Wilson Area School District
Planned Course Guide

Title of planned course: **AP Physics C: Mechanics**

Subject Area: **Science**

Grade Level: **11-12**

Course Description:

AP® Physics C: Mechanics is a nationwide course designed by the College Board. It is equivalent to an introductory course in physics that would be taken by college students training in engineering or science. The course takes a guided-inquiry and student-centered learning approach to understanding concepts and skills and then applying them to solving problems.

Time/Credit for this Course: 7 periods each week (5 lecture + 2 lab)
1.4 weight factor

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Wilson Area School District
Planned Course Materials

Course Title:	AP Physics C: Mechanics
Textbook:	Knight, Randall D. 2004. *Physics for Scientists and Engineers: A Strategic Approach*. Boston: Addison-Wesley.
Supplemental Books:	Knight, Randall D. 2004. Student Workbook that accompanies the course textbook. Boston: Addison-Wesley.
Teacher Resources:	Student Workbook Solutions Manual

Wilson Area School District
Curriculum Map

August:	Fundamentals
September:	Fundamentals / Kinematics
October:	Kinematics
November:	Dynamics
December:	Dynamics / Work, Energy, and Power
January:	Work, Energy, and Power / Particle Systems & Linear Momentum
February:	Particle Systems & Linear Momentum / Circular Motion & Rotation
March:	Circular Motion & Rotation
April:	Oscillations & Gravitation
May:	Full-Course Recap / AP Exam is Given in early May
June:	Independent Projects

Wilson Area School District
Curriculum Scope & Sequence

Planned Course: AP Physics C: Mechanics

Unit: Fundamentals

Time Frame: 4 weeks

State Standards

3.1.12.C	Assess and apply patterns in science and technology.
3.1.12.D	Analyze scale as a way of relating concepts and ideas to one another by some measure.
3.2.12.A	Evaluate the nature of scientific and technical knowledge.
3.2.12.B	Evaluate experimental information for appropriateness and adherence to relevant science processes.
3.2.12.C	Apply the elements of scientific inquiry to solve multi-step problems.
3.2.12.D	Analyze and use the technological design process to solve problems.
3.7.12.B	Evaluate appropriate instruments and apparatus to accurately measure materials and processes.

Anchor(s) or Adopted Anchor:

S11.A.1.1.1 Compare and contrast scientific theories, scientific laws, and beliefs (e.g., the law of gravity, how light travels, formation of moons, …).

S11.A.1.1.2 Analyze and explain how to verify the accuracy of scientific facts, principles, theories, and laws.

S11.A.1.1.3 Evaluate the appropriateness of research questions (e.g., testable vs. not-testable).

S11.A.1.1.4 Explain how specific scientific knowledge or technological design concepts solve practical problems (e.g., momentum, Newton's laws of universal gravitation, … conservation of mass and energy, … atomic theory, theory of relativity, …).

S11.A.1.1.5 Analyze or compare the use of both direct and indirect observation as means to study the world and the universe.

S11.A.2.1 Apply knowledge of scientific investigation or technological design to develop or critique aspects of the experimental or design process.

S11.A.2.1.1 Critique the elements of an experimental design (e.g., raising questions, formulating hypotheses, developing procedures, identifying variables, manipulating variables, interpreting data, and drawing conclusions) applicable to a specific experimental design.

S11.A.2.1.3 Use data to make inferences and predictions, or to draw conclusions, demonstrating understanding of experimental limits.

S11.A.2.1.4 Critique the results and conclusions of scientific inquiry for consistency and logic.

S11.A.2.1.5 Communicate results of investigations using multiple representations.

S11.A.2.2 Evaluate appropriate technologies for a specific purpose, or describe the information the instrument can provide.

S11.A.2.2.1 Evaluate appropriate methods, instruments, and scale for precise quantitative and qualitative observations (e.g., to compare properties of materials, water quality).

S11.A.2.2.2 Explain how technology is used to extend human abilities and precision.

S11.A.3.1.2 Analyze and predict the effect of making a change in one part of a system on the system as a whole.

S11.A.3.1.3 Use appropriate quantitative data to describe or interpret a system (e.g., biological indices, electrical circuit data, automobile diagnostic systems data).

S11.A.3.2 Compare observations of the real world to observations of a constructed model.

S11.A.3.2.1 Compare the accuracy of predictions represented in a model to actual observations and behavior.

S11.C.3.1.3 Explain that acceleration is the rate at which the velocity of an object is changing.

S11.C.1.1.1 Explain that matter is made of particles called atoms and that atoms are composed of even smaller particles (e.g., proton, neutrons, electrons).

Essential Content / Objectives: At the end of the unit, students will be able to:

- Express calculated answers within one position of the correct significant figures.
- Perform order-of-magnitude estimates.
- Use scientific notation in additive, multiplicative, and exponential calculations.
- Solve problems requiring unit conversions and dimensional analysis.
- Design experiments that minimize relative accuracy and precision errors.
- Determine fundamental constants from experimental data using graphical linearization.
- Recognize vectors as quantities that: rely on both direction and magnitude; combine with other velocity and acceleration vectors according to specific mathematical rules; allow the formulation of Physical Laws independent of a particular coordinate system; and can be expressed in component and unit vector forms.
- Use calculus to differentiate and integrate polynomial, exponential, and trigonometric functions.

Core Activities: Students will participate in instructor-led discussions; use analog and digital tools for data-collection and analysis in labs; run computer-based simulations of experiments; and engage in whole-group and small-group problem solving.

Extensions: Current events, actual undergraduate problems, independent investigations

Remediation: One-on-one re-teaching; online physics tutorials; supplemental reading and problem-solving.

Instructional Methods:	Direct instruction, demonstrations, labs, university lecture videos, peer-to-peer knowledge sharing, whole-group problem-solving.
Materials & Resources:	Textbook, workbook, calculator, computer, Internet, lab equipment
Assessments:	In-class Q&A, problem sets, quizzes, lab reports, end-of-unit exam

Wilson Area School District
Curriculum Scope & Sequence

Planned Course: AP Physics C: Mechanics

Unit: Kinematics

Time Frame: 4-5 weeks

State Standards

3.1.12.B	Apply concepts of models as a method to predict and understand science and technology.
3.1.12.D	Analyze scale as a way of relating concepts and ideas to one another by some measure.
3.2.12.B	Evaluate experimental information for appropriateness and adherence to relevant science processes.
3.2.12.C	Apply the elements of scientific inquiry to solve multi-step problems.
3.2.12.D	Analyze and use the technological design process to solve problems.
3.4.10.C	Distinguish among the principles of force and motion.
3.4.12.C	Apply the principles of motion and force.
3.7.12.A	Apply advanced tools, materials, and techniques to answer complex questions.
3.7.12.B	Evaluate appropriate instruments and apparatus to accurately measure materials and processes.

Anchor(s) or Adopted Anchor

S11.A.3.2.1 Compare the accuracy of predictions represented in a model to actual observations and behavior.

S11.C.3.1 Use the principles of motion and force to solve real-world challenges.

S11.C.3.1.3 Explain that acceleration is the rate at which the velocity of an object is changing.

Essential Content / Objectives: At the end of the unit, students will be able to:

- Measure and quantify (in magnitude and direction) the position, velocity, and acceleration of an object using appropriate tools and units, in a reference frame.
- Classify position, velocity, and acceleration as examples of vectors.
- Solve constant-speed problems in linear kinematics.
- Solve constant-acceleration problems in linear kinematics.
- Solve time-varying-acceleration problems in linear kinematics.
- Analyze situations with the particular characteristics of inclined planes.
- Represent and analyze the motion of a projectile as two different motions, a vertical motion with constant acceleration and a horizontal motion with constant speed.
- Calculate for projectiles their range, time-of-flight, and height for situations with and without drag.

Core Activities: Students will participate in instructor-led discussions; use analog and digital tools for data-collection and analysis in labs; run computer-based simulations of experiments; and engage in whole-group and small-group problem solving.

Extensions: Current events, actual undergraduate problems, independent investigations.

Remediation: One-on-one re-teaching; online physics tutorials; supplemental reading and problem-solving.

Instructional Methods: Direct instruction, demonstrations, labs, university lecture videos, peer-to-peer knowledge sharing, whole-group problem-solving.

Materials & Resources: Textbook, workbook, calculator, computer, Internet, lab equipment

Assessments: In-class Q&A, problem sets, quizzes, lab reports, end-of-unit exam

Wilson Area School District
Curriculum Scope & Sequence

Planned Course: AP Physics C: Mechanics

Unit: Dynamics

Time Frame: 6 weeks

State Standards

3.1.12.B	Apply concepts of models as a method to predict and understand science and technology.
3.1.12.D	Analyze scale as a way of relating concepts and ideas to one another by some measure.
3.1.12.E	Evaluate change in nature, physical systems, and man-made systems.
3.2.12.B	Evaluate experimental information for appropriateness and adherence to relevant science processes.
3.2.12.C	Apply the elements of scientific inquiry to solve multi-step problems.
3.2.12.D	Analyze and use the technological design process to solve problems.
3.4.10.C	Distinguish among the principles of force and motion.
3.4.12.C	Apply the principles of motion and force.
3.7.12.A	Apply advanced tools, materials, and techniques to answer complex questions.
3.7.12.B	Evaluate appropriate instruments and apparatus to accurately measure materials and processes.

Anchor(s) or Adopted Anchor:

S11.A.3.2.1 Compare the accuracy of predictions represented in a model to actual observations and behavior.

S11.C.3.1 Use the principles of motion and force to solve real-world challenges.

S11.C.3.1.3 Explain that acceleration is the rate at which the velocity of an object is changing.

Essential Content / Objectives: At the end of the unit, students will be able to:

- Compare and contrast inertial mass and gravitational mass.
- Apply Newton's Laws of Motion to empirically describe the motion of objects in terms of force interactions, mass, and acceleration in a non-accelerating, non-relativistic reference frame.
- Classify force as a vector and determine the single net force produced when multiple forces act upon an object.
- Analyze the forces acting on an object and represent them using a free-body diagram.
- Differentiate between weight force and normal force.
- Solve motion problems in situations where there are constant and non-constant static, kinetic, and rolling friction forces.
- Calculate characteristics of motion when drag force is present.
- Distinguish contact forces (e.g., push/pull, friction) from field forces (e.g., gravitational, electrostatic, or magnetic fields).
- Explain that an object in equilibrium has a net force equal to zero.
- Analyze forces and motions using equilibrium to set boundary conditions.

Core Activities: Students will participate in instructor-led discussions; use analog and digital tools for data-collection and analysis in labs; run computer-based simulations of experiments; and engage in whole-group and small-group problem solving.

Extensions: Current events, actual undergraduate problems, independent investigations.

Remediation:	One-on-one re-teaching; online physics tutorials; supplemental reading and problem-solving.
Instructional Methods:	Direct instruction, demonstrations, labs, university lecture videos, peer-to-peer knowledge sharing, whole-group problem-solving.
Materials & Resources:	Textbook, workbook, calculator, computer, Internet, lab equipment
Assessments:	In-class Q&A, problem sets, quizzes, lab reports, end-of-unit exam

Wilson Area School District
Curriculum Scope & Sequence

Planned Course: AP Physics C: Mechanics

Unit: Work, Power, and Energy

Time Frame: 4 weeks

State Standards

3.1.12.E	Evaluate change in nature, physical systems, and man-made systems.
3.2.12.B	Evaluate experimental information for appropriateness and adherence to relevant science processes.
3.2.12.C	Apply the elements of scientific inquiry to solve multi-step problems.
3.2.12.D	Analyze and use the technological design process to solve problems.
3.4.10.B	Analyze energy sources.
3.4.12.C	Apply the principles of motion and force.
3.7.12.A	Apply advanced tools, materials, and techniques to answer complex questions.
3.7.12.B	Evaluate appropriate instruments and apparatus to accurately measure materials and processes.

Anchor(s) or Adopted Anchor:

S11.C.2.1 Analyze energy sources and transfer of energy, or conversion of energy.

S11.C.2.1.3 Apply the knowledge of conservation of energy to explain common systems (e.g., refrigeration system, rocket propulsion, heat pump).

S11.C.3.1.5 Calculate the mechanical advantage of moving an object using a simple machine.

Essential Content / Objectives: At the end of the unit, students will be able to:

- Represent and quantify the position and velocity of an object or system in terms of kinetic energy and potential energy.
- Calculate the total work performed by objects in a closed system by calculating the change in energy.
- Find the power generated by an object or required to produce some outcome.
- Calculate the kinetic energy of an object.
- Calculate the gravitational and elastic potential energy of an object
- Analyze the effect of position-dependent potentials on an object's energy and motion.
- Apply the Work-Energy Theorem as a boundary condition aid to problem-solving.
- Apply Conservation of Energy as a boundary condition aid to problem-solving.

Core Activities: Students will participate in instructor-led discussions; use analog and digital tools for data-collection and analysis in labs; run computer-based simulations of experiments; and engage in whole-group and small-group problem solving.

Extensions: Current events, actual undergraduate problems, independent investigations.

Remediation: One-on-one re-teaching; online physics tutorials; supplemental reading and problem-solving.

Instructional Methods: Direct instruction, demonstrations, labs, university lecture videos, peer-to-peer knowledge sharing, whole-group problem-solving.

Materials & Resources: Textbook, workbook, calculator, computer, Internet, lab equipment

Assessments: In-class Q&A, problem sets, quizzes, lab reports, end-of-unit exam

Wilson Area School District
Curriculum Scope & Sequence

Planned Course: AP Physics C: Mechanics

Unit: Particle Systems & Linear Momentum

Time Frame: 4 weeks

State Standards

3.1.12.E	Evaluate change in nature, physical systems, and man-made systems.
3.2.12.B	Evaluate experimental information for appropriateness and adherence to relevant science processes.
3.4.10.C	Distinguish among the principles of force and motion.
3.4.12.C	Apply the principles of motion and force.
3.7.12.A	Apply advanced tools, materials, and techniques to answer complex questions.
3.7.12.B	Evaluate appropriate instruments and apparatus to accurately measure materials and processes.

Anchor(s) or Adopted Anchor:

S11.C.1.1.1 Explain that matter is made of particles called atoms and that atoms are composed of even smaller particles (e.g., proton, neutrons, electrons).

S11.C.3.1 Use the principles of motion and force to solve real-world challenges.

S11.C.3.1.1 Explain common phenomena (e.g., motion of bowling ball, a rock in a landslide, an astronaut during a space walk, a car hitting a patch of ice on the road) using an understanding of conservation of momentum.

Essential Content / Objectives: At the end of the unit, students will be able to:

- Represent and quantify the position and velocity of an object or system in terms of linear momentum.
- Calculate impulse.
- Recognize that in a closed system the total linear momentum is conserved and use this fact when solving motion problems.
- Compare and contrast elastic, inelastic, and superelastic collisions
- Find an object's center of mass numerically and experimentally.

Core Activities: Students will participate in instructor-led discussions; use analog and digital tools for data-collection and analysis in labs; run computer-based simulations of experiments; and engage in whole-group and small-group problem solving.

Extensions: Current events, actual undergraduate problems, independent investigations

Remediation: One-on-one re-teaching; online physics tutorials; supplemental reading and problem-solving.

Instructional Methods: Direct instruction, demonstrations, labs, university lecture videos, peer-to-peer knowledge sharing, whole-group problem-solving.

Materials & Resources: Textbook, workbook, calculator, computer, Internet, lab equipment

Assessments: In-class Q&A, problem sets, quizzes, lab reports, end-of-unit exam

Wilson Area School District
Curriculum Scope & Sequence

Planned Course: AP Physics C: Mechanics

Unit: Circular Motion & Rigid-Body Rotation

Time Frame: 4 weeks

State Standards

3.1.12.D	Analyze scale as a way of relating concepts and ideas to one another by some measure.
3.4.10.C	Distinguish among the principles of force and motion.
3.4.12.C	Apply the principles of motion and force.
3.7.12.A	Apply advanced tools, materials, and techniques to answer complex questions.
3.7.12.B	Evaluate appropriate instruments and apparatus to accurately measure materials and processes.

Anchor(s) or Adopted Anchor:

S11.A.3.2.1 Compare the accuracy of predictions represented in a model to actual observations and behavior.

S11.C.3.1 Use the principles of motion and force to solve real-world challenges.

S11.C.3.1.3 Explain that acceleration is the rate at which the velocity of an object is changing.

S11.D.3.1.1 Describe planetary motion and the physical laws that explain planetary motion.

Essential Content / Objectives: At the end of the unit, students will be able to:

- Recognize that a rotating reference frame can give the appearance of an object constrained to travel in a circular path, thus indicating a centripetal acceleration directed from the object toward the center of the rotating reference frame.
- Differentiate between uniform and non-uniform circular motion (UCM and NUCM, respectively).
- Calculate the kinematic and dynamic characteristics of UCM and NUCM.
- Define and calculate torque, the rotational analogue of force for translational motion, as the vector product of an applied force and the distance between the application and an object's axis of rotation that results in the rotation of the object.
- Determine an object's moment of inertia, the rotational analogue of mass for translational motion, by its mass distribution around the axis of rotation.
- Find the angular momentum of a rotating object or system.
- Classify angular position, angular velocity, and angular acceleration as examples of vectors.
- Explain that an object in equilibrium has a net torque equal to zero.
- Relate rotational kinetic energy, the rotational analogue of translational kinetic energy, to rotational inertia and angular velocity.
- Represent and quantify rotational inertia and angular velocity of an object in terms of angular momentum.
- Recognize that in a closed system the angular momenta are conserved and use this fact when solving motion problems.

Core Activities: Students will participate in instructor-led discussions; use analog and digital tools for data-collection and analysis in labs; run computer-based simulations of experiments; and engage in whole-group and small-group problem solving.

Extensions: Current events, actual undergraduate problems, independent investigations

Remediation: One-on-one re-teaching; online physics tutorials; supplemental reading and problem-solving.

Instructional Methods:	Direct instruction, demonstrations, labs, university lecture videos, peer-to-peer knowledge sharing, whole-group problem-solving.
Materials & Resources:	Textbook, workbook, calculator, computer, Internet, lab equipment
Assessments:	In-class Q&A, problem sets, quizzes, lab reports, end-of-unit exam

Wilson Area School District
Curriculum Scope & Sequence

Planned Course: AP Physics C: Mechanics

Unit: Oscillations & Gravitation

Time Frame: 6 weeks

State Standards

3.1.12.A	Apply concepts of systems, subsystems, feedback, and control to solve complex technical problems.
3.1.12.D	Analyze scale as a way of relating concepts and ideas to one another by some measure.
3.1.12.E	Evaluate change in nature, physical systems, and man-made systems.
3.4.10.B	Analyze energy sources.
3.4.10.C	Distinguish among the principles of force and motion.
3.4.12.C	Apply the principles of motion and force.
3.7.12.A	Apply advanced tools, materials, and techniques to answer complex questions.

Anchor(s) or Adopted Anchor:

S11.A.1.3 Describe and interpret patterns of change in natural and human-made systems.

S11.A.1.3.2 Describe or interpret dynamic changes to stable systems (e.g., chemical reactions, human body, food webs, tectonics, homeostasis).

S11.A.3.2.1 Compare the accuracy of predictions represented in a model to actual observations and behavior.

S11.A.3.3 Compare and analyze repeated processes or recurring elements in patterns.

S11.A.3.3.1 Describe or interpret recurring patterns that form the basis of … astronomical order.

S11.A.3.3.3 Analyze physical patterns of motion to make predictions or draw conclusions (e.g., solar system, tectonic plates, weather systems, atomic motion, waves).

S11.C.3.1 Use the principles of motion and force to solve real-world challenges.

S11.D.3.1.1 Describe planetary motion and the physical laws that explain planetary motion.

Essential Content / Objectives: At the end of the unit, students will be able to:

- Perform energy, motion, and force calculations using Newton's Law of Universal Gravitation.
- Use Kepler's Laws to calculate the characteristics of orbits and orbiting objects such as radius, period, apogee, perigee, min/max velocities.
- Solve problems that involve determining ways to maneuver in space.
- Compute the force between two masses using Newton's Law of Universal Gravitation.
- Diagram and quantify how potential energy, kinetic energy, displacement, velocity, acceleration, and the restoring force vary during simple harmonic motion.
- Measure the period, frequency, wavelength, and amplitude of a simple harmonic oscillator and of a physical pendulum.

Core Activities: Students will participate in instructor-led discussions; use analog and digital tools for data-collection and analysis in labs; run computer-based simulations of experiments; and engage in whole-group and small-group problem solving.

Extensions: Current events, actual undergraduate problems, independent investigations

Remediation:	One-on-one re-teaching; online physics tutorials; supplemental reading and problem-solving.
Instructional Methods:	Direct instruction, demonstrations, labs, university lecture videos, peer-to-peer knowledge sharing, whole-group problem-solving.
Materials & Resources:	Textbook, workbook, calculator, computer, Internet, lab equipment
Assessments:	In-class Q&A, problem sets, quizzes, lab reports, end-of-unit exam

Wilson Area School District
Curriculum Scope & Sequence

Planned Course: AP Physics C: Mechanics

Unit: Independent Projects

Time Frame: 3-4 weeks

State Standards None

Anchor(s) or Adopted Anchor: None

Essential Content / Objectives:
There is no “essential content” in this unit. The objective is to keep the post-AP Exam engagement high for graduating seniors by encouraging them to bring forward science topics that interest them. Past topics include the physics of aviation, launching model rockets, making thermite, building remotely controlled vehicles, and fabricating a wind tunnel.

Core Activities: We model the design process, plan the project sequence, research the science behind the topic, identify what we intend to quantify via measurement, observation, or calculation, and then we do it.

Extensions: None

Remediation: None

Instructional Methods: These are student-led, instructor-supported activities. They may include direct instruction, demonstrations, peer-to-peer knowledge sharing, and whole-group problem-solving.

Materials & Resources: Varies by topic

Assessments: Direct observation