Date: _____ Name: _____

[SOLUTIONS]

Class: _____

Module 1: The Observatory

Allan I. Carswell Observatory at York University is a powerful tool that helps us explore the universe from right here on Earth. Using advanced telescopes and imaging technology, it allows astronomers to capture stunning images of planets, stars, and distant galaxies. In this module, we'll dive into how the observatory works, how it collects and processes images, and why observatories are essential for understanding our universe. We'll also discuss important topics like light pollution, telescope technology, and the challenges of space observation. Get ready to see space like never before!

The Allan I. Carswell Observatory

The Allan I. Carswell Observatory at York University in Toronto houses Canada's largest on-campus telescope, featuring a 1-meter primary mirror. This telescope uses a reflecting design, where light from celestial objects enters the telescope and hits a large curved mirror at the back. This mirror reflects and focuses the light toward a smaller mirror called the secondary, which then directs it to cameras or eyepieces for observation. This is the Cassegrain Reflector setup which allows astronomers to capture more light and create clear images of distant stars and galaxies. The amount of light we gather determines what we can see!

Reflecting telescopes are preferred over refracting telescopes because mirrors can be made larger than lenses, enabling them to gather more light and provide detailed views of the universe. Historically refracting telescopes were easier to make, so many early telescopes followed that model. However, they are more expensive (for the same light gathering power), less compact, and introduce errors in the image like chromatic aberration.

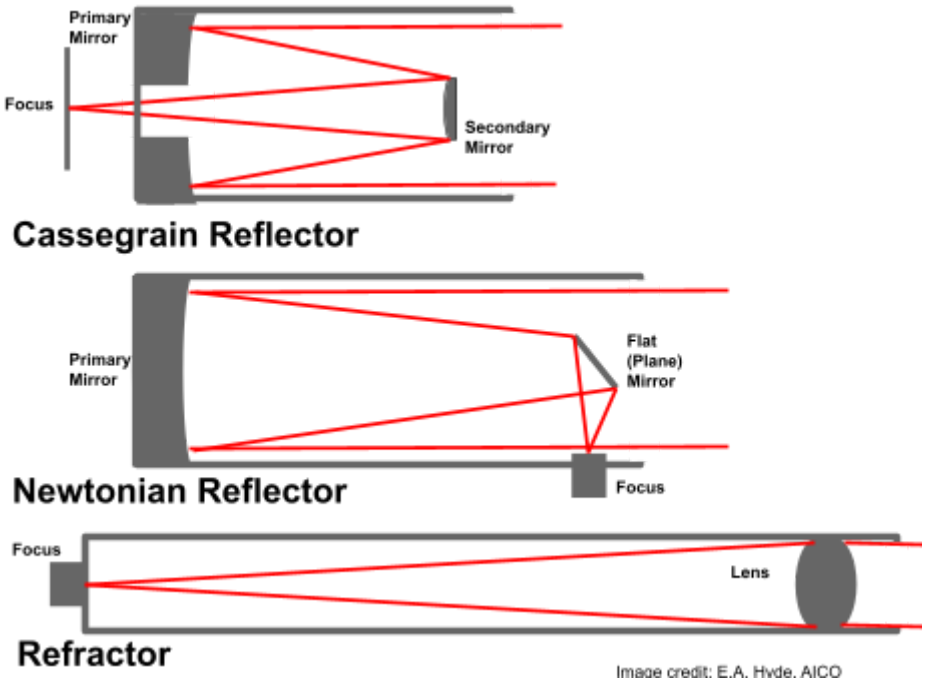

Image credit: E.A. Hyde, AICO

Reflecting vs Refracting Telescopes:

The Carswell Observatory currently houses 3 large telescopes, they are all Cassegrain reflecting types of telescopes:

1. 40 cm
2. 60 cm
3. 1 meter (The largest on campus telescope anywhere in Canada, as of 2025).

Date: _____ Name: _____

Class: _____

Videos to watch for this worksheet:
Allan I. Carswell Observatory: https://youtu.be/1_pDNk0NSNI?si=rLwk1C5dMQRo1l5q
How observatories and telescopes work: https://youtu.be/5v7bN13PjZ8?si=C7jc_L53bZPqmcX1

Short Answer Questions

1. Why is there a limit to what we can see with the naked eye, and how do telescopes help overcome this limitation?

The human eye can only collect a limited amount of light, restricting the ability to see distant and faint objects. Telescopes gather and focus more light, allowing astronomers to observe objects in greater detail and at much farther distances.

2. What is the main difference between a refracting telescope and a reflecting telescope in how they gather and focus light?

A refracting telescope uses lenses to bend (refract) and focus light, whereas a reflecting telescope uses mirrors to collect and direct light. Reflecting telescopes are preferred in large observatories because they can be built larger without the issues associated with lenses, such as chromatic aberration.

3. Why do larger refracting telescopes struggle with light loss, and how does the design of reflecting telescopes solve this problem?

Larger refracting telescopes experience light loss because thicker lenses absorb and scatter light. They also suffer from chromatic aberration, where different wavelengths of light bend at different angles. Reflecting telescopes avoid these issues by using mirrors, which do not absorb light and can be constructed in larger sizes, able to gather more light.

Date: _____ Name: _____

Class: _____

4. What is atmospheric distortion, and how do astronomers try to minimize its effects when using ground-based telescopes?

Atmospheric distortion occurs when turbulence in Earth's atmosphere causes light from stars to shift and blur. Astronomers reduce this effect by placing telescopes on high-altitude locations with stable air, using adaptive optics to correct distortions in real time, or deploying telescopes in space to bypass the atmosphere entirely.

5. Why are telescopes like the Hubble Space Telescope placed in space rather than on Earth, and what advantage does this give them?

Space telescopes avoid the effects of atmospheric distortion and light pollution, allowing them to capture more explicit images. They can also detect wavelengths like ultraviolet and X-rays absorbed by Earth's atmosphere, allowing us to see light that never reaches the ground.

Multiple Choice

1. Why do stars appear to twinkle when viewed from Earth?

A. They are constantly changing brightness
B. Earth's atmosphere distorts the light coming from stars
C. The stars are moving rapidly in space
D. Light from the Sun interferes with their brightness

Date: _____ Name: _____

Class: _____

Multiple Choice cont.

2. What is the main function of the objective lens or mirror in a telescope?

A. To invert the image
B. To bend the light towards the eyepiece
C. To gather and focus light
D. To color-correct the image

3. Why are most research telescopes placed on mountaintops?

A. To be closer to the stars
B. To reduce the effects of atmospheric distortion
C. Because the air is colder and helps with imaging
D. To prevent interference from earthquakes

4. Which of the following is an advantage of space telescopes like Hubble?

A. They are closer to the stars
B. They avoid the distortions caused by Earth's atmosphere
C. They are easier to repair and maintain
D. They can zoom in more than ground-based telescopes

5. Why is it easier to make a large mirror than a large lens for telescopes?

A. Mirrors are lighter and do not need to be perfectly shaped
B. Large lenses tend to lose light and are harder to support
C. Glass for mirrors is cheaper than glass for lenses
D. Lenses break more easily than mirrors

Date: _____ Name: _____

Class: _____

True or False

Answer the following True and False questions. If you answer False explain your reasoning and correct the False statement.

1. True or False: The first telescope was a reflecting telescope that used mirrors.

_____

FALSE: early telescopes were lens based refractors as they were easier to manufacture

2. True or False: A concave mirror is used in reflecting telescopes to collect light.

_____

TRUE

3. True or False: The larger the objective lens or mirror, the more light a telescope can collect.

_____

TRUE

4. True or False: All telescopes are affected by Earth's atmosphere, no matter where they are placed.

_____

FALSE: Space telescopes are not affected by Earth’s atmosphere

5. True or False: The Hubble Space Telescope orbits the Moon to get a clearer view of space.

_____

FALSE: Hubble orbits Earth, not the Moon.