TELESCOPE

Building a Telescope

Materials:

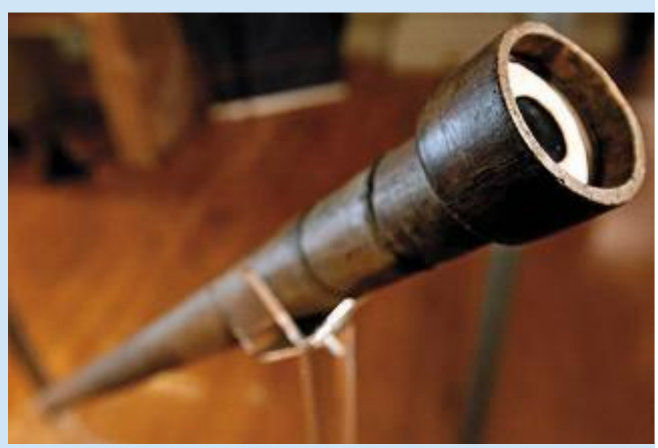
- Cardboard Telescoping Mailing Tube
- Corrugated cardboard (for the outer tube)
- Concave Convex Lens
- Plano Concave Lens

Reference: Building a Telescope Guide (PDF)
https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Building_a_Telescope.html
http://galileo.rice.edu/lib/student_work/astronomy96/mtelescope.html

http://galileo.rice.edu/lib/student_work/astronomy95/ .html

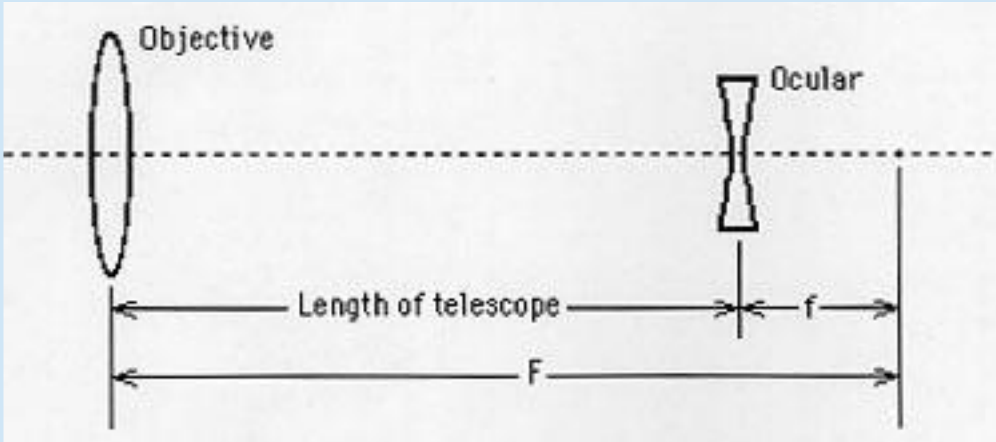
Discuss with participants:
Why do the characters need a telescope?

Instructions:



Traditionally this is what you would do (see links above): follow the instructions. What we discussed in the training is to give the participants an opportunity to play with the set of lenses (with foil and the tubes they can align them), so they discover the properties of lenses and light and figure out which ones they need for doing a Galilean telescope. For advanced participants (high school and some middle school) the guidance should be minimal. For younger participants, the guidance is to allow for exploration of the lenses to form images and learn about focal length, before the instructor aids the creation of the telescope.

What is a Galilean telescope?
A Galilean telescope is defined as having one convex lens and one concave lens. The concave lens serves as the ocular lens, or the eyepiece, while the convex lens serves as the objective. The lens are situated on either side of a tube such that the focal point of the ocular lens is the same as the focal point for the objective lens.



Explore other options:

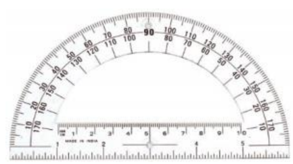
http://www.telescopenerd.com/make-a-telescope/how-to-make-a-telescope.htm

Use the telescope to observe objects around the classroom and outside if time allows. Record observations and compile your knowledge of all observation from all 3 measurements tools you have built.

Using a Telescope

Materials:

- Telescope
- Aluminium foil
- Flashlight
- Tape Measure
- iPads, cellphone or camera (optional)
- Protractor
- Piece of string about 3 feet (1 meter) long
- Large, rectangular table (at least 4 feet [1.3 meters] wide and 2 feet [2/3 meter] deep) with a chair
- Scissors
- Paper
- Markers
- Masking tape









References:
http://mo-www.cfa.harvard.edu/OWN/pdf/eyeScopeT.pdf
https://www.exploratorium.edu/snacks/peripheral-vision

Instructions:

Sharpness of Vision

How sharp is your vision, and how does this compare with the telescope's? Here is a good way to estimate your eye's sharpness of vision.

1. Explain to students that they can estimate their sharpness of vision by seeing how close they must be to just make out two pinpoints of light side-by-side.
2. Prepare the experiment: Punch two pinholes through a square of aluminum foil, about 1/8 inch apart. Place the foil over the flashlight. You should be able to clearly see light coming through both pinholes.
3. While you hold the flashlight, have students stand as far as possible from the flashlight—e.g., at the other end of a corridor—and then have them move towards the light until they can just make out that there are two points of light side by side, rather than one point of light. This is the distance at which they can just resolve the two objects. Students will differ in their sharpness of vision, so some students will be further and some closer to the flashlight.
4. Have students estimate their distance from the flashlight. They can pace off the distance, e.g., using the estimate that the length of their foot is about one foot. Have them record their estimates on the DATA PAGE in their science journals.

NOTE: If you don't have enough room to do this activity, you can make the pinholes closer together, though this is harder to do!

Observe and take notes:
Students will just be able to distinguish ("resolve") the two points of light that are 1/8" apart, from approximately 35 feet away.
By contrast, the telescope can resolve two points of light that are 1/8" apart, from about ____ feet—which is_____ times further away.
We say that the telescope has____ times better sharpness of vision, or equivalently, ____ times better resolution than the human eye. Thus the telescope transports us the equivalent of ____ times closer to the scene we are observing. This is not a huge difference. For now, merely note the comparison. In the wrap-up discussion we'll examine what it means.

Misconception alert: Many students want to know how much the telescope "magnifies." Astronomers don't use the term magnification because it is misleading. For one thing, the magnification you see depends not just on the telescope but on how you display the image—e.g., on a large screen, on a small monitor, etc. Furthermore, a telescope could in principle magnify a scene enormously, yet if the image is blurry, the magnification won't help you see anything. Astronomers prefer to use the term "angular resolution,"

Field of View

Now it's the humans turn to excel. For this experiment, students work in pairs. Each student tries the following:

1. Position yourself so you are centered on the long (wide) side of a table. Mark a point with tape about 2 feet [2/3 meter] in front of you at the far edge of the table. This will be your tabletop protractor's vertex.
2. Using your outstretched arm, a piece of string, and your standard-sized protractor as a guide, create a large-scale tabletop protractor by marking the angles every 10

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degrees with small pieces of tape. Label the piece of tape at the vertex "0 degrees" (on a standard protractor, this would be marked 90 degrees). On either side of this mark, label your tape in ascending 10-degree increments up to 90 degrees on both the left and right.

3. With your left arm level and outstretched, SLOWLY bring your arm from behind your head into your field of view, while wiggling your thumb. Make sure you keep your eyes straight ahead; don't look to the left or right. When you can JUST see that your thumb is wiggling, stop moving your arm and have your partner measure the angle your arm makes with the straightahead direction. (Use the large-scale tabletop protractor.)
4. 2. Do the same with your right arm. The total angle, from left to right, where you can see an object, is your field of view.
5. Have students record this angle on their notepads. Have students compare their eye's field of view, which is close to 150 degrees, with that of the telescope, which is only _____ degrees for the "telescope" and about _____ degrees for their ___________ (e.g. "iPad's camera").
6. Cut out a small piece of paper and add a black dot somewhere on it. The dot is merely a visual target and will be what your partner will stare at during the experiment.
7. Use colored marking pens to draw simple shapes such as a rectangle, square, or triangle on a small piece of paper. Each shape should be slightly more than 1 inch (2.5 cm) in width and height.
8. In large capitals, in the middle of each shape, write a three- or four-letter word (such as DOG, CAT, or EYE). Important: Don't let your partner see any of these objects yet.
9. Tape the focus object (the small piece of paper with the dot on it) on your partner's left thumbnail. Instruct your partner to stare straight ahead at the dot, while keeping his/her left hand stationary.
10. Making sure your partner is staring straight ahead and can't see what you're doing, tape a randomly chosen test object (a colored shape with a word in it) on the right thumb, oriented towards your partner's face.
11. While your partner continues to stare at the focus object without moving the head or left thumb, ask him/her to slowly bring the right arm toward the stationary hand in an arc. Pay close attention to your partner's eyes during this to make sure there is no sideways movement.
12. Ask your partner to pay attention to his/her peripheral vision without looking at the test object and tell you when he or she is first able to correctly discern the following visual information:
    - Partner can detect motion of the test object
    - Partner can correctly identity the test object's color
    - Partner can correctly identify the test object's shape
    - Partner can correctly read the text on the test object
13. Record the angles at which your partner correctly identifies the properties above. (It might be helpful for the person to briefly stop the motion of his/her arm at each point.) You'll likely find that your partner has to move the test object surprisingly close to the focus object before he/she can make out the various details.
14. Collect more data by switching arms or switching partners.
15. Discuss with students: What's the advantage of having a wide field of view, as humans do? What's the advantage of having a narrower field of view, as telescopes do?
16. Having a wide field of view is a survival advantage for humans: We can quickly react to dangers such as animal predators or moving cars. By contrast, telescopes are usually designed to focus on just a small part of the sky.

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