

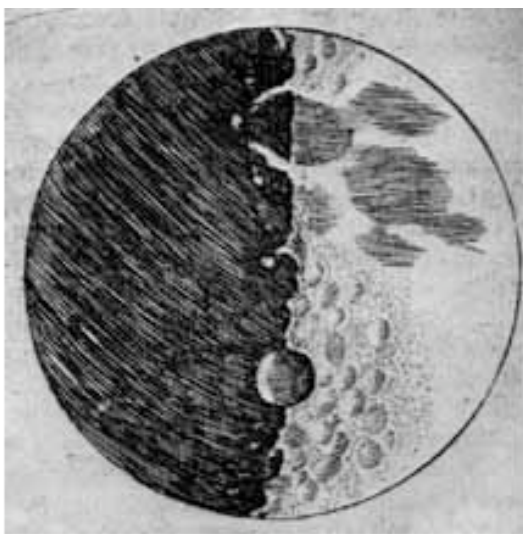


## Making a refractory telescope



Illustration from *Emblemata of Zinne-werck*, Johan de Brune, 1624.

The telescope was discovered by the Dutch, a nation of sailors and sea explorers. They used it at sea to check the flags of distant boats approaching and to decide if they were friends or enemies.



It was the great Italian scientist Galileo Galilei who first used the telescope to observe the sky and he made many important discoveries.

Engraving of the Moon at First Quarter as it appears in Galileo's book *Sidereus Nuncius* (1610)





There are 2 types of telescopes: refractor and reflector. The refractor telescope is a tube that contains 2 lenses: one at the front end with little magnification, which is called the 'objective lens', and another at the bottom end that is closest to your eye, called the 'eyepiece'.

What happens to the light inside that tube?

A replica of Galileo's telescope.

The objective lens is the bigger lens and collects lots of light from an object far away and then refracts or 'bends' that light, bringing it to a point near the bottom end. The smaller eyepiece lens then magnifies that point and brings it into focus to your eye. The tube itself holds the lenses at just the right distance from each other. It also keeps out any other light or dust or moisture that might interfere with the image.

It is very difficult to build big lenses; they weigh a lot and have to be supported around their edges which is the thinnest, most fragile part. They are also difficult to move about ( you want to be able to point your telescope at any point in the sky!) The light can also bend TOO much with a big lens and distort the image.

The biggest refractor telescope was built in 1897 in California at the Yerkes observatory. It is has a diameter of 1 m.



## Making a refractory telescope

★ GOAL: To build a simple refractory telescope similar to the first telescopes. To imagine that first discovery.

★ MATERIALS:

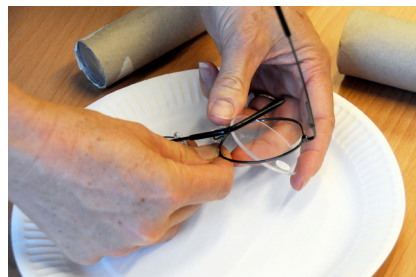
- A pair of reading glasses (those used by people who are longsighted) of around 2 diopters. You can use the ones which are sold cheaply in drugstores.
- A strong magnifying glass (the stronger the better). You can also remove a lens from a pair of kid's binoculars
- 2 cardboard tubes of about 25 cm in length (paper towel rolls work well)
- Masking tape, Scissors



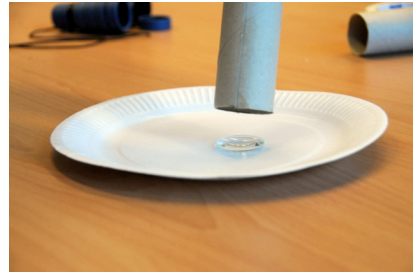
★ AGE GROUP: Supervised, indoor/outdoor demonstration and group activity for 6 years and up.

### WHAT TO DO:

- Remove one lens from the pair of glasses.
- Take your magnifying glass or remove one of the bigger lenses from your binoculars



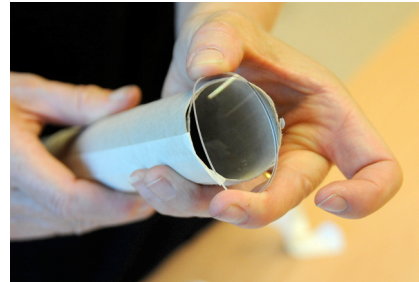
- If you compare the 2 lenses you will see that the magnifying glass or binocular lens is stronger than the glasses lens.
- Cut along the entire length of one of the tubes.
- Hold the tube directly over the stronger lens.
- Grip the tube tightly to make it smaller in diameter (make the cut edges overlap) so that the lens is held securely in place.
- Attach the lens from the magnifying glass to the end of Tube # 1. This will be your 'eyepiece' the part which you will use to observe with.
- Put Tube #1 inside the other tube and check to see that it slides easily up and down. Once you are sure that the lens in Tube #1 is secure, and that the tube can move snugly inside the



second tube ( the tube which is not cut), tape all along the cut border. This way, you will have a tube with variable longitude and you will be able to focus the image.



- Take your glasses lens and attach it with adhesive tape to one end of Tube #2 (the tube which is not cut). This will be your 'objective lens'.



- Start indoors. Direct the telescope to something in the distance like a person or a tree through a window.



- Put your eye to the magnifying glass and slide the tube backwards and forwards until you see the image focused. The image is inverted, that is, upside-down!



**NB\* THIS ACTIVITY CAN NOT BE UNDERTAKEN WITHOUT FIRST UNDERSTANDING THE MOST IMPORTANT RULE OF SKY WATCHING:**

**NEVER UNDER ANY CIRCUMSTANCES  
POINT YOUR TELESCOPE AT THE SUN!!!!**

Source:

Ricardo Moreno, Exploring the Universe, UNAWE Espana

UNAWE is an international programme to inspire young underprivileged children with the beauty and scale of the universe. Universe Awareness illustrates the multicultural origins of modern astronomy in an effort to broaden children's minds, awaken their curiosity in science and stimulate global citizenship and tolerance.

*Universe Awareness is imagination, excitement and fun in the universe for the very young.*

