TAMALPAIS UNION HIGH SCHOOL DISTRICT
Larkspur, California

Course of Study
Physics 1-2

I. INTRODUCTION

Physics 1-2 is a one-year course intended for students who have completed Integrated Science 1-4. This course provides a strong background for college bound students and if often taken concurrently with other elective science courses. Physics 1-2 is part of the recommended college preparatory program of Integrated Science 1-4, Chemistry, and Physics.

The goals of this course are to present physics as a highly organized body of knowledge held together by unifying principles and based on systematic investigations of nature through experimentation.

Physics 1-2 should provide maximum opportunity for students to learn through laboratory experiences, enabling them to appreciate the importance of making careful observations, analyzing facts objectively and synthesizing logical conclusions. Students should leave the course having an understanding and appreciation of how physics affects their daily lives in the 21st century.

Physics 1-2 is a highly quantitative science course, requiring applications of algebra, geometry, and trigonometry concepts, including skills such as solving equations for different variables, using data to represent independent and dependent variables, applying scientific notation, solving proportions, and manipulating formulas. Students lacking such skills should consider postponing Physics until they have strengthened their mathematical background.

This course addresses the district Mission Statement as follows:

- Physics contributes to "…the development of creative, passionate, and self-motivated learners."

- Physics provides students a "… meaningful learning experience(s) to enable them to access and critically analyze information, pose substantive questions, and communicate effectively."

This course addresses the following Tam 21st Century goals:

- Students: Provide an environment supporting academic, social and emotional growth and success and opportunities for student choice.

- Instruction: Provide a program that prepares students for graduation and provides opportunities for student growth, development and post-secondary options.

This course addresses the following Student Learning Outcomes:

Outcome 1	Communicate articulately, effectively and persuasively when speaking and writing.
Outcome 2	Read/view and analyze material in a variety of different disciplines.
Outcome 3	Use technology as a tool to access information, analyze/solve problems, and communicate ideas.
Outcome 5	Apply mathematical knowledge and skills to analyze and solve problems.
Outcome 6	Demonstrate scientific literacy.
Outcome 10	Analyze and propose solutions to contemporary issues using a variety of perspectives.
Outcome 12	Demonstrate school-to-work/post-secondary transition skills and knowledge.

This course is designed to help students attain the state Physics Content Standards. Numbered references to specific Physics Content student objectives (*Science Content Standards for California Public Schools*, 2000, pages 32-35) are included in the following statement of student learning outcomes.

II. STUDENT LEARNING OUTCOMES AND STATE STANDARDS

A. Students will:

1. Develop analytical problem-solving skills
   Indicator a: use algebra, geometry, and trigonometry to solve quantitative physics problems.

   Indicator b: solve quantitative problems with graphical analysis techniques.

2. Develop laboratory skills, including the use of standard laboratory equipment
   Indicator a: collect, analyze and draw conclusions from data

   Indicator b: use inductive and deductive experiments to acquire and test specific hypotheses.

3. Use technology to explore physics
   Indicator a: understand and apply web-based simulations (“applets”) and tutorials

   Indicator b: use software (PowerPoint, Excel, Word, etc.) to present and explain concepts

4. Successfully work in a collaborative setting
   Indicator a: demonstrate during lab activities that individual contribution is productive, supportive, and equitable

Indicator b: contribute to group projects, presentations, or portfolios

B. Students will cover the following State Science Content Standards:

Motion and Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept:
   a. Students know how to solve problems that involve constant speed and average speed.
   b. Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).
   c. Students know how to apply the law F=ma to solve one-dimensional motion problems that involve constant forces (Newton's second law).
   d. Students know that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).
   e. Students know the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.
   f. Students know applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).
   g. Students know circular motion requires the application of a constant force directed toward the center of the circle.
   h. Students know how to solve two-dimensional trajectory problems.
   i. Students know how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.
   j. Students know how to solve two-dimensional problems involving balanced forces (statics).
   k. Students know how to solve problems in circular motion by using the formula for centripetal acceleration in the following form: $a=v^2/r$.
   l. Students know how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).

Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept:
   a. Students know how to calculate kinetic energy by using the formula $E=(1/2)mv^2$.
   b. Students know how to calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) =mgh (h is the change in the elevation).
   c. Students know how to solve problems involving conservation of energy in simple systems, such as falling objects.
   d. Students know how to calculate momentum as the product mv.

e. Students know momentum is a separately conserved quantity different from energy.
f. Students know an unbalanced force on an object produces a change in its momentum.
g. Students know how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.
h. Students know how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.

Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:
   a. Students know heat flow and work are two forms of energy transfer between systems.
   b. Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.
   c. Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.
   d. Students know that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.
   e. Students know that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.

Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:
   a. Students know waves carry energy from one place to another.
   b. Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).
   c. Students know how to solve problems involving wavelength, frequency, and wave speed.
   d. Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.
   e. Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^{8} m/s (186,000 miles/second).
   f. Students know how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept:
   a. Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.
   b. Students know how to solve problems involving Ohm's law.
   c. Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) × I (current) = I^2R.
   d. Students know the properties of transistors and the role of transistors in electric circuits.
   e. Students know charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.
   f. Students know magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.
   g. Students know how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.
   h. Students know changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.
   i. Students know plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.
   j. Students know electric and magnetic fields contain energy and act as vector force fields.
   k. Students know the force on a charged particle in an electric field is qE, where E is the electric field at the position of the particle and q is the charge of the particle.
   l. Students know how to calculate the electric field resulting from a point charge.
   m. Students know static electric fields have as their source some arrangement of electric charges.
      Students know the magnitude of the force on a moving particle (with charge q) in a magnetic field is qvB sin(a), where a is the angle between v and B (v and B are the magnitudes of vectors v and B, respectively), and students use the right-hand rule to find the direction of this force.
   n. Students know how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.

C. Students will cover the content specified in II.B (above) as included on the California Standards Test (CST) in Physics.

III. UNITS OF INSTRUCTION

A. Major Units of Instruction

1. Motion and Forces
2. Energy and Momentum
3. Electromagnetism
4. Waves (including Optics)
5. Heat and Thermodynamics
6. Modern Physics

B. Enduring Understandings and Essential Questions

- Physics - described briefly as a study of matter, energy, and forces - is often regarded as the foundation upon which all other science disciplines are built.
- Knowledge, comprehension, and application of conservation laws (i.e. energy conservation) is essential to problem solving in physics
- Will a “grand unified theory” unite all fundamental forces in the universe?
- Will quantum mechanics (often a study at the atomic scale) and general relativity (often a study at the galactic scale) be united by “super theory”?

C. Knowledge and Skills

Successful students in this course must:

1. Read and write scientifically at a high school level.
2. Have good time management skills.
3. Be goal orientated.
4. Be self-motivated.
5. Work well individually and in a group.
6. Be proficient mathematically at least at the advanced algebra level.

D. Assessment

1. Student Assessment

Students will be evaluated by teacher observation, written projects, quizzes and examinations, lab performance (including reports, quizzes, and technique), homework performance, and oral presentations.

2. Course Assessment

The course will be evaluated through district assessments.

IV. METHODS AND MATERIALS

A. Methods

Lecture, individual and group problem solving, inquiry activities, lab activities (inquiry, skill development, application), individual and group projects, research papers, and oral presentations.

B. Materials

A textbook; laboratory directions; teacher generated lecture notes, activities and practice problems; laboratory equipment and consumable materials; reference materials as needed (internet, periodicals, reference texts); audiovisual materials.

C. Technology

1. Laboratory Equipment
2. Calculators
3. Visual Media (DVD's, LCD projectors, videos, laser discs, overhead projector)
4. Computers (internet research, data collection and analysis)

D. School to Career Goals

Practical applications of physics, including careers, are embedded in the course. Careers related to physics are a part of the textbook as well. Relevant newspaper and magazine articles, book reports about physicists, publicity of talks and lectures outside of class and occasional guest speakers are other avenues used to introduce physics students to physics-related careers.

E. Suggested Instructional Time Allocation

General time allocation: 40% of time will be spent on lab work and analysis; 30% of the time spent on information delivery and discussion; 30% on individual and group student practice and assessment.

V. GENERAL INFORMATION

Physics 1-2 is a 10-credit course open to 11th to 12th grade students.

A. Prerequisites

Students must have passed Algebra 1-2 or equivalent with a grade of "C" or better and Integrated Science 3-4 with a grade of "C" or better each semester. Students must have completed or be concurrently enrolled in Advanced Algebra. Students must pass Physics 1 to enroll in Physics 2 (i.e. receive at least a "D" in Physics 1).

B. Requirements Met

This course may be used as elective credit towards graduation but does not meet any specific graduation requirement. This course is accepted towards the UC/CSU “d” or “g” admissions requirement.

Adopted: 01/24/89
Revised: 07/03
Revised: 11/21/03
Revised: 06/01/10