OBJECTIVE 1: **Students can identify the parts of a telescope and their individual functions.**	**ASSESSMENT:** **Questioning throughout, end quiz.**
OBJECTIVE 2: **Students can describe how telescopes collect and magnify light to create an image.**	**ASSESSMENT:** **Questioning throughout, end quiz.**
OBJECTIVE 3: **Students can explain that when they look at a star, they are seeing an image of the star in the past.**	**ASSESSMENT:** **Questioning throughout, end quiz.**

Academic Standards:

NGSS PS4.B (Strand 5) A great deal of light travels to earth from the sun and distant starts; **(Strand 8)**When light shines on an object, it can be reflected, absorbed, or transmitted

Lesson Materials:

- Hand Lenses (one per student)
- Telescope kits (one per group or student, depending on number of students)
- Lamp or filament
- Various sized pictures of galactic objects
- PowerPoint (optional)

Preparation:

- **Prepare equipment table with dissection materials**

Procedure and Planning:

Introduction:

1. Explain rules/parameters for the session (ex. saying “freeze,” stations (if necessary), “eyes on me,” etc.)
2. Questions: Who knows what we’re learning about today? How much do you know about telescopes? Can anyone explain exactly how telescopes make things that are so far away appear to be closer/bigger? What kinds of things can we see with them? Today we’ll be exploring these questions - but in order to really understand it, we’ll have to start with lenses.
3. Have students divide into groups of 2-3. Each group should select an equipment manager - this will be the only person to come up and grab materials.

Body of Lesson:

4. Have each student group collect hand lenses and a piece of paper. Ask "what kinds of things can you do with magnifying glass?" Record answers in front of the group if possible.
5. Ask the kids to see how close to something they have to be to make it look bigger. Give them a few minutes to play with magnifying glasses and ask them to try to figure out the maximum distance from something they can get and still make it look bigger.
6. Ask what happens if they view an object through the magnifying glass from too far away. The students should notice that it creates a flipped image (turning it upside down), but doesn't really make things look bigger. Ask some of the following questions: "Using what you just figured out, why can't we use one magnifying glass to make the stars look bigger?"
7. Demonstrate the lens' ability to make an image by turning off most of the lights and lighting a filament or lamp. Have the students play with the magnifying glass and figure out exactly how far of a distance it takes to create an image on a piece of paper. Explain that what they are doing demonstrates one part of the telescope, asking which part they think it might be. (The answer is that it demonstrates the front lens, which collects light and creates a flipped image.) This is called the **objective lens** as it creates an image, or object. This lens actually bends - or **refracts** - light.
8. Ask students what they think would happen if they didn't have a second lens. Do they think that the telescope would work? Why or why not? Have them try to make the image on the piece of paper and put their eye directly behind the image. Have them remove the paper and ask them what they see. Is it a larger image?
9. Have the students summarize what the first lens does one last time by drawing it in front of the class (if possible). Also have them draw it on their handout. The first lens creates a flipped image - its main purpose is to collect lots of light, like star light, which is why the first lens is large. Have them use the words "objective lens" here to practice the vocabulary.
10. Ask them how they could make the image bigger. If they have trouble coming up with the answer, remind them to think about how the magnifying glasses made close objects appear larger. Through questioning (and if necessary, through explanation) have students arrive at the conclusion that the second lens in a telescope magnifies the image that the first lens creates. This lens is called the **eye piece**, and is called this because it is where the image is prepared and magnified for the eye.
11. Build a telescope in front of the students, explaining the process. Be sure to place an emphasis on carefully handling lenses. To avoid smudge marks, students should use plastic, polishing cloth, or a powder-free glove.
12. Allow students to build their own telescopes. Again, emphasize the amount of care necessary to handle lenses.
13. Have students work with the telescope to figure out how to adjust it for different lengths. Ask (just to have students explain to each other) what the relationship is between the length of the two lenses from each other and how far away an object is.
14. Practice: Explain to students that there are a few objects throughout the room that they can only spot with their telescopes. The first student to find all objects or the students to find the most objects in the time limit get an "Annie and the Voorwerp" comic.

Body of Lesson(cont.)

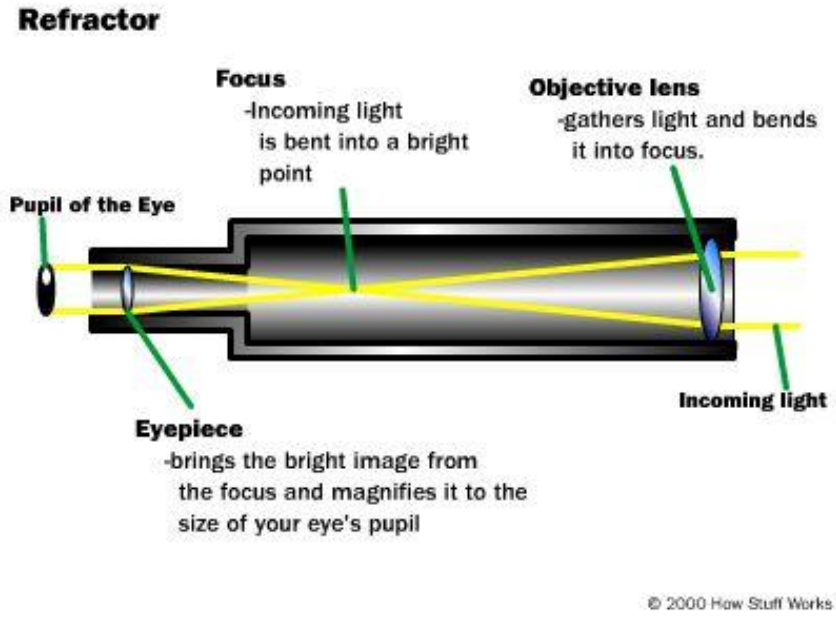
15. Ask students if they know what the pictures are by presenting them with larger images. Explain that because so much light is needed for it to work well, most of our telescopes on earth can't see the farthest things (partially due to the atmosphere, humidity, etc.). The ones that we do have on earth that can see far (like the Twin Keck) are extremely large. Explain which images we can see using a standard telescope (the moon, Jupiter and four of its moons, Saturn, and various stars).
16. Time permitting, work through examples of speed of light (it takes 8 minutes for our sun's light to get to us, it would take 1.3 seconds for a beam of light to reach the moon from the earth). The actual speed in English units is 186000 miles a second or 700 million miles an hour. Ask students what they think a light year means (the distance that light travels in one year). Ask what they think it means to look at a star that is 4 light years away (the image we see is 4 years old). Ask what they think it means to look at stars 100,000 light years away (the image is 100,000 years old). Explain that this is how scientists make suggestions about the universe and how it is expanding and has developed - they can literally see into the past!

Closure:

- **Quiz:** Have students answer the following questions. Correct answers receive space erasers, comics, and astronaut ice cream.
    1. What does the first lens in a telescope do?
    2. What does the second lens do?
    3. Overall, how does a telescope work?
    4. If you push the eyepiece closer to the objective lens, would you be focusing on an object that is closer or farther away?

(If applicable) When we look into the night sky, are we seeing stars as they exist right at this second? Explain.

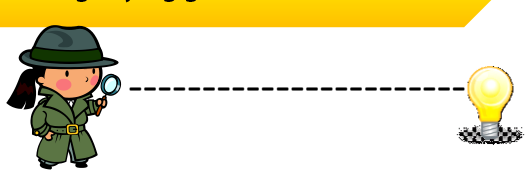
Teacher Reference - How a telescope works:



Using Lenses

When the small lens is closer to something, how does the image it makes change as you move it toward and away from the object?

When the small lens is very far away from something, you can move it back and forth to focus until it creates a picture of it. What do you notice about the picture the magnifying glass creates?



Follow the same steps with a large lens. How is it different from the small lens?

This is how a telescope works: (Draw how a telescope works below and label each part)

Scavenger Hunt:

When you have found all of the items in this hunt, list where they are and what you think that they are.

Number	Where did you find it?	Describe two features of what you found. If you can, make a guess about what it is.
1		
2		
3		
4		
5		

The speed of light: 299,792,458 meters/second which is 186,000 miles per second or 700,000,000 miles per hour!

How old is the light that we see from the sun?

What about from a star that is 4 light years away?

Quiz: I hope you were paying attention!!!