E3 Describe and interpret the science of optical and radio telescopes, space probes and remote sensing technologies

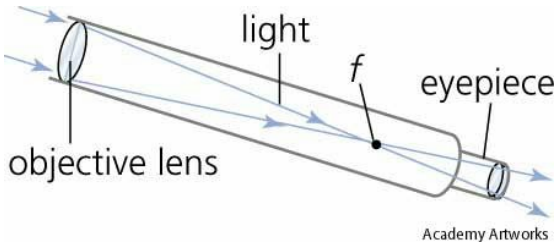
E3.1 explain, in general terms, the operation of optical telescopes, including telescopes that are positioned in space environments

Optical Telescopes

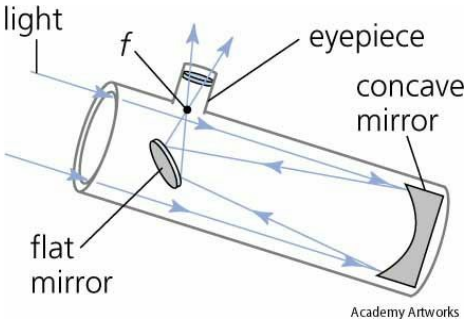
A telescope is a device that allows distant objects to be seen as if they are much closer and brighter. Telescopes are used to observe celestial objects.

Most telescopes work by collecting and magnifying the visible light that is given off by stars or reflected from the surface of planets. These telescopes use light and are called **optical telescopes**. There are two main types of optical telescopes: refracting and reflecting telescopes.

Refracting telescopes use convex lenses to collect light from distant object and focus it so it can be seen clearly. The first telescope ever invented was a refracting telescope.



Reflecting telescopes use curved mirrors to bring reflected light waves to a focal point in order to view distant objects.



Optical interferometry is a technique that uses several telescopes to improve the resolution of images. In this technique, signals from telescopes in separate locations are combined. Optical interferometers are useful for making relatively bright, closely paired objects visible.

The **Hubble Space Telescope** (HST) is named after American astronomer Edwin P. Hubble. It was launched on April 24, 1990, and orbits about 600 km above Earth. In the Hubble telescope, a series of mirrors are used to focus light from very distant objects. The telescope is 4.3 m in diameter and 13 m in length. In July 1994, HST provided astronomers with the first convincing evidence of the existence of black holes. It also provided amazing images of Jupiter when the comet Shoemaker Levy 9 impacted the planet July 1994. These images have helped scientists obtain data for spectral analysis of Jupiter's atmosphere.

E3.2 explain the role of radio and optical telescopes in determining characteristics of stars and star systems

Radio Telescopes

A **radio telescope** consists of a radio receiver and an antenna system that is used to detect radio frequency radiation. Radio wavelengths are longer than those of visible light, so radio telescopes have to be very large to attain the resolution of optical telescopes.

An advantage of radio telescope is that they use radio waves not visible light waves. Radio waves are not as easily distorted as light waves, and they are detectable at any time of day. Radio waves can detect objects that do not emit visible light. These telescopes can also be combined in **radio interferometry** to produce high resolution images. A group of many telescopes are called an **array**.

Optical and radio telescopes provide information about the objects in space.

E3.3 describe and interpret, in general terms, the technologies used in global positioning systems and in remote sensing (e.g., use triangulation to determine the position of an object, given information on the distance from three different points) [Note: This example involves the use of geometric approaches rather than mathematical calculations.]

Satellite Technologies

The **Global Positioning System** (GPS) is a space-based navigation system. It consists of 24 satellites that are orbiting Earth. At any point in time, three satellites are above a certain area and can relay information about the relative position of a receiver on Earth. Information collected from the three satellites is processed using triangulation.

Remote sensing is another technology involving satellites. Satellites orbiting relatively near Earth use sensors to measure the amount of energy, reflected from Earth's surface. This data provides information about the environment and can show changes that occurred on Earth's surface.