WAUCONDA SCHOOL DISTRICT 118
UNIT PLANNING ORGANIZER

Subject: AP Physics I

Unit 10: Universal Gravitation

Pacing: 10 Class Days

STAGE 1 – DESIRED RESULTS

Essential Questions:

1) What does it mean for a force to be fundamental?
2) How is the motion of the moon around the Earth like the motion of a falling apple?
3) How does the effect of Earth's gravitational field on an object change as the object's distance from Earth changes?

Big Ideas:

- Conceptually apply Newton's laws of motion to circular systems
- Mathematically calculate and quantify radial systems
- Objects and systems have properties such as mass and charge. Systems may have internal structure.
- The interactions of an object with other objects can be described by forces.
- Interactions between systems can result in changes in those systems.
- Changes that occur as a result of interactions are constrained by conservation laws.

CCSS (Priority Standards):

Common Core Standards - English Language Arts:

- CCSS.ELA-LITERACY.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.
- CCSS.ELA-LITERACY.WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.
- CCSS.ELA-LITERACY.SL.11-12.1 - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- CCSS.ELA-LITERACY.SL.11-12.1.A - Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
- CCSS.ELA-LITERACY.SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
- CCSS.ELA-LITERACY.SL.11-12.1.C
    - Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.
- CCSS.ELA-LITERACY.SL.11-12.1.D - Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

- CCSS.ELA-LITERACY.SL.11-12.2 - Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
- CCSS.ELA-LITERACY.SL.11-12.4 - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
- CCSS.ELA-LITERACY.SL.11-12.5 - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Common Core Standards - Mathematics:

- CCSS.MATH.PRACTICE.MP1 - Make sense of problems and persevere in solving them.
- CCSS.MATH.PRACTICE.MP2 - Reason abstractly and quantitatively.
- CCSS.MATH.PRACTICE.MP3 - Construct viable arguments and critique the reasoning of others.
- CCSS.MATH.PRACTICE.MP4 - Model with mathematics.
- CCSS.MATH.PRACTICE.MP5 - Use appropriate tools strategically.
- CCSS.MATH.PRACTICE.MP6 - Attend to precision.
- CCSS.MATH.CONTENT.HSN.Q.A.1 - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- CCSS.MATH.CONTENT.HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.
- CCSS.MATH.CONTENT.HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- CCSS.MATH.CONTENT.HSA.SSE.A.1 - Interpret expressions that represent a quantity in terms of its context.
- CCSS.MATH.CONTENT.HSA.SSE.B.3 - Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
- CCSS.MATH.CONTENT.HSA.CED.A.1 - Create equations and inequalities in one variable and use them to solve problems.Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
- CCSS.MATH.CONTENT.HSA.CED.A.2 - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- CCSS.MATH.CONTENT.HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
- CCSS.MATH.CONTENT.HSF.IF.C.7 - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases
- CCSS.MATH.CONTENT.HSF.IF.C.7.A - Graph linear and quadratic functions and show intercepts, maxima, and minima.
- CCSS.MATH.CONTENT.HSS.ID.C.7 - Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
- CCSS.MATH.CONTENT.HSS.ID.C.8 - Compute (using technology) and interpret the correlation coefficient of a linear fit.

Next Generation Science Standards:
Force and Interactions:

- HS-PS2-2 - Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- 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.

Engineering Design:

- 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.

Advanced Placement Physics Standards:

- Model verbally or visually the properties of a system based on its substructure and relate this to changes in the system properties over time as external variables are changed. [LO 1.A.5.1, SP 1.1, SP 7.1]
- Describe a force as an interaction between two objects and identify both objects for any force. [LO 3.A.3.3, SP 1.4]
- Analyze a scenario and make claims (develop arguments, justify assertions) about the forces exerted on an object by other objects for different types of forces or components of forces. [LO 3.A.3.1, SP 6.4, SP 7.2]
- Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. [LO 3.A.2.1, SP 1.1]
- Design a plan to collect and analyze data for motion (static, constant, or accelerating) from force measurements and carry out an analysis to determine the relationship between the net force and the vector sum of the individual forces. [LO 3.B.1.2, SP 4.2, SP 5.1]
- Reexpress a free-body diagram representation into a mathematical representation and solve the mathematical representation for the acceleration of the object. [LO 3.B.1.3, SP 1.5, SP 2.2]
- Create and use free-body diagrams to analyze physical situations to solve problems with motion qualitatively and quantitatively. [LO 3.B.2.1, SP 1.1, SP 1.4, SP 2.2]
- Articulate situations when the gravitational force is the dominant force and when the electromagnetic, weak, and strong forces can be ignored. [LO 3.G.1.1, SP 7.1]
- Apply g = GMr 2 to calculate the gravitational field due to an object with mass M, where the field is a vector directed toward the center of the object of mass M. [LO 2.B.2.1, SP 2.2]
- Approximate a numerical value of the gravitational field (g) near the surface of an object from its radius and mass relative to those of the Earth or other reference objects. [LO 2.B.2.2, SP 2.2]
- Apply F = mg to calculate the gravitational force on an object with mass m in a gravitational field of strength g in the context of the effects of a net force on objects and systems. [LO 2.B.1.1, SP 2.2, SP 7.2]
- Use Newton’s law of gravitation to calculate the gravitational force the two objects exert on each other and use that force in contexts other than orbital motion. [LO 3.C.1.1, SP 2.2]
- Use Newton’s law of gravitation to calculate the gravitational force between two objects and use that force in contexts involving circular orbital motion. [LO 3.C.1.2, SP 2.2]
- Approximate a numerical value of the gravitational field (g) near the surface of an object from its radius and mass relative to those of the Earth or other reference objects. [LO 2.B.2.2, SP 2.2]

STAGE 2 – EVIDENCE

Concepts (What students need to know)	Performance Tasks (What students will be able to do)	21st Century Skills
1) Radial / circular terminology 2) Centripetal acceleration 3) Circular force analysis 4) Uniform circular motion 5) Force analysis for banked / unbanked curves 6) Newton's Law of Universal Gravitation 7) Kepler's Laws of Motion	1) Use force diagrams to analyze and quantify the motions of objects traveling in a circle. 2) Identify and explain the difference between centripetal vs centrifugal force. 3) Apply Newton's Law of Universal Gravitation to determine motions between different objects. 3) Use Kepler's 3rd Law of Planetary Motion to predict and model orbital behaviors of planets and satellites.	1) Utilize computer-based laboratory equipment from Vernier and Pasco scientific 2) Video analysis of motion using Pivot Interactives 3) Comprehensive laboratory write-ups focusing on conceptual understandings and wider applications of the underlying ideas 4) Data analysis through graphical analysis programs including slope, y-intercept, correlation value, and area analysis.

Common Formative/Summative Assessments:

- ➢ Activity - Gravitation (Simulation)
- ➢ Unit Test - Universal Gravitation

Interim Assessments (Informal Progress Monitoring checks):

- ➢ Whiteboard Meetings
- ➢ Lab Challenges
- ➢ Practice Activities & Problems

Modified Common Assessments:

Modified Interim Assessments:

STAGE 3 – LEARNING PLAN
(INSTRUCTIONAL PLANNING)

Suggested Resources/Materials/Informational Texts

Suggested Research-based Effective Instructional Strategies

Identifying Similarities and Differences - The ability to break a concept into its similar and dissimilar characteristics allows students to understand (and often solve) complex problems by analyzing them in a more simple way. Teachers can either directly present similarities and differences, accompanied by deep discussion and inquiry, or simply ask students to identify similarities and differences on their own. While teacher-directed activities focus on identifying specific items, student-directed activities encourage variation and broaden understanding, research shows.

Summarizing and Note Taking - These skills promote greater comprehension by asking students to analyze a subject to expose what's essential and then put it in their own words. According to research, this requires substituting, deleting, and keeping some things and having an awareness of the basic structure of the information presented.

Cues, Questions, and Advance Organizers Cues - Questions, and advance organizers help students use what they already know about a topic to enhance further learning. Research shows that these tools should be highly analytical, should focus on what is important, and are most effective when presented before a learning experience

Cooperative Learning - Research shows that organizing students into cooperative groups yields a positive effect on overall learning. When applying cooperative learning strategies, keep groups small and don't overuse this strategy-be systematic and consistent in your approach.

Reinforcing Effort and Providing Recognition - Effort and recognition speak to the attitudes and beliefs of students, and teachers must show the connection between effort and achievement. Research shows that although not all students realize the importance of effort, they can learn to change their beliefs to emphasize effort.

Taken from: *Marzano's Nine Instructional Strategies for Effective Teaching and Learning*

Academic Vocabulary/ Word Wall	Enrichment/Extensions/ Modifications
Essential Vocabulary: **Worth-Knowing Vocabulary:**	