13. Exploring Starlight (Part 3.1 - Observing in visible and radio wavelengths)

Edexcel GCSE Astronomy Course

13.19 Be able to use star trail photographs to determine the length of the sidereal day

Watch the video and download one of the pdf activity sheets to learn how to calculate the length of the sidereal day from example star trails:

https://www.rmg.co.uk/schools-communities/teacher-resources/star-trails-sidereal-day

Consolidate your knowledge:

What is the definition of a sidereal day?

What other sort of day is there?

Which one is longer and why?

13.20 Know that most modern astronomical observations are recorded using digital sensors that convert light into electrical signals, which can then be processed and stored as data files

Early astronomers could only record their observations by making sketches like these made by Robert Hooke in the 17th century:

https://brunelleschi.imss.fi.it/galileopalazzostrozzi/object/RobertHookeMicrographia.html

Present day astronomers can record digital images of their observation targets which can be stored on computer and manipulated to enhance details, add false colour, stack images to improve visibility, remove unwanted artefacts such as satellite trails, transmitted from spacecraft and shared electronically with others.

Find out and make a note of the meaning of (i) a CCD (ii) a pixel (iii) a spectroscope from this National Schools Observatory link:

https://www.schoolsobservatory.org/learn/tech/instruments

13.21 Understand how astronomers obtain and study the patterns of spectral lines in the light from astronomical objects

Recap on your knowledge of the electromagnetic spectrum then make a list in your notes of all the things astrophysicists can find out by measuring the spectrum of light from distant objects:

https://imagine.gsfc.nasa.gov/science/toolbox/spectra1.html

Go to this link to see some examples of real spectra used by astrophysicists. Find and write down a definition of continuous, emission and absorption spectra:

https://www.eso.org/public/teles-instr/technology/spectroscopy/

13.22 Know that the Earth's atmosphere blocks almost all of the radiation of different wavelengths in the electromagnetic spectrum, except visible light and radio waves

The diagram on the first slide here:
http://www-astro.physics.ox.ac.uk/~pfr/ObsTech/ObsTech2.pdf

And the expandable diagram on this page:
https://blair.pha.jhu.edu/spectroscopy/atm_trans.html

both show the same information, but in a different way.

1. Explain what this difference is and what the words opacity and transparency mean.
2. Estimate the ranges of electromagnetic wavelengths which are able to pass through the Earth's atmosphere with least absorption.
3. Make two lists (i) of which EM waves are transmitted (ii) of which EM waves are blocked by the atmosphere

13.23 Know that only optical and radio telescopes should be located at sea level on the Earth's surface (NB sea level is not the best place - ground level would be more accurate)

Make a table with these headings and find out what type of telescope each example is and where it is located:

Observatory or Telescope Name	Optical or Radio?	Where is it?
Jodrell Bank		
European Southern Observatory		
James Clerk Maxwell Telescope		
Liverpool Telescope		
Keck Telescope		
Square Kilometre Array		

13.24 Understand how a simple radio telescope operates
13.25 Understand why radio telescopes need extremely large apertures in order to maintain a useful resolution
13.26 Understand how multiple radio telescopes can operate as an aperture synthesis system (array)

Find out the three, basic components of a radio telescope here: https://www.csiro.au/en/research/technology-space/astronomy-space/what-is-radio-astronomy

Why are radio telescopes so much larger than optical telescopes? What is different about the EM radiation they are designed to detect?

Radio telescope arrays overcome two engineering problems - they don't need construction of a single, large dish and they don't need to be pointed mechanically at a target. This is explained very clearly in this SETI Institute link: https://www.seti.org/ata-phase-array

13.27 Know that radio astronomy has been important in the discovery of quasars, jets from black holes, the structure of the Milky Way and protoplanetary discs

Find out what a quasar is and why radio astronomers were puzzled by their emission lines when they were first discovered:
https://earthsky.org/astronomy-essentials/definition-what-is-a-quasar/

Watch this fascinating video to find out what causes jets from black holes:
https://www.youtube.com/watch?v=tBK792Ffu1g&ab_channel=QuantaMagazine

The structure of the Milky Way has been mapped using 21cm radio waves emitted by atomic hydrogen which is very abundant in galaxies. This link shows some fantastic images of such mapping in both the Milky Way and the Pinwheel Galaxy (M101):
http://galaxymap.org/drupal/node/202

Here is a great example of a protoplanetary disk discovered by a radio telescope array:https://astronomynow.com/2017/11/03/alma-discovers-cold-dust-around-nearest-star/