

11. Exploring the Solar System - Telescopes

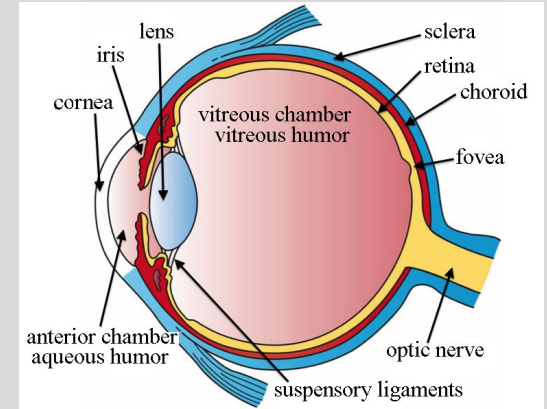
Edexcel GCSE Astronomy Course

11.14 Know that the human eye is limited in astronomical observations by its small aperture and limited sensitivity in low light

http://csep10.phys.utk.edu/OJTA2dev/ojta/course1/telescopes/optical/limitations_tl.html

<https://www.livescience.com/33895-human-eye.html>

<https://skyandtelescope.org/astronomy-resources/astronomy-questions-answers/naked-eye-magnitude-limit/>



11.15 Understand how the objective element of a telescope captures and focuses light so that the image can be magnified by an eyepiece

11.16 Know that convex (converging) lenses and concave (diverging) mirrors can be used to collect and focus light from astronomical objects

11.17 Understand how simple telescopes can be made by combining an objective (lens or mirror) with an eyepiece

A simple introduction to telescopes:

<https://www.dkfindout.com/uk/space/observing-space/refracting-telescopes/> From this link, make a note of the meanings of objective, refraction and eyepiece

From this link, make notes on the difference between refracting and reflecting telescopes and watch the animation:

<https://www.space.fm/astronomy/planetarysystems/telescopetypes.html>

Find out and make a note of what is meant by a Galilean telescope::

<https://lco.global/spacebook/telescopes/refracting-telescopes/>

If you have the items needed, you can make a simple bench telescope:

https://www.youtube.com/watch?v=Bok33AC-ID8&ab_channel=plenum88

Watch this video to find out why the invention of reflecting telescopes was significant: <https://www.hsm.ox.ac.uk/gregorian-telescope>

Look at this video for comparative views through reflectors and refractors:

https://www.youtube.com/watch?v=IWroBauNmd4&ab_channel=EarthtoSpaceScience

Try these quizzes about the basics of telescopes:

https://www.free-astronomy-quiz.com/telescopes_q1.html

https://www.free-astronomy-quiz.com/telescopes_q2.html

This link gives simple summary diagrams showing the parts you need to learn and shows ray paths for both types of telescope:

<https://theuniversespaceandbeyond.weebly.com/telescopes.html>

Some sample past paper questions on telescopes:

Which statement is correct about a refracting telescope?

(1)

- A** The telescope uses a single curved mirror to form an image.
- B** The telescope uses a series of flat and curved mirrors to form an image.
- C** The telescope uses a series of lenses to form an image.
- D** The telescope uses lenses and mirrors to form an image.

Give **two** reasons why the world's largest telescopes are reflectors rather than refractors.

(2)

1

.....

2

.....

Mark Scheme

Q1 C

Q2

<i>Any two from:</i> Large objective lenses are difficult to make Large lenses are hard to support Reflectors can be made of multiple mirrors Telescopes with large lenses are difficult to keep stable and steer/point accurately Lenses introduce false colour/chromatic aberration Reflector design has higher resolution	<i>Insufficient:</i> Cheaper More powerful Easier to build	2
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11.18 Understand the basic design of the following in terms of their key elements: a Galilean refracting telescope b Keplerian refracting telescope c Newtonian reflecting telescope d Cassegrain reflecting telescope (detailed ray diagrams not required)

a Galilean refracting telescope b Keplerian refracting telescope

Use the diagrams and text in the link to complete the table:

Refracting Telescope Type	Objective Lens	Eyepiece Lens	Image Magnification	Real or Virtual Image	Image Orientation
<i>Galilean</i>	<i>Convex</i>		<i>Magnified</i>	<i>Virtual</i>	
<i>Keplerian</i>		<i>Convex</i>			

<https://www.open.edu/openlearn/science-maths-technology/telescopes-and-spectrographs/content-section-1.3>

c Newtonian reflecting telescope d Cassegrain reflecting telescope

Use the links on this page to examine the ray diagrams for these two types of reflecting telescopes:

<https://www.schoolobservatory.org/learn/science/optics/raydiagrams>

There is one key difference between them - what is it?

11.19 Understand that the 'light grasp' of a telescope is directly proportional to the area of the objective element and thus the square of the diameter of the objective element

11.20 Know that the aperture of a telescope is related to the diameter of the objective element

Find out and write down definitions of each of these terms from this link:

<https://www.space.fm/astronomy/planetarysystems/aperturelightgrasp.html>

Aperture

Light grasp

Make a note of the light grasp ratio calculation and try the example question.

11.21 Know that the field of view is the circle of sky visible through the eyepiece, measured in degrees or arcmin

11.22 Understand the resolution of a telescope is: a proportional to the diameter of the objective element b reduced by observing at a longer wavelength

Use this link to find a definition of field of view:

<https://www.space.fm/astronomy/planetarysystems/fieldofview.html>

And this one to find a definition of resolution:

<https://www.space.fm/astronomy/planetarysystems/resolution.html>

- What are the six factors affecting resolution?
- What is the equation for resolution of a telescope?
- For the same objective diameter D , will resolution be better for a visible or an infrared telescope?

11.23 Be able to use the formula for the magnification of a telescope:

magnification = f_o / f_e

where f_o is the focal length of the objective element and f_e is the focal length of the eyepiece

Find and write down a definition of focal length:

<https://www.space.fm/astronomy/planetarysystems/magnification.html>

- What is the relationship between FOV and magnification?
- Which gives a sharper image, a high or a low magnification lens?
- Which lens has the largest FOV 9.7mm or 26mm?
- Which lens has highest magnification 15mm or 40mm?
- Which lens is physically bigger 15mm or 26mm?
- Try the example questions on magnification at the link above.

11.24 Understand the importance of Galileo's early telescopic observations in establishing a heliocentric (Sun-centred) model of the Solar System

Watch this marvellous movie clip and find out what Galileo's four, key pieces of observational evidence were - one related to the Moon, one to Venus and two to Jupiter:

https://www.youtube.com/watch?v=jwY00aykjC4&ab_channel=BritishPath%C3%A9

1.

2.

3.

4.

11.25 Understand the advantages of reflecting telescopes compared to refracting telescopes, in terms of:
a chromatic aberration b very long focal lengths c using large aperture objectives d use of multiple mirrors

Chromatic aberration is explained here:

<https://www.universetoday.com/81874/chromatic-aberration/>

- Why did refracting telescopes need to be very long to correct for this?
- What was Sir Isaac Newton's alternative solution?

The advantages, and some disadvantages, of reflecting telescopes are explained very nicely in this link - make a note of those that are mentioned:

<https://lco.global/spacebook/telescopes/reflecting-telescopes/>

Final telescopes test - take this quiz:

https://www.ducksters.com/science/quiz/telescopes_questions.php

