**AP PHYSICS C (Mechanics and Electricity & Magnetism)**

**Ian Freedman, 2019-20**

**Course Description:** This course is a year-long introduction to college-level physics using calculus. The course covers both (a) Mechanics and (b) Electricity and Magnetism. It emphasizes concepts and skills to solve problems. Laboratory work is an integral part of the course. Students engage in inquiry-based activities to develop their understanding of the course material. Students work together in groups to solve problems. Students present solutions to the class.

**Course Prerequisite**

* Completion of Regents Physics or Honors Physics and strong history in past courses
* Current or previous enrollment in calculus and strong history in past math courses

**Contact Information:**

 ian.freedman@wappingersschools.org

JJHS:845-897-6700

 I’m often in rooms 271, 272 or 273 for extra help

 Students may contact with using Remind. Sign-up information is given later in the syllabus.

**Required Materials:**

 **Scientific calculator or a graphing calculator.** You don’t need a graphing calculator, but it is suggested.

 3-Ring Binder for class notes and handouts

 1-inch 3-Ring Binder to be used as a lab notebook, which will be stored in the classroom

 Pencils (pens are optional, **but pencils are needed for all labs**)

**Restricted materials:**

Students may not to use laptops, tablets or cell phones in class, or other objects that cause distractions.

**Textbook:** Haliday, Resnick & Walker, Fundamentals of Physics (7th Edition)

**Technology:** We will use various technological devices (chromebooks, various sensors, cell phones, computers, etc.) throughout the course.

**Schedule:** Class meets every day during period 3 and on odd-numbered days during period 4.

**AP exam information:**

The AP Physics C exams are on Monday May 4th, 2020 starting at about noon:

 1. Students are strongly encouraged to take the Mechanics test.

 2. Motivated students are also encouraged to take the E&M exam. Due to the amount of content in the curriculum, it’s unlikely we will have time to cover the entire unit on E&M before the test date. Students who wish to take the E&M test will probably need to study independently and solicit additional help outside of regular classroom hours when needed.

**Quiz: On Monday, you will have a multiple-choice quiz on the material contained in the course syllabus!!!** (excludes topics on course outline)

**ROLES AND RESPONSIBILTIES:** In some courses you’ve had before, the teacher’s responsibility was to lecture and your responsibility was to take notes and memorize the material. Not so with this course. In this course, my responsibility is to find ways to help you learn physics. My goals for this course are for you to understand the nature of science through learning physics; understand the big ideas and methods of physics; and develop a lifelong interest in physics. I’ve carefully designed a sequence of lessons and assignments to achieve these goals.

* **Active engagement with daily learning activities.**
* You are expected to **participate in class!**
* You should **ask questions or solicit help**when you need.
* **Physics is hard,** so you may struggle at times. That’s a good thing! That’s how you’ll learn!
* You are expected to do the class work and the homework, and to turn in assignments **on time**.

**CLASS BEHAVIOR AND EXPECTATIONS**

* Please be in your seat when the bell rings.
* Be prepared with all required supplies ready when class starts, **including assignments that are be due.**
* Please **act appropriately and respectfully** **AT ALL TIMES** in class. Please treat my class as a **professional environment**.
* Safety is the top priority in class!!! Please use common sense and practice safety at all times.
* RESPECT is a priority in the classroom. Students are expected to display respectful behavior to the teacher, their peers and themselves at all times. If you are ever unclear of whether an action may be disrespectful or culturally insensitive, it’s probably best to avoid that action or to ask me first.

**RESOURCES:** Thereare many resources to help you with this course.

* Me! I’m often available outside of regular classroom hours. Please don’t hesitate to ask for help or schedule an appointment if you can’t find me in my room/office!!!
* My course page will have files, links and assignments.
* Please work with other students, but do not copy work or let other students copy work. (It is OK to share lab data, but not to copy answers to other questions that require analysis or conclusions)
* Online videos and web sites

**Grading (tentative)**: Is broken down as follows.

**Each quarter:**

 Tests, Quizzes and Video Checks: 60%

 Labs & Assignments: 30%

 Participation, professionalism & preparation 10%

 If I assign projects, they may affect the grade weights mentioned above. Quarter 4, in particular, will likely have a different grading system.

 Note: not all assignments or tests will be weighed equally.

**Total Grade:**

 Quarter 1: 25%

 Quarter 2: 25%

 Quarter 3: 25%

 Quarter 4: 25%

\*Note: if Mr. Freedman decides to assign a final exam and/or final project: each quarter will be weighted 20%, plus the final.

**Homework/Videos:** I sometimes require students to watch videos and take notes as homework. It is **very** important to do this!!! Students who do not watch my videos **ON TIME**, will fall behind in class. (For more info on this practice, look up “Flipped Classroom”).

**Exams & Quizzes.**

 Exams dates and expectations will be made clear in class.

 Please use study guides to prepare for tests!!!

**Attendance & Missed Work:**

* Students are expected to be ON-TIME and to start class promptly!
* If you expect to miss a class, please contact me in advance if possible.
* Students with an excused absence will be allowed to make up missed exams and class work. However, it is **YOUR RESPONSIBILITY** to contact me to work out the details of this.
* Students who miss an exam without an excused absence or otherwise fail to make up a missed test will receive a 0 for that exam.
* Students who fail to turn in any assignment will receive a 0 for that assignment.

**Late Assignments:**

I expect assignments to be turned in on time! You grades will suffer if you do not turn assignments in on time!!!

 Assignments, unless otherwise noted, are due at the beginning of class.

 Late assignments will typically lose at least 30% credit. If they are more than a week late, they will lose 50% credit or more, at my discretion. Assignments turned in after the end of the quarter will not receive a score.

 I reserve the right to assign any score, including a zero, to late assignments.

 I recognize that students sometimes have emergencies or conflicts. If you expect to miss a class, or expect to need an extension on an assignment, please contact me (in advance, when possible) to arrange plans.

**Plagiarism/Copying (Academic Honesty):**

I recognize and appreciate that most studentsare honest and well intentioned. The work in this class can be challenging, and you are **strongly encouraged to speak with me if you ever feel temped to circumvent the rules or present work that is not your own.**

 When there is a question of academic honesty it means that there is a question as to whether the assignment represents your ideas and your work.

 You need to turn in individual, unique lab reports, projects and assignments. Any evidence of copying, lending, cutting and pasting or other plagiarism will be given an automatic zero and may result in disciplinary actions, including failure and/or other penalties as deemed appropriate by the teacher and/or administration.

 Students who knowingly participate in plagiarism by lending their work or lab reports to other students to copy may be subject to the same penalties as mentioned above.

**Labs:**

The course requires at least 20% of the time to be dedicated to labs, although we will certainly do much more than that. Students are expected to engage in inquiry-based lab exercises, to develop an understanding of the course content and to develop an understanding of how scientific laboratories should be conducted, data analysis and error analysis. Students are expected use a composition notebook to journal their lab work. Students will also be expected to present and discuss their results in various forms, such as formal lab reports, oral and poster presentations.

Students will work in small groups to perform weekly student-conducted, hands-on laboratory assignments, but each student must write his or her own report. [SC14 & SC15] Students are to keep a portfolio of all laboratory investigations and reports. [SC16] Laboratories are included in the schedule below. Most labs begin as a problem for which the students must propose and develop their own solution. They then conduct an experiment to test their ideas, make observations, and take measurements. Finally, they form conclusions based on their collected measurements, observations, and data and error analysis. [SC13]

**Tentative Course Outlines**

The aim of AP C course in Physics is to develop the students’ ability to:

1. Read, understand, and interpret physical information—verbal, mathematical, and graphic.

2. Describe and explain the sequence of steps in the analysis of a particular physical phenomenon or problem; that is, describe the idealized model to be used in the analysis, including simplifying assumptions where necessary, state the principles or definitions that are applicable, specify relevant limitations on applications of these principles, carry out and describe the steps of the analysis, verbally or mathematically, and interpret the results or conclusions, including discussion of particular cases of special interest.

3. Use mathematical reasoning - algebraic, geometric, trigonometric, or calculus, where appropriate—in a physical situation or problem. In the achievement of these goals, concentration on basic principles of physics and their application through careful and selective treatment of well-chosen areas is more important than superficial and encyclopedic coverage of many detailed topics.

The AP C course ordinarily forms the first part of the college sequence that serves as the foundation for physics students majoring in the medical arts, physical sciences, or engineering. Methods of the calculus are used wherever appropriate in formulating physical principles and in applying them to physical problems. Strong emphasis is placed on solving a variety of challenging problems, some requiring the calculus. The culmination of the AP course is the AP Examination.

**Mechanics Course Outline**

The course covers Newtonian mechanics in depth and provides instruction in each of the following six content areas outlined in the Course Description:

* Kinematics
* Newton’s laws of motion
* Work, energy, and power
* Systems of particles, linear momentum
* Circular motion and rotation
* Oscillations and gravitation

**Mechanics Topic Overview**

|  |  |  |
| --- | --- | --- |
| Scoring Component | Textbook chapters |  |
|  |  |  |
| SC1 | 1-4 | Newtonian mechanics and kinematics |
| SC 2 | 5-6 | Newtonian mechanics Newton’s Laws of Motion |
| SC 3 | 7 | Newtonian mechanics and instruction in work |
| SC 4 | 7-8 | Newtonian mechanics and instruction in energy |
| SC 5 | 8 | Newtonian mechanics and instruction in power |
| SC 6 | 9 | Newtonian mechanics and instruction in systems of particles |
| SC 7 | 9 | Newtonian mechanics and instruction in linear momentum |
| SC 8 | 10-11 | Newtonian mechanics and instruction in circular motion |
| SC 9 | 10-11 | Newtonian mechanics and instruction in rotation |
| SC 10 | 12 | Newtonian mechanics and instruction in oscillations |
| SC 11 | 13 | Newtonian mechanics and instruction in gravitation |
| SC 12 |  | Introductory differential and integral calculus |
| SC 13 |  | The course uses guided inquire and student-centered learning to foster the development of critical thinking skills |
| SC 14 |  | Students spend a minimum of 20% of instructional time engaged in laboratory work |
| SC 15 |  | A hands-on laboratory component is required |
| SC 16 |  | Each student shall complete a lab notebook or portfolio of lab reports |

**Unit 1: Vectors**

Time: 9 periods

 Unit Objectives:

The student shall:

• Describe the coordinates of a point in space using both Cartesian coordinates and polar coordinates.

• Distinguish between vector quantities and scalar quantities.

• Understand and describe the basic properties of vectors such as the rules of vector addition and graphical solutions for addition of two or more vectors.

• Resolve a vector into its rectangular components.

• Understand the use of the i —j—k unit vectors and describe any vector in terms of its components.

 Unit Content:

1-1 Coordinate Systems and Frames of Reference.

1-2 Vector Quantities and Scalar Quantities.

1-3 Vector Properties.

1-4 Components of a Vector and Unit Vectors.

1-5 Problem Solving Strategies and Procedures.

Tentative Lab Work:

 Graphical Analysis

 Force Table

**Unit 2: Kinematics**

Time: 10 periods

 Unit Objectives:

The student shall:

• Define the displacement and average velocity of a particle in motion.

• Define the instantaneous velocity and understand how this quantity differs from average velocity.

• Define average acceleration and instantaneous acceleration.

• Construct position versus time and velocity versus time graphs for a particle in motion along a straight line.

• From these graphs, determine both average and instantaneous values of velocity and acceleration.

• Obtain the instantaneous velocity and instantaneous acceleration if the position of a particle is given as a function of time.

• Recognize that the equations of kinematics apply when motion occurs under constant acceleration and be able to derive the equations of kinematics from the definitions of acceleration, velocity, and displacement.

• Describe what a body in free fall means. Recognize that the equations of kinematics directly apply to free-fall.

• Apply the equations of kinematics to any situation where the motion occurs under constant acceleration.

 Unit Content:

2-1 One Dimensional Motion.

2-2 One Dimensional Motion with Constant Acceleration.

2-3 Freely Falling Bodies.

2-4 Kinematics Equations Derived from the Calculus.

Tentative Lab Work:

Uniformly Accelerated Motion

Acceleration due to Gravity

**Unit 3: Two-Dimensional Motion**

Time: 7 periods

 Unit Objectives:

The student shall:

• Describe the displacement, velocity, and acceleration of a particle moving in the xy plane.

• Derive expressions for the velocity and displacement as functions of time for a particle moving in a plane with constant acceleration.

• Recognize that two-dimensional motion in the xy plane with constant acceleration is equivalent to two independent motions along the x and y directions with constant acceleration components.

• Discuss the assumptions used in describing projectile motion; that is, two-dimensional motion in the presence of gravity.

• Develop expressions for velocity components and coordinates of a projectile at any time t, in terms of its initial velocity components.

• Predict the position, velocity, range, and maximum altitude of a projectile as a function of time when its projection angle and initial velocity are given.

• Understand the nature of the acceleration of a particle moving in a circle in the xy plane at constant speed.

• Describe the components of acceleration of a particle moving in a curved path, where both the magnitude and direction of v are changing with time.

• Realize that the outcome of a measurement of the motion of a particle depends on the frame of reference of the observer.

 Unit Content:

3-1 Displacement, Velocity, and Acceleration Vectors.

3-2 Motion in Two Dimensions with Constant Acceleration.

3-3 Projectile Motion.

3-4 Uniform Circular Motion.

3-5 Tangential and Radial Acceleration in Curvilinear Motion.

Tentative Lab Work:

Projectile Motion

**Unit 4: Newton’s Laws of Motion**

Time: 11 periods

 Unit Objectives:

The student shall:

• Discuss the concept of force and the effect of an unbalanced force on the motion of a body.

• Distinguish between contact forces and action-at-a-distance forces.

• Be able to identify the four fundamental forces of nature.

• Discuss Newton’s Three Laws of Motion and give physical applications.

• Discuss the concepts of mass and inertia and fully understand the difference between mass and weight.

• Be fully familiar with the SI units of force, mass, weight, and acceleration.

• Define the forces of kinetic friction and static friction and suggest a means of measuring them.

• Draw a free-body diagram for a body or a system of bodies at rest and identify all forces in static equilibrium and solve for all unknown parameters.

• Draw a free-body diagram for a body or a system of bodies in motion with a constant acceleration, set the resultant force equal to the total mass times the acceleration, and solve for the unknown parameters.

 Unit Content:

4-1 Newton's First Law of Motion, the Law of Inertia.

4-2 Action and Reaction, Newton's Third Law of Motion.

4-3 Conditions Necessary for Static or Translational Equilibrium.

4-4 Applications of the First Condition.

4-5 Friction in a Mechanical System.

4-6 The Inclined Plane as a Physical System with Zero Acceleration.

4-7 Mass, Inertia, and Gravitational Weight.

4-8 Resultant Force and Non-Equilibrium.

4-9 Dynamics, Newton's Second Law of Motion.

4-10 Single Body Application of Newton's 2nd Law.

4-11 Application of Newton's 2nd Law to Systems of Bodies.

Tentative Lab Work:

Newton’s Second Law of Motion

Incline Plane

Kinetic and Static Friction

**Unit 5: Centripetal Force and Circular Motion**

Time: 6 periods

 Unit Objectives:

The student shall:

• State the conditions necessary for uniform circular motion.

• Explain how acceleration is possible without a change in speed.

• Calculate the centripetal acceleration of a rotating body.

• Derive the equations of rotational motion and compare them to the equations of linear motion.

• Demonstrate that all equations derived in this unit are dimensionally correct.

• Apply the developed understandings of centripetal force to examples of banked curves and motion in a vertical circle.

• Write verbal and mathematical statements dealing with centripetal and centrifugal force noting the differences.

• Recognize that the motion of a body through a fluid involves forces that have complicated velocity dependence.

 Unit Content:

5-1 Uniform Circular Motion.

5-2 Newton's Second Law and Centripetal Force.

5-3 Motion in a Vertical Circle.

5-4 Motion in a Resistive Medium.

Tentative Lab Work:

Centripetal Force

**Unit 6: Work, Energy, and Power**

Time: 12 periods

 Unit Objectives:

The student shall:

• Define the work done by a constant force, and realizing that work is a scalar.

• Take the dot or scalar product of any two vectors using the definitions of the dot product.

• Recognize that the work done by a force can be positive, negative, or zero.

• Describe the work done by a force that varies with position.

• Define the kinetic energy of a body of mass m traveling with speed v.

• Define the Work-Energy Theorem.

• Define the concept of power.

• Recognize the properties of conservative and non-conservative forces.

• Recognize that the potential energy function can only be defined when dealing with a conservative force.

• State the Law of Conservation of Mechanical Energy noting that mechanical energy is conserved only when conservative forces act on a system.

• Calculate the potential energy function associated with a conservative force.

• Recognize that the gravitational potential energy function can be positive, negative, or zero.

• Account for non-conservative forces acting on a system using the work-energy theorem.

 Unit Content:

6-1 Work Done by a Constant Force.

6-2 Work as the Scalar Product of Two Forces.

6-3 Work Done by a Varying One Dimensional Force.

6-4 Work, Kinetic Energy, and the Work-Energy Theorem.

6-5 Power.

6-6 Conservative and Non-conservative Forces.

6-7 Potential Energy.

6-8 The Law of Conservation of Mechanical Energy and the Work-Energy Theorem.

6-9 Gravitational Potential Energy Near the Surface of the Earth.

6-10 Non-conservative forces and the Work-Energy Theorem.

6-11Energy Diagrams and Stability.

Tentative Lab Work:

Energy Loss on an Incline

Human Horsepower

Hooke’s Law

**Unit 7: Linear Momentum and Impulse**

Time: 9 periods

 Unit Objectives:

The student shall:

 Understand the concept of the linear momentum of a particle.

 Recognize that the impulse of force acting on a particle over some time interval equals the change in momentum of the particle.

 Derive the Law of Conservation of Linear Momentum for a two-particle system using Newton’s Second and Third Laws of Motion.

 Distinguish by definition and example between totally inelastic, partially elastic, and perfectly elastic collisions.

 Predict the velocities of two colliding bodies after impact when the coefficient of restitution, masses, and velocities before impact are given.

Apply momentum principles to two dimensional collisions

 Understand and describe the concept of center of mass for a collection of particles or a rigid body.

 Unit Content:

7-1 Newton's Second and Third Laws and Impulse.

7-2 Linear Momentum and Impulse.

7-3 Conservation of Linear Momentum for a System.

7-4 Collisions- one and two dimensional

7-5 Energy and Work in the Collision Process.

7-6 Center of Mass.

7-7 Motion of a System of Particles.

Tentative Lab Work:

Linear Momentum and Momentum Carts

**Unit 8: Rotational Kinematics**

Time: 10 periods

 Unit Objectives:

The student shall:

• Define the angular velocity and angular acceleration for a particle or a body rotating about a fixed point.

• Recognize that if a body rotates about a fixed axis, every particle in the body has the same angular velocity and angular acceleration.

• Note the similarity between the equations of rotational kinematics and those of linear kinematics.

• Understand and describe the relationships between rotational and linear velocity and angular and linear acceleration.

• Calculate the moment of inertia of a rigid body rotating about a fixed axis.

• Calculate moment of inertia using parallel-axis theorem

• Describe the rotational kinetic energy of a body rotating about a fixed body.

• Understand the concept of torque caused by non-concurrent forces in a system.

• Understand that the resultant torque acting on a body rotating about a fixed axis is a statement of Newton’s Second Law for rotation.

• Recognize that the Work-Energy Theorem can be applied to a rotating rigid body.

 Unit Content:

8-1 Angular Velocity and Angular Acceleration.

8-2 Rotational Kinematics.

8-3 Rotational Motion with Constant Angular Acceleration.

8-4 Relationships Between Rotational Kinematics and Linear Kinematics.

8-6 Calculations of Moments of Inertia. – including parallel axis theorem

8-7 Resultant Torque in Application to Mechanical Systems.

8-8 Work and Energy in Rotational Motion.

Tentative Lab Work:

Moment of Inertia

**Unit 9: Rotational Dynamics, Angular Momentum, and Torque**

Time: 10 periods

 Unit Objectives:

The student shall:

• Define the cross product of any two vectors.

• Define the angular momentum of a particle moving with velocity relative to a specified point.

• Derive the relationship between the resultant torque acting on a particle and the time rate of change of its angular momentum.

• Describe the total angular momentum of a system of particles and a rigid body rotating about a fixed axis.

• Apply the Law of Conservation of Angular to systems of rotating bodies and particles.

 Unit Content:

9-1 Rolling Motion of a Rigid Body.

9-2 Vector Products - The Cross Product.

9-3 Torque as a Cross Product.

9-4 Angular Momentum of a Particle.

9-5 Rotation of a Rigid Body About a Fixed Axis.

9-5 The Conservation of Angular Momentum.

Tentative Lab Work:

Torque – dynamics

**Unit 10: Static Equilibrium of a Rigid Body**

Time: 4 periods

 Unit Objectives:

The student shall:

• Describe the two necessary conditions of equilibrium of a rigid body.

• Locate the center of gravity of a system of particles or a rigid body and understand the subtle difference between center of gravity and center of mass.

• Distinguish between Young’s Modulus, shear modulus, and bulk modulus.

• Determine forces in elastic materials under stress and stain.

• Analyze problems of rigid bodies in static equilibrium using the two conditions of equilibrium.

 Unit Content:

10-1 Rolling Motion of a Rigid Body.

10-2 Vector Products - The Cross Product.

10-3 Torque as a Cross Product.

10-4 Angular Momentum of a Particle.

10-5 Rotation of a Rigid Body About a Fixed Axis.

10-6 The Conservation of Angular Momentum.

Tentative Lab Work:

Torque – Statics

**Unit 11: Oscillatory Motion**

Time: 6 periods

 Unit Objectives:

The student shall:

• Describe the general characteristics of simple harmonic motion, and the significance of the various parameters that appear in the expression for the displacement versus time.

• Start with the expression for the displacement versus time for the simple harmonic oscillator, and obtain equations for velocity and acceleration as functions of time.

• Understand the phase relationships between displacement, velocity, and acceleration for simple harmonic motion, noting that acceleration is proportional to the displacement, but in the opposite direction.

• Determine a value for the phase constant d, given the initial displacement and initial velocity of the body in simple harmonic motion.

• Describe and understand the conditions of simple harmonic motion executed by the mass-spring system (where the frequency depends on k and m) and the simple pendulum (where the frequency depends on L and g).

• Apply energy principles to the simple harmonic oscillator, noting that the total energy is conserved if one assumes there are no non-conservative forces acting on the system.

• Discuss the relationship between simple harmonic motion and the motion of a point on a circle moving with uniform angular velocity.

• Give a qualitative description of damped oscillations and forced oscillations.

 Unit Content:

11-1 Simple Harmonic motion for a simple pendulum.

11-2 Simple Harmonic motion for mass on a spring

11-3 Characteristics of a physical pendulum.

11-4 Energy of oscillators

11-5 Damped and forced oscillations

Tentative Lab Work:

Simple Harmonic Motion on a Spring

**Unit 12: Gravitation**

Time: 6 periods

 Unit Objectives:

The student shall:

• State Kepler’s three Laws of Planetary Motion and recognize that the laws are empirical in nature; that is, they are based on astronomical data.

• Describe the nature of Newton’s Universal Law of Gravitation, and the method of deriving Kepler’s Third Law from this law for circular orbits.

• Recognize that Kepler’s Second Law is a consequence of conservation of angular momentum and the central nature of the gravitational force.

• Understand the concepts of the gravitational field and gravitational potential energy, and know how to derive the expression for the potential energy for a pair of particles separated by some distance d.

• Describe the total energy of a planet or satellite moving in a circular orbit about a large body located at the center of motion. Note that the total energy is negative, as it must be for any closed orbit.

• Understand the meaning of escape velocity, and know how to obtain the expression for it using the principle of conservation of energy.

• Learn the method for calculating the gravitational force between a particle and an extended body.

 Unit Content:

12-1 Newton’s Universal Law of Gravitation.

12-2 Weight and Gravitational Force.

12-3 Kepler’s Laws of Planetary Motion.

12-4 The Gravitational Field.

12-5 Gravitational Potential Energy.

12-6 Energy considerations and Satellite Motion.

12-7 The Gravitational Force between a Particle and a Spherical Mass.

Note: Labs may be added or adapted at instructor’s discretion.

**Electricity & Magnetism Course Outline**

The course provides instruction in each of the following five content areas outlined in the Course Description:

* Electrostatics
* Conductors, capacitors, and dielectrics
* Electric circuits
* Magnetic fields
* Electromagnetism

**E&M Topic Overview**

|  |  |  |
| --- | --- | --- |
| Scoring Component | Textbook chapters |  |
|  |  |  |
| SC1 | 21-24 | Instruction in E&M in electrostatics |
| SC 2 | 21-24 | Instruction in E&M in conductors |
| SC 3 | 25 | Instruction in E&M in capacitors |
| SC 4 | 25 | Instruction in E&M in dielectrics (Gauss’ Law) |
| SC 5 | 26-27 | Instruction in E&M in electric circuits |
| SC 6 | 28-29 | Instruction in E&M in magnetic fields |
| SC 7 | 30 | Instruction in E&M in electromagnetism |
| SC 8 |  | Introductory differential and integral calculus |
| SC 9 |  | The course uses guided inquire and student-centered learning to foster the development of critical thinking skills |
| SC 10 |  | Students spend a minimum of 20% of instructional time engaged in laboratory work |
| SC 11 |  | A hands-on laboratory component is required |
| SC 12 |  | Each student shall complete a lab notebook or portfolio of lab reports |

**Unit 1: The Electrostatic Field**

Time: 13 periods

 Unit Objectives:

The student shall:

• Describe the fundamental properties of electrical charge and the nature of electrostatic forces between charged bodies.

• Describe the processes involved in charging a conductor by contact and by induction.

• Use coulomb’s Law to determine the net electrostatic force on a point electric charge due to a known distribution of a finite number of point charges.

• Calculate the electrical field E (both magnitude and direction) at a specified location in the vicinity of a group of point charges.

• Calculate the electrical field due to a continuous charge distribution the charge may be distributed uniformly or non-uniformly along a line, over a surface, or throughout a volume.

• Visualize qualitatively the electric field throughout a region of space in terms of

 electric field lines.

• Describe qualitatively the motion of a charged particle in a uniform electric field.

 Unit Content:

1-1 Properties of Electrical Charges.

1-2 Insulators and Conductors.

1-3 Coulomb’s Law.

1-4 The Electrical Field.

1-5 Electrical Field of a Continuous Charge Distribution.

1-6 Electrical Field Lines.

1-7 The Motion of Charged Particles in a Uniform Electrical Field.

Tentative Lab Work:

Inductive and Conductive charging of an electroscope

**Unit 2: Electrical Potential and Gauss’ Law**

Time: 13 periods

 Unit Objectives:

The student shall:

• Calculate the electric flux through a surface; in particular, find the net flux through a closed surface.

• Understand that a gaussian surface must be real or imaginary closed surface within a conductor, a dielectric, or in space. Also remember that the net electric flux through a closed gaussian surface is equal to the net charge enclosed by the surface divided by the permittivity constant for free space.

• Use Gauss’ Law to evaluate the electric field at points in the vicinity of charge distributions that exhibit spherical, cylindrical, or planar symmetry.

• Describe the properties that characterize an electrical conductor in electrostatic equilibrium.

• Understand that each pointy in the vicinity of a charge distribution can be characterized by a scalar quantity called the electric potential. The values of this potential function over the region (a scalar field) are related to the values of the electrostatic field over the region (a vector field).

• Calculate the electric potential difference between any two points in a uniform electrical field.

• Calculate the electric potential difference between any two points in the vicinity of a group of point charges.

• Calculate the electric potential energy associated with a group of point charges.

• Calculate the electric potential due to continuous charge distributions of reasonable symmetry.

• Obtain an expression for the electric field (a vector quantity) over a region of space if the scalar electric potential function for the region is known.

• Calculate the work done by an external force in moving a charge q between any two points in an electric field when an expression giving the field function as a function of position is known, or when the charge distribution-giving rise to the field is known.

 Unit Content:

2-1 Electric Flux.

2-2 Gauss’ Law.

2-3 Applications of Gauss’ Law to Charged Insulators.

 A. The point charge.

 B. Spherically symmetric charge distribution.

 C. Thin spherical shell.

 D. Cylindrically symmetric charge distribution.

 E. Non-conducting plane sheet of charge.

2-4 Conductors in Electrostatic Equilibrium.

2-5 Potential Difference and Electric Potential.

2-6 Potential Differences in a Uniform Electrical Field.

2-7 Equal Potential Surfaces.

2-8 Electrical Potential and Potential Energy due to Point Charges.

2-9 Electrical Potential due to Continuous Charge Distributions.

2-10 The Electrical Field Vector and Potential Difference.

2-11 Potential of a Charged Conductor.

2-12 The Millikan Oil-Drop Experiment

Tentative Lab Work:

Mapping electric fields and equipotentials for various charge distributions

**Unit 3: Capacitance and Dielectrics**

Time: 10 periods

 Unit Objectives:

The student shall:

• Use the basic definition of capacitance and the equation for finding the potential difference between two points in an electric field in order to calculate the capacitance of a capacitor for cases of relative simple geometry.

• State the effects of the size and the shape of a conductor on its ability to store a charge.

• Compute the capacitance of a parallel-plate capacitor when the area of the plates is known and their separation in a medium of known dielectric constant are given.

• State three advantages realized by insertion of a dielectric between the plates of a capacitor.

• Define permittivity and give an example illustrating its effect on a capacitor.

• Calculate the equivalent capacitance of a number of capacitors arranged in (1) series, (2) parallel, and (3) combination.

• Determine the energy density of a charged capacitor.

 Unit Content:

3-1 Definition of Capacitance.

3-2 Calculation of Capacitance.

3-3 Combinations of Capacitors.

3-4 Energy of a Charged Capacitor.

3-5 Capacitors with Dielectrics.

Tentative Lab Work:

Qualitative analysis of capacitor characteristics

**Unit 4: Current and Resistance**

Time: 10 periods

 Unit Objectives:

The student shall:

• Calculate the current density, electron drift velocity, and quantity of charge passing a point in a given time interval in a specified current-carrying conductor.

• Determine the resistance of a conductor using Ohm’s Law.

• Calculate the resistance based on the physical characteristics of a conductor.

• Make calculations of the variation of resistance with temperature that involves the concept of the temperature coefficient of resistivity.

• Use Joule’s Law to calculate the power displaced in a resistor.

 Unit Content:

4-1 The Battery.

4-2 Battery Current.

4-3 Resistance and Ohm’s Law.

4-4 Resistance and Resistivity.

4-5 Superconductors.

4-6 Temperature Variation of Resistance.

4-7 Electrical Energy and Power.

Tentative Lab Work:

Resistivity of materials

**Unit 5: Direct Current Circuits**

Time: 13 periods

 Unit Objectives:

The student shall:

• Define electromotive force and the role it plays in DC electrical theory.

• State Ohm's Law for an entire electrical circuit verbally and mathematically and apply it to the solution of electrical problems involving internal battery resistance and total resistance of the circuit.

• Demonstrate Ohm's Law with a voltmeter, an ammeter, a rheostat, a source of emf, and appropriate lead wires and draw a schematic diagram of an electrical set-up, using appropriate symbols for the electrical equipment used.

• Calculate resistance across a bank of resistors in series and parallel.

• Calculate total resistance of an entire circuit.

• Compute power loss in a given DC circuit.

• Apply Kirchhoff’s rules to solve multiloop circuits.

• Calculate the energy expended by a source of emf while charging a capacitor.

 Unit Content:

5-1 The Electromotive Force, emf.

5-2 Resistors in Series and Parallel.

5-3 Kirchhoff’s rules.

5-4 RC Circuits.

Tentative Lab Work:

Series – Parallel Combination circuits

Wheatstone Bridge

Internal Resistance of a battery

RC time constant (charging and discharging)

**Unit 6: Magnetism**

Time: 8 periods

 Unit Objectives:

The student shall:

• Write the basic law of magnetic forces (the Lorentz force) and apply it to physical situations.

• Determine the force on a current-carrying wire placed in a known magnetic field.

• Calculate the magnetic torque on a wire carrying current I when it is orientated in a known magnetic field of strength B.

• Understand the essential features of the mass spectrometer and the cyclotron and make appropriate calculations regarding the operations of these instruments.

 Unit Content:

6-1 Definition and Properties of the Magnetic Field.

6-2 Magnetic Forces on a Current-Carrying Wire.

6-3 Torque on Current-Carrying Loops.

6-4 Motion of a Charged Particle in a Magnetic Field.

Tentative Lab Work:

Mapping magnetic fields for various pole configurations

**Unit 7: The Biot-Savart Law and Ampere’s Law**

Time: 11 periods

 Unit Objectives:

The student shall:

• Use the Biot-Savart Law to calculate the magnetic induction at a specified point in the vicinity of a current element, and by integration

 find the total magnetic field due to a number of important geometric arrangements.

• Understand the basis for defining the ampere and the coulomb in terms of the magnetic force between parallel current-carrying

 conductors.

• Use Ampere’s Law to calculate the magnetic field due to a steady current configuration that have a sufficiently high degree of

 symmetry such as a long straight conductor, a long solenoid, and a toroidal coil.

• Calculate the magnetic field at interior points and at exterior points of a solenoid.

• Calculate the magnetic flux through a surface area placed in a magnetic field.

 Unit Content:

7-1 The Biot-Savart Law.

7-2 Ampere’s Law

7-3 The Magnetic Force Between Two Parallel Conductors.

7-4 The Magnetic Field of a Solenoid.

7-5 Magnetic Flux.

7-6 Gauss’ Law in Magnetism.

7-7 Displacement Current and the Generalized Ampere’s Law.

7-8 Magnetism in Matter.

Tentative Lab Work:

Current Balance

**Unit 8: Faraday’s Law**

Time: 11 periods

 Unit Objectives:

The student shall:

• Calculate the emf (or current) induced in a circuit when the magnetic flux through the circuit is changing in time. The variation in flux might be due to a change in (i) area of the circuit, (ii) magnitude of the magnetic field, (iii) the direction of the magnetic field, or (iv) the orientation of the circuit in the field.

• Calculate the emf induced between the ends of a conducting bar as it moves through a region where there is a constant magnetic field.

• Apply Lenz’s Law to determine the direction of an induced emf or current.

Calculate the maximum and instantaneous value of the sinusoidal emf generated in a conducting loop rotating in a constant magnetic field.

 Unit Content:

8-1 Faraday’s Law of Induction.

8-2 Motional emf.

8-3 Lenz’s Law.

8-4 Induced emf’s and Electric Fields.

8-5 Motors and Generators.

Tentative Lab Work:

Qualitative analysis of induced emf

Lenz’ Law

Investigations of solenoids

**Unit 9: Induction**

Time: 11 periods

 Unit Objectives:

The student shall:

• Calculate the inductance of a device of suitable geometry.

• Calculate the magnitude and direction of the self-induced emf in a circuit containing one or more inductive elements when the current changes with time.

• Determine the instantaneous values of the current in an LR circuit as the current changes with time.

• Calculate the total magnetic energy stored in a magnetic field.

• Calculate the emf induced by mutual inductance.

• Understand the essential features of the LRC circuit.

 Unit Content:

9-1 Self-Inductance.

9-2 Energy in a Magnetic Field.

9-3 Mutual Inductance.

9-4 The LR and LC Circuits.

9-5 The RLC Circuit.

9-6 Maxwell’s Equations

Tentative Lab Work:

Time constant of a RL circuit

**Physics Laboratory Safety Contract**

1. Do not touch laboratory equipment until informed to do so by your teacher.
2. Use only materials and equipment authorized by your instructor.
3. Do not begin the lab until your instructor tells you to do so.
4. DO ONLY EXPERIMENTS THAT ARE ASSIGNED OR APPROVED BY YOUR TEACHER. UNAUTHORIZED EXPERIMENTS ARE PROHIBITED.
5. The physics office and storage rooms are off limits to students, except when specific approval is given by the teacher in charge.
6. Never work alone in the laboratory. A teacher must be present and aware of what you are doing.
7. Listen carefully for special instructions or warnings given by the teacher as part of the introduction to the lab exercise.
8. Please be quiet when the teacher is giving announcements.
9. When working with electrical circuits, be sure that the current is turned off before making any changes in the circuit, and get the teacher’s permission before starting the electrical flow. Your hands, body, and work area need to be dry when working with live circuits. Electricity must be turned off when finished.
10. Please note the location of the emergency shower, eye and face wash fountain, and fire extinguishers, and know how to use them.
11. Students should know the proper fire and safety drill procedures.
12. Student apparel should be appropriate for laboratory work.
13. Work areas should be kept clean and tidy.
14. Students must return equipment to its original placement after each class.
15. Students are financially responsible for lost or broken equipment that results from carelessness or misuse.
16. NEVER engage in horseplay or practical jokes. Do not misuse equipment. Remember, the laboratory is a place of serious work.
17. If you see other students engaging in dangerous, reckless or inappropriate behavior, contact the teacher IMMEDIATELY!
18. **Students should always clean up work areas after each class.**
* **FAILURE TO FOLLOW THE ABOVE RULES WILL RESULT IN DISMISSAL OF THE STUDENT FROM THE LABORATORY.**

How to Be Successful in this Class

This class is like a house, continually building upon a foundation of past topics.

* Understand that this is a difficult class! Even if you did well in past science classes, you might struggle. If so, please talk to me and follow my advice!!!
* Don’t fall behind.
* If you do fall behind, catch up ASAP.
* If you miss class, make up the material ASAP.
* Watch the videos BEFORE class starts.
* Do the homework ON TIME.
* Work and study in groups!
* Talk to me (after class/school or in class) ASAP if you’re starting to struggle.
* It’s not just problem solving. You NEED to understand concepts.
* Do all of your labs.
* Take good notes.
* Participate in class.
* Ask questions if you’re confused.

**Use an AP Physics C review book to study for the AP test.**

I tentatively suggest: Cracking the AP Physics C Exam, 2018 Edition, by The Princeton Review

**Links to Good Regents Physics review Sites**

* www.apphysicslectures.com/
* Khan academy
* Youtube
* www.stmary.ws/highschool/physics/ (for concepts)
* www.stmary.ws/highschool/physics/home/review/review\_all.htm (for more review materials)
* [www.physicsclassroom.com/Class/](http://www.physicsclassroom.com/Class/) (for concepts, simulations and problems)
* http://phet.colorado.edu/ (for simulations)

Sign up for the Physics Email &/or Text Notifications

All students are **REQUIRED** to sign up to **Remind** ([www.remind.com](http://www.remind.com)).

Parents are **strongly encouraged** to sign up as well.

Signing up takes 1 minute, and your contact information remains anonymous to everyone in the class.

**AP Physics:** There are three ways to sign up:

1. Go to [www.remind.com](http://www.remind.com) and enter the code below, OR
2. Text the code below to 81010, OR
3. Download the Remind app and enter the code below. (Note: you do not need to download the app to register)

**STUDENTS:** Enter the class code: **@freeap19**

**PARENTS/GUARDIANS:** Enter the class code: **@freeap19-p**

\*Note: if you text 81010 you will receive text messages. If you use the web site or the app, you can use alternative alert methods, such as email or phone notifications.

Parent/Guardian Handout

Dear Parents/Guardians:

I’m so excited to help your student learn physics this year! This year, we’ll be studying the nature of the universe, from the motion of objects to the wild and amazing behavior of objects like black holes, and much more. Students will do a lot of hands-on learning and lab work, so they will be expected to participate regularly in class activities.

Because physics requires a unique set of thinking and problem-solving skills, it can be challenging for students, including some students who have done well in other science classes. I encourage you to talk regularly with your student about his or her progress. If you sense struggling, please encourage him or her to reach out to me for extra help, or contact me directly with questions, concerns or requests. My contact information is provided below.

Similarly, there will be times when I will want to contact you. For that reason, I ask that you do the following:

1. Please help your student fill out the information form I attached.
2. Please ensure that the school district has your accurate contact information, including email addresses and phone numbers. I will send out occasional emails using the contact information stored in ParentPortal.
3. Please sign up for Remind (See below), which I often use to send out alerts and announcements.
4. I also post announcements on a **class Web page**, which you can find on John Jay’s Web site, through [www.wappingersschools.org](http://www.wappingersschools.org).

Thanks for your support this year. If you ever have questions, the best way to contact me is usually through email. I’m also happy to set up meetings by appointment.

**Signing up for REMIND Notifications**

* All students are **REQUIRED** to sign up to **Remind** ([www.remind.com](http://www.remind.com)).
* Parents are **STRONGLY ENCOURAGED** to sign up as well.
* Signing up takes 1 minute, and your contact information remains anonymous to everyone in the class.
* You may message me directly through the Remind app or Remind.com. This is often the fastest way to reach out to me with brief questions or comments.

**AP Physics:** There are three ways to sign up:

1. Go to [www.remind.com](http://www.remind.com) and enter the code below, OR
2. Text the code below to 81010, OR
3. Download the Remind app and enter the code below. (Note: you do not need to download the app to register)

**STUDENTS:** Enter the class code: **@freeap18**

**PARENTS/GUARDIANS:** Enter the class code: **@freeap18-p**

\*Note: if you text 81010 you will receive text messages. If you use the web site or the app, you can use alternative alert methods, such as email or phone notifications.

Sincerely,

Ian Freedman

John Jay Senior HS, Physics

ian.freedman@wcsdny.org

**Students & Parent/Guardian Information Form**

------ Read, sign, and date, and return THIS PAGE to Mr. Freedman -------

**Student Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**STUDENTS each item initial below to acknowledge the following:**

 read the course syllabus

 abide by the course plagiarism policy

 abide by the Laboratory Safety Contract

 have signed up for Remind

 agree to abide by all class rules and regulations, and to ask questions if you’re ever uncertain about any policies or procedures

Student Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**PARENT/GUARDIANS initial below to acknowledge the following:**

 read the Parent/Guardian HANDOUT

 enroll in Remind in order to receive parent notification (strongly recommended)

 checked to be sure that the district has the correct up-to-date contact information

 student has shown the syllabus to you (optional reading, but I encourage you to look it over)

**Parent/Guardian Name(s):**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Parent/Guardian Signature:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Parent/Guardian Phone #(s) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Parent/Guardian e-mail address(es): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Additional comments or questions?**