Tools of Astronomy Notes

Light is a form of electromagnetic radiation. Scientists call the light you can see visible light. If you shine white light through a prism, the light spreads out to make a range of different colors with different wavelengths, called a spectrum. The electromagnetic spectrum includes the entire range of radio waves, microwaves infrared, visible light, ultraviolet radiation, X-rays, and gamma rays.

Telescopes are instruments that collect and focus light and other forms of electromagnetic radiation. A telescope that uses lenses or mirrors to collect and focus visible light is called an optical telescope. The two major types of optical telescopes are refracting telescopes and reflecting telescopes.

Telescopes used to detect radio waves from objects in space are called radio telescopes. Most radio telescopes have curved, reflecting surfaces. As with optical telescopes, the larger a radio telescope is, the more radio waves it can collect. Radio telescopes can be used day or night. They can also be used during cloudy weather because radio waves can pass through clouds.

Most ultraviolet radiation, X-rays, and gamma rays are blocked by Earth’s atmosphere. To detect these wavelengths, astronomers have placed the Hubble space telescope in space. Some space telescopes also detect visible light or infrared radiation. The Earth’s atmosphere interferes with these forms of radiation. By placing a telescope in space astronomers get a clearer picture of the universe.

Spectroscopes are another useful tool for astronomers. A spectroscope breaks the light from a star into a spectrum. Each element has a unique spectrum. This allows astronomers to compare the spectrum of a star to known elements. Using this technique, called spectral analysis, astronomers can determine what a star made of is without going there.
Understanding Telescopes

Background
Most of the universe is invisible to us because we only see the visible light portion of the electromagnetic spectrum. In other words, when you look at a planet, let’s say Mars, through most telescopes you are only seeing the portion of the spectrum that can be made visible by special cells in the human eye. We call these types of telescopes optical telescopes since they only collect visible energy. However, there are other ways to “see” the universe.

There are two basic types of optical telescopes, refractors and reflectors.

**Refracting telescopes** (lenses) use lenses to gather and bend light making things seem larger. The lenses used in refracting telescopes are called concave and convex. Convex lenses make light bend inward. Concave lenses bend light outward. The combination of these two lenses makes things seem bigger and clearer.

**Reflecting telescopes** (mirrors) use mirrors and lenses to collect and magnify light. With a reflecting telescope, light is collected by a big concave mirror. Concave mirrors focus light inward. The mirror reflects light to a smaller flat mirror. This secondary mirror directs the light through the eyepiece lens at the side of the telescope. The eyepiece magnifies the image and directs it to your eye.

We have seen how visible light is used in optical telescopes. Visible light, however, is only a small part of the electromagnetic spectrum. In recent years the remainder of the electromagnetic spectrum has revealed extensive information about our Universe. One non-visual light wave used extensively for astronomical observations is the radio frequency band. Telescopes observing at these wavelengths are commonly called radio telescopes. Although they do not look like optical telescopes, radio telescopes are built to accomplish the same gathering and focusing tasks that optical telescopes perform on visible light.

Radio Telescope
A **radio telescope** typically consists of a **parabolic** (bowl-shaped) antenna similar to a modern satellite dish. This dish collects incoming **radio or microwave** radiation and focuses it onto a sensitive receiver located behind or below the antenna. Inside the receiver, the incoming waves are converted into electrical signals. Computers then process those signals to form images of the sky as it would look if our eyes were able to see at radio or microwave frequencies.

**Radio telescopes** have some clear advantages over optical telescopes. Radio telescopes can be used both day and night. They can also be used on cloudy days, because radio waves can pass through clouds. Over the last half-century, radio astronomers have used radio telescopes to make important discoveries. By studying the sky with both radio and optical telescopes, astronomers gain a much more complete understanding of the universe.

The **Hubble Space Telescope** (HST) is a NASA telescope which was launched in **1990** into a low-Earth orbit 600 km above the ground. During its lifetime Hubble has become one of the most important science projects ever. Hubble's orbit above the Earth's atmosphere allows astronomers to see **very clear images of space**. The advantage of using a telescope in space is that you don't have to look through the Earth's atmosphere. It is a real advantage to get above the atmosphere. Hubble Space Telescope pictures are much more detailed than you can get from the ground. Hubble can also access the **ultraviolet and infrared** parts of the spectrum **not visible** from the ground.

**The diagrams below show how light is bent by lenses and mirrors. This information will be used in **part two** of the answer sheet.**

![Diagram of light bending through lenses and mirrors.](image-url)
Understanding Telescopes
Answer Sheet

Part One Questions:

1. What are the two main types of optical telescopes?
   a. __________________________
   b. __________________________

2. Which type of telescope only uses lenses to focus the light?
   ____________________________________

3. Which type of telescope uses both lenses and mirrors to focus the light?
   _________________________________

4. What type of light does a radio telescope use to study the universe?
   _________________________________

5. What are the advantages that a radio telescope has over optical telescopes?
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   ____________________________________
   ____________________________________
   ____________________________________

6. What is the Hubble Space Telescope (HST)?
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   ____________________________________
   ____________________________________

7. What are the advantages that the HST has over Earth based telescopes?
   ____________________________________
   ____________________________________
   ____________________________________
   ____________________________________
Part Two Questions:
The diagrams below show a variety of reflecting and refracting telescope designs. Refer to the diagrams of how mirrors and lenses bend light to determine how light travels through each telescope. Follow the light from where it enters the telescope to the eyepiece. Use a ruler to draw straight lines.

8.

9.

10.

11.