



Indiana Content Standards for Educators

SCIENCE—EARTH AND SPACE SCIENCE

Earth and space science teachers are expected to have a broad and comprehensive understanding of the knowledge and skills needed for this educator license, and to use that knowledge to help students prepare for the challenges and opportunities of the twenty-first century. This requires the ability to identify, comprehend, analyze, synthesize, and evaluate the basic principles, fundamental concepts, and essential content defined in these standards, and to apply that knowledge to the tasks of planning and delivering effective instruction and assessment.

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Science—Earth and Space Science Educator Standards

Standard 1: The Nature and Processes of Science

Earth and space science teachers have a broad and comprehensive understanding of the nature of science and the processes of scientific inquiry.

Standard 2: Central Concepts and Connections in Science

Earth and space science teachers have a comprehensive understanding of the core ideas in other science disciplines and of the relationships between science, engineering, technology, and society.

Standard 3: Stars, Galaxies, and the Universe

Earth and space science teachers have a broad and comprehensive understanding of the origin, structure, and components of the universe.

Standard 4: Earth and the Solar System

Earth and space science teachers have a broad and comprehensive understanding of the solar system and the sun-moon-Earth system.

Standard 5: Earth's Origin, Evolution, and Structure

Earth and space science teachers have a broad and comprehensive understanding of the origin, evolution, and structure of Earth.

Standard 6: Earth Processes and Materials

Earth and space science teachers have a broad and comprehensive understanding of the physical and chemical processes that shape Earth's surface and the materials that Earth is composed of.

Standard 7: Freshwater Systems and the Oceans

Earth and space science teachers have a broad and comprehensive understanding of the hydrosphere.

Standard 8: The Atmosphere, Weather, and Climate

Earth and space science teachers have a broad and comprehensive understanding of the atmosphere, weather, and climate.

Standard 9: Biogeochemical Cycles, Geologic Resources, and the Environment

Earth and space science teachers have a broad and comprehensive understanding of the cycling of matter through biogeochemical cycles, the use and management of geologic resources, and the effects of human activities on the environment.

Standard 10: Science Instruction and Assessment

Earth and space science teachers have a broad and comprehensive understanding of content-specific instruction and assessment in science.

The Indiana Educator Standards for Science—Earth and Space Science describe the knowledge and skills that teachers need to help students achieve the learning outcomes defined by the Indiana Revised Academic Standards for Science. The Indiana Academic Standards can be found [here](#).

Science—Earth and Space Science Educator Standards

Standard 1: The Nature and Processes of Science

Earth and space science teachers have a broad and comprehensive understanding of the nature of science and the processes of scientific inquiry, including:

- 1.1 the characteristics, assumptions, and goals of science
- 1.2 the tentative nature of scientific knowledge, which is subject to change as new evidence, new tools, or new ways of thinking become available
- 1.3 the formulation of testable hypotheses and the principles and procedures for designing and conducting scientific investigations
- 1.4 common tools, materials, and technology used in Earth and space science investigations
- 1.5 the collection, organization, analysis, interpretation, and communication of scientific data, including the use of technology
- 1.6 the safe execution of laboratory exercises and safe storage and disposal of chemicals and materials
- 1.7 the role and applications of mathematics in science
- 1.8 the characteristics and uses of various sources of scientific information and the evaluation of scientific information, claims, and arguments
- 1.9 the role of peer review and critical evaluation of the results of scientific investigations, models, and explanations

Standard 2: Central Concepts and Connections in Science

Earth and space science teachers have a comprehensive understanding of the core ideas in other science disciplines and of the relationships between science, engineering, technology, and society, including:

- 2.1 the unifying concepts and processes that cut across the sciences and engineering
- 2.2 the basic concepts and major principles of physical science
- 2.3 the basic concepts and major principles of life science
- 2.4 the basic characteristics, principles, and goals of the engineering, or technological, design process
- 2.5 the interconnections between the various disciplines of science
- 2.6 the interrelationships between science and technology
- 2.7 the social, cultural, and ethical aspects of science and technology
- 2.8 the historical development of important ideas in science from different periods and cultures

Science—Earth and Space Science Educator Standards

Standard 3: Stars, Galaxies, and the Universe

Earth and space science teachers have a broad and comprehensive understanding of the origin, structure, and components of the universe, including:

- 3.1 the Big Bang theory of the universe's origin, evidence supporting the Big Bang theory, the scale and evolution of the universe, and Hubble's law
- 3.2 the Hertzsprung-Russell diagram, characteristics and life cycles of different types of stars, and the nucleosynthesis of elements
- 3.3 characteristics of supernovae, black holes, white dwarfs, and neutron stars
- 3.4 characteristics and formation of different types of galaxies
- 3.5 the role of gravity in the formation of stars and galaxies
- 3.6 characteristics of different types of telescopes and the principles and applications of spectroscopy

Standard 4: Earth and the Solar System

Earth and space science teachers have a broad and comprehensive understanding of the solar system and the sun-moon-Earth system, including:

- 4.1 the nebular theory of the solar system's origin, planetesimals, and protoplanets
- 4.2 asteroids, comets, the Oort cloud, the Kuiper belt, and the asteroid belt
- 4.3 the composition, orientation, and orbital characteristics of the planets and their moons
- 4.4 Earth's place in the solar system, its orbit, axial rotation, and planetary characteristics
- 4.5 the sun-moon-Earth system and its relationship to ocean tides, seasons, day length, and Earth's energy budget
- 4.6 solar and lunar eclipses, the phases of the moon, and the origin and characteristics of the moon
- 4.7 the apparent motion of objects in the sky and the celestial sphere model
- 4.8 the role of gravity in the formation of the solar system, Newton's laws, and Kepler's laws of planetary motion

Standard 5: Earth's Origin, Evolution, and Structure

Earth and space science teachers have a broad and comprehensive understanding of the origin, evolution, and structure of Earth, including:

- 5.1 origin of Earth in the early solar system and the evolution of the hydrosphere, atmosphere, lithosphere, and biosphere
- 5.2 Earth's internal structure and the properties and physical and chemical characteristics of Earth's layered interior
- 5.3 the use of seismology in the study of Earth's interior
- 5.4 the properties and source of Earth's magnetic field and its effect on other Earth systems
- 5.5 the geologic time scale, the fossil record, and the principles and applications of modern evolutionary theory
- 5.6 the principles and applications of radiometric dating, relative dating, and stratigraphy
- 5.7 the geologic history of Indiana

Standard 6: Earth Processes and Materials

Earth and space science teachers have a broad and comprehensive understanding of the physical and chemical processes that shape Earth's surface and the materials that Earth is composed of, including:

- 6.1 the characteristics, identification, and composition of rocks and minerals, including the rocks and minerals of Indiana
- 6.2 interactions among the hydrosphere, atmosphere, lithosphere, and biosphere
- 6.3 the theory of and supporting evidence for plate tectonics
- 6.4 processes involved in the formation of igneous, metamorphic, and sedimentary rocks
- 6.5 different types of igneous activity and volcanism
- 6.6 earthquakes, geologic faulting, and folding
- 6.7 weathering, erosion, and deposition
- 6.8 glacial processes and the effects of continental glaciations on Indiana and the Great Lakes region
- 6.9 soil formation processes and the characteristics of different soil types, including the soils of Indiana

Standard 7: Freshwater Systems and the Oceans

Earth and space science teachers have a broad and comprehensive understanding of the hydrosphere, including:

- 7.1 the physical and chemical properties of water
- 7.2 freshwater lakes, ponds, and wetlands
- 7.3 groundwater aquifers, watersheds, and groundwater flow processes
- 7.4 the evolution and characteristics of river systems under different geographic conditions
- 7.5 the characteristics and evolution of ocean basins
- 7.6 the physical and chemical properties of ocean water
- 7.7 characteristics of surface currents and thermohaline circulation
- 7.8 characteristics of ocean waves and coastal processes
- 7.9 surface water and groundwater systems in Indiana and the Great Lakes region

Standard 8: The Atmosphere, Weather, and Climate

Earth and space science teachers have a broad and comprehensive understanding of the atmosphere, weather, and climate, including:

- 8.1 the structure, composition, and properties of the atmosphere's different layers
- 8.2 the processes of energy transfer to and within the atmosphere
- 8.3 the physical and biological characteristics of the world's different climate regions
- 8.4 the global climate system, changes in climate over geologic time, and recent climate change
- 8.5 weather systems, air masses, fronts, the polar-front and subtropical jet streams, air pressure, and local and global winds
- 8.6 thunderstorms, tornadoes, middle latitude cyclones, hurricanes, and other types of severe weather
- 8.7 weather conditions and events that commonly affect Indiana, including lake-effect snow and blizzards
- 8.8 weather maps, computer models, and the tools and technologies used in meteorology and climatology

Standard 9: Biogeochemical Cycles, Geologic Resources, and the Environment

Earth and space science teachers have a broad and comprehensive understanding of the cycling of matter through biogeochemical cycles, the use and management of geologic resources, and the effects of human activities on the environment, including:

- 9.1 the physical and chemical processes of the carbon cycle and its relationship to human activities, the climate system, and ocean chemistry
- 9.2 the phosphorus and nitrogen cycles and their relationship to human activities and the biosphere
- 9.3 the formation, extraction, use, and management of mineral resources and fossil fuels, including those found in Indiana and the surrounding region
- 9.4 the scientific principles underlying the use and development of solar energy, geothermal energy, and wind energy
- 9.5 the environmental effects of human activities on local and global scales

Standard 10: Science Instruction and Assessment

Earth and space science teachers have a broad and comprehensive understanding of content-specific instruction and assessment in science, including:

- 10.1 the Indiana Revised Academic Standards for Science
- 10.2 the National Science Education Standards, the NCATE/NSTA Standards for Science Teacher Preparation, the Common Core State Standards for Literacy: Science and Technical Subjects, and the ISTE National Educational Technology Standards
- 10.3 instructional strategies and resources for promoting students' development of conceptual understanding, inquiry skills, and scientific habits of mind
- 10.4 strategies and skills for planning and designing science instruction, including the use of techniques and approaches that meet the needs of diverse learners
- 10.5 instructional strategies and communication methods that encourage active inquiry, supportive interaction, and collaboration in the science classroom
- 10.6 strategies and resources for promoting students' reading, writing, and mathematics skills in science
- 10.7 strategies and skills for selecting, adapting, and using technological resources to enhance teaching and learning in science
- 10.8 procedures, resources, and guidelines for maintaining a safe science learning environment
- 10.9 strategies and skills for effectively assessing student understanding and mastery of essential science concepts and skills

Selected Bibliography of Standards and Sources Related to Science—Earth and Space Science

State and National Standards and Curriculum Frameworks

1. Indiana Department of Education. (2010). *Indiana revised academic standards for science*. http://www.indianascience.org/files/standards_03_29_10.pdf
2. Council of Chief State School Officers (CCSSO)/National Governors Association (NGA). (2010). *Common core state standards for English language arts & literacy in history/social studies, science, and technical subjects*. http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf
3. National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press. <http://www.nap.edu/catalog/4962>
4. National Science Teachers Association. (2003). *Standards for science teacher preparation*. <http://www.ncate.org/ProgramStandards/NSTA/NSTASTandards.doc>
5. American Association for the Advancement of Science. (1993). *Project 2061: Benchmarks for science literacy*. New York: Oxford University Press. <http://www.project2061.org/publications/bsl/default.htm>
6. International Society for Technology in Education. (2008). *National educational technology standards for teachers*. http://www.iste.org/Libraries/PDFs/NETS_for_Teachers_2008_EN.sflb.ashx
7. National Research Council. (2010). *A framework for science education: Preliminary public draft*.

Sources on Science—Earth and Space Science Content

8. American Association for the Advancement of Science and the National Science Teachers Association. *Atlas of science literacy*. Volume 1 (2001) and Volume 2 (2007). Washington, DC: American Association for the Advancement of Science.
9. Harris, M. T. (2002). Developing geoscience student-learning centered courses. *Journal of Geoscience Education*, 50(5), 515-23.
10. Gille, S. (2004). Integrating science into policy in the classroom: Three case studies on the atmosphere. *Journal of Earth System Science Education*, 1 (Article + Case Studies), JESSE-04-300-07.
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Selected Bibliography of Standards and Sources Related to Science—Earth and Space Science

Sources on Student Learning and Pedagogical Methodology

14. Committee on Science Learning, Kindergarten Through Eighth Grade, National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K–8.* (R. A. Duschl, H. A. Schweingruber, and A. W. Shouse, Eds.). Washington, DC: The National Academies Press.
15. Committee on High School Science Laboratories: Role and Vision, National Research Council. (2006). *America's lab report: Investigations in high school science.* (S. R. Singer, M. L. Hilton, and H. A. Schweingruber, Eds.). Washington, DC: The National Academies Press.
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17. Weiss, I. R., Knapp, M. S., Hollweg, K. S., & Burrill, G. (Eds.). (2001). *Investigating the influence of standards: A framework for research in mathematics, science, and technology education.* Washington, DC: National Academy Press.
18. Adams, P. E., & Krockover, G. H. (1997). Beginning science teacher cognition and its origins in the preservice secondary science teacher program. *Journal of Research in Science Teaching*, 34(6), 633–53.
19. Kaser, J. S., & Bourexis, P. S. (1999). *Enhancing program quality in science and mathematics.* Thousand Oaks, CA: Corwin Press, Inc.
20. Veal, W. R., van Driel, J., & Hulshof, H. (2001). PCK: How teachers transform subject matter knowledge. *International Journal of Leadership in Education*, 4(3), 285–91.
21. Penuel, W. R., & Gallagher, L. P. (2009). Preparing teachers to design instruction for deep understanding in middle school Earth science. *Journal of the Learning Sciences*, 18(4), 461–508.
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Alignment of Educator Standards with State and National Standards

Indiana Educator Standards for Science—Earth and Space Science	Indiana Revised Academic Standards for Science	Indiana Core Standards for Science	National Science Education Standards	NCATE/NSTA Standards for Science Teacher Preparation	Common Core State Standards for Literacy: Science and Technical Subjects	ISTE National Educational Technology Standards
<u>Standard 1: The Nature and Processes of Science</u> Earth and space science teachers have a broad and comprehensive understanding of the nature of science and the processes of scientific inquiry.	Gr. 5–8 Process Standards, ES Nature of Science Standard		Gr. 5–8, CS – A; Gr. 5–8, CS – E; Gr. 5–8, CS – G; Gr. 9–12, CS – A; Gr. 9–12, CS – E; Gr. 9–12, CS – G;	Standard 2 – Nature of Science, Standard 3 – Inquiry, Standard 1 – B.4.33–34, Standard 1 – C.1.2–3, Standard 9 – Safety and Welfare	Reading Gr. 6–8, 1–10; Reading Gr. 9–10, 1–10; Reading Gr. 11–12, 1–10	
<u>Standard 2: Central Concepts and Connections in Science</u> Earth and space science teachers have a comprehensive understanding of the core ideas in other science disciplines and of the relationships between science, engineering, technology, and society.	Gr. 5–8, Process Standards, ES Nature of Science Standard, 5.1, 6.1, 7.1, 8.1, 5.3, 6.3, 7.3, 8.3, 5.4, 6.4, 7.4, 8.4	5.1, 6.1, 7.1, 8.1, 5.3, 6.3, 7.3, 8.3, 5.4, 6.4, 7.4, 8.4	Gr. 5–8, CS – E; Gr. 5–8, CS – F; Gr. 9–12, CS – E; Gr. 9–12, CS – F	Standard 4 – Issues; Standard 1 – B.4.29, 31		

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Indiana Educator Standards for Science—Earth and Space Science	Indiana Revised Academic Standards for Science	Indiana Core Standards for Science	National Science Education Standards	NCATE/NSTA Standards for Science Teacher Preparation	Common Core State Standards for Literacy: Science and Technical Subjects	ISTE National Educational Technology Standards
<u>Standard 3: Stars, Galaxies, and the Universe</u> Earth and space science teachers have a broad and comprehensive understanding of the origin, structure, and components of the universe.	5.2, 6.2, ES.1	5.2, 6.2, ES.1	Gr. 5–8, CS – D; Gr. 9–12, CS – D	Standard 1 – B.3.20, Standard 1 – C.4.a.9, Standard 1 – C.4.b.17		
<u>Standard 4: Earth and the Solar System</u> Earth and space science teachers have a broad and comprehensive understanding of the solar system and the sun-moon-Earth system.	5.2, 6.2, ES.2	5.2, 6.2, ES.2	Gr. 5–8, CS – D; Gr. 9–12, CS – D	Standard 1 – B.3.21, Standard 1 – C.4.a.8, Standard 1 – C.4.b.17		
<u>Standard 5: Earth's Origin, Evolution, and Structure</u> Earth and space science teachers have a broad and comprehensive understanding of the origin, evolution, and structure of Earth.	7.2, 8.2, ES.3, ES.5	7.2, 8.2, ES.5	Gr. 5–8, CS – D; Gr. 9–12, CS – D	Standard 1 – B.3.21; Standard 1 – C.4.a.1, C.4.a.8; Standard 1 – C.4.b.13, C.4.b.16, C.4.b.18		

Alignment of Educator Standards with State and National Standards

Indiana Educator Standards for Science—Earth and Space Science	Indiana Revised Academic Standards for Science	Indiana Core Standards for Science	National Science Education Standards	NCATE/NSTA Standards for Science Teacher Preparation	Common Core State Standards for Literacy: Science and Technical Subjects	ISTE National Educational Technology Standards
<u>Standard 6: Earth Processes and Materials</u> Earth and space science teachers have a broad and comprehensive understanding of the physical and chemical processes that shape Earth's surface and the materials that Earth is composed of.	7.2, 8.2, ES.3, ES.5	7.2, 8.2, ES.3, ES.5	Gr. 5–8, CS – D; Gr. 9–12, CS – D	Standard 1 – B.3.24 Standard 1 – C.4.a.2-3, Standard 1 – C.4.b.13		
<u>Standard 7: Freshwater Systems and the Oceans</u> Earth and space science teachers have a broad and comprehensive understanding of the hydrosphere.	8.2, ES.4	8.2, ES.4	Gr. 5–8, CS – D; Gr. 9–12, CS – D	Standard 1 – B.3.22, Standard 1 – C.4.a.1, Standard 1 – C.4.a.6, Standard 1 – C.4.b.14–15		
<u>Standard 8: The Atmosphere, Weather, and Climate</u> Earth and space science teachers have a broad and comprehensive understanding of the atmosphere, weather, and climate.	8.2, ES.4	8.2, ES.4	Gr. 5–8, CS – D; Gr. 9–12, CS – D	Standard 1 – B.3.23, Standard 1 – C.4.a.6–7, Standard 1 – C.4.b.14–15		

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Indiana Educator Standards for Science—Earth and Space Science	Indiana Revised Academic Standards for Science	Indiana Core Standards for Science	National Science Education Standards	NCATE/NSTA Standards for Science Teacher Preparation	Common Core State Standards for Literacy: Science and Technical Subjects	ISTE National Educational Technology Standards
<u>Standard 9: Biogeochemical Cycles, Geologic Resources, and the Environment</u> Earth and space science teachers have a broad and comprehensive understanding of the cycling of matter through biogeochemical cycles, the use and management of geologic resources, and the effects of human activities on the environment.	8.2, ES.3, ES.4, ES.5, ES.6	8.2, ES.3, ES.4, ES.6	Gr. 5–8, CS – D; Gr. 9–12, CS – D	Standard 1 – B.3.26, B.4.30; Standard 1 – C.4.a.4; Standard 1 – C.4.a.11–12; Standard 1 – C.4.b.11–12, C.4.b.15, C.4.b.19		
<u>Standard 10: Science Instruction and Assessment</u> Earth and space science teachers have a broad and comprehensive understanding of content-specific instruction and assessment in science.			Teaching Standards A – E, Assessment Standards A – E	Standard 5 – General Skills of Teaching, Standard 6 – Curriculum, Standard 8 – Assessment, Standard 9 – Safety and Welfare	Reading Gr. 6–8, 1–10; Reading Gr. 9–10, 1–10; Reading Gr. 11–12, 1–10; Writing Gr. 6–8, 1–10; Writing Gr. 9–10, 1–10; Writing Gr. 11–12, 1–10	1a–1d, 2a–2d, 3a–3d, 4a–4b