Important Concepts . . .

# Preview Review

*Science* *Grade 9* *TEACHER KEY*

## *W1 - Lesson 5: Optical and Radio Telescopes*

V5-07

## Important Concepts of Grade 9 Science

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W3 - Lesson 5 ..... Transfer of Materials through the Air, Ground, and Water/Biological Impacts of Hazardous Chemicals
W3 - Quiz

## Materials Required

Textbook:
*Science in Action 9*

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

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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

## *TEACHER KEY*

***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.

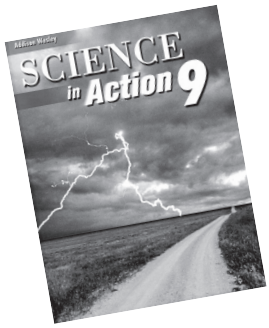
## The Electromagnetic Spectrum

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.

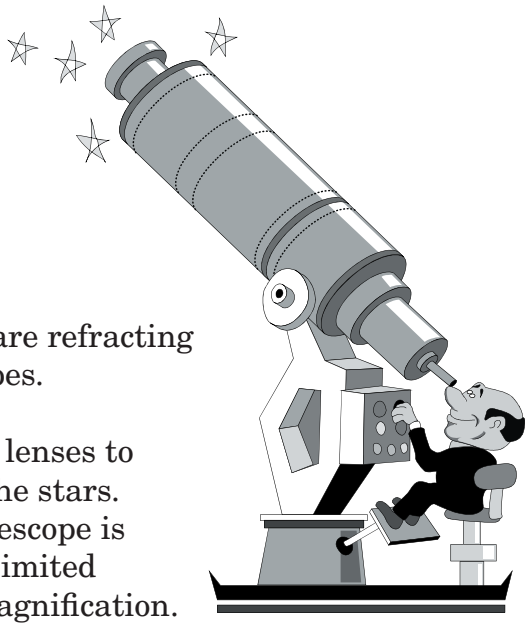
   ***Wavelength is a measurement of the distance from one point on a wave (such as a crest) to the same point on the next wave. Frequency is the count of the number of waves that pass a single point in one second.***




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

   ***The wavelength of radio waves is $10^6$ micrometers. They have a very low frequency. In comparison, the wavelength of visible light is 1 micrometer. Visible light has a higher frequency than radio waves.***

## 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.

***Refracting telescopes use two lenses to gather and focus starlight. Reflecting telescopes use mirrors to gather and focus the light.***

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

***The largest reflecting telescope is 6 meters in diameter. The larger the diameter of the mirror, the better a scientist can see (in terms of resolution).***

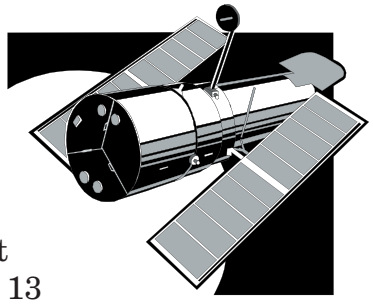
5. Describe how the Keck I and Keck II telescopes in Mauna Kea (Hawaii) are designed to see the stars.

***Keck I and II use several lightweight segments to build one large mirror. They are 10 meters in diameter and are each made of 36 hexagonal mirrors.***

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.

***A reflecting telescope with segmented mirrors allows a scientist to view the stars with the highest resolution. The larger the diameter, the better a scientist can see.***

## 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?

   ***The Hubble Telescope is made up of solar panels, a primary light gathering mirror, imaging electronics, and a sun shield. It is modular in design so that astronauts can replace pieces of the telescope without shutting the whole telescope down.***

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

   ***Light pollution, air pollution, clouds, humidity, and high winds can interfere with stargazing. There are no problems like these in space.***

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

   ***It runs 24 hours a day but it is involved in other activities such as turning the telescope or switching data transmission modes.***

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

    ***It orbits the Earth.***

## 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*.

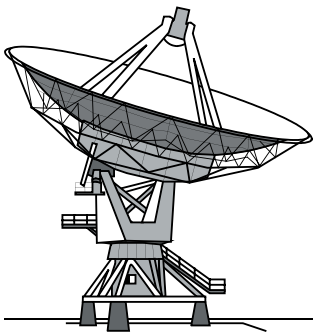
11. Identify one advantage and one disadvantage of using a radio telescope over an optical telescope.

***Advantage – Radio waves are not affected by the weather and can be detected day or night***

***Advantage – Radio waves are not distorted by clouds, pollution, or the atmosphere.***

***Disadvantage – Radio telescopes are very large in comparison to optical telescopes.***

***Disadvantage – Radio telescopes cannot be used to see visible light.***



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

***A radio telescope can have a diameter of 300 meters compared to six meters for an optical telescope.***

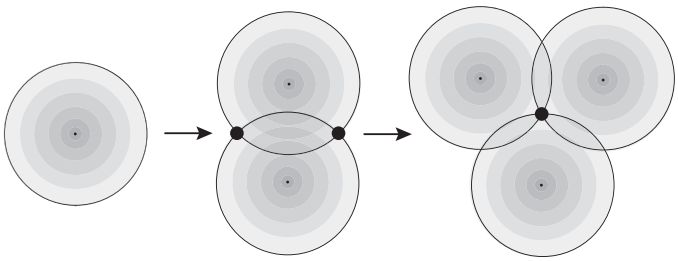
13. Give a specific example of radio interferometry.

***The very large Array in Socorro, New Mexico, uses twenty-seven 25m (in diameter) radio telescopes that are arranged in a Y pattern.***

## 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?

***24 satellites***

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

***Because the satellites send radio signals out in all directions, it takes three satellites to determine a person's position.***

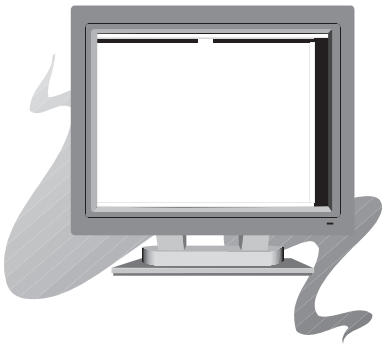
## Internet Websites

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

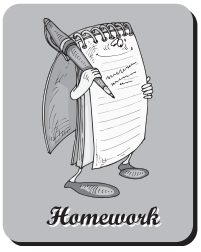
**www.seds.org/billa/bigeyes.html**

**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.

***Answers will vary.***

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

***Answers will vary.***

18. How do your observations compare?

***You should be able to see more clearly using the paper tube. The tube helps focus the starlight.***