Important Concepts . . .

Preview Review

Science *Grade 9*

W1 - Lesson 5: Optical and Radio Telescopes

V5-07

Important Concepts of Grade 9 Science

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W1 - Lesson 2 .....Electrical Circuits
W1 - Lesson 3A ..... Energy Consumption
W1 - Lesson 3B ..... The Distribution of Matter in Space
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W3 - Quiz

Materials Required

Textbook:
Science in Action 9

Science Grade 9
Version 5
Preview/Review W1 - Lesson 5

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The Alberta Distance Learning Centre has an Internet site that you may find useful. The address is as follows: **http://www.adlc.ca**

The use of the Internet is optional. Exploring the electronic information superhighway can be educational and entertaining. However, be aware that these computer networks are not censored. Students may unintentionally or purposely find articles on the Internet that may be offensive or inappropriate. As well, the sources of information are not always cited and the content may not be accurate. Therefore, students may wish to confirm facts with a second source.

Preview/Review Concepts for Grade Nine Science

W1 - Lesson 5:
Optical and Radio Telescopes

OUTLINE

By the end of this lesson, you should

- describe the electromagnetic spectrum
- understand the difference between reflecting and refracting telescopes
- explain what the Hubble Space Telescope is
- explain what a radio telescope is
- understand what a GPS is

GLOSSARY

electromagnetic spectrum - the complete range of wavelengths over which electromagnetic energy extends; includes gamma rays, X-rays, ultraviolet rays, visible light, infrared radiation, microwaves, and radio and television signals

interferometry - a technique of combining observations of two or more telescopes to produce images that have better resolution than produced by telescope alone

Hubble Space Telescope - one of the largest, most complex satellites ever built; launched in 1990 from the space shuttle *Discovery*, it uses a series of mirrors to focus light from extremely distant objects

W1 - Lesson 5: Optical and Radio Telescopes

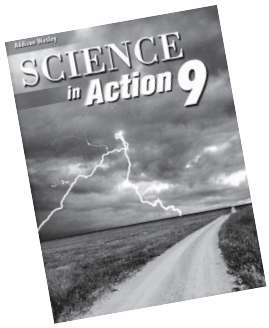
Have you ever wondered how we know that our galaxy "The Milky Way" is spiral shaped? Or how we know that the planet Saturn has rings surrounding it? This knowledge is due to the use of telescopes, or more specifically, optical and radio telescopes.

The Electromagnetic Spectrum

Earth receives many different kinds of information from space due to the presence of electromagnetic energy. **Electromagnetic energy** in space travels at the speed of light (300,000 km/s) and can be divided into gamma rays, X rays, ultraviolet rays, visible light, infrared radiation, microwaves, and radio and television signals. The different wavelengths of each of these types of energy make up the **electromagnetic spectrum.** Scientists use optical telescopes to view the visible light that is emitted from space. Radio telescopes identify the radio waves that come from space.

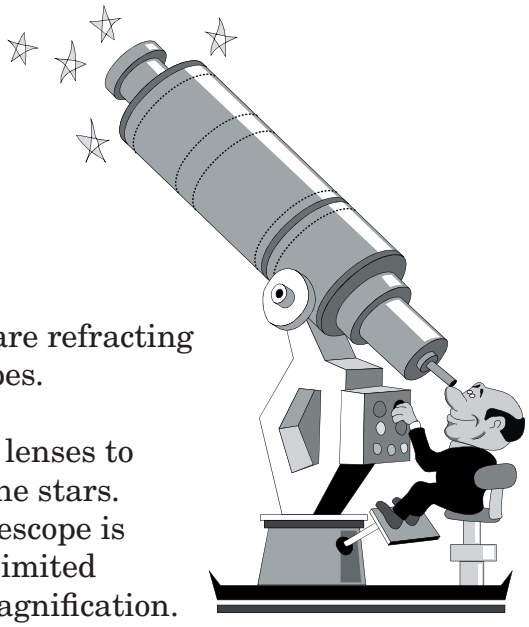
Read page 440 of *Science in Action 9*.

1. Explain the difference between frequency and wavelength of electromagnetic energy.



2. How do radio waves compare to visible light in terms of wavelength and frequency?

Optical Telescopes



Galileo viewed Saturn's rings with his version of a telescope in 1610. He could magnify an object 20 or 30 times. An **optical telescope** is a series of lenses and mirrors that are used to gather and focus light coming from the stars. Two main types of optical telescopes are refracting telescopes and reflecting telescopes.

Refracting telescopes use two lenses to collect and focus the light from the stars. The largest type of refracting telescope is about 1 meter in diameter. The limited size of this telescope limits its magnification.

Reflecting telescopes are made using concave mirrors that are coated with a metal such as aluminum to gather and focus light from objects in space. The largest reflecting telescope has a diameter of 6 metres. The mirror in this telescope is made by pouring molten glass into a large spinning mold. This process is called **spin casting**.

Another type of reflecting telescope is made of segmented mirrors that are combined to build one large mirror. An example of this is in the Mauna Kea observatory.

Multiple telescopes can be used together to improve the detail and viewing distance of images in space. This technique is called **interferometry.**

Read pages 436-437 of *Science in Action 9*.

3. Explain the basic difference between refracting and reflecting telescopes.

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4. How large can reflecting telescopes be made? What effect does this have on the observation of stars?

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5. Describe how the Keck I and Keck II telescopes in Mauna Kea (Hawaii) are designed to see the stars.

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6. A scientist wants to peer into space to try to identify a star in another galaxy. With which type of telescope should be used for the most success? Explain your answer.

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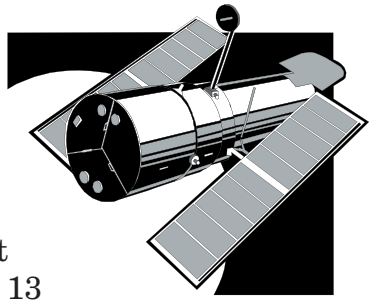
The Hubble Space Telescope



In the last fourteen years, scientists have been able to chart new galaxies using the **Hubble Space Telescope**. This telescope was launched in 1990 and orbits Earth as a satellite sending images it receives back to Earth. It is approximately 13 metres long with a diameter of 4.3 metres. It has a modular design so that pieces of the telescope can be replaced without interrupting the images being taken.

Read page 438 of *Science in Action 9*.

7. Outline the parts that make up the Hubble Space Telescope. Why is its modular design important?

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8. Explain why it is able to take better pictures of space than telescopes of a similar size found on the Earth.

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9. Does the Hubble Telescope take pictures 24 hours a day? Explain.

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10. Why is the Hubble Space Telescope considered a satellite? Explain.

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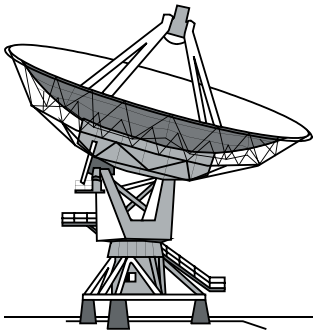
Radio Telescopes

Scientists are able to detect radio waves from space. Radio waves have low frequency and long wavelength compared to other types of electromagnetic energy. To detect these wavelengths, a **radio telescope** is used. Radio telescopes consist of large curved dishes of metal mesh that focus the wavelengths to a receiver in the middle. The receiver is then attached to a computer that is used to interpret the radio wavelengths.

Compared to optical telescopes, radio telescopes collect information twenty-four hours a day and are unaffected by the weather or pollution. Images from several small radio telescopes can also be combined to collect more detailed data. This technique is called **interferometry.**

Read pages 441-443 of *Science in Action 9*.

11. Identify one advantage and one disadvantage of using a radio telescope over an optical telescope.



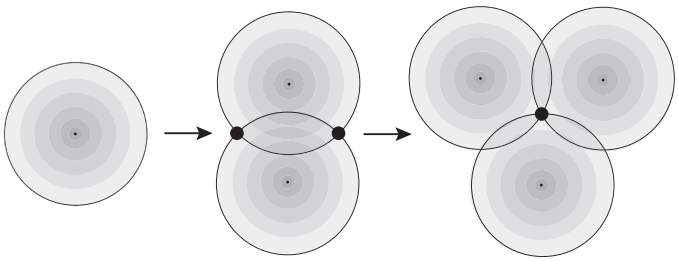
12. How large are radio telescopes in comparison to optical telescopes?

13. Give a specific example of radio interferometry.

Global Positioning Systems

Many new vehicles are equipped with **global positioning systems** (GPS). This system uses different satellites orbiting Earth to determine one's location on Earth. At any one time, three satellites are above you which determine your position. A GPS works by sending **radio signals** from the satellites to a hand-held receiver. A computer is attached to the receiver and completes the calculations to determine where you are located.

A receiver on Earth hears the radio signal sent by the satellite. This signal is sent in all directions by the satellite. We could imagine this by drawing one circle on a piece of paper. A second satellite sends another radio signal. We could then draw a second circle intersecting (or meeting) the first circle at **two points.** A third satellite sends out a radio signal. If we draw the third circle intersecting the other two, **one specific location** can be identified.



Read page 430 of *Science in Action 9*.

14. How many satellites orbiting the Earth are involved in a global positioning system?

15. Explain why three satellites are required to determine your position on Earth using a GPS.

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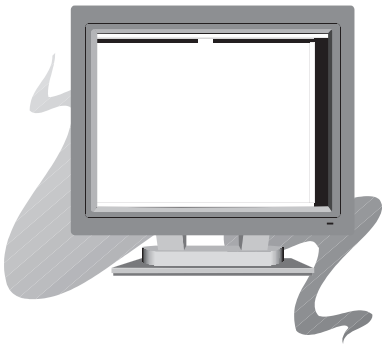
Internet Websites

The addresses for the websites below were valid at the time of printing.

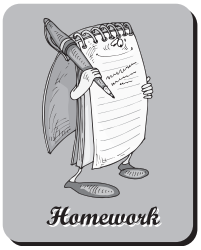
www.seds.org/billa/bigeyes.html

www.nrao.edu

www.howstuffworks.com/gps.htm



Now that you have completed this lesson, you should be able to explain the differences between optical telescopes, radio telescopes, and a global positioning system. Complete the following homework assignment.



Homework

16. Find a dark spot and view the night sky with your eyes. Describe what you see.

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17. Take an empty paper towel roll or toilet paper roll and look at the sky again. Describe what you see.

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18. How do your observations compare?

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