



## Grades 9–12

### 3.3.9-12.B Earth and Space Science: Space Systems

**Students who demonstrate understanding can** *construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.*

**Clarifying Statement:** Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).

**Assessment Boundary:** N/A

Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
<p><b>Constructing Explanations and Designing Solutions</b></p> <p>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> <li>Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.</li> </ul>	<p><b>The Universe and Its Stars</b></p> <ul style="list-style-type: none"> <li>The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.</li> <li>The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.</li> <li>Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.</li> </ul> <p><b>Electromagnetic Radiation</b></p> <ul style="list-style-type: none"> <li>Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Energy cannot be created or destroyed—only moved between one place and another place, between objects and/or fields, or between systems.</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Interdependence of Science, Engineering, and Technology</b></p> <ul style="list-style-type: none"> <li>Science and engineering complement each other in the cycle known as research and development (R&amp;D). Many R&amp;D projects may involve scientists, engineers, and others with wide ranges of expertise.</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p> <ul style="list-style-type: none"> <li>Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</li> <li>Science assumes the universe is a vast single system in which basic laws are consistent.</li> </ul>



**Pennsylvania Context:** N/A

**PA Career Ready Skills:** Select expressive communication strategies specific to context.

### Connections to Other Standards Content and Practices

Standard Source	Possible Connections to Other Standard(s) or Practice(s)
<b>Agriculture (AFNR)</b>	CS.06.01.01.a: Research and explain the foundational cycles in AFNR (e.g., water cycle, nutrient cycle, carbon cycle, etc.).
<b>Science, Environmental Literacy and Sustainability (NAAEE)</b>	9-12 Strand 1.G. Drawing conclusions and developing explanations: Learners propose explanations that address their initial environmental questions using quantitative and qualitative data and evidence that has been collected and analyzed.
<b>PA Core Standards: ELA</b>	CC.3.5.9-12.A: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. CC.3.5.11-12.A: Cite 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. CC.3.6.9-12.B: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
<b>PA Core Standards and Practices: Math</b>	MP.2: Reason abstractly and quantitatively. CC.2.1.HS.F.3: Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data display. CC.2.1.HS.F.4: Use units as a way to understand problems and to guide the solution of multistep problems.
<b>PA Standards: Social Studies</b>	N/A
<b>Educational Technology (ISTE)</b>	1.3. Knowledge Constructor: Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
<b>Technology and Engineering (ITEEA)</b>	STEL-10: Assess how similarities and differences among scientific, mathematical, engineering, and technological knowledge and skills contributed to the design of a product or system.