Elizabethtown Area School District

Honors Physics

Course Number:	331	Length of Course:	1 semester – 18 weeks
Grade Level:	11-12 Elective	Total Clock Hours:	120 hours
Length of Period:	80 minutes	Date Written:	June 11, 2007
Periods/Week:	5 periods/week	Written By:	David Cherry
Credits (if app.):	1.0	Weighted:	1.1 as of 2010/2011

Prerequisite: Pre-Calculus

Course Description:

This course is intended for the highly motivated student. It is assumed that students have strong math skills, allowing them to approach the study of physics from a mathematical as well as laboratory approach. Students who sign up for this class must have strong skills in algebra, vector analysis, geometry, and science. Labs will involve some basic statistical analysis of data that will be taught within the course. Knowledge of calculus is not necessary for this course, but references will be made to calculus-based ideas. Topics of study include mechanics, electricity and magnetism, thermodynamics, waves and optios, sound, light, and modern physics.

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I. Overall Course/Grade Level Standards

Students will know and be able to do the following as a result of taking this course.

A. Discuss the meaning and significance of the basic principles of physics.

B. Analyze technical problems, organize technical information, create a labeled sketch, develop a logical approach to problem solving, arrive at a solution, and ascertain the reasonableness of the solution.

C. Interpret graphs (graphs constructed on paper and Microsoft Excel), and be able to correctly present laboratory and classroom data in a graphical format.

D. Synthesize new approaches to problems by considering skills, knowledge, and experiences gained in prior units of study or other courses.

E. Collect, statistically analyze, and interpret data taken from computers, mechanical, or electrical equipment in the laboratory, as well as prepare written results detailing important points of the lab and the significance of the results.

F. Recognize the role of the computer as a data collection and analysis instrument in the modern laboratory setting.

G. Analyze and make predictions concerning the position, speed, and acceleration of objects, particularly the special case of constant acceleration and objects in free fall (motion in one dimension).

H. Analyze the motion of objects in two dimensions (projectile motion, uniform circular motion, simple harmonic motion).

I. Resolve vectors and perform vector operations such as dot product and cross product.

J. Determine forces in physical systems and construct free body diagrams.

K. Apply Newton's laws of motion to friction and non-friction situations, use the law of universal gravitation, and apply the impulse momentum theorem.

L. Apply conservation principles (conservation of energy, conservation of mechanical energy, and conservation of momentum).

M. Calculate, work, power, kinetic energy, and potential energy, understand the relationship between work and energy (work-kinetic energy theorem).

N. Know the basic principles of rotational motion.

O. Analyze basic electrical circuits (using Kirchhoff's voltage and current laws).

P. Use Ohm's laws, and calculate equivalent resistances for basic resistive circuits as well as draw and interpret basic schematic diagrams.

Q. Know the basic properties of magnetic and electric fields.

R. Know the properties of sound waves and mechanical waves, including the Doppler effect and conditions for complete destructive and constructive interference.

S. Know the properties of light waves and the electromagnetic spectrum, including the nature of color and the dual nature of light.

T. Know the thermodynamic systems, methods of heat transfer, laws of thermodynamics and how to interpret PV diagrams.

U. Know the basic characteristics of optical systems, reflection, refraction and interference of light, and be able to predict image characteristics mathematically, or through construction of ray diagrams.

V. Know and recognize the basic vocabulary of each physics discipline, including fundamental SI units, variables, and equations.

W. Analyze a basic RC circuit, identify the time constant and calculate voltages, currents, and charges during times of charging, discharging, and steady state conditions. Understand the basic electrostatic properties of capacitors.

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Curriculum Form

II. Content

Major Areas of Study

Unit	Estimated Time	Materials
1. Newtonian Mechanics	12 weeks	Textbook, Prepared Notes, PASCO Science Workshop 750 Computer Interfaces and Probes, Computers, Prepared Problems, Mechanics Lab Equipment
2. Electricity and Magnetism	3 weeks	Textbook, Prepared Notes, PASCO Science Workshop 750 Computer Interfaces and Probes, Computers, Prepared Problems, Electricity and Magnetism Lab Equipment,
3. Heat, Thermodynamics	1.5 weeks	Textbook, Prepared Notes, PASCO Science Workshop 750 Computer Interfaces and Probes, Computers, Prepared Problems, Thermodynamics Lab Equipment
4. Waves and Geometric Optics	1.5 weeks	Textbook, Prepared Notes, PASCO Science Workshop 750 Computer Interfaces and Probes, Computers, Prepared Problems, Waves and Optics Lab Equipment

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Name of Course: Honors Physics
Name of Unit: Newtonian Mechanics
Essential Question: How does the universe, and everything in it, move?

Unit Objectives	Priority	Aligned to Course Standard	Aligned to PA Standard
A. Kinematics **1.** Vectors **a)** Students will be able to identify all quantities in Newtonian mechanics as either a vector or a scalar quantity. **b)** Students will be able to resolve a displacement, velocity, or acceleration vector into its vector components. **c)** Students will be able to perform vector addition (graphically and mathematically), vector dot product (work, power), and vector cross product (torque). Students will be able to recognize that the dot product of two vectors is a scalar, and the cross product of two vectors is a vector. **d)** Students will be able to utilize unit vector notation in an orthogonal coordinate system. **2.** Motion in One Dimension **a)** Students will be able to understand the mathematical relationships among position, velocity, and acceleration for an object (treated as a point particle) moving in a straight line. **b)** Students will be able to understand the graphical interrelationship between a position vs. time graph, velocity vs. time graph, and an acceleration vs. time graph for constant acceleration. Students will be able to identify the slope of a tangent line on a position vs. time graph as instantaneous velocity, slope of a line on a velocity vs. time graph as acceleration. Students will be able to calculate the area under a velocity vs. time graph as change in position, and the area under an acceleration graph as change in velocity. Students will be able to sketch each graph. **c)** Given a mathematical equation of position vs. time or velocity vs. time, students will be able to differentiate the expression to obtain the velocity vs. time or acceleration vs. time. **d)** Students will be able to utilize the five equations for constant acceleration to solve free response problems (X and Y directions—derive Y from X-dir.). **e)** Students will be able to describe qualitatively, with the aid of graphs, the acceleration, velocity, and displacement of an object when it is released from rest or is projected vertically upward or downward with a specified initial velocity. **3.** Motion in Two Dimensions **a)** Students will gain a full understanding of independence of motion in the X and Y directions. **b)** Students will be able to identify the horizontal acceleration of a projectile to be zero, and the vertical acceleration of a projectile to be 9.8 m/s^2 downward. **c)** Students will be able to utilize equations from motion in one dimension to	E	V I H G F E D C B A	3.1.12B 3.1.12C 3.1.12D 3.2.12A 3.2.12B 3.2.12C 3.2.12D 3.4.12C 3.4.10C 3.7.12B

solve problems in motion in two dimensions. **d)** Students will be able to combine equations from motion in one dimension to obtain expressions for range, total time in air, and maximum height of a projectile (horizontal and angled projection). **e)** Students should understand the general motion of a particle in two dimensions so that, given functions x(t) and y(t) which describe this motion, they can determine the components, magnitude, and direction of the particle's velocity and acceleration as functions of time. **f)** Students will be able to identify and sketch graphs of position vs. time, velocity vs. time, and acceleration vs. time for projectile motion (both X and Y directions).			
B) Newton's Laws **1.** First Law (Law of Inertia) **a)** Students will be able to analyze situations in which a particle remains at rest (static equilibrium), or moves with a constant velocity in a straight line, under the influence of several forces. **b)** Students will understand the idea of an inertial frame of reference and a non-inertial frame of reference. **2.** Second Law (**F** = m**A**) **a)** Students will be able to calculate, for a body moving in one direction, the velocity change that results when a constant force acts over a specified time interval. **b)** Students will be able to utilize Newton's Second Law in the impulse momentum form. **(1)** Students will be able to relate impulse to the change in linear momentum and the average force acting on a body. **(2)** Students will be able to identify the area under a force vs. time graph as the impulse. **c)** Students will be able to analyze situations in which an object moves with a specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or one of the forces that makes up the net force in situations such as: **(1)** Motion in the X and Y-direction with constant acceleration. **(2)** Motion in a horizontal circle. **(3)** Motion in a vertical circle. **d)** Students will be able to draw complete free-body diagrams for objects that are in static equilibrium and objects that are accelerating. **(1)** Students will be able to draw and accurately label a free-body diagram showing all real forces that act on the object. **(2)** From an accurately labeled free-body diagram students will be able to write down vector summation equations along appropriate coordinate axes (X, Y, radial, tangential, or rotated). **(3)** Students will be able to identify the center of mass of symmetrically shaped objects of uniform density, or locate the center of mass of a system consisting of two symmetrically shaped bodies. **e)** Students will be able to apply Newton's Second Law to objects that are undergoing terminal velocity. **3.** Static and Kinetic Frictional Considerations **a)** Students should have an understanding of the relative magnitude of coefficients of friction and understand their significance. **b)** Students will be able to write down a relationship between the normal and frictional forces on a surface (horizontal or on a ramp). **c)** Students will be able to analyze situations in which a body slides down a rough inclined plane or is pulled or pushed across a rough surface.	E	V K J F E D C B A	3.1.12B 3.1.12D 3.2.12A 3.2.12B 3.2.12C 3.2.12D 3.4.12C 3.4.10C 3.7.12B

d) Students will be able to analyze static friction situations to determine under what circumstances a body will undergo slippage, or to calculate the magnitude of the force of static friction. **4.** Third Law (Law of Action/Reaction) **a)** Students should understand how to apply Newton's Third Law so that, for a given force, they can identify the body on which the reaction force acts and state the magnitude and direction of this reaction force. **b)** Students will understand that action and reaction forces will not produce identical accelerations unless the bodies are of equal mass. **5.** Systems of Two or More Bodies (Coupled Systems) **a)** Students should be able to apply Newton's Laws in analyzing the force between the two bodies that accelerate together along a horizontal or vertical line, or objects coupled on a ramp. **b)** Students will be able to analyze the motion of a system of two bodies coupled together with a string. **c)** Students will be able to understand the forces involved in a large-scale system, such as planetary bodies, coupled by gravitational forces. This analysis includes treating the objects as if they are point masses.			
C. Work, Energy, and Power **1.** Work **a)** Students will be able to calculate the work done by a constant force on an object that undergoes a specified displacement. **b)** Students will relate the work done by a force to the area under a graph of force vs. position, and calculate this work in cases where the force is a linear and non-linear function of position (in this case by integration of function). **c)** Students will be able to calculate work as the dot product of the constant force and displacement vectors. **d)** Students will be able to calculate the work done by a variable force (such as a spring force) by integrating the function (for spring $F = -kx$). **2.** Kinetic Energy, Work-Kinetic Energy Theorem **a)** Students will be able to calculate the kinetic energy of an object. **b)** Students will be able to use the work-kinetic energy theorem to calculate the change in kinetic energy or speed that results from performing a specified amount of work on an object. **c)** Students will be able to calculate the work performed by the net force on a body that undergoes a specified change in speed or kinetic energy. **d)** Students will be able to determine the change in a body's kinetic energy and speed that results from the application of specified forces, or to determine the force that is required in order to bring an object to rest in a specified distance. **3.** Conservative Forces and Potential Energy **a)** Students should be able to identify forces as either conservative or non-conservative (mainly frictional forces). **b)** Students will be able to calculate the gravitational potential energy of an object in a uniform gravitational field. **c)** Students will understand that work done by a conservative force is equal to the negative of the change in potential energy. **d)** Students will be able to calculate elastic potential energy. **e)** Students should be able to express the gravitational potential energy of a rigid body in terms of the position of its center of mass. **4.** Conservation of Mechanical Energy, Conservation of Energy **a)** Students will be able to apply conservation of mechanical energy to situations where only conservative forces are present. **b)** Students will be able to identify situations in which mechanical energy is	E	V M L F E D C B A	3.1.12B 3.1.12D 3.1.12E 3.2.12A 3.2.12B 3.2.12C 3.2.12D 3.4.12A 3.4.12C 3.4.10B 3.4.10C 3.7.12B

converted from one form to another (example: GPE converted to KE) and identify situations in which mechanical energy is, or is not conserved. **c)** Students will be able to amend a conservation of mechanical energy equation to include frictional considerations. **d)** Students will be able to apply conservation of energy principles in their analysis of bodies that are moving in a gravitational field. **e)** Students will be able to apply conservation of energy principles in their analysis of bodies that move under the influence of a spring force. **5.** Power **a)** Students will be able to calculate the power required to maintain the motion of a body with constant acceleration such as a body moving on a level surface, a body raised at a constant rate, or a body that is overcoming friction. **b)** Students will be able to calculate the work performed by a force that supplies constant power, or the average power supplied by a force that performs a specified amount of work. **c)** Students will be able to calculate power as the dot product of force and velocity vectors.			
D. Linear Momentum, Conservation of Linear Momentum, Collisions **1.** Students will be able to calculate the linear momentum of an object. **2.** Students will be able to set up and solve conservation of momentum statements for collisions in one-dimensional and two-dimensional situations. **3.** Students will be able to apply conservation of linear momentum to determine the final velocity of one of the objects when two objects that are moving in one or two dimensions collide. **4.** Students will be able to identify a collision as elastic, inelastic, or perfectly inelastic and apply conservation of momentum. Students should be able to give examples of each type of collision. **5.** If a collision is proven to be inelastic, students should be able to calculate the amount of kinetic energy lost as a result of the collision.	E	V L F E D C B A	3.1.12B 3.1.12D 3.2.12A 3.2.12B 3.2.12C 3.2.12D 3.4.12C 3.4.10B 3.4.10C 3.7.12B
E. Circular Motion and Rotational Systems **1.** Uniform Circular Motion **a)** Students will be able to relate the radius of a circle and the speed or rate of revolution of a particle to the magnitude of its centripetal acceleration. **b)** Students will be able to describe the direction of a particle's velocity, force, and acceleration at any instant during the objects motion. **c)** Students will be able to determine the components of the velocity, force and acceleration vectors at any instant. **2.** Torque and Rotational Statics **a)** Students should be able to calculate torque as a vector cross product. **b)** Students should be able to determine the direction of the torque using the right hand rule. **c)** Students should be able to calculate torque as the product of the force and lever arm. **d)** Students will be able to identify the conditions for translational and rotational equilibrium of a rigid body. **e)** Students will understand and apply the sign conventions for torque. **f)** Students will be able to apply the conditions for translational and static equilibrium of a rigid body under the influence of a number of coplanar forces applied at different locations. **g)** Students will be able to look up the moment of inertia for common and uncommon shapes in a table.	I	V N H D C B A	3.1.12B 3.1.12D 3.2.12A 3.2.12B 3.2.12C 3.2.12D 3.4.12C 3.7.12B
F. Oscillatory Motion **1.** General Skills	E	V H	3.1.12B 3.1.12C

a) Students will be able to mathematically analyze spring mass, simple pendulum, physical pendulum, and conical pendulum oscillatory systems. **b)** Students will be able to sketch or identify a graph of displacement vs. time and determine from such a graph the amplitude, period, and frequency of oscillatory motion. **c)** Students will be able to write down and describe each term of the displacement function in the form of $x(t) = A\cos(\omega t + \phi)$. **d)** Students will be able to identify points in the motion where velocity, acceleration, and displacement are zero or achieve maximum positive and negative values for each type of oscillatory motion. **e)** Students will be able to derive an expression for velocity and acceleration as a function of time for oscillatory motion. **f)** Students will be able to understand and apply the relationship between frequency and period. **g)** Students should be able to state how the total energy of an oscillating system depends upon the amplitude of the motion, and identify points in the motion where this energy is all potential or all kinetic. **h)** Students will be able to calculate the kinetic and potential energies of an oscillatory system as functions of time, and realize that the sum of kinetic and potential energy is constant. **2.** Spring Mass **a)** Students will be able to derive an expression for the period of oscillation of the spring mass system. **b)** Students will be able to apply the expression for the period of oscillation of the spring mass system. **3.** Simple Pendulum **a)** Students will be able to derive an expression for the period of oscillation of the simple pendulum (using small angle approximation). **b)** Students will be able to apply the expression for the period of oscillation of the simple pendulum system. **c)** Students will know that mass has no effect on the period of a simple pendulum. **4.** Physical Pendulum **a)** Students will be able to derive the expression for the period of oscillation of the physical pendulum system. **b)** Students will be able to apply the expression for the period of oscillation of the physical pendulum system.		F E D C B A	3.1.12D 3.2.12A 3.2.12B 3.2.12C 3.2.12D 3.4.12C 3.7.12B
G. Gravitation **1.** Students will be able to use the law of universal gravitation to determine the force that one spherically symmetric mass exerts on another. **2.** Students will understand the significance of the law of universal gravitation as an important inverse square law. **3.** Students will be able to determine the proper conditions under which the law of universal gravitation is relevant. **4.** Students will be able to determine the strength of the gravitational field at a point outside a spherically symmetric mass.	I	V K D C B A	3.1.12C 3.2.12A 3.2.12D 3.4.12C

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Vocabulary and Unit Essential/Key Questions
Unit: Newtonian Mechanics
Unit Essential Question: How does the universe, and everything in it, move?

Unit Key Questions:

1. How do vector quantities relate to concepts within Newtonian mechanics?
2. What two qualities are necessary for a complete description of a vector quantity?
3. What is a resultant vector?
4. Can an object travel at a constant speed and still accelerate?
5. How does the concept of independence of motion apply to projectile motion?
6. What direction is acceleration directed for objects that move in a circle?
7. How can an object move if there is no net force acting on it?
8. What causes objects to accelerate?
9. Do Newton's Laws apply in a non-inertial frame of reference?
10. Will objects in motion continue in motion?
11. What is a direct measure of an object's inertia?
12. Does the length of a simple pendulum have any effect on its period?
13. Does pendulum-bob mass have any effect upon the period of a simple pendulum?
14. What constants have a role in the period of a spring mass system?
15. How does distance from axis of rotation influence the period of a physical pendulum?
16. How does mass distribution affect rotational inertia?
17. How do conservation of energy principles apply to different collision types?
18. If friction is present, is overall energy conserved?
19. How does friction affect the motion of objects?
20. Will all objects in free-fall accelerate at a rate of 9.8 m/s^2?
21. What factors affect the terminal velocity of an object in free fall?
22. What forces act on astronomical bodies?
23. How is momentum conserved in different collision types?
24. What are the conditions for static equilibrium?
25. What effect does increasing lever arm have on torque?
26. Do the major conservation principles in mechanics apply to rotational dynamics?
27. What does the slope of a line on a position vs. time graph represent?
28. What does the slope of a line on a velocity vs. time graph represent?
29. What does the "area under the curve" on a velocity vs. time graph represent?
30. What does the "area under the curve" on an acceleration vs. time graph represent?
31. What is the time rate of work?
32. What type of energy is associated with an object's state or position?
33. What type of energy is associated with the motion of objects?
34. Do action and reaction forces produce identical accelerations?
35. What direction is the velocity directed for an object undergoing uniform circular motion?

Critical Vocabulary: acceleration, amplitude, center of mass, centripetal, centripetal force, crest, delta, displacement, dynamic, elastic collision, energy, equilibrium condition, force, frequency, gravitational field, Hooke's law, impulse, inelastic collision, inertia, inertial frame of reference, Joule, kinematics, kinetic energy, kinetic friction, lever arm, mass, momentum, net, Newton, normal force, oscillation, perfectly inelastic collision, period, phase, potential energy, power, projectile, rate, reaction force, resonance, resultant, scalar, speed, static friction, static's, tangential velocity, terminal velocity, torque, trough, vector, velocity, watt, weight, work

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Name of Course: Honors Physics
Name of Unit: Electricity and Magnetism
Essential Question: How are the basic principles of electricity and magnetism incorporated into products we use in our everyday lives?

Unit Objectives	Priority	Aligned to Course Standard	Aligned to PA Standard
A) Vectors **1.** Students will be able to identify all quantities in electricity and magnetism as either a vector or a scalar quantity. **2.** Students will be able to resolve vectors into their vector components. **3.** Students will be able to perform vector addition (graphically and mathematically), vector dot product, and vector cross product. Students will be able to recognize the dot product of two vectors is a scalar, and the cross product of two vectors is a vector.	C	V I D B A	3.2.12A 3.2.12D
B) Electrostatics **1.** Electric Charge **a)** Students should be able to identify the two types of electric charge. **b)** Students should understand that charges can be isolated. **c)** Students will be able to determine the direction of the force on a charged particle brought near an uncharged or grounded conductor. **2.** Electric Field **a)** Students will be able to define electric field in terms of the amount of force experienced by a test charge. **b)** Students will be able to calculate the magnitude and direction of the force exerted on a positive or negative charge placed in a uniform electric field. **c)** Students will be able to analyze the motion of a particle of specified charge and mass in a uniform electric field. **3.** Coulomb's Law **a)** Students will be able to understand Coulomb's Law as an important inverse square law. **b)** Students should be able to determine the force that acts between specified point charges, and describe the electric field of an isolated point charge. **c)** Students will be able to use vector addition to determine the electric field produced by two or more point charges (principle of superposition). **4.** Capacitors **a)** Students should know the definition of capacitance so they can relate stored charge and voltage for a capacitor. **b)** Students will be able to relate voltage, charge, and stored energy for a capacitor. **c)** Students will recognize situations in which energy stored in a capacitor is converted to other forms. **d)** Students will be able to calculate the energy stored in a parallel plate capacitor. **8.** Dielectrics **a)** Students will be able to understand how the insertion of a dielectric	C	V O D C B A	3.1.12B 3.1.12C 3.2.12A 3.2.12D 3.4.12A 3.4.10C

between the plates of a charged parallel-plate capacitor influences its capacitance, and the voltage between the plates. **b)** Students will know what materials are commonly used as dielectrics.			
C) Electric Circuits **1.** Current, Resistance, Voltage, Power **a)** Students should understand that the convention universally adopted for current flow is the movement of positive charges. **b)** Students should understand the definition of electric current. **c)** Students will be able to define resistance. **d)** Students will be able to use Ohm's Law to relate current and voltage for a resistor. **2.** Steady-State Direct Current Circuits with Voltage Sources and Resistors Only **a)** Students should be able to identify on a circuit diagram whether a circuit is a series circuit, a parallel circuit, or a series-parallel circuit. **b)** Students will be able to find equivalent resistances of series circuits, parallel circuits, and series-parallel circuits. **c)** Students will be able to determine the ratio of the voltages across resistors connected in series, parallel, or series-parallel. **d)** Students will be able to calculate the voltage, current, and power dissipated for any resistor in a network connected to a voltage source. **e)** Students will be able to design series-parallel circuits that produce a given current and voltage for one specified component, and draw a diagram for the circuit using conventional circuit symbols. **f)** Students will be able to apply Kirchhoff's rules to direct current, series series-parallel, and parallel circuits. **g)** Students will be able to apply Kirchhoff's rules to set up and solve systems of simultaneous equations to determine unknown currents. **h)** Students should understand that the resistance of an ammeter is low and the resistance of a voltmeter is high. **i)** Students will be able to demonstrate correct methods of connecting meters (or computer probes) in order to measure voltage or current. **3.** Capacitors in Direct Current Circuits **a)** Students will be able to calculate the equivalent capacitance of a series or parallel combination of capacitors. **b)** Students will be able to describe how stored charge is divided between two capacitors connected in parallel. **c)** Students will be able to determine the ratio of voltages for two capacitors connected in series. **d)** Students will be able to relate voltage, charge, and stored energy for a capacitor. **e)** Students will be able to explain the meaning of an RC time constant and be able to calculate its value. **f)** Students will be able to recognize situations in which energy stored in a capacitor is converted to other forms. **g)** Students should be able to calculate the voltage or stored charge, under steady-state conditions, for a capacitor connected in an RC circuit. **h)** Students will be able to sketch and identify graphs of charge, current, and voltage vs. time for a capacitor that is charging or discharging. **i)** Students will be able to utilize expressions to calculate stored charge, voltage, and current as a capacitor is charging or discharging. **j.** Students will be able to determine voltages, currents, and charges immediately after a switch has been closed and also after steady-state conditions have been established.	E	W V P O F E D C B A	3.1.12B 3.1.12D 3.1.12E 3.2.12A 3.2.12B 3.2.12C 3.2.12D 3.4.12A 3.4.10B 3.4.10C 3.7.12B
D) Magnetostatics	C	V	3.1.12C

1. Forces on Moving Charges in a Magnetic Field **a)** Students will understand that a charged particle in a magnetic field experiences a force. **b)** Students should be able to deduce the direction of a magnetic field from information provided about the forces experienced by charged particles moving through that field. **c)** Students will be able to describe the path of a charged particle moving in a uniform magnetic field, which starts from rest, and which enters a uniform magnetic field moving with a specified initial velocity. **2.** Magnetic Fields of Long Current-Carrying Wires **a)** Students will understand how to calculate the magnitude and direction of the magnetic field at a point near a long current-carrying wire. **b)** Students will be able to use the superposition principle to determine the net magnetic field produced by two long current-carrying wires. **c)** Students will be able to determine if two long, parallel, current-carrying wires will attract or repel one another based on current directions. Students will also be able to calculate the force of attraction or repulsion.		Q F E D C B A	3.2.12A 3.2.12D 3.4.10C 3.7.12B

Elizabethtown Area School District

Unit: Electricity and Magnetism

Unit Essential Question: How are the basic principles of electricity and magnetism incorporated into products we use in our everyday lives?

Unit Key Questions:

1. What is the algebraic relationship between voltage, current, and resistance?
2. What is the flow of charge?
3. What is EMF?
4. What device offers resistance to the flow of electrons?
5. How is power calculated in a resistive network?
6. What characterizes a series circuit?
7. What characterizes a parallel circuit?
8. What characterizes a series/parallel circuit?
9. How do resistive devices combine in a series circuit?
10. How do resistive devices combine in a parallel circuit?
11. How do resistive devices combine in a series/parallel circuit?
12. How does current behave in a series circuit?
13. How does current behave in a parallel circuit?
14. How does voltage across resistive devices behave in a series circuit?
15. How does voltage across resistive devices behave in a parallel circuit?
16. How do we break a resistive network down into an equivalent resistance?
17. How is electricity generated and sent to our homes?
18. What are the main types of electric power production in the United States?
19. What type of electricity comes into our homes?
20. What are the two types of electronic circuits?
21. What are the two main branches of study in electronics?
22. What type of circuitry do most of our modern electronic devices use?
23. What is an integrated circuit?
24. What are the three basic building blocks of digital electronic circuitry?
25. How do we apply Kirchhoff's current law to a resistive network?
26. How do we apply Kirchhoff's voltage law to a resistive network?
27. What are the four categories we can classify materials into with regard to their electrical properties?
28. What reference charge to we use to determine direction of electric field?
29. How much force is necessary to assemble a group of point charges?
30. What factors influence the force felt by a charged particle next to another charged particle?
31. Can a magnetic monopole exist?

Critical Vocabulary: alternating current, ampere, analog circuitry, branch, charge, circuit, conductor, coulomb, digital circuitry, direct current, EMF, electron, electric field, electric potential, electrodynamics, electrostatics, equivalent resistance, generator, insulator, integrated circuit, magnetic field, node, Ohm's law, Ohm, parallel circuit, potential, potential difference, power, resistor, semiconductor, series circuit, superconductor, transformer, volt, voltage, watt

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Name of Course: Honors Physics
Name of Unit: Heat, Thermodynamics
Essential Question: How did the understanding and application of thermodynamic principles contribute to our industrialized society?

Unit Objectives	Priority	Aligned to Course Standard	Aligned to PA Standard
A) Temperature and Heat **1.** Students should understand the mechanical equivalent of heat, and be able to calculate how much a substance will be heated as it performs a specified quantity of mechanical work. **2.** Students should understand the concepts of specific heat, heat of fusion, and heat of vaporization. **3.** Students will be able to identify, given a graph relating the quantity of heat added to a substance and its temperature, the melting point, the boiling point, and will be able to determine the heat of fusion, heat of vaporization and the specific heat of each phase. **4.** Students will be able to determine how much heat must be added to a sample of a substance to raise its temperature from one specified value to another, or to cause melting or vaporization of the substance. **5.** Students will be able to determine the final temperature achieved when substances, at different temperatures, are mixed together and allowed to come to thermal equilibrium.	I	V T F E D C B A	3.1.12B 3.1.12D 3.2.12B 3.2.12D 3.4.10A 3.4.12A 3.4.12B 3.7.12B
C) Thermodynamics **1.** Ideal Gases **a)** Students will be able to apply the ideal gas law to relate the pressure and volume of a gas during an isothermal expansion or compression. **b)** Students will be able to relate the pressure and temperature of an ideal gas during constant-volume heating or cooling, or the volume and temperature during constant pressure heating or cooling. **c)** Students will be able to calculate the work performed on or by a gas during an expansion or compression at a constant pressure. **d)** Students will understand the process of adiabatic expansion or compression of a gas. **e)** Students will be able to identify and draw on a PV diagram an isobaric process, adiabatic process, isothermal process, and an isovolumetric process. **2.** Laws of Thermodynamics **a)** Students will have an understanding of the "zeroth" law of thermodynamics. **b)** First Law of Thermodynamics **(1)** Students will be able to relate the heat absorbed by a gas, the work performed by the gas, and the internal energy change of the gas for the major thermodynamic processes. **(2)** Students will be able to relate the work performed by a gas in a cyclic process to the area enclosed by a curve on a PV diagram. **(3)** Students will understand the sign conventions for heat and work in	I	V T L D C B A	3.1.12C 3.2.12A 3.2.12D 3.4.10A 3.4.12A 3.4.12B

the first law of thermodynamics. **c)** Second Law of Thermodynamics, Entropy, Heat Engines, Carnot Cycle **(1)** Students will be able to calculate the maximum possible efficiency of a heat engine operating between two given temperatures. **(2)** Students will be able to calculate the actual efficiency of a heat engine. **(3)** Students will be able to relate the heats exchanged at each thermal reservoir in a Carnot cycle to the temperatures of the reservoir. **(4)** Students will be able to draw a basic schematic diagram of a heat engine or a refrigerator.			

Elizabethtown Area School District
Curriculum Form

Unit: Heat, Thermodynamics

Unit Essential Question: How did the understanding and application of thermodynamic principles contribute to our industrialized society?

Unit Key Questions:

1. Is heat a form of energy?
2. What are three different temperature scales, and how are they interrelated?
3. What is the lowest theoretical temperature that could ever be achieved?
4. What is latent heat of fusion?
5. What is latent heat of vaporization?
6. Can a substance lose (gain) heat energy and not incur a temperature drop (rise)?
7. What are the four states of matter?
8. What is specific heat of a substance, and how is it calculated?
9. What is the basic relationship between pressure, temperature, and volume?
10. Most materials, when heated, will expand or contract?
11. How do we calculate heat energy lost or gained in a system?
12. Is heat energy gained in a system considered to be positive or negative?
13. What is an isovolumetric process, and how would it be represented on a PV diagram?
14. What is an isochoric process, and how would it be represented on a PV diagram?
15. What is an isobaric process, and how would it be represented on a PV diagram?
16. What is an isothermal process, and how would it be represented on a PV diagram?
17. What is an adiabatic process, and how would it be represented on a PV diagram?
18. What experimental process could be used to determine the specific heat of an unknown substance?
19. Why is it that some substances feel colder than others if they are maintained at the same temperature?
20. What are three main heat transfer mechanisms?
21. What is the lowest possible temperature?
22. How does the specific heat of water compare with the specific heat of other common materials?
23. Why do molecules of warm air move upward?
24. Why does the direction of coastal winds change from day to night?

Critical Vocabulary: absolute zero, adiabatic, calorie, Celsius, entropy, conduction, convection, Fahrenheit, gas, heat, isobaric, isochoric, isothermal, isovolumetric, Joule, Kelvin, latent heat, of fusion, latent heat of vaporization, liquid, Pascal, plasma, pressure, radiation, solid, specific heat, temperature, thermal equilibrium, volume

Elizabethtown Area School District

Name of Course: Honors Physics
Name of Unit: Waves and Geometric Optics
Essential Question: How has mankind's curiosity about our solar system and the distant stars led to developments and advancements in the field of optics?

Unit Objectives	Priority	Aligned to Course Standard	Aligned to PA Standard
A) Waves **1.** Traveling Waves **a)** Students will be able to sketch and identify graphs that represent traveling waves and determine the amplitude, wavelength, and frequency of a wave from such a graph. **b)** Students will be able to state and apply the relationship among wavelength, frequency, and velocity of a wave. **b)** Students will be able to determine what factors influence the speed of sound in air, solids, and liquids. **2.** Doppler Effect **a)** Students will be able to explain the mechanism that gives rise to a frequency shift in both the moving-source and moving observer, and derive an expression for the frequency heard by an observer. **b)** Students will be able to write and apply the equations (with appropriate sign conventions) that describe the moving-source and moving-observer Doppler effect.	I	V R F E D C B A	3.1.12C 3.2.12A 3.2.12C 3.2.12D 3.4.12C 3.4.10C
B) Physical Optics **1.** Interference and Diffraction **a)** Students will be able to describe the conditions under which the waves reaching an observation point from two sources will interfere constructively, or destructively. **b)** Students will be able to mathematically determine locations of interference maxima or minima for two point sources or determine the frequencies or wavelengths that can lead to constructive or destructive interference at a certain point. **2.** Chromatic Dispersion and the Electromagnetic Spectrum **a)** Students will be able to understand that chromatic dispersion takes place because index of refraction varies with wavelength. **b)** Students will understand which ray deviates the most from the normal as light passes from higher to lower index of refraction, or vice-versa. **c)** Students will know the names associated with the different portions of the electromagnetic spectrum and will be able to arrange them in order of increasing wavelength.	C	V U S R F E D C B A	3.1.12B 3.1.12C 3.1.12D 3.2.12D 3.2.12B 3.2.12C 3.2.12D 3.4.12C 3.4.10C 3.7.12B
C) Geometric Optics **1.** Reflection and Refraction **a)** Students will be able to determine how the speed and wavelength of light change when light passes from one medium into another.	E	V U F E	3.1.12B 3.1.12D 3.2.12A 3.2.12B

b) Students will be able to show on a diagram the directions of reflected and refracted rays as light passes from one medium to another. **c)** Students will be able to use Snell's Law to relate the directions of the incident ray and the refracted ray, and the indices of refraction of the media. **d)** Students will be able to identify conditions under which total internal reflection will occur. **2.** Plane and Spherical Mirrors **a)** Students will know the mathematical relationship between the focal point of a spherical mirror to its center of curvature. **b)** Given a diagram of a mirror with the focal point shown, students will be able to perform a ray tracing diagram (using three principle rays) to locate the image of a real object to determine if the image is real or virtual, upright or inverted, enlarged or reduced in size. Students will also be able to confirm this information with proper mathematical relationships. **c)** Students will be able to locate the image formed of a real object in a plane mirror, and do a proper ray tracing to show this image. **3.** Converging and Diverging Lenses **a)** Students will be able to determine whether the focal length of a lens is increased or decreased as a result of a change in the curvature of its surfaces or in the index of refraction of the material of which the lens is made or the medium in which it is immersed. **b)** Students will be able to determine by ray tracing the location of the image of a real object located inside or outside the focal point of the lens, and state whether the resulting image is upright or inverted, real or virtual. **c)** Students will be able to use the thin lens equation to relate the object distance, image distance, and focal length for a lens, and determine the image size in terms of the object size.		D C B A	3.2.12D 3.4.12C 3.7.12B

Elizabethtown Area School District

Unit: Waves and Geometric Optics

Unit Essential Question: How has mankind's curiosity about our solar system and the distant stars led to developments and advancements in the field of optics?

Unit Key Questions:

1. What is reflection?
2. How are images formed in a mirror by the process of reflection?
3. What is refraction?
4. How are images formed in lenses by the process of refraction?
5. What is interference?
6. What is chromatic dispersion?
7. Under what conditions is a real image formed in a mirror?
8. Under what conditions is a virtual image formed in a mirror?
9. What is a real image?
10. What is a virtual image?
11. Under what conditions is a real image formed in a lens?
12. Under what conditions is a virtual image formed in a lens?
13. Where does visible light fall in the electromagnetic spectrum?
14. What wavelengths of light fall in the visible spectrum?
15. What frequencies of light fall in the visible spectrum?
16. What is the vertex of a mirror or lens?
17. What is the radius of curvature of a mirror or lens?
18. What is the focal point of a mirror or lens?
19. How do we perform a ray tracing to locate images for objects in a mirror?
20. How do we perform a ray tracing to locate images for objects in a lens?
21. How do we apply Snell's Law to refracted rays as light passes from one medium to another?
22. What is the speed of light in a vacuum?
23. Does the speed of light vary from one medium to another?
24. How do we define index of refraction?
25. What is the difference between light that is chromatic and light that is monochromatic?
26. What is total internal reflection, and how does this principle apply to modern communications?
27. What is Doppler shift?
28. What conditions are necessary for complete constructive or destructive interference?

Critical Vocabulary: aberration, angle of incidence, angle of reflection, beats, coherent light, converging lens, critical angle, diffraction, diffraction grating, diffuse reflection, dispersion, diverging lens, Doppler effect, electromagnetic spectrum, electromagnetic wave, focal length, focus, frequency, hertz, incoherent light, infrared, interference, laser, lens, longitudinal wave, monochromatic, node, opaque, period, pitch, polarization, real image, reflection, refraction, spectrum, standing wave, total internal reflection, transverse wave, trough, vibration, virtual image, wavelength, white light

Elizabethtown Area School District

III. Course Assessments

Check types of assessments to be used in the teaching of the course.
(Provide examples of each type.)

__X_ Objective Tests/Quizzes
____ Constructed Responses
____ Essays
__X_ Reports
____ Projects
____ Portfolios
____ Presentations
__X_ Performance tasks
__X_ Lab Activities
____ Response Journals
____ Logs
____ Computer Simulations
____ Research Papers
__X_ Class Participation
__X_ Notetaking
__X_ Daily Assignments
____ Writing Samples
____ __________________

Provide copies of common assessments that will be utilized for all students taking this course. Overall course/grade level standards will be measured by a common course assessment. Unit objectives will be measured on an ongoing basis as needed by the classroom teacher to assess learning and plan for instruction. List common assessements below and recommended date/time frame for administration (at least quarterly).

	Name of Assessment	When given?
1.	Unit Tests	At the conclusion of each major unit
2.	Final Exam	At the conclusion of the semester
3.	Lab Summary	At the conclusion of a lab
4.	Lab Questions	At the conclusion of a lab

IV. Expected levels of achievement

Current grading scale:

As defined in the current grading policy outlined in the student handbook.

A+	98-100
A	95-99
A-	92-94
B+	89-91
B	86-88
B-	83-85
C+	80-82
C	77-79
C-	74-76
D+	71-73
D	68-70
D-	65-67
F	0-64

PA Proficiency Levels
Advanced Proficient
Basic Below Basic

Example of common assessment:

A

F

Honors Physics Newton's Laws Exam

M1 **M2**

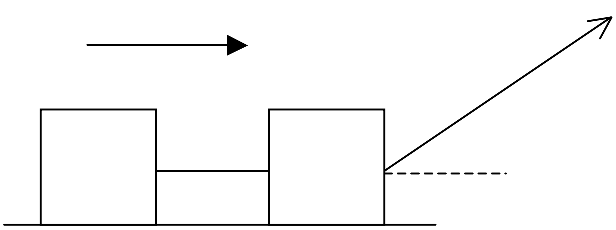
θ

1. (2 pts) **A)** According to Newton's third law, if a baseball bat exerts a 20 N force on a baseball, then the ball must do what?

2. (6 pts) An object with a mass of 50 kg <u>slides</u> with a constant velocity on a horizontal surface. **A)** Draw a complete free body diagram of this situation (all forces in X and Y directions). **B)** What is the numerical value of the normal force? **C)** If the force used to slide the object is 100 N, what is the coefficient of kinetic friction?

3. (4 pts) A 500 kg elevator is moving downward (it is also accelerating downward at 2.5 m/s^2). What is the tension in the elevator cable?

4. (10 pts) M1 = 5.0 kg M2 = 10.0 kg F = 200 N θ = 25° μ_k is .25 for both blocks system moves to the right and accelerates right: What is the acceleration of the system?



5. (2 pts) A hammer is used to exert a force on a nail. According to Newton's third law the nail exerts an equal and opposite force on the hammer. Do those forces produce the same acceleration on each object? YES NO

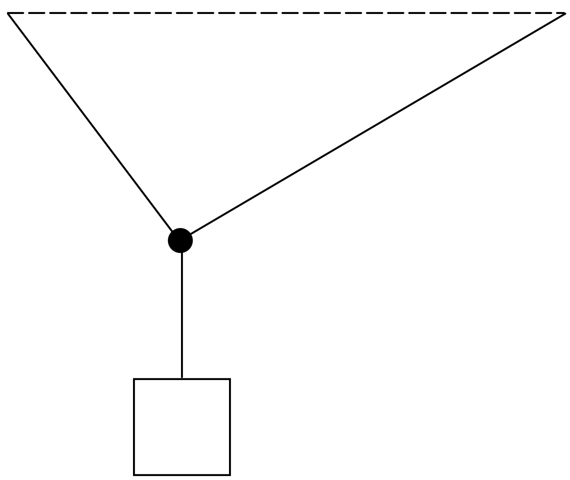
ϕ θ

6. (2 pts) What is the only thing the **coefficient** of static friction (μ_s), and the **coefficient** of kinetic friction (μ_k) depend upon?

7. (2 pts) Is your weight the same on the moon as it is on earth?

8. (2 pts) An object is being pushed with a force of 75 N along a rough horizontal floor at a constant velocity. The frictional force opposing the motion of the object is?
A) greater than 75 N B) equal to 75 N C) less than 75 N

9. (12 pts) $\theta = 55°$ $\phi = 35°$ M = 15.0 kg What is the tension in each cable T1, T2, T3?

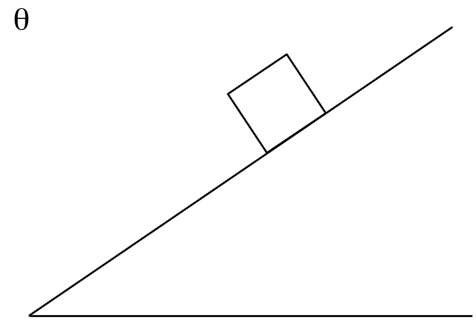


10. (2 pts) Object one has a mass of 10 kg. Object two has a mass of 20 kg. Which object has more inertia?

11. (3 pts) What force is necessary to accelerate an object, which has a mass of 1500 kg, from 20 m/s to 50 m/s in 15 seconds?

12. (5 pts) We apply a 40 N force to slide a crate of mass M across a rough horizontal floor at a constant velocity (no acceleration). If the coefficient of kinetic friction (μ_k) is 0.3, what is the numerical value of M?

13. (4 pts) **A)** Draw a complete free body diagram (showing all forces and components of forces parallel and perpendicular to the ramp) for an object at rest on an incline at an angle of θ degrees with the horizontal (incline is not frictionless).



B) (2 pts) Based on your free body diagram above, please apply Newton's second law ($\Sigma F_y = ma_y$) to the object in the Y-direction (Y-direction is perpendicular to the ramp).

C) (2 pts) Based on your free body diagram above, please apply Newton's second law ($\Sigma F_x = ma_x$) to the object in the X-direction (X-direction is parallel to the ramp).

14. (5 pts) A .20 kg ball is coming towards a bat with an initial velocity $V_i = 55$ m/s. The ball is bunted, and travels in the opposite direction off the bat with a speed $V_f = 25$ m/s. The impact time for the ball/bat collision is 1.8×10^{-3} seconds. What average force acted on the ball?

15. (5 pts) What is the gravitational force that exists between two objects M1 = 500 kg and M2 = 1500 kg separated by a distance of 25 m?

16. (5 pts) A car of mass 1500 kg travels at a constant speed of 25.0 m/s along a flat, circular road of radius 200 meters. What is the minimum value of the coefficient of static friction between the tires and the road surface that will prevent the car from slipping?