

**RENTON SCHOOL DISTRICT NO. 403
DEPARTMENT OF INSTRUCTIONAL SERVICES**



**Physics 3, 4
Curriculum Guide
Grades 11-12**

Adopted by the Board of Directors June 8, 2005

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A PHILOSOPHY OF EDUCATION FOR THE RENTON PUBLIC SCHOOLS

A basic function and duty of a free society is the education of its children, youth and adults.

It is the responsibility of the schools to provide each student with the opportunities necessary to develop the scholarship, skills and attitudes which will enable the student to achieve mental, physical, emotional and social maturity.

Further, each student should, as a result of the school experience, be able to make decisions and to accept responsibility for those decisions.

GENERAL INSTRUCTIONAL GOALS

Policy 6010

The Renton School District fosters an educational process which helps all students achieve their highest potential.

The Renton School District:

LEARNING

- Offers a curriculum which prepares our students for the future.
- Emphasizes that diversity contributes positively to the individual and to the community.
- Provides learning experiences matched to the needs, interests, and abilities of our diverse student population.
- Extends learning opportunities beyond the school.

INSTRUCTION

- Offers a variety of high quality instructional resources and services to students, staff, and community.
- Supports multiple instructional strategies.
- Provides resources and opportunities for continuing professional development of our staff.
- Conducts ongoing evaluations of our instructional programs.
- Maintains safe and inviting facilities that are conducive to learning.

COMMUNITY

- Creates partnerships which involve students, parents, staff, and other community members and organizations.
- Promotes effective communication.
- Values and encourages development of a spirit of community service.
- Respects the rights and responsibilities of all.

As a result of the educational process in Renton, students will understand and apply:

Language skills including reading, writing and communication, with opportunities to learn world languages.

Mathematics skills including concepts, procedures, problem solving, reasoning, and mathematical language.

Science skills including concepts, principles, and the scientific process.

Social studies skills, concepts, and processes -- emphasizing history, geography, economics, international perspectives, multiculturalism, and participatory democracy.

Arts and humanities skills, concepts, and processes to create, perform, solve problems and respond effectively.

Health and physical education skills, concepts, and processes to promote lifelong physical, mental, and social well being.

In order to strengthen the above curricular areas, Renton students will understand and apply:

Thinking skills including the ability to gather and analyze information, think logically, critically and creatively, integrate experience and knowledge in making reasoned judgments, and solve problems.

Career and life skills necessary for successful and responsible participation in family, work, and community.

Technological skills to support learning, problem solving, and communication.

Skills necessary to be a lifelong learner and contributor to the general welfare and the quality of life for all.

EVALUATION: The Renton School District regularly reviews, evaluates, and modifies these General Instructional Goals to meet the changing needs of students, staff, and community.

SCIENCE PROGRAM GOALS

The Renton Science Program will:

1. Provide students with the opportunities to master, maintain and apply the basic facts, concepts, skills and processes associated with science.
2. Develop positive attitudes in students toward themselves through their relationships with science.
3. Foster curiosity, initiative, creativity, and objectivity.
4. Encourage student understanding and respect for the environment.
5. Develop rational thinking processes which underlie the scientific approach to problem solving, i.e.
 - a. Define the problem
 - b. Make observations and collect data
 - c. Analyze and classify data
 - d. Build hypotheses.
 - e. Design and carry out experiments.
 - f. Evaluate results and build theories.
 - g. Build models systems to explain theories.
6. Develop fundamental skills in:
 - a. Manipulating laboratory materials and equipment.
 - b. Gathering, organizing and communicating scientific information.
7. Develop knowledge of and a respect for the past contributions, the future possibilities and the existing limitations of science in solving problems that are faced in society.
8. Provide for the reinforcement of study and academic skills taught in other areas of the curriculum such as mathematics and language arts.
9. Provide an opportunity for the student to acquire an understanding of the relationship of science to everyday living and various occupations.
10. Increase student awareness of historical developments in science.
11. Provide curriculum opportunities for both college and vocationally oriented students.
12. Establish and maintain a safe learning environment and develop safety awareness in students.

Any study of science involves reviewing data that has accumulated over time and from which testable hypotheses are derived. From this process scientific theories emerge. It is recognized that there are other points of view and these will be treated with respect. The study of these views, however, shall be done in forums outside the school.

COURSE OVERVIEW

PHYSICS 3, 4

Draft Curriculum Guide April 2005

Physics 3 and 4 is a one year advanced physics laboratory course offered to students who have completed Physics 1 and 2. This course was developed for three reasons:

1. It was found that it was impossible, in the introductory physics course, to adequately cover all the essential material.
2. Many students, having completed Physics 1 and 2 as juniors, and having developed an interest in Physics, wanted an opportunity to further pursue their study.
3. This course is designed to prepare students for the Advanced Placement Physics B Exam.

HISTORY OF COURSE DEVELOPMENT PHYSICS 3, 4

In 1987, a committee of Physics teachers was formed which reviewed the new Physics 1, 2 curriculum. Its goal was to identify which units in Physics 1 and 2 could not be completed in the one year program. This material combined with those chapters that were considered optional would then become the content of the Physics 3 and 4 course. This guide contains these topics and their objectives.

In 1993 and 1998, the three physics teachers in the district reviewed several textbooks and the curriculum guide. It was the consensus of the committee that the guide adequately met the needs of the students taking this course. The new text recommended covers the curriculum well and at a level more appropriate to the type of students that take the course.

In 2005, a new committee of physics teachers was formed to review several textbooks and the curriculum guide. Again it was the consensus of the committee that the guide adequately met the needs of the students taking this course. After reviewing several algebra-based physics textbooks, Physics (Second Edition) by James Walker was unanimously chosen. It was felt that this textbook would offer the greatest opportunity for variability in instructional techniques and the greatest potential for student interest and success.

The current course would also incorporate interactive computer simulations that would enrich many of the important concepts in the student text. Some labs would involve using microcomputer based interfaces and computer probes.

SCOPE AND SEQUENCE

PHYSICS 3, 4

Physics 3-4 is designed to provide students with a strong background in physics by stressing the major concepts they will consistently apply throughout the course. In developing a unit plan the following breakdown may be helpful:

1. Mechanics, vibrations, waves and sound Chapters 1-12
2. Kinetic theory and thermodynamics Chapters 13-15
3. Electricity and magnetism Chapters 16-22
4. Light and optics Chapters 23-25
5. Modern physics Chapters 26-33

The textbook contains more topics than can be covered in most one-year courses. Since this is a second year physics course, the instructors have the flexibility in focusing on topics that were not covered extensively in Physics 1 and 2.

COURSE CONTENT AND OBJECTIVES

PHYSICS 3, 4

- 1) MECHANICS (Chapters 2-13)
 - i) Kinematics
 - (a) Motion in one dimension
 1. Understand the general relationship among position, velocity, and acceleration for the motion of a particle along a straight line.
 - a. Understand the special case of motion with constant acceleration.
 - (b) Motion in two dimensions
 1. Know how to deal with displacement and velocity vectors.
 2. Understand the motion of projectiles in a uniform gravitational field. Understand the uniform circular motion of a particle.
 - ii) Newton's Laws of motion
 - (a) Static equilibrium (First Law)
 1. Analyze a situation in which a particle remains at rest, or moves with constant velocity, under the influence of several forces.
 - (b) Dynamics of a single body (Second Law)
 1. Understand the relation between the force that acts on a body and resulting change in the body's velocity .
 2. Understand how Newton's second Law, $F=ma$, applies to a body subject to forces such as gravity, the pull of strings, or contact forces.
 3. Analyze situations in which a body moves with specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or of one of the forces that makes up the net force .
 4. Understand the effect of fluid friction on the motion of a body.
 - (c) Systems of two or more bodies (Third Law)
 1. Understand Newton's third law so that, for a given force, they can identify the body on which the reaction force acts and state the magnitude and direction of this reaction.
 2. Apply Newton's Third Law in analyzing the force of contact between two bodies that accelerate together along a horizontal or vertical line, or between two surfaces that slide across one another.
 - a. Know that the tension is constant in a light string that passes over a massless pulley and be able to use this fact in analyzing the motion of a system of two bodies joined by a string.
 - iii) Work, energy, and power
 - (a) Work and the Work-Energy Theorem
 1. Understand the definition of work and understand the Work-Energy Theorem.

- (b) Conservative forces and potential energy
 1. Understand the concept of a conservative force and understand the concept of potential energy.
 - (c) Conservation of Energy
 1. Understand the concepts of mechanical energy and of total energy.
 2. Recognize and solve problems that call for application both of conservation of Energy and Newton's Laws.
 - (d) Power
 1. Calculate the power required to maintain the motion of a body with constant acceleration.
- iv) Systems of Particles, Linear Momentum
- (a) Center of mass
 1. Understand the technique for finding center of mass.
 - (b) Impulse and momentum
 1. Relate mass, velocity, and linear momentum for a moving body, and calculate the total linear momentum of a system of bodies. Relate impulse to the change in momentum and the average force acting on a body.
 - (c) Conservation of linear momentum, collisions
 1. Identify situations in which linear momentum, or a component of the linear momentum vector, is conserved.
 2. Apply linear momentum conservation to determine the final velocity when two bodies that are moving along the same line, or at right angles, collide and stick together, and calculate how much kinetic energy is lost in a situation.
- v) Rotation
- (a) Torque and rotational statics
 1. Calculate the magnitude and direction of the torque associated with a given force Calculate the torque on a rigid body due to gravity.
 - (b) State the conditions for translational and rotational equilibrium of a rigid body. Apply these conditions in analyzing the equilibrium of a rigid body under the combined influence of a number of coplanar forces applied at different locations.
- vi) Oscillations
- (a) Understand the kinematics of a simple harmonic so students can:
 1. Sketch or identify a graph of displacement as a function of time, and determine from such graph the amplitude, period, and frequency of the motion.
 2. Identify points in the motion where the velocity is zero or achieves its maximum positive or negative value.
 3. State qualitatively the relation between acceleration and displacement in simple harmonic motion.
 4. Identify points in the motion where the acceleration zero or achieves its greatest positive or negative value.
 5. State and apply the function between frequency and period for simple harmonic.
 6. State how the total energy of an oscillating system depends on the amplitude of the motion, sketch or identify a graph

of kinetic or potential energy as a function of time, and identify points in the motion where this energy is all potential or all kinetic.

- (b) Apply the knowledge of simple harmonic motion to the case of mass on a spring and to the case of a pendulum, so students can:
 1. Apply the expression for the period of oscillation of a mass on a spring and for the period of a simple pendulum.
 2. State what approximation must be made in deriving the period.

vii) Gravitation

- (a) Know Newton's Law of Universal Gravitation so they can:
- (b) Determine the force that one spherically symmetrical mass exerts on another.
- (c) Determine the strength of the gravitational field at a specified point outside a spherically symmetrical mass.
- (d) Understand the motion of a body in orbit under the influence of gravitational forces so students can:
- (e) For a circular orbit recognize that the motion does not depend on the body's mass, describe qualitatively how the velocity, period of revolution, and centripetal acceleration depend upon the radius of the orbit, and derive expressions for the velocity and period of revolution in such an orbit.
- (f) For a general orbit apply conservation of angular momentum to determine the velocity and radial distance at any point in the orbit. Apply angular momentum conservation and energy conservation to relate the speeds of a body at the two extremes of an elliptic orbit.

2) HEAT, KINETIC THEORY, AND THERMODYNAMICS (Chapters 16-18)

i) Temperature and heat

- (a) Understand the "mechanical equivalent of heat" so that students can calculate how much a substance will be heated by the performance of a specified quantity of mechanical work.
- (b) Understand heat transfer and thermal expansion so students can:
 1. Determine the final temperature achieved when substances, all at different temperatures, are mixed and allowed to come to thermal equilibrium.
 2. Understand how the rate of heat conduction through a slab of material depends on the thickness and area of the slab and on the temperature difference between the two faces of the slab, so they can calculate how the heat flow changes if one or more of these factors is changed.
 3. Analyze qualitatively what happens to the size and shape of a body when it is heated.

ii) Kinetic theory and Thermodynamics

(a) Ideal gases

1. Understand the kinetic theory model of an ideal gas so students can state the assumption of the model. Explain qualitatively how the model explains the pressure of a gas in terms of collisions with the container walls, and explain how the model predicts that, for fixed volume, pressure must be proportional to temperature.

- a. Relate the pressure and volume of a gas during an isothermal expansion or compression.
 2. Calculate the work performed on or by a gas during an expansion or compression at constant pressure.
 3. Understand the process of adiabatic expansion or compression of a gas.
 4. Identify or Sketch on a PV graph the curves that represent each of the above processes.
- (b) Law of Thermodynamics
1. (First Law) Relate the heat absorbed by a gas, the work performed by the gas, and the internal energy change of the gas for any of the processes above.
 2. Relate the work performed by a gas in a cyclic process to the area enclosed by a curve on a PV diagram.
 3. (Second Law) Determine whether entropy will increase, decrease, or remain the same during a particular situation.
 4. Compute the maximum possible efficiency of a heat engine operating between two given temperatures.
 5. Relate the heat exchanged at each thermal reservoir in a Carnot cycle to the temperatures of the reservoirs.

3) ELECTRICITY AND MAGNETISM (Chapters 19-23)

i) Electrostatics

(a) Charge, field, and Potential

1. Define the electric field in terms of the force on a test charge.
2. Calculate the magnitude and direction of the force on a positive or negative charge placed in a specified field.
3. Given a diagram on which an electric field is represented by flux lines, determine the direction of the field at a given point, identify locations where the field is strong and where it is weak, and identify where positive or negative charges must be present.
4. Analyze the motion of a particle of specified charge and mass in a uniform electric field.
5. Calculate the electrical work done on a positive or negative charge that moves through a specified potential difference.
6. Given a sketch of equipotentials for a charge configuration, determine the direction and approximate magnitude of the electric field at various positions.
7. Apply conservation of energy to determine the speed of a charged particle that has been accelerated through a specified potential difference.
8. Calculate the potential difference between two points in a uniform electric field, and state which is at the higher potential.

(b) Coulomb's law and field and potential of point charges

1. Determine the force that acts between specified point charges, and describe the electric field of single point charge.
2. Use vector addition to determine the electric field produced by two or more point charges.

3. Determine the electric potential in the vicinity of one or more point charges.
- ii) Conductors, Capacitors, dielectrics
- (a) Electrostatics with conductors
 1. Explain the mechanics responsible for the absence of electric field inside a conductor, and why all excess charge must reside on the surface of the conductor.
 2. Explain why a conductor must be an equipotential, and apply this principle in analyzing what happens when conductors are joined by wires.
 3. Determine the direction of the force on a charged particle brought near an uncharged or grounded conductor.
 4. Describe and sketch a graph of the electric field and potential inside and outside a charged conducting sphere.
 5. Describe qualitatively the process of charging by induction.
 - (b) Capacitors and dielectrics
 - i. Know the definition of capacitance so students can relate stored charge and voltage for a capacitor.
 - ii. Relate voltage, charge, and stored energy for a capacitor.
 - iii. Recognize situations in which energy stored in a capacitor is converted to other forms.
 - iv. Describe the electric field inside the capacitor, and relate the strength of this field to the potential difference between the plates and the plate separation.
 - v. Determine how changes in dimension will affect the value of the capacitance.
- iii) Electric Circuits
- (a) Current, resistance, power
 1. Understand the definition of electric current so students can relate the magnitude and direction of the current in a wire or ionized medium to the rate of flow of positive and negative charge.
 2. Understand conductivity, resistivity, and resistance so students can relate current and voltage for a resistor.
 3. Describe how the resistance of a resistor depends upon its length and cross-sectional area
 4. Apply the relations for the rate of heat production in a resistor.
 - (b) Steady-state direct current circuits with batteries and resistors only
 1. Identify on a circuit diagram resistors that are in series or in parallel.
 2. Determine the ratio of the voltages across resistors connected in series or the ratio of the currents through resistors connected in parallel.
 3. Calculate the equivalent resistance of two or more resistors connected in series or in parallel, or of a network of resistors that can be broken down into series and parallel combinations.

4. Calculate the voltage, current, and power dissipation for any resistor in such a network of resistors connected to a single battery.
5. Design a simple series-parallel circuit that produces a given current and terminal voltage for one specified component, and draw a diagram for the circuit using conventional symbols.
6. Calculate the terminal voltage of a battery of specified emf and internal resistance from which a known current is flowing.
7. Apply Ohm's Law and Kirchhoff's rules to DC circuits in order to determine a single unknown current, voltage, or resistance.
8. Understand the properties of voltmeters and ammeters so students can state whether the resistance of each is high or low.
9. Identify or show correct methods of connecting meters into circuits in order to measure voltage or current.

(c) Capacitors in Circuits

1. Understand the behavior of capacitors connected in series and in parallel so students can calculate the equivalent capacitance of a series or parallel combination.
2. Describe how stored charge is divided between two capacitors connected in parallel.
3. Determine the ratio of voltages for two capacitors connected in series.
4. Calculate the voltage or stored charge, under steady-state conditions, for a capacitor connected to a circuit consisting of a battery and resistors.
5. Determine voltages and currents immediately after a switch has been closed and also after steady-state conditions have been established.

iv) Magnetostatics

(a) Forces on moving charges in magnetic fields

1. Understand the force experienced by a charged particle in a magnetic field so students can calculate the magnitude and direction of the force in terms of q , v , and B , and explain why the magnetic force can perform no work.
2. Deduce the direction of a magnetic field from information about the forces experienced by charged particles moving through that field.
3. State and apply the formula for the radius of the circular path of a charge that moves perpendicular to a uniform magnetic field, and derive this formula from Newton's Second Law and the magnetic force law.
4. Describe the most general path possible for a charged particle moving in a uniform magnetic field, and describe the motion of a particle that enters a uniform magnetic field moving with specified initial velocity.
5. Describe quantitatively under what conditions particles will move with constant velocity through crossed electric and magnetic fields.

- (b) Forces on current-carrying wires in magnetic fields
 1. Calculate the magnitude and direction of the force on a straight segment of current-carrying wire in a uniform magnetic field.
 2. Indicate the direction of magnetic forces on a current-carrying loop of wire in a magnetic field, and determine how the loop will tend to rotate as a consequence of these forces.
- (c) Fields of long current-carrying wires
 1. Calculate the magnitude and direction of the magnetic field at a point in the vicinity of such a wire.
 2. Use superposition to determine the magnetic field produced by two long wires.
 3. Calculate the force of attraction or repulsion between two long current-carrying wires.
- v) Electromagnetism
 - (a) Electromagnetic Induction
 1. Understand the concept of magnetic flux so students can calculate the flux of a uniform magnetic field through a loop of arbitrary orientation.
 2. Understand Faraday's Law and Lenz's Law so students can recognize situations in which changing flux through a loop will cause an induced emf or current in the loop.
 3. Calculate the magnitude and direction of the induced emf and current in a square loop of wire pulled at a constant velocity into or out of a uniform magnetic field.
 4. Calculate the magnitude and direction of the induced emf and current in a loop of wire that rotates at a constant rate about an axis perpendicular to a uniform magnetic field.
 5. Calculate the magnitude and direction of the induced emf and current in a conducting bar moving perpendicular to a uniform magnetic field.

4) WAVES AND OPTICS (Chapters 25-28)

- i) Wave motion (including sound and physical optics)
 - (a) Understand description of waves so students can:
 1. Sketch or identify graphs that represent traveling waves and determine the amplitude, wavelength, and frequency of a wave from such a graph.
 2. State and apply the relation among wavelength, frequency, and velocity for a wave.
 3. Sketch or identify graphs that describe reflection of a wave from the fixed or free end of a string.
 4. Write and apply the formula for the speed of waves on a string and know qualitatively what factors determine the speed of sound.
 - (b) Understand the physics of standing waves so students can:
 1. Sketch possible standing wave modes for a stretched string that is fixed at both ends, and determine the amplitude, wavelength, and frequency of such standing waves.

2. Describe possible standing sound waves in a pipe that has either open or closed ends, and determine the wavelength and frequency of such standing waves.
- (c) Understand Doppler effect for sound so students can:
1. Explain the mechanism that gives rise to a frequency shift in both the moving-source and moving-observer case, and derive an expression for the frequency by the observer.
 2. Write and apply the equations that describe the moving-source and moving-observer Doppler-effect, and sketch or identify graphs that describe the effect.
 3. Understand the principle of superposition so students can apply it to traveling waves moving in opposite directions, and describe how a standing wave may be formed by superposition.
- (d) Understand the interference and diffraction of waves so students can:
1. Display an understanding of how two slits produce a pattern of light and dark bands from the constructive and destructive interference of light waves.
 2. Understand the geometry of interference from two slits; use the derived equation to calculate the wavelength of light waves.
 3. Explain how single slit diffraction patterns occur based on geometry; use the derived equation to relate the width of the pattern to slit width and light wavelength.
 4. Explain the advantages of diffraction grating over two slits; understand the operation of a spectrometer.
 5. Explain how diffraction effects cause a small lens to have limited resolution.
 6. Observe various street lights through diffraction gratings and photograph or sketch the results.
- ii) Geometrical optics
- (a) Understand the principles of reflection and refraction so students can:
1. Describe the image produced by a plane mirror.
 2. Define focal point and explain the rules of ray tracing applied to concave mirrors.
 3. Define spherical aberration and describe the use of parabolic mirrors.
 4. Distinguish between real and virtual images.
 5. Explain the formation of real images by concave mirrors; use ray diagrams to locate the image; calculate the location using the mirror equation.
 6. Explain and demonstrate using ray diagrams the formation of virtual, enlarged images by concave mirrors.
 7. Explain and demonstrate using ray diagrams the formation of virtual images by convex mirrors; calculate the location of these images.
 8. Differentiate between concave and convex lenses.
 9. Describe the formation of an image by a convex lens; use ray diagram to locate the image; calculate the location using the lens equation.

10. Describe the formation of a virtual image by a convex lens; diagram and calculate the location of these images.
11. Describe the formation of virtual images by concave lens.
12. Understand the derivation of the lens equation (reproduction is not necessary).
13. Define chromatic aberration and understand how it is eliminated.
14. Explain the operation of the optical instruments described. Study the optics of a camera carefully. Find the focal length of the lens and the image distance.

5) MODERN PHYSICS (CHAPTERS 29-32)

i) Atomic Physics and Quantum Effects

- (a) Describe Thomson's experiment measuring the mass to charge ratio of the electron; solve problems associated with this experiment.
- (b) Display an understanding of the mass spectrograph as an analytical tool; use data provided to solve the problem.
- (c) Describe the interaction of electric and magnetic fields which produce electromagnetic waves; recognize the frequency or wavelength of many common waves.
- (d) Explain the principles of the detection of electromagnetic waves.
- (e) Describe the nature of X-rays.
- (f) Study the generation of microwaves, their use in cooking and possible harmful effects to people.
- (g) Display an understanding of the spectrum emitted by a hot body and the basics of the theory that explains this spectrum.
- (h) Define the photoelectric effect; recognize the fact that wave theory cannot explain this phenomenon but the quantum theory can; use equations in the text to solve problems involving the work function of materials, frequency of incident light, and kinetic energy of photoelectrons.
- (i) Explain the Compton effect in terms of the particle-like photon colliding elastically with an electron.
- (j) Explain the results of the wave nature of matter and solve problems using equations in the text.
- (k) Recognize the dual nature of both electromagnetic radiation and matter and the impact of the Heisenberg uncertainty principle.
- (l) Explain the method used by Rutherford and co-workers to determine the structure of the atom; describe the Rutherford model.
- (m) Describe the experimental results that suggested the existence of the neutron; contrast the proton with the neutron.
- (n) Distinguish continuous from line spectra; contrast emission and absorption spectra; list some uses of spectrography.
- (o) List the assumption used by Bohr to develop his atomic model; define energy levels and ground and excited states; display an understanding of the connection between photon energy and atomic energy changes .
- (p) Describe fluorescence and phosphorescence in terms of excited states of atoms.

- (q) By reference to the text only, use the orbital radius and energy level equations to solve problems using the Bohr model.
- (r) Display an appreciation of the contributions of the Bohr model and its shortcomings; describe the wave model of the atom.
- (s) Describe a laser and the properties of laser light; display an understanding of the processes involved in the operation of the laser.

ii) Nuclear Physics

- (a) Define atomic number and mass number; find the charge and mass of the nucleus.
- (b) Define an isotope and a nuclide; calculate the numbers of neutrons, protons, and electrons in an isotope.
- (c) Describe the three modes of radioactive decay; calculate the changes in atomic number and mass number accompanying each mode of decay.
- (d) Write equations for the three forms of decay.
- (e) Define half-life; calculate the amount of material and its activity remaining after a certain time.
- (f) Balance nuclear equations describing the result of nuclear reactions.
- (g) Describe the operation of a linear accelerator.
- (h) Describe the operation of a synchrotron.
- (i) Describe the operations of different radiation detectors.
- (j) List the two families of fundamental particles; describe the difference between fundamental particles and force carriers.
- (k) Describe anti-particles; calculate the energy of gamma rays emitted when particles annihilate with their anti-particles.
- (l) Follow the description of the quark model of the nucleon; understand the place of additional quark and leptons in the quark model.

iii) Special Relativity

- (a) Understand the use of techniques of Chapter 1-5 to the description of mechanics from moving frames of reference.
- (b) Recognize that electromagnetism did not work in moving frames; understand the problem posed by the Michelson-Morley experiment.
- (c) State Einstein's two postulates.
- (d) State the new meaning of time; define time dilation; recognize the resolution of the twin paradox.
- (e) Display an understanding of the contraction of moving bodies.
- (f) Recognize how the muon experiment tests both time dilation length contraction.
- (g) Use Einstein's method of adding velocities and recognize how it solves the problem of the limiting speed of light.
- (h) Understand the nature of the increase in mass of rapid-moving material.
- (i) Recognize the origin and significance of the mass-energy equivalence.
- (j) Recognize the realm in which relativistic effects are important and the importance of relativity to our approach to physics.

Washington State Science Essential Academic Learning Requirements

The following science components and benchmarks have been compiled with the student learning objectives for the middle school science program. The components of each benchmark are explicitly stated in the specific curriculum for each grade level.

- 1. SYSTEMS:** The student understands and uses scientific concepts and principles to understand systems.
 - 1.1 Properties of Systems (PR):** Use properties to identify, describe, and categorize substances, materials, and objects, and use characteristics to categorize living things.
 - 1.2 Structure of Systems (ST):** Recognize the components, structure, and organization of systems and the interconnections within and among them.
 - 1.3 Changes in Systems (CH):** Understand how interactions within and among systems cause changes in matter and energy.
- 2. INQUIRY:** The student knows and applies the skills, processes, and nature of scientific inquiry.
 - 2.1 Investigating Systems (IN):** Develop the knowledge and skills necessary to do scientific inquiry.
 - 2.2 Nature of Science:** Understand the nature of scientific inquiry.
- 3. DESIGN:** The student knows and applies the design process to develop solutions to human problems in societal contexts.
 - 3.1 Designing Solutions:** Apply design processes to develop solutions to human problems or meet challenges using the knowledge and skills of science and technology.
 - 3.2 Science, Technology, and Society:** Know that science and technology are human endeavors, interrelated to each other, to society, and to the work place.

LABORATORY ACTIVITIES

PHYSICS 3, 4

Mechanics

Laboratory Techniques-Measurement
Graphical Analysis of Motion- Variable acceleration
Graphical Analysis of Motion- Uniform acceleration
Trajectories on the Air Table-Projectile motion
Acceleration Produced by Varying Forces
Finding G
Centripetal Forces
Elastic collisions/Inelastic Collisions
Conservation of Momentum
Moment of Inertia

Thermodynamics, Heat Energy, and Temperature

Boyle's Law
Charles' Law
Specific Heat of a Metal
Heat of Fusion of ice

Electricity and Magnetism

Induced EMF
Electric Generators
Generators and Motors
Lenz's Law
Measurement of Magnetic Field Strength Charge to Mass Ratio of the Electron
Induced Current and Lenz's Law
The DC Generator - The DC Motor
Energy Transfer by An Electric Motor

Waves and Optics

Mass on a spring (SHM) Speed of Sound in air Images Produced by Curved Mirrors
Convex Lenses
Diffraction Grating
Measuring the Wavelengths of Light Waves
Snell's Law
Multiple Images
Photocells

Modern Physics

A Model for the Quantum Concept
The Spectra of Elements
Half-Life Simulation
Simulation of Nuclear Collisions

INSTRUCTIONAL MATERIALS

PHYSICS 3, 4

Basic Text: Physics Second Edition, James S. Walker, Prentice Hall, 2004
Supplemental Text: Physics Fifth Revised Edition, Douglas C. Giancoli, Prentice Hall, 2002.

For the instructor:

Instructor's Resource CD-ROM with testing software (part of Walker, Prentice Hall:)

WebAssign

PhysLets Physics; Christian & Belloni, Pearson-Prentice Hall

For the students:

Student Pocket companion (part of Walker: Prentice Hall)

Interactive Physics 2004 Software, MSC Software;

Physics: A Laboratory Manual: Puri, P. Zober, G. Zober; (Pearson Custom Publ. 2001)

EVALUATION

PHYSICS 3, 4

The following criteria are applicable in the total evaluation of student progress:

1. Achievement on teacher developed tests.
2. Class participation
3. Student performance in the laboratory
4. Laboratory reporting techniques.
5. Solutions to assigned questions and problem sets
6. Oral presentations
7. Student performance using interactive computer simulations.

STUDENT ASSESSMENT

Evaluation of students to the objectives listed in this guide will be measured in a variety of ways.

A major focus of assessment will be a movement away from the traditional “cookbook” science where every student receives a set of procedures, completes the procedures, and receives the same answer to an investigation. Focus instead will be on a more inquiry and project-based science classroom where students are assessed on their ability to design investigations, write thorough procedures, and demonstrate a clear understanding of the scientific process. Students will use a WASL-type format when designing investigations and writing procedures. Students will be explicitly asked to form hypotheses with reasons, outline manipulated, responding, and controlled variables, and will have to write clear, concise, and thorough procedures. Likewise, students will be expected to complete detailed analyses of their investigation results.

In addition to laboratory investigations, reading, discussions, student journals, student self-evaluations, demonstrations, projects, teacher reflection, tests and quizzes, and presentations are among the many methods student progress will be assessed in the science classroom. Questioning, the cornerstone of science, will continue to be supported. Without good questions on the part of both teachers and students, we cannot expect teachers to have an accurate understanding of achievement and students to see a purpose in their learning.

It is intended that assessment will continue to be the blueprint for classroom teaching. As teachers we must remember that teaching science content is like building a house; we cannot expect our students to have a deep understanding of knowledge without a strong foundation in the process of science and how it helps human lives. Multi-faceted assessments support strong teaching will help provide teacher insight into the structure of the foundation being laid on our students.

INTEGRATING TECHNOLOGY

The recent bond passed by voters in 2004, will allow the Renton School District to update the technology available to students. Because of this, we are able to incorporate new technological advances in the science classroom. Included in this are:

- 1) CD-Rom simulations- Direct tool manipulations can be used by students in the computer lab or projected onto a TV or overhead screen to be viewed by the entire class. Students are able to simulate lab conditions, manipulate variables, and receive immediate feedback and results.
- 2) I-text subscriptions- to be purchased for students in lieu of providing a textbook for every student. The I-text subscriptions will allow students and parents to view all text resources from their home computers. This provides the opportunity for parents to connect with their students, the curriculum, and current advancements in science, therefore creating a forum for conversation about school and science.
- 3) DVD and VHS lab videos- can be viewed by the class in lieu of an actual lab investigation for discussion purposes or can be used for make-up work for absent students.