Utah	Physics Standards	Conceptual Physics 13e Page Reference
Standard PHYS.1.	Analyze and interpret data to determine the cause and effect relationship between the net force on an object and its change in motion as summarized by Newton's Second Law of Motion. Emphasize one-dimensional motion and macroscopic objects moving at non-relativistic speeds. Examples could include objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force. (PS2.A)	Chapter 4, especially 4.1–4.6; Chapter 9.1 the Law of Universal Gravitation
Standard PHYS.1.2	Use mathematics and computational thinking to support the claim that the total momentum of a system is conserved when there is no net force acting on the system. Emphasize the quantitative conservation of momentum in interactions and the qualitative meaning of this principle. Examples could include one-dimensional elastic or inelastic collisions between objects within the system. (PS2.A)	Chapter 6, especially 6.5-6.7
Standard PHYS.1.3	Design a solution that has the function of minimizing the impact force on an object during a collision. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution. Emphasize problems that require application of Newton's Second Law of Motion or conservation of momentum. (PS2.A, ETS1.A, ETS1.B, ETS1.C)	6.3–6.7; Chapter 6 Think and Do; Chapter 6 Think and Discuss #97
Standard PHYS.2.1	Analyze and interpret data to track and calculate the transfer of energy within a system. Emphasize the identification of the components of the system, along with their initial and final energies, and mathematical descriptions to depict energy transfer in the system. Examples of energy transfer could include the transfer of energy during a collision or heat transfer. (PS3.A, PS3.B)	Chapter 7, especially 7.3–7.6 and chapter review questions; Chapter 6, especially 6.2–6.7 and chapter review questions
Standard PHYS.2.2	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system. Emphasize that uniform distribution of energy is a natural tendency. Examples could include the measurement of the reduction of temperature of a hot object or the increase in temperature of a cold object. (PS3.B)	15.2; 16.1; Chapter 16 Think and Solve #39

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Standard PHYS.2.3	Develop and use models on the macroscopic scale to illustrate that energy can be accounted for as a combination of energies associated with the motion of objects and energy associated with the relative positions of objects. Emphasize relationships between components of the model to show that energy is conserved. Examples could include mechanical systems where kinetic energy is transformed to potential energy or vice versa. (PS3.A)	Chapter 7, especially 7.1, 7.3–7.6 and end-of-chapter Think and Do & Think and Discuss
Standard PHYS.2.4	Design a solution by constructing a device that converts one form of energy into another form of energy to solve a complex real-life problem. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution. Examples of energy transformation could include electrical energy to mechanical energy, mechanical energy to electrical energy, or electromagnetic radiation to thermal energy. (PS3.A, PS3.B, ETS1.A, ETS1.B, ETS1.C)	Chapter 25; Chapter 24, especially 24.5-25.7; 7.5-7.8 and Chapter 7 Review; Chapter 24 Think and Do #33 (make an electromagnet); engineering design component is partial
Standard PHY 2.5	Design a solution to a major global problem that accounts for societal energy needs and wants. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution. Emphasize problems that require the application of conservation of energy principles through energy transfers and transformations. Examples of devices could include one that uses renewable energy resources to perform functions currently performed by nonrenewable fuels or ones that are more energy efficient to conserve energy. (PS3.A, PS3.B, PS3.D, ETS1.A, ETS1.B, ETS1.C)	7.9; 16.5–16.7 and Chapter 16 Think and Discuss #102; Chapters 24–25 (electric motors, generators, and power production); Chapters 7, 24, and 25 address energy conservation and transformations with limited emphasis on design
Standard PHYS.3.1	Use mathematics and computational thinking to compare the scale and proportion of gravitational and electric fields using Newton's Law of Gravitation and Coulomb's Law. Emphasize the comparative strength of these two field forces, the effect of distance between interacting objects on the magnitudes of these forces, and the use of models to understand field forces. (PS2.B)	Chapter 9, especially 9.1-9.3, 9.6, 9.8, Plug and Chug, and Think and Solve; Chapter 22, especially 22.1, 22.4, 22.8, Plug and Chug, and Think and Solve
Standard PHYS.3.2	Plan and conduct an investigation to provide evidence that an electric current causes a magnetic field and that a changing magnetic field causes an electric current. Emphasize the qualitative relationship between electricity and magnetism without necessarily conducting quantitative analysis. Examples could include electromagnets or generators. (PS2.C)	23.1–23.2, 23.8; 24.5–24.7 and Chapter 24 Think and Do #33; 25.1–25.3, 25.5

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Standard PHYS.3.3	Analyze and interpret data to compare the effect of changes in position of interacting objects on electric and gravitational forces and energy. Emphasize the similarities and differences between charged particles in electric fields and masses in gravitational fields. Examples could include models, simulations, or experiments that produce data or illustrate field lines between objects. (PS3.C)	9.1–9.3, 9.6, 9.8; 22.1, 22.4, 22.8–22.9 — Newton's Law of Gravitation, Coulomb's Law, inverse-square relationships, gravitational and electric fields, electric potential, and comparisons of field forces
Standard PHYS.3.4	Develop and use a model to evaluate the effects on a field as characteristics of its source and surrounding space are varied. Emphasize how a field changes with distance from its source. Examples of electric fields could include those resulting from point charges. Examples of magnetic fields could include those resulting from dipole magnets or current-bearing wires. (PS3.C)	22.1–22.4, 22.8-22.9, Chapter 22 Plug and Chug & Think and Solve; 24.3, 24.5–24.7; 9.3, 9.6— models of electric, magnetic, and gravitational fields; effects of source characteristics and distance on field strength
Standard PHYS.4.	Analyze and interpret data to derive both qualitative and quantitative relationships based on patterns observed in frequency, wavelength, and speed of waves traveling in various media. Emphasize mathematical relationships and qualitative descriptions. Examples of data could include electromagnetic radiation traveling in a vacuum or glass, sound waves traveling through air or water, or seismic waves traveling through Earth. (PS4.A)	19.1-19.4, 19.7-19.8; Chapter 19 Review
Standard PHYS.4.2	Engage in argument based on evidence that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model better explains interactions within a system than the other. Emphasize how the experimental evidence supports the claim and how models and explanations are modified in light of new evidence. Examples could include resonance, interference, diffraction, or the photoelectric effect. (PS4.A, PS4.B)	Chapter 29, Chapter 31
Standard PHYS.4.3	Evaluate information about the effects that different frequencies of electromagnetic radiation have when absorbed by biological materials. Emphasize that the energy of electromagnetic radiation is directly proportional to frequency and that the potential damage to living tissue from electromagnetic radiation depends on the energy of the radiation. (PS4.B)	26.3 and 26.6; 31.2; 33.9 (food irradiation)

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Standard PHYS.4.4	Ask questions and construct an explanation about the stability of digital transmission and storage of information and their impacts on society. Emphasize the stability of digital signals and the discrete nature of information transmission. Examples of stability and instability could include that digital information can be stored in computer memory, is transferred easily, copied and shared rapidly can be easily deleted, has limited fidelity based on sampling rates, or is vulnerable to security breaches and theft. (PS4.A)	21.7 analog and digital signals (limited support for standard); 26.3 electromagnetic waves used for wireless communication (radio, television, cell phones)
Standard PHYS.4.5	Obtain, evaluate, and communicate information about how devices use the principles of electromagnetic radiation and their interactions with matter to transmit and capture information and energy. Emphasize the ways in which devices leverage the wave-particle duality of electromagnetic radiation. Examples could include solar cells, medical imaging devices, or communication technologies. (PS4.A, PS4.B, PS4.C)	26.3 electromagnetic radiation and communication technologies; Chapter 26 Think and Solve #37 (radio communication); 28.8 pinhole cameras and Think and Explain #79–81 (image capture); 31.3–31.5 and Chapter 31 Think and Explain (photoelectric effect, photons, wave-particle duality, and evidence for wave and particle models)