Honors Physics

Semester A Summary:

Honors Physics A Standard is designed to describe the physical world using a small number of basic assumptions, concepts, and equations. The course emphasizes relating physics to the everyday world. Physics A focuses on understanding motion. The student will explore the concepts involved with motion in one- and two-dimensions, forces, work and energy, momentum and collisions, circular motion and gravitation. The students will recognize the importance of the laws of thermodynamics.
Approximately 40 percent of the course involves virtual laboratory investigations. Some activities will require ordinary household items such as rulers, meter sticks, balls or marbles, string, paper, and pencils. Throughout the course, the student will engage in activities to encourage critical thinking, including using multiple examples to generate broader generalizations, exploring an increased complexity of conceptual relationships, and studying content appropriate for college preparation studies.

Semester A Outline

1. **Course Overview**
    1. Physics A Course Overview
2. **Science Processes**
    1. Science Processes Introduction
        - In this section, you will practice empathic listening.
    2. Defining Science
        - In this section, you will define science and explain the limitations of science. You will also learn about lab safety and proper handling of chemical substances.
    3. Accuracy and Precision
        - In this section, you will apply accuracy and precision along with significant figures in the context of the limitations of measurement.
    4. Making a Scientific Hypothesis
        - In this section, you will identify a hypothesis as a tentative and testable statement.
    5. Scientific Theories
        - In this section, you will define scientific theory and distinguish between theories and hypotheses.
    6. Hypothesis vs. Theory
        - In this section, you will distinguish the difference between a scientific hypothesis and a scientific theory.
    7. Science Processes Review
    8. Science Processes Unit Test
3. **Kinematics**
    1. Kinematics Introduction
    2. Distance and Displacement

- In this section, you will distinguish between distance and displacement.

3. Speed and Velocity
    - In this section, you will distinguish between speed and velocity.
4. Acceleration
    - In this section, you will calculate the acceleration of an object in motion.
    - In this section, you will use data as evidence to describe that the relationship between the observed quantities is accurately modeled across the range of data by the formula $a = Fnet/m$, for example, double force yields double acceleration.
5. Projectile Motion
    - In this section, you will describe the path of a projectile in two dimensions.
6. Kinematics Portfolio 1
    - In this portfolio project, you will investigate the motion of a horizontally-launched marble. The learning experience will develop a framework for the process of experimentation and the analysis of data.
    - In this section, you will complete a portfolio assessment analyzing the motion of a projectile launched on the horizontal.
7. Kinematics Portfolio 2
    - In this section, you will complete a portfolio assessment analyzing the motion of a projectile launched on the horizontal.
8. Kinematics Apply
9. Kinematics Review
10. Kinematics Unit Test

4. **Newton's Laws and Dynamics**
    1. Newton's Laws and Dynamics Introduction
    2. Force and Newton's First Law
        - In this section, you will apply Newton's First Law and the concept of force in real-world scenarios.
    3. Hooke's Law
        - In this section, you will calculate the spring constant of an elastic material by using data on force and displacement.
    4. Net Force and Free-Body Diagrams
        - In this section, you will determine the net force on an object by analyzing a free-body diagram.
    5. Second Law of Motion
        - In this section, you will analyze data that represent the net force on a macroscopic object, its mass (which is held constant), and its acceleration.
    6. Correlation and Causation
        - In this section, you will distinguish between causal and correlational relationships linking force, mass, and acceleration. You will use the data as empirical evidence to tell the difference between these relationships.
    7. Newton's Third Law
        - In this section, you will explain everyday phenomena, such as a hammer hitting a nail, using Newton’s third law of motion. You will also compare the force pairs in given situations.
    8. Friction
        - In this section, you will compare kinetic and static friction.
    9. Newton's Laws and Dynamics Apply
    10. Newton's Laws and Dynamics Review
    11. Newton's Laws and Dynamics Unit Test
5. **Energy and Work**

1. Energy and Work Introduction
2. Forms of Energy
    - In this section, you will define energy and analyze the different forms it can take.
3. Energy Transfer
    - In this section, you will describe relationships between components in classical models that account for energy.
4. Model Limitations
    - In this section, you will identify and/or describe the limitations of the computational model, based on the assumptions that were made in creating the algebraic descriptions of energy changes and flows in the system.
5. Conservation of Mechanical Energy
    - In this section, you will use mathematical thinking to calculate whether mechanical energy is being conserved in a given system ($KE = \frac{1}{2}mv^2$, $PE_g = mgh$, $PE_e = \frac{1}{2}kx^2$).
    - In this section, you will use the conservation of mechanical energy to analyze the motion of a pendulum.
6. Energy and Work Apply
7. Energy and Work Review
8. Energy and Work Unit Test

6. **Momentum**
    1. Momentum Introduction
    2. What is Momentum
        - In this section, you will calculate the momentum of each object in a system as the product of its mass and its velocity, $p = mv$.
    3. Conservation of Momentum
        - In this section, you will evaluate how the total momentum of a system of two interacting objects is constant if there is no net force on the system.
    4. Proving Conservation of Momentum
        - In this section, you will support a claim, based on an analysis of the total momentum of the system, that the momentum of the system is the same before and after the interaction between the objects in the system so that momentum of the system is constant
    5. Inelastic and Elastic Collisions
        - In this section, you will analyze elastic and inelastic collisions considering conservation considerations.
    6. Simple Machines and Efficiency
        - In this section, you will obtain and communicate information to describe the efficiency of everyday machines, such as automobiles, hairdryers, refrigerators, and washing machines.
        - In this section, you will analyze mechanical devices that change an applied force and learn how to measure their efficiency.
    7. Momentum Portfolio 1
        - In this portfolio, you will investigate the forces acting on a moving vehicle to analyze how seat belts and airbags save lives in a car crash.
        - In this section, you will complete a portfolio assignment analyzing how seat belts and airbags save lives in a car crash.
    8. Momentum Portfolio 2
        - In this section, you will complete a portfolio assignment analyzing how seat belts and airbags save lives in a car crash.
        - The student will demonstrate an understanding of scientific and engineering

practices by defining design problems that involve the development of a process or system with interacting components and criteria and constraints.

9. Momentum Portfolio 3
    - In this section, you will complete a portfolio assignment analyzing how seatbelts and airbags save lives in a car crash.
10. Momentum Apply
    - In this section, you will explain why a baseball that is rolling eventually stops and what happens to its kinetic energy.
11. Momentum Review
12. Momentum Unit Test

7. **Circular Motion and Gravitation**
    1. Circular Motion and Gravitation Introduction
    2. Centripetal Force
        - In this section, you will describe the acceleration involved in circular motion.
    3. Gravitational Attraction
        - In this section, you will describe the gravitational attraction between two objects as the product of their masses divided by the separation distance squared , where a negative force is understood to be attractive.
    4. Satellites
        - In this section, you will analyze the motion of satellites in stable orbit.
    5. Kepler's Laws of Planetary Motion
        - In this section, you will apply Kepler’s first law of planetary motion to understand the orbits of planets.
        - In this section, you will apply Kepler's second law of planetary motion to understand the orbits of planets.
        - In this section, you will apply Kepler's Third Law of planetary motion to understand the orbits of planets.
    6. Circular Motion and Gravitation Apply
    7. Circular Motion and Gravitation Review
    8. Circular Motion and Gravitation Unit Test
8. **Physics A Semester Review and Test**
    1. Physics A Semester Review
    2. Physics A Semester Exam

Semester B Summary:

Honors Physics B Standard is designed to describe the physical world using a small number of basic assumptions, concepts, and equations. The course emphasizes relating physics to the everyday world. Physics B focuses on the characteristics of waves and describes the behavior of waves with emphasis on light and sound. The student will understand the relationship between electricity and magnetism. Finally, the student will gain a simple understanding of atomic physics.
Approximately 40 percent of the course involves virtual laboratory investigations. Some activities will require ordinary household items such as rulers, meter sticks, balls or marbles, string, paper, and pencils.
Throughout the course, the student will engage in activities to encourage critical thinking, including using multiple examples to generate broader generalizations, exploring an increased complexity of conceptual relationships, and studying content appropriate for college preparation studies.

Semester B Outline

1. **Course Overview**
    1. Physics B Course Overview
2. **Thermodynamics**
    1. Thermodynamics Introduction
    2. First Law of Thermodynamics
        - In this section, you will define heat as a form of energy, which can not be created nor destroyed, but it can be converted to another form.
    3. States of Matter
        - In this section, you will analyze the amount of heat energy needed to change a substance from one state to another using both a conceptual and a mathematical approach.
    4. Thermal Energy Transfer Portfolio 1
        - In this portfolio, you will develop, conduct, and evaluate investigations of the second law of thermodynamics.
        - In this section, you will develop an investigation plan for the second law of thermodynamics. You will describe the data to be collected and evidence derived from the data, such as the measurements of the thermal energy lost by a hot equal to the thermal energy gained by a cold object.
    5. Thermal Energy Transfer Portfolio 2
        - In this section, you will develop an investigation plan for the second law of thermodynamics. You will describe the data to be collected and evidence derived from the data, including the heat capacity of the components in the system, which should be obtained from scientific literature.
        - In this section, you will describe an investigation plan for the second law of thermodynamics, including how a nearly closed system will be constructed.
        - In this section, you will conduct an investigation that provides evidence of the second law of thermodynamics.
    6. Thermal Energy Transfer Portfolio 3
        - In this section, you will collect and record data in an investigation of the second law of thermodynamics that can be used to calculate the change in thermal energy of each of the two components of a system.
        - In this section, you will evaluate an investigation of the second law of thermodynamics. You will assess the accuracy and precision of the data collected, as well as the limitations of the investigation.
    7. Thermal Energy Transfer Portfolio 4
        - In this section, you will evaluate an investigation of the second law of thermodynamics. You will assess the ability of the data to provide the evidence required.
    8. Heat Engines and Efficiency
        - In this section, you will analyze thermal efficiency limitations according to the second law of thermodynamics.
    9. Thermodynamics Apply
    10. Thermodynamics Review
    11. Thermodynamics Unit Test
3. **Electricity and Circuits**
    1. Electricity and Circuits Introduction
    2. Conductors and Insulators
        - In this section, you will identify materials as conductors or insulators based on their electric properties.
    3. Coulomb's Law

- In this section, you will identify and describe the electrostatic force between two objects as the product of their individual charges divided by the separation distance squared $\left(F_E = k\frac{q_1 q_2}{r^2}\right)$, where a negative force is understood to be attractive.

4. Electric Fields
    - In this section, you will explore the qualitative and quantitative properties of electric fields.
5. Ohmic Device Resistance
    - In this section, you will apply conservation of energy concepts to the design of an experiment that will demonstrate the validity of Kirchhoff's Voltage Law, $\Sigma\Delta V = 0$, in a circuit with only a battery and resistors either in series or parellel.
    - In this section, you will develop graphical, mathematical, and pictorial representations that describe the relationship between length, cross-sectional area, and resistivity of an ohmic device.
    - In this section, you will apply graphical, mathematical, and pictorial representations that describe the relationship between length, cross-sectional area, and resistivity of an ohmic device to describe how changing the composition, size, or shape of the device can affect the resistance.
    - In this lesson, you will explore the relationship between voltage, resistance, and current using a PhET® simulation titled Ohm's law.
6. Series and Parallel Circuits
    - In this section, you will analyze relationships in resistance, voltage, and current in parallel and series circuits.
    - In this section, you will identify materials as conductors or insulators based on their electric properties.
7. Kirchhoff's Laws and Circuits
    - In this section, you will apply conservation of energy concepts to the design of an experiment that will demonstrate the validity of Kirchhoff's loop rule ($\Sigma V = 0$) in a circuit with only a battery and resistors in, at most, one pair of parallel branches.
    - In this section, you will apply conservation of an electric charge (i.e., Kirchhoff's Current Law) to the comparison of electric current in various segments of an electrical circuit with a single battery and resistors in series. You will also predict how those values would change if configurations of the circuit are changed.
    - In this section, you will apply conservation of an electric charge (i.e., Kirchhoff's Junction Rule) to the comparison of electric current in various segments of an electrical circuit with a single battery and resistors in one parallel branch. You will also predict how those values would change if configurations of the circuit are changed.
8. Electricity and Circuits Apply
9. Electricity and Circuits Review
10. Electricity and Circuits Unit Test

4. **Electricity and Magnetism**
    1. Electricity and Magnetism Introduction
    2. Electric Current and Magnetic Field
        - In this section, you will describe a phenomenon under investigation, including how an electric current produces a magnetic field and that a changing magnetic field produces an electric current.
    3. Investigating Currents and Fields

- In this section, you will plan an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. You will also include a description of the procedure and the apparatus.

4. Measurable Effects of Electromagnetism
    - In this section, you will investigate the relationship between an electric current and a magnetic field. This will include describing the data to be collected, conducting the investigation, and describing the evidence that will come from the data.
5. Causal Relationships
    - In this section, you will describe why the relationships between electric currents and magnetic fields must be causal and not correlational. You will cite specific cause-and-effect relationships.
6. Electricity and Magnetism Apply
    - In this section, you will create a presentation explaining electric motors and some of their specific uses.
7. Electricity and Magnetism Review
8. Electricity and Magnetism Unit Test

5. **Waves**
    1. Waves Introduction
    2. Comparing Waves
        - In this section, you will compare mechanical and electromagnetic waves in terms of wave characteristics and behavior.
    3. Characteristics of Waves
        - In this section, you will describe relevant components in mathematical representations.
    4. Frequency and Wavelength
        - In this section, you will identify and/or describe relevant components in the mathematical representations of waves. Your description will include the relationships between frequency, wavelength, and speed of waves traveling in various specified media.
    5. Wave Application
        - In this section, you will use the mathematical relationship $v = \lambda f$ to assess claims about any of the three quantities when the other two quantities are known for waves traveling in various specified media.
    6. Interference of Waves
        - In this section, you will study the interference of traveling waves.
    7. Sound Wave Phenomena
        - In this section, you will explain what happens to the observed frequency of a sound wave when the relative positions of an observer and wave source changes, such as in the Doppler effect.
        - In this section, you will communicate scientific and technical information about how the principle of superposition explains the resonance and harmonic phenomena in air columns and on strings and common sound devices.
    8. The Speed of Sound
        - In this section, you will demonstrate how the wave speed for a wave changes as the medium through which the wave travels changes.
    9. Nature of Light
        - In this section, you will investigate how light travels.
        - In this section, you will understand the intensity and color of light.

10. Reflection and Refraction
    - In this section, you will describe image formation by reflection from a flat mirror and by refraction through a convex lens.
    - In this section, you will describe image formation by reflection from a flat mirror and by refraction through a convex lens.
    - In this section, you will use mathematics, the laws of reflection and refraction, and ray diagrams to describe light behavior.
11. Wavelength in Different Media
    - In this section, you will express the relative change in wavelength in terms of cause (different media) and effect (different wavelengths but same frequency)
12. Waves Portfolio 1
    - In this portfolio, you will study building design to understand how different building styles react to seismic waves. You will design a high-rise building with structural features that improve earthquake resistance. You will also study the way waves propagate through the Earth's core and make and test a hypothesis about the Earth's interior. You will use the properties of seismic waves to design an early warning system for earthquakes that maximizes warning time.
    - In this section, you will complete a portfolio assignment analyzing how an understanding of seismic waves can be used to understand the interior of the Earth, design solutions for buildings, and save lives.
13. Waves Portfolio 2
    - In this section, you will complete a portfolio assignment analyzing how an understanding of seismic waves can be used to understand the interior of the Earth, design solutions for buildings, and save lives.
14. Waves Portfolio 3
    - In this section, you will complete a portfolio assignment analyzing how an understanding of seismic waves can be used to understand the interior of the Earth, design solutions for buildings, and save lives.
15. Waves Apply
    - In this section, you will apply what you know about how wavelength, frequency, and wave speed are connected to study how animals use sound to communicate.
16. Waves Review
17. Waves Unit Test

6. **Quantum Theory and Particle Physics**
    1. Quantum Theory and Particle Physics Introduction
    2. Particle-Wave Duality
        - In this section, you will evaluate how electromagnetic radiation can be described either by a wave model or a particle model by evaluating claims and evidence for and against each position.
    3. The Photoelectric Effect
        - In this section, you will evaluate the photoelectric effect to determine how it supports the argument that electromagnetic radiation can be described by a particle model.
    4. EM Radiation Energy Transfer Models
        - In this section, you will evaluate the claims and reasoning for modeling electromagnetic radiation as both a wave and particle. You will consider the transfer of energy and information within and between systems and evaluate why for some aspects the wave model is more useful and for other aspects

the particle model is more useful to describe the transfer of energy and information.

5. Mass-Energy Equivalence
    - In this section, you will calculate mass-energy equivalence and describe its applications.
6. Atomic Structure
    - In this section, you will compare the different parts of atoms.
7. Emission Spectra
    - In this section, you will explain the emission spectra produced by various atoms.
8. Radioactivity and Radioactive Decay
    - In this section, you will describe the probability of a decay event within a sample of unstable nuclei.
9. Absorbed Radiation Effects
    - In this section, you will identify the characteristics, common sources, potential to cause harm, and applications of different types of electromagnetic radiation.
    - In this section, you will analyze the effects of radiation on the human body.
10. Half Lives and Radiocarbon Dating
    - In this section, you will define the half-life ($\frac{t_1}{2}$) and decay constant λ.
    - In this section, you will perform an intestigation on probability and calculate half-life from acquired data.
    - In this section, you will identify information to communicate how radioactive decay processes have practical applications, such as food preservation, cancer treatments, fossil and rock dating, and as radioisotopic medical tracers.
11. Quantum Theory and Particle Physics Apply
12. Quantum Theory and Particle Physics Review
13. Quantum Theory and Particle Physics Unit Test

7. **Physics B Semester Review and Test**
    1. Physics B Semester Review
    2. Physics B Semester Exam