Competencies for Secondary Teachers: Physics/Math, Grades 7-12

2014

In addition to the Arkansas Teaching Standards, the teacher of Physics/Math, grades 7-12, shall demonstrate knowledge and competencies in the following areas:

1. Central concepts or current theories of Physics NRC Framework	1.1 Ability to demonstrate a knowledge of mechanics 1.2 Ability to demonstrate a knowledge of electricity and magnetism 1.3 Ability to demonstrate a knowledge of optics and waves 1.4 Ability to demonstrate a knowledge of heat and thermodynamics 1.5 Ability to demonstrate a knowledge of modern physics, atomic and nuclear structure
2. Principles of Physics NRC Framework CCSS - English/Language Arts: English Language Arts & Literacy in Science, and Technical Subjects, grades 7-12 CCSS – Mathematics, grades 7-12	2.1 Ability to demonstrate a deep understanding following active investigations in mechanics including • Vectors and Scalars • Kinematics • Dynamics and Fluid Mechanics 2.2 Ability to demonstrate a deep understanding following active investigations in the principles of electricity and magnetism including • Electrostatics • Electrical properties of Conductors, Insulators, and Semiconductors • Capacitance and Inductance • Differences between Alternating and Direct Current Simple Series, Parallel, and Combination Circuits • Magnetic fields, Magnetics forces, and Properties of Magnetic Materials 2.3 Ability to demonstrate a deep understanding following active investigations in the principles of optics and waves including • Wave Phenomena • Fundamentals of the Doppler Effect • Characteristics of Sound • Electromagnetic Waves and the Electromagnetic Spectrum • Geometric Optics 2.4 Ability to demonstrate a deep understanding following active investigations in the principles of heat and thermodynamics including • Temperature, Temperature scales, Heat, and Heat capacity • Mechanics of Heat Transfer • Different forms of Energy and Transformations between them • Energy involved in Phase Transitions between various States of Matter • Kinetic Molecular Theory and the Ideal Gas Laws • Laws of Thermodynamics 2.5 Ability to demonstrate a deep understanding following active investigations in the principles of modern physics, atomic, and nuclear structure including

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	• Organization, Structure, and States of Matter • Nature of Atomic and Subatomic Structure • Relationship of Atomic Spectra to Electron Energy Levels • Characteristics, Processes, and Effects of Radioactivity • Topics in Modern Physics
3. Incorporate Crosscutting Concepts NRC Framework	3.1 Ability to understand and exhibit knowledge of patterns 3.2 Ability to understand and exhibit knowledge of cause and effect 3.3 Ability to understand and exhibit knowledge of scale, proportion, and quantity 3.4 Ability to understand and exhibit knowledge of systems and system models 3.5 Ability to understand and exhibit knowledge of energy and matter, flows, cycles, and conservation 3.6 Ability to understand and exhibit knowledge of structure and function 3.7 Ability to understand and exhibit knowledge of stability and change
4. Incorporate Science and Engineering Practices NRC Framework	4.1 Knowledge and practice of the eight practices of science and engineering that the NRC Framework identifies as essential for all students to learn science and engineering are listed below: • Asking questions (for science) and defining problems (for engineering) • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematics and computational thinking • Constructing explanations (for science) and designing solutions (for engineering) • Engaging in argument from evidence • Obtaining, evaluating, and communicating information
5. Incorporate History and Nature of Science NRC Framework	5.1 Ability to apply appropriate practices and knowledge to experimental design 5.2 Ability to apply appropriate practices and knowledge to show scientific knowledge is based on empirical evidence 5.3 Ability to apply appropriate practices and knowledge to show scientific knowledge is open to revision in light of new evidence 5.4 Ability to apply appropriate practices and knowledge to scientific models, laws, mechanisms, and theories that explain natural phenomena 5.5 Ability to collect, process, analyze, and report data including sources of error 5.6 Ability to apply appropriate practices and knowledge to

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	demonstrate scientific knowledge assumes an order and consistency in natural systems 5.7 Ability to apply appropriate practices and knowledge to demonstrate science is a human endeavor 5.8 Ability to demonstrate that science addresses questions about the natural and material world
6. Incorporate Safety	6.1 Ability to design activities in a grade 7-12 classroom that demonstrate the safe and proper techniques for the preparation, storage, dispensing, supervision, and disposal of all materials used within their subject area science instruction 6.2 Ability to design and demonstrate activities in a grade 7-12 classroom that demonstrate an ability to implement emergency procedures and the maintenance of safety equipment, policies and procedures that comply with established state and/or national guidelines 6.3 Ability to ensure safe science activities appropriate for the abilities of all students 6.4 Ability to design and demonstrate activities in a 7-12 classroom that demonstrate ethical decision-making with respect to the treatment of all living organisms in and out of the classroom 6.5 Ability to emphasize safe, humane, and ethical treatment of animals and comply with the legal restrictions on the collection, keeping, and use of living organisms
7. Integration of STEM (science, technology, engineering, and mathematics) CCSS - English/Language Arts: English Language Arts & Literacy in Science, and Technical Subjects, grades 7-12 CCSS – Mathematics, grades 7-12 NRC Framework	7.1 Ability to understand and model key concepts of science, technology, engineering, and mathematics (STEM) 7.2 Ability to develop and deliver STEM-integrated, student-centered lessons and lab investigations, taking into account factors such as safety measures, grades 7-12 classroom dynamics, problem solving, and project-based learning strategies, etc., which integrate grade-appropriate standards and practices 7.3 Ability to understand and apply the engineering design process used to solve real-world problems in grades 7-12 lessons 7.4 Ability to collect, evaluate, synthesize, and share real world data 7.5 Ability to apply knowledge of STEM toward solving human and environmental problems 7.6 Ability to utilize vocabulary, primary concepts, definitions, and models applicable to scientific investigations and engineering and design challenges 7.7 Ability to develop and deliver STEM lesson assessments (formative and summative) 7.8 Ability to recognize how an integrated approach can enrich the learning environment and build connections between STEM content areas

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	7.9 Ability to appreciate the nature of science and scientific inquiry through solving real-world problems 7.10 Ability to develop and implement grades 4-8 STEM units and lessons 7.11 Ability to share, model, and practice strategies to support the integration of STEM areas with emphasis in the 4-8 classroom
8. Incorporate Principles of Engineering Design, Technology, and Applications of Science CCSS - English/Language Arts: English Language Arts & Literacy in Science, and Technical Subjects, grades 7-12 CCSS – Mathematics, grades 7-12 NRC Framework	8.1 Ability to demonstrate a deep understanding following active investigations in the principles of the engineering design cycle in the context of grades 7-12 science including • Defining and Delimiting an Engineering Problem • Developing Possible Solutions • Optimizing the Design Solution 8.2 Ability to demonstrate a deep understanding following active investigations in the principles of the links among engineering, technology, science, and society in the context of grades 7-12 science including • Interdependence of Science, Engineering, and Technology • Influence of Engineering, Technology, and Science on Society and the Natural World 8.3 Ability to display and apply proper knowledge and practices of the impact of physics and technology on society and the environment 8.4 Ability to display and apply proper knowledge and practices of major issues associated with energy use and production 8.5 Ability to display and apply proper knowledge and practices of applications of physics in daily life
9. Disciplinary Literacy CCSS-ELA	<u>Reading in Science and Technical Subjects, Grades 7-12</u> Reading competencies for literacy in science and technical subjects for grades 7-12 include the ability to read informational texts in science and technical subjects closely and critically to analyze the key ideas and details as well as craft and structure with the purpose of integrating knowledge and ideas both within and across texts by 9.1 Citing specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account 9.2 Determining the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms 9.3 Following precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, analyzing the specific results based on explanations in the text 9.4 Determining the meaning of symbols, key terms, and other

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	domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 7-12 text and topics 9.5 Analyzing how the text structures information or ideas are organized into categories or hierarchies, demonstrating understanding of the information or ideas 9.6 Analyzing the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved 9.7 Integrating and evaluating multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem 9.8 Evaluating the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information 9.9 Synthesizing information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible 9.10 Reading and comprehending a variety of scientific and technical documents appropriate for instruction within the 7-12 text complexity band <u>Writing in History/Social Studies, Science, and Technical Subjects, Grades 7-12</u> Writing competencies for literacy in history/social studies, science, and technical subjects for grades 7-12 will be demonstrated by 9.11 Writing arguments focused on discipline-specific content by • Introducing precise, knowledgeable claim(s), establishing the significance of the claim(s),distinguishing the claim(s) from alternate or opposing claims, and creating an organization that logically sequences the claim(s), counterclaims, reasons, and evidence • Developing claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. • Using words, phrases, and clauses as well as varied syntax

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	to link the major sections of the text, creating cohesion, and clarification of the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. • Establishing and maintaining a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Providing a concluding statement or section that follows from or supports the argument presented 9.12 Writing informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes by • Introducing a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension • Developing the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic • Using varied transitions and sentence structures to link the major sections of the text, creating cohesion, and clarifying the relationships among complex ideas and concepts • Using precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; conveying a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers • Providing a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic) 9.13 Producing clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience 9.14 Developing and strengthening writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience

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	9.15 Using technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information 9.16 Conducting short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem, narrowing or broadening the inquiry when appropriate, synthesizing multiple sources on the subject, demonstrating understanding of the subject under investigation 9.17 Gathering relevant information from multiple authoritative print and digital sources, using advanced searches effectively, assessing the strengths and limitations of each source in terms of the specific task, purpose, and audience, integrating information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source, and following a standard format for citation 9.18 Drawing evidence from informational texts to support analysis, reflection, and research 9.19 Writing routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences
10. Mathematical Practices CCSS-M Mathematical Practices 1-8	Standard 10: To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know how to develop student expertise in the content area incorporating the following Standards for Mathematical Practice throughout all 7-12 mathematics by 10.1 Making sense of problems and persevering in solving them 10.2 Reasoning abstractly and quantitatively 10.3 Constructing viable arguments and critiquing the reasoning of others 10.4 Modeling with mathematics 10.5 Using appropriate tools strategically 10.6 Attending to precision 10.7 Looking for and making use of structure 10.8 Looking for and expressing regularity in repeated reasoning
11. Number and Quantity NCTM: A.1.1 - A.1.5 CCSS: Math. Content. HSN	Standard 11: To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to number and quantity with their content understanding and mathematical practices, supported by appropriate technology and varied representational tools, including

	concrete models by 11.1 Knowing structure, properties, relationships, operations, and representations including standard and non-standard algorithms, of numbers and number systems including integer, rational, irrational, real, and complex numbers 11.2 Knowing fundamental ideas of number theory (divisors, factors and factorization, primes, composite numbers, greatest common factor, least common multiple, and modular arithmetic) 11.3 Knowing quantitative reasoning and relationships that include ratio, rate, and proportion and the use of units in problem situations 11.4 Knowing vector and matrix operations, modeling, and applications 11.5 Knowing historical development and perspectives of number, number systems, and quantity including contributions of significant figures and diverse cultures
12. Algebra NCTM/NCATE: A.2.1 - A.2.5 CCSS: Math. Content. HSA	Standard 12: To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to algebra with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models by 12.1 Knowing algebraic notation, symbols, expressions, equations, inequalities, and proportional relationships, and their use in describing, interpreting, modeling, generalizing, and justifying relationships and operations 12.2 Knowing function classes including polynomial, exponential, and logarithmic, absolute value, rational, and trigonometric, including those with discrete domains (e.g., sequences), and how the choices of parameters determine particular cases and model specific situations 12.3 Knowing functional representations (tables, graphs, equations, descriptions, recursive definitions, and finite differences), characteristics (e.g., zeroes, intervals of increase or decrease, extrema, average rates of change, domain and range, and end behavior), and notations as a means to describe, reason, interpret, and analyze relationships and to build new functions 12.4 Knowing patterns of change in linear, quadratic, polynomial, and exponential functions and in proportional and inversely proportional relationships and types of real-world relationships these functions can model 12.5 Knowing linear algebra including vectors, matrices, and

	transformations 12.6 Knowing abstract algebra, including groups, rings, and fields, and the relationship between these structures and formal structures for number systems and numerical and symbolic calculations 12.7 Knowing historical development and perspectives of algebra including contributions of significant figures and diverse cultures
13. Geometry and Trigonometry NCTM: A.4.1 - A.3.10 CCSS: Math. Content. HSG CCSS: Math.Content.HSF.TF	Standard 13: To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to geometry and trigonometry with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models by 13.1 Knowing core concepts and principles of Euclidean geometry in two and three dimensions and two-dimensional non-Euclidean geometries 13.2 Knowing transformations including dilations, translations, rotations, reflections, glide reflections, compositions of transformations, and the expression of symmetry in terms of transformations 13.3 Knowing congruence, similarity and scaling, and their development and expression in terms of transformations 13.4 Knowing right triangles and trigonometry 13.5 Knowing application of periodic phenomena and trigonometric identities 13.6 Knowing identification, classification into categories, visualization, and representation of two- and three-dimensional objects (triangles, quadrilaterals, regular polygons, prisms, pyramids, cones, cylinders, and spheres) 13.7 Knowing formula rationale and derivation (perimeter, area, surface area, and volume) of two- and three-dimensional objects (triangles, quadrilaterals, regular polygons, rectangular prisms, pyramids, cones, cylinders, and spheres), with attention to units, unit comparison, and the iteration, additivity, and invariance related to measurements 13.8 Knowing geometric constructions, axiomatic reasoning, and proof 13.9 Knowing analytic and coordinate geometry including algebraic proofs (e.g., the Pythagorean Theorem and its converse) and equations of lines and planes, and expressing geometric properties of conic sections with equations

	13.10 Knowing historical development and perspectives of geometry and trigonometry including contributions of significant figures and diverse cultures
14. Statistics and Probability NCTM: A.4.1 - A.4.6 CCSS: Math. Content. HSS	Standard 14: To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to statistics and probability with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models by 14.1 Knowing statistical variability and its sources and the role of randomness in statistical inference 14.2 Creating and implementing of surveys and investigations using sampling methods and statistical designs, statistical inference (estimation of population parameters and hypotheses testing), justification of conclusions, and generalization of results 14.3 Knowing univariate and bivariate data distributions for categorical data and for discrete and continuous random variables, including representations, construction and interpretation of graphical displays (e.g., box plots, histograms, cumulative frequency plots, scatter plots), summary measures, and comparisons of distributions 14.4 Knowing empirical and theoretical probability (discrete, continuous, and conditional) for both simple and compound events 14.5 Knowing random (chance) phenomena, simulations, and probability distributions and their application as models of real phenomena and to decision making 14.6 Knowing historical development and perspectives of statistics and probability including contributions of significant figures and diverse cultures
15. Calculus NCTM: A5.1-5.6	Standard 15: To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to calculus with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models by 15.1 Knowing limits, continuity, rates of change, the Fundamental Theorem of Calculus, and the meanings and techniques of differentiation and integration 15.2 Knowing parametric, polar, and vector functions 15.3 Knowing sequences and series 15.4 Knowing multivariate functions

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	15.5 Knowing applications of function, geometry, and trigonometry concepts to solve problems involving calculus 15.6 Knowing historical development and perspectives of calculus, including contributions of significant figures and diverse cultures
16. Discrete Mathematics NCTM: A.6.1 - A.6.5	Standard 16: To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to discrete mathematics with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models by 16.1 Knowing discrete structures including sets, relations, functions, graphs, trees, and networks 16.2 Knowing enumeration including permutations, combinations, iteration, recursion, and finite differences 16.3 Knowing propositional and predicate logic 16.4 Knowing applications of discrete structures such as modeling and solving linear programming problems and designing data structures 16.5 Knowing historical development and perspectives of discrete mathematics including contributions of significant figures and diverse cultures