LOCALLY DEVELOPED COURSE OUTLINE

Physics - Advanced (2019)35-5

Submitted By:

The Red Deer School Division

Submitted On:

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Course Basic Information

Outline Number	Hours	Start Date	End Date	Development Type	Proposal Type	Grades
35-5	125.00	02/01/2019	08/31/2023	Developed	Authorization	G12

Course Description

Outcomes for this course are based on the curriculum as set out in the Fall 2017 College Board Physics 1 and 2 algebra-based course and exam descriptions. Upon completion of this Advanced Physics 35, students will have the equivalent experience to a 6 hour college level, non-calculus physics course.

A number of advanced topics will be covered, including rotational kinematics and dynamics, fluids, thermodynamics, and circuits, beyond the Physics 20 and 30 curricula.

The course emphasizes understanding physical science literacy and applying physics concepts to think critically and solve problems. Algebra and trigonometry are the primary mathematical tools for problem solving.

By completing this course, students will have the foundational knowledge necessary to write the AP Physics 1 and AP Physics 2 exams in May. Notably, these exams can not be used for assessment of this course.

Course Prerequisites

Physics 30

Sequence Introduction (formerly: Philosophy)

Advanced Physics 35 is intended to foster greater depth of conceptual understanding through the use of student-centered opportunities for inquiry. This course focuses on the big ideas in a six-hour college-level physics sequence and provides students with enduring, conceptual understandings of foundational physics principles. This approach will encourage students to spend less time on mathematical routines and more time engaged in building competencies through essential concepts, such as the critical thinking and reasoning skills necessary to engage in the science practices used throughout their study of algebra-based Physics and subsequent course work in science disciplines.

Having a deep understanding of physics principles requires the ability to reason about physical phenomena using important science process skills such as explaining causal relationships, applying and justifying the use of mathematical routines, designing experiments, analyzing data and making connections across multiple topics within the course. Therefore, Advanced Physics 35 pairs the core essential knowledge with the fundamental scientific reasoning skills necessary for authentic scientific inquiry and engages students at an academic level equivalent to two semesters of a typical college or university algebra□based, introductory physics course sequence. The result will be readiness for the study of advanced topics in subsequent post-secondary courses

Student Need (formerly: Rationale)

The Emphasis on Science Practices (similar to Alberta Education competencies)
Science Practice 1: Students can use representations and models to communicate scientific phenomena and solve scientific problems.
Science Practice 2: Students can use mathematics appropriately.
Science Practice 3: Students can engage in scientific questioning to extend thinking or to guide investigations.
Science Practice 4: Students can plan and implement data-collection strategies in relation to a particular scientific question.
Science Practice 5: Students can perform data analysis and evaluation of evidence.
Science Practice 6: Students can work with scientific explanations and theories.
Science Practice 7: Students are able to connect and relate knowledge across various scales, concepts, and representations in and across the domains.
A practice is a way to coordinate knowledge and skills in order to accomplish a goal or task. The science practices enable students to establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena. Because content, inquiry and reasoning are equally important in Advanced Physics, each learning objective described in the concept outline combines content with inquiry and reasoning skills described in the science practices.
The science practices that follow the concept outline of this framework capture important aspects of the work that scientists engage in, at the level of competence expected of Advanced Physics students.
To promote a deep understanding of the science practices, there are many inquiry-based lab investigations, offered freely by the College Board, for students to complete.

Scope and Sequence (formerly: Learner Outcomes)

Advanced Physics 35 extends Physics 20 and Physics 30 to foster greater depth of conceptual understanding. Teachers will have time to cover the concepts and skills students will need to demonstrate in order to earn credit for the introductory algebra-based college physics course. There should also be sufficient time for students to work on inquiry-based lab investigations

Guiding Questions (formerly: General Outcomes

1 Students understand and calculate 2-D accelerated kinematics problems.

2 Students understand and calculate advanced forces problems involving point masses.

3 Students understand and calculate advanced energy problems involving point masses.

4 Students understand and calculate advanced momentum questions.

5 Students understand and calculate advanced electric field and voltage problems using formulas from a formula sheet.

6 Students understand rotational kinematics concepts and be able to solve various types of rotational kinematics problems using provided formula sheets.

7 Students understand and calculate rotational dynamics problems using the many formulas supplied with formula sheets.

8 Students understand and calculate properties of ideal fluids when they are static or flowing using formulas available on a formula sheet.

9 Students understand and calculate properties involving heat transfer, internal energy, atomic properties, work on a gas, heat, pressure, and volume.

10 Students understand series, parallel, and combination circuits using resistors and steady-state capacitors and calculate capacitances, resistances, voltages, currents, and power at various points in circuits using formula sheets.

11 Students understand and calculate various advanced topics in magnetism and electromagnetic induction using formulas provided on a formula sheet.

12 Students understand and calculate various advanced topics in modern physics using a formula sheet.

13 Students understand wave propagation and calculate various advanced topics with waves using a formula sheet.

Learning Outcomes (formerly: Specific Outcomes)

1 Students understand and calculate 2-D accelerated kinematics problems.	**35-5**
1.1 Solve kinematics problems where an object experiences acceleration in two dimensions, typically x and y.	X
1.2 Analyze the motion of a system qualitatively and semi-qualitatively using the center of mass of an isolated two-object system.	X

2 Students understand and calculate advanced forces problems involving point masses.	**35-5**
2.1 Identify and rotate an x-y coordinate system so one axis is parallel to a direction of acceleration and is able to draw a free-body using the newly rotated cartesian plane.	X
2.2 Solve static equilibrium systems, when the x-y cartesian plane has been rotated, using the concept of zero net force in the x and y directions.	X
2.3 Solve 2-D accelerated systems, when the x-y cartesian plane has been rotated, using Newton's second law in x and y directions.	X

3 Students understand and calculate advanced energy problems involving point masses.	**35-5**
3.1 Understand the definitions of conservative (gravitational, elastic, electric) and non-conservative (frictional, tension, normal, applied) forces and solve energy problems knowing when and how to deal with the different class of forces.	X

4 Students understand and calculate advanced momentum questions.	**35-5**
4.1 Calculate the center of mass of a system of point objects.	X

4.2 Understand that in an isolated system the total momentum does not change, so the velocity of the center of mass of a system does not change.	X
4.3 Calculate conservation of momentum questions using center of mass.	X

5 Students understand and calculate advanced electric field and voltage problems using formulas from a formula sheet.	**35-5**
5.1 Understand that matter has a property called electric permittivity and the permittivity of matter has a different value than that of free space.	X
5.2 Use a modified Coulomb's law formula with permittivity of free space constant.	X
5.3 Understand the formulas associated with parallel plater capacitors and calculate solutions to problems involving voltages, electric field strengths, charge on plates, and potential energy in ideal capacitors.	X
5.4 Use isolines to understand how equipotential lines and equipotential maps work for parallel plate, point, many point, sphere, and many sphere charged systems.	X
5.5 Predict the structure of isolines of electric potential by constructing them from a given electric field and use them to determine the work done on a charge in the field.	X

6 Students understand rotational kinematics concepts and be able to solve various types of rotational kinematics problems using provided formula sheets.	**35-5**
6.1 Express the rotational motion of an object using narrative, mathematical, and graphical representations.	X
6.2 Design an experimental investigation of the rotational motion of an object using rotational kinematics.	X
6.3 Analyze experimental data describing the rotational motion of an object and is able to express the results to the analysis using narrative, mathematical, and graphical representations.	X

6.4 Use the "Right-Hand Rule" for rotational vectors to find the direction of angular velocity and angular acceleration.	X

7 Students understand and calculate rotational dynamics problems using the many formulas supplied with formula sheets.	**35-5**
7.1 Understand how to find the lever arm of a force and know that it is the perpendicular distance from the axis of rotation to the line of application of force.	X
7.2 Determine or calculate the length of the lever arm of a force causing torque.	X
7.3 Determine the torque on an object by using the force and lever arm.	X
7.4 Uses the net torque on a balanced system being zero to calculate static equilibrium problems for systems of objects that can rotate.	X
7.5 Compare the torques on an object caused by various forces and lever arms.	X
7.6 Design an experiment and analyze data that tests a question about torques in a balanced rigid system.	X
7.7 Calculate torques on a two-dimensional system in static equilibrium, by examining a representation or model (a diagram or physical construction).	X
7.8 Predict and calculate the change in angular velocity about an axis for an object when forces exerted on the object cause a torque about that axis	X
7.9 Predict the behavior of rotational collision situations by the same processes that are used to analyze linear collision situations using an analogy between impulse and change of linear momentum and angular impulse and change of angular momentum.	X
7.10 Solve for the change in angular momentum of an object using torques exerted on the object.	X

7.11 Plan data collection strategies and collect data to establish that torque, angular velocity, angular acceleration, and angular momentum can be predicted accurately when the variables are treated as being clockwise or counterclockwise with respect to a well-defined axis of rotation.	X
7.12 Calculate values for initial and/or final angular momentum, or change in angular momentum of a system, or average torque or time during which the torque is exerted in analyzing a situation involving torque and angular momentum.	X
7.13 Predict, qualitatively, and/or calculate, quantitatively, the angular momentum of a system for a situation in which there is no net external torque.	X
7.14 Calculate the angular momentum and rotational inertia of a system in terms of locations and velocities of objects that make up the system. Calculations should be able to be done with a fixed set of extended objects and point masses. (Note: memorization for the moment of inertia of an object beyond a point particle or group of point particles is not needed.)	X
7.15 Calculate, using the parallel axis theorem, the moment of inertia of an object that has its axis of rotation moved. (Note: this is not tested on an AP exam but is covered in University).	X
7.16 Analyze rigid body systems when the system has both translational and rotational kinetic energy.	X

8 Students understand and calculate properties of ideal fluids when they are static or flowing using formulas available on a formula sheet.	**35-5**
8.1 Understand that matter has the property of density and predict the density, differences in densities, or change in density of matter under different conditions.	X
8.2 Design an experiment to determine the density of an object and/or compare the densities of several objects.	X
8.3 Correctly draw, using a given format, a free body diagram of an object in a fluid.	X
8.4 Calculate the buoyant force on an object using the volume of the object and the density of the fluid in a gravitational field.	X

8.5 Understand and use Archimedes' Principle to analyze and calculate buoyant force scenarios.	X
8.6 Understand the concept of pressure and how it relates to microscopic contact forces on surfaces.	X
8.7 Calculate either pressure, force, or area based on information provided or experimental data.	X
8.8 Understand the difference between absolute and gauge pressure and calculate one from the other.	X
8.9 Understand Pascal's Law of fluid pressure and force and calculate pressures or forces at various depths in an ideal fluid.	X
8.10 Use Pascal's Law to calculate situations with mechanical advantage such as hydraulic systems with pistons of various areas and ideal (non-compressible) fluids.	X
8.11 Understand and use the continuity equation to calculate volume and mass flow rates in ideal fluids using conservation of mass principles.	X
8.12 Understand the properties of an ideal fluid and how it can be used when static and moving situations.	X
8.13 Understand how conservation of energy explains the Bernoulli Equation.	X
8.14 Calculate pressures, velocities, or heights within moving fluid systems using the Bernoulli equation.	X
8.15 Calculate pressures, velocities, or heights within moving fluid systems using the Bernoulli equation when the continuity equation (mass conservation) is also needed.	X

9 Students understand and calculate properties involving heat transfer, internal energy, atomic properties, work on a gas, heat, pressure, and volume.	**35-5**
9.1 Understand thermal conductivity and calculate heat flow using the thermal conductivity equation.	X
9.2 Extrapolate from pressure and temperature or volume and temperature data to make the prediction that there is a temperature at which the pressure or volume extrapolates to zero.	X

9.3 Understand the 0th Law of Thermodynamics and use it as an equivalence relation on pairs of thermodynamic systems.	X
9.4 Predict the direction of heat energy transfer due to temperature differences based on interactions at the microscopic level.	X
9.5 Understand and calculate pressure, volume, and temperature of gases using Boyle's law, Charles' law, and combined gas law equations.	X
9.6 Understand and calculate length contraction of solids, due to temperature changes, using the coefficient of linear expansion.	X
9.7 Understand and calculate volume contraction of solids and liquids, due to temperature changes, using the coefficient of volumetric expansion.	X
9.8 Calculate heat problems involving heat, mass (of liquids and solids), specific heat capacity and temperature change.	X
9.9 Understand and be able to describe how heat flows during conduction, convection and radiation processes.	X
9.10 Extrapolate from pressure and temperature or volume and temperature data to make the prediction that there is a temperature at which the pressure or volume extrapolates to zero.	X
9.11 Understand and use two versions of the ideal gas law, one with moles and the ideal gas constant and the other involving particle number and Boltzmann's constant.	X
9.12 Collect data to determine the relationships between pressure, volume, and temperature and the amount of an ideal gas.	X
9.13 Analyze graphical representations of macroscopic variables for an ideal gas to determine the relationships between these variables to ultimately determine the ideal gas law formula.	X
9.14 Understand that during average collisions between molecules, kinetic energy is transferred from faster molecules to slower molecules.	X
9.15 Understand that the temperature of a system characterizes the average kinetic energy of its molecules.	X

9.16 Connect the statistical distribution of microscopic kinetic energies of molecules to the macroscopic temperature of the system.	X
9.17 Calculate the root mean square speed of molecules in a gas at a given temperature and understand how kinetic energy and speed are related to the mass or molar mass of the gas particles.	X
9.18 Predict qualitative changes in the internal energy of a thermodynamic system involving the transfer of energy due to heat or work done and justify those predictions in terms of conservation of energy principles (1st Law of Thermodynamics).	X
9.19 Create a plot of pressure versus volume for a thermodynamic process from given data.	X
9.20 Understand isovolumetric (isochoric), isothermal, isobaric, and adiabatic processes and be able to analyze P versus V graphs where a gas is taken through various stages with any of the previously listed processes.	X
9.21 Calculate the work done on a gas during an isovolumetric (isochoric), isothermal, isobaric, and/or adiabatic process.	X
9.22 Calculate the internal energy change on a gas during an isovolumetric (isochoric), isothermal, isobaric, and/or adiabatic process.	X
9.23 Understand how the 2nd Law of Thermodynamics describes the change in entropy for reversible and irreversible processes and relate entropy to the state of a gas system.	X
9.24 Understand that entropy is a state function and that some system energy is unavailable to do work due to the state of disorder and that the entropy of the universe is always increasing.	X
9.25 Use the concept of entropy, and the idea that the entropy of the universe is always increasing, to qualitatively understand engine cycles.	X

10 Students understand series, parallel, and combination circuits using resistors and steady-state capacitors and calculate capacitances, resistances, voltages, currents, and power at various points in circuits using formula sheets.	**35-5**

10.1 Determine that a circuit is a closed loop of current (both electrical and conventional) and know when current is able to flow through different components.	X
10.2 Understand that the resistivity of a material depends on its molecular and atomic structure as well as temperature.	X
10.3 Calculate ideal resistance using resistivity, length, and area of a conductor.	X
10.4 Apply Kirchoff's loop rule (conservation of energy) to simple and complex circuits involving series and parallel elements that can be resistors and/or capacitors.	X
10.5 Analyze ideal and non-ideal batteries in circuits.	X
10.6 Construct or interpret a graph of energy changes within an electrical circuit with only a single battery and resistors and/or capacitors in series and/or parallel.	X
10.7 Calculate the total resistance for resistors in series, parallel, or simpler series/parallel combination circuits.	X
10.8 Calculate the total capacitance for capacitors in series, parallel, or simpler series/parallel combination circuits.	X
10.9 Use conservation of energy principles (Kirchoff's loop rule) to describer and make predictions regarding electrical potential difference, charge, and current in steady-state circuits composed of various combinations of resistors and capacitors.	X
10.10 Calculate current, voltage, or resistance in series, parallel, or combination circuits involving resistors and steady-state (only) capacitors using ohms law.	X
10.11 Design an experiment using series and parallel resistors or capacitors so that data can be collected and analyzed.	X
10.12 Apply Kirchoff's junction rule (conservation of charge) to simple and complex circuits involving series and parallel elements that can be resistors and/or capacitors.	X
10.13 Determine missing values and direction of electric current in branches of a circuit with resistors and capacitors from values and directions of current in other branches of the circuit through appropriate selection of nodes and application of the junction rule.	X

10.14 Understand that the magnitude of charge on one of the plates in a parallel plate capacitor is the same as the other plate (but opposite in sign).	X
10.15 Calculate how the capacitance of a capacitor varies with the dielectric value, the area, and the plate distance in ideal capacitors.	X

11 Students understand and calculate various advanced topics in magnetism and electromagnetic induction using formulas provided on a formula sheet.	**35-5**
11.1 Understand that matter has a property called magnetic permeability and that it has a constant value for materials that is different than the value from free space.	X
11.2 Calculate the magnetic field around a wire, around a moving charge, and within a solenoid/coil.	X
11.3 Calculate force, charge, velocity, or external magnetic field for a particle moving within an external magnetic field at any angle to the field (not just perpendicular).	X
11.4 Calculate force, length, current, or external magnetic field for a particle moving within an external magnetic field at any angle to the field (not just perpendicular).	X
11.5 Understand that paramagnetic materials interact weakly with an external magnetic field and that the magnetic dipole moments of the material do not remain aligned after the external magnetic field is removed.	X
11.6 Understand that diamagnetic materials interact extremely weakly (usually) with an external magnetic field.	X
11.7 Calculate magnetic flux by understanding that it is proportional to the magnetic field strength, the area of the field, and the angle between them.	X
11.8 Calculate the induced voltage in a wire (or solenoid) using the change in flux (either changing magnetic field strength, area, or the angle between them) over time.	X
11.9 Understand that the conservation of energy concept determines the direction of the induced emf relative to the change in the magnetic flux.	X

11.10 Understand how ideal step-up and step-down transformers work to change the voltage and current using AC voltage and current.	X

12 Students understand and calculate various advanced topics in modern physics using a formula sheet.	**35-5**
12.1 Calculate momentums and velocities in closed-system nuclear decays using conservation of energy or momentum and analyzing the motion of the center of mass of the closed system.	X
12.2 Predict and calculate various features of diffraction patterns including patterns caused by subatomic particles using the de Broglie equation.	X
12.3 Understand the wave property of matter by understanding the Davisson-Germer diffraction experiment.	X
12.4 Use the graphical wave function representation of a particle to predict qualitatively the probability of finding a particle in a specific spatial region.	X
12.5 Use a standing wave model with the circumference as an integer multiple of the de Broglie wavelength to provide a qualitative explanation that accounts for the existence of specific allowed energy states of an electron around an atom.	X

13 Students understand wave propagation and calculate various advanced topics with waves using a formula sheet.	**35-5**
13.1 Calculate the propagation of a wave using a sine or cosine function involving the wavelength, amplitude and frequency of the wave.	X

Facilities or Equipment

Facility

There are no special facilitiesrequired for this course,outside of the typicalhigh school Science classroom.

Facilities:

Equipment

Some additional equipment is suggested for labs and demonstrations, beyond what would be available for Physics 20 or 30 labs. Only the specialty equipment is listed, so common items like masses and spring scales are not included in this list. Some of the equipment listed may be used in other courses (such as Science 9 electrical unit and Chemistry 20 Gases).

1. Conservation of Linear Momentum Wheel
2. Disks, hoops, and spheres for rotational energy and moment of inertia lab
3. Various resistors, capacitors, wire, voltmeters, and ammeters for electrical circuits lab
4. Syringes for Boyle's law lab
5. Various density blocks for buoyancy lab
6. Various containers to be used in a fluid dynamics lab

Learning and Teaching Resources

The following suggested student and teacher resources are *optional*. It is highly reco
students have access to a college-level textbook to use as a resource for the increas
difficulty and the alternative questions. The College Board provides textbook lists tha
approved to cover the AP Physics 1 and 2 curriculum and there are many to choose
Optional textbook with extra chapters:
Cutnell, John and Johnson, Kenneth.Physics 9e. 9th edition. John Wiley and Sons, 2
Optional textbook with only AP curriculum:
Cutnell, John and Johnson, Kenneth.Cutnell & Johnson Physics Advanced Placeme
10e. 10th edition. John Wiley and Sons, 2014.
Video Lesson Tutorials which are free to use:
Twu Physics: https://sites.google.com/site/twuphysicslessons/home
Formula sheets
Recommended: AP Physics 1 and 2 formula sheets

Sensitive or Controversial Content

There arenoanticipatedcontroversial orsensitivetopicswithin thecontentofthis course

Issue Management Strategy

There are no anticipated issue management strategies within the content of this course

Health and Safety

There are no safety issuesor requirements above thetypical Physics 20 or 30 course.

Risk Management Strategy

There are no risk management strategies beyond a typical Physics 20 or 30 course.

Statement of Overlap with Existing Programs

StatementofOverlapwithExistingPrograms

Provincial Courses with Overlap and/or Similar
Physics 20 and 30
Identified Overlap/Similarity
None
Reasoning as to Why LDC is Necessary
Advanced Physics 35-5 reflects the Advanced Placement Curriculum and provides additional time for bridging topics that will not be explicitly tested on either the AP Physics 1, AP Physics 2, or the Physics 30 diploma exams. The course further requires hands-on lab work and in-depth study of advanced topics, thereby requiring 5 credits worth of time.
Locally Developed Course with Overlap and/or Similar
Physics (IB) 25-35 (various versions)
Identified Overlap/Similarity
There are some similar topics in IB and AP but each course has different focus.
Reasoning as to Why LDC is Necessary
Physics (AP) 35-5 covers the Advanced Placement Curriculum and labs. The IB program is different from advanced placement programs. Schools offering IB courses would only choose the Physics (IB) course and schools offering AP would offer the Physics (AP) 35-5 course.
Locally Developed Course with Overlap and/or Similar
Physics (AP) 35-3
Identified Overlap/Similarity
There is overlap between Physics (AP) 35-3 and Physics (AP) 35-5. There is some overlap in each section of the learning outcomes.
Reasoning as to Why LDC is Necessary
Physics (AP) 35-5 covers all the curriculum from both the AP Physics 1 and AP Physics 2 curriculum and does not include any overlap with Physics 20 or 30. This course is required to adequately cover the advanced topics plus provide enough time for students to properly do inquiry-based lab investigations.

Student Assessment

There are no required assessments, although it is recommended that homework be more in line with a college level course.

Course Approval Implementation and Evaluation

There are no unique processes connected to this course.