Physics in Context Correlation with Arkansas Science Curriculum Framework

(Revised 2005)

Strand 1: Motion and Forces

Content Standard 1: Students shall understand one-dimensional motion.

MF.1.P.1	Compare and contrast *scalar* and *vector* quantities.	8-17, 23-24, 32-33, 41, 53-54, 93, 125-131, 134-136, 174, 240, 327-338; Lab 2.1; www.learningincontext.com
MF.1.P.2	Solve problems involving constant and average velocity: $v = \frac{d}{t}$ $v_{ave} = \frac{\Delta d}{\Delta t}$	122-137; Lab 3.1; www.learningincontext.com
MF.1.P.3	Apply *kinematic* equations to calculate distance, time, or velocity under conditions of constant *acceleration:* $a = \frac{v}{t}$ $a_{ave} = \frac{\Delta v}{\Delta t}$ $\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$ $v_f = v_i + a\Delta t$ $\Delta x = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$ $v_f^2 = v_i^2 + 2a\Delta x$	128-131, 136-137, 172, 181; www.learningincontext.com
MF.1.P.4	Compare graphic representations of motion: d-t v-t a-t	123-130; www.learningincontext.com
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).	251-253, 259; www.learningincontext.com
MF.1.P.6	Compare and contrast contact force (e.g., friction) and *field* forces (e.g., *gravitational* force).	8-11, 17-26, 35-38, 48-55, 61-62, 109-111, 116-117, 171-183, 185-190, 196-197, 248-250; www.learningincontext.com
MF.1.P.7	Draw free body diagrams of all forces acting upon an object.	12-14, 24, 35-36, 49-55, 170-183, 187-190, 196-197, 301; Lab 2.1;

		www.learningincontext.com
MF.1.P.8	Calculate the applied forces represented in a free body diagram.	12-14, 24, 35-36, 49-55, 170-183, 187-190, 196-197, 301; www.learningincontext.com
MF.1.P.9	Apply Newton's first law of motion to show balanced and unbalanced forces.	12-26, 41, 85-87, 170, 173-174, 176-178, 180-182, 189, 326; www.learningincontext.com
MF.1.P.10	Apply Newton's second law of motion to solve motion problems that involve constant forces: $F = ma$	171-174, 181-183, 244; www.learningincontext.com
MF.1.P.11	Apply Newton's third law of motion to explain action-reaction pairs.	332-338, 351; www.learningincontext.com
MF.1.P.12	Calculate frictional forces (i.e., *kinetic* and static): $\mu_k = \frac{F_k}{F_n}$ $\mu_s = \frac{F_s}{F_n}$	174-183; Lab 4.1; www.learningincontext.com
MF.1.P.13	Calculate the *magnitude* of the force of friction: $F_f = \mu F_n$	176-183; www.learningincontext.com

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Content Standard 2: Students shall understand two-dimensional motion.

MF.2.P.1	Calculate the *resultant vector* of a moving object	14-16, 126-128, 338; www.learningincontext.com
MF.2.P.2	Resolve two-dimensional *vectors* into their *components:* $d_x = d\cos\theta$ $d_y = d\sin\theta$	www.learningincontext.com
MF.2.P.3	Calculate the *magnitude* and direction of a *vector* from its *components:* $d^2 = x^2 + y^2$ $\tan^{-1}\theta = \frac{x}{y}$	www.learningincontext.com
MF.2.P.4	Solve two-dimensional problems using balanced forces: $W = \mathrm{T}\sin\theta$ where $W = weight; \mathrm{T} = tension$.	Not covered in this course.
MF.2.P.5	Solve two-dimensional problems using the Pythagorean Theorem or the quadratic formula: $a^2 + b^2 = c^2$ $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	12, 16, 127; www.learningincontext.com

MF.2.P.6	Describe the path of a projectile as a *parabola.*	www.learningincontext.com
MF.2.P.7	Apply *kinematic* equations to solve problems involving projectile motion of an object launched at an angle: $v_x = v_i \cos\theta = \text{constant}$ $\Delta x = v_i(\cos\theta)\Delta t$ $v_{y,f} = v_i(\sin\theta) - g\Delta t$ $v_{y,f}^2 = v_i^2(\sin\theta)^2 - 2g\Delta y$ $\Delta y = v_i(\sin\theta)\Delta t - \frac{1}{2}g(\Delta t)^2$	www.learningincontext.com
MF.2.P.8	Apply *kinematic* equations to solve problems involving projectile motion of an object launched with initial horizontal velocity: $v_{y,f} = -g\Delta t$ $\quad$ $v_x = v_{x.i} = \text{constant}$ $\therefore v_{y,f}^2 = -2g\Delta y$ $\quad$ $\therefore \Delta x = v_x \Delta t$ $\therefore \Delta y = -\frac{1}{2}g(\Delta t)^2$	www.learningincontext.com
MF.2.P.9	Calculate *rotational motion* with a constant force directed toward the center: $F_c = \frac{mv^2}{r}$	www.learningincontext.com
MF.2.P.10	Solve problems in circular motion by using *centripetal acceleration*: $a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$	www.learningincontext.com

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Content Standard 3: Students shall understand the dynamics of rotational equilibrium.

MF.3.P.1	Relate radians to degrees: $\Delta\theta = \frac{\Delta s}{r}$ where Δs = *arc length; r = radius.*	89-92, 125-126, 132, 232-233, 236-237, 240-242
MF.3.P.2	Calculate the *magnitude* of *torque* on an object: $\tau = Fd(\sin\theta)$ where $\tau = torque$.	17-23, 25-26, 92 Trig functions not used to calculate components in this course.
MF.3.P.3	Calculate angular speed and *angular acceleration:* $\omega_{ave} = \frac{\Delta\theta}{\Delta t}$ $\alpha = \frac{\Delta\omega}{\Delta t}$	131-137, 232-233, 236-237, 241-242, 303; Lab 7.2; www.learningincontext.com
MF.3.P.4	Solve problems using *kinematic* equations for angular motion: $\omega_f = \omega_i + \alpha\Delta t$	www.learningincontext.com

	$\Delta\theta = \omega_i \Delta t + \frac{1}{2}\alpha(\Delta t)^2$ $\omega_f^2 = \omega_i^2 + 2\alpha(\Delta\theta)$ $\Delta\theta = \frac{1}{2}(\omega_i + \omega_f)\Delta t$	
MF.3.P.5	Solve problems involving *tangential speed:* $v_t = r\omega$	132-134, 233; www.learningincontext.com
MF.3.P.6	Solve problems involving *tangential acceleration:* $a_t = r\alpha$	www.learningincontext.com.
MF.3.P.7	Calculate *centripetal acceleration:* $a_c = \frac{v_t^2}{r}$ $a_c = r\omega^2$	471, 490; www.learningincontext.com
MF.3.P.8	Apply Newton's universal law of gravitation to find the gravitational force between two masses: $F_g = G\frac{m_1 m_2}{r^2}$ where $G = 6.673\times10^{-11}\ \frac{N\cdot m^2}{kg^2}$.	48-49, 183; www.learningincontext.com

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Content Standard 4: Students shall understand the relationship between work and energy.

MF.4.P.1	Calculate net work done by a constant net force: $W_{net} = F_{net} d\cos\theta$ where $W_{net} = work$.	82-94; Lab 2.2, 2.3
MF.4.P.2	Solve problems relating kinetic energy and potential energy to the *work-energy theorem:* $W_{net} = \Delta KE$	238-239, 241-249; www.learningincontext.com
MF.4.P.3	Solve problems through the application of conservation of mechanical energy: $ME_i = ME_f$ $\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$	229, 251-253, 259-261; www.learningincontext.com
MF.4.P.4	Relate the concepts of time and *energy* to power.	298-323; Lab 6.1, 6.2; www.learningincontext.com
MF.4.P.5	Prove the relationship of time, *energy* and power through problem solving: $P = \frac{W}{\Delta t}$ $P = Fv$ where P = power; W = work; F = force; V = velocity; T = time.	298-323; www.learningincontext.com

Physics in Context – Arkansas Correlation (continued)

Strand 1: Motion and Forces

Content 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.	324-351; www.learningincontext.com
MF.5.P.2	Solve problems using the impulse-momentum theorem: $F \Delta t = \Delta p$ or $F\Delta t = mv_f - mv_i$ where Δp = change in momentum; $F \Delta t$ = *impulse.*	329-338, 343-351; www.learningincontext.com
MF.5.P.3	Compare total momentum of two objects before and after they interact: $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$	333-338; www.learningincontext.com
MF.5.P.4	Solve problems for perfectly inelastic and elastic *collisions*: $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f'$ $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ where v_f is the final velocity.	333-334; www.learningincontext.com

Strand 1: Motion and Forces

Content 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: $F_B = F_{g(displacedfluid)} = m_f g$	34-36, 44-45; Lab 1.2; www.learningincontext.com
MF.6.P.2	Apply Pascal's principle to an enclosed *fluid* system: $P = \frac{F_1}{A_1} = \frac{F_2}{A_2}$ where $P = pressure$.	37-39, 46; www.learningincontext.com
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.	254-258, 261; Lab 4.2, 5.1, 6.2; www.learningincontext.com
MF.6.P.4	Use the ideal gas law to predict the properties of an ideal gas under different conditions. **PHYSICS** $PV = Nk_BT$ N = number of gas particles k_b = Boltzmann's constant (1.38x10^{-23} J/k) T = temperature **CHEMISTRY** $PV = nRT$ n = number of moles (1 mole = 6.022x10^{23} particles) R = Molar gas constant (8.31 J/mole K) T = temperature	Not covered in this course.

Strand 2: Heat and Thermodynamics

Content Standard 7: Students shall understand the effects of thermal energy on particles and systems.

HT.7.P.1	Perform *specific heat capacity* calculations: $C_p = \frac{Q}{m\Delta T}$	71-79, 165, 322; Lab 1.4, 5.4; www.learningincontext.com
HT.7.P.2	Perform calculations involving *latent heat:* $Q = mL$	74-76, 78-79, 165, 286-287; www.learningincontext.com
HT.7.P.3	Interpret the various sections of a heating curve diagram.	74-75; www.learningincontext.com
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.	75-76, 78-79, 165, 286-287; www.learningincontext.com

Strand 2: Heat and Thermodynamics

Content 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.	280-287
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.*	282-287, 292-294; www.learningincontext.com
HT.8.P.3	Calculate the efficiency of a heat engine by using the second law of thermodynamics: $Eff = \frac{W_{net}}{Q_h} = \frac{Q_h - Q_c}{Q_h} = 1 - Q_c$ where Q_h = *energy added as heat* ; Q_c = *energy removed as heat*.	288-291, 294; www.learningincontext.com
HT.8.P.4	Distinguish between *entropy* changes within systems and the *entropy* change for the universe as a whole.	Not covered in this course.

Strand 3: Waves and Optics

Content Standard 9: Students shall distinguish between *simple harmonic motion* and waves.

WO.9.P.1	Explain how force, velocity, and *acceleration* change as an object vibrates with *simple harmonic motion*.	248-251, 376-377; www.learningincontext.com
WO.9.P.2	Calculate the spring force using Hooke's law: $F_{elastic} = -kx$ where $-k$ = *spring constant*	248-249, 260; Lab 1.1, 5.2, 8.1; www.learningincontext.com

WO.9.P.3	Calculate the *period* and frequency of an object vibrating with a *simple harmonic motion:* $T = 2\pi\sqrt{\frac{L}{g}}$ $f = \frac{1}{T}$ where $T = period$	358-360, 364-366; Lab 8.1; www.learningincontext.com
WO.9.P.4	Differentiate between *pulse* and *periodic waves.*	355-356; Lab 8.2; www.learningincontext.com
WO.9.P.5	Relate *energy* and *amplitude.*	356-357; www.learningincontext.com

Strand 3: Waves and Optics

Content 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.	388-398, 401-402, 422-423; Lab 9.1; www.learningincontext.com
WO.10.P.2	Apply the law of reflection for flat mirrors: $\theta_{in} = \theta_{out}$	427-429, 446; Lab 10.1; www.learningincontext.com
WO.10.P.3	Describe the *image*s formed by flat mirrors.	428-429, 446; www.learningincontext.com
WO.10.P.4	Calculate distances and *focal lengths* for curved mirrors: $\frac{1}{p}+\frac{1}{q}=\frac{2}{R}$ where p = object distance; q = image distance; R = radius of curvature.	429-433, 446-447; Lab 10.1; www.learningincontext.com
WO.10.P.5	Draw ray diagrams to find the *image* distance and *magnification* for curved mirrors.	430-433, 446-447; www.learningincontext.com
WO.10.P.6	Solve problems using Snell's law: $n_i(\sin\theta_i) = n_r(\sin\theta_r)$	436-439, 447-448; www.learningincontext.com
WO.10.P.7	Calculate the *index of refraction* through various media using the following equation: $n = \frac{c}{v}$ where n = index of refraction; c = speed of light in vacuum; v = speed of light in medium.	434-435, 448; www.learningincontext.com
WO.10.P.8	Use a ray diagram to find the position of an *image* produced by a lens.	440-445, 448-449; Lab 10.2; www.learningincontext.com
WO.10.P.9	Solve problems using the thin-lens equation: $\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$ where q = image distance; p = object distance; f = focal length.	442-445, 448-449; Lab 10.2; www.learningincontext.com

WO.10.P.10	Calculate the *magnification* of lenses: $M = \frac{h'}{h} = -\frac{q}{p}$ where M = magnification; h' = image height; h = object height; q = image distance; p = object distance.	443-445; Lab 10.2; www.learningincontext.com

Strand 4: Electricity and Magnetism

Content Standard 11: Students shall understand the relationship between *electric forces* and *electric fields*.

EM.11.P.1	Calculate *electric force* using Coulomb's law: $F = k_c(\frac{q_1 \times q_2}{r^2})$ where k_c = Coulomb's constant $8.99 \times 10^9 N \bullet \frac{m^2}{c^2}$.	51-53
EM.11.P.2	Calculate *electric field* strength: $E = \frac{F_{electric}}{q_0}$.	52-54, 109
EM.11.P.3	Draw and interpret *electric field* lines.	54-55, 109-111, 117

Strand 3: Electricity and Magnetism

Content Standard 12: Students shall understand the relationship between electric *energy* and *capacitance.*

EM.12.P.1	Calculate electrical potential *energy*: $PE_{electric} = -qEd$	365-366, 272-273, 275-276
EM.12.P.2	Compute the electric potential for various charge distributions: $\Delta V = \frac{\Delta PE_{electric}}{q}$	54-59
EM.12.P.3	Calculate the *capacitance* of various devices: $C = \frac{Q}{\Delta V}$	264-265, 275-276
EM.12.P.4	Construct a *circuit* to produce a pre-determined value of an Ohm's law variable.	203-215, 322; Lab 1.3, 3.3, 4.3, 5.3, 6.3; www.learningincontext.com

Strand 3: Electricity and Magnetism

Content Standard 13: Students shall understand how magnetism relates to induced and alternating *currents*.

EM.13.P.1	Determine the strength of a *magnetic field.*	266-269
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.*	267, 276

EM.13.P.3	Determine the *magnitude* and direction of the force on a *current*-carrying wire in a *magnetic field.*	269, 276
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.*	267, 276
EM.13.P.5	Calculate the induced electromagnetic field (*emf*) and *current* using Faraday's law of *induction:* $emf = -N\frac{\Delta[AB(\cos\theta)]}{\Delta t}$ where N = number of loops in the *circuit.*	270-272, 276; Lab 5.3 This equation is not addressed.

Strand 4: Nuclear Physics

Content 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: $E = hf$	399-403, 471, 488; www.learningincontext.com
NP.14.P.2	Calculate the de Broglie wavelength of matter: $\lambda = \frac{h}{p} = \frac{h}{mv}$	475-476; www.learningincontext.com
NP.14.P.3	Distinguish between classical ideas of measurement and Heisenberg's *uncertainty principle.*	Not covered in this course.
NP.14.P.4	Research emerging theories in physics, such as string theory.	Not covered in this course.

Strand 4: Nuclear Physics

Content Standard 15: Students shall understand the process of nuclear decay.

NP.15.P.1	Calculate the binding *energy* of various nuclei.	407-410, 418-419; www.learningincontext.com
NP.15.P.2	Predict the products of nuclear decay.	410-413, 419-420; www.learningincontext.com
NP.15.P.3	Calculate the decay constant and the *half-life* of a radioactive substance.	Lab 9.2; www.learningincontext.com

Strand 5: Nature of Science

Content Standard 16: Students shall demonstrate an understanding that science is a way of knowing.

NS.16.P.1	Describe why science is limited to natural explanations of how the world works.	Embedded throughout the course.
NS.16.P.2	Compare and contrast the criteria for the formation of hypotheses, theories and laws.	Embedded throughout the course.
NS.16.P.3	Summarize the guidelines of science: • results are based on observations, evidence, and testing • hypotheses must be testable • understandings and/or conclusions may change as new data are	Embedded throughout the course.

	generated • empirical knowledge must have peer review and verification before acceptance	

Strand 5: Nature of Science

Content Standard 17: Students shall safely design and conduct a scientific inquiry to solve valid problems.

NS.17.P.1	Develop the appropriate procedures using controls and variables (dependent and independent) in scientific experimentation.	Embedded throughout the course.
NS.17.P.2	Research and apply appropriate safety precautions (ADE Guidelines) when designing and/or conducting scientific investigations.	Embedded throughout the course.
NS.17.P.3	Identify sources of bias that could affect experimental outcome.	Embedded throughout the course.
NS.17.P.4	Gather and analyze data using appropriate summary statistics (e.g., percent yield, percent error).	Embedded throughout the course.
NS.17.P.5	Formulate valid conclusions without bias.	Embedded throughout the course.

Strand 5: Nature of Science

Content Standard 18: Students shall demonstrate an understanding of historical trends in physics.

NS.18.P.1	Recognize that theories are scientific explanations that require empirical data, verification and peer review.	Embedded throughout the course.
NS.18.P.2	Research historical and current events in physics.	Embedded throughout the course.

Strand 5: Nature of Science

Content Standard 19: Students shall use mathematics, science equipment, and technology as tools to communicate and solve physics problems.

NS.19.P.1	Use appropriate equipment and technology as tools for solving problems (e.g., balances, scales, calculators, probes, glassware, burners, computer software and hardware).	Embedded throughout the lab activities of this course.
NS.19.P.2	Manipulate scientific data using appropriate mathematical calculations, charts, tables, and graphs.	Embedded throughout the course.
NS.19.P.3	Utilize technology to communicate research findings.	Embedded throughout the course.

Strand 5: Nature of Science

Content Standard 20: Students shall describe the connections between *pure* and *applied science.*

NS.20.P.1	Compare and contrast the connections between *pure science* and *applied science* as it relates to physics.	Embedded throughout the course.
NS.20.P.2	Give examples of scientific bias that affect outcomes of experimental results.	Embedded throughout the course.

NS.20.P.3	Discuss why scientists should work within ethical parameters.	Embedded throughout the course.
NS.20.P.4	Evaluate long-range plans concerning resource use and by-product disposal for environmental, economic, and political impact.	Embedded throughout the course.
NS.20.P.5	Explain how the cyclical relationship between science and technology results in reciprocal advancements in science and technology.	Embedded throughout the course.

Strand 5: Nature of Science

Content Standard 21: Students shall describe various physics careers and the training required for the selected career.

NS.21.P.1	Research and evaluate careers in physics using the following criteria: • educational requirements • salary • availability of jobs • working conditions	Embedded throughout the course.

Physics Suggested Labs

Motion and Forces	Speed and acceleration (e.g., mousetrap cars)	Lab 3.1
	Coefficient of friction	Lab 4.1
	Vectors	Lab 2.1
	Projectile motion (e.g., rockets, shoot for your grade)	Simulations at www.learningincontext.com
	Tension (e.g., bridges, paper towers)	
	Rotational motion	Lab 5.1, 7.2
	Power	Lab 6.1, 6.2
	Momentum (e.g., egg drop)	Lab 7.2
	Fluid mechanics	Lab 2.2, 3.2, 5.1, 6.2
	Buoyant force	
Heat and Thermodynamics	Calorimeter	Lab 3.4, 4.4
	Thermodynamics	Lab 5.4
Waves and Optics	Simple harmonic motion	Lab 8.1
	Optics	Lab 10.1, 10.2, 10.3
Electricity and Magnetism	Electrical circuit	Lab 1.3, 2.3, 3.3, 4.3, 6.3
	Electromagnetic	Lab 5.3