Astronomy **Summary Knowledge Organiser** – Ch. 2 (Topic 6) **Celestial observation (i) Stars & constellations**

How objects appear in the night sky when seen with the naked eye

The SUN Physical nature = a yellow dwarf star (class G2) with an angular size of 0.5 degrees.
Description of appearance = A very bright yellow extended object.

The MOON Physical nature = a natural satellite of the Earth with an angular size of 0.5 degrees.
Description of appearance = a bright white extended object with darker patches.

A STAR Physical nature = a hot sphere of gas where nuclear fusion is transforming mass into ENERGY.
Description of appearance = a single point of light.

OPTICAL DOUBLE STAR Physical nature = two stars that appear close together but may be far apart. It is simply a 'line of sight' effect! Description of appearance =Two points of light close together.

SUPERNOVA = a **bright new point of light** that is **visible for a few weeks** before **slowly fading**.

CONSTELLATION Physical nature = The sky is split into **88 different areas** called constellations.
Description of appearance = A recognized pattern of stars in the sky.

ASTERISM = A smaller recognized pattern made up of stars within one, or across different, constellations.

STAR CLUSTERS = **close group of single points of light**. **GALAXIES/NEBULAE** = **faint fuzzy patch of light**.

PLANETS = a **single point of light** that does **not twinkle**, they **move slowly eastwards night to night**.

COMETS = an **extended fuzzy object** with **1 or 2 tails**, that moves slowly across the sky from night to night.

METEOR (shooting star) = a **streak of light** that lasts for only a **few seconds**.

ARTIFICIAL SATELLITES = a **point of light** moving in a **straight line** until it disappears into Earth's shadow.

AIRCRAFT = a **red or green light** or a **flashing white light** that moves across the night sky in a few minutes.

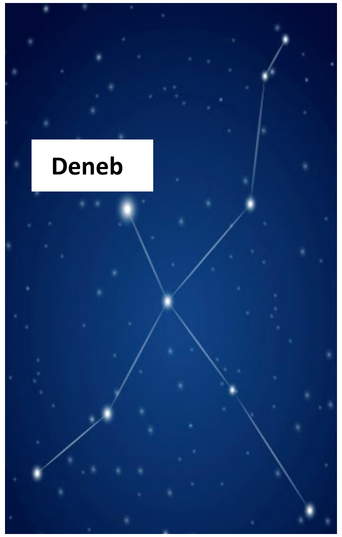
The **asterisms** below can be used as **POINTERs** to help astronomers **navigate** their way around the night sky.

Formalhaut

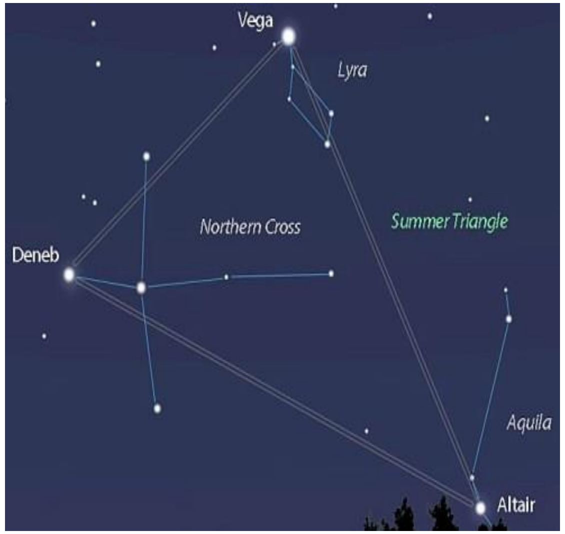
Cassiopeia

Southern Cross

Cygnus

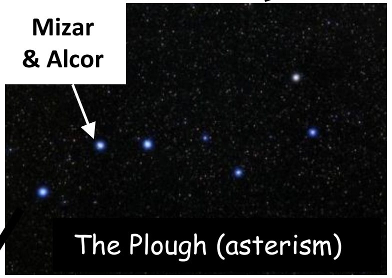


Summer Triangle (asterism)



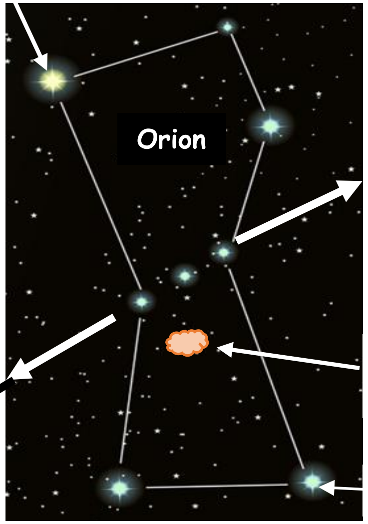
Polaris

Mizar & Alcor



Arcturus

Betelgeuse



Taurus & the Pleiades open star cluster

Orion nebula

Rigel

Sirius

Astronomy **Summary Knowledge Organiser** – Ch. 2 (Topic 6) (ii) **Celestial observation & the celestial sphere**

The **CELESTIAL SPHERE** is an **imaginary sphere** that surrounds the Earth that is **covered by a network of lines** that are similar to those of latitude and longitude that cover the Earth's surface.
On Earth, latitude is measured in degrees, north or south of the equator, the equivalent of this on the celestial sphere is measured from the **celestial equator** (again in **degrees**, but this time **+** or **-**) and is called **DECLINATION** (**dec.**).
On Earth, longitude is measured in degrees, east or west of the Prime Meridian, however the celestial sphere has no equivalent to this zero line of longitude. Because of this astronomers have added *the path taken by the Sun on the celestial sphere over one year* (**the ecliptic**) to the sphere and the point where it **cuts the celestial equator** (**as it moves S to N**) represents the celestial spheres zero point for **RIGHT ASCENSION** (**R.A**), measured in hrs/mins/secs. This very special point where the ecliptic intercepts the celestial equator is called the **FIRST POINT OF ARIES** and its coordinates are **0h0m0s R.A.** and **0°dec.**

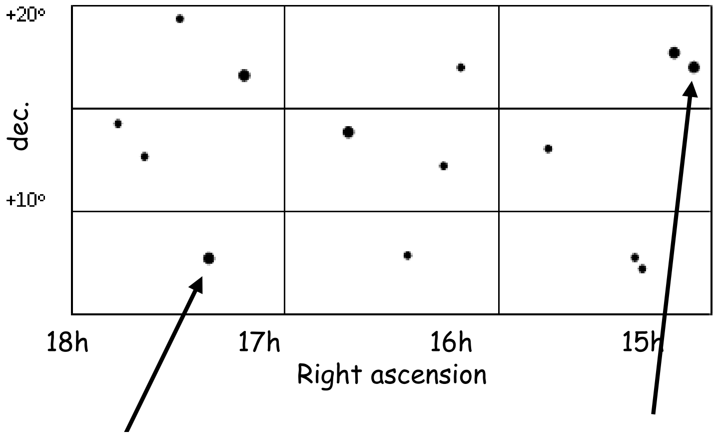
CONVERTING degrees into R.A.

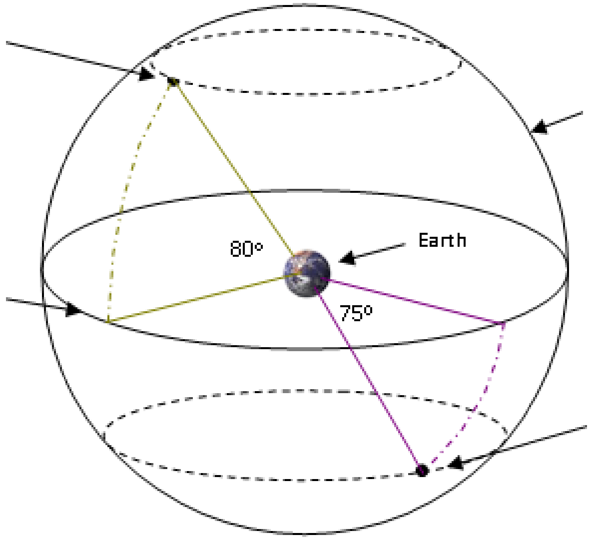
15° = 1 hour
15° = 60 min
5° = 20 min

45° = 3 hours
0.25° = 1 min
1° = 4 min

The **EQUATORIAL COORDINATE SYSTEM** uses **right ascension** (measured ***eastwards*** from the First Point of Aries) and **declination** (measured north (+) or south (-) of the celestial equator).

Oddly, ***R.A. increases to the left****, this is because when imagining the celestial sphere we have to remember we are '****inside it, looking outwards****'.*

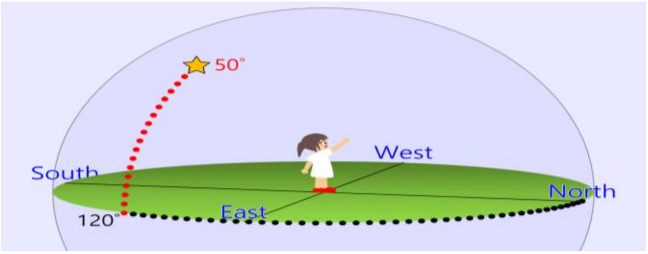




The **HORIZONTAL COORDINATE SYSTEM** is much easier to use, so many **AMATEUR ASTRONOMERS** choose to use this instead. This is an **alti-azimuth system** and uses **AZIMUTH** to give a **bearing** telling you **which direction to look in** and **ALTITUDE** to tell you **how far up to look**!

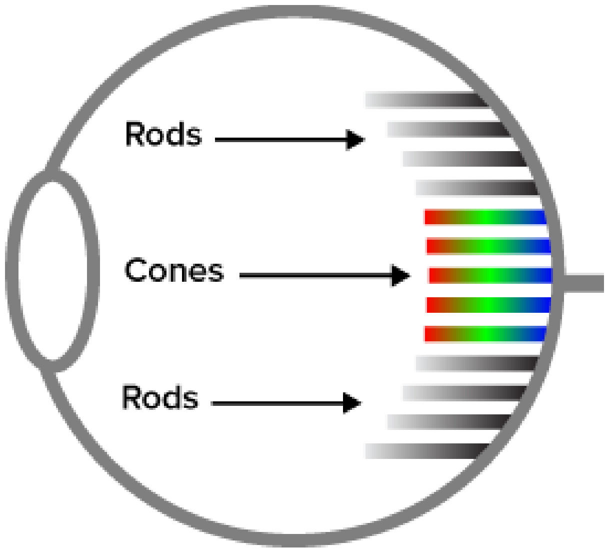
The **AZIMUTH** bearing is given in **degrees** from **geographic due North** and again is measured ***eastwards*** from due north eg. **180° azimuth** means the observer looks North, then moves along the horizon eastwards 180° and the star should be directly above that point on the horizon. Clearly, ***90° = East, 180° = South and 270° = West.***

The **ALTITUDE** is the **angle** an object is **from the observer's horizon** and is again given in **degrees.** The altitude value can *range* ***from 0° to 90°***.



Many factors affect the **VISIBILITY** of objects in the night sky- the **landscape** (trees & buildings can block views), **cloud cover**, **light pollution** (**skyglow** from nearby urban areas & the **local light glare**), the **transparency** of the atmosphere (recent **rainfall removes dust and pollen** particles that would scatter and absorb light) and the **seeing conditions** (a measurement of the '**steadiness**' of the atmosphere that we quantify using the **I-V ANTONIADI SCALE**).

Astronomy **Summary Knowledge Organiser** – Ch. 2 (Topic 6) **Celestial observation** (iii) **Diurnal motion**



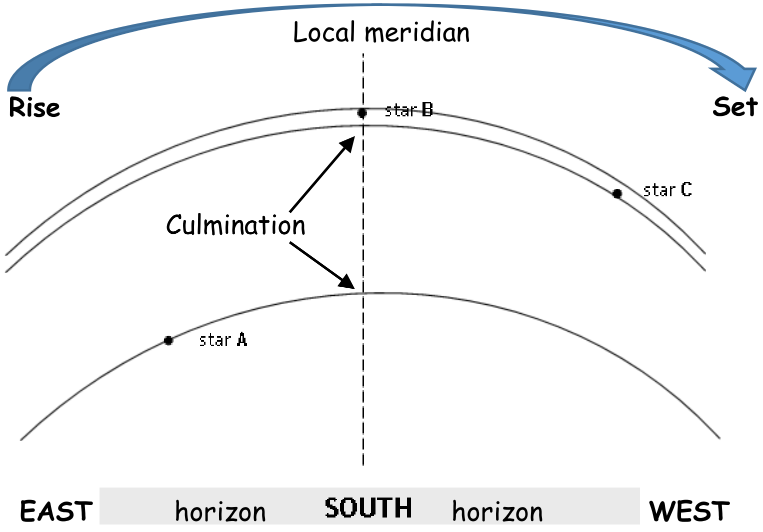
Before observing the night sky we must ensure our **EYES** are **DARK ADAPTED (**you need to experience **20-30 mins** of continuous darkness**).** A lens at the front of the eye focusses images onto the **RETINA** at the back. The retina contains **2 types of cells** that are **photoreceptive** (sensitive to light). **RODS** are **ideal for night vision** because the are **sensitive to changes in light intensity** and still **work even in very dark conditions. CONES** are **colour sensitive** but **only work if the light is bright enough**! Cones lie straight on the eyes optical axis. If you look directly at a dim object the light will be focussed onto the cone cells and because they are not activated in dim light you may not be able to see it!

To see dim objects we need to stimulate the rod cells and since these are located off-set from the eyes optical axis we need to '**look slightly to the side of the object**' so that the light is focussed onto these highly sensitive cells. Using this **naked eye technique** to observe dim objects is called **AVERTED VISION**.

If you are trying to identify objects in the night sky when **NAKED EYE OBSERVING** your potential sources of information are **star charts**, **planispheres**, **computer programs** (eg Stellarium) or '**astronomical apps**'.

All observations such be carried out when the object you are observing is '**close to CULMINATION**'. At culmination objects will **appear at their brightest** and be **at their highest point in the sky.** Observing at culmination has two advantages – the '**colour**' of the object will be more likely to be **detected** (higher position in the sky usually means a **better contrast** due to the darker sky) and '**extended objects**'(such as **star clusters)** can be **better resolved**.

To calculate an objects **culmination time (HALF-WAY between them)** we simply find its **rising** and **setting time. All** the objects seen in the day or night sky **culminate directly South** of the observer. An imaginary line drawn upwards from the **southern CARDINAL POINT** on the horizon tells us where all objects will culminate for that observer, it is called the **LOCAL MERIDIAN**.



Looking south

The apparent motion of the stars in the night sky is to **RISE in the EAST**, culminate directly south and then **SET in the WEST**. It is called **DIURNAL MOTION** and is caused by the Earth **rotating on its axis west to east**. The Earth takes **23h56m** to rotate **360°** relative to the stars. This called a **SIDEREAL DAY**.

During this time the Earth also **moves 1° around its orbit of the Sun** and so it **needs to rotate for an extra 4 minutes** to **re-align a given point on the Earth's surface with the Sun**. As a result a **SOLAR DAY** is **24h0m.**

This difference of 4 minutes causes the stars to **rise**, **culminate** and **set 4 minutes EARLIER each day**!!

Most astronomers observe the stars as opposed to the Sun and so they use clocks based on **LOCAL SIDEREAL TIME (LST)** rather than normal clock time.

The LST of an observer is **the right ascension of a star that is on the observers meridian at that moment in time.** If a star with a right ascension of 14h45m is seen on an observers meridian then that observers LST is 14:45.

Astronomers also use the term **HOUR ANGLE** to help explain where stars are relative to an observers meridian.

A stars hour angle tells us **how long ago the star crossed the observers meridian**. If a star has an **hour angle of 1h20m** then it crossed the observers meridian 1 hour 20 minutes earlier. If a stars hour angle has a **NEGATIVE VALUE** it means the star has not crossed the meridian yet.

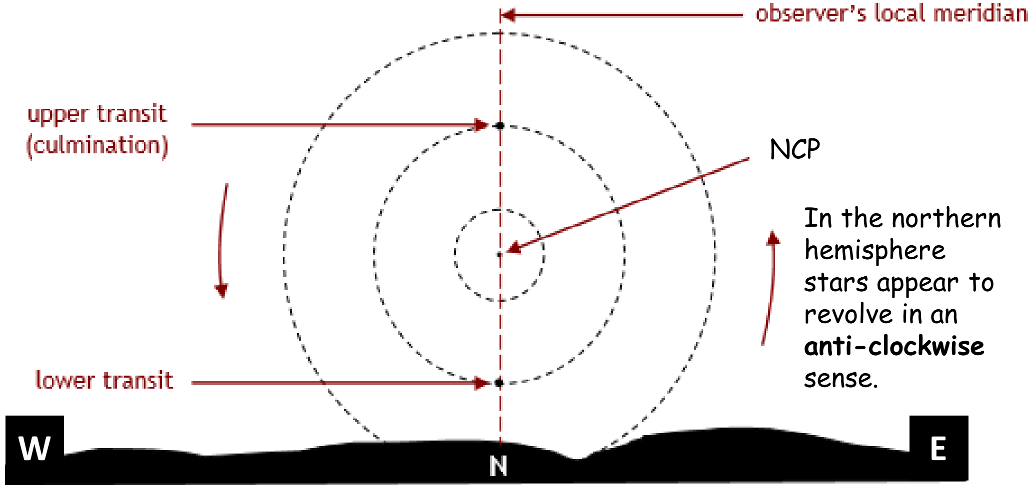
If a star has an **hour angle of -2h30m** then it will cross the observers meridian in 2 hours 30 minutes time and so this is when it will be best to observe it!

The following equation links a stars hour angle & right ascension to the local sidereal time;

hour angle = local sidereal time – star right ascension

Astronomy **Summary Knowledge Organiser** – Ch. 2 (Topic 6) **Celestial obs'** (iv) **Circumpolar stars**

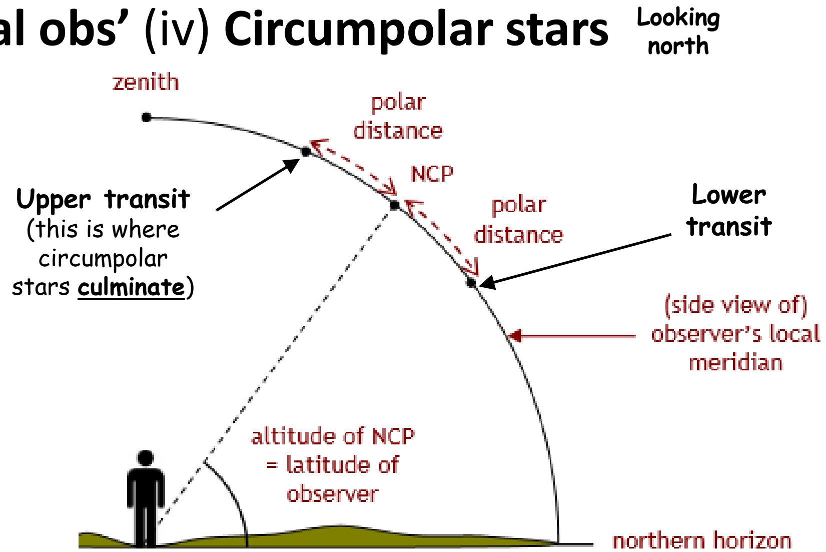
If we look **NORTHWARDS** the **stars appear to REVOLVE ANTI-CLOCKWISE around the North Celestial Pole (NCP).**
Since, **Polaris lies very close to the NCP** other stars appear to move **east to west** <u>above</u> Polaris and have an **<u>upper transit</u>** when they cross the observers meridian.
<u>Below</u> Polaris stars move **west to east** and have a **<u>lower transit</u>**.



If you want to know what **LATITUDE** you are stood at you can simply **estimate the altitude of Polaris** above the horizon.

observer latitude = altitude of the NCP

(Polaris is only 0.5° from it).



A stars **POLAR DISTANCE** (or **<u>co-declination</u>**) tells us its **angular distance from the NCP**.
NCP dec. = +90° so we can use the equation below to calculate a stars polar distance;

Polar distance = 90° – dec.

A stars **<u>altitude</u>** at its **upper transit** & **lower transit** allows us to link its **equatorial** & **horizontal coordinates**:

Altitude at upper transit = observer latitude + star polar distance

Altitude at lower transit = observer latitude - star polar distance

CIRCUMPOLAR STARS have such **small polar distances** that they **'never set below the horizon'** and so **always remain visible.** If a star is circumpolar its **polar distance must be <u>less than</u> the altitude of the NCP** (and the 'latitude of the observer' – because this is always the same as the altitude of the NCP).
To calculate if a star is circumpolar or not we use the following equation:

$$\text{declination} > 90 - \text{latitude}$$

If a stars **declination** is **<u>greater than</u> 90 minus the observers latitude, the star IS circumpolar.**
If a stars **declination** is **<u>NOT greater than</u> 90 minus the observers latitude, the star IS NOT circumpolar.**