Physics

Grade 11

Prerequisites: Biology and Chemistry

Credit Value: 6

ABSTRACT

Physics provides students with a comprehensive up-to-date approach to an extensive study of the nature and interaction of forces and energy transformations. Prior physical science knowledge is extended by incorporating advanced mathematical skills including geometric concepts and algebraic operations. Topics include kinematics, dynamics, forces, circular and projectile motion, conversation of energy and momentum, astrophysics, waves, sound, light, optics, and electrostatics. Throughout the Physics course, students explore topics that are directly applied to real-world technologies. The coursework and laboratory explorations prepare students for college courses, as well as advanced courses in the science content area.
### Physics – Grade 11

**Monthly Overview**

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<td>HS-PS1-3, HS-PS3-1, HS-PS3-2, HS-PS3-3, HS-PS3-5</td>
<td>HS-PS3 (1-5)</td>
<td>HS-PS2 (1-5), HS-PS3-2, HS-PS3-5</td>
<td>HS-PS--(1-5)</td>
<td>HS-PS2 (1-4)</td>
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**Essential Question:**

- Why are Scientific International (SI) standardized units important in science?
- What measurements are necessary to describe motion?
- Why are Newton’s three laws so important?
- How can we analyze force vectors?
- How does circular motion differ from linear motion and how are they similar?

**Content:**

- **Measurement and Problem Solving**
- **Kinematics**
- **Dynamics**
- **Concurrent and Parallel Forces**
- **Circular and Projectile Motions**

**Skills and Topics:**

- Demonstrate the ability to use laboratory instruments and measurement devices
- Apply dimensional analysis to convert different standards of measurement
- Organize different data sets into appropriate graphs best suited to the data collected
- Demonstrate the ability to manipulate algebraic formulas
- Recognize basic SI units (e.g., meters, grams, liters) and synthesize into compound units (e.g., g/km/s, kg x m/s²)
- Describe, calculate, and graph motion in terms of distance, velocity, elapsed time, and acceleration
- Recognize quantities that require direction, as well as size (e.g., vectors)
- Demonstrate the ability to add vectors by means of adding components
- Distinguish between vector and scalar measurements
- Construct vector diagrams
- Use function to model real-world phenomena and solve problems involving varying quantities (e.g., linear, exponential, periodic sine and cosine functions)
- Explain and interconnect Newton’s three laws of motion and their real-world applications
- Recognize and apply the vector nature of Newton’s third law of motion
- Identify different types of forces (e.g., frictional, gravitational, normal, tension)
- Differentiate among fundamental forces (e.g., electroweak, gravitational, nuclear, strong)
- Distinguish between the principles of mass versus weight
- Distinguish between static and kinetic frictional forces and relate to Newton’s first law of motion and momentum
- Determine the effect of acceleration on equilibrium
- Construct free-body diagrams to represent the vector nature of forces to solve problems
- Combine and resolve component forces
- Use triangle trigonometry to solve vector addition problems
- Solve friction problems
- Manipulate centripetal force and determine the acceleration of an object on a circular path
- Determine the relationship between the orbital radius and orbital speed of satellites
- Define and apply angular displacement, average angular velocity, and angular acceleration to solve problems involving objects in rotational motion
- Calculate the period and frequency of iterations
- Differentiate between tangential velocity and angular velocity
### SOMERVILLE PUBLIC SCHOOLS

### Physics – Grade 11

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| **Skills and Topics:** | • describe the effect that changing one variable results in changes in other variables and the shape, position, and characteristics of the graph of $f(x)$  
• judge the meaning, utility, and reasonableness of the results of symbols  
• interpret algebraic or graphical solutions in terms of the context of the problem and the appropriate units of measurement  
• recognize the limits of estimation, assess the resulting amount of error, and determine whether the error is within acceptable tolerance levels | • perform graphical analysis problems to determine the position of an object at a particular time within motion in one dimension | | • determine the value and importance of acceleration due to gravity “$g$” (e.g., 9.80 m/s$^2$)  
• use the value of “$g$” to calculate free-fall displacement | • distinguish between centripetal acceleration and tangential acceleration  
• recognize the vector nature of angular variables  
• apply the equations of kinematics in two dimensions  
• perform graphical analysis problems to determine the position of an object at a particular time within motion in two dimensions  
• determine the maximum height and time of an object in projectile motion  
• estimate lines of best fit using technology and apply for interpolations within a range of data |

**Integration of Technology:** Internet, Web Quests, wireless laptop computers, SMART Boards, *Vernier™* interface and probes, *Graphical Analysis* software, multimedia presentations, video streaming, podcasting, NOAA

**Writing:** Open-ended responses, conclusions and analysis of exploratory activities, lab reports

**Formative Assessments:** Warm-up activities, exploratory activities, class discussions, student participation, Nearpod, Kahoot, group projects and activities, Google Applications

**Summative Assessments:** Quizzes, tests, projects, presentations, Lab reports
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<tr>
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<tr>
<td>o Unit of measure</td>
<td>o Velocity tubes</td>
<td>o Measuring “g” (gravity)</td>
<td>o Inclined plane</td>
<td>o Projectile motion</td>
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<td>o Mass, volume, and density</td>
<td>o Free fall</td>
<td>o Fig Newton</td>
<td>o Friction</td>
<td>o Simple harmonic motion</td>
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<tr>
<td>o Graph matching with Logger Pro</td>
<td>o Measuring “g”</td>
<td>o What goes up?</td>
<td>o Resolving forces</td>
<td>o Pendulum springs</td>
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<td></td>
<td>o Indirect height</td>
<td>o Newton’s second law using Logger Pro</td>
<td>o Component forces</td>
<td>o 2-D motion and inclined plane</td>
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<td></td>
<td></td>
<td></td>
<td>o Friction using Logger Pro</td>
<td>o Centripetal motion</td>
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*Laboratory experiments and reports include, but are not limited to, the above list.*
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<td>☑ Media Literacy</td>
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*2016 NJSLS

RST: Reading in Science and Technical Subjects
WHST: Writing in History, Science, and Technical Subjects
SL: Speaking and Listening
L: Language

N: Real Number System
A: Algebra
F: Functions
G: Geometry
S: Statistics and Probability
MD: Measurement and Data
N-Q: Quantities
N-VM: Vector and Matrix Quantities
A-SSE: Seeing Structure in Expressions
A-REI: Reasoning with Equations and Inequalities
F-IF: Interpreting Functions
F-BF: Building Functions
F-LE: Linear, Quadratic, and Exponential Models
F-TF: Trigonometric Functions

G-CO: Congruence
G-SRT: Similarity, Right Triangles, and Trigonometry
G-C: Circles
G-GPE: Expressing Geometric Properties with Equations
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**Essential Question:**
- How can forces and energy be related?
- How can natural laws apply universally?
- How do vibrations move?
- How can light behave like a particle and a wave?
- How can electricity be harnessed?

**Content:**
- Conservation of Energy and Momentum
- Law of Universal Gravitation, Astronomy, and Astrophysics
- Waves and Sound
- Light and Optics
- Electrostatics

**Skills and Topics:**
- distinguish between impulse, momentum, energy, work, and power
- solve problems involving momentum and work
- distinguish between positive and negative work
- combine Newton’s second law, work, and kinetic energy and synthesize into the Work-Energy theorem
- apply the Work-Energy theorem to solve problems
- determine work done by the force of gravity (e.g., gravitational potential energy)
- explore Kepler’s second law describing the behavior of planets in elliptical orbits
- apply Kepler’s third law of circular and elliptical orbits to evaluate the equal sweeps of a line joining a planet to the sun (e.g., conservation of angular momentum)
- generalize the effects of Newton’s law of universal gravitation on all particles in the universe
- derive force of attraction between celestial bodies
- define different forms of waves (e.g., compression, transverse, longitudinal, periodic)
- identify the regions of rarefaction within the condensation of a longitudinal sound wave
- determine the velocity of sound wave vibrations through different forms of matter
- relate Hooke’s law to stress and strain
- derive force of attraction between celestial bodies
- distinguish between reflection and refraction using various mirrors and Snell’s Law
- solve light problems isolating the angles of refraction, incidence, and the critical angle to calculate the refractive index and the total internal reflection
- explore the application to fiber optics
- apply polar interference to the perception of images at special angles of incidence (e.g., sunglasses)
- explain how the human eye perceives light and images
- calculate voltage, current, resistance, capacitance, and power
- distinguish between charging by contact and charging by induction
- define and apply Coulomb’s Law
- map the electric force lines of an electric field
- define shielding and draw analogies to the inner shells of an atom
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<td>determine the conservation of energy among conservative forces</td>
<td>use the universal gravitational constant (the big “G”) to determine the force of attraction between two particles or two celestial bodies</td>
<td>relate the power of sound waves over a specified area to the intensity of the sound</td>
<td>compare and contrast different lenses and how they can be combined to correct human sight problems</td>
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<td>combine voltage, electric current, and electrical resistance and synthesize into Ohm’s Law of Constant Resistance</td>
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<tr>
<td>combine Newton’s second law, the impulse of a force, and the linear momentum of an object and synthesize into the Principle of Conservation of Linear Momentum</td>
<td>calculate the orbital radius and the orbital speed of a satellite or planet in orbit around the sun</td>
<td>determine the resultant resonance from driven harmonic motion</td>
<td>investigate the technology of lenses used in instrumentation (e.g., the compound microscope and the telescope)</td>
<td>use Ohm’s Law to solve for all components algebraically</td>
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<td>apply the Impulse-Momentum theorem to problem-solving situations</td>
<td>explore the technology of networked satellites of the Global Positioning System (GPS)</td>
<td>expand on the properties of waves</td>
<td>discuss electromagnetic waves in terms of photons</td>
<td>distinguish the properties of wiring circuits in series and parallel</td>
<td>discuss safety and the physiological effects of current</td>
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<td>distinguish between collisions in one and two dimensions</td>
<td>study celestial objects (e.g., stars, planets, comets, asteroids, galaxies)</td>
<td>draw analogies from waves to sound</td>
<td>explain the photoelectric effect</td>
<td>measure current and voltage using the appropriate measurement tools</td>
<td>compare and contrast the nature of electrical forces and fields to the nature of magnetic forces and fields</td>
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<td>determine the center of mass and gravity of an object</td>
<td>describe the standard model for the evolution of the universe in terms of the divergence of the fundamental forces from the single unified force</td>
<td>determine the requirements for changes in pitch, volume, and frequency</td>
<td>discuss and apply the momentum of a photon, the Compton effect (scattered photons have lowered frequency), and the De Broglie wave length</td>
<td>discuss safety and the physiological effects of current</td>
<td>combine electricity and magnetism into the electromagnetic field and technological applications</td>
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<td>define and use the concepts of torque and rotational kinetic energy to perform work</td>
<td>use exponential and periodic functions to calculate growth/decay and change in the natural world</td>
<td>distinguish among constructive, destructive, diffraction, standing transverse, longitudinal, and complex waves and their effects on sound</td>
<td>examine applications to real-world examples</td>
<td>compare and contrast the nature of electrical forces and fields to the nature of magnetic forces and fields</td>
<td>explore geomagnetic-reversal data (e.g., calculate the average rate of seafloor spreading)</td>
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| **Skills and Topics:** | • model and explain the physical science principles that account for the global energy budget  
• predict the impact changes in internal and external energy sources on biogeochemical systems  
• discuss the greenhouse effect on seasonal weather patterns and climate | | • explain the Doppler effect | | |

| **Integration of Technology:** | Internet, Web Quests, wireless laptop computers, SMART Boards, Vernier™ interface and probes, Graphical Analysis software, multimedia presentations, video streaming, podcasting, NOAA |
| **Writing:** | Open-ended responses, conclusions and analysis of exploratory activities, lab reports |
| **Formative Assessments:** | Warm-up activities, exploratory activities, class discussions, student participation, lab activities, Google applications, google classroom, |
| **Summative Assessments:** | Quizzes, tests, projects, presentations, final examination, lab experiments |
| **Performance Assessments:** | Laboratory reports:  
○ Roller coaster simulations  
○ Momentum on air tracks  
○ Conservation of mechanical energy  
Laboratory report:  
○ Orbits of Earth, the moon, and Mercury | Laboratory reports:  
○ Slinky waves  
○ Speed of sound  
○ Wave properties  
○ Simple harmonic motion  
○ Sound waves using Logger Pro | Laboratory reports:  
○ Mirrors  
○ Lenses  
○ Index of refraction of glass  
○ Curved mirrors  
○ Converging lenses | Laboratory reports:  
○ Ohm’s Law  
○ Series and parallel circuits  
○ Electrostatics  
○ Series and parallel resistors |

*Laboratory experiments and reports include, but are not limited to, the above list.*
## 21st Century Themes:
- Global Awareness
- Civic Literacy
- Financial, Economic, Business, and Entrepreneurial Literacy
- Health Literacy

## 21st Century Skills:
- Creativity and Innovation
- Media Literacy
- Critical Thinking and Problem Solving
- Communication and Collaboration
- Information Literacy
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Course Description

Physics provides students with a comprehensive up-to-date approach to an extensive study of the nature and interaction of forces and energy transformations. Prior physical science knowledge is extended by incorporating advanced mathematical skills including geometric concepts and algebraic operations. Topics include kinematics, dynamics, forces, circular and projectile motion, conservation of energy and momentum, astrophysics, waves, sound, light, optics, and electrostatics. Throughout the Physics course, students explore topics that are directly applied to real-world technologies. The coursework and laboratory explorations prepare students for college courses, as well as advanced courses in the science content area.

Course Content

This course will consist of the following units of study:
- Measurement and Problem Solving
- Kinematics
- Dynamics
- Concurrent and Parallel Forces
- Circular and Projectile Motions
- Conservation of Energy and Momentum
- Law of Universal and Gravitation, Astronomy, and Astrophysics
- Waves and Sound
- Light and Optics
- Electrostatics

Course Objectives

The student will demonstrate the ability to answer in detail the following essential questions:
- Why are Scientific International (SI) standardized units important in science?
- What measurements are necessary to describe motion?
- Why are Newton’s three laws so important?
- How can we analyze force vectors?
- How does circular motion differ from linear motion and how are they similar?
- How can forces and energy be related?
Course Objectives (continued)

- How can natural laws apply universally?
- How do vibrations move?
- How can light behave like a particle and a wave?
- How can electricity be harnessed?
- What are the post-graduation and/or career options that apply to the course content?

Evaluation Process

A final average of 65% or better is required to be awarded course credit. Throughout the length of this course, students may be evaluated on the basis of, but not limited to:

- Formative Assessments, such as writing prompts, journals, and portfolios
- Summative Assessments, such as quizzes, tests, and midterm and final examinations
- Performance Assessments, such as projects and presentations
- Technology-based Applications, such as electronic portfolios, Web Quests, ThinkQuest, and podcasting
- Class Participation
- Homework

Specific weights will be determined by course and level.
Physics
Student Agreement

STUDENT NAME: ____________________________________________________________

Last Name                                             First Name

GRADE: ____________________

My signature below indicates that I have received a copy of the Somerville Public Schools Course Requirements for Physics.

I acknowledge my responsibility to read and understand all of the information contained in the Physics Course Requirements information and syllabus packet.

_________________________________________    __________
Student Signature                                      Date

Note: Please share the course requirements for Physics with your parents.