Name: _____ Form: _____

GCSE

Astronomy

Club

1.4 Earth, Moon, Sun

Earth, Moon, Sun Interactions

a) Demonstrate an understanding that the Moon and Sun appear to be the same size when viewed from Earth

The diameter of the Moon: 3475 km The diameter of the Sun: 1392000 km. Ratio of diameters: 1 : 401

The distance to the Moon: 384,400 km The distance to the Sun: 149 60000 km. Ratio of distances: 1 : 389

Explain why this important for a total solar eclipse to occur:

The sun is roughly 400 times 'bigger' than the moon but is also roughly 400 times further away. They therefore appear roughly the same size as viewed from the Earth - angular size.

b) Recall the period of the lunar phase cycle

The period of the lunar phase cycle is 29.53 days.

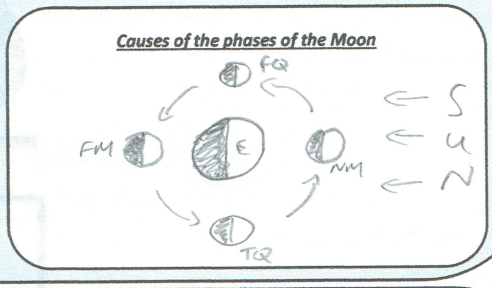
c) Demonstrate an understanding of lunar phases and deduce the lunar phase cycle from given data

Draw the following lunar phases and calculate the exact number of days into the cycle when they occur:

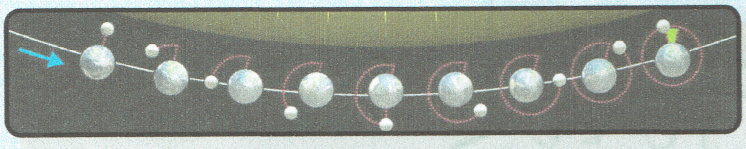
New Moon	Waxing Crescent	First Quarter	Waning Gibbous	Full Moon	Waning Gibbous	Third Quarter	Waning Crescent
0.00 days	3.7 days	7.4 days	11.1 days	14.8 days	18.5 days	22.2 days	25.9 days

Explain what causes the phases of the Moon:

As the Moon orbits around the Earth different parts of the moon are in sunlight/darkness. The appearance of the moon changes with its position relative to the Earth and Sun.



d) Use diagrams to explain why the lunar phase cycle is (2.2 days) longer than the orbit period of the Moon



Explain how this diagram shows why the lunar phase cycle is 2.2 days longer than the orbit period of the Moon:

The moon takes 27.3 days to orbit the Earth - the same time it takes to rotate once on its own axis. But the Earth also moves relative to the sun, so an extra couple of days are needed for the Moon to get into the position it was in, relative to the Earth, when the cycle started.

e) Describe the appearance of partial and total solar and lunar eclipses

How a partial solar eclipse appears to an observer

Description in words: Moon partially covers the Sun's disc. Looks like a bite

How a total solar eclipse appears to an observer

Description in words: Dark silhouette of the moon obscures the Sun's light allowing the corona to be visible.

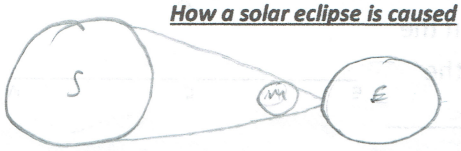
How a lunar eclipse appears to an observer

full moon but in shadow or reddish hinge

Description in words: Red colour due to sun light refracting + scattering when passing through the Earth's atmosphere

f) Describe, using diagrams, the mechanisms causing solar and lunar eclipses

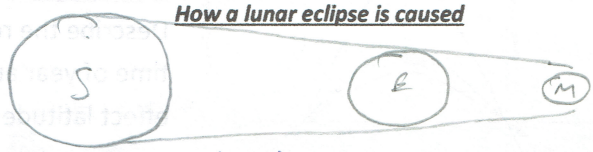
How a solar eclipse is caused



Description in words:

The Moon passes between the sun and earth and fully or partly blocks the sun, casting a shadow on the Earth.

How a lunar eclipse is caused



Description in words: when the moon passes directly behind the Earth into its shadow, when all 3 are aligned on the night of a full moon.

g) Demonstrate an understanding that the duration of total solar and lunar eclipses are different and that they do not occur every new and full Moon

Eclipses do not occur every new and full moon because If the Moon and Earth's orbits were in the same plane, there would be a solar (at new moon) and lunar (at full moon) eclipse each month. The moon's orbit is inclined to the Earth's at 5° so they can only happen when the orbits intersect.

The duration of each eclipse depends on the size of the shadow created. The moon's shadow on the Earth is much smaller than the Earth's shadow on the moon. ∴ A solar eclipse lasts for only a few minutes (and only visible in a small area). A lunar eclipse lasts for a few hours (and can be seen over most of the side of the Earth at night).

h) Describe the terms 'solar day' and 'sidereal day'

Solar day definition: The time it takes for the Earth to rotate on its axis so that the Sun appears in the same position.

Sidereal day definition: " " so that the distant stars appear in the same position

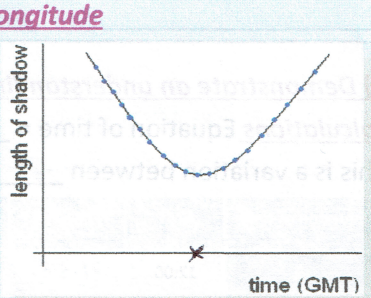
i) Explain why a solar day is longer than a sidereal day

The solar day is around 4 minutes longer. If we take the reference position of the Sun as noon – when the Sun reaches its highest point in the sky – then the time between successive noons is around 4 minutes longer than the actual rotation period of the planet because the Earth moves along its orbit around the Sun as it turns on its axis.

j) Interpret simple shadow stick data to determine local noon and observer's longitude

Draw a cross on the x-axis of the graph to depict local noon.

Local noon was measured to occur at 12:18. On the same day, local noon was measured in Greenwich at 12:06. Calculate the longitude of the observer:



24hrs = 360°

1440 mins in 24hrs → 1° = 4mins

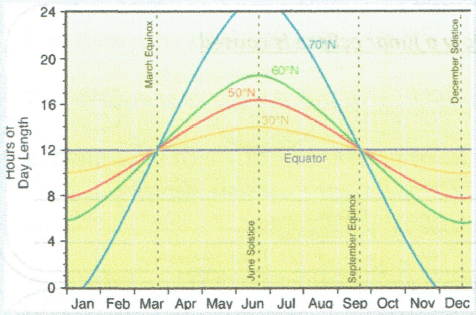
Difference between local noons = 12 mins = 3° W

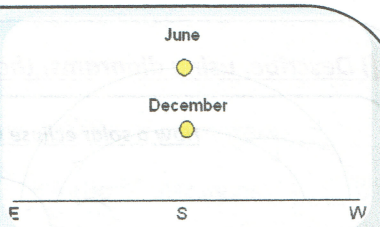
k) Describe how a sundial can be used to determine time

Describe how to make a sundial, how to read time from the sundial: An upright stick in the ground will cast a shadow that moves throughout the day. The shadow will be shortest at local noon. Marks can be made as hours (as measured on a watch) pass by to enable time to be read.

Describe the corrections you have to make to your reading to convert it to GMT and explain why these corrections are necessary: A sundial marks local solar time. This will be different to GMT unless you are at the same longitude. To convert the sundial time to GMT you need to use the Equation of Time and correct for longitude differences (and any summer/daylight saving time adjustments). The EoT equates the non-uniform solar time to the uniform GMT.

l) Interpret charts and diagrams showing the variation in daylight length during a year





Describe the relationship between the time of year and day length, and the effect latitude has on this: At the equator, day length does not vary. As you move towards the poles, the length of a day varies (as does the altitude of the sun above the horizon), performing a Maximum - minimum cycle over the course of a year. The variation is greater at bigger latitudes.

Explain how these variations are caused: The Earth is tilted on its axis, and it's orientation to the sun changes throughout the year as it orbits. For a given point on the surface, sometimes the axis points toward the sun and sometimes away. For a given latitude (other than the equator), as the seasons pass, the hours of sun/daylight vary: winter = tilt away = short days; summer = tilt towards = long days.

m) Demonstrate an understanding that there are seasonal variations in the rising and setting of the Sun

Explain why the Sun sets earlier and rises later in winter than summer: In winter, for a given point/latitude, the Earth's tilt is away from the Sun. As a result, the portion of the globe illuminated during daytime is smaller. As the Earth rotates, the Sun does not rise above the horizon until more time has passed and it also dips below the horizon sooner. In summer, the sun rises in the NE and sets in the NW; in winter it is SE and SW.

Explain the terms 'Equinox' and 'Solstice' A solstice occurs when the sun appears to 'stand still'. As the seasons progress, each day the sun appears higher or lower in the sky. On 2 days only, the sun reaches its highest or lowest point and appears to 'change direction'. Equinoxes also happen twice a year, when the sun is directly over the equator and both hemispheres have equal hours of daylight. The sun rises due East and sets due West.

n) Demonstrate an understanding of the terms 'apparent Sun' and 'mean Sun'

Apparent Sun: or true or apparent solar time. The time the Sun shows in the day at the same point.

Mean Sun: a uniform timescale for practical use based on a fictitious mean Sun which moves at a constant rate across the sky.

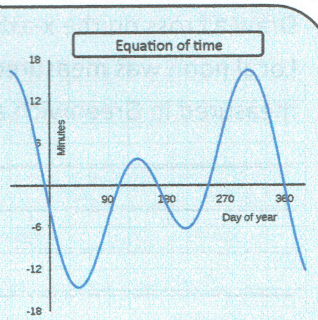
Reason for the need for Mean Sun: because the solar day length varies through the year because the Earth's orbit is an ellipse and its axis is tilted.

o) Demonstrate an understanding of the term 'equation of time' and perform simple calculations

Equation of time = ~~Greenwich~~ apparent solar time (GMA) - mean solar time (GMMA)

This is a variation between apparent solar time and mean solar time caused by the elliptical nature of the Earth's orbit and the Earth's axial tilt relative to the ecliptic

Equation of time	GMT	Apparent time in Greenwich (0°)	Apparent time in Skye (6°W)	Apparent time in Dover (1.3°E)
-3	12:00	11.57	11.33	12.01
+9	13:57	14.06	13.42	14.11
+13	10:43	10.56	10.32	11.01



p) Describe aurorae and recall from where on Earth they are most likely to be observed

Description of aurorae: Natural light display in the (night) sky at high latitudes produced by ionization in the atmosphere from charged particles from the solar wind penetrating through the magnetosphere

Southernmost point where the Aurora Borealis has ever been observed: Likely around 15°N - Occasionally seen at 35°N eg. Greece/Tunisia

Northernmost point where the Aurora Australis has ever been observed: Occasionally seen at 40°S eg. North Island of New Zealand or southern tip of New South Wales.

q) explain how aurorae are caused.

See part (p) - The excitation of atmospheric constituents emits light of varying color + complexity (dependent on acceleration but usually in polar bands), as the molecules 'de-excite'