AP® Physics 2 Syllabus

This document is intended to fulfill both the requirements of the Lynn Public Schools and the College Board. The parts of this syllabus that are intended to satisfy the requirements of the College Board start on page 3.

Course Information

Course Name: AP® Physics 2: Algebra-Based (or AP® Physics 2)

College Board Syllabus Number: 1628255v1

Syllabus URL: http://www.mrbigler.com/AP-Physics-2/syllabus-AP-Physics-2.PDF

LPS Course Number: 182

Credits: 6 credits

School: Lynn English High School, Lynn, MA

School Code: 221265

Room: 304

Teacher: Mr. Jeffrey Bigler

Email: MrBigler@MrBigler.com or BiglerJ@LynnSchools.org

Afternoon Back: officially Wednesday, but I'm also available most Mondays, Thursdays, & Fridays

Science Prerequisite: B− or better in AP® Physics 1 **OR** A− or better in Physics 1 and permission of instructor.

Math Prerequisite: B− or better in honors Precalculus **OR** A− or better in Algebra 3 and Trigonometry

Textbook: *Physics Fundamentals,* by Vincent P. Coletta. (Physics Curriculum & Instruction, Inc.: 2010). Available to students in both print (hardcover) and electronic form.

Supplemental Text: *AP® Physics 2 Class Notes,* by Mr. Bigler. (Self-published through CreateSpace.com.) Available to students in both print (softcover) and electronic form.

Required Materials: textbook & supplemental text, a folder or binder (to keep worksheets and handouts), lab notebook (composition book; pages must *not* be removable), scientific (or graphing) calculator (must have exponents, trigonometry functions and scientific notation).

Classroom Expectations

Detailed policies & procedures are described in a separate document.

In summary:

1. Maintain a positive attitude, with ongoing effort and willingness to be proactive about getting extra help when needed.
2. Complete all assignments in the time allotted, unless prior arrangements have been made. Students are encouraged to collaborate on homework, but it is your responsibility to make sure that you are ultimately capable of solving each of the problems on your own and without assistance.
3. Be present during class, mentally as well as physically. Arrive on time. Maintain focus and effort. Contribute to discussions. Bring completed assignments, notes, calculator, and writing implements to class.

4. If you are struggling, come in for extra help after school. Mr. Bigler's official afternoon back is Monday. However, he is usually available after school every afternoon except for Tuesdays (which is when the Science Team meets), unless his presence is required at an after-school meeting. (Please confirm his availability during the school day to make sure. Faculty meetings are on the first Wednesday of every month; science department meetings are on the second Thursday of every month.)
5. Do your own work on tests and quizzes. Cheating, copying or plagiarism will result in a zero and notification of a parent or guardian. More importantly, cheating will not help you learn anything or pass the AP exam.
6. Treat all staff, students, equipment and furniture appropriately and respectfully.
7. Mr. Bigler does not use a lab safety contract—safety is required at all times and is not something you have the option of agreeing to or not. Mr. Bigler will not micromanage your lab experiences, but he will make sure you know what the potential dangers are and how to keep yourself and everyone else safe. Safety violations may result in a disciplinary referral, loss of the privilege of participating in the lab or activity (which may result in a failing grade) and/or payment of restitution for damaged equipment.
8. Adhere to all school rules, policies and procedures as published in the student handbook.

Grades

Your grade is calculated by the *eSchool Plus* grading system, based on the grades and weights entered by Mr. Bigler. The grade weights are:

- Unit tests, formal lab reports, and major projects: 100 points
- Quizzes, lab write-ups, and minor projects: 50 points
- Participation in lab experiments: 25 points
- Homework & classwork assignments: 5 points
- Mid-term exam: 150 points

Mr. Bigler is responsible for entering grades and weights correctly into *eSchool Plus*, but the grades themselves are calculated by *eSchool Plus*. You are responsible for monitoring your grades through the Home Access Center (HAC).

If you believe that your grade has been calculated incorrectly, it is your responsibility to bring it to Mr. Bigler's attention. He will check the calculation manually and adjust your grade as appropriate.

Homework

Homework is due at the beginning of class and will be graded ✓+ (5 points) or ✓− (4 points), based on how much of the homework you attempted (with work shown). Retrieving your homework from your locker after class has started costs 1 point. Late work is worth 3 points if turned in before the unit test on the topic, and 2 points afterwards, provided that it is 100% complete and has correct answers and all work shown. Students who are in the building at any time during the school day (even if they are on a field trip during physics class) are expected to turn in assignments on the due date.

Attendance & Make-Up Work

Absent students are expected to obtain and complete any assignments that they missed. Absent students are also expected to schedule make-up tests with Mr. Bigler within one week, unless other arrangements are made on the day the student returns to school. According to district policy, students who are absent from school seven or more times during a quarter (as calculated by *eSchool Plus*) receive a failing grade for the quarter in all classes.

Curricular Requirements		Page(s)
CR1	Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.	4
CR2a	The course design provides opportunities for students to develop understanding of the foundational principles of thermodynamics in the context of the big ideas that organize the curriculum framework.	5
CR2b	The course design provides opportunities for students to develop understanding of the foundational principles of fluids in the context of the big ideas that organize the curriculum framework.	5
CR2c	The course design provides opportunities for students to develop understanding of the foundational principles of electrostatics in the context of the big ideas that organize the curriculum framework.	5
CR2d	The course design provides opportunities for students to develop understanding of the foundational principles of electric circuits in the context of the big ideas that organize the curriculum framework.	5
CR2e	The course design provides opportunities for students to develop understanding of the foundational principles of magnetism and electromagnetic induction in the context of the big ideas that organize the curriculum framework.	5
CR2f	The course design provides opportunities for students to develop understanding of the foundational principles of optics in the context of the big ideas that organize the curriculum framework.	6
CR2g	The course design provides opportunities for students to develop an understanding of the foundational principles of modern physics in the context of the big ideas that organize the curriculum framework.	6
CR3	Students have opportunities to apply AP® Physics 2 learning objectives connecting across enduring understandings as described in the curriculum framework. These opportunities must occur in addition to those within laboratory investigations.	6
CR4	The course provides students with opportunities to apply their knowledge of physics principles to real world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate citizens.	7
CR5	Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with an emphasis on inquiry-based investigations.	4,8
CR6a	The laboratory work used throughout the course includes investigations that support the foundational AP® Physics 2 principles.	8
CR6b	The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.	8

Curricular Requirements		Page(s)
CR7	The course provides opportunities for students to develop their communication skills by recording evidence of their research of literature or scientific investigations through verbal, written, and graphic presentations.	8
CR8	The course provides opportunities for students to develop written and oral scientific argumentation skills.	7

Course Introduction

Textbook:

Coletta, Vincent P. *Physics Fundamentals.* 2nd Edition. Lakeville, MN: Physics Curriculum & Instruction, Inc., 2010. Available to students in both print and electronic formats. **[CR1]**

Supplemental Text: Mr. Bigler. *Class Notes for AP® Physics 2*. Self-published. Available to students in both print and electronic formats.

CR1: Students and teachers have access to college-level resources including college-level textbooks and reference materials in print or electronic format.

About this course:

The AP® Physics 2 course meets for five periods of 48 minutes each plus one contiguous 90-minute period for lab work in each seven-day cycle. **[CR5]** Lab work is integral to the understanding of the concepts in AP® Physics 2, which has been designed by the College Board as equivalent to an algebra-based college-level physics class. At the end of the course, students will take the AP® Physics 2 Exam, which will test their knowledge and ability to apply the concepts taught in the classroom and learned through experimentation.

CR5: Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with an emphasis on inquiry-based investigations.

The content for the course is based on six big ideas:

- Big Idea 1 – Objects and systems have properties such as mass and charge. Systems may have internal structure.
- Big Idea 2 – Fields existing in space can be used to explain interactions.
- Big Idea 3 – The interactions of an object with other objects can be described by forces.
- Big Idea 4 – Interactions between systems can result in changes in those systems.
- Big Idea 5 – Changes that occur as a result of interactions are constrained by conservation laws.
- Big Idea 6 – Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.
- Big Idea 7 – The mathematics of probability can be used to describe the behavior of complex systems and to interpret the behavior of quantum mechanical systems.

Evaluation:

Students will be graded on homework, quizzes, laboratory work, projects, and exams. Exams and will consist of questions similar to the ones students will see on the AP Exam. Homework assignments and quizzes will consist of problems from the textbook, supplements, and old AP Exams. Projects are long-term, and typically will involve groups of students developing a plan, collecting data and/or research, and presenting conclusions in a meaningful way. Laboratory work is student-centered and inquiry-based, as discussed below.

Grades will be determined based on students' completion of homework, performance on tests and quizzes, and quality of content and writing for laboratory reports.

Topics Covered:

1. Fluids **[CR2b]** (Big Ideas 1, 3, and 5)
    a. Properties of fluids—gases and liquids
    b. Hydrostatic Pressure & Pascal's Principle
    c. Buoyancy (Archimedes' Principle)
    d. Fluid Flow Continuity (Conservation of Mass)
    e. Conservation of Energy & Bernoulli's Principle
2. Thermodynamics **[CR2a]** (Big Ideas 1, 4, 5, and 7)
    a. Temperature
    b. Pressure
    c. Heat/Energy Transfer
    d. Ideal Gases & Gas Laws
    e. Kinetic-Molecular Theory (KMT)
    f. Laws of Thermodynamics
    g. Entropy
    h. PV diagrams & Heat Engines
    i. Probability & Thermal Equilibrium
3. Electricity & Magnetism (Big Ideas 1, 2, 3, 4, and 5)
    a. Elementary Charges & Fundamental Particles **[CR2c]**
    b. Charging & Charge Distribution **[CR2c]**
    c. Coulomb's Law **[CR2c]**
    d. Electric Fields **[CR2c]**
    e. Electric Potential, Potential Difference & Potential Energy **[CR2c]**
    f. Equipotentials **[CR2c]**
    g. Electric Dipoles **[CR2c]**
    h. Electric Current **[CR2d]**
    i. Ohm's Law & Resistor Networks **[CR2d]**
    j. Kirchhoff's Rules **[CR2d]**
    k. Capacitance **[CR2d]**
    l. Steady-State RC Circuits **[CR2d]**
    m. Magnetism & Magnetic Fields **[CR2e]**
    n. Magnetic Forces **[CR2e]**
    o. Interactions between Charged Particles & Magnetic Fields **[CR2e]**
    p. Electromagnetic Induction (Faraday's & Lenz's Laws) **[CR2e]**
    q. AC Circuits (Transformers, *etc.*) **[CR2e]**

CR2b: The course design provides opportunities for students to develop understanding of the foundational principles of fluids in the context of the big ideas that organize the curriculum framework.

CR2a: The course design provides opportunities for students to develop understanding of the foundational principles of thermodynamics in the context of the big ideas that organize the curriculum framework.

CR2c: The course design provides opportunities for students to develop understanding of the foundational principles of electrostatics in the context of the big ideas that organize the curriculum framework.

CR2d: The course design provides opportunities for students to develop understanding of the foundational principles of electric circuits in the context of the big ideas that organize the curriculum framework.

CR2e: The course design provides opportunities for students to develop understanding of the foundational principles of magnetism and electromagnetic induction in the context of the big ideas that organize the curriculum framework.

4. Optics **[CR2f]** (Big Idea 6)
    a. Nature of Light & Electromagnetism
    b. Reflection, Mirrors & Critical Angle
    c. Refraction & Lenses
    d. Total Internal Reflection
    e. Thin-Film Interference
    f. Polarization
    g. Interference & Diffraction
5. Modern Physics **[CR2g]** (Big Ideas 1, 3, 4, 5, 6, and 7)
    a. Brief History & Development of Modern Physics in the Late 19th & Early 20th Centuries
    b. The Bohr Model of the Hydrogen Atom
    c. Fundamental Forces
    d. Theory of Photons & Photoelectric Effect
    e. Radioactivity, Nuclear Reactions & Radiations
    f. Half-Life
    g. Mass-Energy Equivalence
    h. Quantized Energy States for Electrons in Atoms
    i. Energies of Photon Emission & Absorption
    j. Wave Particle Duality & de Broglie Wavelength
    k. Electron Diffraction
    l. Photon Momentum & Photon-Particle Collisions
    m. Wave Functions & Probability

CR2f: The course design provides opportunities for students to develop understanding of the foundational principles of optics in the context of the big ideas that organize the curriculum framework.

CR2g: The course design provides opportunities for students to develop an understanding of the foundational principles of modern physics in the context of the big ideas that organize the curriculum framework.

Outside the Classroom Lab Experience

In addition to in-class lab experiments, students will design and build a toy canoe using only concrete and steel mesh that is capable of carrying a standard tenpin bowling ball (diameter 0.217 m; mass 7.25 kg) without sinking. Students must write a full description of the design and construction process, including measurements and supporting calculations, to show that their canoe is capable of performing the required task. Students will not be permitted to test their design in advance; on the day that the project is due, students will bring their canoes to a nearby pond to be tested. [LO 1.E.11, 1.E.1.2, 3.A.4.1, 3.A.4.2, 3.A.4.3, 3.B.1.4] **[CR3]**

CR3: Students have opportunities to apply AP® Physics 2 learning objectives connecting across enduring understandings as described in the curriculum framework. These opportunities must occur in addition to those within laboratory investigations.

Real World Physics Solutions

In order for students to become scientifically literate citizens, students are required to use their knowledge of physics while looking at a real world problem. **[CR4] [SP 3.1, 3.2, 3.3]** Students may choose either of the following situations:

- Choose a Hollywood movie and will point out three (or more) instances of bad physics that relate to topics covered in AP® Physics 2. Present this information to the class, describing the inaccuracies both qualitatively and quantitatively.
- Research a power plant in Massachusetts. Present qualitative and quantitative information to the class on the energy conversion(s) that the plant utilizes and calculate an estimate of the plant's overall efficiency.

After all of the presentations have taken place, the class will vote on one of the movie presentations to use as the basis for a debate. The debate will address possible changes that would eliminate (or substantially reduce) the inaccuracies without substantially altering the plot.

On the day before the debate, the class will engage in a brainstorming session to choose one of the instances of bad physics to address and to suggest possible plot changes. When the class has come up with two or more mutually exclusive remedies for the same plot hole, the class will form teams by choosing which of the changes to support. On the following class day, the class will hold a formal debate about the suggested changes, pointing out benefits of their team's suggestion and problems with the other teams' suggestions. **[CR8]**

CR4: The course provides students with opportunities to apply their knowledge of physics principles to real world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate citizens.

CR8: The course provides opportunities for students to develop written and oral scientific argumentation skills.

Laboratory Activities:

A minimum of twenty-five percent of the course will involve lab work. **[CR5]** Some of the labs may take more than one class day to finish, and students may have to do work outside of class as well.

Students are expected to write up laboratory experiments in an appropriate laboratory notebook format consisting of the following components: **[CR7]**

- Title
- Objective
- Background/Experimental Design
- Procedure
- Data & Observations
- Analysis, including calculations, graphs, and qualitative and quantitative error analysis.
- Conclusions

Every major unit will involve one or more laboratory experiments **[CR6a]**, with an emphasis on guided inquiry **[CR6b]**. Collectively, laboratory work will engage students in all seven science practices.

Laboratory activities and simulations in this class are included in the following table. The type of inquiry[1] (Structured Inquiry = SI; Guided Inquiry = GI) is noted in the second column.

CR5: Students are provided with the opportunity to spend a minimum of 25 percent of instructional time engaging in hands-on laboratory work with an emphasis on inquiry-based investigations.

CR7: The course provides opportunities for students to develop their communication skills by recording evidence of their research of literature or scientific investigations through verbal, written, and graphic presentations.

CR6a: The laboratory work used throughout the course includes investigations that support the foundational AP® Physics 2 principles.

CR6b: The laboratory work used throughout the course includes guided-inquiry laboratory investigations allowing students to apply all seven science practices.

[1] Martin-Hansen, Lisa. "Defining Inquiry." NSTA WebNews Digest, published 2/1/2002. Accessed via http://www.nsta.org/publications/news/story.aspx?id=46515 on 1/6/2015.

Name	Inquiry Format	Short Description	Science Practices
Force on a Bed of Nails	SI	Students place a balloon on a bed of nails and plot the number of nails in contact with the balloon *vs.* the weight needed to burst it.	2.1, 2.2, 2.3 5.1, 5.2, 5.3
Fluid Velocity through a Constriction	GI	Students use video analysis software to determine the area and velocity of the plunger of a syringe *vs.* the area of the opening and velocity of the fluid exiting.	2.1, 2.2, 2.3 4.1, 4.2, 4.3, 4.4 5.1, 5.2, 5.3 6.1, 6.2
Density of an Unknown Fluid	GI	(Based on FRQ #6 from the 2002B AP® Physics B exam.) Students devise and implement a procedure to measure the density of a fluid using a weight hanging from a spring.	2.1, 2.2, 2.3 4.1, 4.2, 4.3, 4.4 5.1, 5.2, 5.3
Thermal Dice	SI	Students model heat exchange between molecules using 6-sided dice.	1.1, 1.2, 1.3, 1.4, 1.5
Entropy Dice	SI	Students model energy microstates using a combination of dice and pennies.	1.1, 1.2, 1.3, 1.4, 1.5
Heat-Engine Boat	GI	Students construct a boat powered by a candle that heats the water in a copper coil.	6.1, 6.2, 6.4
Charge on a Balloon	GI	Students determine the amount of charge on a pair of identically-charged balloons by determining the force that the charges exert in lifting the balloons as they repel each other.	3.1, 3.2, 3.3 4.1, 4.2, 4.3, 4.4 6.1, 6.2, 6.4 7.1, 7.2
Building a Light Bulb	GI	Students build a working light bulb using batteries and graphite for the filament. Students make observations about the bulb’s brightness with different lengths and thicknesses of graphite and apply their observations to properties of resistors.	1.1, 1.2, 1.3, 1.4 6.1, 6.2, 6.4
Lightbulb Mystery Circuits	GI	Students analyze mystery circuits with incandescent light bulbs and determine the circuit diagram by turning bulbs on and off and observing changes in the bulbs’ brightness.	1.1, 1.2, 1.3, 1.4, 1.5 4.1, 4.2, 4.3, 4.4 5.1, 5.2, 5.3
RC Circuits	SI	Students measure capacitance by measuring the time it takes an RC circuit to charge and discharge and plotting results on semi-logarithmic graph paper.	1.1, 1.2, 1.3, 1.4 2.1, 2.2, 2.3 4.1, 4.2, 4.3, 4.4 5.1, 5.2, 5.3
Force on a Current-Carrying Wire	GI	Students run a circuit through two neodymium magnets and measure the maximum mass that can be hung from the wire with observable deflection when the current is switched on.	2.1, 2.2, 2.3 5.1, 5.2, 5.3 6.1, 6.2, 6.4 7.1, 7.2
Ray Tracing	SI	Students bounce light from a light box off various convex and concave mirrors and pass light through convex and concave lenses and use a ray tracing diagram to determine the focal length of the mirrors and lenses.	1.1, 1.2, 1.3, 1.4, 1.5 2.1, 2.2, 2.3 5.1, 5.2, 5.3

Name	Inquiry Format	Short Description	Science Practices
Index of Refraction	GI	Students devise and implement a procedure for determining the index of refraction of a block of an unknown substance.	4.1, 4.2, 4.3, 4.4 5.1, 5.2, 5.3 6.1, 6.2
Diffraction of a Laser Beam	GI	Students use red, green and blue lasers placed inside spectrum tubes to measure the slit distance of the diffraction grating.	2.1, 2.2, 2.3 4.1, 4.2, 4.3, 4.4 5.1, 5.2, 5.3
Half-Life Simulation	SI	Students model the decay of atoms using coins that land heads *vs.* tails and plot results on semi-logarithmic graph paper.	1.1, 1.2, 1.3, 1.4, 1.5