Build Your Own Refracting Telescope!

Level: Grades (6-8)

Credit: Activity by NASA "Building a Telescope" and adapted by NSO
https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Building_a_Telescope.html
Procedure from EpicFanasy / Stormthecastle.com - https://www.youtube.com/watch?v=msIAdyljrwI

Objective

Students will be able to...

- Construct a simple refracting telescope
- Calculate the magnification of telescope
- Compare and evaluate telescope designs among peers

Materials

- ❑ 2 Cardboard paper towel tubes or other "tube-like" items
- ❑ Glue or Tape
- ❑ Corrigated cardboard
- ❑ X-acto knife or Scissors
- ❑ 2 convex lenses (see "lenses" for lens options)

Lenses

Eyepiece Lens:
Convex
Focal Length: 2-4"
Diameter: 0.5-2"

Objective Lens:
Convex
Focal Length: 8-14"
Diameter: 1-2"

Theory

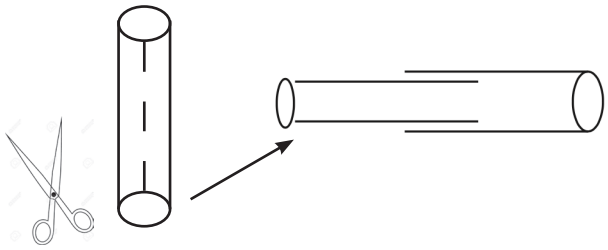
In a simple refracting telescope, there are two lenses: the objective lens and the eyepiece lens. Light from a distant object is focused by the objective lens. This forms an image in front of the eyepiece. The eyepiece acts as a magnifier to enlarge the image.

Magnification can be calculated using the following formula:

M = focal length of the objective / focal length of the eyepiece

Procedure

1. Start with your cardboard paper towel tubes. Make a cut down the length of one tube. Overlap the edges slightly and tape them back together. The overlap should be just enough so that the resized tube can fit snuggly into the unaltered second tube.

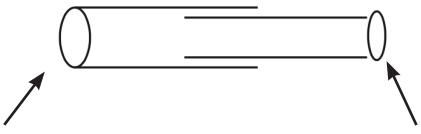


2. Trace a circle on the corrigated cardboard slightly smaller than your lens. Cut the circle out. Push the lens into the hole in the cardboard so that it fits snuggly. Do this for both of the lenses.

3. Cut the cardboard around the lens so that you form a cardboard ring holding the lens, about the size of the end of you paper towel tube. Do this for both lenses.

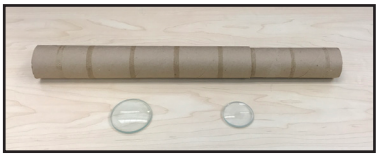
"lens/cardboard combo"

4. Attach one lens/cardboard combo to the end of one paper towel tube using glue or tape. Do the same with the other lens/cardboard combo, attaching each lens to a seperate tube. Be sure that the smaller eyepiece lens is attached to the inner cardboard tube.



Larger Objective Lens

Smaller Eyepiece Lens



5. You now have a simple telescope! Slide the smaller tube in and out to focus your image.

(Optional) Decorate your telescope with paints, markers, or construction paper

Observations, Data, and Conclusions

Calculate the power or magnification (M) of your telescope. Use the following formula:

M = power or magnification

F_e = focal length of the eyepiece

F_o = focal length of the objective

$$M = \frac{F_o}{F_e}$$

Magnification: _____

Observe an object through your telescope.

1. Does the object look bigger than when observing with your eyes only?

2. Does the object look clearer?

3. Are you able to focus your image by sliding the smaller tube in or out of the larger tube?

4. How is the observed image oriented?

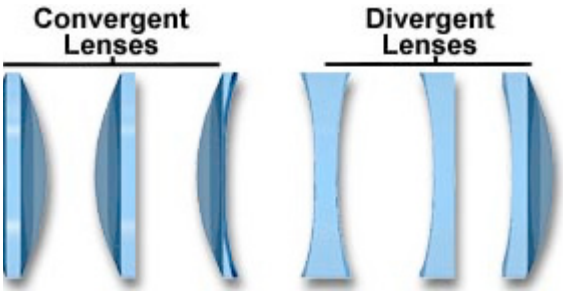
5. Does the amount of magnification observed through your telescope match your calculated magnification? Why or why not?

Enrichment

Once you're familiar with the steps needed to build a telescope, experiment with different types of lenses, building materials, and overall design. Apply your skills in engineering to develop even better homemade telescopes! :)

Variables to manipulate:

- Lens type (e.g. double concave, double convex, plano concave, convex concave, etc.



- Lens focal lengths - Experiment with lenses of different focal lengths
- Lens diameters - Experiment with lenses of different diameters
- Tubes - Experiment with different tube diameters, lengths, materials, shape, etc.

Standards

MS-ETS1-3.4.1 – Analyze and interpret data to determine similarities and differences in findings.

MS-ETS1-2 – Evaluate competing design solutions based on jointly developed and agreed-upon design criteria

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The National Solar Observatory is sponsored by the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the National Science Foundation