CARY ACADEMY

UPPER SCHOOL
SCIENCE CURRICULUM

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CARY ACADEMY

Upper School Curriculum

SCI: Biology Pathways 101 - 102

Cary Academy students can choose between two introductory courses in biology, each of which uses a student-centered, active-learning approach with hands-on activities and laboratories that develop inquiry skills and conceptual understandings. Students acquire an in-depth understanding of biology when they are directly involved with the concepts and skills they are learning. Both courses emphasize the process of discovery over the memorization of facts so that students don't just learn about science, they think science. Students should select the introductory biology course that best reflects their interests and preparation, knowing that either course will fulfill Cary Academy graduation requirements and will prepare a student for further study of biology at an advanced level, as well as any other science course.

SCI101: BIOLOGY: ECOLOGICAL FOCUS

This model-based and lab-based course explores the over-arching principals of biology through the lens of ecology. Students will examine how organisms meet the characteristics of life and the interconnection of organisms and their environments at both the macroscopic and microscopic levels. Special emphasis will be placed on energy storage and transfer within and between organisms as well as the variety of strategies and adaptations organisms employ to endure challenges in their environment. Students will examine features of a variety of organisms, both multi- and unicellular, via digital images, microscopic work and dissection. Students will gain scientific literacy skills in the realms of experimental design, research, data collection, analysis, and communication.

SCI102: BIOLOGY: MOLECULAR FOCUS

This inquiry-based and lab-based course explores the fundamental concepts of biology through a molecular perspective. Studying biology from the microscopic to macroscopic levels of the organism, students develop the understanding that DNA and gene expression dictate the form, function, and influence the behavior of living things. Current explanations of evolution and natural selection are examined at the level of genes in populations. Students come to recognize that living systems are chemical systems. The course will include the following seven organizing principles that are designed to promote biological literacy: experimental design; interaction and interdependence; evolution; genetic continuity; growth, development, and differentiation; energy, matter, and organization; and, maintenance of a dynamic equilibrium. Prerequisites: Chemistry: Particle Nature of Matter or Chemistry: Interactive Framework of Matter

CARY ACADEMY

Upper School Curriculum

SCI: Chemistry Pathways SCI 201 - 202

Cary Academy students can choose between two introductory courses in chemistry, each of which asks students to think about their surroundings in terms of atoms–the incredibly tiny building blocks that form us and everything around us. Concepts in these courses are developed in a natural way, starting with direct observations in the laboratory and then moving to the development of models to explain observed behaviors. Students should select the introductory chemistry course that best reflects their interests and their mathematical readiness, knowing that either course will prepare them for further study of chemistry at an advanced level, as well as any biology course.

SCI 201: PARTICLE EXPLORATION OF MATTER

This lab-based course is designed to propel students into the marvels of the atomic world. Students will learn about the physical and chemical properties of matter by making direct observations and developing conceptual models that explain those macroscopic behaviors and their underlying mechanisms at the atomic and molecular level. Students will practice using evidence to support scientific claims and will learn to construct and interpret abstract representations of their knowledge, including graphs, diagrams and equations. Special emphasis will be placed on energy storage and transfer and the role that energy plays in both physical and chemical changes. Students will also explore topics in physical chemistry, including heat transfer, bonding, intermolecular forces, and intramolecular forces.

SCI 202: INTERACTIVE FRAMEWORK OF MATTER

This lab-based course explores the chemical nature of matter by studying the intricacies of atomic interactions. Students will begin by modeling the subatomic structure of atoms, then work their way up toward explanations of the behavior and properties of elements and compounds. The approach is significantly quantitative in character, with an emphasis on data analysis and formal lab reporting. Atomic properties and energy transfers will be used to explain and predict chemical reactions and model the formation of new compounds. The molecular structure of compounds will also provide the foundation for understanding the force interactions at the molecular level. Special topics will include organic chemistry as preparation for basic biochemistry.

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Upper School Curriculum

SCI 301: Physics: Waves, Electricity and Light

How do eyes and vision correction work? What is going on inside the wall when you flip a light switch? Why does a siren sound different when it's coming toward you? Explore the physics of everyday phenomena in a hands-on, collaborative environment. Topics will include the ray model of light, mechanical and light waves, and electric circuits with a primary focus on conceptual understanding. Students will conduct experiments, analyze data, and interpret results to understand the world using the same process used by physicists. This course fulfills the physics graduation requirement. It can also precede or follow a mechanics course for those who want exposure to more physics topics.

GENERAL COURSE OBJECTIVES:

Upon completing the scope of study in this course, a student should be able, at the developmentally appropriate level, to:

Be a **critical thinker** who:

- gathers, analyzes and evaluates evidence, arguments, claims and beliefs
- recognizes how parts of a whole interact to produce overall outcomes
- can estimate quantitative solutions to appropriate situations
- demonstrates logical reasoning in solving a problem

Be a **creative thinker** who:

- visualizes the natural world on both macro- and micro- scales
- who goes beyond basic mastery of content knowledge and/or skills

Be a **clear and effective communicator** who:

- cooperates effectively with others to generate knowledge and understanding, solve problems, and produce creative works
- articulates his/her findings both orally and in a concise, logical writing style
- interprets graphical and experimental data in a clear and appropriate manner, including drawing cause/effect relationships when appropriate
- illustrates experimental data in a clear graphical or mathematical manner
- draws proper conclusions from experimental and /or graphical data
- uses appropriate lab skills and technology to generate and analyze data, model scientific concepts and present findings

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Upper School Curriculum
SCI 302: Physics: Mechanics

Physics mechanics is a course designed for the student who has a strong background in mathematics. Students gain an understanding of the physical principles that govern mechanics, along with an introduction to electric circuits. Students develop skills in problem solving, critical thinking, and scientific reasoning. Students continue to develop and refine their experimental design skills through laboratory experiences. They use a variety of tools to collect data in the laboratory, and then use mathematics to interpret results. Students use graphing software to develop curve fits and learn to use proportional reasoning to model relationships among variables. Conceptual reasoning and symbols only algebra is emphasized, and so is the skill of articulating the meaning and implications of physical models. Students learn how to tie concepts from different units together to develop a coherent understanding of the physical world. This course prepares students for further study in Physics II.

GENERAL COURSE OBJECTIVES:

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Be a **critical thinker** who:
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SCOPE AND SEQUENCE:

Linear Motion
- Graph Interpretation & Generation
- Linear Motion
- Distance & Speed
- Position, Displacement, Velocity, & Acceleration
- Average vs. Instantaneous

Vectors
- Vectors vs. Scalars
- Addition & Subtraction of Vectors (Graphically & Mathematically using Trigonometry)
- Vector Resolution
- Adding Vectors by Components

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Newton's Laws
- Forces
- Mass vs. Weight
- Newton's Laws of Motion
- Static and Dynamic Equilibrium
- Free Body Diagrams
- Friction
- Inclined Planes

Two-Dimensional Motion
- Circular Motion
- Projectile Motion

Work & Energy
- Work done by constant forces
- Work done by varying forces & springs
- Work-Kinetic Energy Theorem
- Power
- Potential Energy
- Work done by Conservative vs. Non-conservative Forces
- Conservation of Mechanical Energy
- Energy Conservation with Dissipative Forces

Electric Circuits
- Components of a Simple Circuit
- Electric Current
- Resistance & Resistors
- Capacitors
- Series Circuits
- Parallel Circuits
- Ohm's Law
- Equivalent Resistance

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Upper School Curriculum

SCI 305/306/307: Competitive Science Teams

This course is designed to help students who do, or plan to, participate in high school science competitions master the concepts and techniques needed to be successful in their selected competitions. Students focusing on projects will spend their time in hands on work, data analysis and theoretical calculation. Students preparing for a written testing event will be expected to design study and/or review prep materials. Our science competition teams also meet during club time, and students in the class will be expected to attend full club meetings during club time when organizational information is presented, and when collaborating on an event or project with students who are not taking this class. Topics explored in the Science Olympiad, HOSA, and USA Young Physicists team typically include aspects of life science, physics, chemistry, materials science, computer science, scientific inquiry, earth science, astronomy, engineering, forensics, anatomy/physiology.

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Upper School Curriculum
SCI 365: Advanced Physics: Mechanics

This first-year physics course is designed for the student who is taking or has completed Advanced Calculus. Students gain an understanding of the physical principles that govern mechanics and students learn how to carefully analyze complex, university level problems. Students continue to develop and refine their experimental design skills through laboratory experiences. Students use a variety of tools to collect data in the laboratory, and then use mathematics including Calculus to interpret results. They use graphing software to develop curve fits and learn to use proportional reasoning to model relationships among variables. Conceptual reasoning and symbols only algebra is emphasized, as is articulating the meaning and implications of physical models. Students learn how to tie concepts from different units together to develop a coherent understanding of the physical world. While the intent of this course is not solely to prepare students for taking the Advanced Placement test, most students choose to sit for the first half of the Advanced Placement (AP) examination (Physics C), covering mechanics. This course prepares the student for further studies in physics at the Advanced level.

GENERAL COURSE OBJECTIVES:

Upon completing the scope of study in this course, a student should be able, at the developmentally appropriate level, to:

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- draws proper conclusions from experimental and /or graphical data
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SCOPE AND SEQUENCE:

Experiment Design And Analysis
- Procedure Design & Data Collection
- Graph Interpretation & Generation
- Proportional Reasoning & Curve Fitting

Linear Motion
- Distance & Speed
- Linear Position, Displacement, Velocity, & Acceleration
- Average vs. Instantaneous
- Frames of Reference
- Relative Motion

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Rotational Motion
- Angular Position, Displacement, Velocity, & Acceleration

Vectors
- Vectors vs. Scalars
- Addition & Subtraction of Vectors (Graphically & Algebraically)
- Scalar Products
- Vector Cross Products

Newton's Laws
- Forces
- Free Body Diagrams
- Mass vs. Weight
- Newton's Laws of Motion
- Static and Dynamic Equilibrium
- Free Fall
- Friction
- Drag Force & Terminal Speed (Solve using Differential Equations)

Two-Dimensional Motion
- Projectile Motion
- Circular Motion

Universal Gravitation
- Newton's Universal Law of Gravitation
- Orbits of Planets & Satellites

Rotational Dynamics
- Rotational Inertia
- Torque
- Center of Mass
- Rotational Equillibrium

Work & Energy
- Work done by constant forces
- Work done by varying forces & springs
- Work-Kinetic Energy Theorem
- Power
- Potential Energy
- Work done by Conservative vs. Non-conservative Forces
- Conservation of Mechanical Energy
- Energy Conservation with Dissipative Force

Impulse & Momentum
- Center of Mass
- Collisions and Impulse
- Conservation of Momentum in 1 & 2 Dimensions
- Elastic & Inelastic Collisions

Rotational Conservation Laws
- Rotational Kinetic Energy
- Angular Momentum

Oscillations
- Simple Harmonic Motion (Writing & Solving Differential Equations)
- Mass on a Spring
- Pendulums

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- Resonance

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SCI 413: Forensic Science

This course is intended for students interested in learning about the scope of forensic science as evidence is collected, examined and presented in court. The elements of instruction include: discussions led by the teacher as well as guest professionals; a variety of media presentations; practical exercises in the collection and preservation of various types of physical evidence commonly found at the crime scene or in conjunction with a criminal investigation; and field trips to a crime laboratory, court rooms and/or criminal justice academy. Upon completion of this course the student should be familiar with the capabilities of the forensic laboratory and understand the nature and importance of physical evidence as it relates to criminal investigation and court proceedings. Through a variety of lab activities students develop a working knowledge of the proper methods and techniques involved with collection and preservation of the more commonly encountered items of physical evidence.

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SCOPE AND SEQUENCE: OVERVIEW

Crime Scene Investigation: Working the Scene
- Types of Scenes
- Searches
- Collecting Evidence
- Types of Physical Evidence

Fingerprint Evidence
- Patterns and Minutia
- Inking Prints
- Developing Latent Prints
- AFIS and IAFIS

Trace Evidence
- Hair

- Fibers
- Soil
- Glass
- Other

Serology
- Confirmation Tests
- Blood Typing
- Spatter

DNA
- Extraction
- Analysis
- CODIS

Other Impression Evidence
- Shoe Prints
- Tire Tracks
- Tool Marks

Medical Examination: Manner and Cause of Death
- Post Mortem Interval
- Pathology
- Anthropology
- Entomology
- Odontology

Firearms
- Weapons
- Bullets
- Trajectories

Questioned Documents
- Handwriting/Printing
- Paper
- Toxicology
- Drugs
- Other Chemicals

Fire and Explosives
- Arson
- Point of Origin
- Burn Patterns
- Accelerants

Forensic Psychology
- Profiling
- Serial Killers

Forensic Art
- 3-D Reconstructions
- Sketches

Cybercrimes

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Upper School Curriculum

SCI 460: Advanced Biotechnology

This course provides students with a broad overview of the science of biotechnology as it relates to the human health and food production industries, with particular emphasis upon cell biology, genetics, recombinant DNA methodology, and protein production and isolation. Students will develop proficiency in the laboratory techniques unique to the biotechnology field and work in concert with area scientists and academic/industrial partners to apply their learning to authentic experiments.

Prerequisites: Biology and Chemistry (B or better) as well as permission of department chair.

SCOPE AND SEQUENCE:

What is Biotechnology?
The Biotech Lab (Equipment, Lab Safety, Scientific Notebooks, etc.)
The Basics

1) **Pipetting and Micropipettes**
    a. Precision vs. accuracy
2) **Solutions in Biotech**
    a. Application of math in biology
        i. Review of metric system with a focus on small units
        ii. Factor label method for conversion
    b. Making solutions (typical molecular biology solutions)
    c. General procedures (sterile vs. not sterile, equipment, etc.)
        i. Mass/volume solutions
        ii. Percent nass/volume Solutions
        iii. Molar Solutions
    d. Dilutions (serial and other)
3) **Agarose Gel Electrophoresis of Lambda DNA**
    a. Restriction enzyme digestions of lambda DNA
    b. Setting up and running a gel
    c. Visualizing a gel and mapping the DNA (BLAST of lambda DNA, NEB)
4) **DNA Isolation and Measurement- Human DNA**
    a. Buccal cell mouthwash method (human DNA extraction)
    b. Buccal swab method (human DNA extraction)
    c. Spectrophotometry- human DNA and lambda DNA
5) **Diagnostics in Biotechnology**
    a. PCR preparations- making DNA using a plasmid
    b. Genomic DNA testing
        i. PCT taste testing
        ii. Transposon testing
        iii. rimer design

    Experimental Design #1- Diagnostic PCR to investigate some aspect of a genome (bacteria, human, canine, plants) other than human disease diagnostic
    Experimental Design #2 - GMO or other
6) **Bacterial Growth and Plasmid DNA Isolation**
    a. Sterile Technique
    b. Bacterial Growth
    c. Bacterial DNA Extraction
7) **Basic Cloning, Bacterial Transformation, and Plasmid DNA Isolation**
    a. Basic cloning strategies
    b. Cloning of a gene into an expression vector

c. Determination of transformants and confirmation
d. Experimental Design #3- Clone your gene of interest

8) **RT-PCR for measurement of transcription**
9) **Protein Purification and Testing**
    a. Overexpression of a gene in bacteria
    b. Protein purification using his-tag
        i. Running a protein gel
        ii. Characterizing proteins
    c. Analysis of protein activity
        i. Assay development
        ii. Assay troubleshooting

***Independent Experiments**

Experimental Design #4- Student choice

Possibilities for independent experiments:

- A project with a collaborator in RTP or an area university
- Optimization of bacterial growth rates or transformation efficiency
- Optimization of a simple DNA extraction using Chelex, Proteinase K, and Rnase followed by ethanol precipitation.
- Clone a gene from any DNA source using PCR.
- qPCR if we acquire a machine or use a collaborator machine
- Restriction enzyme plasmid mapping
- Bioinformatics and phylogenic trees using GenBank and Clustal Omega
- Antimicrobials in plants
- Plant, canine, or bacterial bioinformatics- create a test to differentiate different sub-types
- Test the quantity of GMOs in foods (requires RT-PCR)
- Protein profiles of various meat (SDS-Page)
- Animal maternity tests
- Canine medical testing (PCR, DNA extraction, cloning, sequencing)
- Test veggie burgers for meat (PCR, DNA extraction)
- Test vegetarian food for insect contamination (PCR, DNA extraction)
- Identification of fish types using protein profiles (protein isolation, SDS-Page)
- Bacterial profiles: Cotton socks vs. those with polyester- (bacterial DNA extraction, sequencing)
- Protein profiles for cooking meat to various "doneness"- (protein isolation, SDS-Page)
- PV92ALU insertions in different populations
- Any other independent project that is approved by the instructor

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Upper School Curriculum

SCI 510: Advanced Biology

This course introduces biology concepts and coursework that are equivalent to college-level introductory biology. Topics introduced in introductory biology and chemistry will be explored in greater detail and will be used to generate an advanced understanding of living organisms and their components. This course provides students with enduring, conceptual understandings of modern biology and the content that supports them, extensive experience with the scientific process and prepares students for the Advanced Placement (AP) Biology exam.

GENERAL COURSE OBJECTIVES:
Upon completing the scope of study in this course, a student should be able, at the developmentally appropriate level, to:

Be a **critical thinker** who:
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SCOPE AND SEQUENCE:

The areas of focus include the following four underlying principles, called the Big Ideas:

Big Idea 1: the process of evolution drives the diversity and unity of life
- A. Evolution: Change over Time
- B. Descent from Common ancestry
- C. Evolution Continues in a Changing Environment
- D. Natural Processes and the Origin of Living systems

Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis
- A. Role of Free Energy and Matter for Life Processes
- B. Cell Maintenance of Internal Environment
- C. Role of Feedback Mechanisms in Homeostasis
- D. Growth and Homeostasis Are Influenced by Environmental Changes
- E. Temporal Regulation and coordination to Maintain Homeostasis

Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes
- A. Heritable Information
- B. Cellular and molecular Mechanisms of Gene Expression
- C. Genetic Variation Can Result from Imperfect Processing

D. How cells Transmit and Receive Signals
E. How Information Transmission Results in Changes

Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties
A. Interactions within Biological Systems
B. Competition and Cooperation
C. Diversity affects Interactions within the Environment

There is an emphasis on science practices with laboratory experiences that involve the development of advanced inquiry and reasoning skills. Investigative techniques will include wet labs, computer simulations and software packages, statistical methodology, dissection and other techniques appropriate for studying biology at this level. This course meets for extended periods – two 45-minute periods AND three 90-minute periods – each week.

CARY ACADEMY

Upper School Curriculum
Science 520: Advanced Chemistry

This course is for students who enjoyed their experience in Chemistry and want to challenge themselves to reach a more thorough understanding of how atoms determine the composition and properties of everything around them. Advanced Chemistry introduces concepts and coursework that are equivalent to college general chemistry and most students in this course choose to sit for the Advanced Placement (AP) Chemistry examination. As a college level course, Advanced Chemistry requires a faster pace and more independent study than Chemistry. This course also requires the student to have a solid foundation of knowledge and skills from introductory chemistry. Some topics from introductory chemistry will be explored in greater detail and many new concepts will be introduced. Laboratory experiences will play an integral role in the program. Advanced Chemistry will meet for extended periods to accommodate the time demands of an advanced laboratory program.

GENERAL COURSE OBJECTIVES:

Upon completing the scope of study in this course, a student should be able, at the developmentally appropriate level, to:

Be a **critical thinker** who:
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SCOPE AND SEQUENCE:

I. Aqueous Chemistry
- The Behavior of Substances in Water
- Reacting Substances Amongst Water Molecules
- Analytical Chemistry

<Brief Introduction to Kinetics (Unit 12 - Part I) >
- How Collisions and Energy Make Reactions Happen!
- What Factors Affect the Speed of a Reaction?

II. Thermodynamics
- Heat Energy and its Measurement
- The Driving Forces of Nature as the Laws of Thermodynamics

III. Atomic Structure and the Periodic Table (supplemental to Chemistry I)
- Exploring the Inner Workings of an Atom

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IV. Chemical Bonding and Molecular Structure (supplemental to Chemistry I)
- Other Theories of Bonding
- The Structure and Nomenclature of Organic Substances

V. The Properties of Gases (supplemental to Chemistry I)
- The Behavior of Chemicals in the Gaseous State

VI. The Condensed States (supplemental to Chemistry I)
- The Behavior of Chemicals in the Liquid and Solid States

VII. The Properties of Solutions
- The Solubility of Substances
- Colligative Properties

VIII. The Equilibrium Condition
- What Happens When Reactions Proceed in Both Directions?

IX. Acid-Base Chemistry
- Acidic, Basic, or Neutral? The Story of Chemical Opposites

X. Solubility and Complex Ion Equilibria
- Is Anything Really Insoluble?

XI. Electrochemistry
- The Relationship Between Chemical Reactions and Electrical Energy

XII. Chemical Kinetics (part II)

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Upper School Curriculum

SCI 550: Advanced Environmental Science

This course introduces environmental science concepts, linking together many disciplines to understand the nature of environmental problems and possible solutions. Aspects of human, social, and political constructs will be included in our study of biological, chemical, and physical aspects of the environment. Opportunities to conduct environmental analyses allow students to delve into current environmental concerns that affect everyday lives worldwide. Topics include: sustainability & global change, earth systems & resources, land & water use, energy production & use, and waste & recycling. A distinct laboratory component allows students to measure and test environmental parameters through lab experiments and field work, and projects allow them to demonstrate understanding of concepts. Content differs significantly from the AP Environmental Science syllabus-students taking the AP Environmental Science exam need to independently study the sections not covered in this course.

GENERAL COURSE OBJECTIVES:

Upon completing the scope of study in this course, a student should be able to:

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SCOPE AND SEQUENCE:

OVERARCHING TOPICS COVERED	SUBTOPICS COVERED
Working in the Laboratory and the Field	o Formulating Hypotheses o Learning the tools for data collection o Collecting data by measuring and observing o Using data to test hypotheses o Analyzing and evaluating results
Earth systems and resources	o The Atmosphere o Global Water resources and use o Soil and soil dynamics (rock cycle)
The Living World	o Biosphere o Biomes

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	o Ecosystem Structure o Energy Flow o Ecosystem Diversity o Natural Ecosystem Change o Natural Biogeochemical Cycles
Populations	o Population biology concepts o Human Population concepts o Poverty and its causes. o Role of Women in Society
Land and Water Use	o Agriculture o Forestry o Rangelands o Other land use such as Urban Development o Mining o Fishing o Global Economics of commodities and energy
Energy Resources and Consumption	o Energy Consumption o Nonrenewable Energy Sources o Nuclear Energy o Energy Conservation o Renewable Energy sources o Energy Infrastructure
Pollution	o Pollution Types o Environmental Impacts o Economic Impacts o Laws
Global Change	o Stratospheric Ozone o Climate Change (Global Warming) o Loss of Biodiversity o Treaties and conventions

Course work is heavily supplemented with hands-on laboratory activities and research projects. All students are taught proper format for writing lab reports and have multiple opportunities to use Internet/technology resources for research, data collection and presentations.

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Upper School Curriculum

SCI 565: Advanced Topics in Physics

This second year physics course is for those students who wish to pursue advanced experiments and advanced calculus-based problem solving. It will focus on algebra and calculus-based studies of electricity and magnetism, and include additional topics in modern physics as time allows. Experiments are designed to measure many of the fundamental constants of the universe such as the charge and mass of the electron, the permittivity and permeability of free space, Planck's constant, and the speed of light. While the intent of this course is not to prepare students for taking the Advanced Placement tests, most students choose to sit for the second half of the Advanced Placement (AP) examination (Physics C), covering electricity and magnetism.

GENERAL COURSE OBJECTIVES:

Upon completing the scope of study in this course, a student should be able, at the developmentally appropriate level, to:

Be a **critical thinker** who:

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- recognizes how parts of a whole interact to produce overall outcomes
- can estimate quantitative solutions to appropriate situations
- demonstrates logical reasoning in solving a problem

Be a creative thinker who

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Be a **clear and effective communicator** who:

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SCOPE AND SEQUENCE:

Experiments and Data Analysis
Design of Experiments
Presentation of Data through Tables and Graphs
Graphical Analysis
Interpretation of graphical information, including physical meaning of slopes/constants.
Scaling Rules

Orbital Mechanics
Introduction to VPython
Review of Universal Gravitation
Field Model Summary
Elliptical Orbit Program and Computational Experiments
Review of Conic Sections
Application to Elliptical Orbits and Hyperbolic Encounter
3-body problem, binary stars, alternate universes

Electric Field
Electrostatic Phenomena
Structure of Matter (Conductors and Insulators)
Coulomb's Law

CARY ACADEMY

Field Vectors and Superposition
Field Lines
Field of a Dipole – VPython simulation, computational experiments and limits
Field of a Dipole – Analytical calculation and limits
Fields of distributed charges – computational experiments
Fields of distributed charges – analytical calculations and limits
Gauss's Law

Electric Potential
Equipotential Lines
Electric Field and Field Strength
Uniform Field Strength and Potential
Point Charge Strength and Potential
Motion of Charges in Electric Fields
Electric Potential of Dipole and Distributed Charges

Electric Circuits
Consequences of the Fundamental Charge
Capacitor and Battery
Surface Charge Density in Current-Carrying Wire
Ohm's Law and Resistivity
Series Circuits
Parallel Circuits
Combination Circuits
Realistic Models of Batteries and Wires
Kirchoff's Rules

Magnetic Field
Magnetic Field Lines
Bar Magnets
Field due to Long Straight Wire
Magnetic Domains
Magnetic Force Law
Motion of Charges in Magnetic Fields
Biot Savart Law
Field due to Configurations of Currents
Ampere's Law
Field due to Solenoid

Electromagnetism
Faraday's law
Generators and Motors
Maxwell's Equations and Light

Relativity
Galilean/Newtonian Space-Time Diagram and Relative Motion
Reference Frames - Synchronizing Clocks
Einsteinian Space-Time Diagram – Time Axis
Einsteinian Space-Time Diagram – Space Axis
Problem-solving with the space-time diagram
Lorentz Transformation Equations
Velocity transformation
Momentum and Energy

Advanced Circuits
RC circuits
RL circuits
RLC circuits
Applications

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AP Exam Review