

Standard ESS.1.2 - **Construct an explanation** of the Big Bang theory based on astronomical evidence of electromagnetic radiation, motion of distant galaxies, and composition of matter in the universe. Emphasize redshift of electromagnetic radiation, cosmic microwave background radiation, and the observed composition and distribution of matter in the universe. (PS4.B, ESS1.A)

4: Advanced	3: Proficient	2: Approaching Proficiency	1: Beginning Proficiency
I can: Construct an explanation to describe the Big Bang theory using its supporting evidence including redshift of electromagnetic radiation, cosmic background radiation, AND the composition and distribution of matter in the universe. AND Make a claim, using evidence and reasoning, to refute a different theory in favor of the Big Bang Theory.	I can: Construct an explanation to describe the Big Bang theory using its supporting evidence including redshift of electromagnetic radiation, cosmic background radiation, AND the composition and distribution of matter in the universe.	I can: Explain the Big Bang theory using its supporting evidence including redshift of electromagnetic radiation, cosmic background radiation, OR the composition and distribution of matter in the universe.	I can: Summarize the Big Bang theory.

Please Note: The law of conservation of matter and energy is not included in the information given to students, but is prior knowledge that is acceptable to use as evidence to help answer question 5 of this assessment.

Sources

- Cosmic times: https://imagine.gsfc.nasa.gov/educators/programs/cosmictimes/online_edition/1955/origin.html
- Hubble's data: <https://starchild.gsfc.nasa.gov/docs/StarChild/questions/redshift.html>
- Distribution of matter: <https://www.universetoday.com/159982/astonomers-make-a-new-map-of-all-the-matter-and-dark-matter-in-the-universe/>
- What is the big bang: <https://spaceplace.nasa.gov/big-bang/en/>
- https://www.schoolsobservatory.org/learn/astro/cosmos/bigbang/bb_evid

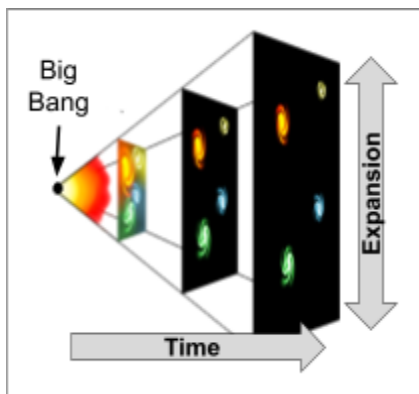
Reading 1: What is the Big Bang Theory?

The big bang theory is how astronomers explain the way the universe began. It is the idea that the universe began as just a single point, then expanded and stretched to grow as large as it is right now.

13.8 billion years ago the universe was just hot, tiny particles mixed with energy. It was nothing like what we see now. As everything expanded and took up more space, it cooled down. The tiny particles grouped together. They formed atoms. Then those atoms grouped together and over lots of time, atoms came together to form stars and galaxies.

The first stars created bigger atoms and groups of atoms. That led to more stars being born. At the same time, galaxies were crashing and grouping together. As new stars were being born and dying, then things like asteroids, comets, planets, and black holes formed.

Figure 1: The Big Bang Theory



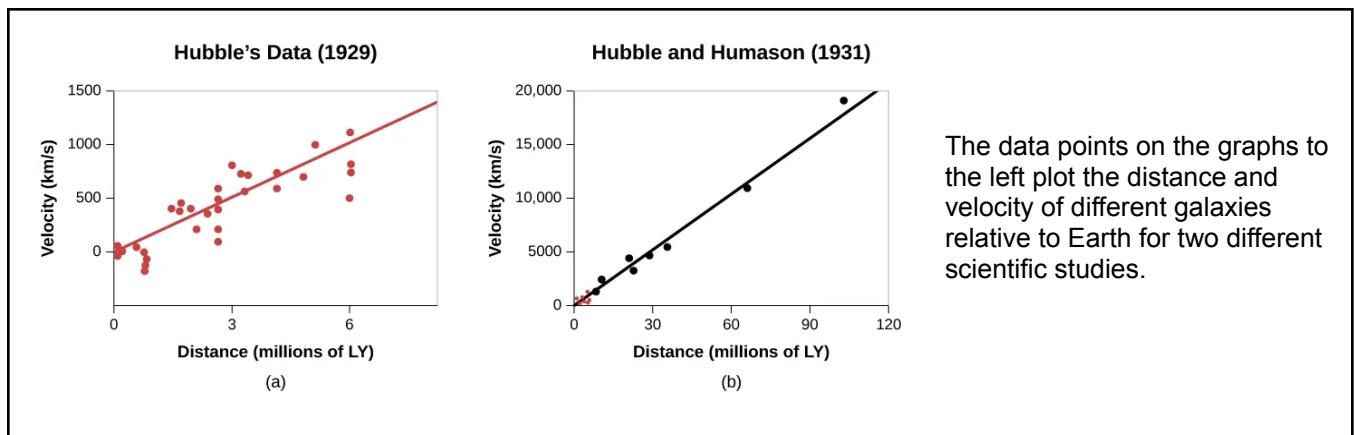
The diagram to the left shows the changes in size, matter distribution, and energy according to the Big Bang theory.

Reading 2: Redshifted Galaxies

The light we observe from galaxies is stretched by the time it reaches us. This stretches its wavelengths making it appear redder than it should - a phenomenon called redshift. Observations show that almost everything in the Universe is redshifted, moving apart like dots on an expanding balloon.

If you could wind time backwards, you would see galaxies moving closer together. If you could go back far enough, all the matter and energy in the Universe would be in one place.

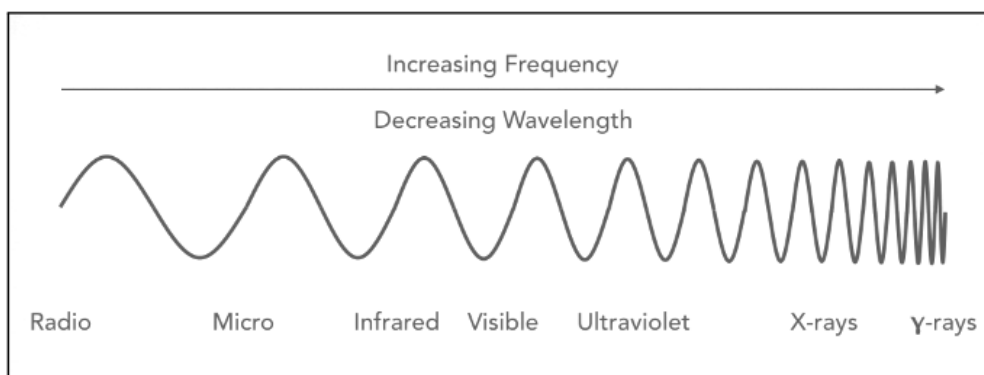
Figure 2: Redshift Data



Reading 3: Cosmic Microwave Background Radiation

Just after it formed 13.8 billion years ago, the whole Universe was very hot. As it grew in size, the infrared heat energy produced a "glow" which filled the entire Universe. This glow still exists, but the wavelengths of energy have stretched as the universe expanded. We now detect it in the microwave part of the electromagnetic spectrum and it is called the cosmic microwave background radiation.

Figure 3: The Electromagnetic Spectrum

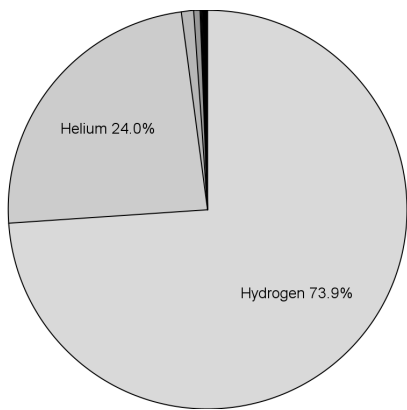


The diagram to the left shows the different wavelengths of the electromagnetic spectrum (light energy).

Reading 4: Elements

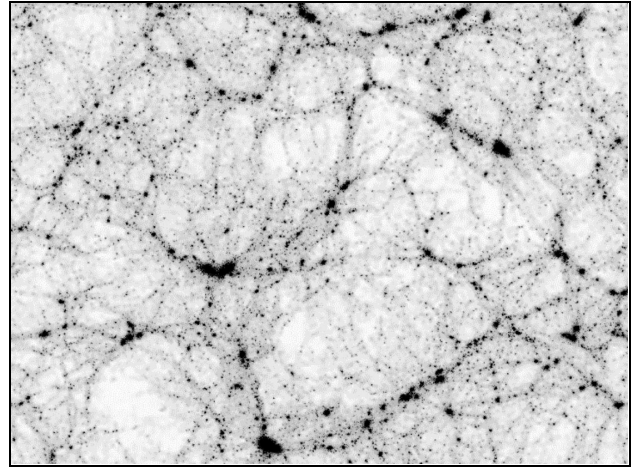
Using powerful telescopes, scientists have studied distant stars and galaxies to determine what the universe is made of. They have found that almost everything is hydrogen and helium. These simple elements were created soon after the universe formed and are the building blocks of all other elements. As hydrogen and helium were drawn together by gravity to form stars. Bigger, more complex elements were formed in the cores of the stars during their life cycles.

Figure 4: Abundance and Distribution of Elements in the Universe



The chart above shows the current observed percentages of different elements in the universe.

- Hydrogen 73.9%
- Helium 24.0%
- Oxygen 1.0%
- Carbon 0.5%
- Neon 0.1%
- Iron 0.1%
- Nitrogen 0.1%
- All Others 0.3%



The diagram above shows the current distribution of matter in the universe according to simulations.

1. Use Reading 1 and Figure 1 to **summarize** the Big Bang theory.

Summary:

2. Use Reading 2 and Figure 2 to **gather evidence** and **explain** how the abundance of redshifted galaxies supports the Big Bang theory.

Evidence:

Explanation:

3. Use Reading 3 and Figure 3 to **gather evidence** and **explain** how the presence of the cosmic microwave background radiation supports the Big Bang theory.

Evidence:

Explanation:

--

4. Use Reading 4 and Figure 4 to **gather evidence** and **explain** how the abundance and distribution of elements in the universe supports the Big Bang theory.

Evidence:
Explanation:

Reading 5

From NASA's Cosmic Times, 1955

Origin of Everything: Hot Bang or Ageless Universe?

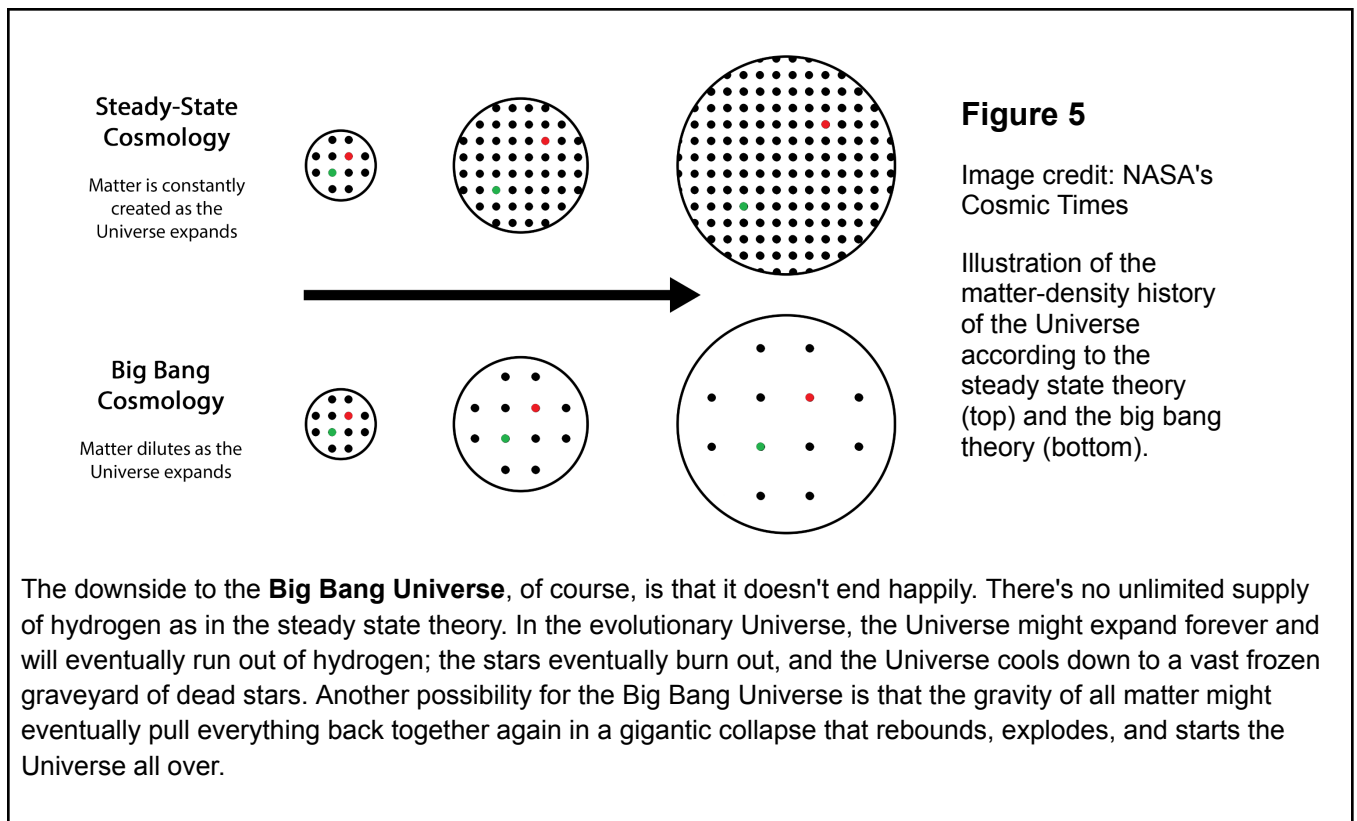
Has the Universe always existed similar to as it is today, or does it have a beginning, middle and an end?

The **steady state theory** says the Universe forever looks much like it does today; this "steady state" theory competes with the big bang theory of the Universe. The **big bang theory** claims an initial collection of hot particles expanded from a single tiny point at the dawn of time. These original particles formed all the Universe's hydrogen (and perhaps helium) in one gigantic event.

Both theories explain – in entirely different ways – the fact that the Universe is expanding. This expansion was first detected in 1914, when an astronomer surveyed some galaxies and noticed the light from all of them was "red-shifted."

In the **steady-state theory** the expansion comes from the spontaneous formation of matter. According to the theory, expansion is caused by the continuous bubbling up of the element hydrogen from empty space. This hydrogen eventually gathers and condenses into stars which then go through their life cycles.

In contrast, there is the **big bang theory** which says the expansion and radioactive decay of a hot ball of neutrons at the birth of the Universe created all hydrogen and some helium. These elements formed as matter cooled. The first stars were made of only this original hydrogen and helium and then went through their life cycles, died, and created new stars. The big bang theory also explains why galaxies are moving away from each other: they are all still affected by the power of the initial blast. It also explains the presence of cosmic background radiation.



5. Use the information from the previous questions and Reading 5 and Figure 5 above to **gather evidence** to help you answer the question, **make a claim** to answer the question, and **explain your reasoning**. Your explanation should include:

Why have modern scientists accepted the Big Bang theory to explain the formation of the universe and have discarded the Steady State theory? Your answer should include:

- A. The expansion of the universe over time.
- B. The composition of the universe.
- C. The energy (heat, light) of the universe.

Evidence:

Claim:

Explain Your Reasoning:

