AP Physics 1 Curriculum Map

Time Frame	Big Idea	Enduring Understanding	Essential Knowledge	Suggested Resources
MP 1 (and through-out the course)	**1:** Objects and systems have properties such as mass and charge. Systems may have internal structure.	**1.A:** The internal structure of a system determines many properties of the system.	**1.A.1:** A system is an object or a collection of objects. Objects are treated as having no internal structure. **1.A.5:** Systems have properties determined by the properties and interactions of their constituent atomic and molecular substructures.	Giancoli, Ch 1 Demos as appropriate
		1.B: Electric charge is a property of an object or system that affects its interactions with other objects or systems containing charge.	**1.B.1**: Electric charge is conserved. The net charge of a system is equal to the sum of the charges of all the objects in the system. **1.B.2**: There are only two kinds of electric charge. Neutral objects of systems contain equal quantities of positive and negative charge, with the exception of some fundamental particles that have no electric charge. **1.B.3**: The smallest observed unit of charge that can be isolated is the electron charge, also known as the elementary charge	Giancoli Ch. 16 E-Statics Lab Oil Drop Experiment Video
		1.C Objects and systems have properties of inertial mass and gravitational mass that are experimentally verified to be the same and that satisfy conservation principles.	**1.C.1** Inertial mass is the property of an object or a system that determines how its motion changes when it interacts with other objects or systems.	Giancoli Ch. 4 Mass demos

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	1: Objects and systems have properties such as mass and charge. Systems may have internal structure (cont'd).		**1.C.2**: Gravitational mass is the property of an object or a system that determines the strength of the gravitational interaction with other objects, systems, or gravitational fields. **1.C.3:** Objects and systems have properties of inertial mass and gravitational mass that are experimentally verified to be the same and that satisfy conservation laws.	
		1.E: Materials have many macroscopic properties that result from the arrangement and interactions of the atoms and molecules that make up the material.	1.E.2 Matter has a property called resistivity.	Giancoli, Ch. 18 Resistance Lab
	2: Fields existing in space can be used to explain interactions.	2.A: A field associates a value of some physical quantity with every point in space. Field models are useful for describing interactions that occur at a distance (long-range forces) as well as a variety of other physical phenomena.	2.A.1: A vector field gives, as a function of position (and perhaps time), the value of a physical quantity that is described by a vector.	Giancoli, Ch. 5, 16
		2.B: A gravitational field is caused by and object with mass.	2.B.1: A gravitational field, g, at the location of an object with mass, m, causes a gravitational force of magnitude mg to be exerted on the object in the direction of the field. 2.B.2: The gravitational field caused by a spherically symmetric object with mass is radial and, outside the object, varies as the inverse square of the radial distance from the center of that object.	Giancoli, Ch. 5 "Apple & Moon" Video

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MP 2	**3:** The interactions of an object with other objects can be described by forces.	**3.A**: All forces share certain common characteristics when considered by observers in inertial reference frames.	3.A.1: An observer in a particular reference frame can describe the motion of an object using such quantities as position, displacement, distance, velocity, speed, and acceleration. 3.A.2: Forces are described by vectors. 3.A.3: A force exerted on an object is always due to the interaction of that object with another object. 3.A.4: If one object exerts a force on a second object, that second object always exerts a force of equal magnitude on the first object in the opposite direction.	Giancoli, Ch. 3 "Dune Buggy" Lab Giancoli, Ch. 4 Vector Lab
		3.B: Classically, the acceleration of an object interacting with other objects can be predicted by using $a = \Sigma F/m$	**3.B.1:** If an object of interest interacts with several other objects, the net force is the vector sum of the individual forces. **3.B.2:** Free body diagrams are useful tools for visualizing forces being exerted on a single object and writing the equations that represent a physical situation. **3.B.3:** Restoring forces can result in oscillatory motion. When a linear restoring force is exerted on an object displaced from a n equilibrium position, the object will undergo a special type of motion called simple harmonic motion (SHM). Examples should include: gravitational force exerted by the earth on a simple pendulum, mass-spring oscillator.	Giancoli, Ch. 4 FBD problems

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	3: The interactions of an object with other objects can be described by forces (cont'd).	**3.C:** At the macroscopic level, forces can be categorized as either long-range (action-at-a-distance) forces or contact forces.	**3.C.1**: Gravitational force describes the interaction of one object that has mass with another object that has mass. **3.C.2:** Electric force results from the interaction of one object that has an electric charge with another object that has an electric charge. **3.C.4:** Contact forces result from the interaction of one object touching another object, and they arise from interatomic electric forces. These forces include tension, friction, normal, spring (Physics 1) and buoyant (Physics 2).	
		3.D: A force exerted on an object can change the momentum of the object.	**3.D.1:** The change in momentum of an object is a vector in the direction of the net force exerted on the object. **3.D.2:** The change in momentum of an object occurs over a time interval.	
		3.E: A force exerted on an object can change the kinetic energy of the object.	**3.E.1:** The change in the kinetic energy of an object depends on the force exerted on the object and on the displacement of the object during the time interval that the force is exerted.	Work-Energy Lab
		3.F: A force exerted on an object can cause a torque on that object.	**3.F.1:** Only the force component perpendicular to the line connecting the axis of rotation and the point of application of the force results in a torque about that axis. **3.F.2:** The presence of a net torque along any axis will cause a rigid system to change its rotational motion or an object to change its rotation motion about that axis. **3.F.3:** A torque exerted on an object can change the angular momentum of an object.	Giancoli, Ch. 8 Balanced Torques Lab

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		3.G: Certain types of forces are considered fundamental.	**3.G.1:** Gravitational forces are exerted at all scales and dominate at the largest distance and mass scales.	
MP 3	**4:** Interactions between can result in changes in those systems.	**4.A:** The acceleration of the center of mass of a system is related to the net force exerted on the system, where $a = \Sigma F/m$	**4.A.1:** The linear motion of a system can be described by the displacement, velocity, and acceleration of its center of mass.

4.A.2: The acceleration is equal to the rate of change of velocity with time, and velocity is equal to the rate of change of position with time.

4.A.3: Forces that systems exert on each other are due to interactions between objects in the systems. If the interacting objects are parts of the same system, there will be no change in the center-of-mass velocity of that system. | Giancoli, Ch. 7 |
| | | **4.B:** Interactions with other objects or systems can change the total linear momentum of a system. | **4.B.1:** The change in linear momentum for a constant-mass system is the product of the mass of the system and the change in velocity of the center of mass.

4.B.2: The change in linear momentum of the system is given by the product of the average force on that system and the time interval during which the force is exerted. | Conservation of Momentum Lab |
| | | **4.C:** Interactions with other objects or systems can change the total energy of a system. | **4.C.1:** The energy of a system includes its kinetic energy, potential energy, and microscopic internal energy. Examples should include gravitational potential energy, elastic potential energy, and kinetic energy. | |

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	4: Interactions between can result in changes in those systems (cont'd).		**4.C.2:** Mechanical energy (the sum of kinetic and potential energy) is transferred into or out of a system when an external force is exerted on a system such that a component of the force is parallel to its displacement. The process through which the energy is transferred is called work.	
		4.D: A net torque exerted on a system by other objects or systems will change the angular momentum of the system.	**4.D.1:** Torque, Angular velocity, angular acceleration, and angular momentum are vectors and can be characterized as positive or negative, depending upon whether they give rise to or correspond to counterclockwise or clockwise rotation with respect to an axis. **4.D.2**: The angular momentum of a system may change due to interactions with other objects or systems. **4.D.3**: The change in angular momentum is given by the product of the average torque and the time interval during which the torque is exerted.	Giancoli, Ch. 8 Centripetal Force Lab
	5: Changes that occur as a result of interactions are constrained by conservation laws.	**5.A:** Certain quantities are conserved, in the sense that the changes of those quantities in a given system are always equal to the transfer of that quantity to or from the system by all possible interactions with other systems.	**5.A.1:** A system is an object or a collection of objects. The objects are treated as having no internal structure. **5.A.2:** For all systems under all circumstances, energy, charge, linear momentum, and angular momentum are conserved. For an isolated or a closes system, conserved quantities are constant. An open system is one that exchanges any conserved quantity with its surroundings.	Giancoli, Ch. 6

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	5: Changes that occur as a result of interactions are constrained by conservation laws (cont'd).		**5.A.3**: An interaction can be either a force exerted by objects outside the system or the transfer of some quantity with objects outside the system.	
			5.A.4: The boundary between a system and its environment is a decisions made by the person considering the situation in order to simplify or otherwise assist in analysis.	
		5.B: The energy of a system is conserved.	**5.B.1:** Classically, an object can only have kinetic energy since potential energy requires an interaction between two or more objects.	Giancoli, Ch. 6
			5.B.2: A system with internal structure can have internal energy, and changes in a system's internal structure can result in changes in internal energy. (Mass-spring systems and simple pendulums are covered in AP 1)	
			5.B.3: A system with internal structure can have potential energy. Potential energy exists within a system if the objects within that system interact with conservative forces.	
			5.B.4: The internal energy of a system includes the kinetic energy of the objects that make up the system and the potential energy of the configuration of the objects that make up the system.	
			5.B.5: Energy can be transferred by an external force exerted on an object or system that moves the object or system through a distance; this energy transfer is called work. Energy transfer in mechanical or electrical systems may occur at different rates. Power is defined as the rate of energy transfer into, out of, or within a system.	Power Lab

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	5: Changes that occur as a result of interactions are constrained by conservation laws (cont'd).		**5.B.9:** Kirchhoff's loop rule describes conservation of energy in electrical circuits. The application of Kirchhoff's laws to circuits is introduced in Physics 1 and further developed in Physics 2.	Circuits Lab
		5.C: The electric charge of a system is conserved.	**5.C.3:** Kirchhoff's junction rule describes the conservation of electric charge in electrical circuits. Since charge is conserved, current must be conserved at each junction in the circuit. Examples should include circuits that combine resistors in series and parallel. (One branch, one batter, and resistors only for AP 1.)	
		5.D: The linear momentum of a system is conserved.	**5.D.1:** In a collision between objects, linear momentum is conserved. In an elastic collision, kinetic energy is the same before and after. **5.D.2:** In a collision between object, linear momentum is conserved. In an inelastic collision, kinetic energy is *not* the same before and after. **5.D.3:** The velocity of the center of mass of the system cannot be changed by an interaction within the system. (AP 1 does not include detailed CM calculations.)	Collision Lab
MP 4		**5.E:** The angular momentum of a system is conserved.	**5.E.1:** If the net external torque exerted on the system is zero, the angular momentum of the system does not change.	

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	5: Changes that occur as a result of interactions are constrained by conservation laws (cont'd).		**5.E.2:** The angular momentum of a system is determined by the locations and velocities of the objects that make up the system. The rotational inertia of an object or system depends upon the distribution of mas within the object or system. Changes in the radius of a system or in the distribution of mass within the system result in changes in the system's rotational inertia, and hence in its angular velocity and linear speed for a given angular momentum. Examples should include elliptical orbits in ant Earth-satellite system. Mathematical expressions for the moments of inertia will be provided where needed. Students will not be expected to know the parallel axis theorem.	Rotational Inertia Lab
	6: Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.	**6.A:** A wave is a traveling disturbance that transfers energy and momentum.	**6.A.1:** Waves can propagate via different oscillation modes such as transverse and longitudinal. **6.A.2:** For propagation, mechanical waves require a medium, while electromagnetic waves do not require a physical medium. Examples should include light traveling through a vacuum and sound not traveling through a vacuum. **6.A.3:** The amplitude is the maximum displacement of a wave from its equilibrium position. **6.A.4:** Classically, the energy carried by a wave depends upon, and increases with, amplitude. Examples should include sound waves.	Giancoli, Ch. 11, 12 Wave Demonstrator Demo Spring Lab Resonance Lab

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	6: Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena (cont'd).	**6.B:** A periodic wave is one that repeats as a function of both time and position and can be described by its amplitude, frequency, wavelength, speed, and energy.	**6.B.1:** For a periodic wave, the period is the repeat time of the wave. The frequency is the number of repetitions of the wave per unit time. **6.B.2:** For a periodic wave, the wavelength is the repeat distance of the wave. **6.B.4:** For a periodic wave, the wavelength is the ratio of speed over frequency. **6.B.5:** The observed frequency of a wave depends on the relative motion of source and observer. This is a qualitative treatment only.	Giancoli, Ch. 11, 12
		6.D: Interference and superposition lead to standing waves and beats.	**6.D.1:** Two or more wave pulses can interact in such a way as to produce amplitude variations in the resultant wave. When two pulses cross, they travel through each other; they do not bounce off each other. Where the pulses overlap, the resulting displacement can be determined by adding the displacements of the two pulses. This is called superposition. **6.D.2:** Two or more traveling waves can interact in such a way as to produce amplitude variations in the resultant wave. **6.D.4:** Standing waves are the result of the addition of incident and reflected waves that are confined to a region and have nodes and antinodes. Examples should include waves on a fixed length of string, and sound waves in both closed and open tubes. **6.D.5**: Beats arise from the addition of waves of slightly different frequency.	Interference Demo Bets Demo Resonance Video Breaking Glass Video