Board Approved
October 2015

Wilson Area School District
Planned Course Guide

Title of Planned Course: Project-based Physics

Subject Area: Science

Grade Level: 12

Course Description: Project-based Physics will reinforce the concepts introduced in the introductory physics course in a project-based environment. Communication skills and writing are emphasized over mathematical models. A journal will be kept throughout the course and students will be expected to complete daily journal entries. Each unit of study will culminate with a capstone project that will require students to complete a performance-based assessment.

Time/Credit for this Course: ½ year / 0.5 credit

Curriculum Writer: John Harvey

Board Approved
October 2015

Wilson Area School District
Planned Course Materials

Course Title: Project-based Physics

Supplemental Books: "How Things Work: The physics of everyday life"
Louis Bloomfield

Teacher Resources:

- Various websites
  - Howstuffworks.com
  - Teachengineering.com

Board Approved
October 2015

Curriculum Map

Week 1 – 4

Fan (rubber band) carts – (Chapter 1, The Laws of Motion)

- Rockets
- Dropped objects
- Cars, ramps, and constant velocity objects
- projomo

Week 5 – 9

Make-a-Mobile – (Chapter 2, The Laws of Motion part 2)

- Seesaws
- Friction experiments (method to reduce friction)
- Collisions (effect of speed, mass, type of collision)
- Angular momentum

Week 10 – 14

Roller Coasters (Chapter 3, Mechanical Objects)

- Springs and spring scales
- Multi springs and multi scales
- Bouncing balls (COR)
- Carousels (rotational motion and radius)

Week 15 - 18

Electric House (Chapter 10, section 3, Electric Curcuits)

- Simple circuits
- Home wiring
- Fuses and nichrome wire
- Motors and power/energy

Special Interest Project (individual or group)

a. Students create a project and explain the physics principles behind it.

Final Exam

Matchbox and track
Create an experiment and carry it out

Board Approved
October 2015

Curriculum Scope and Sequence

Planned Course: Applied Physics II

Unit: Laws of Motion I

Time Frame: 4 weeks

State Standards: 3.1.12.A, B, C, D, E; 3.2.12.A, B, C, D; 3.4.12.C; 3.7.12.A, B

Anchor(s) or adopted anchor: S11.A.1.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.C.3.1

Essential content/objectives: At end of the unit, students will be able to:

- Apply the principles of kinematics to models of one and two-dimensional motion
- Graphically analyze the motion of moving objects
- Analyze the effect of force on a mass
- Identify the forces acting on an object
- Determine the net force on an object
- Determine the work done on an object under the influence of forces
- Estimate the mechanical advantage of a ramp in lifting an object

Core Activities: Students will complete/participate in:

- Instructor-led discussions
- Individual journaling exercises
- Prefabricated and design experiments
- Capstone projects and conceptual problem sets

Extensions:

- Research opportunities
- Next-time Questions

Remediation:

- Small group reinforcement

Instructional Methods:

- Direct instruction
- Demonstrations
- Lab activities
- Inquiry-based learning
- Journaling

Materials & Resources:

- Readings
- Computers
- Internet
- Lab equipment

Assessments:

- Journal entries
- Lab reports
- Problem sets
- In-class Q&A

Board Approved
October 2015

Curriculum Scope and Sequence

Planned Course: Applied Physics II

Unit: Laws of Motion II

Time Frame: 4 weeks

State Standards: 3.1.12.A, B, C, D, E; 3.2.12.A, B, C, D; 3.4.12.C; 3.7.12.A, B

Anchor(s) or adopted anchor: S11.A.1.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.C.3.1

Essential content/objectives: At end of the unit, students will be able to:

- Examine the differences between rotational and translational motion
- Apply the concept of net torque and static equilibrium to a mechanical model
- Identify the center of mass of various objects
- Identify the forces acting on an object
- Analyze the effect of friction on stationary, sliding and rolling objects
- Relate the concepts of work, energy, time and power
- Analyze the Impulse-momentum theorem

Core Activities: Students will complete/participate in:

- Instructor-led discussions
- Individual journaling exercises
- Prefabricated and design experiments
- Capstone projects and conceptual problem sets

Extensions:

- Research opportunities
- Next-time Questions

Remediation:

- Small group reinforcement

Instructional Methods:

- Direct instruction
- Demonstrations
- Lab activities
- Inquiry-based learning
- Journaling

Materials & Resources:

- Readings
- Computers
- Internet
- Lab equipment

Assessments:

- Journal entries
- Lab reports
- Problem sets
- In-class Q&A

Board Approved
October 2015

Curriculum Scope and Sequence

Planned Course: Applied Physics II

Unit: Mechanical Objects

Time Frame: 4 weeks

State Standards: 3.1.12.A, B, C, D, E; 3.2.12.A, B, C, D; 3.4.12.C; 3.7.12.A, B

Anchor(s) or adopted anchor: S11.A.1.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.C.3.1

Essential content/objectives: At end of the unit, students will be able to:

- Analyze springs as they adhere to Hooke's Law
- Relate the restoring force in a spring to weight
- Use apparent weight to determine the acceleration of an object
- Determine the coefficient of restitution of different objects using energy conservation principles
- Relate the speed of a rotating object to its radius of rotation
- Analyze the forces involved in playground and amusement park rides
- Analyze energy conservation in a roller coaster

Core Activities: Students will complete/participate in:

- Instructor-led discussions
- Individual journaling exercises
- Prefabricated and design experiments
- Capstone projects and conceptual problem sets

Extensions:

- Research opportunities
- Next-time Questions

Remediation:

- Small group reinforcement

Instructional Methods:

- Direct instruction
- Demonstrations
- Lab activities
- Inquiry-based learning
- Journaling

Materials & Resources:

- Readings
- Computers
- Internet
- Lab equipment

Assessments:

- Journal entries
- Lab reports
- Problem sets
- In-class Q&A

Board Approved
October 2015

Curriculum Scope and Sequence

Planned Course: Applied Physics II

Unit: Electric Circuits

Time Frame: 4 weeks

State Standards: 3.1.12.A, B, C, D, E; 3.2.12.A, B, C, D; 3.7.12.A, B

Anchor(s) or adopted anchor: S11.A.1.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.C.3.1

Essential content/objectives: At end of the unit, students will be able to:

- Identify the basic components of a DC circuit
- Apply Ohm's Law to basic circuit designs
- Analyze basic series and parallel circuits
- Analyze a combination circuit
- Draw and physically build each of the above circuit types
- Explain the use of fuses and circuit breakers in household applications
- Wire a switch, outlet and lightbulb socket as found in home construction

Core Activities: Students will complete/participate in:

- Instructor-led discussions
- Individual journaling exercises
- Prefabricated and design experiments
- Capstone projects and conceptual problem sets

Extensions:

- Research opportunities
- Next-time Questions

Remediation:

- Small group reinforcement

Instructional Methods:

- Direct instruction
- Demonstrations
- Lab activities
- Inquiry-based learning
- Journaling

Materials & Resources:

- Readings
- Computers
- Internet
- Lab equipment

Assessments:

- Journal entries
- Lab reports
- Problem sets
- In-class Q&A

Board Approved
October 2015

Capstone Projects

Each of the four curricular units will include a capstone project which incorporates most of the relevant topics within each unit. The four projects are outlined below:

Unit 1 Capstone: Mini racer

Objective: to design and build a racecar using stored energy as the power source.

Materials:

- Mousetraps provided by the students
- Rubberbands and string provided by the instructor

Analysis: Students will compete for several factors, including top speed, acceleration, and distance covered. Measurements to be made are interval distance, interval time, total distance, total time. Calculations to be made include: interval speed, average speed, interval acceleration. From these calculations, and corresponding graphs, the concept of max acceleration and max speed will be determined.

Unit 2 Capstone: Mini mobiles

Objective: to design and create a mobile that will remain in static equilibrium

Materials:

- Dowels provided by the instructor
- Lightweight thread provided by the student
- Minimum of 6 objects to hang from mobile provided by the student (student choice)

Analysis: Students will attempt to design and create a mobile in which each dowel rod will hang horizontally. The mobile must have a theme. Each component of the mobile should contribute to the theme. Independent buyers (judges) will be brought in to try and identify the theme. The mobiles will then be ranked in terms of design, balance, creativity, and theme.

Unit 3 Capstone: Paper Roller Coaster

Objective: to design and build a roller coaster out of paper that earns the most points in a cost/benefit analysis.

Materials:

- Roller coaster track templates provided by the instructor
- Marble
- Invisible tape.

Analysis: After completing a few mini labs using track sections, students will begin the design and build process for their coaster. All coasters must be between 0.5 and 1 m tall, and fit within a 24" by 18" base. Students must purchase all raw materials with points, and points are earned through incorporating various track elements and parameters. A final score is determined by total points at the end of the project. Students need to determine a marketing strategy and theme for their coaster as part of the design process. Data and calculations include total time, average speed, initial energy, final energy (on last element), energy dissipation, and cost per second of ride time.

Unit 4 Capstone: Electric House

Objective: Students will design and create a model building complete with working circuitry lights.

Materials:

- Building material provided by the student
- Furnishings (up to students) lights, wiring, power sources and switches. (provided by instructor)

Analysis: Students will design, sketch, and ultimately make a building of their choice that contains at least one of each of the following (series circuit, parallel circuit, combination circuit, and a variable resistance) Students must also include full circuit diagrams on a blueprint-style sketch as well as calculations (VIP charts) for each of the three circuits. Students will present and demonstrate their models for the class and will be subject to peer questioning and grading. Safety concerns and functionality must be considered in the design.

Final Exam Project: Design your own experiment

For the final exam, the students may work in pairs to create an experiment using matchbox cars and track. They must have a preapproved purpose and procedure. The experiment must have graphable data for comparative analysis. Data collection will be done before the exam date, and the exam time will be allocated to finalizing the written report, which will be completed and emailed to the instructor for grading.

**Students may come up with an original experiment on any topic in Physics, but it must be preapproved by the instructor.

Special Interest Project: Students have the option to complete one "special interest project" in which they present and explain a physics demonstration, or they perform a "how stuff works"-style presentation for the class. Each of these special interest projects must be accompanied by a well-written report that is 3-4 pages in length, including diagrams, tables and documented sources. Each student can complete one special interest project during the semester for extra-credit. **This is not intended as "instead-of" credit. Special interest projects will only be graded if all capstone projects are completed with a passing grade**