Physics Endorsement Competencies 5-12

2007 Standards for Physics
1.0 Common Core – Content:
The physics teacher knows, understands, and applies scientific concepts and principles, including major unifying themes, that are needed to advance student learning as defined by state and national standards developed by the science education community. The physics teacher has a deep understanding of the following big ideas of physics:
1.1 Application of mathematical concepts and skills to the analysis of physical systems including:
1.1.1 Interpretation of graphs • Linear • Quadratic • Exponential • Trigonometric
1.1.2 Algebra • Proportional reasoning • Interpretation of multivariable equations • Manipulation of multivariable equations
1.1.3 Vectors • addition and subtraction • multiplication by a scalar • dot product and cross product • vector components
1.1.4 Matrix addition and multiplication
1.1.5 Concepts of calculus relevant to physics • Limits • Derivatives and integrals of functions • Slope of and area under graph • Line, surface, and volume integrals of vector and scalar fields
1.2 Mechanics, including:
1.2.1 Kinematics • Interpretation of graphs • Representations of motion including vector representations • Motion in one and two dimensions • Rotational kinematics

1.2.2 Dynamics
• Identification of forces
  • Type of Force
  • Object exerting the force
  • Object on which force is exerted
• Newton's Laws
• Static and kinetic friction

- Circular motion
- Rotational dynamics

1.2.3 Energy
- Work as the mechanical form of energy transfer
- Forms of energy (translational kinetic, rotational kinetic, elastic potential, gravitational potential and their connections to thermal and chemical)
- Conditions under which the mechanical energy of a system is constant

1.2.4 Momentum
- Linear Momentum
  - Impulse as momentum transfer
  - Conditions under which the linear momentum of a system is constant
- Angular Momentum
  - Of a rigid a body
  - Of a particle
  - Conditions under which the angular momentum of a system is constant

1.2.5 Gravitation
- Kepler's Laws
- Newton's Universal Law of Gravitation

1.3 Electricity and Magnetism, including:
- Electrostatics
- Magnetostatics
- Electric circuits including RC circuits
- Electric and magnetic forces on charged particles
- Lenz' Law and Faraday's Law
- Electromagnetic waves
- Electromagnetic phenomena applied to electric motors and generators

1.4 Waves and Optics
- Mechanical pulses and waves
  - Propagation
  - Transmission
  - Reflection
  - Standing Waves
- Sound
- Models of light and appropriate application of each model in explaining phenomena
  - Ray model (both monochromatic and RGB)
  - Wave model
  - Photon model
- Geometrical Optics
  - Patterns of light created by extended light sources and irregular apertures
  - Reflection and Refraction
    - Mirrors and Lenses
- Physical Optics
  - Interference

- Diffraction

1.5 Other major concepts of physics including:

- Fluid Statics and Dynamics
- Particle nature of matter and its supporting evidence
- Conservation Laws
- Heat and Temperature
- Ideal Gas Law
- Thermodynamics

1.7 The physics teacher has a basic understanding of:

- Technological applications of electricity and electronics
- Atomic Structure and Spectroscopy
- Nuclear physics, radioactivity, fission and fusion
- Fundamental particles, fundamental forces
- Wave/particle duality
- Heisenberg's Uncertainty Principle and Bohr's Correspondence Principle
- Frames of reference and Galilean relativity
- Special relativistic kinematics
- Interrelationship of matter and energy
- Applications of physics concepts and principles to contexts in biology, chemistry, and earth and space science

1.8 The Physics teacher knows student ideas in physics

- Motion
- Nature of forces
- Forces and Motion
- Energy
- Light
- Heat and Temperature
- Electric Circuits
- Basic electricity and magnetism

1.9 **Inquiry** – The physics teacher knows and understands scientific inquiry:

- Operational definitions of physical quantities
- Understand how to generate and evaluate questions that can be answered through scientific investigations.
- Understand how to plan and conduct systematic and complex scientific investigations.
- Synthesize a revised scientific explanation using evidence, data, and inferential logic.
- Analyze how physical, conceptual, and mathematical models represent and are used to investigate objects, events, systems, and processes.
- Apply understanding of how to report complex scientific investigations and explanations of objects, events, systems, and processes, and how to evaluate scientific reports.
- Analyze why curiosity, honesty, cooperation, openness, and skepticism are important to scientific explanations and investigations.

- Analyze scientific theories for logic, consistency, historical and current evidence, limitations, and capacity to be investigated and modified.
- Evaluate inconsistent or unexpected results from scientific investigations using scientific explanations.
- Analyze scientific investigations for validity of method and reliability of results.
- Understand how scientific knowledge evolves.

1.10 Nature and Context of Science - The physics teacher knows the values, beliefs, and assumptions inherent to the creation of scientific knowledge within the scientific community, and contrasts science to other ways of knowing.

- Analyze local, regional, national, or global problems or challenges in which scientific design can be or has been used to design a solution.
- Evaluate the scientific design process used to develop and implement solutions to problems or challenges.
- Evaluate consequences, constraints, and applications of solutions to a problem or challenge.
- Analyze how scientific knowledge and technological advances discovered and developed by individuals and communities in all cultures of the world contribute to changes in societies.
- Analyze how the scientific enterprise and technological advances influence and are influenced by human activity
- Analyze the scientific, mathematical, and technological knowledge, training, and experience needed for occupational/career areas of interest.

2.0 Common Core – Instructional Methodology:

2.1 Skills of Teaching: Physics teachers know the equipment, materials, and preparation required in the laboratory, including:

- Design of controlled investigations
- Data collection, analysis and presentation
- Preparation of laboratory reports
- Operation of equipment
- Preparation of materials
- Lab safety (including storage and disposal of hazardous waste)
- Estimation skills

2.1.1 Physics teachers, incorporating instructional materials, create a community of diverse student learners who can construct meaning from science and possess a disposition for further inquiry and learning. Skills of Teaching refers to:

- Able to use science teaching actions, strategies, and methodologies.
- Able to establish interactions with students, including questioning techniques, that promote learning and achievement.
- Able to effectively organize classroom, laboratory, and field experiences in different student groupings.
- Able to use advanced technology to extend and enhance learning.
- Able to use prior conceptions and student interests to promote new learning.
- Able to design investigations for physics.
- Able to analyze and present data in physics.
- Able to prepare laboratory reports in physics.

- Able to operate physics laboratory equipment.
- Able to prepare materials used in the physics laboratory.
- Able to establish and enforce lab safety (including storage and disposal of hazardous waste) in the physics laboratory.
- Engage students in academic discourse of physics concepts.
- Provide instruction on technical writing skills.
- Monitor students' understanding of content through a variety of assessment strategies, provide feedback to students to assist learning, adjust instruction and encourage students to learn to work together to solve problems.
- Being able to use advanced technology to extend and enhance learning.
- Design, conduct, and evaluate laboratory activities that target the development of science concepts, using techniques, equipment, and facilities that meet current technological standards including computer applications to science teaching and hands-on laboratory experiences, equipment, and laboratory notebook.
- Being able to use prior conceptions and student interests to promote new learning.
- Integrate reading, writing, communication, mathematics, social studies, and health/fitness into the teaching of physics.

2.2 Curriculum – Physics teachers know the earth science curriculum.

- Understand the application of student learning goals including the EARLs and GLEs to design lessons that target state standards (i.e., read with comprehension, write with skill, and communicate effectively with responsibility in a variety of ways and settings, know and apply the core concepts).

2.2.1 The physics teacher develops and applies a coherent, focused physics curriculum that is consistent with state and national standards for physics education and appropriate for addressing the need, abilities, and interests of students. Curriculum refers to:

- Able to develop and apply an extended framework of goals, plans, materials, and resources for instruction.
- Able to develop and apply science principles, both in and out of school.
- Able to plan instruction which promotes problem analysis, critical thinking, creativity, leadership development and decision-making based upon subject matter, organization and integration of content and the relationship of content to education, career and life goals; student learning and motivation, with emphasis on individual differences and diversity; the community and community resources; and current education standards and practices.
- Select, analyze, modify and incorporate instructional materials to meet the learning needs and reading level of diverse learners including curriculum resources and technology; inquiry based laboratory experiences; and information from the internet, professional organizations, and business and industry.

2.3 Social Context – Physics teachers know the relation between science and the community and know the human and institutional resources in the community. The social context of science teaching refers to:

- Knowing examples of social and community support networks within which occur life science teaching and learning.
- Knowing the relationship of science teaching and learning to the needs and values of various communities.

2.3.1 Physics teachers can relate science to the community and use human and institutional resources in the community to advance the education of their students in physics. The social context of science teaching refers to:

- Being able to develop the social and community support network within which science teaching and learning occur.
- Being able to relate science teaching and learning to the needs and values of the community.
- Being able to involve people and institutions from the community in the teaching of science.

2.4 Assessment - The physics teacher knows a variety of contemporary assessment strategies to evaluate the intellectual, social, and personal development of the learner in all aspects of physics. Assessment refers to:

- Knowing the measurement and evaluation of student learning in a variety of dimensions including state assessments.

2.4.1 The physics teacher uses a variety of contemporary assessment strategies to evaluate the intellectual, social, and personal development of the learner in all aspects of science. Assessment refers to:

- Identifying outcomes to be measured.
- Being able to align learning targets, instructions, and outcomes.
- Being able to measure and evaluate student learning in a variety of dimensions.
- Being able to use outcome data to guide and change instruction.
- Monitoring and assessing students' understanding of content through a variety of means, providing feedback to students to assist learning and adjusting instructional strategies.

2.5 Environment for Learning – Physics teachers know safe and supportive learning environments reflecting high expectations for the success of all students. Learning environments refers to:

- Know examples of changes that can make physical spaces more effective for learning science.
- Know typical examples of psychological and social environments of the student engaged in learning science
- Know safety in all areas related to science instruction.

2.5.1 Physics teachers design and manage the instructional environment::

- Able to design/manage physical spaces to enhance learning of science.
- Able to create a climate that promotes fairness.
- Able to establish and maintain rapport with students.
- Able to communicate clear, challenging expectations to each student.
- Able to establish and maintain consistent standards of classroom behavior.
- Able to use instructional time effectively.
- Able to create a safe environment conducive to learning.

3.0 Common Core – Professional Practice:

3.1 Physics teachers have a knowledge base that prepares them for professional practice. Professional practice refers to:

- Knowledge of science and educational professional organizations.
- Knowledge of standards of ethical behavior consistent with the best interests of

students and the community.
3.2 Physics teachers participate in the professional community, improving practice through their personal actions, education, and development. Professional practice refers to teachers being able to: • Participate in the activities of the professional community to include colleagues, organizations, and other agencies, to improve student learning. • Demonstrate ethical behavior consistent with the best interests of students and the community, as stated in Washington's Code of Professional Conduct, and local, state, and federal laws and regulations. • Reflect on professional practices and continuous efforts to ensure the highest quality of science instruction. • Willingly work with students and new colleagues as they enter the profession. • Communicate effectively with parents/guardians, business and industry, and other agencies, and the community at large to support learning by all students.