

# Composition of the Universe

## Novice

- The universe is composed primarily of Hydrogen, with some Helium.
- Most of the stuff in the universe is contained in stars and gas.

## Intermediate

- The universe is 98% Hydrogen (by mass), just under 2% Helium, and less than 1% everything else.
- Substances are made from different types of atoms, which combine with one another in various ways.
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
- In a gas, the molecules are widely spaced except when they happen to collide.

## Expert

- If you could weigh all the stuff in the universe, it would be 98% Hydrogen. If you could count all the atoms in the universe instead, it would be around 75% Hydrogen.
- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- 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.
- 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.
- Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.
- 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.

### Related NGSS

Grade Level	Student Performance Expectations
3-5	<p>5-ESS2</p> <p><b>Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.</b></p>
MS	<p>MS-ESS2-1</p> <p><b>Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.</b></p>
HS	<p>HS-ESS1-3</p> <p><b>Communicate scientific ideas about the way stars, over their life cycle, produce elements.</b></p>

### Related CCSSM

Grade Level	Student Performance Expectations
3-5	<p><b>CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.</b> Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to <i>decontextualize</i>—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to <i>contextualize</i>, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.</p> <p><b>CCSS.MATH.PRACTICE.MP4 Model with mathematics.</b> Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation,</p>

	<p>realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.</p>
MS	<p><b>CCSS.MATH.CONTENT.6.EE.B.6</b>  Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.</p> <p><b>CCSS.MATH.CONTENT.7.EE.B.4</b>  Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.</p>
HS	<p><b>CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.</b>  Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to <i>decontextualize</i>—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to <i>contextualize</i>, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.</p>