *energy added as heat* ; Q_c = *energy removed as heat*
HT.8.P.4	Distinguish between *entropy* changes within systems and the *entropy* change for the universe as a whole

Key: HT.8.P.1 = Heat and Thermodynamics. Standard 8. Physics. 1st Student Learning Expectation

Strand: Waves and Optics

Standard 9: Students shall distinguish between *simple harmonic motion* and waves.

WO.9.P.1	Explain how force, velocity, and *acceleration* change as an object vibrates with *simple harmonic motion*
WO.9.P.2	Calculate the spring force using Hooke's law: $F_{elastic} = -kx$ Where $-k$ = *spring constant*
WO.9.P.3	Calculate the *period* and frequency of an object vibrating with a *simple harmonic motion:* $T = 2\pi\sqrt{\frac{L}{g}}$ $f = \frac{1}{T}$ Where $T = period$
WO.9.P.4	Differentiate between *pulse* and *periodic waves*
WO.9.P.5	Relate *energy* and *amplitude*

Key: WO.9.P.1 = Waves and Optics. Standard 9. Physics. 1st Student Learning Expectation

Strand: Waves and Optics

Standard 10: Students shall compare and contrast the law of reflection and the law of refraction.

WO.10.P.1	Calculate the frequency and wavelength of electromagnetic radiation
WO.10.P.2	Apply the law of reflection for flat mirrors: $\theta_{in} = \theta_{out}$
WO.10.P.3	Describe the *image*s formed by flat mirrors
WO.10.P.4	Calculate distances and *focal lengths* for curved mirrors: $\frac{1}{p} + \frac{1}{q} = \frac{2}{R}$ Where p = object distance; q = image distance; R = radius of curvature
WO.10.P.5	Draw ray diagrams to find the *image* distance and *magnification* for curved mirrors
WO.10.P.6	Solve problems using Snell's law: $n_i(\sin\theta_i) = n_r(\sin\theta_r)$
WO.10.P.7	Calculate the *index of refraction* through various media using the following equation: $n = \frac{c}{v}$ Where n = index of refraction; c = speed of light in vacuum; v = speed of light in medium
WO.10.P.8	Use a ray diagram to find the position of an *image* produced by a lens
WO.10.P.9	Solve problems using the thin-lens equation: $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$ Where q = image distance; p = object distance; f = focal length
WO.10.P.10	Calculate the *magnification* of lenses: $M = \frac{h'}{h} = -\frac{q}{p}$ Where M = magnification; h' = image height; h = object height; q = image distance; p = object distance

Key: WO.10.P.1 = Waves and Optics. Standard 10. Physics. 1st Student Learning Expectation

Strand: Electricity and Magnetism

Standard 11: Students shall understand the relationship between *electric forces* and *electric fields*.

EM.11.P.1	Calculate *electric force* using Coulomb's law: $F = k_c(\frac{q_1 \times q_2}{r^2})$ Where k_c = Coulomb's constant $8.99 \times 10^9 N \bullet \frac{m^2}{c^2}$
EM.11.P.2	Calculate *electric field* strength: $E = \frac{F_{electric}}{q_0}$
EM.11.P.3	Draw and interpret *electric field* lines

Key: EM.11.P.1 = Electricity and Magnetism. Standard 11. Physics. 1st Student Learning Expectation

Strand: Electricity and Magnetism

Standard 12: Students shall understand the relationship between electric *energy* and *capacitance.*

EM.12.P.1	Calculate electrical potential *energy*: $PE_{electric} = -qEd$
EM.12.P.2	Compute the electric potential for various charge distributions: $\Delta V = \frac{\Delta PE_{electric}}{q}$
EM.12.P.3	Calculate the *capacitance* of various devices: $C = \frac{Q}{\Delta V}$
EM.12.P.4	Construct a *circuit* to produce a pre-determined value of an Ohm's law variable

Key: EM.12.P.1 = Electricity and Magnetism. Standard 12. Physics. 1st Student Learning Expectation

Strand: Electricity and Magnetism

Standard 13: Students shall understand how magnetism relates to induced and alternating *currents*.

EM.13.P.1	Determine the strength of a *magnetic field*
EM.13.P.2	Use the *first right-hand rule* to find the direction of the force on the charge moving through a *magnetic field*
EM.13.P.3	Determine the *magnitude* and direction of the force on a *current*-carrying wire in a *magnetic field*
EM.13.P.4	Describe how the change in the number of *magnetic field* lines through a *circuit* loop affects the *magnitude* and direction of the induced *current*
EM.13.P.5	Calculate the induced electromagnetic field (*emf*) and *current* using Faraday's law of *induction:* $emf = -N \frac{\Delta[AB(\cos\theta)]}{\Delta t}$ Where N = number of loops in the *circuit*

Key: EM.13.P.1 = Electricity and Magnetism. Standard 13. Physics. 1st Student Learning Expectation

Strand: Nuclear Physics

Standard 14: Students shall understand the concepts of *quantum* mechanics as they apply to the atomic spectrum.

NP.14.P.1	Calculate *energy* quanta using Planck's equation: $E = hf$
NP.14.P.2	Calculate the de Broglie wavelength of matter: $\lambda = \frac{h}{p} = \frac{h}{mv}$
NP.14.P.3	Distinguish between classical ideas of measurement and Heisenberg's *uncertainty principle*
NP.14.P.4	Research emerging theories in physics, such as string theory

Key: NP.14.P.1 = Nuclear Physics. Standard 14. Physics. 1st Student Learning Expectation

Strand: Nuclear Physics

Standard 15: Students shall understand the process of nuclear decay.

NP.15.P.1	Calculate the binding *energy* of various nuclei
NP.15.P.2	Predict the products of nuclear decay
NP.15.P.3	Calculate the decay constant and the *half-life* of a radioactive substance

Key: NP.15.P.1 = Nuclear Physics. Standard 15. Physics. 1st Student Learning Expectation

Strand: Nature of Science

Standard 16: Students shall demonstrate an understanding that science is a way of knowing.

NS.16.P.1	Describe why science is limited to natural explanations of how the world works
NS.16.P.2	Compare and contrast the criteria for the formation of hypotheses, theories and laws
NS.16.P.3	Summarize the guidelines of science: • results are based on observations, evidence, and testing • hypotheses must be testable • understandings and/or conclusions may change as new data are generated • empirical knowledge must have peer review and verification before acceptance

Key: NS.16.P.1 = Nature of Science. Standard 16. Physics. 1st Student Learning Expectation

Strand: Nature of Science

Standard 17: Students shall safely design and conduct a scientific inquiry to solve valid problems.

NS.17.P.1	Develop the appropriate procedures using controls and variables (dependent and independent) in scientific experimentation
NS.17.P.2	Research and apply appropriate safety precautions (ADE Guidelines) when designing and/or conducting scientific investigations
NS.17.P.3	Identify sources of bias that could affect experimental outcome
NS.17.P.4	Gather and analyze data using appropriate summary statistics (e.g., percent yield, percent error)
NS.17.P.5	Formulate valid conclusions without bias

Key: NS.17.P.1 = Nature of Science. Standard 17. Physics. 1st Student Learning Expectation

Strand: Nature of Science

Standard 18: Students shall demonstrate an understanding of historical trends in physics.

NS.18.P.1	Recognize that theories are scientific explanations that require empirical data, verification and peer review
NS.18.P.2	Research historical and current events in physics

Key: NS.18.P.1 = Nature of Science. Standard 18. Physics. 1st Student Learning Expectation

Strand: Nature of Science

Standard 19: Students shall use mathematics, science equipment, and technology as tools to communicate and solve physics problems.

NS.19.P.1	Use appropriate equipment and technology as tools for solving problems (e.g., balances, scales, calculators, probes, glassware, burners, computer software and hardware)
NS.19.P.2	Manipulate scientific data using appropriate mathematical calculations, charts, tables, and graphs
NS.19.P.3	Utilize technology to communicate research findings

Key: NS.19.P.1 = Nature of Science. Standard 19. Physics. 1st Student Learning Expectation

Strand: Nature of Science

Standard 20: Students shall describe the connections between *pure* and *applied science.*

NS.20.P.1	Compare and contrast the connections between *pure science* and *applied science* as it relates to physics
NS.20.P.2	Give examples of scientific bias that affect outcomes of experimental results
NS.20.P.3	Discuss why scientists should work within ethical parameters
NS.20.P.4	Evaluate long-range plans concerning resource use and by-product disposal for environmental, economic, and political impact.
NS.20.P.5	Explain how the cyclical relationship between science and technology results in reciprocal advancements in science and technology

Key: NS.20.P.1 = Nature of Science. Standard 20. Physics. 1st Student Learning Expectation

Strand: Nature of Science

Standard 21: Students shall describe various physics careers and the training required for the selected career.

NS.21.P.1	Research and evaluate careers in physics using the following criteria: • educational requirements • salary • availability of jobs • working conditions

Key: NS.21.P.1 = Nature of Science. Standard 21. Physics. 1st Student Learning Expectation

Acceleration	The rate of change of velocity; the slope of the tangent line on a v-t graph
Amplitude	The amount of vibration, often measured from the center to one side; may have different units, depending on the nature of the vibration
Capacitance	Ability of a conductor to store energy
Centripetal acceleration	Acceleration directed toward the center of a circular path
Circuit	An electrical device in which charge can come back to its starting point and be recycled rather than getting stuck in a dead end
Collision	An interaction between moving objects that lasts for a certain time
Component	The part of a velocity, acceleration, or force that is along one particular coordinate axis
Current	The rate at which charge crosses a certain boundary
Dynamics	A branch of physics concerned with the study of motion
Electric field	The force per unit charge exerted on a test charge at a given point in space
Electrical force	One of the fundamental forces of nature; a non-contact force can be either repulsive or attractive
emf	The energy per unit charge supplied by a source of electric current
Energy	A numerical scale used to measure the heat, motion, or other properties that would require fuel or physical effort to put into an object; a scalar quantity with units of Joules
Entropy	A measure of the disorder of a system
Field	A property of a point in space describing the forces that would be exerted on a particle if it was there
First right-hand rule	Determines the direction of the magnetic field around a current-carrying wire; when holding wire in right hand, point thumb in the direction of the conventional current and the fingers circle the wire and point in the direction of the magnetic field
Fluid	A gas or liquid
Focal length	A property of a lens or mirror, equal to the distance from the lens or mirror to the image it forms of an object that is infinitely far away
Half-life	The time required for half the original nuclei of a radioactive material to undergo radioactive decay and become non-radioactive
Image	A place where an object appears to be, because the rays diffusely reflected from any given point on the object have been bent so that they come back together and then spread out again from the image point, or spread apart as if they had originated from the image
Index of refraction	An optical property of matter; the speed of light in a vacuum divided by the speed of light in the substance in question
Induction	The production of an electric field by a changing magnetic field, or vice-versa

Kinematics	The part of dynamics that describes motion without regard to its causes
Kinetic friction	A friction force between surfaces that are slipping past each other
Latent heat	The energy per unit mass that is transferred during a phase change of a substance
Magnetic field	A field of force, defined in terms of the torque exerted on a test dipole
Magnification	The factor by which an image's linear size is increased (or decreased)
Magnitude	The numerical value associated with a vector; the vector stripped of any direction
Parabola	The mathematical curve whose graph has y proportional to x^2
Period	The time require for one cycle of a periodic motion
Resultant	A vector representing the sum of two or more vectors
Rotational motion	The motion of a body that spins about an axis
Scalar	A physical quantity that has a magnitude, but no direction
Simple harmonic motion	Vibration about an equilibrium position in which restoring force is proportional to the displacement from equilibrium
Specific heat capacity	Amount of energy needed to raise the temperature of 1kg of any substance by 1˚ Celsius
Tangential acceleration	The instantaneous linear acceleration of an object directed along the tangent to the object's circular path
Tangential speed	The instantaneous linear speed of an object directed along the tangent to the object's circular path
Torque	The force applied in rotational motion
Uncertainty Principle	States that it is impossible to measure simultaneously both the position and the movement of an object with complete certainty
Vector	Physical quantity that has a magnitude and a direction
Work-kinetic energy theorem	The net work done on an object is equal to the change in the kinetic energy of the object

Appendix

Physics Suggested Labs

Motion and Forces	
	speed and acceleration (e.g., mousetrap cars)
	coefficient of friction
	vectors
	projectile motion (e.g., rockets, shoot for your grade)
	tension (e.g., bridges, paper towers)
	rotational motion
	power
	momentum (e.g., egg drop)
	fluid mechanics
	buoyant force
Heat and Thermodynamics	
	calorimeter
	thermodynamics
Waves and Optics	
	simple harmonic motion
	optics
Electricity and Magnetism	
	electrical circuit
	electromagnetic

Physics Greek Letter Index

α	angular acceleration
β	potential difference
Δ	change of (e.g., $y_f - y_i$ or $T_2 - T_1$)
γ	gamma photons
τ	torque
θ	angle
ω	angular velocity
μ	coefficient of friction
λ	decay constant or wavelength
ρ	density
π	ratio $\frac{circumference}{diameter}$ of a circle. approximately 3.14
Ω	ohm
I	inertia
Σ	sum of quantity