COMPETENCIES FOR TEACHERS OF PHYSICS, GRADES 7-12

In addition to the Arkansas Teaching Standards (ATS) and the competencies for the Teacher Excellence and Support System (TESS), including competencies regarding the knowledge and use of educational technology that reflect the International Society for Technology in Education standards, the teacher of Physics, grades 7-12, shall also demonstrate knowledge and competencies in the following areas:

1. CONTENT KNOWLEDGE

NSTA/ASTE: Standard 1

NRC Framework

Praxis 5265

AAPT

AR K-12 Science Standards

NSTA/ASTE Standard 1: *Effective teachers of science understand and articulate the knowledge and practices of contemporary science and engineering. They connect important disciplinary core ideas, crosscutting concepts, and science and engineering practices for their fields of licensure.*

1.1 Uses and applies major concepts, principles, theories, laws, and interrelationships of their fields of licensure and supporting fields. Explains the nature of science and the cultural norms and values inherent to the current and historical development of scientific knowledge

1.2 Demonstrates knowledge of crosscutting concepts, disciplinary core ideas, practices of science and engineering, the supporting role science-specific technologies, and contributions of diverse populations to science

1.3 Demonstrates knowledge of how to implement science standards, learning progressions, and sequencing of science content for teaching their licensure level 7-12 students

NRC Framework: Core Component Ideas in the Physical Sciences:

1.4 Core Idea PS1: Matter and Its Interactions

- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions
- PS1.C: Nuclear Processes

Key concepts: Coulomb's Law, Nuclear Physics, Properties of Design Material, and Nature of Atomic and Subatomic Structure

1.5 Core Idea PS2: Motion and Stability: Forces and Interactions

- PS2.A: Forces and Motion
- PS2.B: Types of Interaction
- PS.2C: Stability and Instability in Physical Systems

Key concepts: Newton's Laws, Kinematics, Impulse=Change in Momentum, Conservation of Energy, Uni. Gravitation, Coulomb's Law, Current, Magnetism, and Induction, Vectors and Scalars, Dynamics, and Fluid Mechanics

1.6 Core Idea PS3: Energy

- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship Between Energy and Forces
- PS3.D: Energy in Chemical Processes and Everyday Life

Key concepts include: Forms of Energy, Conservation of Energy, Magnetic Fields, Thermodynamics, and Electromagnetic Fields

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1.7 Core Idea PS4: Waves and Their Applications in Technologies for Information Transfer

- PS4.A: Wave Properties
- PS4.B: Electromagnetic Radiation
- PS4.C: Information Technologies and Instrumentation

Key concepts include: Waves, Refraction, Information Technology, Wave-Particle Duality, Photoelectric Eff., Absorption, Optics, Longitudinal Waves, Simple Harmonic Motion, and E&M Waves

2. CONTENT PEDAGOGY

NSTA/ASTE: Standard 2

AAPT

NSTA/ASTE Standard 2: *Effective teachers of science plan learning units of study and equitable, culturally responsive opportunities for all students based upon their understanding of how students learn and develop science knowledge, skills, and habits of mind. Effective teachers also include appropriate connections to science and engineering practices and crosscutting concepts in their instructional planning.*

2.1 Uses science standards and a variety of appropriate, student-centered, and culturally relevant science disciplinary-based instructional approaches that follow safety procedures and incorporate science and engineering practices, disciplinary core ideas, and crosscutting concepts

2.2 Incorporates appropriate differentiation strategies, wherein all students develop conceptual knowledge and an understanding of the nature of science. Lessons should engage students in applying science practices, clarifying relationships, identifying natural patterns and empirical experiences

2.3 Uses engineering practices in support of science learning wherein all students design, construct, test and optimize possible solutions to a problem

2.4 Aligns instruction and assessment strategies to support instructional decision making that identifies and addresses student misunderstandings, prior knowledge, and naïve conceptions

Possible assessment types to use in instruction:

Summative assessments are performed in periodic intervals to assess a collection of knowledge at a particular point in time. Summative assessments may take the form of traditional assessments, including quizzes, exams, lab reports, and term papers but may also include projects, posters, presentations, etc.

Student self-assessment could be in the form of a journal that is used to Student self-assessment could be in the form of a journal that is used to encourage students to reflect and assess their progress

Performance-based assessments have proven to be effective in assessing three-dimensional learning. This requires students to demonstrate content knowledge (DCIs), the ability to make connections (CCCs), and developing solutions to solve a problem (SEPs)

Model-based assessment allows students to demonstrate content knowledge. The creative diagramming aspect of the model means that students, especially English for Speakers of Other Languages (ESOL) can demonstrate content understanding without being bogged down by vocabulary; they can show their comprehension is deeper than vocabulary

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Third party assessment tools have the advantage of being unbiased and statistically valid. Local, district, and state assessments may be examples of third-party assessments, including end-of-course exams.

2.5 Integrates science-specific technologies to support all students' conceptual understanding of science and engineering

3. LEARNING ENVIRONMENT

NSTA/ASTE: Standard 3

NSTA/ASTE Standard 3: *Effective teachers of science are able to plan for engaging all students in science learning by identifying appropriate learning goals that are consistent with knowledge of how students learn science and are aligned with standards. Plans reflect the selection of phenomena appropriate to the social context of the classroom and community, and safety considerations, to engage students in the nature of science and science and engineering practices. Effective teachers create an anti-bias, multicultural, and social justice-learning environment to achieve these goals.*

3.1 Plans a variety of lesson plans based on science standards that employ strategies that demonstrate their knowledge and understanding of how to select appropriate teaching and motivating learning activities that foster an inclusive, equitable, and anti-bias environment

3.2 Plans learning experiences for all students in a variety of environments (e.g., laboratory, field and community) within their fields of licensure

3.3 Plans lessons in which all students have a variety of opportunities to investigate, collaborate, communicate, evaluate, revise, and defend their own explanations of: scientific phenomena, observations, and data

4. SAFETY

NSTA/ASTE: Standard 4

Praxis 5265

COSSS

NSTA/ASTE Standard 4: *Effective teachers of science demonstrate biological, chemical, and physical safety protocols in their classrooms and workspace. They also implement ethical treatment of living organisms and maintain equipment and chemicals as relevant to their fields of licensure.*

4.1 Implements activities appropriate for the abilities of all students that demonstrate safe techniques for the procurement, preparation, use, storage, dispensing, supervision, and disposal of all chemicals/materials/equipment used within their fields of licensure

4.2 Demonstrates the awareness to recognize, prevent, and appropriately respond to hazardous situations(i.e. manage overcrowding; implement emergency procedures; maintain safety equipment; provide adequate student instruction and supervision; and follow policies and procedures that comply with established state and national guidelines, appropriate legal state (Arkansas Code Annotated § 6-10-113 [2012] for eye protection) and national safety standards (e.g., OSHA, NFPA, EPA), and best professional practices (e.g., NSTA, NSELA))

4.3 Demonstrates ethical decision-making with respect to safe and humane treatment of all living organisms in and out of the classroom, and comply with the legal restrictions and best professional practices on the collection, care, and use of living organisms as relevant to their fields of licensure

COMPETENCIES FOR TEACHERS OF PHYSICS, GRADES 7-12

5. IMPACT ON STUDENT LEARNING

NSTA/ASTE: Standard 5

NSTA/ASTE Standard 5: *Effective teachers of science provide evidence that students have learned and can apply disciplinary core ideas, crosscutting concepts and science and engineering practices because of instruction. Effective teachers analyze learning gains for individual students, the class as a whole, and subgroups of students disaggregated by demographic categories, and use these to inform planning and teaching.*

5.1 Implements assessments that show all students have learned and can apply disciplinary knowledge, nature of science, science and engineering practices, and crosscutting concepts in practical, authentic, and real-world situations

5.2 Collects, organizes, analyzes, and reflects on formative and summative evidence and uses those data to inform future planning and teaching

5.3 Analyzes science-specific assessment data based upon student demographics, categorizing the levels of learner knowledge, and reflect on results for subsequent lesson plans

6. PROFESSIONAL KNOWLEDGE AND SKILLS

NSTA/ASTE: Standard 6

New America

NSTA/ASTE Standard 6: *Effective teachers of science strive to continuously improve their knowledge of both science content and pedagogy, including approaches for addressing inequities and inclusion for all students in science. They identify with and conduct themselves as part of the science education community.*

6.1 Engages in critical reflection on their own science teaching to continually improve their instructional effectiveness

6.2 Participates in professional development opportunities to deepen their science content knowledge and practices

6.3 Participates in professional development opportunities to expand their science-specific pedagogical knowledge

New America:

6.4 Reflects on one's cultural lens

6.5 Recognizes and redresses biases in the system

6.6 Promotes respect for students' differences

6.7 Collaborates with families and the local community

7. INCORPORATES CROSSCUTTING CONCEPTS

NRC Framework

Praxis 5265

7.1 Understands and exhibits knowledge of patterns

7.2 Understands and exhibits knowledge of cause and effect and mechanism and explanation

7.3 Understands and exhibits knowledge of scale, proportion, and quantity

7.4 Understands and exhibits knowledge of systems and system models

7.5 Understands and exhibits knowledge of energy and matter, flows, cycles, and conservation

7.6 Understands and exhibits knowledge of structure and function

7.7 Understands and exhibits knowledge of stability and change

7.8 Teacher candidates will facilitate opportunities for 7-12 students to identify and demonstrate understanding of these crosscutting concepts paired with the disciplinary core ideas and science and engineering practices

COMPETENCIES FOR TEACHERS OF PHYSICS, GRADES 7-12

8. INCORPORATES SCIENCE AND ENGINEERING PRACTICES

NRC Framework

Praxis 5265

8.1 Knows and practices the eight practices of science and engineering that the Framework (NRC) identifies as essential for all students to learn and describes in detail are listed below:

- Asks questions (for science) and defining problems (for engineering)
- Develops and uses models
- Plans and carries out investigations
- Analyzes and interprets data
- Uses mathematics and computational thinking
- Constructs explanations (for science) and designs solutions (for engineering)
- Engages in argument from evidence
- Obtains, evaluates, and communicates information

8.2 Teacher candidates will facilitate opportunities for 7-12 students to demonstrate application of the Science and Engineering Practices paired with the disciplinary core ideas and the crosscutting concepts

9. INCORPORATES HISTORY AND NATURE OF SCIENCE

NRC Framework

Praxis 5625: Section VI

9.1 Applies appropriate practices and knowledge to show scientific investigations use a variety of methods

9.2 Applies appropriate practices and knowledge to show scientific knowledge is based on empirical evidence

9.3 Applies appropriate practices and knowledge to show scientific knowledge is open to revision in light of new evidence

9.4 Applies appropriate practices and knowledge to scientific models, laws, mechanisms, and theories that explain natural phenomena

9.5 Applies appropriate practices and knowledge to show science is a way of knowing

9.6 Applies appropriate practices and knowledge to demonstrate scientific knowledge assumes an order and consistency in natural systems

9.7 Applies appropriate use of scientific measurement and notation systems (i.e., precision vs accuracy, metric and SI units, unit conversions, scientific notation and significant figures, linear vs. logarithmic scales [e.g., pH])

9.8 Teacher candidates will facilitate opportunities for 7-12 students to demonstrate application of the History and Nature of Science

10. ANCHORING INSTRUCTION IN PHENOMENA

Seeing Students Learn Science: Integrating Assessment and Instruction in the Classroom: National Academies Press

AR K-12 State Standards

10.1 Engages students in active scientific thinking

10.2 Helps students make connections and to understand how science ideas are important

10.3 Identifies phenomena that describe events or facts that can be observed

10.4 Engages students in making sense of novel phenomena to gain conceptual understanding of what they observe in the world

10.5 Elicits students' natural curiosity about something that can be explained scientifically

10.6 Develops a range of activities that allow students to develop three-dimensional understanding of the core ideas and cross cutting concepts while using science and engineering skills

COMPETENCIES FOR TEACHERS OF PHYSICS, GRADES 7-12

11. SUPPORTING COMPETENCIES

NSTA-P

NRC Framework

AR K-12 State Standards

Praxis 5625

11.1 Mathematics:
- Understands how mathematical and statistical models evaluate the strength of a conclusion
- Understands how mathematical models are used in physics
- Understands what are the applications of calculus and differential equations in physics
- Understands how to use logarithms, trigonometric functions, Pythagorean theorem, vector resolution and addition

11.2 Chemistry:
- Understands what is matter
- Understands nature of atomic and subatomic structure, including atomic models
- Understands nuclear chemistry
- Knows what trends exist in the Periodic Table and how do those trends reflect atomic structure
- Understands in what ways do atoms combine to form novel substances
- Understands relationship of atomic spectra to electron energy levels

11.3 Earth and Space Sciences:
- Understands what are the predictable patterns caused by Earth's motion in the Solar System

11.4 Engineering, Technology and Applications:
- Understands that the engineering design process begins with identifying a problem and developing clear goals that the final product or system must meet
- Understands the process for developing potential design solutions, including models or prototypes
- Understands how to compare and improve various proposed design solutions

12. SCIENTIFIC PROCEDURES AND TECHNIQUES

Praxis 5265: Section VI (B)

12.1 Understands how to collect, evaluate, manipulate, interpret, and report data
- Significant figures in collected data and calculations
- Organization and presentation of data
- Knows how to interpret and draw conclusions from data presented in tables, graphs, and charts (e.g., trends in data, relationships between variable, predictions, and conclusions based on data)

12.2 Understands basic error analysis
- Determining mean
- Accuracy and precision
- Identifying sources and effects of error and its impact on percent error