

## **Two Small Pieces of Glass: The Amazing telescope**

### **Teachers Guide**

The purpose of this guide is to integrate some of the information from the program into your classroom before and after your students view *Two Small Pieces of Glass: The Amazing Telescope*. We have provided information on how to electronically access lesson outlines and objectives, worksheets, demonstrations and activities that will spark the imagination and interest of your students. We are also providing a glossary, taken from the script, for any words that may be foreign to your student's vocabulary.

This guide is merely a beginning to help you integrate astronomy and physics into your classroom. We encourage you to expand upon the content of this guide to further the interest in science for your students.

### **Synopsis of the Show**

While attending a local star party, two teenage students learn how the telescope has helped us understand our place in space and how telescopes continue to expand our understanding of the Universe. Their conversation with a local female astronomer enlightens them on the history of the telescope and the discoveries these wonderful tools have made. The students see how telescopes work and how the largest observatories in the world use these instruments to explore the mysteries of the universe.

While looking through the astronomer's telescope, the students, along with the planetarium audience, explore the Galilean Moons, Saturn's rings, and spiral structure of galaxies. During their conversation with the astronomer, they also learn about the discoveries of Galileo, Huygens, Newton, Hubble and many others.

### **Desired learning outcomes:**

- Compare reflection to refraction.
- Explain how light is dispersed by a lens and how this affects image quality
- Explain how the shape of a lens or mirror can affect the image quality.
- Describe how a reflecting telescope forms an image
- Explore the history of telescopes from Galileo to the Great Observatories.
- Identify the major events associated with the development of telescopes from Galileo to the Great Observatories.
- Describe how technological advances have improved telescopes.
- Describe how science has advanced the technology associated with telescopes.
- Describe how improvements in telescopes have allowed scientists to make new discoveries.

## World Wide Web Educator Lesson Plans and Activities

- **Telescopes from the Ground Up: Exploring the history of telescopes from Galileo to NASA's great observatories**

*Telescopes From the Ground Up* traces the history of telescope development and highlights the interplay between technological and scientific advances. In this modular activity, milestones in telescope development are highlighted in the 10 sections called "eras," with specific examples included in the associated "telescope pages." The human component is integrated through the biography pages, which provide a glimpse of the inventors and astronomers behind the telescopes. The science of light and telescopes is presented in the section "Get to the Root of It," which can be used for review, learning the basics, or remediation. Depending on the teacher's objective, "Get to the Root of It" can be accessed prior to doing the activity and/or while working through the eras and telescope pages.

Available in electronic format through the Space Telescope Science Institute's Amazing Space link.

<http://amazing-space.stsci.edu/resources/explorations/groundup/>

- **Space-Based Astronomy: An Educator Guide with Activities for Science, Mathematics and Technology Education.**

This NASA educator guide tells the story of why it is important to observe celestial objects from outer space and how to study the entire electromagnetic spectrum.

Available in electronic format through NASA spacelink

[http://www.aiaa.org/kidsplace/kidsplacepdfs/58277main\\_Space.Based.Astronomy.pdf](http://www.aiaa.org/kidsplace/kidsplacepdfs/58277main_Space.Based.Astronomy.pdf)

- **NASA's Imagine the Universe**

This site is intended for middle and high school students, and for anyone interested in learning about our universe.

Imagine the Universe lesson plans are available at this link

[http://imagine.gsfc.nasa.gov/docs/teachers/lesson\\_plans.html](http://imagine.gsfc.nasa.gov/docs/teachers/lesson_plans.html)

- **Star Child: A learning Center for Young Astronomers**

The information and activities found in StarChild can be used to engage, excite, and educate students in elementary school. It contains easy-to-understand information about the solar system, the Universe, and other "space stuff" as well as activities, movies, puzzles, etc. Each topic has a short quiz at the end. This site, written by middle school teachers, is a great educational resource with lots of fun!

The StarChild site is a service of NASA and the Goddard Space Flight Center

<http://starchild.gsfc.nasa.gov/docs/StarChild/StarChild.html>

Teachers Center lesson plans

<http://starchild.gsfc.nasa.gov/docs/StarChild/teachers/teachers.html>

- **How Teachers Can Get Involved In The International Year of Astronomy**

If you are a teacher, this site provides some ideas on how you and your students can participate in the International Year of Astronomy 2009, celebrating 400 years since Galileo began observing the heavens through his telescope.

<http://www.astronomy2009.us/Content/Documents/IYAGetInvolved-Teachers-27Jan2009.pdf>

- **How Homeschool Families Can Get Involved In The International Year of Astronomy**

If you are a homeschool family or umbrella group, this site provides some ideas for how you can participate in the International Year of Astronomy 2009, celebrating 400 years since Galileo began observing the heavens through his telescope.

<http://www.astronomy2009.us/Content/Documents/IYAGetInvolved-HomeSchool-27Jan2009.pdf>

- **Refracting Telescope Kit**

You and your students can build a simple 16-power refracting telescope, similar to Galileo's first telescopes. Discover how he was able to make astonishing discoveries with crude instruments that lacked precision and clarity. The kit includes instructions and activities.

Refracting Telescope Kits are available through Science First @

[http://www.sciencefirst.com/vw\\_prdct\\_md1.asp?mdl\\_cd=6540000](http://www.sciencefirst.com/vw_prdct_md1.asp?mdl_cd=6540000)

## **Other Resources**

### **Binary Star Systems**

- [http://chandra.harvard.edu/xray\\_sources/binary\\_stars.html](http://chandra.harvard.edu/xray_sources/binary_stars.html)
  - The Chandra X-Ray Observatory website explains the different types of binary star systems. Includes satellite photos, and demonstrational videos. Intended for high school and above.

### **Dark Matter**

- <http://heasarc.gsfc.nasa.gov/docs/rosat/gallery/display/darkmatter.html>
  - This is a display from ROSAT. It has some information about dark matter in a short paragraph as well as data from the satellite. It is a good resource for middle/high school students and teachers.

### **Galaxies**

- <http://www.seds.org/messier/galaxy.html>
  - A description of the different classes of galaxies (spiral, elliptical, etc.), what kinds of objects galaxies contain, and when most galaxies were formed. High school and above.

### **General Astronomy**

- <http://darkskyinstitute.org/astronomy.html>
  - This Web site is an astronomy course for middle/high school students using the Internet.
- [http://heasarc.gsfc.nasa.gov/docs/www\\_info/webstars.html](http://heasarc.gsfc.nasa.gov/docs/www_info/webstars.html)
  - WebStars: Astrophysics in Cyberspace, a large list of other astronomy sites, with short descriptions.

- <http://apod.gsfc.nasa.gov/apod/astropix.html>
  - Astronomy Picture of the Day: Each day a different image or photograph of our fascinating Universe is featured, along with a brief explanation written by a professional astronomer. Archived pictures (sorted by date and by subject) go back to June, 1995. The text is very informative and contains useful links to related information. Accessible for high school students and above.

## Optics

- <http://www.opticsforkids.com/>
  - An introduction to optics, including facts about rainbows, stars, and lasers. Material appropriate for K-12 readers.

## Multiwavelength Astronomy

- <http://coolcosmos.ipac.caltech.edu/>
  - Have you ever wondered what your cat might look like in infrared light? See for yourself, with the pictures provided on this website. Many other kinds of animals are included as well. Interesting for all ages.
- [http://coolcosmos.ipac.caltech.edu/cosmic\\_classroom/multiwavelength\\_astronomy/multiwavelength\\_astronomy/index.html](http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_astronomy/index.html)
  - A gallery of Messier Objects (a catalog of easily observed astronomical objects), showing each in various wavelengths. Includes explanations of the features we can see using each wavelength. Very colorful! Interesting for any age.

## Stars

- [http://starchild.gsfc.nasa.gov/docs/StarChild/universe\\_level2/stars.html](http://starchild.gsfc.nasa.gov/docs/StarChild/universe_level2/stars.html)
  - Stars and the lives of stars are explained for 5-8 graders, complete with glossary terms linked and questions.
- [http://starchild.gsfc.nasa.gov/docs/StarChild/solar\\_system\\_level2/sun.html](http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/sun.html)
  - All about the Sun for the 5-8 grader.

## **Telescopes Of The World**

An interactive site displaying information on all the major telescopes in the world.

- <http://www.400years.org/interactive.php>

## **Hubble Space Telescope Images**

A presentation and explanation of some of the best images taken by the Hubble Space Telescope

- <http://www.seds.org/hst/hst.html>

## **What's Happening in the Sky Today?**

Sky & Telescope - Sky at a Glance

- <http://www.skyandtelescope.com/observing/highlights>

Sky & Telescope's Planet Observing Page

- <http://www.skyandtelescope.com/observing/objects/planets/>

Printable Star Charts

- <http://skymaps.com/downloads.html>

## **Planets**

Welcome to the Planets (JPL)

- <http://pds.jpl.nasa.gov/planets/>

Solar System Exploration Homepage

- <http://sse.jpl.nasa.gov/index.cfm>

Views of the Solar System

- <http://solarviews.com/eng/homepage.htm>

## **Sunspots**

Space Weather Bureau

- <http://www.spaceweather.com/>

Sky & Telescope's Solar Observing Page

- <http://www.skyandtelescope.com/observing/objects/sun/>

Sunspots

- <http://www.exploratorium.edu/sunspots/index.html>

National Solar Observatory

- <http://www.nso.edu/>

## **Moon**

Sky & Telescope's Moon Page

- <http://www.skyandtelescope.com/observing/objects/moon/>

Moon Phase Picture for Any Date and Time (1800-2199)

- <http://tycho.usno.navy.mil/vphase.html>

## **Stars & Constellations**

Constellations (SEDS)

- <http://www.seds.org/Maps/Const/constS.html>

Stars and Constellations

- <http://www.astro.wisc.edu/~dolan/constellations/>

Double Stars, Variable Stars, Star Clusters (Sky & Telescope)

- <http://www.skyandtelescope.com/observing/objects/>

## **Meteors and Meteor Showers**

Sky & Telescope's Meteor Page

- <http://www.skyandtelescope.com/observing/objects/meteors/>

Meteor Showers

- <http://stardate.org/nightsky/meteors/>

## **Telescopes**

Telescopes for Beginners

- [http://www.squidoo.com/Telescopes\\_for\\_Beginners](http://www.squidoo.com/Telescopes_for_Beginners)
- <http://www.rocketroberts.com/astro/first.htm>
- <http://www.skyandtelescope.com/howto/howtoequipment/3304526.html>
- <http://science.howstuffworks.com/telescope1.htm>

## **Astronomy Careers**

Frequently Asked Questions About Being an Astronomer

- <http://www.noao.edu/education/astfaq.html>



