| **General Physics 2 A B C - Syllabus Addendum for Prospective Teachers**<br>Serway, R. A. (2006) *Principle of Physics* 4th Edition | | |
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| **Chapter** | **Subject Matter Requirements for Prospective Teachers General Science** | **Academic content standards for kindergarten through grade twelve, adopted by the California State Board of Education** |
| Ch 1-Introduction and Vectors | 9.1e Construct and analyze simple vector and graphical representations of motion and forces (e.g., distance, speed, time) | Science Content Standards for California Public Schools, Grade 8: 1a Students know position is defined in relation to some choice of a standard reference point and a set of reference directions; 1b Students know that average speed is the total distance traveled divided by the total time elapsed and that speed of an object of an object along the path travels can vary; 1c Students know how to solve problems involving distance; time, and average speed; 1d Students know the velocity of an object must be described by specifying both the direction and the speed of the object; 1e Students know changes in velocity may be due to changes in speed, direction, or both; 1g Students know how to interpret graphs of position versus time and graphs of speed versus time for motion in a single direction |
| Ch 2-Motion in One Dimension | 9.1c Describe the relationships among position, distance, displacement, speed, velocity, acceleration, and time, and perform simple | Science Content Standards for California Public Schools, Grade 8: 1c Students solve problems involving distance, time, and average speed |

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| | calculations using these variables for both linear and circular motion | |
| Ch 3-Motion in Two Dimensions | 9.1c Describe the relationships among position, distance, displacement, speed, velocity, acceleration, and time, and perform simple calculations using these variables for both linear and circular motion | Science Content Standards for California Public Schools, Grade 8: 1c Students solve problems involving distance, time, and average speed |
| | 9.1e Construct and analyze simple vector and graphical representations of motion and forces (e.g., distance, speed, time) | Science Content Standards for California Public Schools, Grade 8: 1a Students know position is defined in relation to some choice of a standard reference point and a set of reference directions; 1b Students know that average speed is the total distance traveled divided by the total time elapsed and that speed of an object of an object along the path travels can vary; 1c Students know how to solve problems involving distance; time, and average speed; 1d Students know the velocity of an object must be described by specifying both the direction and the speed of the object; 1e Students know changes in velocity may be due to changes in speed, direction, or both; 1g Students know how to interpret graphs of position versus time and graphs of speed versus time for |

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| | | motion in a single direction |
| Ch 4-The Laws of Motion | 9.1a Discuss and apply Newton's laws (i.e., first, second, third, and law of universal gravitation) | Science Content Standards for California Public Schools, Grade 8: 1a Students know position is defined in relation to some choice of a standard reference point and a set of reference directions; 1b Students know that average speed is the total distance traveled divided by the total time elapsed and that the speed of an object along the path traveled can vary; 1c Students know how to solve problems involving distance, time, and average speed; 1d Students know the velocity of an object must be described by specifying both the direction and the speed of the object; 1e Students know changes in velocity my be due to changes in speed, direction or both |
| | 9.1d Identify the separate forces that act on a body (e.g., gravity, pressure, tension/compression, normal force, friction) and describe the net force on the body | Science Content Standards for California Public Schools, Grade 8: 2b Students know when an object is subject to two or more forces at once, the result is the cumulative effect of all the forces. |
| | 9.1e Construct and analyze simple vector and graphical representations of motion and forces (e.g., distance, speed, time) | Science Content Standards for California Public Schools, Grade 8: 1a Students know position is defined in relation to some choice of a standard reference point and a set of reference directions; 1b Students know that average speed is the total distance |

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| | | traveled divided by the total time elapsed and that speed of an object of an object along the path travels can vary; 1c Students know how to solve problems involving distance; time, and average speed; 1d Students know the velocity of an object must be described by specifying both the direction and the speed of the object; 1e Students know changes in velocity may be due to changes in speed, direction, or both; 1g Students know how to interpret graphs of position versus time and graphs of speed versus time for motion in a single direction |
| | 9.1f Identify fundamental forces, including gravity, nuclear forces, and electromagnetic forces (magnetic and electric), and explain their roles in nature, such as the role of gravity in maintaining the structure of the universe | Science Content Standards for California Public Schools, Grade 8: 2a Students know a force has both direction and magnitude; 2b Students know when an object is subject to two or more forces at once the result is the cumulative effect of all the forces; 2c Students know when the forces of an object are balanced the motion of the object does not change; Students know to identify separately the two or more forces that are acting on a single static object including gravity , elastic forces due to tension or compression in matter and friction; 2e Students know that when the forces on a object are unbalanced, the object will change its |

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| | | velocity; 2f Students know the greater the mass of an object, the more force is needed to achieve the same rate of change in motion; 2g Students know the role of gravity in forming and maintaining the shapes of planets, stars, and solar system |
| | 9.1g Explain and calculate mechanical advantages for levers, pulleys, and inclined planes | Science Content Standards for California Public Schools, Grade 7: 6h Students know how to compare joints in the body with structures used in machines and simple devices; 6i Students know how levers confer mechanical advantage and how the application of this principle applies to the musculoskeletal system |
| Ch 5-More Applications of Newton's Laws | 9.1a Discuss and apply Newton's laws (i.e., first, second, third, and law of universal gravitation) | Science Content Standards for California Public Schools, Grade 8: 1a Students know position is defined in relation to some choice of a standard reference point and a set of reference directions; 1b Students know that average speed is the total distance traveled divided by the total time elapsed and that the speed of an object along the path traveled can vary; 1c Students know how to solve problems involving distance, time, and average speed; 1d Students know the velocity of an object must be described by specifying both the direction and the speed of the object; 1e Students |

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| | 9.1g Explain and calculate mechanical advantages for levers, pulleys, and inclined | Science Content Standards for California Public Schools, Grade 7: 6h |

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| | planes | Students know how to compare joints in the body with structures used in machines and simple devices; 6i Students know how levers confer mechanical advantage and how the application of this principle applies to the musculoskeletal system |
| Ch 6-Energy and Energy Transfer | 9.1d Identify the separate forces that act on a body (e.g., gravity, pressure, tension/compression, normal force, friction) and describe the net force on the body | Science Content Standards for California Public Schools, Grade 8: 2b Students know when an object is subject to two or more forces at once, the result is the cumulative effect of all the forces. |
| | 9.1g Explain and calculate mechanical advantages for levers, pulleys, and inclined planes | Science Content Standards for California Public Schools, Grade 7: 6h Students know how to compare joints in the body with structures used in machines and simple devices; 6i Students know how levers confer mechanical advantage and how the application of this principle applies to the musculoskeletal system |
| Ch 7-Potential Energy | 9.1d Identify the separate forces that act on a body (e.g., gravity, pressure, tension/compression, normal force, friction) and describe the net force on the body | Science Content Standards for California Public Schools, Grade 8: 2b Students know when an object is subject to two or more forces at once, the result is the cumulative effect of all the forces. |
| Ch 10-Rotational Motion | 9.1a Discuss and apply Newton's laws (i.e., first, second, third, and law of universal gravitation) | Science Content Standards for California Public Schools, Grade 8: 1a Students know position is defined in relation to some |

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| | | choice of a standard reference point and a set of reference directions; 1b Students know that average speed is the total distance traveled divided by the total time elapsed and that the speed of an object along the path traveled can vary; 1c Students know how to solve problems involving distance, time, and average speed; 1d Students know the velocity of an object must be described by specifying both the direction and the speed of the object; 1e Students know changes in velocity my be due to changes in speed, direction or both |
| Ch 11-Gravity, Planetary Orbits, and the Hydrogen Atom | 9.1a Discuss and apply Newton's laws (i.e., first, second, third, and law of universal gravitation) | Science Content Standards for California Public Schools, Grade 8: 1a Students know position is defined in relation to some choice of a standard reference point and a set of reference directions; 1b Students know that average speed is the total distance traveled divided by the total time elapsed and that the speed of an object along the path traveled can vary; 1c Students know how to solve problems involving distance, time, and average speed; 1d Students know the velocity of an object must be described by specifying both the direction and the speed of the object; 1e Students know changes in velocity my be due to changes in |

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| | | speed, direction or both |
| | 9.1f Identify fundamental forces, including gravity, nuclear forces, and electromagnetic forces (magnetic and electric), and explain their roles in nature, such as the role of gravity in maintaining the structure of the universe | Science Content Standards for California Public Schools, Grade 8: 2a Students know a force has both direction and magnitude; 2b Students know when an object is subject to two or more forces at once the result is the cumulative effect of all the forces; 2c Students know when the forces of an object are balanced the motion of the object does not change; Students know to identify separately the two or more forces that are acting on a single static object including gravity , elastic forces due to tension or compression in matter and friction; 2e Students know that when the forces on a object are unbalanced, the object will change its velocity; 2f Students know the greater the mass of an object, the more force is needed to achieve the same rate of change in motion; 2g Students know the role of gravity in forming and maintaining the shapes of planets, stars, and solar system |
| Ch 12-Oscillatory Motion | 8.1a Compare the characteristics of sound, light, and seismic waves (e.g., transverse/longitudinal, travel through various media, relative speed) | Science Content Standards for California Public Schools, Grade 3: 1d Students know energy can be carried from one place to another by waves, such as water waves and sound waves by electric current and by moving objects; Grade 6: 3a Students know energy can be carried from one place to another by heat flow or by waves including water, light and sound waves, or by moving |

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| | | objects; Grades 9-12: Physics 4a Students know waves carry energy from one place to another; 4f Students know how to identify the characteristic properties of waves: Interference (beats), diffraction, reaction, Dopler effect, and polarization |
| Ch 13-Mechanical Waves | 8.1a Compare the characteristics of sound, light, and seismic waves (e.g., transverse/longitudinal, travel through various media, relative speed) | Science Content Standards for California Public Schools, Grade 3: 1d Students know energy can be carried from one place to another by waves, such as water waves and sound waves by electric current and by moving objects; Grade 6: 3a Students know energy can be carried from one place to another by heat flow or by waves including water, light and sound waves, or by moving objects; Grades 9-12: Physics 4a Students know waves carry energy from one place to another; 4f Students know how to identify the characteristic properties of waves: Interference (beats), diffraction, reaction, Dopler effect, and polarization |
| | 8.1b Explain that energy is transferred by waves without mass transfer and provide examples | Science Content Standards for California Public Schools, Grades 9-12: Physics 4b Students know how to identify transverse and longitudinal waves in mechanical media such as springs and ropes and on the earth (seismic waves); 4d Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates |
| Ch 15- Fluid Mechanics | 9.1b Define pressure and relate it to fluid flow and buoyancy (e.g., heart valves, atmospheric pressure) | Science Content Standards for California Public Schools, Grade 7: 6j Students know that contractions of the heart generate blood pressure and that the heart valves prevent backflow of blood in the circulatory system |
| Ch 19-Electric Forces and Electric Fields | 9.1f Identify fundamental forces, including gravity, nuclear forces, and electromagnetic forces (magnetic and electric), and | Science Content Standards for California Public Schools, Grade 8: 2a Students know a force has both direction and |

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| | explain their roles in nature, such as the role of gravity in maintaining the structure of the universe | magnitude; 2b Students know when an object is subject to two or more forces at once the result is the cumulative effect of all the forces; 2c Students know when the forces of an object are balanced the motion of the object does not change; Students know to identify separately the two or more forces that are acting on a single static object including gravity , elastic forces due to tension or compression in matter and friction; 2e Students know that when the forces on a object are unbalanced, the object will change its velocity; 2f Students know the greater the mass of an object, the more force is needed to achieve the same rate of change in motion; 2g Students know the role of gravity in forming and maintaining the shapes of planets, stars, and solar system |
| | 10.1a Describe and provide examples of electrostatic and magnetostatic phenomena | Science Content Standards for California Public Schools, Grade 4: 1e Students know electrically charged objects attract or repel each other; 1f Students know that magnets have two poles and that like poles repel each other and unlike poles attract each other |
| | 10.1b Predict charges or poles based on attraction/repulsion observations | Science Content Standards for California Public Schools, Grade 4: 1e Students know electrically charged objects attract or |

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| | | repel each other; 1f Students know that magnets have two poles and that like poles repel each other and unlike poles attract each other |
| Ch 20-Electric Potential and Capacitance | 10.1a Describe and provide examples of electrostatic and magnetostatic phenomena | Science Content Standards for California Public Schools, Grade 4: 1e Students know electrically charged objects attract or repel each other; 1f Students know that magnets have two poles and that like poles repel each other and unlike poles attract each other |
| | 10.1f Define and calculate power, voltage differences, current, and resistance in simple circuits | Science Content Standards for California Public Schools, Grade 8: 1g Students know electrical energy can be converted to heat, light, and motion; Grades 9-12: Physics 5a Students know how to predict the voltage or current in simple direct current electric circuits constructed from batteries, wires, resistors and capacitors; 5b Students know to solve problems involving Ohm's law; 5c Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) x I (current) = $I^2R$ |
| Ch 21-Current and Direct Current Circuits | 10.1e Design and interpret simple series and parallel | Science Content Standards for California Public |

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| | circuits | Schools, Grade 4: 1a Students know how to design and build simple series and parallel circuits by using components such as wires, batteries and bulbs; Grades 9-12: Physics 5a Students know how to predict the voltage or current in simple direct current electric circuits constructed from batteries, wires, resistors and capacitors |
| | 10.1f Define and calculate power, voltage differences, current, and resistance in simple circuits | Science Content Standards for California Public Schools, Grade 8: 1g Students know electrical energy can be converted to heat, light, and motion; Grades 9-12: Physics 5a Students know how to predict the voltage or current in simple direct current electric circuits constructed from batteries, wires, resistors and capacitors; 5b Students know to solve problems involving Ohm's law; 5c Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) x I (current) = $I^2R$ |
| Ch 22-Magnetic Forces and Magnetic Fields | 9.1f Identify fundamental forces, including gravity, nuclear forces, and electromagnetic forces (magnetic and electric), and | Science Content Standards for California Public Schools, Grade 8: 2a Students know a force has both direction and |

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| | explain their roles in nature, such as the role of gravity in maintaining the structure of the universe | magnitude; 2b Students know when an object is subject to two or more forces at once the result is the cumulative effect of all the forces; 2c Students know when the forces of an object are balanced the motion of the object does not change; Students know to identify separately the two or more forces that are acting on a single static object including gravity , elastic forces due to tension or compression in matter and friction; 2e Students know that when the forces on a object are unbalanced, the object will change its velocity; 2f Students know the greater the mass of an object, the more force is needed to achieve the same rate of change in motion; 2g Students know the role of gravity in forming and maintaining the shapes of planets, stars, and solar system |
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| | | repel each other; 1f Students know that magnets have two poles and that like poles repel each other and unlike poles attract each other |
| | 10.1c Build a simple compass and use it to determine direction of magnetic fields, including the Earth's magnetic field | Science Content Standards for California Public Schools, Grade 4: 1b Students know how to build a simple compass and use it to detect magnetic effects including Earth's magnetic field |
| | 10.1d Relate electric currents to magnetic fields and describe the application of these relationships, such as in electromagnets, electric current generators, motors, and transformers | Science Content Standards for California Public Schools, Grade 4: 1C Students know electric currents produce magnetic fields and know how to build a simple electro magnet; 1d Students know the role of electromagnets in the construction of electric motors electric generators and simple devices such as doorbells and earphones |
| Ch 23-Faraday's Law and Inductance | 10.1d Relate electric currents to magnetic fields and describe the application of these relationships, such as in electromagnets, electric current generators, motors, and transformers | Science Content Standards for California Public Schools, Grade 4: 1C Students know electric currents produce magnetic fields and know how to build a simple electro magnet; 1d Students know the role of electromagnets in the construction of electric motors electric generators and simple devices such as doorbells and earphones |
| Ch 25- Reflection and Refraction of Light | 8.1c Explain how lenses are used in simple optical systems, including the camera, telescope, | Science Content Standards for California Public Schools, Grade 3: 4c Students know telescopes magnify the appearance of some distant objects in the sky |

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| | microscope, and the eye | including the moon and the planets. The number of stars that can be seen through telescopes is dramatically greater than the number that can be seen by the unaided eye; Grade 7: 6d Students know how simple lenses are used in a magnifying glass, the eye, a cameral, a telescope, and a microscope |
| Ch 26-Image Formation by Mirrors and Lenses | 8.1d Explain and apply the laws of reflection and refraction | Science Content Standards for California Public Schools, Grade 7: 6e Students know white light is a mixture of many wavelengths and that retinal cells react differently to different wavelengths; 6g Students know the angle of reflection of a light beam is equal to the angle of incidence |
| Ch 27-Wave Optics | 8.1d Explain and apply the laws of reflection and refraction | Science Content Standards for California Public Schools, Grade 7: 6e Students know white light is a mixture of many wavelengths and that retinal cells react differently to different wavelengths; 6g Students know the angle of reflection of a light beam is equal to the angle of incidence |
| | 8.1e Compare transmission, reflection, and absorption of light in matter | Science Content Standards for California Public Schools, Grade 3: 2a Students know sunlight can be locked to create shadows; 2b Students know light is reflected from mirrors and other surfaces; 2c Students know the color of light striking an object affects the way the object is seen; 2d Students know an object is seen when light traveling from the object enters the eye; Grade 7: 6a Students know visible light is a small band within a very broad electromagnetic spectrum; 6c Students know that light travels in straight lines if the medium it travels through does not change |
| Ch 30- Nuclear Physics | 9.1f Identify fundamental forces, including gravity, nuclear forces, and electromagnetic forces (magnetic and electric), and explain their roles in nature, | Science Content Standards for California Public Schools, Grade 8: 2a Students know a force has both direction and magnitude; 2b Students |

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| | such as the role of gravity in maintaining the structure of the universe | know when an object is subject to two or more forces at once the result is the cumulative effect of all the forces; 2c Students know when the forces of an object are balanced the motion of the object does not change; Students know to identify separately the two or more forces that are acting on a single static object including gravity , elastic forces due to tension or compression in matter and friction; 2e Students know that when the forces on a object are unbalanced, the object will change its velocity; 2f Students know the greater the mass of an object, the more force is needed to achieve the same rate of change in motion; 2g Students know the role of gravity in forming and maintaining the shapes of planets, stars, and solar system |
| Ch 31- Particle Physics | 9.1f Identify fundamental forces, including gravity, nuclear forces, and electromagnetic forces (magnetic and electric), and explain their roles in nature, such as the role of gravity in maintaining the structure of the universe | Science Content Standards for California Public Schools, Grade 8: 2a Students know a force has both direction and magnitude; 2b Students know when an object is subject to two or more forces at once the result is the cumulative effect of all the forces; 2c Students know when the forces of an object are balanced the motion of the object does not change; Students know to identify separately the two or more forces that are |

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