Happy Anniversary, Hubble!

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LesPlan Educational Services Ltd. aims to help teachers develop students’ understanding of and ability to critically assess current issues and events by providing quality up-to-date, affordable, ready-to-use resources.

SUGGESTED APPROACH

WHAT IN THE WORLD? is a complete current events program that can be used on its own or to supplement an existing classroom routine. This classroom-ready resource offers ‘something for everyone’ and can be taught as a whole or in parts, in-class, or as a homework assignment.

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• IS EASY TO USE


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Look up, way up. On a clear night, the stars are spectacular. But with the naked eye, it’s not possible to see the details of our universe.

That’s why, in 1610, Italian astronomer Galileo constructed a telescope. Stargazers could now get a clearer view of objects in space. They discovered that the planet Saturn had rings, for example. Jupiter had moons. And the Milky Way was not a cloud, but rather a collection of countless stars.

Over the years, as telescopes became more technologically sophisticated, so did our understanding of space. However, there’s a problem with ground-based telescopes. The Earth’s atmosphere blurs their view of space. That’s true even for telescopes built on high mountain tops. The atmosphere is a fluid, chaotic soup of gas and dust, and it blocks certain wavelengths of light from reaching our world. (On a positive note, that shifting air makes the stars twinkle!)

The solution? Put the telescope in space, above the Earth’s atmosphere. An American astrophysicist first floated this idea in 1946. It was an outrageous suggestion at the time, as no one had even succeeded at launching a rocket into space.

But by 1975, the European Space Agency and NASA were drafting plans for this space telescope. And in April 1990, the Hubble Space Telescope hitched a ride aboard the Space Shuttle Discovery to low-Earth orbit. The school bus-sized observatory has been circling the globe ever since, 568 kilometres above our heads. It travels at about 27,000 kilometres per hour, completing one orbit in 97 minutes.

**How Hubble works**

Like any telescope, Hubble has a long tube that is open at one end to let in light, as well as mirrors to focus the light. Hubble’s primary mirror is 2.4 metres across. It needs to be large to collect as much light as possible so the telescope can see faint objects in space. Celestial objects emit light in a wide variety of wavelengths, from ultraviolet (UV) through visible to near infrared. Hubble can detect all these wavelengths. The incoming light bounces off the primary mirror to a secondary mirror and eventually to a focal point — Hubble’s “eye.” Scientific instruments turn the detected light into digital signals that are stored in onboard computers and transmitted to Earth. The digital data are then transformed into amazing images.

In some cases Hubble captures a quick ‘snapshot.’ In others, it stays focussed on a small area of apparently empty sky for days or weeks. This ‘deep field’ view allows scientists to probe the distant universe to unprecedented depths. It captures light coming from thousands of galaxies, including some of the farthest galaxies ever seen.

The deepest, widest view of the universe ever put together by Hubble took over 250 days of telescope time, and was stitched together from nearly 7500 individual exposures.

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**Definitions**

**Celestial**: of or relating to the sky

**Chaotic**: happening in a confused way and without any order

**Galaxy**: a collection of star systems; any of the billions of systems each having many stars and nebulae and dust

**NASA**: National Aeronautics and Space Administration – an independent agency of the U.S. government responsible for aviation and spaceflight

**Orbit**: the path taken by an object moving around a larger object in space

**Space Shuttle**: a partially reusable low Earth orbital spacecraft system that was operated from 1981 to 2011 by NASA
Out-of-this World Discoveries

Hubble casts its gaze both near and far. At the near end, it has revealed new details of our moon and the solar system around our Sun. But Hubble can see so much farther. It can detect faint light from galaxies trillions of kilometres away.

Because the distances in space are so vast, it takes this light a long time to reach Hubble. When it takes a picture of a galaxy 100 million light years away, it shows the galaxy as it looked 100 million years ago. Hubble is not only seeing through vast distances, it is seeing far back in time.

This is exciting because it gives astronomers a ringside seat to the evolution of galaxies and stars. We witness stars coming to life in the glowing gas of a nebula. We see galaxies spiral and collide with other galaxies.

Dying stars collapse inward, leaving behind dense neutron stars or black holes. Or they expand, puffing off their outer layers, creating a glowing gas cloud. Some explode in violent supernovas.

Thanks to Hubble, scientists have pinned down the age of the universe. It is about 13.8 billion years old. They’ve determined it contains at least 100 billion galaxies.

Another revelation? There are thousands of exoplanets orbiting other stars in space. Hubble has even been able to analyze the chemical composition surrounding these exoplanets, finding significant amounts of water vapour on a few of them. The data could be helpful in our search for extraterrestrial life.

The Dark Side

Black holes have always been a fascinating aspect of deep space, sucking in everything around them, including light. Thanks to Hubble, we not only know black holes exist, but also that supermassive black holes are common in the dense core of galaxies.

Then there’s dark matter. This mysterious material radiates no light, but its gravity holds individual galaxies and galaxy clusters together. Because dark matter also distorts light, scientists have been able to use the observed distortions to calculate where dark matter is hiding in the universe.

Perhaps the biggest surprise of all is dark energy. Hubble has revealed that our universe is expanding — and that this cosmic expansion is accelerating. Scientists had previously supposed that the universe would be slowing down after the initial Big Bang. But through Hubble’s observations of light from distant supernovas, astronomers have determined that distant galaxies are flying away from us at increasingly higher speeds. The universe is now expanding faster than it did billions of years ago.

The only way this makes sense is if there is some mysterious unknown force in space that works against gravity and contributes to this ongoing expansion. Scientists have dubbed this anti-gravity force “dark energy.”

Dark energy is estimated to make up 68 percent of everything (matter and energy) in the universe. The celestial objects that we can see, such as galaxies, make up a mere five percent. Dark matter accounts for the remaining 27 percent.

Did You Know?

NASA has two new telescopes in the works. One, the James Webb Space Telescope, is scheduled for launch in March 2021. The other, the Wide Field Infrared Survey Telescope (WFIRST), is targeted for the mid 2020s.

The View is Fine!

Hubble has cracked open a window to the wonders and enigmas of deep space. It has helped redefine our universe, tackling problems that had plagued astronomers for decades, as well as discovering new mysteries no one imagined. It’s quite a handy tool!

The telescope was designed to operate for at least 15 years. It is now celebrating its 30th anniversary, has captured over 1.4 million pictures, and is still going strong. During Hubble’s lifetime there have been five servicing missions, which have completely revamped and upgraded the observatory.

No more upgrades are planned, however. Hubble will just continue operating until… it doesn’t. Even in low-Earth orbit, Hubble experiences some atmospheric drag so without some intervention, it will eventually crash to Earth.

Until then, enjoy the light show.

Definitions

**Big Bang:** the cosmic explosion that is hypothesized to have marked the origin of the universe

**Black Hole:** a region of space resulting from the collapse of a star and that has an extremely high gravitational field

**Enigma:** something mysterious and difficult to understand

**Exoplanet:** a planet that orbits a star outside the solar system

**Nebula:** a very large cloud of dust and gas in outer space

**Neutron Star:** a dense celestial object that consists mainly of closely packed neutrons and that results from the collapse of a much larger star

**Supernova:** an exploding star that produces an extremely bright light
Answer the following in complete sentences:

1. What are telescopes used for? Who built the first space telescope?

2. What problem do ground-based telescopes have when observing space?

3. When did planning for a space-based telescope start? When was this telescope launched into space?

4. Explain how the Hubble telescope captures light emitted by distant objects.

5. How does Hubble turn this captured light into images?

6. Describe the range of the Hubble telescope.

7. Explain why some images from the Hubble telescope are reflections of the distant past.

8. What has Hubble revealed about the expansion of the universe? How is Dark Energy contributing to this expansion?

9. List at least three other important discoveries that Hubble has helped astronomers find.
BETWEEN THE LINES

An **inference** is a conclusion drawn from evidence. A **plausible inference** is supported by evidence in the article and is consistent with known facts outside of the article.

What inference(s) can you draw from the fact that NASA has two new telescopes, the James Webb Space Telescope and the Wide Field Infrared Survey Telescope, in the works?

JUST TALK ABOUT IT


2. As you see it, what is the importance of this story? Explain.

3. What reasons can you suggest to explain why many people are interested in astronomy? Are you curious about the universe? Why or why not?

ONLINE

Note: The links below are listed at www.lesplan.com/en/links for easy access.


2. Find out what the Hubble Telescope saw on your birthday. Enter the month and date to see images: https://www.nasa.gov/content/goddard/what-did-hubble-see-on-your-birthday

3. Read more about the Hubble Space Telescope and why it’s important at https://www.bbc.co.uk/newsround/52365257


6. Read an explanation of how the Hubble Space Telescope works at https://science.howstuffworks.com/hubble.htm ★
SCIENCE, TECHNOLOGY, AND THE ENVIRONMENT
THE HUBBLE TELESCOPE
– WINDOW INTO A HIDDEN UNIVERSE

ACROSS
2) huge cloud of dust and gas in space
4) _____ matter
6) gases that surround a planet or star
8) the Earth’s satellite
10) all of space and everything in it including stars, planets, galaxies, etc.
12) huge cosmic explosion (2)
14) Italian astronomer
16) NASA = _____ Aeronautics and Space Agency
17) exploding star that produces a very bright light

DOWN
1) black holes suck in everything, including _____
3) a planet that orbits a star outside our solar system
5) a scientist who studies space, stars, planets, and the universe
7) the universe is still _____
9) Space Shuttle that launched the Hubble telescope
11) something mysterious and hard to understand
13) a collection of star systems
15) Hubble’s primary _____ is 2.4 metres across

https://www.nasa.gov/content/hubble/grand-swirls-from-nasas-hubble
A. Write the letter that corresponds to the best answer on the line beside each question:

______ 1. Which 17th century astronomer constructed a telescope to observe objects in space?
   a) Copernicus  b) Hubble  c) Galileo  d) Kepler  e) Webb

______ 2. What blocks certain light wavelengths from reaching ground-based telescopes?
   a) the jet stream  b) air pollution  c) supernovas  d) the atmosphere  e) the wind

______ 3. When was the Hubble telescope launched into orbit?
   a) 1946  b) 1953  c) 1975  d) 1990  e) 2001

B. Mark the statements T (True) or F (False). If a statement is True, write one important fact to support it on the line below. If a statement is False, write the words that make it true on the line below.

______ 4. True or False? The Hubble telescope can observe objects well beyond our own galaxy.
   True

______ 5. True or False? Because distance in space is so vast, the Hubble telescope can capture images from the past.
   False

C. Fill in the blanks to complete each sentence.

7. Scientists calculate that the universe is about 13.8 ________________ years old.

8. Hubble confirmed the existence of ________________ which suck in everything around them, including light.

9. The Hubble telescope revealed that “dark energy” is causing the universe to ________________.

D. Respond to the following question in paragraph form. (Use a separate sheet of paper if necessary.)

As you see it, what is the significance of the Hubble space telescope? Give reasons to support your response.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
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Did you know...

. . . that each issue of *The Canadian Reader*, *What in the World?* and *Building Bridges* includes a PDF file (complete document) and a Word file (articles and questions only)

Students can complete assignments directly in the word file. Teachers can email the file to students or post it on the Internet. The Word file also allows teachers to:

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3) You can import the entire Word file into LibreOffice (or another similar program) and then save as a new file.

Google Docs and LibreOffice

- You can easily upload the Word file to Google Docs to share it with students or other teachers.

- You can translate Google Docs into another language (see Tools>Translate document) but you will need to edit the document to suit your requirements. Google Docs can translate into over 100 languages including Spanish, Mandarin, and German.

- LibreOffice is a free alternate to Microsoft Office and offers the same functionality. It’s easy to install and use.
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A. Eisler, Burnaby, BC

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B. Thibodeau, Saskatoon, SK

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D. Faerber, Pembroke, ON
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