

## GCSE Astronomy Topic 1 Key Facts

### The Earth

**Eratosthenes** first measured the circumference of the Earth accurately. He measured the altitude of the Sun North of a place where the Sun was at the zenith at exactly the same time. Knowing the distance and the angle one can work out the circumference.

The Earth is a slightly flattened sphere with average diameter 13,000km

The Earth takes 23 hours 56 minutes to rotate. This is a **sidereal day**.

The Earth is the only known planet with liquid water and a range of temperatures that could support life.

- **Poles** – the points that the axis of rotation of the Earth passes through
- **Equator** – a circle around the middle of the Earth at equal distances from each pole.
- **Zenith** – the point directly above you in the sky
- **Horizon** – an imaginary line where the land meets the sky
- **Latitude** – the angle of a location North or South of the equator
- **Meridian** – an imaginary circle that passes through both poles. The prime meridian goes through Greenwich
- **Longitude** – the angle of a location East or West of the prime meridian

### The Atmosphere

The sky is blue because blue light from the Sun is scattered more than bigger wavelengths so appears to come from all directions

Most of the atmosphere is Nitrogen. The 21% oxygen and water vapour it contains is important for human survival.

Visible light, microwaves and some radio waves can pass through the atmosphere

Infra red, ultra violet and x rays are mostly absorbed so observatories tend to be high up or in space.

The light from stars is slightly distorted as it refracts through different layers in the Earth's atmosphere, especially if pollution is present.

Light pollution may be caused by light from human activity. If the background sky is less dark the stars stand out less and so are harder to see.

### Telescopes

A **refracting** telescope uses lenses to produce a magnified image

A **reflecting** telescope includes a large mirror to produce a magnified image

It is much easier and cheaper to produce a large mirror than a large lens so big telescopes tend to be reflectors

### The Moon

The Moon's diameter is 3,500km and it is 380,000km from Earth

Its rotational and orbital periods are both 27.3 days. Because of this we only see one side from Earth

The Moon has virtually no atmosphere as its gravity is too low to keep one

Manned and unmanned vehicles have orbited the Moon and mapped its far side. The far side has more craters and fewer maria. This may be because its crust is thicker so molten rock does not flow to the surface as easily.

## **Moon Features**

Named features you should recognise are the Sea of Tranquility, Ocean of Storms, Sea of Crises, Craters Tycho, Copernicus and Kepler, Apennine mountain range

Lunar seas are called mare. Molten rock due to giant impacts cools to form smooth darker regions

Craters are the result of impacts. The edges of large craters form highlands

Rilles are grooves formed by collapsed lava tunnels

Wrinkle ridges were formed as the crust cooled

## **Apollo**

The Apollo missions were to explore the Moon

They left behind **A.L.S.E.P.s** (Apollo Lunar Surface Experiments Packages)

Amongst other things these measure seismic activity, gravity strength and devices to measure the distance to Earth precisely

The Moon may have been formed by a collision between the Earth and an object the size of Mars (Giant Impact Hypothesis)

Some of the rocks brought back from the Moon contain certain isotopes which suggest they have the same origin as some rocks on Earth

## **The Sun**

The Sun's diameter is 1.4 million km and its average distance to Earth is 150 million km or 1 AU (Astronomical Unit)

The outer layers of the Sun are

- The Photosphere – the visible surface, 5,800K
- The Chromosphere – gases in this absorb certain wavelengths so we get dark lines in the solar spectrum
- The Corona – The Crown. Faint and not dense but very hot, about 2 million K

## **Sunspots**

These are patches on the surface of the Sun which appear dark. They are slightly cooler than the surface. Loops in the Sun's magnetic field leave and enter here.

By observing sunspots we can determine the period of rotation of the Sun. 25 days at the equator and 36 days at the poles.

The number of sunspots increases then decreases over an 11 year cycle. They also move towards the poles. This can be shown on a "butterfly" diagram.

## Fusion

Nuclear fusion happens in the Sun's core. Hydrogen nuclei fuse together to form Helium nuclei. There is a small decrease in mass which releases lots of energy ( $E = mc^2$ )

## Observing the Sun

The Sun emits huge amounts of radiation covering all of the electromagnetic spectrum. One useful wavelength is a red colour called H alpha which is emitted by excited hydrogen atoms. Astronomers can use filters which cut out all but a very narrow range of wavelengths.

To observe the Sun safely one can do it indirectly, by looking at a projected image.

The Sun also emits lots of charged particles. This is called the solar wind. The Earth's magnetic field protects us from the harmful effects by deflecting these particles.

Some of these charged particles enter the Earth's atmosphere at extreme northern and southern latitudes causing aurora, e.g. the Northern Lights, by exciting atoms in the atmosphere to produce light.

## Earth – Sun – Moon

The appearance of the Moon changes over a 29.5 day cycle. The shapes we see are called **phases** of the Moon.

New moon – waxing crescent – first quarter – waxing gibbous – full moon – waning gibbous – third quarter – waning crescent



The lunar phase cycle takes 2.2 days more than its orbital rotational period because of how far the Earth moves around the Sun in this time.

The Sun's diameter is about 400 times smaller than the Moon's. It is also about 400 times further away. Because of this they appear roughly the same size in the sky.

## Eclipses

**Solar eclipses** - When the Moon comes between the Earth and the Sun.

These are rare because the orbit of the Moon is slightly tilted.

Partial eclipse – some of the Sun is covered.

Totality lasts for around a minute. In this time the Sun's corona is visible.

**Lunar eclipses** – When the Earth comes between the Moon and the Sun.

The Moon appears red as the light falling on it has passed through the Earth's atmosphere so all the blue has been scattered.

They last for several hours as the shadow of the Earth is big

## The Sun and time

The Sun rises in the East and sets in the West

Sunrise and sunset times vary throughout the year.

- Summer solstice – the longest day, near June 21<sup>st</sup>, the Sun is highest in the sky
- Winter solstice – the shortest day, near December 21<sup>st</sup>, the Sun is lowest in the sky
- Spring and autumn equinox – days and nights are equal, March 21<sup>st</sup> and September 21<sup>st</sup>

These variations are because of the tilt of the Earth's rotational axis (  $23.5^{\circ}$  ) relative to the ecliptical plane

**Local noon** – this is the time at which the Sun culminates (is highest) in the sky

The shadow made by a vertical stick would be shortest at this time

**Solar day** - The time between one local noon and the next

The solar day varies throughout the year due to the tilt of the Earth and because its orbit isn't circular

**Apparent Sun** – the Sun as we see it in the sky

**Mean Sun** – an imaginary Sun that culminates exactly every 24 hours

**Greenwich Mean Time** – the mean Sun culminates at exactly 12:00 every day using this time

## The Equation of Time

The difference between GMT and the actual solar time on any day is called the Equation of Time.

- If a sundial at Greenwich said it was 12:10 at 12:00 GMT then the EOT on that day is +10 minutes
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- If a sundial at Greenwich said it was 11:55 at 12:00 GMT then the EOT on that day is -5 minutes

What a sundial reads also depends on the observer's longitude.

- For every degree East of Greenwich an observer is their sundial will read a time 4 minutes after GMT (their sundial is ahead of one at Greenwich)
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- For every degree West of Greenwich an observer is their sundial will read a time 4 minutes before GMT (their sundial is behind one at Greenwich)