

COURSE TITLE

Physics

LENGTH

Full Year

DEPARTMENT

STEM Department

SCHOOL

Rutherford High School

DATE

September 10, 2018

Physics

I. Introduction/Overview/Philosophy

The field of physics investigates natural and human created phenomena such as interactions in terms of forces between objects, the related energy transfers, and their consequences. After completing this course, students should be able to recognize that through a common set of physical principles, mechanisms of cause and effect in all system and processes can be understood.

II. Objectives

Course Outline:

1. Kinematics
 - a. Linear Motion
 - b. Free Fall
 - c. 2-D motion (projectiles)
2. Newton's Law (Forces/Dynamics)
 - a. First Law
 - b. Second Law
 - c. Third Law
 - d. Friction
 - e. Tension
 - f. Inclined Planes
3. Circular Motion
 - a. Centripetal Force
 - b. Gravitation
 - c. Satellite Motion
 - d. Orbits
4. Momentum
 - a. Momentum/Impulse
 - b. Linear Collisions
 - c. 2-D Collisions
5. Energies
 - a. Kinetic Energy
 - b. Gravitational Potential Energy
 - c. Elastic Energy
 - d. Work and Work/Energy Theorem
 - e. Conservation Laws
6. Waves/Sound
 - a. Wave forms and pulses
 - b. Interference
 - c. Resonance
 - d. Open/closed pipes
 - e. Beats

7. Electric Forces
 - a. Introduction to Charge
 - b. Coulomb's Law
 - c. Conceptual Application
 - d. Numerical Application
8. E&M Waves (Including Quantization)
 - a. Light as a wave
 - b. Light as a particle
 - c. Photoelectric Effect
 - d. Common everyday applications/observations
9. Applied Physics (Real Scenarios)
 - a. Project 1: Popular Physics Research Project
 - b. Project 2: Hollywood Physics Research Project
 - c. Macgyver Physics

Student Outcomes:

After successfully completing this course, the student will:

- Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
- Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision
- Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
- Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
- Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
- Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
- Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

New Jersey Student Learning Standards***CAREER READY PRACTICES***

CRP1 Act as a responsible and contributing citizen and employee.

Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

CRP2 Apply appropriate academic and technical skills.

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation

CRP4 Communicate clearly and effectively and with reason.

Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

CRP5. Consider the environmental, social and economic impacts of decisions.

Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.

CRP6. Demonstrate creativity and innovation.

Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

CRP7. Employ valid and reliable research strategies.

Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.

Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

CRP11. Use technology to enhance productivity.

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

TECHNOLOGY

Standard 8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.

Strand A. Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.

8.1.12.A.3- Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.

Standard 8.2 Technology Education, Engineering, Design, and Computational Thinking - Programming:

All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

Strand C. Design: The design process is a systematic approach to solving problems.

8.2.12.C.5- Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.

Strand E. Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.

8.2.12.E.1- Demonstrate an understanding of the problem-solving capacity of computers in our world.

21ST CENTURY LIFE AND CAREERS***9.2 Career Awareness, Exploration, and Preparation******Strand C: Career Preparation***

9.2.12.C.1 Review career goals and determine steps necessary for attainment.

COMPANION STANDARDS FOR SCIENCE AND TECHNICAL SUBJECTS

RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

NEW JERSEY STUDENT LEARNING STANDARDS- SCIENCE

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media

HS-PS4-2. Evaluate questions about the advantages of using digital transmission and storage of information

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

III. Proficiency Levels

Physics is appropriate for all students who have completed at least two years of science.

IV. Methods of Assessment

Student Assessment

The teacher will provide a variety of assessments during the course of the year. The assessment may include but is not limited to: homework, class participation, tests and quizzes, laboratory reports, research reports, and projects.

Curriculum/Teacher Assessment

The teacher will provide the subject area supervisor with suggestions for changes on an ongoing basis.

V. Grouping

Physics is appropriate for grade 11 and 12 students.

VI. Articulation/Scope & Sequence/Time Frame

Course length is one year.

VII. Resources

Texts/Supplemental Reading/References

Resources include but are not limited to:

1. Text
 - a. Zitzewitz, Paul. Physics, Principles and Problems. Glencoe/McGraw Hill, Columbus Ohio, 2002.
2. Additional Resources
 - a. Faughn, Jerry and Raymond Serway. Holt Physics. Holt, Rinehart and Winston. Austin, 2000.
 - b. Hewitt, Paul. Conceptual Physics. Prentice Hall, Upper Saddle River, NJ. 2002.
 - c. Various websites appropriate to topics being studied.

VIII. Suggested Activities

Appropriate activities are listed below in the curriculum map.

IX. Methodologies

The following methods of instruction are suggested: lecture, working in groups/working with a partner, laboratory experiments, and hands-on activities.

X. Interdisciplinary Connections

Applications to math, biology, and language arts literacy will be made on a daily basis through a variety of projects and explorations.

XI. Differentiating Instruction for Students with Special Needs: Students with Disabilities, Students at Risk, English Language Learners, and Gifted & Talented Students

Differentiating instruction is a flexible process that includes the planning and design of instruction, how that instruction is delivered, and how student progress is measured. Teachers recognize that students can learn in multiple ways as they celebrate students' prior knowledge. By providing appropriately challenging learning, teachers can maximize success for all students.

Differentiating in this course includes but is not limited to:

Differentiation for Support (ELL, Special Education, Students at Risk)

- Peer mentoring on problems
- Differentiated teacher feedback on assignments
- Modeling out problems on whiteboard
- Visual aids as we project problems on whiteboard

- Study guides
- Tiered assignments
- Scaffolding of materials and assignments
- Re-teaching and review
- Guided note taking
- Exemplars of varied performance levels
- Multi-media approach to accommodating various learning styles

Differentiation for Enrichment

- Supplemental reading material for independent study
- Flexible grouping
- Tiered assignments
- Topic selection by interest
- Enhanced expectations for independent study
- Elevated questioning techniques using Webb's Depth of Knowledge matrix

XII. Professional Development

The teacher will continue to improve expertise through participation in a variety of professional development opportunities.

XII. Curriculum Map/Pacing Guide

| Unit Topic | Time Allocated | Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students | Standards | Assessments |
|--|----------------|---|---|---|
| Kinematics <ul style="list-style-type: none"> • Linear Motion • Free Fall • 2-D motion (projectiles) | 6 weeks | <i>For Support:</i> College Board Equation Sheet, graphing calculator <i>For Enhancement:</i> Real world applications, Phet Computer, Simulations, Student Choice, Student driven projects | HS-PS2-1 CRP1,2,4,6,7,9,10,12 8.1.12.A.3 8.2.12.C.5 8.2.12.E.1 RST.11-12.3 RST.11-12.4 WHST11-12.2 | <i>Formative Assessment:</i> Homework, classwork, hands-on demos, labs, questioning <i>Summative Assessment:</i> Quiz – Linear Motion Quiz – Free Fall Test – Free Fall/Linear Motion Quiz – 2-D motion Test – All kinematics |
| Newton’s Law (Forces/Dynamics) <ul style="list-style-type: none"> • First Law • Second Law • Third Law • Friction • Tension • Inclined Planes | 8 weeks | <i>For Support:</i> College Board Equation Sheet, graphing calculator, Khan Academy <i>For Enhancement:</i> Analytical thinking tasks, Real world applications, Phet Computer, Simulations | HS-PS2-1 HS-PS2-2 HS-PS2-5 CRP1,2,4,6,7,9,10,12 8.1.12.A.3 8.2.12.C.5 8.2.12.E.1 RST.11-12.3 RST.11-12.4 WHST11-12.2 | <i>Formative Assessment:</i> Homework, classwork, questioning, labs <i>Summative Assessment:</i> Quiz – Newton’s Laws (concept) Quiz – 2 nd Law simple applications Quiz – 3 rd law applications Test – Newton’s Laws Quiz – Friction/Tension Quiz Inclined Plane Test – All Forces Benchmark |
| Circular Motion <ul style="list-style-type: none"> • Centripetal Force • Gravitation | 4 weeks | <i>For Support:</i> College Board Equation Sheet, graphing calculator, Use of Prompts | HS-PS2-1 HS-PS2-4 HS-PS2-5 HS-ESS1-4 | <i>Formative Assessment:</i> Homework, classwork, hands-on demos, labs, group work |

| Unit Topic | Time Allocated | Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students | Standards | Assessments |
|---|----------------|--|---|--|
| <ul style="list-style-type: none"> • Satellite Motion • Orbits | | <i>For Enhancement:</i> Real world applications, Phet Computer, Simulations, Adjusted Student pacing | CRP1,2,4,6,7,9,10,12 8.1.12.A.3 8.2.12.C.5 8.2.12.E.1 RST.11-12.3 RST.11-12.4 WHST11-12.2 | <i>Summative Assessment:</i> Quiz – Centripetal force/circular motion Quiz – Applications to other forces Quiz – Gravitation Test – Satellite Motion Quiz – Orbits Test – Circular Motion |
| Momentum <ul style="list-style-type: none"> • Momentum/Impulse • Linear Collisions • 2-D Collisions | 3 weeks | <i>For Support:</i> College Board Equation Sheet, graphing calculator, Testing Accommodations, <i>For Enhancement:</i> Interest based content, Real world applications, Phet Computer, Simulations, | NGSS: HS-PS2-2 HS-PS2-3 CRP1,2,4,6,7,9,10,12 8.1.12.A.3 8.2.12.C.5 8.2.12.E.1 RST.11-12.3 RST.11-12.4 WHST11-12.2 | <i>Formative Assessment:</i> Homework, group work, classwork, hands-on demos, labs <i>Summative Assessment:</i> Quiz – Momentum, Impulse, 1-D collisions Quiz – 2-D collisions Test – Momentum |
| Energies <ul style="list-style-type: none"> • Kinetic Energy • Gravitational Potential Energy • Elastic Energy • Work and Work/Energy Theorem • Conservation Laws | 4 weeks | <i>For Support:</i> College Board Equation Sheet, graphing calculator, Rephrasing of Questions, Pre-teaching of vocabulary <i>For Enhancement:</i> Khan Academy, Phet Computer, Simulations, Adjustment Student pacing | HS PS3-1 HS PS3-2 HS PS3-3 CRP1,2,4,6,7,9,10,12 8.1.12.A.3 8.2.12.C.5 RST.11-12.3 RST.11-12.4 WHST11-12.2 | <i>Formative Assessment:</i> Homework, classwork, hands-on demos, labs <i>Summative Assessment:</i> Quiz – Kinetic and Potential Energy Quiz – Elastic Energy and its conservation Quiz – Complex conservation laws Test – Energies and Conservation Laws Benchmark |
| Waves/Sound <ul style="list-style-type: none"> • Wave forms and pulses | 2 weeks | <i>For Support:</i> College Board Equation Sheet, | HS-PS4-1 CRP1,2,4,6,7,9,10,12 | <i>Formative Assessment:</i> Homework, classwork, hands-on demos, labs |

| Unit Topic | Time Allocated | Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students | Standards | Assessments |
|---|----------------|--|---|--|
| <ul style="list-style-type: none"> • Interference • Resonance • Open/closed pipes • Beats | | graphing calculator, Khan Academy, Use of prompts <i>For Enhancement:</i> Real world applications, Phet Computer, Independent Study, Adjustment Student pacing | 8.1.12.A.3 8.2.12.C.5 RST.11-12.3 RST.11-12.4 WHST11-12.2 | <i>Summative Assessment:</i> Quiz – Waves and interference Quiz – Resonance (pipes) and beats Test – Sound unit |
| Electric Forces <ul style="list-style-type: none"> • Introduction to Charge • Coulomb’s Law • Conceptual Application • Numerical Application | 3 weeks | <i>For Support:</i> College Board Equation Sheet, graphing calculator, Scaffolding, Teacher Modeling <i>For Enhancement:</i> Extension Activities, Real world applications, Phet Computer, Simulations, | HS-PS1-3 HS-PS2-4 CRP1,2,4,6,7,9,10,12 8.1.12.A.3 RST.11-12.3 RST.11-12.4 WHST11-12.2 | <i>Formative Assessment:</i> Group work, homework, classwork, hands-on demos, labs <i>Summative Assessment:</i> Quiz – Charge and Coulomb’s Law Concepts Quiz – Numerical and Conceptual Applications Test – Electrical Forces |
| E&M Waves (Including Quantization) <ul style="list-style-type: none"> • Light as a wave • Light as a particle • Photoelectric Effect • Common everyday applications/observations | 4 weeks | <i>For Support:</i> College Board Equation Sheet, graphing calculator, Authentic Assessments <i>For Enhancement:</i> Real world applications, Phet Computer, Simulations, Student-driven projects | HS-PS4-1 HS-PS4-2 CRP1,2,4,6,7,9,10,12 8.1.12.A.3 RST.11-12.3 RST.11-12.4 WHST11-12.2 | <i>Formative Assessment:</i> Homework, questioning, classwork, hands-on demos, labs <i>Summative Assessment:</i> Quiz – Simple energy/power calculations Quiz – conceptual photoelectric analysis Test – Application to everyday observations |
| Applied Physics (Real Scenarios) <ul style="list-style-type: none"> • Project 1: Popular Physics Research Project • Project 2: Hollywood | 4 weeks | <i>For Support:</i> Internet searches, white paper references, student-centered calculations | HS-PS1 HS-PS2 HS-PS3 HS-PS4 CRP1,2,4,6,7,9,10,12 | <i>Formative Assessment:</i> Homework, classwork, research and presentations <i>Summative Assessment:</i> |

| Unit Topic | Time Allocated | Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students | Standards | Assessments |
|---|----------------|---|---|--|
| Physics Research Project • Final Assessment – Macgyver Physics (compare to science consultant on production staff) | | <i>For Enhancement:</i> Real world applications, Phet Computer, Simulations, Adjustment Student pacing | 8.1.12.A.3 8.2.12.C.5 RST.11-12.3 RST.11-12.4 WHST11-12.2 | Project 1 - research will count as a quiz grade, presentation will count as a test grade Project 2 - research will count as a quiz grade, presentation will count as a test grade Final Benchmark Assessment |