Q1: What are the reasons for looking at the universe in infrared light?

**Answer:**

There are several reasons for using infrared light to study the universe. First, the universe is expanding, and light from distant objects is stretched as it travels across the vast distances of space. The visible light that left very distant stars is stretched so much that it is now infrared light, which is not visible to the human eye. Therefore, detecting infrared light will allow astronomers to analyze light from very distant stars.

Second, infrared light can pass through dust, allowing astronomers to see objects shrouded in dust. Stars are born in dusty regions, so looking through the dust gives astronomers a glimpse of how stars are born.

Third, most things in the universe give off infrared light, but not everything gives off visible light. Therefore, astronomers can use infrared telescopes to see objects that cannot be seen with visible-light observatories. Astronomers, for example, use infrared telescopes to study extrasolar planets to see how they form and whether they have an atmosphere that could support life.

Q2: What kinds of things can astronomers see with an infrared telescope?

**Answer:**

Student answers will vary, but they should include the following ideas:

- Astronomers will be able to see back to the early generations of stars and the very first galaxies to discover how they formed and if they are similar to or different from today’s stars and galaxies.

- Astronomers will see stars in the process of forming and learn about stellar evolution: how stars are born, live, and die.
Astronomers will study planets and the dusty material from which they form, as well as other cool objects that give off infrared, but not visible, light.

Astronomers will probe our own solar system’s distant outermost regions to learn about the Kuiper belt and Oort cloud, believed to be the repositories for leftover solar system building blocks.

Astronomers will study the planets in infrared light to learn about the features that are not apparent in visible light or are hidden behind the haze of dusty atmospheres, like that of Saturn’s moon Titan.

Astronomers will extend their learning to extrasolar planetary systems and will compare them to the planets in our solar system.

Q3:
If you could use the James Webb Space Telescope to observe anything in the universe, what would you like to observe and/or discover?

Answer:
Student answers will vary, but they may want to use the Webb telescope to look for the first galaxies, to study star birth and planet formation, or to look for other planets that might harbor life. There are also many discoveries to make in the area of stellar evolution, such as detecting “failed stars” (called brown dwarfs), and understanding star-forming regions in other galaxies. Students might also decide to use the telescope to look at any number of other objects not described in the reading.

Vocabulary words

Astronomer
A scientist who studies the universe and the celestial bodies residing in it, including their composition, history, location, and motion. Many of the scientists at the Space Telescope Science Institute are astronomers. Astronomers from all over the world use the Hubble Space Telescope.

Atmosphere
The layer of gases surrounding the surface of a planet, moon, or star.

Big Bang
A broadly accepted theory for the origin and evolution of our universe. The theory says that the observable universe started roughly 13.8 billion years ago from an extremely dense and incredibly hot initial state.
**Black hole**
A region of space containing a huge amount of mass compacted into an extremely small volume. A black hole’s gravitational influence is so strong that nothing, not even light, can escape its grasp. Swirling disks of material – called accretion disks – may surround black holes, and jets of matter may arise from their vicinity.

**Extrasolar planet**
A planet that orbits a star other than the sun.

**Galaxy**
A collection of stars, gas, and dust bound together by gravity. The smallest galaxies may contain only a few hundred thousand stars, while the largest galaxies have thousands of billions of stars. The Milky Way galaxy contains our solar system. Galaxies are classified or grouped by their shape. Round or oval galaxies are elliptical galaxies and those showing a pinwheel structure are spiral galaxies. All others are called irregular because they do not resemble elliptical or spiral galaxies.

**Giant planet**
A large planet with a small, rocky core and a deep atmosphere that is composed mostly of hydrogen and helium. Our solar system contains four giant planets: Jupiter, Saturn, Uranus, and Neptune. This group is also known as Jovian planets.

**Infrared (IR) light**
The part of the electromagnetic spectrum that has slightly lower energy than visible light but is not visible to the human eye. Just as there are low-pitched sounds that cannot be heard, there is low-energy light that cannot be seen. Some infrared light can be detected as the heat from a fire or a light bulb.

**James Webb Space Telescope (JWST)**
An orbiting telescope that will collect infrared light from celestial objects. JWST is the scientific successor to the Hubble Space Telescope. Unlike Hubble, JWST will be placed approximately 930,000 miles (1,500,000 kilometers) from Earth and cannot be serviced by astronauts.

**Kuiper belt**
A region in our outer solar system where many “short-period” comets originate. The orbits of short-period comets are less than 200 years. This region begins near Neptune’s orbit at 30 astronomical units (AU) and extends to about 50 AU away from the sun. An astronomical unit is the average distance between Earth and the sun. The Kuiper belt may have as many as 100 million comets.

**Near-infrared**
The region of the infrared spectrum that is closest to visible light. Near-infrared light has slightly longer wavelengths and slightly lower frequencies and energies than visible light.
**Supernova(e)**
The explosive death of a massive star whose energy output causes its expanding gases to glow brightly for weeks or months. A supernova remnant is the glowing, expanding gaseous remains of a supernova explosion.

**Wavelength**
The distance between two wave crests. Radio waves can have lengths of several feet; the wavelengths of X-rays are roughly the size of atoms.

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**Education Standards**

**Common Core Standards for English Language Arts**

**College and Career Readiness Anchor Standard for Reading**

**CCSS.ELA-Literacy.CCRA.R.10**
Read and comprehend complex literary and informational texts independently and proficiently.

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