#454/464 AP PHYSICS/LAB / AP PHYSICS EXAM PREP

GRADE: 12

LEVEL: AP

CREDITS: 5/5

PREREQUISITES: 454
"A" in Science Course 451 or 452,
"A" in Math Course 360 and
enrolled in Math Course 361 or
Math Course 384

464
Science Course 454

BASIC TEXT: Physics, 4th Ed., D.C. Giancoli, Prentice-Hall, 1995

SUPPLEMENTATL READINGS: None

REQUIRED MATERIALS: Pen/Pencil
Notebook
Calculator (preferably, Graphing Calculator)

COURSE DESCRIPTION: This course is a college-level/-graded physics course, Which emphasizes the basic principles of physics, esp., the conservation laws and the concepts of waves, fields and particles. The AP exam is required.

MISSION RELATED GOALS: Foster problem solving
Foster communication
Academic excellence
Intellectual curiosity
Respect rights of others
Successful, contributing society
Self-confidence

Students will communicate effectively, solve complex problems and work with others towards a common goal while developing appropriate problem solving skills. The students will respect the rights of others while promoting personal growth in accepting responsibility and working individually within a group setting.

STUDENT EXPECTATIONS FOR LEARNING ADDRESSED: (How this course ties with the Expectations for Student Learning).

- Communicate effectively – In their classroom discussions and other oral and written presentations, students will obtain information and present ideas in a clear, articulate manner.
- Solve complex problems – In their labs and projects, students will use higher order thinking skills to assess and solve multi-step problems.
- Work with others towards a common goal – Again, in their labs and projects, students will accept personal responsibility and work interdependently in a group setting.
- Contribute to the community and the global society – Students will understand that scientific knowledge will enable them as citizens to better promote the welfare of the local and global society.
- Respect the rights of others – In the classroom setting students will be led to establish appropriate rules and then to follow those rules for the benefit of all the members of the class.
- Exercise life skills that promote personal growth – Students will recognize the role that science education may play in achieving their future goals. Students will communicate effectively and work towards a common goal while developing appropriate problem solving skills. The students will respect the rights of others while promoting personal growth in accepting responsibility and working individually within a group setting.

GENERAL PERFORMANCE OBJECTIVES: (What the student will know and be able to do upon course completion)

The students will be able to:

- Express all units in the SI system of measurement.
- Represent types of motion in scalar and vector quantities and/or graphs.
- Identify and apply the laws of motion to real-life situations.
- Determine the resultant forces on an object by using Newton's Laws of Motion.
- Apply the law of Conservation of Momentum to colliding objects.
- Apply the law of Conservation of Mechanical Energy to various situations.
- Analyze the concepts of work and power and their relationship to Energy.
- Interpret aspects of waves by using sound and light as applications of wave motion.
- Analyze the behavior of light using the concepts of geometric optic and physical
- optics.
- Demonstrate an understanding of the wave/particle duality of light.
- Apply electrical principles by designing and constructing basic electric circuits.
- Discover the relationship between heat and work
- Demonstrate how thermal energy is applied to practical devices.
- Apply electromagnetic principles by problem solving.

MASSACHUSETTS FRAMEWORKS STRAND(S)

From the Massachusetts Science and Technology/Engineering Curriculum Framework, May 2001, Physics, Grade 9 or 10:

Strand 3: Physical Sciences (Chemistry and Physics)

CURRICULUM FRAMEWORK LEARNING STANDARDS (# and description):

From the Massachusetts Science and Technology/Engineering Curriculum Framework, May 2001, Physics, Grade 9 or 10:

1. Motion and Forces:
   - 1.1 Distinguish between vector quantities (velocity, acceleration, and force) and scalar quantities (speed and mass)
   - 1.2 Illustrate how to represent vectors graphically and to be able to add them graphically.
   - 1.3 Distinguish between, and solve problems involving, velocity, speed, and constant acceleration.
   - 1.4 Create and interpret graphs of motion (position vs. time, speed vs. time, velocity vs. time, constant acceleration vs. time)
   - 1.5 Explain the relationship between mass and inertia.
   - 1.6 Interpret and apply Newton's first law of motion.
   - 1.7 Interpret and apply Newton's second law of motion to show how an object's motion
   - 1.8 Use a free body force diagram with only co-linear forces to show forces acting on an object, and determine the net force on it.
   - 1.9 Qualitatively distinguish between static and kinetic friction, what they depend on and their effects on the motion of objects.
   - 1.10 Interpret and apply Newton's third law of motion.
   - 1.11 Understand conceptually Newton's law of universal gravitation.
   - 1.12 Identify appropriate standard international units of measurements for force, mass distance, speed, acceleration, and time, and explain how they are measured.

2. Conservation of Energy and Momentum:
   - 2.1 Interpret and provide examples that illustrate the law of conservation of energy. *
   - 2.2 Provide examples of how energy can be transformed from kinetic to potential and vice versa.
   - 2.3 Apply quantitatively the law of conservation of mechanical energy to simple systems.
   - 2.4 Describe the relationship among energy, work, and power both conceptually and quantitatively.
   - 2.5 Interpret the law of conservation of momentum and provide examples that illustrate it. Calculate the momentum of an object.

2.6 Identify appropriate standard international units of measurement for energy, work, power, and momentum.

3. Heat and Heat Transfer:
   - 3.1 Relate thermal energy to molecular motion.
   - 3.2 Differentiate between specific heat and heat capacity.
   - 3.3 Explain the relationship among temperature change in a substance for a given amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.
   - 3.4 Recognize that matter exists in four phases, and explain what happens during a phase change.

4. Waves:
   - 4.1 Differentiate between wave motion (simple harmonic nonlinear motion) and the motion of objects (nonharmonic).
   - 4.2 Recognize the measurable properties of waves and explain the relationships among them.
   - 4.3 Distinguish between transverse and longitudinal waves.
   - 4.4 Distinguish between mechanical and electromagnetic waves.
   - 4.5 Interpret and be able to apply the laws of reflection and refraction (qualitatively) to all waves.
   - 4.6 Recognize the effects of polarization, wave interaction, and the Doppler effect.
   - 4.7 Explain, graph, and interpret graphs of constructive and destructive interferences of waves.
   - 4.8 Explain the relationship between the speed of a wave (e.g. sound) and the medium it travels through.
   - 4.9 Recognize the characteristics of a standing wave and explain the conditions under which two waves on a string or in a pipe can interfere to produce a standing wave.

5. Electromagnetism:
   - 5.1 Recognize the characteristics of static charge, and explain how a static charge is generated.
   - 5.2 Interpret and apply Coulomb's law.
   - 5.3 Explain the difference in concept between electric forces and electric fields.
   - 5.4 Develop a qualitative and quantitative understanding of current, voltage, resistance and the connection between them.
   - 5.5 Identify appropriate units of measurement for current, voltage, and resistance, and explain how they are measured.
   - 5.6 Analyze circuits (find the current at any point and the potential difference between any two points in the circuit) using Kirchoff's and Ohm's laws.

6. Electromagnetic Radiation:
   - 6.1 Describe the electromagnetic spectrum in terms of wavelength and energy and are able to identify specific regions such as visible light.

6.2 Explain how the various wavelengths in the electromagnetic spectrum have many useful applications such as radio, television, microwave appliances, and cellular telephones.
6.3 Calculate the frequency and energy of an electromagnetic wave from the wavelength.
6.4 Recognize and explain the ways in which the direction of visible light can be changed.

UNITS AND THEMES (Topical Outline including duration of unit) STANDARD # COVERED:

I.	Mathematical Relationships	1 Week	1.12
II.	Kinematics	2 Weeks	1.1 – 1.4
III.	Forces	3 Weeks	1.5 – 1.10
IV.	Momentum	2 Weeks	2.1 – 2.6
V.	Energy	2 Weeks	2.1 – 2.6
VI.	Circular Motion; Gravitation	2 Weeks	1.11
VII.	Thermodynamics	1 Week	3.1 – 3.4
VIII.	Waves	1 Week	4.1 – 4.9
IX.	Light	1 Week	4.5 – 4.6
X.	Basic Electricity	2 Weeks	5.1 – 5.6
XI.	Electromagnetism	1 Week	6.1 – 6.4

COURSE OUTLINE:

I. Mathematical Relationships **1 Week**
- A. SI Units
- B. Scientific notation/significant digits
- C. Graphing
- D. Basic Trigonometry

II. Kinematics **3 Weeks**
- A. Scalar and Vector Quantities
- B. Displacement
- C. Velocity
- D. Acceleration
- E. Graphical Analysis of Motion
- F. Motion in 2 dimensions
- G. Vector Operations

III. Forces **5 Weeks**
- A. Newton's Laws of Motion
- B. Statics
- C. Bodies in Equilibrium

D. Elasticity
E. Dynamics
F. Friction
G. Free Fall

IV. Momentum **3 Weeks**

A. Impulse
B. Linear Momentum
C. Law of Conservation of Momentum
D. Inertial/non-inertial Frames of Reference
E: Rotational Motion
F. Angular Momentum

V. Energy **3 Weeks**

A. Work
B. Mechanical Energy
C. Work-Energy Theorem and Conservation of Energy
D. Power, Efficiency

VI. Circular Motion; Gravitation **3 Weeks**

A. Kinematics/Dynamics of Uniform Circular Motion
B. Nonuniform Circular Motion
C. Universal Gravitation
D. Kepler's Laws of Planetary Motion

VII. Thermodynamics **3 Weeks**

A. Thermal Energy and Temperature
B. Temperature Scales
C. Laws of Thermodynamics
D. Specific Heat

VIII. Waves **2 Weeks**

A. Types
B. Characteristics
C. Speed in different Media
D. Transmission
E. Interference

IX. Light **3 Weeks**

A. Properties
B. Electromagnetic Spectrum
C. Reflection and Refraction
D. Polarization
E. Diffraction and Interference
F. Optics
G. Wave Nature of Light

X. Basic Electricity **5 Weeks**

A. Static Electricity
B. Coulomb's Law
C. Electric Field
D. Electric Potential
E. Capacitance
F. Ohm's Law
G. Current Electricity
H. DC Electric Circuits

XI. **Electromagnetism** **5 Weeks**

A. Magnetic Fields
B. Magnetic Forces on a Moving Charge
C. Induced EMF
D. AC Circuits
E. Electromagnetic Waves

SUGGESTED INTEGRATED ACTIVITIES:

- Bridge Design and Construction
- "Egg Drop"
- Time line of significant scientific advances and historical events from Copernicus's birth to Newton's death. Students should include scientists such as Brahe and Kepler as well as importantpolitical leaders, musicians, writers and artists.

SUGGESTED INTEGRATED ACTIVITIES (Tie-ins with other disciplines and student activities):

USE OF TECHNOLOGY:

- Use of Classroom computer(s) and an integrated software package
- Use of scientific calculators
- Graphical Analysis software
- Computerized data collection/analysis hardware & software (proposed)
- Video programs
- Overhead projector and transparencies

ASSESSMENT TECHNIQUES:

- White-Board presentations of homework problem solutions
- White-Board presentations of Laboratory data/analysis
- Laboratory Reports
- Projects
- Chapter/Unit tests
- End-of-course exam
- AP B Exam
- School-wide rubric will be utilized where appropriate

STATE STANDARDS: Mass. Curriculum Frameworks: Introductory Physics

1. Motion and Forces: 1.1 – 1.12
2. Conservation of Energy and Momentum: 2.1 – 2.6
3. Heat and Heat Transfer: 3.1 – 3.4
4. Waves: 4.1 – 4.9
5. Electromagnetism: 5.1 – 5.6
6. Electromagnetic Radiation: 6.1 – 6.4

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- Demonstrate how thermal energy is applied to practical devices.
- Apply electromagnetic principles by problem solving.

COURSE OUTLINE:

UNITS AND THEMES COVERED

D. **Mathematical Relationships**

A. SI Units

B. Scientific notation/significant digits
C. Graphing
D. Order of Magnitude Calculations

E. **Kinematics**
A. Scalar and Vector Quantities
B. Displacement
C. Velocity
D. Acceleration
E. Graphical Analysis of Motion
F. Motion in 2 or 3 dimensions.
G. Vector Operations

F. **Forces**
A. Newton's Laws of Motion
B. Statics
C. Bodies in Equilibrium
D. Elasticity
E. Dynamics
F. Friction
G. Free Fall

G. **Momentum**
A. Impulse
B. Linear Momentum
C. Law of Conservation of Momentum
D. Inertial/non-inertial Frames of Reference
E. Rotational Motion
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H. **Energy**
A. Work
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Circular Motion; Gravitation

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I. **Thermodynamics**
A. Thermal Energy and Temperature
B. Temperature Scales
C. Laws of Thermodynamics

D. Specific Heat

J. **Waves**
   A. Types
   B. Characteristics
   C. Speed in different Media
   D. Transmission
   E. Interference

K. **Light**
   A. Properties
   B. Electromagnetic Spectrum
   C. Reflection and Refraction
   D. Polarization
   E. Diffraction and Interference
   F. Optics
   G. Wave Nature of light

L. **Basic Electricity**
   A. Static Electricity
   B. Coulomb's Law
   C. Electric Field
   D. Electric Potential
   E. Capacitance
   F. Ohm's Law
   G. Current Electricity
   H. DC Electric Circuits

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