Arkansas Physics Standards Correlation

Science Curriculum Framework: Physics

	Physics for Scientists and Engineers	**Principles of Physics**	**Conceptual Physics**
Strand: Motion and Forces			
Standard 1: Students shall understand one-dimensional motion.			
MF.1.P.1 Compare and contrast *scalar* and *vector* quantities	3.1 - 3.2	3.1 - 3.2	3.1 - 3.2
MF.1.P.2 Solve problems involving constant and average velocity: $v = d/t$, $v_{ave} = \Delta d/\Delta t$	2.3 - 2.4	2.3 - 2.4	2.3 - 2.4
MF.1.P.3 Apply kinematic equations to calculate distance, time, or velocity under conditions of constant acceleration: $a = v/t$, $a_{ave} = \Delta v/\Delta t$ $\Delta x = \frac{1}{2}(v_i + v_f)\,\Delta t$ $v_f = v_i + a\Delta t$ $\Delta x = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$ $v_f^2 = v_i^2 + 2a\Delta x$	Chapter 2	Chapter 2	Chapter 2
MF.1.P.4 Compare graphic representations of motion: d-t v-t a-t	2.6 - 2.9, 2.14, 15.15	2.6 - 2.9, 15.13	2.6 - 2.7
MF.1.P.5 Calculate the components of a free falling object at various points in motion: $v_f^2 = v_i^2 + 2a\Delta y$ Where a = gravity (g)	2.26 - 2.29	2.23 - 2.26	2.18 - 2.19
MF.1.P.6 Compare and contrast contact force (e.g., friction) and field forces (e.g., gravitational force)	5.1, 5.4, 5.11, 5.12, 5.18, 13.1, 23.7, 30.1	5.1, 5.4, 5.11, 5.12, 5.18, 13.1, 23.7, 30.1	5.1, 5.4, 5.11, 5.12, 5.16, 12.1, 22.6, 28.1
MF.1.P.7 Draw free body diagrams of all forces acting upon an object	5.14 - 5.15	5.14 - 5.15	5.14 - 5.15
MF.1.P.8 Calculate the applied forces represented in a free body diagram	Chapters 5 & 6	Chapters 5 & 6	Chapter 5
MF.1.P.9 Apply Newton's first law of motion to show balanced and unbalanced forces	5.2, Chapters 5 & 6	5.2, Chapters 5 & 6	5.2, Chapter 5
MF.1.P.10 Apply Newton's second law of motion to solve motion problems that involve constant forces: $F = ma$	5.5, Chapters 5 & 6	5.5, Chapters 5 & 6	Chapter 5
MF.1.P.11 Apply Newton's third law of motion to explain action-reaction pairs	5.10, Chapters 5 & 6	5.10, Chapters 5 & 6	5.10, Chapter 5
MF.1.P.12 Calculate frictional forces (i.e., kinetic and static): $\mu_k = F_k/F_n$, $\mu_s = F_s/F_n$	5.18 - 5.20	5.18 - 5.20	5.16 - 5.18

	Physics for Scientists and Engineers	**Principles of Physics**	**Conceptual Physics**
MF.1.P.13 Calculate the magnitude of the force of friction: $F_f = \mu F_n$	5.18 - 5.20	5.18 - 5.20	5.16 - 5.18
Standard 2: Students shall understand two-dimensional motion.			
MF.2.P.1 Calculate the resultant vector of a moving object	3.5 - 3.6	3.5 - 3.6	3.5 - 3.6
MF.2.P.2 Resolve two-dimensional vectors into their components: $d_x = d \cos\theta$, $d_y = d \sin\theta$	3.11	3.11	
MF.2.P.3 Calculate the magnitude and direction of a vector from its components: $d^2 = x^2 + y^2$, $\tan^{-1}\theta = x/y$	3.12	3.12	
MF.2.P.4 Solve two-dimensional problems using balanced forces: $W = T \sin\theta$ Where W = weight; T = tension	Chapters 5 & 6	Chapters 5 & 6	Chapter 5
MF.2.P.5 Solve two-dimensional problems using the Pythagorean Theorem or the quadratic formula.	4.24	4.23	
MF.2.P.6 Describe the path of a projectile as a parabola	4.12	4.11	4.7
MF.2.P.7 Apply kinematic equations to solve problems involving projectile motion of an object launched at an angle: $v_x = v_i \cos\theta$ = constant $\Delta x = v_i(\cos\theta)\Delta t$ $v_{yf} = v_i(\sin\theta) - g\Delta t$ $v_{yf}^2 = v_i^2 (\sin\theta)^2 - 2g\Delta y$ $\Delta y = v_i(\sin\theta)\Delta t - \frac{1}{2}g(\Delta t)^2$	Chapter 4	Chapter 4	Chapter 4
MF.2.P.8 Apply kinematic equations to solve problems involving projectile motion of an object launched with initial horizontal velocity	Chapter 4	Chapter 4	Chapter 4
MF.2.P.9 Calculate rotational motion with a constant force directed toward the center: $F_c = mv^2/r$	9.7 - 9.9	9.6 - 9.8	8.5
MF.2.P.10 Solve problems in circular motion by using centripetal acceleration: $a_c = v^2/r = 4\pi^2 r/T^2$	Chapter 9	Chapter 9	Chapter 8
Standard 3: Students shall understand the dynamics of rotational equilibrium.			
MF.3.P.1 Relate radians to degrees: $\Delta\theta = \Delta s/r$ Where Δs = arc length; r = radius	1.19, 10.1	1.19, 10.1	1.13, 9.1

	Physics for Scientists and Engineers	**Principles of Physics**	**Conceptual Physics**
MF.3.P.2 Calculate the magnitude of torque on an object: $\tau = Fd \ (\sin \theta)$	11.1 - 11.2	11.1 - 11.2	10.1 ($\tau = rF$ only)
MF.3.P.3 Calculate angular speed and angular acceleration: $\omega_{ave} = \Delta\theta/\Delta t$, $\alpha = \Delta\omega/\Delta t$	10.3 - 10.6	10.3 - 10.6	9.3 - 9.6
MF.3.P.4 Solve problems using kinematic equations for angular motion: $\omega_f = \omega_i + \alpha\Delta t$ $\Delta\theta = \omega_i\Delta t + \frac{1}{2}\alpha(\Delta t)^2$ $\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$ $\Delta\theta = \frac{1}{2}(\omega_i + \omega_f)\Delta t$	10.9 - 10.13	10.7 - 10.10	
MF.3.P.5 Solve problems involving tangential speed: $v_t = r\omega$	10.14, 10.16	10.11, 10.13	9.7, 9.9
MF.3.P.6 Solve problems involving tangential acceleration: $a_t = r\alpha$	10.15, 10.17	10.12, 10.14	9.8
MF.3.P.7 Calculate centripetal acceleration: $a_c = r\omega^2$, $a_c = v_t^2/r$	9.4	9.4	8.3
MF.3.P.8 Apply Newton's universal law of gravitation to find the gravitational force between two masses	13.1, 13.9, 13.11	13.1, 13.7	12.1
Standard 4: Students shall understand the relationship between work and energy.			
MF.4.P.1 Calculate net work done by a constant net force: $W_{net} = F_{net}d \cos\theta$	7.1	7.1	6.1
MF.4.P.2 Solve problems relating kinetic energy and potential energy to the work-energy theorem: $W_{net} = \Delta KE$	7.9 - 7.14, 7.17	7.7 - 7.11, 7.14	6.5 - 6.8, 6.11
MF.4.P.3 Solve problems through the application of conservation of mechanical energy: $ME_i = ME_f$ $\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$	7.22 - 7.25	7.19 - 7.22	6.16 - 6.19
MF.4.P.4 Relate the concepts of time and energy to power	7.15	7.12	6.9
MF.4.P.5 Prove the relationship of time, energy and power through problem solving: $P = W/\Delta t$, $P = Fv$ Where P = power; W = work; F = force; v = velocity; t = time	7.15	7.12	6.9

	Physics for Scientists and Engineers	**Principles of Physics**	**Conceptual Physics**
Standard 5: Students shall understand the law of conservation of momentum.			
MF.5.P.1 Describe changes in momentum in terms of force and time	8.3 - 8.4	8.3	7.3
MF.5.P.2 Solve problems using the impulse-momentum theorem: $F\Delta t = \Delta p$, $F\Delta t = mv_f - mv_i$ Where Δp = change in momentum; $F\Delta t$ = impulse	8.3 - 8.6	8.3 - 8.5	7.3 - 7.4
MF.5.P.3 Compare total momentum of two objects before and after they interact: $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$	8.7 - 8.10	8.6 - 8.9	7.5 - 7.7
MF.5.P.4 Solve problems for perfectly inelastic and elastic collisions: $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f'$ $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$	8.11 - 8.21	8.10 - 8.19	7.8 - 7.13
Standard 6: Students shall understand the concepts of *fluid* mechanics.			
MF.6.P.1 Calibrate the applied buoyant force to determine if the object will sink or float: $F_B = F_{g(\text{displaced fluid})} = m_f g$	14.9 - 14.14	14.9 - 14.14	13.7 - 13.10
MF.6.P.2 Apply Pascal's principle to an enclosed fluid system: $P = F_1/A_1 = F_2/A_2$ Where P = pressure	14.15	14.15	13.11
MF.6.P.3 Apply Bernoulli's equation to solve fluid-flow problems: $p = \frac{1}{2}\rho v^2 + \rho gh$ = constant Where ρ = density	14.20 - 14.23	14.20 - 14.22	13.14 - 13.15
MF.6.P.4 Use the ideal gas law to predict the properties of an ideal gas under different conditions $PV = Nk_BT$ N = number of gas particles k_B = Boltzmann's constant ($1.38\text{x}10^{-23}$ J/K) T = temperature $PV = nRT$ n = number of moles (1 mole = 6.022x1023 particles) R = molar gas constant (8.31 J/mol·K) T = temperature	20.5 - 20.8	20.5 - 20.8	19.5 - 19.8

	Physics for Scientists and Engineers	Principles of Physics	Conceptual Physics
Strand: Heat and Thermodynamics			
Standard 7: Students shall understand the effects of thermal energy on particles and systems.			
HT.7.P.1 Perform specific heat capacity calculations: $C_p = Q/(m\Delta T)$	19.16 - 19.19	19.14 - 19.16	18.12 - 18.13
HT.7.P.2 Perform calculations involving latent heat: $Q = mL$	19.22 - 19.24	19.19 - 19.21	18.15 - 18.16
HT.7.P.3 Interpret the various sections of a heating curve diagram			
HT.7.P.4 Calculate heat energy of the different phase changes of a substance: $Q = mC_p\Delta T$ $Q = mL_f$ $Q = mL_v$ Where L_f = Latent heat of fusion; L_v = Latent heat of vaporization	19.16 - 19.19, 19.22 - 19.24, 19.32	19.14 - 19.16, 19.19 - 19.21, 19.29	18.12 - 18.13, 18.15 - 18.16, 18.21
Standard 8: Students shall apply the two laws of thermodynamics.			
HT.8.P.1 Describe how the first law of thermodynamics is a statement of energy conversion	21.1	21.1	20.1
HT.8.P.2 Calculate heat, work, and the change in internal energy by applying the first law of thermodynamics: $\Delta U = Q - W$ Where ΔU = change in system's internal energy	Chapter 21	Chapter 21	Chapter 20
HT.8.P.3 Calculate the efficiency of a heat engine by using the second law of thermodynamics: $Eff = W_{net}/Q_h = (Q_h - Q_c)/Q_h = 1 - Q_c/Q_h$ Where Q_h = energy added as heat; Q_c = energy removed as heat	22.1, 22.11, 22.14, 22.15, 22.23	22.1, 22.12 - 22.14, 22.18	21.1, 21.8, 21.9, 21.12
HT.8.P.4 Distinguish between entropy changes within systems and the entropy change for the universe as a whole	22.5 - 22.8, 22.18 - 22.21	22.5 - 22.8	21.4 - 21.6
Strand: Waves and Optics			
Standard 9: Students shall distinguish between *simple harmonic motion* and waves.			

	Physics for Scientists and Engineers	**Principles of Physics**	**Conceptual Physics**
WO.9.P.1 Explain how force, velocity, and acceleration change as an object vibrates with simple harmonic motion	15.1, 15.10, 15.12	15.1, 15.9, 15.11	14.1, 14.7, 14.8
WO.9.P.2 Calculate the spring force using Hooke's law: $F_{elastic} = -kx$ Where $-k$ = spring constant	5.28 - 5.29	5.28 - 5.29	5.23
WO.9.P.3 Calculate the period and frequency of an object vibrating with a simple harmonic motion: $T = 2\pi\sqrt{(L/g)}$, $f = 1/T$ Where T = period	15.4, 15. 25 - 15.31	15.3, 15.22 - 15.26	14.3, 14.9 - 14.12
WO.9.P.4 Differentiate between pulse and periodic waves	16.3	16.3	15.3
WO.9.P.5 Relate energy and amplitude	16.19		
Standard 10: Students shall compare and contrast the law of reflection and the law of refraction.			
WO.10.P.1 Calculate the frequency and wavelength of electromagnetic radiation	16.7	16.7	15.7
WO.10.P.2 Apply the law of reflection for flat mirrors: $\theta_{in} = \theta_{out}$	36.5 - 36.7	35.5 - 35.7	31.5 - 31.6
WO.10.P.3 Describe the images formed by flat mirrors	36.3 - 36.4	35.3 - 35.4	31.3 - 31.4
WO.10.P.4 Calculate distances and focal lengths for curved mirrors: $1/p + 1/q = 2/R$ Where p = object distance; q = image distance; R = radius of curvature	36.10, 36.18 - 36.20	35.10, 35.16 - 35.18	31.9, 31.15 - 31.17
WO.10.P.5 Draw ray diagrams to find the image distance and magnification for curved mirrors	36.14 - 36.17	35.12 - 35.15	31.11 - 31.14
WO.10.P.6 Solve problems using Snell's law: $n_i(\sin\theta_i) = n_r(\sin\theta_r)$	37.3 - 37.4	36.3 - 36.4	32.3 - 32.4
WO.10.P.7 Calculate the index of refraction through various media using the following equation: $n = c/v$ Where n = index of refraction; c = speed of light in a vacuum; v = speed of light in medium	37.2	36.2	32.2
WO.10.P.8 Use a ray diagram to find the position of an image produced by a lens	38.2 - 38.6	37.2 - 37.6	33.2 - 33.6

	Physics for Scientists and Engineers	**Principles of Physics**	**Conceptual Physics**
WO.10.P.9 Solve problems using the thin-lens equation: $1/p + 1/q = 1/f$ Where p = object distance; q = image distance; f = focal length	38.7 - 38.12	37.7 - 37.11	33.7 - 33.8
WO.10.P.10 Calculate the magnification of lenses: $M = h'/h = -q/p$ Where M = magnification; h' = image height; h = object height; q = image distance; p = object distance	38.7, 38.10, 38.12	37.7, 37.10, 37.11	33.7 - 33.8
Strand: Electricity and Magnetism			
Standard 11: Students shall understand the relationship between *electric forces* and *electric fields*.			
EM.11.P.1 Calculate electric force using Coulomb's law: $F = k_c(q_1 q_2)/r^2$ Where k_c = Coulomb's constant 8.99×10^9 $N\cdot m^2/C^2$	23.9 - 23.11, 23.13 - 23.14	23.9 - 23.11, 23.13 - 23.14	22.8 - 22.10
EM.11.P.2 Calculate electric field strength: $E = F_{electric}/q_0$	24.1	24.1	23.1
EM.11.P.3 Draw and interpret electric field lines	24.4 - 24.6	24.4 - 24.6	23.4 - 23.6
Standard 12: Students shall understand the relationship between electric *energy* and *capacitance.*			
EM.12.P.1 Calculate electrical potential energy: $PE_{electric} = -qEd$	25.1 - 25.2	25.1 - 25.2	24.1 - 24.2
EM.12.P.2 Compute the electric potential for various charge distributions: $\Delta V = \Delta PE_{electric}/q$	25.8 - 25.13	25.7 - 25.10	24.4 - 24.5
EM.12.P.3 Calculate the capacitance of various devices: $C = Q/\Delta V$	28.1 - 28.8	28.1 - 28.6	26.1 - 26.3
EM.12.P.4 Construct a circuit to produce a pre determined value of an Ohm's law variable	Chapters 27 & 29	Chapters 27 & 29	Chapters 25 & 27
Standard 13: Students shall understand how magnetism relates to induced and alternating *currents*.			
EM.13.P.1 Determine the strength of a magnetic field	30.6, Chapters 30 - 32	30.7, Chapters 30 - 32	28.7, Chapters 28 & 29

	Physics for Scientists and Engineers	**Principles of Physics**	**Conceptual Physics**
EM.13.P.2 Use the first right-hand rule to find the direction of the force on the charge moving through a magnetic field	30.6	30.7	28.7
EM.13.P.3 Determine the magnitude and direction of the force on a current-carrying wire in a magnetic field	30.23	30.22	28.18
EM.13.P.4 Describe how the change in the number of magnetic field lines through a circuit loop affects the magnitude and direction of the induced current	32.1 - 32.2, 32.5, 32.7	32.1 - 32.2, 32.5, 32.7	29.1 - 29.2, 29.5, 29.7
EM.13.P.5 Calculate the induced electromagnetic field (emf) and current using Faraday's law of induction: emf = $-N\Delta[AB(\cos\theta)]/\Delta t$ Where N = number of loops in the circuit	32.7 - 32.12	32.7 - 32.10	29.7 - 29.8
Strand: Nuclear Physics			
Standard 14: Students shall understand the concepts of *quantum* mechanics as they apply to the atomic spectrum.			
NP.14.P.1 Calculate energy quanta using Planck's equation: $E = hf$	42.4 - 42.5	41.4 - 41.5	36.3 - 36.4
NP.14.P.2 Calculate the de Broglie wavelength of matter: $\lambda = h/p = h/(mv)$	43.4 - 43.5, 43.7	42.4 - 42.5, 42.7	37.2
NP.14.P.3 Distinguish between classical ideas of measurement and Heisenberg's uncertainty principle	43.11	42.10	37.6
NP.14.P.4 Research emerging theories in physics, such as string theory	44.22	43.22	38.19
Standard 15: Students shall understand the process of nuclear decay.			
NP.15.P.1 Calculate the binding energy of various nuclei	44.9 - 44.11	43.9 - 43.11	38.9 - 38.11
NP.15.P.2 Predict the products of nuclear decay	44.13 - 44.17	43.13 - 43.17	38.13 - 38.16
NP.15.P.3 Calculate the decay constant and the half-life of a radioactive substance	44.18 - 44.21	43.18 - 43.21	38.17 - 38.18