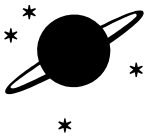
THE IRISH FEDERATION OF ASTRONOMICAL SOCIETIES

PRESENT

THE

NOVICE ASTRONOMER OBSERVING CHALLENGES

HANDBOOK



A Self-contained Handbook and Logbook for the Novice Astronomer, as part of the IFAS *Observing Certificates Programme*

AUTUMN 2004

THE OBSERVING CERTIFICATES WORKING GROUP
WORKING UNDER THE IRISH FEDERATION OF ASTRONOMICAL SOCIETIES

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OBSERVING PROGRAMME REGULATIONS

1. To take part in the *Observing Certificates Programme* you must be a member of one of the member clubs or societies of the IFAS. Check out the list of clubs and links to their websites at the IFAS webpage, *www.irishastronomy.org*, or on page 4 of this handbook.

2. Observations must be made **after September 18th 2004** (the launch date), AND after the date of purchase of this handbook.

3. You must either post or hand this Handbook to the Observations Secretary who will then verify your recordings. Your Handbook must be received at least 21 days before the star party at which you wish to receive your certificate (*Connaught* in January, *COSMOS* in March, *Whirlpool* in September).

4. Duplicate observations must be made for each Observing Challenge. If, for example, you observe M31, the Andromeda Galaxy for the *Messier Objects Observing Challenge*, you cannot use the same observation for the *Binocular Sky Observation Challenge*.

Please remember that the people involved in this project are volunteers who are giving their time freely to run and maintain this programme. The purpose behind the *IFAS Observing Certificates Programme* is to encourage better, more systematic, and more organised observation of the night sky. These rules are there to help the programme run smoothly, and should not be seen as restrictive or harsh. We're just trying to be fair.

No person or organisation profits financially from this *IFAS Observing Certificates Programme*. The cost of these handbooks is to strictly cover their printing and binding.

Received From: _____ Dated: _____

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www.irishastronomy.org

The IFAS is made up by membership of the following National Amateur Astronomical Societies & their members:

Astro 2 (NUI Maynooth)
(http://astro2.iwarp.com/)

Bausch & Lomb Astronomy Society
(www.geocities.com/bauschandlombastronomysociety/BLAS.html)

Cork Astronomy Club
(www.qsl.net/ei5fk/astronomy.html)

East Antrim Astronomical Society
(www.eaas.co.uk)

Galway Astronomy Club
(http://homepage.eircom.net/~galwayastronomyclub)

Kerry Astronomy Club
(http://homepage.eircom.net/~kerryac)

Irish Astronomical Association
(www.btinternet.com/~jimmyaquarius)

Irish Astronomical Society
(www.irishastrosoc.org)

Shannonside Astronomical Club
(http://go.to/sac)

Slaneyside Astronomy Society
(wexford_astronomy@yahoo.ie)

South Dublin Astronomical Society
(skynotes@eircom.net)

Tullamore Astronomical Society
(www.tullamoreastronomy.com)

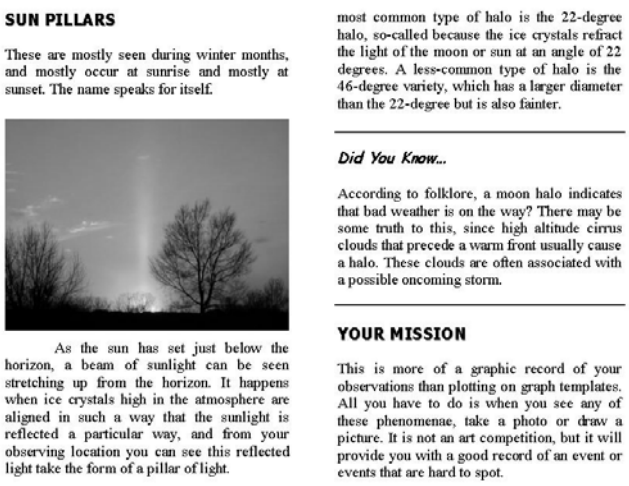
FOREWORD: AN INTRODUCTION

Welcome to the ***Novice Astronomer Observing Challenge***. This programme is run in conjunction with others under the Irish Federation of Astronomical Societies' ***Observing Certificates Programme***.

If you have always wanted to know where to start, then this is the book for you. As you progress, there are other challenges for you to take part in: The Messier Observing Challenge, The Binocular Observing Challenge, The Deep Sky Observing Challenge, and many more. While this handbook is orientated towards the almost absolute beginner, anyone considering themselves a novice can take part! These are designed to encourage you to become a better astronomical observer.

During the course of this handbook and logbook, you will encounter the basic sections all astronomers get familiar with first. This is a learning curve, it is meant to be a slight bit fun - but is in no way is it to be considered a competition. There is no *1st Place*. The aim of this programme is to award astronomers across Ireland and abroad who are members of Irish astronomical clubs and societies, for their efforts and endeavours, no matter how small they may seem. This programme is designed to encourage the amateur astronomer starting out on the hobby, and to enhance their awareness of what is within their grasp, yet may not know its there.

This Handbook is designed to be easy to follow. With introductions to all the topics covered, and handy little ***Did You Knows***, we hope it meets your expectations. Feel free to contact the group representative at the address shown at the bottom if you feel anything needs attention.



SUN PILLARS

These are mostly seen during winter months, and mostly occur at sunrise and mostly at sunset. The name speaks for itself.

As the sun has set just below the horizon, a beam of sunlight can be seen stretching up from the horizon. It happens when ice crystals high in the atmosphere are aligned in such a way that the sunlight is reflected a particular way, and from your observing location you can see this reflected light take the form of a pillar of light.

most common type of halo is the 22-degree halo, so-called because the ice crystals refract the light of the moon or sun at an angle of 22 degrees. A less-common type of halo is the 46-degree variety, which has a larger diameter than the 22-degree but is also fainter.

Did You Know...

According to folklore, a moon halo indicates that bad weather is on the way? There may be some truth to this, since high altitude cirrus clouds that precede a warm front usually cause a halo. These clouds are often associated with a possible oncoming storm.

YOUR MISSION

This is more of a graphic record of your observations than plotting on graph templates. All you have to do is when you see any of these phenomenae, take a photo or draw a picture. It is not an art competition, but it will provide you with a good record of an event or events that are hard to spot.

When you have this logbook completed, see the very last section in this book, just inside the back cover. There you will find instructions on what to do once you have completed (as much as possible) this handbook.

Please send it at least 3 weeks (21 days) before the Star Party in which you wish to be awarded (**Whirlpool Star Party**, September, *Shannonside Astronomy Club*; **Connaught Star Party**, January, *Galway Astronomical club*; **COSMOS**, March/April, *Tullamore Astronomical Society*). Approximate dates of these star parties can be found on the IFAS website (www.irishastronomy.org), or by contacting the Secretary of the club/society hosting the star party.

There are 2 Certificates to be awarded – the first for the ***IFAS Novice Astronomer Challenge Participation***, and a second for ***Outstanding Work in the Novice Handbook***.

So, without further ado, we welcome you to your new challenges in Astronomy. May your endeavours bring you to new heights in the oldest of hobbies!

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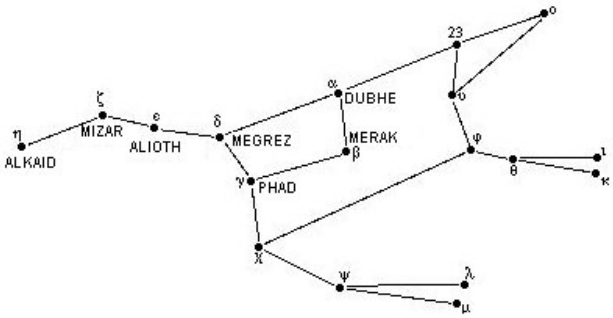
ASTRONOMICAL AIDS TO THE CASUAL NOVICE

If you are starting out in Astronomy and are eager to get out in to the field so to speak, then it's no harm to follow this section to help you along the way. This will help you enjoy the hobby even more, and keep you comfortable while you do so.

FIRST THINGS FIRST

The best observing instruments, of course, are your eyes. To start, why not take up a small book about the night sky. Get familiar with the patterns of stars that make up the constellations with a Star Chart or Atlas. Learn how to find constellations or other celestial objects by using the more prominent ones as guides, such as Ursa Major - better known as The Plough and recognisable to novices and keen amateur astronomers alike.



whatever you call it, it is one of the most recognised constellations in the Northern Hemisphere. Dubhe & Merak are the *pointer stars* to the Pole Star, *Polaris*.

Many stars make imaginary pointers to other well-known stars and celestial objects. On any clear night, simply look up: Dubhe and Mirak, the last 2 stars in the Plough's 'bowl', point to Polaris, the Pole Star (celestial North); Cassiopaeia looks like a W or M, and the star clusters around it, and the radiant of the Perseids beside it; and during Winter, Orion's Belt made up of 3 stars in almost a straight line in a south-west kind of direction follow this to bring you to Sirius, the brightest star in the sky. All these aids lead to bigger and better things. Like all great endeavours, you first have to start small!

As you learn more, you will want to get something to improve your observing power. If you are new to astronomy as a hobby, you will probably have been told by now that a good pair of binoculars are well worth spending your money on. They are cheap, robust, and are easy to maintain and store. A good size to start from would be 10X50's. What does this mean? 10 is the magnification, and 50 is the size of the objective lens (at the front of the binocular) in millimetres. Thus, 10X50's allow a larger field of view than 10X40's with the same magnification. If your price range allows, go for bigger! When you have these, the ***IFAS Binocular Challenge Handbook*** will provide some interesting challenges for you to explore!

Get a star atlas. They come in many sizes, from the *MiniGem* series that fit in your pocket to almost A3 size. See *Appendix D – Recommended Reading* for useful book titles. Many will have easy to recognise shapes and colours for the different categories of objects that can be found in a binoculars or telescope. Invest, too, in a small red flashlight. This is important because you will need to see what you are reading at a dark observing site, but not ruin your night vision. It can take your eyes about 20-25 minutes to FULLY adjust to very dark surroundings, and a normal flashlight will ruin that in a flash! A red candy wrapper fixed over the flashlight window is a good aid.

BE PREPARED

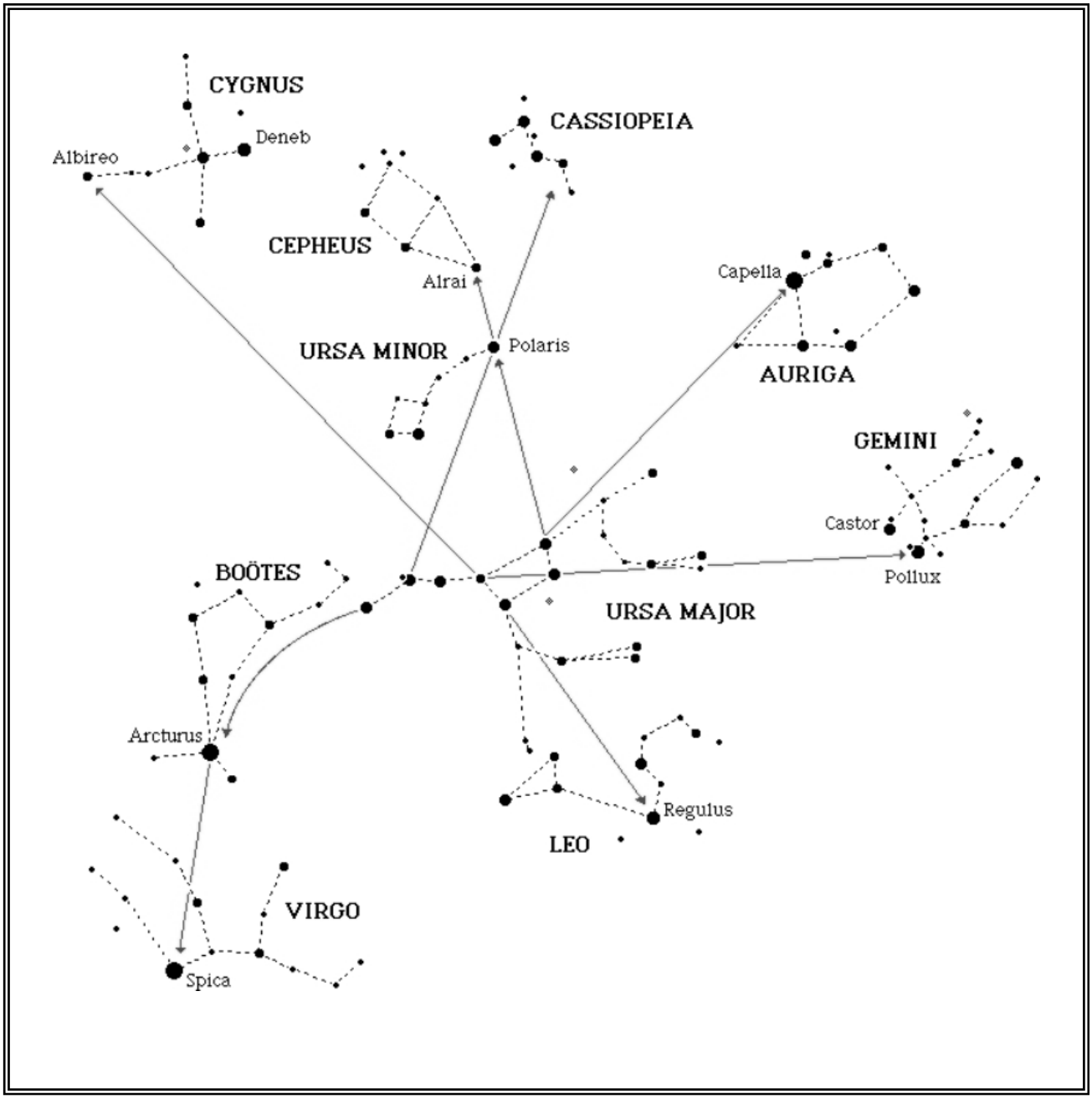
Be sure to wrap up warm. On very cold nights, it is important to do so if you intend to stay out for long periods. Boots are a must, with 2 pairs of socks. 2 pairs are better than 1 because not only will they keep your feet warm from the cold ground, but also comfortable while you are standing for long periods. Sometimes 2 pairs of gloves are handy - small thin pair with the fingertips cut off for grabbing eyepieces, pencils etc, while a bigger pair to put over them to keep them warm. A woolly hat instead of a baseball cap. 2 fleeces are thin yet comfortable and warm, inside a warm coat. A scarf for the neck. If you have to wear jeans, wear them over a tracksuit pants. Of course, during summer months, this might seem drastic, but even then you will still feel the cold when you are not frequently moving about.

Take notes when you are observing - you never know what you might see. But, use a HB pencil. Ink in a pen will freeze and the pen may burst. A clipboard with some plain paper attached is ideal for writing on. Bring an easy-chair to sit on to take a break now and again. It is not good to stand and crick your neck skyward for long periods of time!

If you smoke, try not to when you are out in the cold. Smoking is a vasoconstrictor , this means it will restrict blood to your extremities, making them feel colder, quicker. Alcohol and coffee fall into the same category. Bring hot drinks in a thermos instead, like tea or even better, soup. Snacks are allowed too, but try to avoid anything greasy - getting greasy fingerprints on eyepieces etc. is not good!

If you are travelling some distance to you observing site, be prepared for the worst. You may discover you will run out of petrol/diesel and will have to stay the night! Have a sleeping bag or blanket in the car just in case. Spare batteries for your flashlight, a bottle of water (for when you're thirsty!), and even a book to read are great companions if you get stuck somewhere till daylight comes. Above all this, remember to have the fuel can in the boot of your car topped up, and you wont have to worry at all.

As you go to lectures and observing nights, you will hear astronomers call out objects in the sky by their names or perhaps even their M numbers e.g. The Orion Nebula is also M42, the Crab Nebula is M1 etc. Don't be distracted from hearing all these odd sounding names and numbers - as you learn more, you will remember them too!



Map showing *Ursa Major* and the more prominent constellations, which can be located via *Ursa Major*.

TERMS AND PHRASES

This section just introduces the beginner to the plethora of words, terms, and phrases you will come across in Astronomy.

Aphelion: see Orbit.
Apogee: see Orbit.
Black hole: the theoretical end-product of the total gravitational collapse of a massive star or group of stars. Crushed even smaller than the incredibly dense neutron star, the black hole may become so dense that not even light can escape its gravitational field. It has been suggested that black holes may be detectable in proximity to normal stars when they pull matter away from their visible neighbours. Strong sources of X rays in our galaxy and beyond may also indicate the presence of black holes. Recent evidence suggests that black holes are so common that they probably exist at the core of nearly all galaxies.
Conjunction: the alignment of two celestial bodies at the same celestial longitude. Conjunction of the Moon and planets is often determined with reference to the Sun. For example, Saturn is said to be in conjunction with the Sun when Saturn and the Earth are aligned on opposite sides of the Sun.
Mercury and Venus, the two planets with orbits within Earth's orbit, have two positions of conjunction. Mercury (or Venus) is said to be in inferior conjunction when the Sun and the Earth are aligned on opposite sides of Mercury (or Venus). Mercury is in superior conjunction when Mercury and the Earth are aligned on opposite sides of the Sun.
Elongation: the angular distance between two points in the sky as measured from a third point. The elongation of Mercury, for example, is the angular distance between Mercury and the Sun as measured from Earth. Planets whose orbits are outside the Earth's can have elongations between 0° and 180°. (When a planet's elongation is 0° it is at conjunction; when it is 180°, it is at opposition.) Because Mercury and Venus are within the Earth's orbit, their greatest elongations measured from the Earth are 28° and 47°, respectively.
Galaxy: gas and millions of stars held together by gravity. All that you can see in the sky (with a very few exceptions) belongs to our galaxy-a system of roughly 200 billion stars. The exceptions you can see are other galaxies. Our own galaxy, the rim of which we see as the "Milky Way," is about 100,000 light-years in diameter and about 10,000 light-years in thickness.
Neutron star: the extremely dense spinning star that is one of the possible results when a massive star's core has imploded on itself in a supernova. Some neutron stars pulse radio waves into space as they spin; these are known as pulsars.
Occultation: the eclipse of one celestial body by another. For example, a star is occulted when the Moon passes between it and the Earth.
Opposition: the alignment of two celestial bodies when their longitude differs by 180°. Opposition of the Moon and planets is often determined with reference to the Sun. For example, Saturn is said to be at opposition when Saturn and the Sun are aligned on opposite sides of the Earth. Only the planets whose orbits lie outside the Earth's can be in opposition to the Sun.
Orbit: the path travelled by a body in space. The term comes from the Latin *orbis*, which means circle or circuit, and *orbita*, which means a rut or a wheel track. Theoretically, there are four mathematical figures, or models, of possible orbits: two are open (hyperbola and parabola) and two are closed (ellipse and circle), but in reality all closed orbits are ellipses. Ellipses can be nearly circular, as are the orbits of most planets, or very elongated, as are the orbits of most comets, but the orbit revolves around a fixed, or focal, point. In our solar system, the Sun's gravitational pull keeps the planets in their elliptical orbits; the planets hold their moons in place similarly. For planets, the point of the orbit closest to the Sun is the perihelion, and the point farthest from the Sun is the aphelion. For orbits around the Earth, the point of closest proximity is the perigee; the farthest point is the apogee. See also Retrograde.
Perigee: see Orbit.
Perihelion: see Orbit.
Planet: a celestial body in orbit around a star. Even in ancient times, it was known that a number of "stars" did not stay in the same position relative to the others. There were five such restless "stars" known-Mercury, Venus, Mars, Jupiter, and Saturn-and the Greeks referred to them as *planetes*, a word which means "wanderers." That Earth is one of the planets was realized later. The additional planets were discovered after the invention of the telescope.
In 1995, several of these extrasolar planets were discovered orbiting stars similar to our Sun. Swiss astronomers found a planet orbiting star 51 in the constellation Pegasus, about 40 light-years away. It is the first planet ever discovered to circle a normal Sun-like star.

Pulsar: a source of radio waves, emitted in bursts at regular intervals. Pulsars are believed to be rapidly spinning neutron stars, so crushed by their own gravity that a million tons of their matter would hardly fill a thimble.

Quasar: "quasi-stellar" object. Originally thought to be peculiar stars in our own galaxy, quasars are now believed to be the most remote objects in the universe. Quasars emit tremendous amounts of light and microwave radiation. Recent Hubble Space Telescope images suggest that there may be a variety of mechanisms for "turning on" quasars. Although a number of images show collisions between pairs of galaxies, which could trigger the birth of quasars, some pictures reveal apparently normal, undisturbed galaxies possessing quasars.

Quasars are among the most baffling objects in the universe because of their small size and enormous energy output. Quasars are not much bigger than Earth's solar system, but pour out 100 to 1,000 times as much light as an entire galaxy containing a hundred billion stars. A quasar detected in March 2000 with a redshift of 5.8 is 12 billion light-years from Earth and is the most distant object ever observed to date.1 A super massive black hole, gobbling up stars, gas, and dust, is theorized to be the "engine" powering a quasar. Most astronomers agree that an active black hole is the only credible possibility that explains how quasars can be so compact, variable, and powerful. However, no conclusive evidence supports this assumption.

Retrograde: describes the clockwise orbit or rotation of a planet or other celestial body, which is in the direction opposite to the Earth and most celestial bodies. As viewed from a position in space north of the solar system (from some great distance above the Earth's North Pole), all the planets revolve counter-clockwise around the Sun, and all but Venus, Uranus, and Pluto rotate counter-clockwise on their own axes. These three planets, therefore, have retrograde motion.

Sometimes retrograde is also used to describe apparent backward motion as viewed from Earth. This motion happens when two bodies rotate at different speeds around another fixed body. For example, the planet Mars appears to be retrograde when the Earth overtakes and passes by it as they both move around the Sun.

Satellite (or moon): a body in orbit around a planet.

Star: a celestial body consisting of intensely hot gases held together by its own gravity. Stars derive their energy from nuclear reactions going on in their interiors, generating their own heat and light. Stars are very large. Our Sun, which is the nearest star, has a diameter of 865,400 mi-a comparatively small star.

A dwarf star is a small star that is of relatively low mass and average or below average luminosity. The Sun is a yellow dwarf, which is in its main sequence, or prime of life. This means that nuclear reactions of hydrogen maintain its size and temperature. By contrast, a white dwarf is near death in the life cycle of a star. White dwarfs come into being in one of two ways: either as the result of the implosion, or supernova, of a massive star, or after the collapse of a red giant.

A red giant is a star nearing the end of its life. When a star begins to lose hydrogen and burn helium instead, it gradually collapses, and its outer region begins to expand and cool. The light we see from these stars is red because of their cooler temperature.

A brown dwarf lacks the mass to generate nuclear fission like a true star, but it is also too massive and hot to be a planet. A brown dwarf usually cools into a dark, practically invisible object. The existence of brown dwarfs, was confirmed in Nov. 1995 when astronomers at Palomar Observatory in California took the first photograph of this mysterious object.

Supernova: the explosion of a star. There are two common types of supernova. Type Ia is the brighter of the two and happens when a white dwarf star draws large amounts of matter from a nearby star into itself, creating a super-powered fusion process ending in the star's collapse. The second, more well-known type, IIa, is the result of the collapse of a massive star. Massive stars are born and develop through the process of atomic fusion of hydrogen into helium, which uses and releases an immense amount of energy. The massive star's heat causes the creation of the star's dense center, made of heavier and heavier elements (even iron) as the process continues. This core of heavy elements causes there to be a gravitational force inside the star. When there isn't enough hydrogen to power the fusion any longer, the star's core collapses inward on itself, releasing a huge amount of energy (the supernova), which may be brighter than the massive star's host galaxy.

AN IDEA OF SIZE OR SCALE

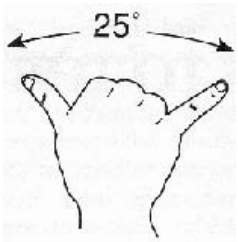
If you have seen a picture of a total eclipse of the Sun, you would have noticed that the black disk of the Moon just about covers the bright disk of the Sun. If you were to suspend a €1 coin about 2.5 meters in front of your eye, it would just about cover the Moon's disk.

The Sun is nearly 1.6 million km in diameter, the Moon is 3,200km, and that €1 coin is just over 2 cm across. Yet they appear nearly equal. This is because they appear to take up the same amount of space in front of our eyes. What this really means is that they appear to have the same angular diameter - in this case about half a degree.

Degrees are further divided into 60 arcminutes (60'), with each arcminute made up of 60 arcseconds (60"). This scale allows us to measure angles in the sky or apparent size of a celestial object. For example, the full Moon measures (on average) 0.5 degrees, or 30 arcminutes (30') in diameter.

CELESTIAL DISTANCES

Your closed fist held at arms length is about 10 degrees. Your stretched hand i.e. from the tip of your thumb to the tip of your little *baby* finger FULLY outstretched is about 25 degrees. Four outstretched hands, or about twice as many closed fists will take you from the horizon to the zenith.



If you know the Plough you will find that its overall length is rather more than one outstretched hand, at almost 25 degrees. Some familiarity with angular measure is necessary to find your way easily about the night sky.

ASTRONOMICAL DISTANCES

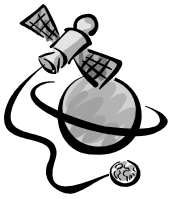
For the purposes of the *Novice Astronomer Observing Challenge*, you will not need to use these measurements, but while we are on the subject, lets take a moment to go through a few figures.

As you know, long-distance is measured in miles or kilometres. This is useful when we refer to measurements on, or even near Earth. But if we travel further into space and we see how vast it actually is, these units of measurements are not practical.

Astronomers therefore use a more manageable metre-stick within the solar system known as the *Astronomical Unit (AU)*. One astronomical unit is simply the mean Earth-Sun distance which is roughly 149, 597, 870 kilometres — mind you, it would still take over 177 years continuous driving (within the national road speed limit!) to reach the Sun!

The void between the planets may be measured in tens of millions of kilometres but to bridge the gap to even the nearest star requires kilometre-long leaps of mind-boggling proportions so we use the ***Light-year (Ly)***. A light-year is simply the distance travelled by a ray of light in a year. We know light itself has a finite speed of approximately 300, 000 km/s. So, using simple mathematics, a light year can then be calculated to be of 9·46 *trillion* km!

By the way, a light-year is a measure of *distance*, not of *time*. However, looking at the night sky we genuinely are looking back in time and see celestial bodies as they were because of how long even light needs to cross the huge distances.



For even greater distances among stars in our galaxy, the term ***Parsec*** is used. This is the equivalent to 3.26 Ly.

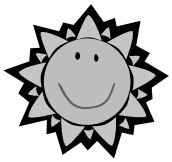
Once you get beyond the stars and into the realm of galaxies, even the light-year becomes unwieldy when talking in large numbers. The term ***Megaparsec*** (1000 *parsecs*) is freely banded about by cosmologists, though they are even reduced to describing distances to objects at the edge of the observable Universe in terms of their ***recessional velocity***, or ***red shift***, of which the quantity ***z*** is used in equations.

STAR MAGNITUDES

The magnitude of a star refers to its brightness, not to its size. The scale of magnitudes is a logarithmic one. A difference of one magnitude is a difference of 2.5 times in brightness. A difference of five magnitudes is a difference of 100 times in brightness. The lower the magnitude number (a negative value), the greater the brightness.

The stars in The Plough range from about magnitude 2 to magnitude 3.5. The faintest stars you can see with the naked eye on a really dark night, with no Moon and away from city lights, are magnitude 6 or 7. Binoculars show stars two to four magnitudes fainter, while the most powerful telescopes in the world are able to show magnitudes approaching +30. The *apparent magnitude* of a star depends on its true brightness and its distance. The term magnitude if not qualified, refers to apparent brightness.

The term *absolute magnitude* is the magnitude a star would show if it was placed at a standard distance of 10 parsecs (a parsec is the distance a star must lie to exhibit a parallax of one arc-second; it is equivalent to about 3·26 light years.)



While we are on the subject of brightness and all that, have you ever wondered why stars seem to *twinkle*, while planets do not? Its simple – The planets give off a steady light source because they reflect light from the sun. Also, due to their relative closeness to Earth compared to all other stars, their point as a source of light is therefore stronger. Thus, when the light passes through our atmosphere, it is not refracted as much due to the movement of air, and appears to twinkle far less than stars.

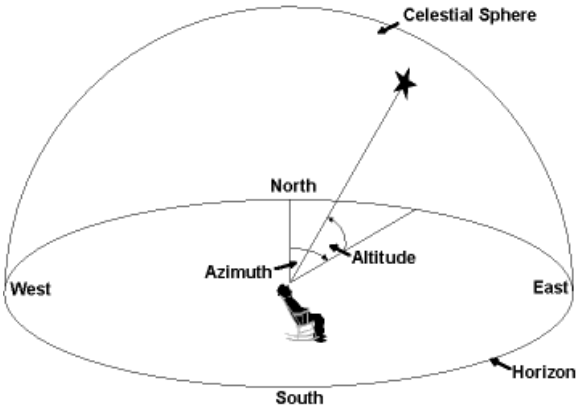
THE REVOLVING HEAVENS

We all know the Heavens don't revolve, it is the other way round - Earth rotates on its axis. But it looks otherwise and it is easier to describe things as we see them for our immediate purpose. The fact that the Earth turns on its axis about every 24 hours causes the Sun to rise in the east and set in the west, and it is due south at noon. A similar situation applies to all the other heavenly bodies, except that since they appear to move relative to the Sun they are not south every day at noon.

The stars appear to drift west in such a way that any particular star is due south four minutes earlier each day or night. If you multiply four minutes by 365 you get something close to 24 hours. So if a star is south at eight o'clock tonight, it will be south four minutes earlier tomorrow, and two hours earlier in a month. In six months it will be south at about eight in the morning. In a year it will be south at eight in the evening. It follows that we see different constellations in different seasons, but over a year, we see all we can see from Ireland.

POSITIONING IN THE SKY

Starting at any landmark and going right around the horizon is three hundred and sixty degrees. The azimuth of an object is a measure of it's point relative to the horizon as measured from true north which starts at 0° with due East being 90° and so on. Going from a point on the horizon straight up to the point overhead — the zenith — is ninety degrees and a measure of altitude.



Astronomers use a kind of celestial longitude and latitude called ***Right Ascension (R.A.)*** and ***Declination (Dec)*** to accurately plot the position of an object on the celestial sphere.

Right ascension is expressed in hours (h), minutes (m) and seconds (s) running eastward from 0 to 24 hours right around the sky. The zero point of right ascension is taken as the vernal equinox — the point where the Sun crosses the celestial equator, moving from south to north, in its course around the sky.

An object's declination is written in terms of how many degrees, minutes, and

seconds north (+) or south (-) of the celestial equator it is.

THE CHALLENGES

LETS BEGIN!

THE SUN

While you may not know it, you can in fact observe the sun. But, let this be said before you read on – **NEVER LOOK DIRECTLY AT THE SUN THROUGH ANY OPTICAL AID.** You will be permanently blinded *instantly*, and experience great pain as its heat burns the back of your eye - just so that you know!

Without the sun we would not be here to help you in your gathering of knowledge in Astronomy! The sun is 1,400,000km (864,000 miles) in diameter – Earth is a mere 12,700km (7,500 miles) in diameter! The sun uses nuclear fusion to turn hydrogen into helium with the release of a great amount of energy into the form of plasma, heat, and light. At the core, this process produces temperatures to be estimated at about 14 million degrees Celsius!

It is entirely a huge ball of fluid-like plasma. It is estimated the sun is about 5 billion years old. It is also estimated to be at the half way mark in its life.

Did You Know…

1 cm^2 of the suns surface shines with the same brightness and heat as 225,000 candles? Pretty bright eh?

Did You Also Know…

When astronomers measure distances, apart from the light year and the parsec, the Astronomical Unit (AU) is also used? This is the average distance from the sun to Earth – a distance of about 149 million km (93 million miles)!

WHAT TO USE

There is a new technology called Baader Film, which you can use with filters on telescopes and binoculars. It is the safest material to use to make solar filters and *eclipse shades* with. It is cheap, and available via mail order from many astronomy accessory outlets.

Going away from the telescope, you can use welders glass placed in front of your eyes to look at the sun. DO NOT use this either at the eyepiece of an optical instrument, or at the objective lens – even though the image is reduced in brightness, nearly all of the heat still passes through it.

Welders glass is graded according to strength. The best AND ONLY value welders glass you should look for is Grade 14EW (Grade 13EW would suffice if you cannot get the 14EW). This is very strong and black, and is safe enough to look at the sun with your eyes. Below this grade and it will not be strong enough, and may glare your eyes if used. It is available from most good hardware stores.

The method of Solar Projection is the best way to view the sun by magnification

YOUR MISSION

Included here is the template for recording sunspots. These are areas on the sun's surface that are cooler than the surrounding area, and thus look darker. Their temperature is about 4,000 degrees Celsius. The average temperature of the sun's surface as a whole is about 6,000 degrees Celsius.

Most sunspots are big enough to be seen as small pinpricks against the bright disc of the sun. Sunspots move across the sun as it rotates. The sun itself takes about 24 days to rotate. You can then track the movement of the sunspots.

Therefore, you should be able to track a minimum of a 12 day period for the sunspot rotation. Extra points will be awarded for the tracking of sunspots during a 24 day-or-more period.

Using your eclipse shades or welders glass, you must fill in as many sunspot charts as possible to show the tracking of sunspots. Sometimes the weather will not cooperate, but the more you record the sun on clear days, the more you can show the motion of the sunspots.

TRACKING SUNSPOTS

Use these templates to track to position and motion of sunspots over the given time period. Note the time and date of your observation in each template. If your location is different from 1 observing session to the next, add this to the **NOTES** section.

NAME: _____ **LOCATION:** _____

DATE: _____ **TIME:**_____

NOTES:

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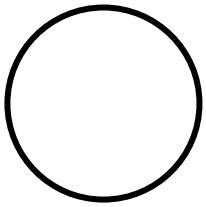

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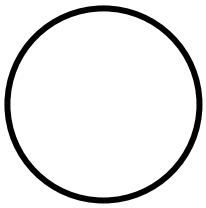

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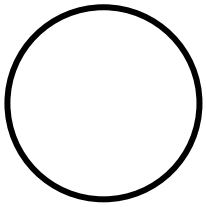

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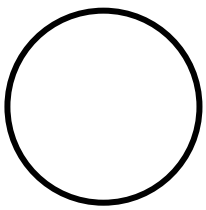

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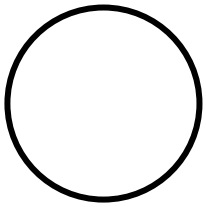

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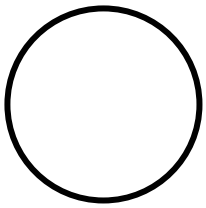

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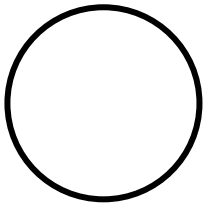

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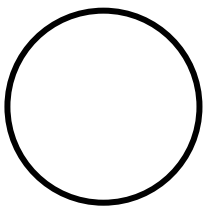


THE MOON

Our nearest neighbour in space, responsible for brightening the dead of night, and creating the tides, how much do you know about The Moon?

A BRIEF HISTORY

In actual fact, this could take millions of years to watch unfold!

The evolutionary model of the Solar System was finally understood when the planetismal model cracked the puzzle of how the planets rotate. Most, including Earth, spin on their axis in the same direction - counter clockwise as viewed from the north. But Venus, Pluto, and Uranus spins clockwise.

The planetismal theory accounts for these anomalies by proposing that Venus, Pluto, and Uranus were struck, during the late bombardment epoch, by objects that knocked them over or reversed their directions of rotation. This portrayal gains more support from the strange case of Miranda, a satellite of Uranus. Its surface, imaged by Voyager 2 in 1986, is a remarkable mix of old cratered-terrain, young smooth terrain, and several other features unlike anything else seen in the solar system. Theory has it that Miranda was hit so hard that it was nearly destroyed. Its remains flew apart, and then fell back together to form a strangely jumbled world. If so, Miranda is late bombardment road kill.

Our Moon is a mystery. Its is too big; its more than a quarter of the diameter of the Earth; its made of the wrong stuff. While Earth has a massive iron core, the moon contains virtually no iron. Its density, about 3.3 grams per cubic cenitmeter, resembles that of Earth's mantle, but not the core. Nor does the moon have much in the way of volatile chemicals like water.

And yet, to further confuse matters, there are similarities between the two objects; many minerals are found on both, and their relative abundance of various isotopes, such as those of oxygen (which on the moon is bound up in rock), is much the same. Finally, the Moons orbit is all wrong. Every other major satellite in the solar system orbits above its planets' equator. This is true even for satellites of tipped-over Uranus. But while Earth's axis is tipped relative to the orbital plane, by 23 degrees, the moon orbits along Earth's orbital plane, not its equator.

Taken together, these considerations seem to rule out two otherwise promising theories of how the Earth-Moon system originated. The first of these proposed that they formed together, from an eddy in the vast disk of material that surrounded the newborn Sun. But if this were the case, both bodies would have about the same chemical composition. Yet the moon is poor in iron.

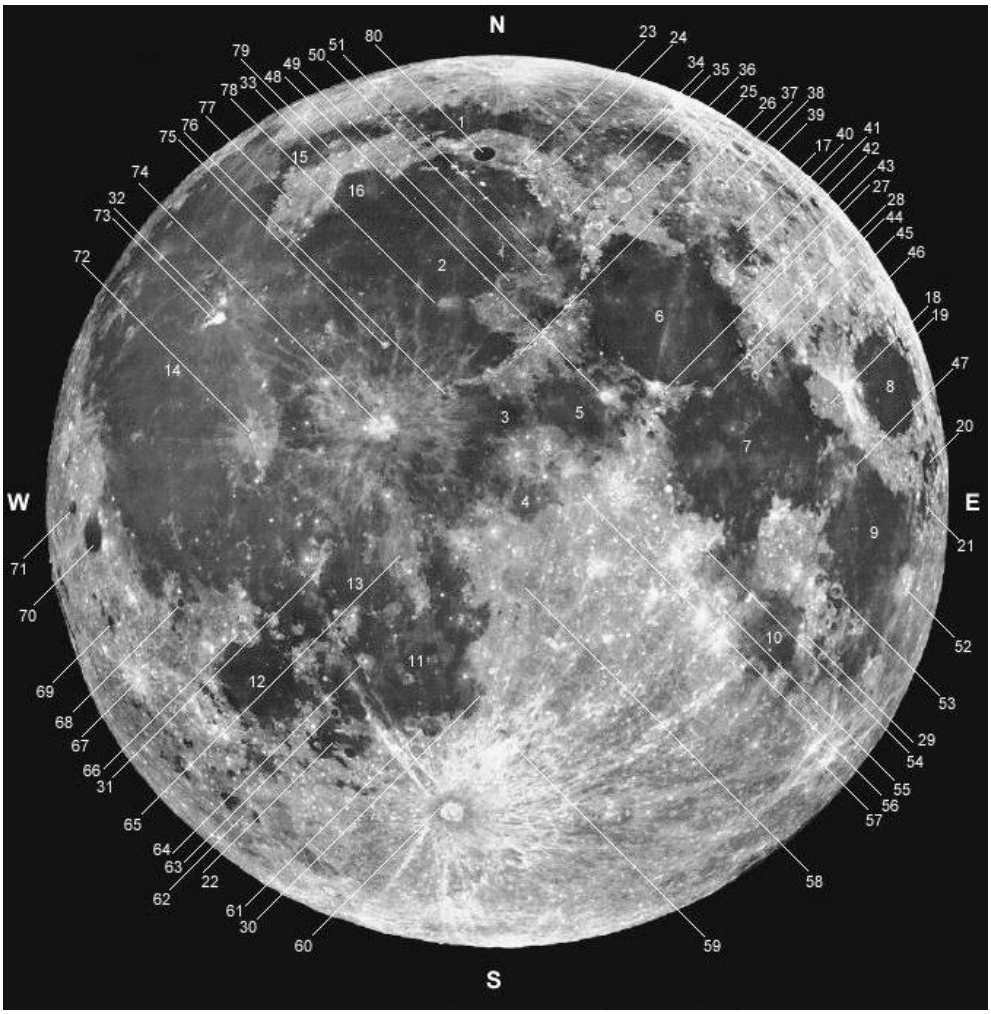
The other theory held that the moon formed elsewhere but was captured by Earth. But studies of orbital dynamics show that such capture would have required the unlikely intervention of a third planetary body. This is a long odds proposition, and no such object has been found. And capture theory fails to account or the similarities in composition between Earth and the moon revealed in their isotopic ratios.

Recently a new account, based on the planetismal model and dubbed "The Big Splash", has provided possible answers to this riddle. According to this account the young Earth, while still red hot beneath its thin new crust, was struck by a massive, contending planet approximately the size of Mars. Most of the material of the wrecked invading planet was incorporated into the liquified Earth, adding to the mass of the home planet. But vapour generated by the intense heat when the two objects collided was squirted out into space in a matter of minutes. There, the vapour settled into orbit and condensed as the Moon. Because the material came mostly from Earth's crust rather than its core, the moon today lacks iron and so is lower in density than Earth.

But because the two objects shared a mingled origin, some chemical simulations suggest that the infant Earth was indeed hit by at least one planet as big as Mars, and also two or three lesser but still hefty planetismal's.

A similar scenario could explain why Mercury, the innermost planet, has a much larger iron core than would be expected from so small a planet. A smaller planet hitting Mercury could have vaporized much of its rocky crust, leaving behind only the core of what was a larger planet - and perhaps, one further from the sun, the crash having knocked Mercury down into its present orbit. Plenty of work remains to be done before these questions are fully resolved.

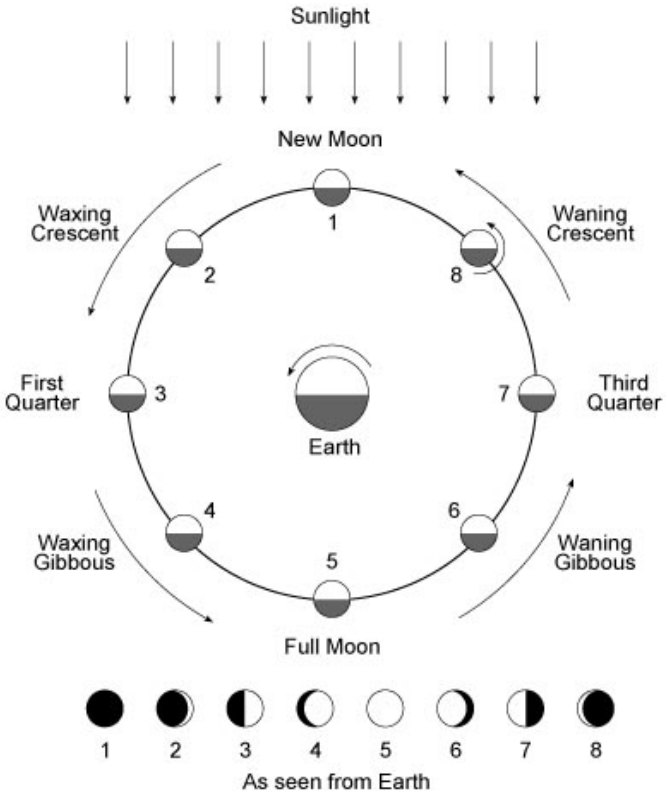
LUNAR FEATURES



1- Mare Frigoris (Sea of Cold)
2- Mare Imbrium (Sea of Rains)
3- Sinus Aestuum (Bay of Seething)
4- Sinus Medii (Bay of the Center)
5- Mare Vaporum (Sea of Vapours)
6- Mare Serenitatis (Sea of Serenity)
7- Mare Tranquillitatis (Sea of Tranquillity)
8- Mare Crisium (Sea of Crises)
9- Mare Fecunditatis (Sea of Fecundity)
10- Mare Nectaris (Sea of Nectar)
11- Mare Nubium (Sea of Clouds)
12- Mare Humorum (Sea of Moisture)
13- Mare Cognitum (Known Sea)
14- Oceanus Procellarum (Ocean of Storms)
15- Sinus Roris (Bay of Dew)
16- Sinus Iridum (Bay of Rainbows)
17- Lacus Somniorum (Lake of Sleep)
18- Palus Somnii (Marsh of Sleep)
19- Mare Anguis (Sea of Snakes)
20- Mare Undarum (Sea of Waves)
21- Mare Spumans (Sea of Foam)
22- Palus Epidemiarum (Marsh of Diseases)
23- Montes Alpes
24- Vallis Alpes (Alpine Valley)
25- Montes Caucasus
26- Montes Apenninus
27- Montes Haemus
28- Montes Taurus
29- Montes Pyrenaeus
30- Rupes Recta (Straight Wall)
31- Montes Riphaeus
32- Vallis Schröteri (Schröter's Valley)
33- Montes Jura
34- Crater Aristotle
35- Crater Cassini
36- Crater Eudoxus
37- Crater Endymion
38- Crater Hercules
39- Crater Atlas
40- Crater Mercurius
41- Crater Posidonius
42- Crater Zeno
43- Crater Le Monnier
44- Crater Plinius
45- Crater Vitruvius
46- Cráter Cleomedes
47- Crater Taruntius
48- Crater Manilius
49- Crater Archimedes
50- Crater Autolycus
51- Crater Aristillus
52- Crater Langrenus
53- Crater Goclenius
54- Crater Hypatia
55- Crater Theophilus
56- Crater Rhaticus
57- Crater Stevinus
58- Crater Ptolemaeus
59- Crater Walter
60- Crater Tycho
61- Crater Pitatus
62- Crater Schickard
63- Crater Campanus
64- Crater Bulliadus
65- Crater Fra Mauro
66- Crater Gassendi
67- Crater Byrgius
68- Crater Billy
69- Crater Crüger
70- Crater Grimaldi
71- Crater Riccioli
72- Crater Kepler
73- Crater Aristarchus
74- Crater Copernicus
75- Crater Pytheas
76- Crater Eratosthenes
77- Crater Mairan
78- Crater Timocharis
79- Crater Harpalus
80- Crater Plato

THE PHASES

As you have seen, the moon exhibits phases from night to night. And due to the nature of the Moon's orbit round Earth, it may be one of only a handful of moons in the Solar System to show these phases.



The cause of these phases is the relative positions of the Sun, Earth, and Moon. As seen in the diagram above, the phases seen from Earth depend on where the Moon lies in its orbit round Earth (the white areas being the lighted areas).

Notice that no matter what phase the Moon is in, HALF of it is ALWAYS lit by the Sun. (Which half is always lit? The half that is facing the Sun!) The reason that we do not always see a Moon, which is half-illuminated is because of our position relative to the Moon and the Sun. As the Moon moves in its orbit, different portions of it *appear* to be lit up as we look at it from Earth. Coupled with the fact that the Moon does not orbit round our equator as most other planets' moons do, as it is tilted at about 23 degrees, is why we see lunar phases.

For example, if the Moon is at position 1 in the diagram, the half of it that is lit by the sun is facing away from us, so we do not see the moon at all. This is called a New Moon. When the Moon is at position 3, we see half of the half of the Moon that is lit up. We call this a quarter Moon. The important point is that the moon doesn't change, nor does the amount of the Moon which is illuminated by the Sun. The only thing that changes is the position of the Moon relative to us and the Sun. This change in position causes the phases. The phase list above shows the phase seen corresponding the picture below left.

HARVEST MOONS & BLUE MOONS

According to folklore, the ***Harvest Moon*** is nearer, bigger, and brighter than any other full moon. However, it is simply the Full Moon that falls closest to the autumnal equinox. The fact that it looks so large is the result of the "Moon illusion", which always makes the Moon look bigger when it is near the horizon and smaller when higher in the sky.

When the Moon is low down we can compare it to objects on the horizon so we interpret it as being big; higher up, it is in a blank sky so to speak, where we have nothing to relate its size to.

On average, the Moon rises around one hour later each night. What marks out the Harvest Moon is that it comes up around sunset for several successive evenings. The Moon's orbit is tilted relative to the celestial equator and therein lies the key to the Harvest Moon. The further north of the celestial equator an object is, the longer it is above the horizon. At the time of the autumnal equinox, the Full Moon is moving rapidly northward in its tipped-up orbit.

On the evening of Full Moon it rises as the Sun sets. The next evening, the Moon is several degrees further north in the sky and rises earlier than we expect — only 15 minutes or so later than the previous evening. Unless you time the risings carefully, it will look like a replay of last evening.

Once in a Blue Moon is a common way of saying *not very often*, but what exactly is a *Blue Moon*? According to the popular definition, it is the second Full Moon to occur in a single calendar month. The average interval between each Full Moon is about 29.5 days, whilst the length of an average month is roughly 30.5 days. This makes it very unlikely that any given month will contain two Full Moons, though it does sometimes happen. On average, there will be 41 months that have two Full Moons in every century, so you could say that *once in a Blue Moon* actually means *once every two-and-a-half years*.

YOUR MISSION

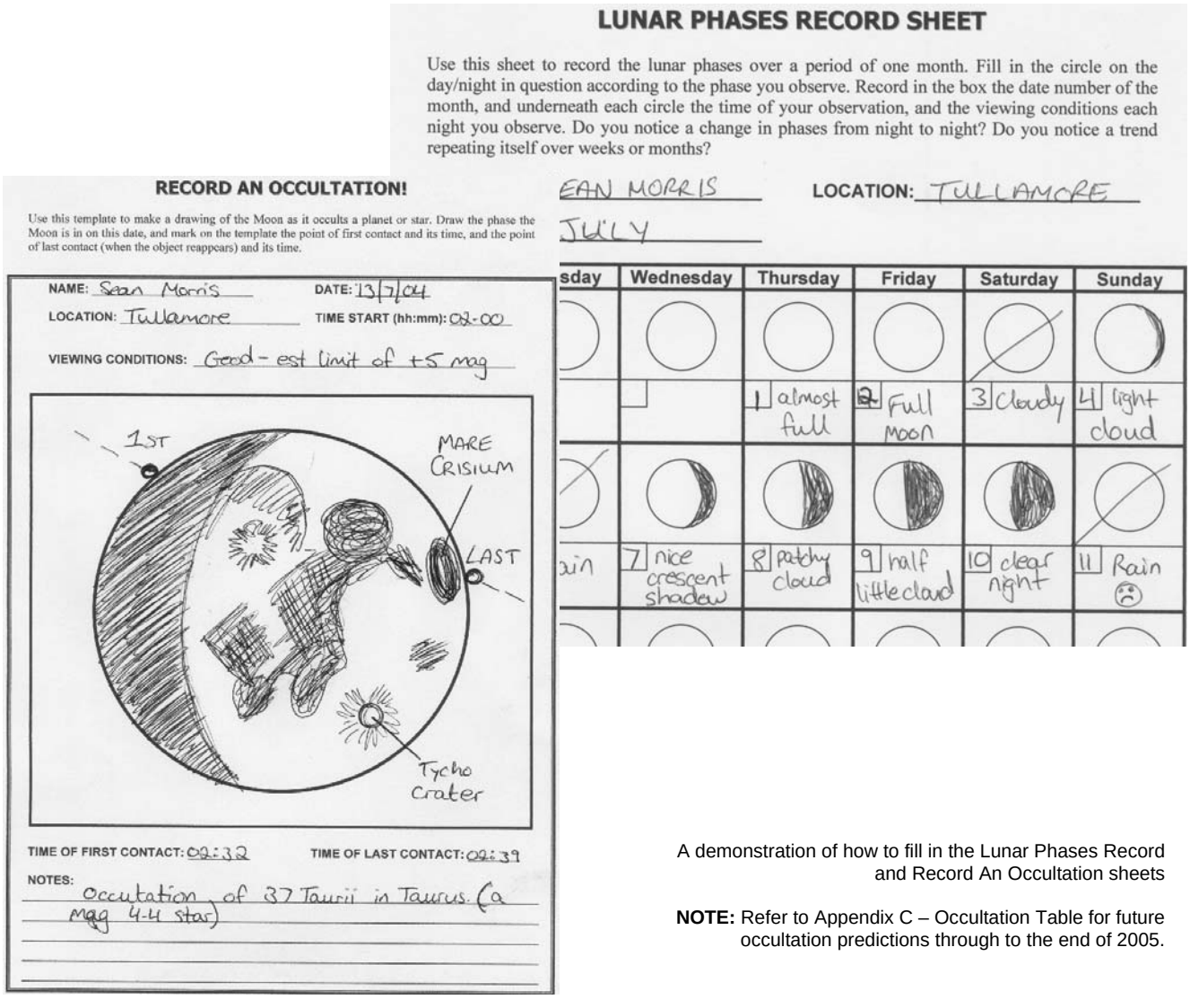
This challenge has 3 parts. The first part requires you to (as much as possible) record the phases of the moon for 1 CALENDAR month at a time. Do you notice the phases change in the patterns described? Can you determine the youngest phase you can see after New Moon? Does it change brightness from night to night? How far apart is the moon from 1 point in the sky at e.g. 9pm one night, and at 9pm the following night? An example of how to fill in the Lunar Phases Record Sheets is shown.

The second part requires you to draw and recognise as many lunar features you can see on the clearest night of your choice, but closest to Full Moon (you can draw as many 'moons' as you as the templates allow at different phases). The templates are provided for you. Note the shading of the maria (seas) as opposed to the brightness of the highlands and craters. What do you think this tells you about them and the make up of the moon? Also, if you look at the Moon when it is near New, do you notice any features in the dark side?

The third part requires you to record an occultation (if any) during your observing sessions of a planet or star. An occultation occurs when the Moon (or any other body) passes between Earth and a more distant body, blocking it from view for a short period of time. Identify the star or planet from a star chart, record the time of first contact when the distant object disappears from view, and the time it reappears. This can be done either by naked eye or binocular, but your timing must be as accurate as possible. A good site on the internet for synchronising your watch is:

http://sourceforge.net/projects/nettime/

You may make as many occultation observations as you wish.



LUNAR PHASES RECORD SHEET

Use this sheet to record the lunar phases over a period of one month. Fill in the circle on the day/night in question according to the phase you observe. Record in the box the date number of the month, and underneath each circle the time of your observation, and the viewing conditions each night you observe. Do you notice a change in phases from night to night? Do you notice a trend repeating itself over weeks or months?

EAN MORRIS LOCATION: TULLAMORE

JULY

sday	Wednesday	Thursday	Friday	Saturday	Sunday
		1 almost full	2 Full moon	3 Cloudy	4 light cloud
ain	7 nice crescent shadow	8 patchy cloud	9 half little cloud	10 clear night	11 Rain ☹

RECORD AN OCCULTATION!

Use this template to make a drawing of the Moon as it occults a planet or star. Draw the phase the Moon is in on this date, and mark on the template the point of first contact and its time, and the point of last contact (when the object reappears) and its time.

NAME: Sean Morris DATE: 13/7/04

LOCATION: Tullamore TIME START (hh:mm): 02-00

VIEWING CONDITIONS: Good - est limit of +5 mag

TIME OF FIRST CONTACT: 02:32 TIME OF LAST CONTACT: 02:39

NOTES: Occultation of 37 Tauri in Taurus. (a Mag 4-4 star)

A demonstration of how to fill in the Lunar Phases Record and Record An Occultation sheets

NOTE: Refer to Appendix C – Occultation Table for future occultation predictions through to the end of 2005.

LUNAR PHASES RECORD SHEET

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NAME: _____ **LOCATION:**_____

MONTH: _____

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

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NAME: _____ **LOCATION:**_____

MONTH: _____

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

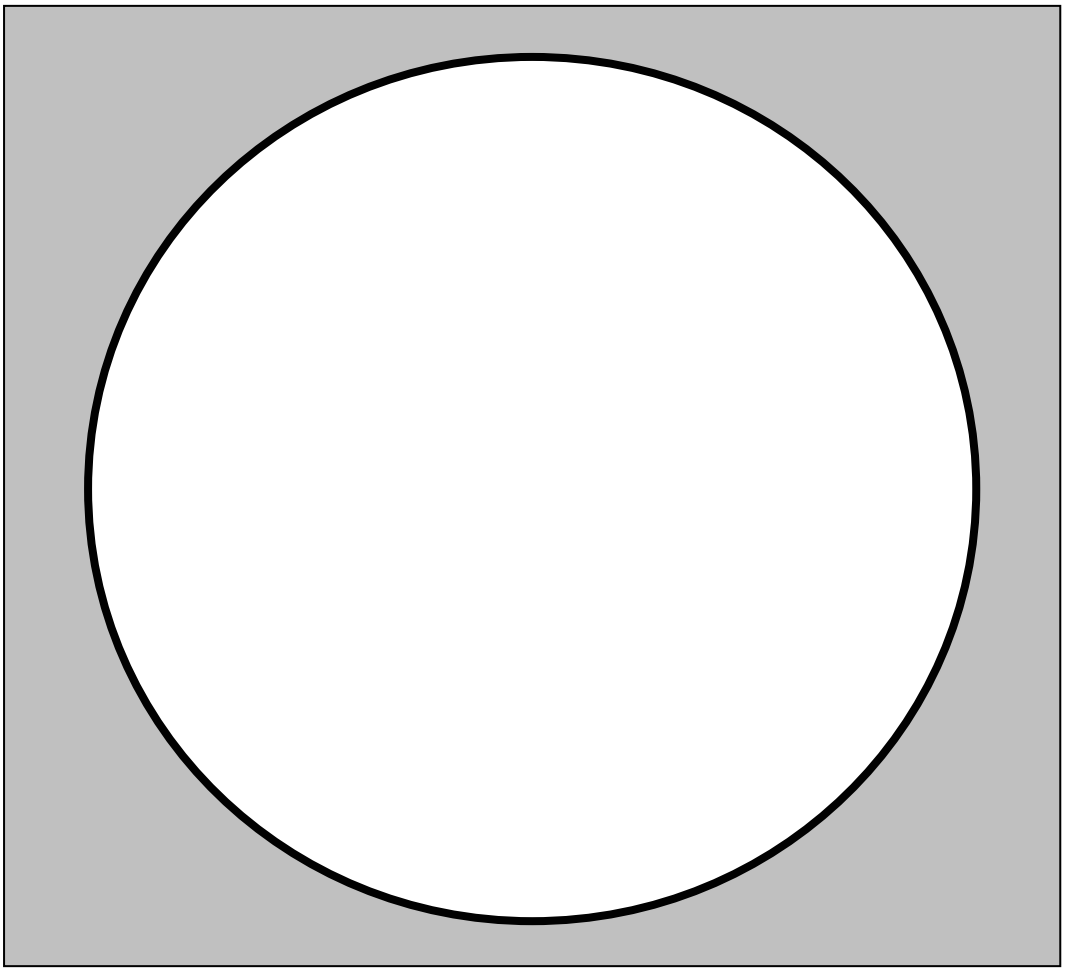
DRAW THE MOON

Use this template to make a drawing of the Moon on any clear night. Try to do so closest to a Full Moon, but also try during other phases. Name the most prominent features you can see.

NAME: _____ **DATE:** _____ **TIME:** _____

LOCATION: _____ **CHART NO.:** _____

VIEWING CONDITIONS: _____



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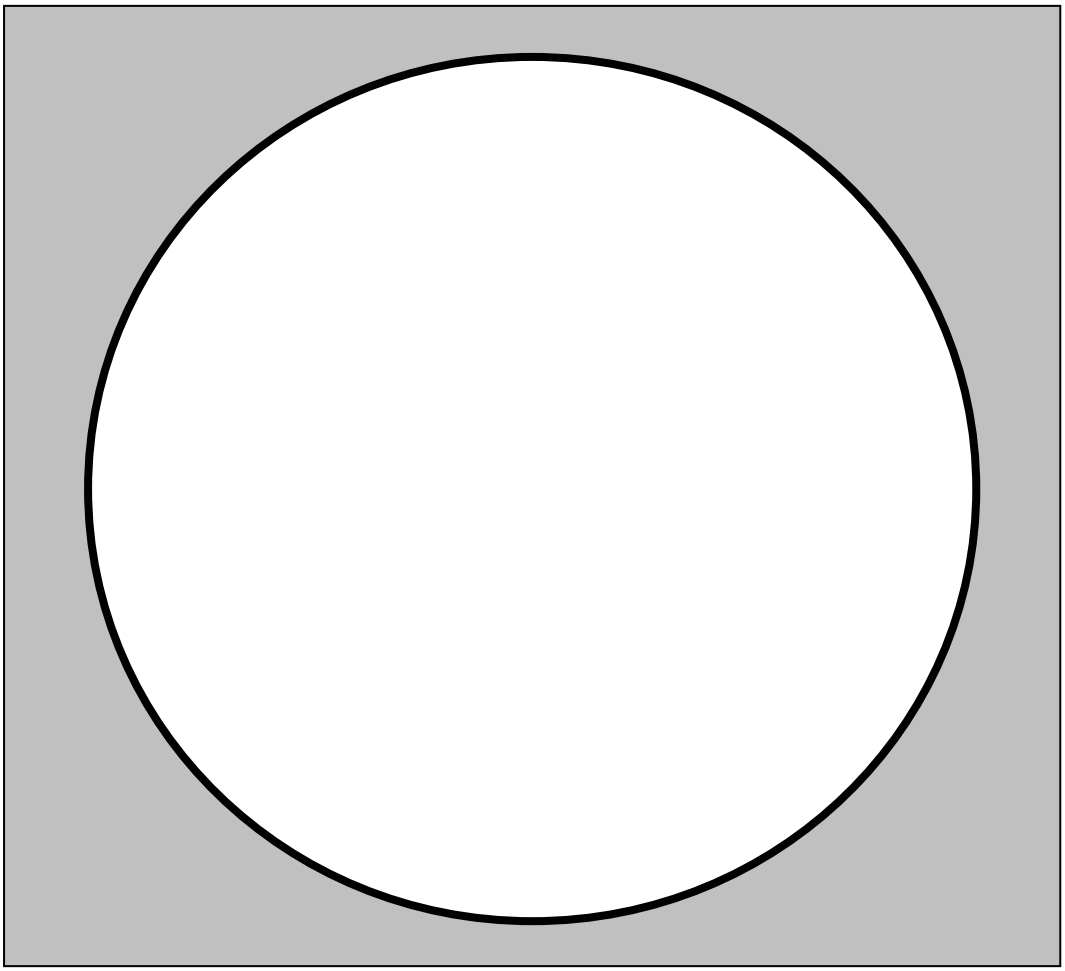
VIEWING CONDITIONS: _____



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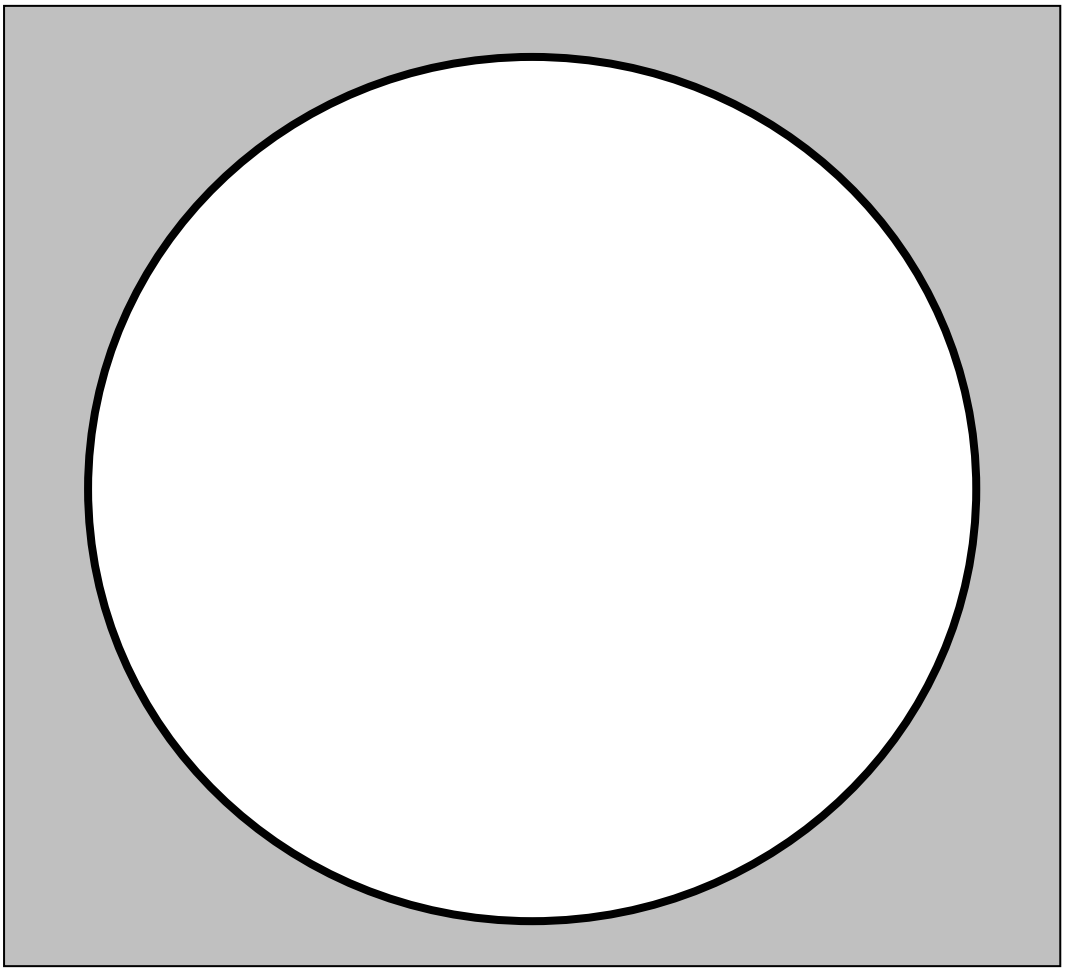
LOCATION: _____ **CHART NO.:** _____

VIEWING CONDITIONS: _____



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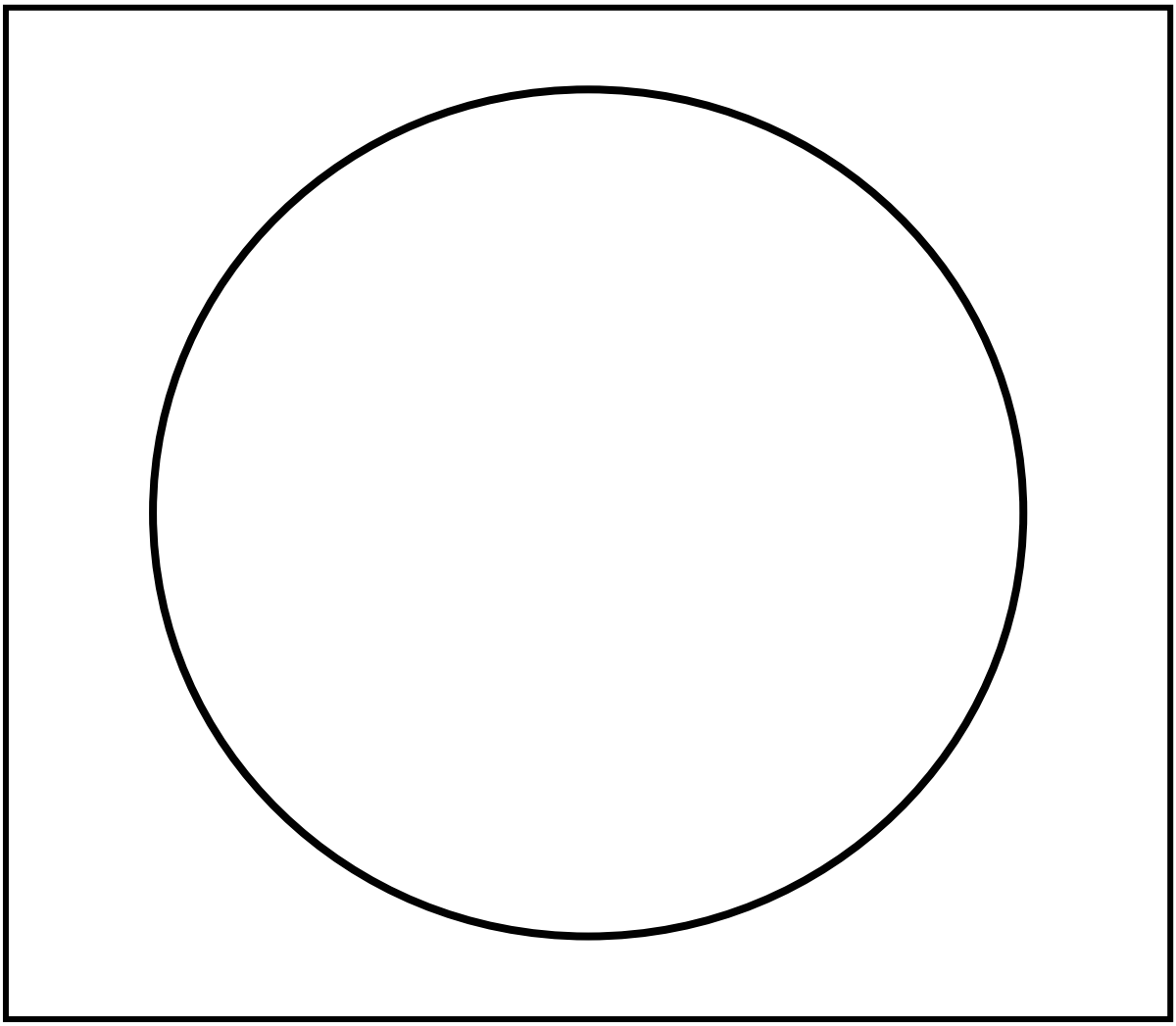
NAME: _____ **DATE:** _____

LOCATION: _____ **TIME START (hh:mm):** _____

VIEWING CONDITIONS: _____



TIME OF FIRST CONTACT: _____ **TIME OF LAST CONTACT:** _____

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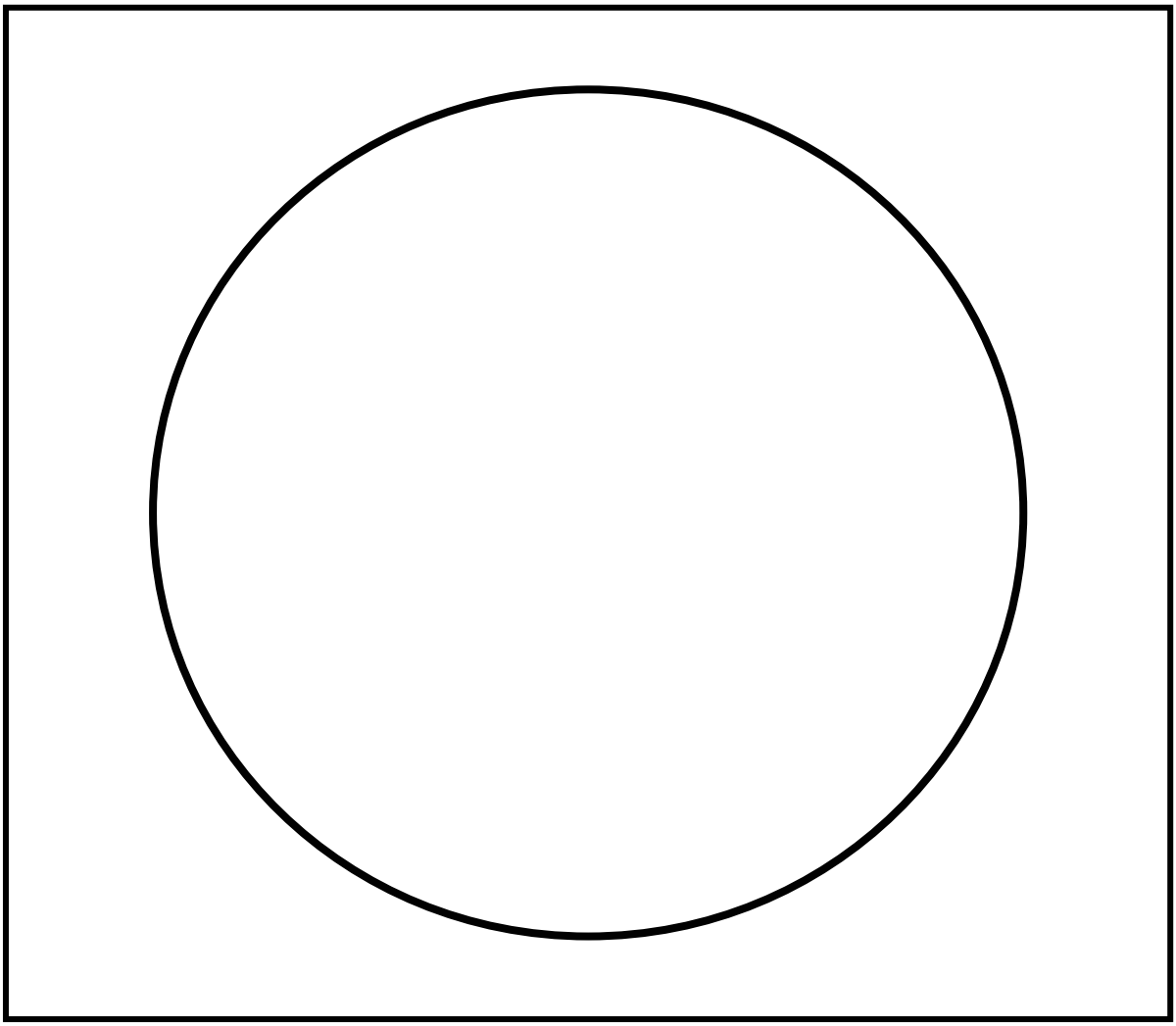

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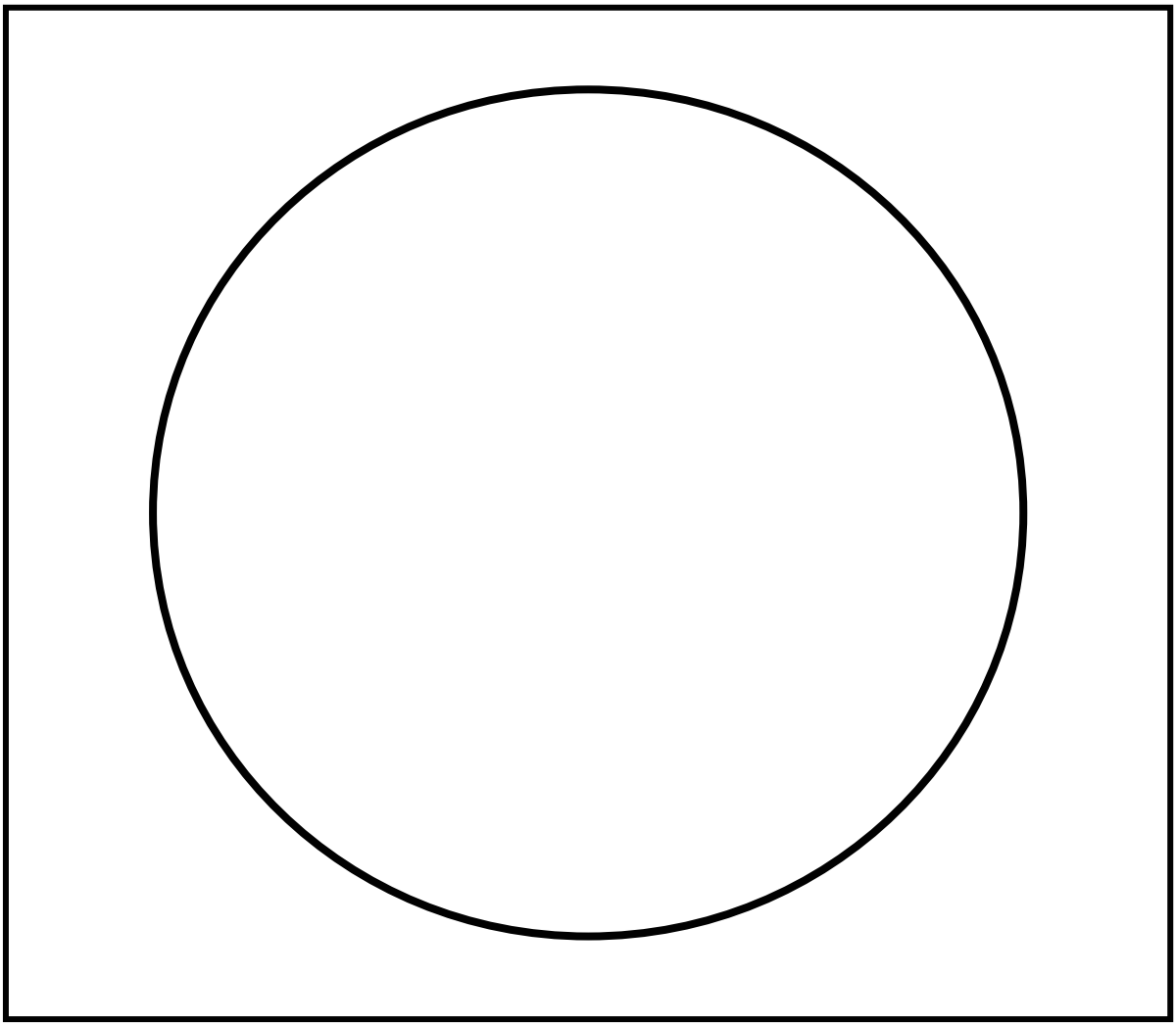

TIME OF FIRST CONTACT: _____ **TIME OF LAST CONTACT:** _____

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THE PLANETS

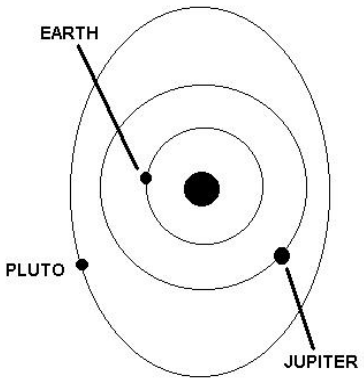
Before the advent of light pollution, only 2 of the 8 planets away from Earth could not be seen with the naked eye. Today, it is Uranus that is the lucky planet to see with the naked eye.
But before we go into how to see the planets, it is best to give a short introduction into our Solar System

THE PLANETARY MERRY-GO-ROUND

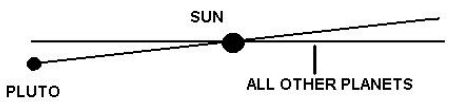
The primordial soup, which gave birth to the sun and planets has long since dissipated. Except for numerous asteroids and comets, the planets and the sun are pretty much all that is left behind from a growing-up period lasting about 5 billion years. Today, the Solar System is about half its expected age.

I think you know what the Solar System generally looks like – the planets all spin on their own axis, and in turn go round the sun in the same direction. Apart from Venus, Uranus and Pluto, all the planets spin in a counter-clockwise direction in their orbits.

If you look at the Solar System from above looking down (diagram below), all the planets would seem to follow generally circular paths in their orbit. Pluto is the only one that is different. Twice in its 248 year orbit round the sun, it will actually cross Neptune's orbit because its orbit is like a squashed circle, or an *ellipse*.



Also, if you viewed the Solar System edge-on from the side (diagram below), the planets would appear to follow a general level or *plane*. This plane of the orbits is called the *ecliptic*. Earth is taken as the marker to the Sun where the ecliptic is level. Only Pluto is drastically out of alignment of the ecliptic.



When you look at star charts, you will notice this marked on them. The ecliptic is like the equator of the Solar System. Therefore, as the planets all rotate round the sun, they do so along the ecliptic. It sounds confusing, but when you look at astronomy magazines on a monthly basis, you will see the positions of the planets visible in the sky change along the ecliptic. You will soon notice a trend, and that you can use this to find the planets among the stars.

You will also notice that the planets closer to Earth move the fastest through the sky from month to month. Mercury, Venus and Mars may even show changes over a period of a few *weeks*. Jupiter, Saturn and Uranus obviously take longer to make a change.

Along the ecliptic lie the constellations of the Zodiac. This is therefore also where the sun passes through. If you have ever heard of a planet being at opposition to the sun e.g. Jupiter, picture it like this: you look up and see Jupiter in the sky, and it lies on the ecliptic. If you imagined a straight line passing from Jupiter through you, it would point directly to the sun on the opposite side of our imaginary celestial sphere of which we are the center.

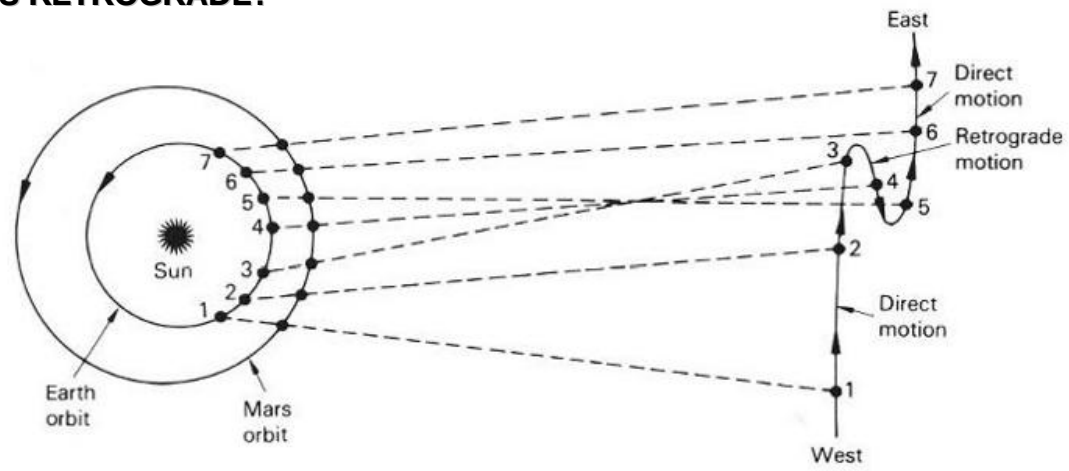
With this in mind, it would be handy to learn the 12 signs of the Zodiac. *Learn 12 whole signs,* you say? Well, bear in mind, there *are* 88 constellations! What is the benefit of knowing just the 12 Zodiacal constellations? They lie on the ecliptic! Therefore, the planets, at some stage, will pass through all of them.

PLANETARY (IN) MOTION

Generally, they exhibit the same patterns during their orbits. However, the planets behind us (Mars, Jupiter, Saturn, and Uranus – as far as naked eye planets go) also exhibit a motion called *retrograde motion*, where it seems to double back on itself for a short while (weeks, maybe a few months), before resuming its original course. This may happen at best many months apart, can sometimes be years apart.

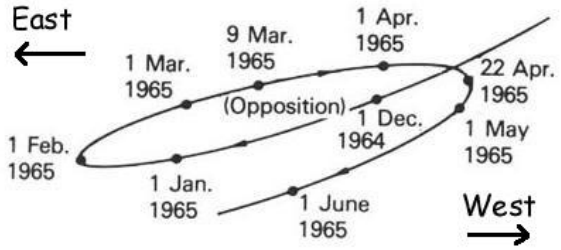
The inner planets (Mercury and Venus) seem to travel quicker in their orbit too, because they lie within Earths orbital radius. Mercury is actually called the Elusive Planet, due to its proximity to the sun – it is often too close to the sun, and lies within its glare. For only 3 or 4 weeks a year you might get a glimpse of it as it moves in and out along its orbit.

WHAT IS RETROGRADE?



The best way is by examining the diagram below. This shows the retrograde motion of Mars (taken in 1965).

Under normal circumstances, the planet appears to move to the East (shown moving upwards in the diagram), but when it is being overtaken by Earth, our faster motion makes Mars appear to be going backwards (downwards in the diagram). The normal motion is called *direct* motion, and the backwards motion is called *retrograde* motion. Such motion occurs at *opposition*, when Mars is opposite the Sun in the sky, and rises after sunset. When you take the points against the background and plot them on paper, they look like this:



There are other terms you should get familiar with that you will see on monthly sky charts: *conjunction*, *opposition*, *occultation*, *elongation* – you can find out the meaning s to these in the *Astronomical Aids* section.

Did You Know…

Saturn is so light in mass that if there was an ocean of water big enough, it would float? Seriously! And it's the second largest planet too!

A LOT OF VARIETY

Mercury's core is so big and rich in iron it would take almost 5,000 years at current mining rates to extract it all.
Venus is named after the Roman goddess of beauty and love – its surface temperature is in excess of 240 degrees C.
Mars has the largest volcano in the Solar System – Olympus Mons is 24km (15 miles) high.
Ceres, the largest known asteroid ***in the belt*** is about the same size as France.
Jupiter rotates in just over 9 hours, and can hold al the other planets and asteroids of the Solar System - with room to spare.
Saturn has 33 known moons (as of August 2004), and thousands of different rings.
Uranus rotates virtually on its side.
Neptune has clocked the fastest wind speed in the Solar System in its Great Dark Spot – Voyager 2 recorded it at 2,000km/h (1,250mph) in 1989.
Pluto's year is the equivalent to 278 Earth years.

YOUR MISSION

There is no particular way to record the motion of the planets. All you have to do in this section is record the motion of a chosen planet in each template (as many as you wish) for as long as you have this booklet. Dot or **X** the spot relative to the background stars, and date it.

On the first night of your attempt, draw in the background stars that night, and then you won't have to fill them in again. Take your time to do this, and you will have an excellent map to plot the planets course against for the duration of your challenge.

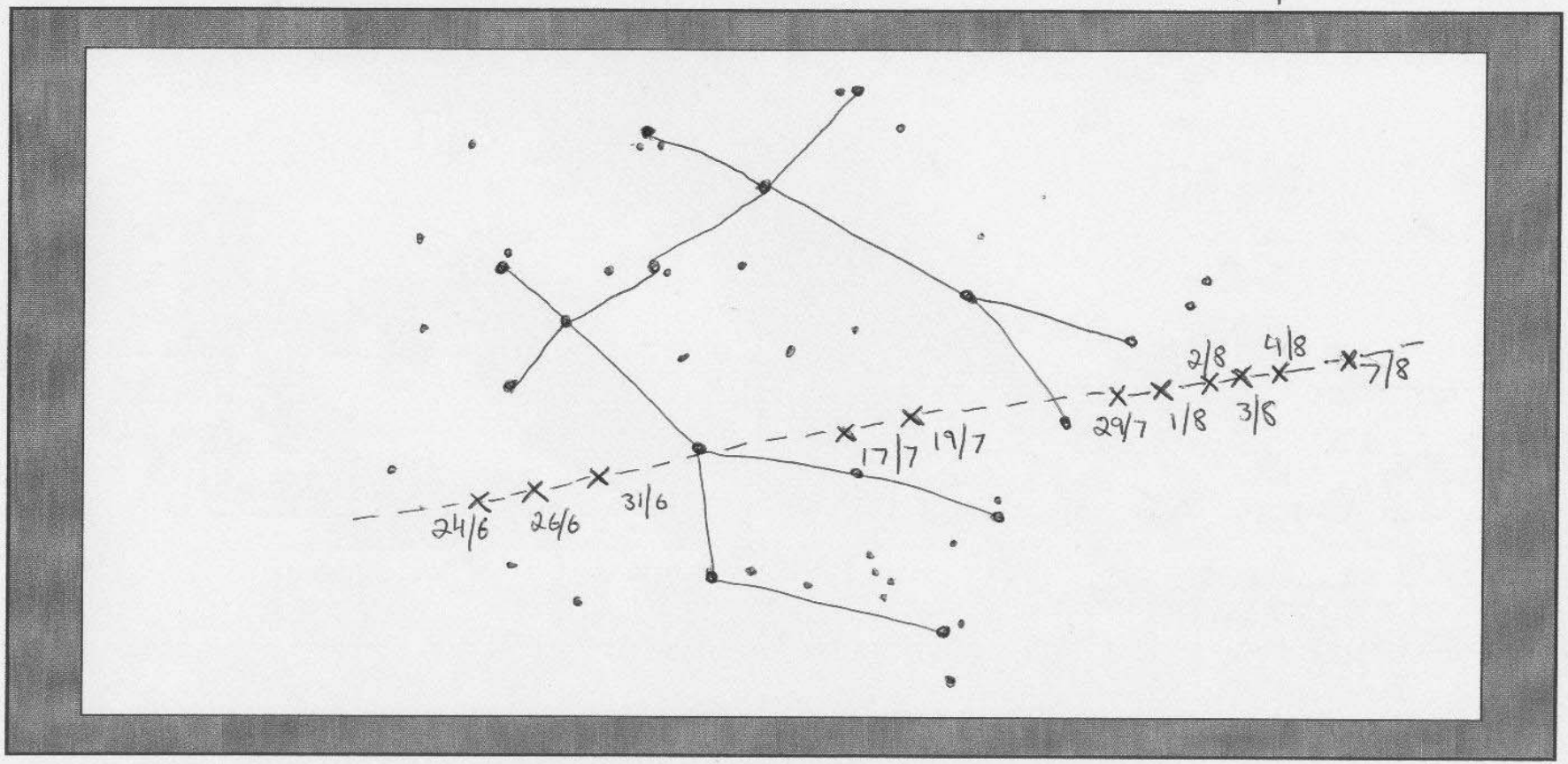
An example of how to do this is shown on the next page.

TRACKING THE PLANETS

Use this Template to record the motion of a chosen planet. Use one planet for each template used. Plot a dot or an X each time you record the position of that planet against the background stars, and mark that dot with the date.

NAME: SEAN MORRIS LOCATION: TULLAMORE

PLANET: MARS DATE START: 24/6/03 DATE END: 07/8/03



TRACKING THE PLANETS

Use this Template to record the motion of a chosen planet. Use one planet for each template used. Plot a dot or an X each time you record the position of that planet against the background stars, and mark that dot with the date.

NAME: _____ **LOCATION:** _____

PLANET: _____ **DATE START:** _____ **DATE END:** _____

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Use this Template to record the motion of a chosen planet. Use one planet for each template used. Plot a dot or an X each time you record the position of that planet against the background stars, and mark that dot with the date.

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PLANET: _____ **DATE START:** _____ **DATE END:** _____

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NAME: _____ **LOCATION:** _____

PLANET: _____ **DATE START:** _____ **DATE END:** _____

THE STARS

Without the stars, there would have never been astronomy – or even astrology for that matter. For the last few thousands of years, history has shown how the subject of astronomy has grown, today being a foremost subject of *Natural Philosophy*, Physics. By now, you know that stars make up patterns according to stories and legends, called the *constellations*. Today, there are 88 recognised constellations. They are derived mostly from Greek mythology, but also from Persian and Roman stories.

IN THE BEGINNING

Long ago, the Greeks showed an amazing amount of interest in the sciences, in what was known as the Golden Ages. Aristotle, Pythagoras, and Archimedes all claimed to discover new ways of measuring distance, mathematical angles, and mass respectively. Socrates gave insight into how the known world may have been created. Thales predicted how an eclipse might occur.

Around this time, from 700 B.C. onwards, the legends of the constellations placed among the stars were mainly for recognising distinct patterns in the sky, as a form of time keeping. Indeed, the ancient Greek poet Hesiad, describes how astronomy influenced Greek society and planning in his epic, *Works And Days*:

"*... when the Pleiades rise it is time to use the sickle, but the plough when they are setting; 40 days they stay away from heaven; when Arcturus ascends from the sea and, rising in the evening, remain visible for the entire night, the grapes must be pruned; but when Orion and Sirius come in the middle of heaven and the rosy fingered Eos sees Arcturus, the grapes must be picked; when the Pleiades, the Hyades, and Orion are setting, then mind the plough; when the Pleiades, fleeing Orion, plunge into the dark sea, storms may be expected; 50 days after the sun's turning is the right time for man to navigate; when Orion appears, Demeter's gift has to be brought to the well-smoothed threshing floor.*"

Greek Mythology played an important part in society. The Greeks worshipped many gods (Zeus et all), most of whom had worldly adventures worthy of a permanent etching in the sky for all to see for generations to come. As Greece conquered, and was conquered by foreign lands, its myths and stories travelled with the soldiers who populated the far reaches of the known world. These were passed down from generation to generation, using the paths of the stars to draw the characters. What we have today is 88 patterns in the sky telling stories of heroes and adventures, known as the constellations.

CHARTING YOUR WAY AROUND

As your own interest in Astronomy has no doubt started from the first time you looked up at the stars, then its not surprising that this handbook should help you as a guide to finding your way among them. What we have started with in this section is the basic tour round the ecliptic. As you probably know by now, the Moon and planets travels along the ecliptic, and the 12 signs of the Zodiac lie along it.

What we intend is for you to know the basics of these 12 constellations, and then (using your star atlas, planesphere, or charts), navigate your way from these constellations, to find other constellations – and in time, the treasures they hold.

You already have the Ursa Major locator chart in the *Astronomical Aids* section. You will notice from this chart how to find 3 constellations that lie on the ecliptic (Gemini, Leo, and Virgo). On a clear night with a good view, unobstructed by buildings and trees, you should be able to find at least 2 of these, and then track the rest along the ecliptic. You will not see all of them on any night, but you will be able to start recognising the constellations as you follow the imaginary line of the ecliptic from constellation to constellation. As the year progresses, all of them, at some stage come into view.

YOUR MISSION

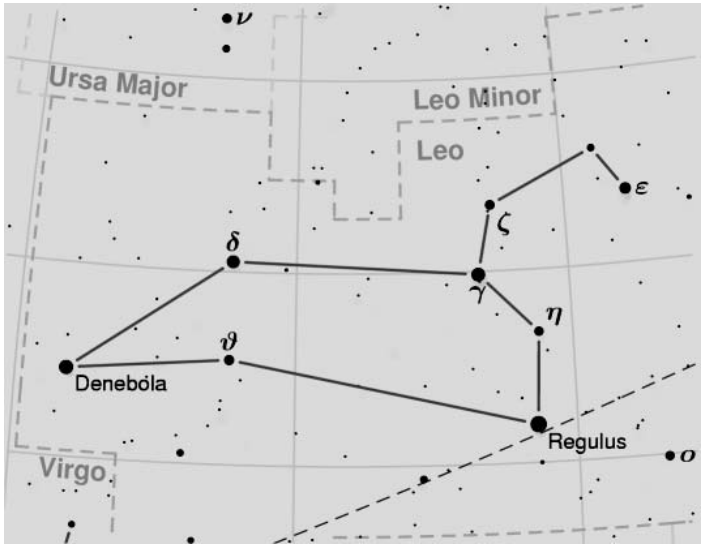
As this is going to be naked eye observing, you will not be required to seek out deep sky objects like nebulae and galaxies. What we want you to do is to observe the constellations – get to know them, their patterns, and how to find constellations near others .

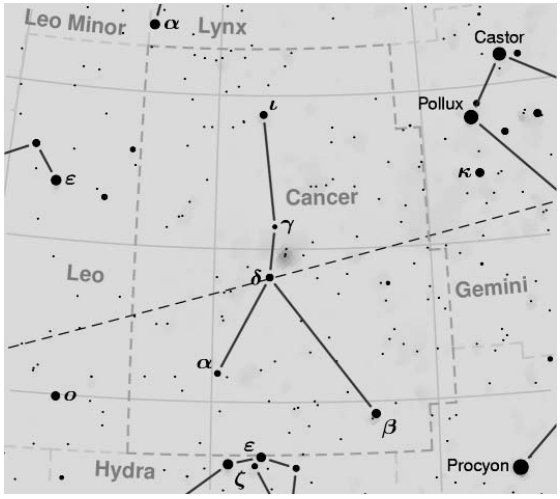
Your mission is to use the blank charts provided, and draw the constellations given. There are also a blank chart to allow you to sketch any other constellation of your choice – this can be one you know as a proper constellation, or an asterism (pattern) you have always seen, but don't know the name of, make-believe or not!

THE ZODIACAL CONSTELLATIONS

NAME: Leo
ABBREV: Leo
KNOWN AS: The Lion

MYTH: Leo is generally accepted to represent the Nemean Lion, killed by Hercules during his first labour. According to myth, the Nemean lion had an impenetrable skin. Hercules got around this potentially serious obstacle by wrestling the lion and strangling it to death. He then removed one of its claws, and used it to skin the animal. From then on, Hercules wore the skin of the Nemean Lion as protection.



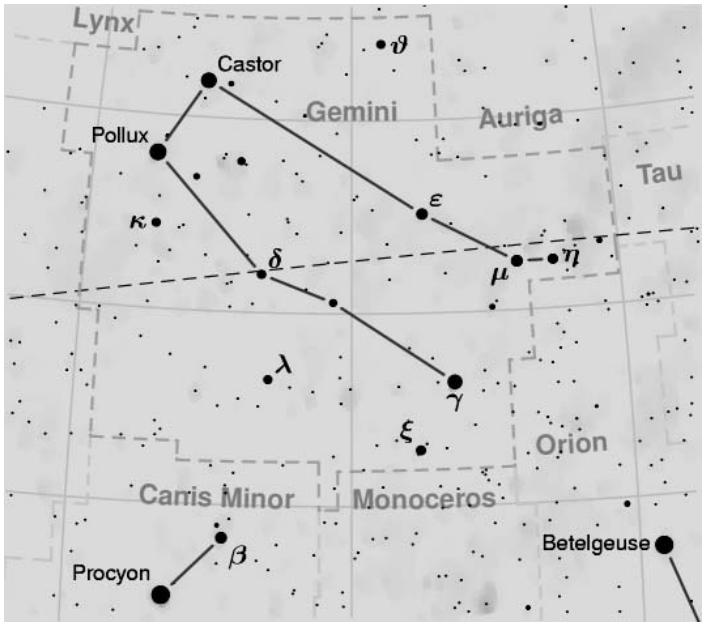


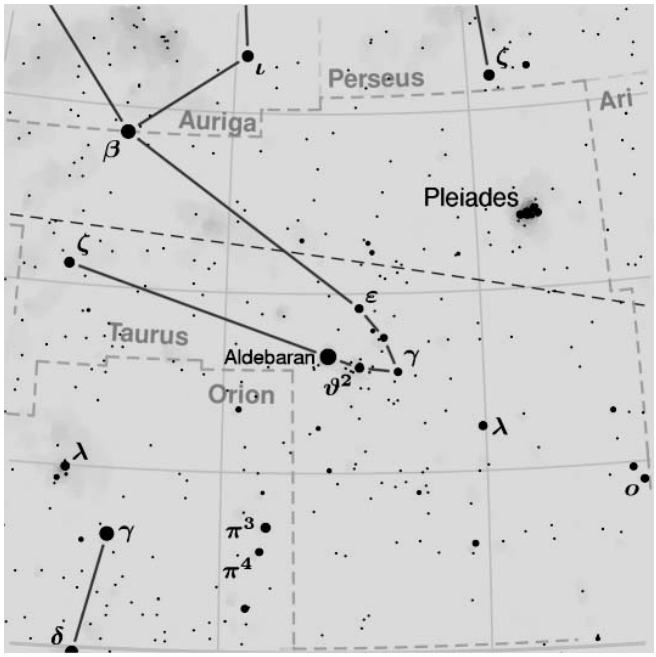
NAME: Cancer
ABBREV: Cnc
KNOWN AS: The Crab

MYTH: Like many other constellations, its mythological importance is uncertain; however, the most widely accepted story is that Cancer was the crab sent to harass Hercules while he was on his second labour. As he battled the Lernaean Hydra, the ever-jealous Juno sent Cancer to nip at the hero's heels. The crab was eventually crushed beneath Hercules's feet, but Juno placed it in the heavens as a reward for its faithful service.

NAME: Gemini
ABBREV: Gem
KNOWN AS: The Twins

MYTH: Gemini represents the twin brothers Castor and Pollux. Both were mothered by Leda, and were therefore brothers of Helen, but they had different fathers: In one night, Leda was made pregnant both by Jupiter in the form of a swan and by her husband, the king Tyndarus of Sparta. Pollux, as the son of a god, was immortal and was renowned for his strength, while his mortal brother Castor was famous for his skill with horses. Both brothers voyaged in search of the Golden Fleece as Argonauts, and then fought in the Trojan War to bring their sister home to her husband Menelaus. They are traditionally depicted as armed with spears and riding a matched pair of snow-white horses.
The most common explanation for their presence in the heavens is that Pollux was overcome with sorrow when his mortal brother died, and begged Jupiter to allow him to share his immortality. Jupiter, acknowledging the heroism of both brothers, consented and reunited the pair in the heavens.



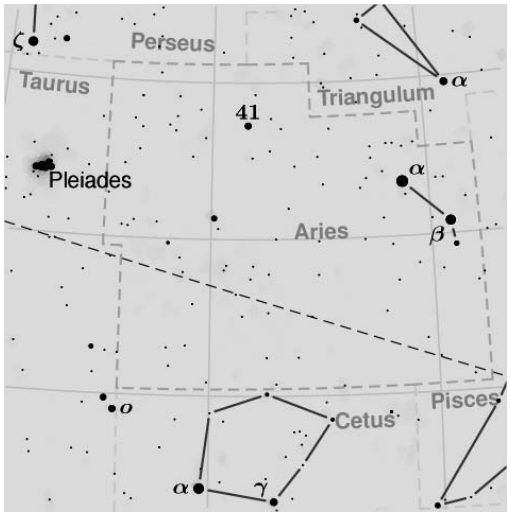


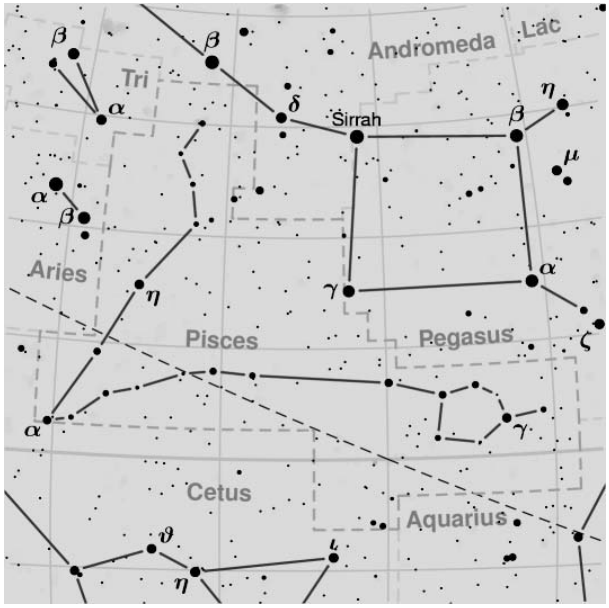
NAME: Taurus
ABBREV: Tau
KNOWN AS: The Bull

MYTH: Taurus represents the bull-form taken on by Jupiter when he became enamoured of Europa, princess of Phoenicia:
"*Majesty and love go ill together, nor can they long share one abode. Abandoning the dignity of his sceptre, the father and ruler of the gods, whose hand wields the flaming three-forked bolt, whose nod shakes the universe, adopted the guise of a bull; and mingling with the other bullocks, joined in their lowing and ambled in the tender grass, a fair sight to see. His hide was white as untrodden snow, snow not yet melted by the rainy South wind. The muscles stood out on his neck, and deep folds of skin hung along his flanks. His horns were small, it is true, but so beautifully made that you would swear they were the work of an artist, more polished and shining than any jewel. There was no menace in the set of his head or in his eyes; he looked completely placid*" (Metamorphoses II 847-858)
The princess Europa was impressed by the beauty and gentleness of the bull, and the two played together on the beach. Eventually, Europa climbed onto the bull's back, and he swam out to sea with her. He took her to Crete and revealed his true self.
The constellation Taurus consists of only the head and shoulders of the snowy white bull. The representation in the stars seems to show a raging bull, however, always about to plunge into Orion, which is somewhat at odds with the story.

NAME: Aries
ABBREV: Ari
KNOWN AS: The Ram

MYTH: Aries represents the ram of the Golden Fleece sought by Jason and the Argonauts. The ram had originally been presented to Nephele by Mercury when her husband took a new wife, Ino, who persecuted Nephele's children. To keep them safe, Nephele sent Phrixus and Helle away on the back of the magical ram, who flew away to the east. Helle fell off into the Hellespont (now the Dardanelles) between the Aegean Sea and the Sea of Marmara, but Phrixus safely made it to Colchis on the eastern shore of the Black Sea. Phrixus sacrificed the ram and presented the Golden Fleece to the king, Aeetes.
Roughly 2000 years ago, the vernal equinox was in the constellation Aries. This is no longer the case, due to precession of the earth's axis, but Aries is still regarded as the first constellation in the zodiac.



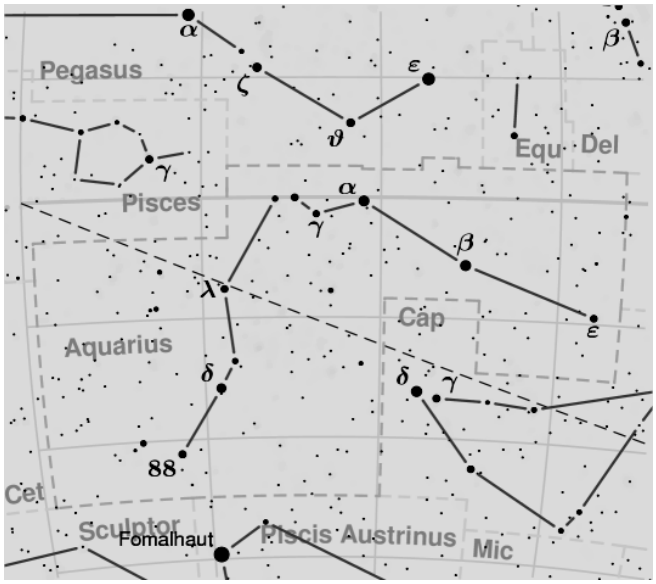


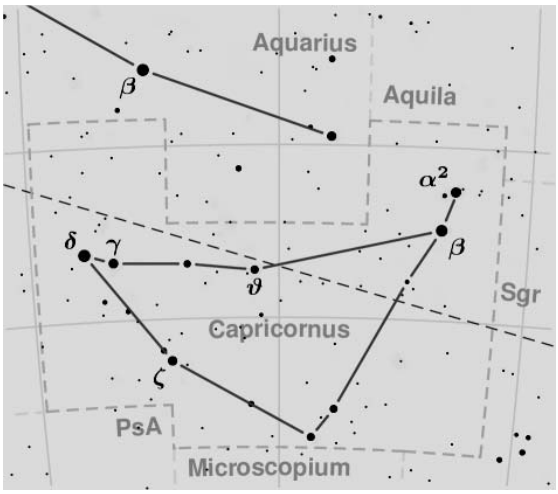
NAME: Pisces
ABBREV: Psc
KNOWN AS: The Fishes

MYTH: The horrible Earthborn giant Typhoeus suddenly appeared one day, startling all the gods into taking on different forms to flee. Jupiter, for instance, transformed himself into a ram; Mercury became an ibis; Apollo took on the shape of a crow; Diana hid herself as a cat; and Bacchus disguised himself as a goat. Venus and her son Cupid were bathing on the banks of the Euphrates River that day, and took on the shapes of a pair of fish to escape danger. Minerva later immortalized the event by placing the figures of two fish amongst the stars. Pisces represents two fish, tied together with a cord.

NAME: Aquarius
ABBREV: Aqr
KNOWN AS: The Water Carrier

MYTH: The water carrier represented by the zodiacal constellation Aquarius is Ganymede, a beautiful Phrygian youth. Ganymede was the son of Tros, king of Troy (according to Lucian, he was also son of Dardanus). While tending his father's flocks on Mount Ida, Ganymede was spotted by Jupiter. The king of gods became enamoured of the boy and flew down to the mountain in the form of a large bird, whisking Ganymede away to the heavens. Ever since, the boy has served as cupbearer to the gods.



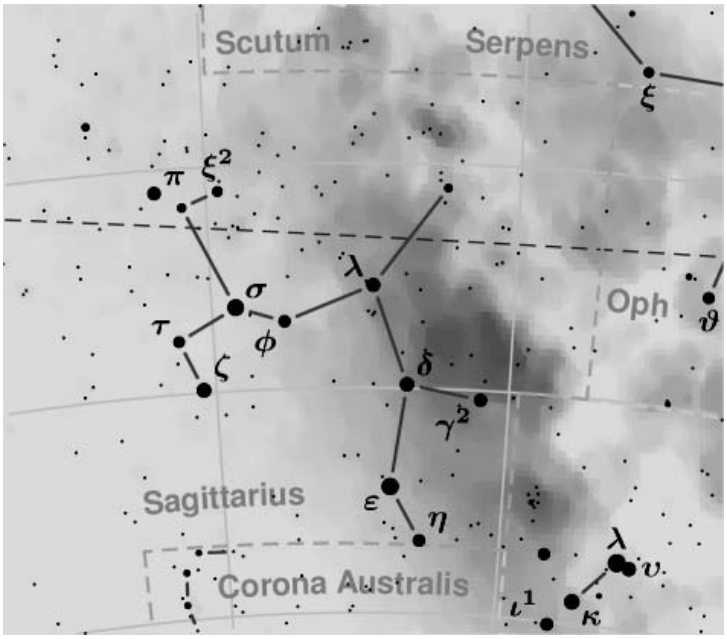


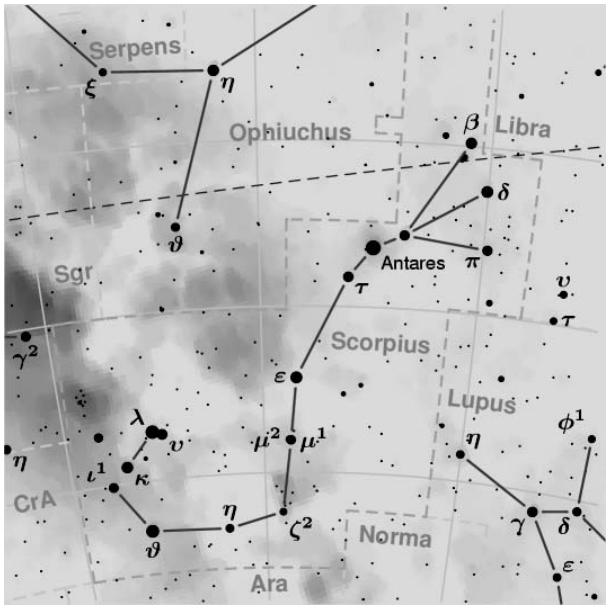
NAME: Capricornus
ABBREV: Cap
KNOWN AS: The Goat

MYTH: This constellation, like Pisces, depicts the result of the sudden appearance of the Earthborn giant Typhoeus. Bacchus was feasting on the banks of the Nile at the time, and jumped into the river. The part of him that was below water was transformed into a fish, while his upper body became that of a goat. From this point of view, he saw that Typhoeus was attempting to tear Jupiter into pieces; he blew a shrill note on his pipes, and Typhoeus fled. Jupiter then placed the new shape of Bacchus in the heavens out of thanks for the rescue.
Capricornus has therefore from antiquity been represented by a figure with the head and body of a goat and the tail of a fish.

NAME: Sagittarius
ABBREV: Sgr
KNOWN AS: The Archer

MYTH: Sagittarius represents the centaur Chiron. Most of the centaurs were regarded in myth as bestial - they were, after all, half horse. However, the ancient Greeks had a great deal of respect for the horse, and so were reluctant to make the centaurs entirely bad. In fact, Chiron was renowned for his gentleness. He was an excellent archer, musician, and physician, and tutored the likes of Achilles, Jason, and Hercules.
Chiron was accidentally shot and wounded by Hercules. The arrow, which had been dipped in the poison of the Lernaean Hydra, inflicted great suffering on Chiron - so great in fact, that even the talented physician could not cure himself. In agony, but as an immortal unable to find release in death, Chiron instead offered himself as a substitute for Prometheus. The gods had punished Prometheus for giving fire to man by chaining him to a rock. Each day an eagle would devour his liver, and each night it would grow back. Jupiter, however, had at the request of Hercules agreed to release Prometheus if a suitable substitute could be found. Chiron gave up his immortality and went to Tartarus in place of Prometheus; in recognition of his goodness, Jupiter placed him in the stars.





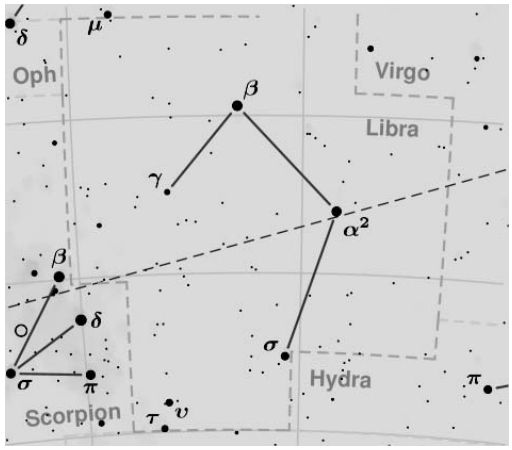
NAME: Scorpius
ABBREV: Sco
KNOWN AS: The Scorpion

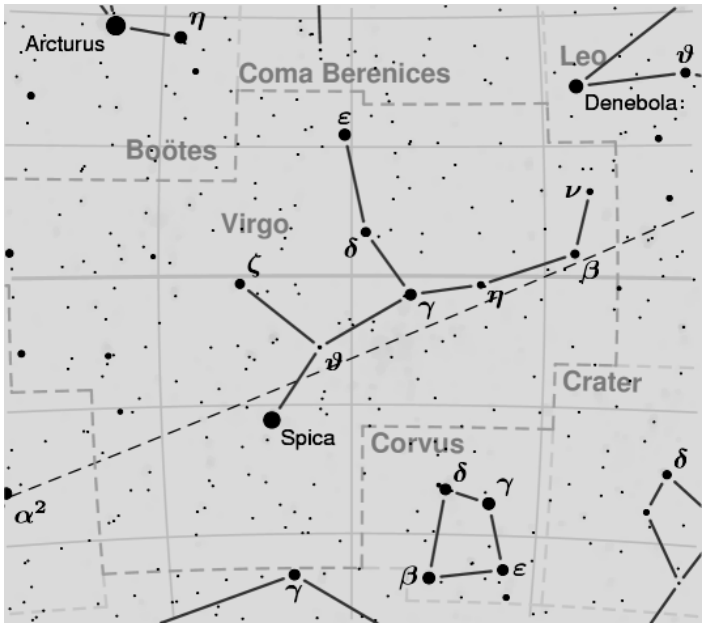
MYTH: The Scorpion is generally believed to be responsible for the death of the great hunter Orion. According to some myths, the scorpion stung Orion in response to his boast that he could defeat any beast; according to others, it was sent by Apollo, who was concerned for his sister Diana's continued chastity.
In either case, Scorpius was placed in the opposite side of the sky from Orion so as to avoid any further conflict. It is to the southeast of Libra, and is marked by the bright red star Antares. Antares is Greek for "Rival of Ares," the Greek war-god. The star is so named because of its brightness and colour, which are approximately the same as of the planet Mars.

NAME: Libra
ABBREV: Lib
KNOWN AS: The Scales

MYTH: Libra represents the balance or scales, and is one of the oldest constellations. Although now associated with Virgo, a goddess of justice who had scales as the emblem of her office, it was once associated with the Autumn equinox. On that day, the days and nights are of equal length (i.e. the moon and the sun are in balance).

Libra is represented in the heavens next to the hand of Virgo.





NAME: Virgo
ABBREV: Vir
KNOWN AS: The Virgin

MYTH: According to the ancient poets, the virgin is also sometimes known as Astraea. She lived on Earth during the Golden Age of man, which is described by Hesiod:
"*First a golden race of mortal men were made by the immortals who have Olympian homes. They lived in Kronos' [Saturn's] time, when he ruled the sky, they lived like gods, with carefree heart, free and apart from trouble and pain; grim old age did not afflict them, but with arms and legs always strong they played in delight, apart from all evils; They died as if subdued by sleep; and all good things were theirs; the fertile earth produced fruit by itself, abundantly and unforced; willingly and effortlessly they ruled their lands with many goods. But since the earth hid this race below, they are daimones by the plans of great Zeus [Jupiter], benevolent earthly guardians of mortal men, who watch over judgments and cruel deeds, clothed in air and roaming over all the Earth*" (Works and Days 109-125).
The "daimones" of which Hesiod speaks are invisible spirits which watch over men. Presumably, although it is unclear, Astraea is the daimone whose province is justice. The emblem of her office was therefore the scales (Libra), which are seen next to Virgo in the sky.

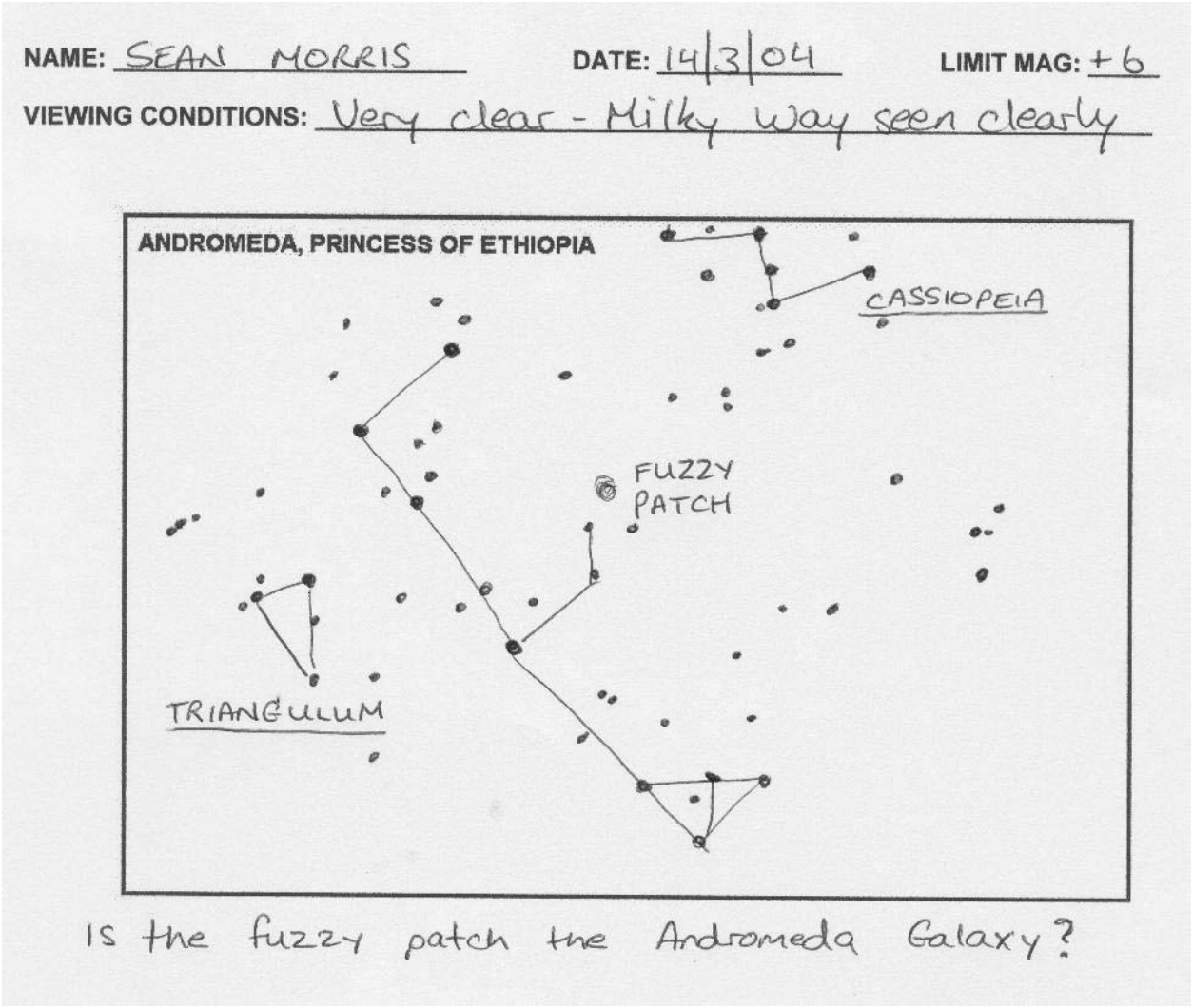
DRAW A CONSTELLATION

This is where you get to familiarise yourself with other constellations. Apart from the ones mentioned in this section, we are not going to ask you to draw the remaining 76 constellations! What we want you to do is to draw the stated constellations as you see them from your location.

Use a guide to help you – this is not a test, so there is no such thing as cheating! A star atlas or a planesphere will be able to help you.

As described in the *Astronomical Aids* section, use a pencil – a pen will be useless after a short period of time. You will want to spend about 5 minutes at least to observe the constellation. You will be amazed how much detail you can actually see when you let your eyes become adjusted to the dark.

The following (rough sketch) is an example of how to fill in this section:



Sometimes, astronomers like to draw a portion of the sky that appeals to them. It might be a spectacular area of star fields, it might be intersected with an arm of the Milky Way, or just might have an interesting asterism made by the stars that are not pointed out in any star atlas or catalogue. Feel free to include more drawings if you want. The best extras to use are a clipboard and white sheets of plain A4 paper.

Be sure to include any notes with your sketches in this following sections e.g. easy/hard to sketch, if light pollution a factor, any interested onlookers. Space is provided for you on the last page of this section.

NAME: _____ DATE: _____ LIMIT MAG: _____

VIEWING CONDITIONS: _____

ANDROMEDA, PRINCESS OF ETHIOPIA

NAME: _____ DATE: _____ LIMIT MAG: _____

VIEWING CONDITIONS: _____

CYGNUS, THE SWAN

NAME: _____ DATE: _____ LIMIT MAG: _____

VIEWING CONDITIONS: _____

HERCULES

NAME: _____ DATE: _____ LIMIT MAG: _____

VIEWING CONDITIONS: _____

LYRA, THE LYRE OR HARP

NAME: _____ DATE: _____ LIMIT MAG: _____

VIEWING CONDITIONS: _____

ORION, THE HUNTER

NAME: _____ DATE: _____ LIMIT MAG: _____

VIEWING CONDITIONS: _____

URSA MINOR, THE LITTLE BEAR

DRAW YOUR *OWN* CONSTELLATION!

In this section, we want you to draw a constellation of your choice. It can be one you know of and always wanted to study it in more naked eye details, or a pattern of stars you have always seen, don't yet know if it's a proper constellation, but one that you recognise. Give it a name, either one that you made up, or one that you know.

NAME: _____ **DATE:** _____ **TIME:** _____

LOCATION: _____ **LIMIT MAGNITUDE:** _____

VIEWING CONDITIONS: _____

CHOSEN CONSTELLATION:_____

FURTHER NOTES AND COMMENTS:

METEORS

More commonly known with the childhood name of *shooting* or *falling star*, these are, of course, not so! Meteors are seen every clear night. And even though we know today that they are nothing more then mere cosmic sand, until the last 200 years or so, they were the stuff of legend.

In ancient times, objects in the night sky conjured superstition and were associated with gods and religion. But the misunderstandings about meteors lasted longer than those of most celestial objects.

Meteorites (the pieces that make it to ground), were long ago thought to be cast down as gifts from angels. Others thought the gods were displaying their anger. As late as the 17th Century, many believed they fell from thunderstorms (they were nicknamed *thunderstones*). Many scientists were sceptical that stones could fall from the clouds or the heavens, and often they simply didn't believe the accounts of people who claimed to have seen such things.

In 1807, a fireball exploded over Connecticut in the United States, and several meteorites rained down. By then, the first handful of asteroids had been discovered, and a new theory emerged suggesting meteorites were broken bits off asteroids or other planets (a theory that still holds).

But that is for the bigger meteors that make it through the atmosphere. Most of the meteors you see blazing across the night sky are typically dust and sand. They burn up harmlessly in the upper atmosphere by friction caused when they collide with air molecules at speeds over 115,000 miles per hour! Prior to becoming a Meteor, it is known as a *Meteroid* as it travels through space.

WHEN CAN WE SEE METEORS?

All year round, many meteors will fall from a particular points in the sky at different times, known as the *radiants*. Each time an extraordinary burst occurs it is called a meteor shower. Some last for a few days, others for weeks. They all have a peak when, in a period lasting only hours, sometimes hundreds will be seen around the world from the one radiant. The most common one in recent times is the Leonid Shower, which peaks on November 17th each year. The radiant is located within the constellation Leo. Between 2001 and 2003, this shower reached a 33 year peak where over 1,000 meteors per hour could bee seen. Unfortunately for us, the Irish weather was not in our favour each time.

And in December, both the Geminids (from Gemini) and the Orionids (from Orion) give bright displays for crisp winter nights. Indeed, during the winter months are the best time for viewing meteors, even the faint ones. The air is clean and clear, it gets dark quickly, and the constellations with these radiants are high in the sky.

By far the best common shower is **the Perseids**. These happen every August, with a peak on August 12th. The radiant falls in the constellation of Perseus (see *Appendix A*). Since 1992, this shower has been met with high expectations, due in part to the passing of the comet P/Swift-Tuttle in that year.

Like all comets, they come in from the abyss of the outer Solar System, are pulled in by the sun's gravity, slingshot round and are cast back into space. Most comets are periodical, in that they will return again in the future. One of the most famous, Halley's Comet has a period of 76 years. Comet Encke has the shortest of 3.3 years. P/Swift-Tuttle has a period just over 150 years! Some comets will pass close to or even through the plane of Earth's orbit (don't worry, they won't hit us for thousands of years to come!). Thus, at the same time each year, Earth will pass through this dust tail left behind. The result – sometimes the best meteor displays one could ever see!

LOOKING AT THE PERSEIDS

Even though Earth has passed through the dust trail left by Swift-Tuttle since 1992, it has moved slightly in relation to Earth as the Solar System moves through space. This means that more than likely from 2004, predictions show an increase in activity in the years to come as Earth passes through a new part of the dust trail. You could expect to see *at least* 80 meteors per hour, maybe even well past 100, *if* you get to nice dark skies. People in towns and built up areas will only see the brighter ones, as most of the dimmer meteors will be washed out by light pollution.

So, all you need to prepare for this, is to wrap up warm, bring a flask of soup, and your favourite easy chair or outdoor blanket - then just sit back and watch the stars fall!

METEOR SHOWERS

Whilst Meteors can be seen every night, most are sporadic, in that subsequent meteors may follow no set pattern, or have no parent source or radiant. There are many chances to observe meteor showers throughout the year.

They get their names from the constellation from whence they come e.g. the April Lyrids fall from Lyra, in April (any constellation can have 2 or more showers during the year). The list below shows some of the more common meteor showers seen during the year:

NAME	DURATION	MAX/ZHR*
Quadrantids	Dec 28 – Jan 7	Jan 4/40
April Lyrids	Apr 16 – 25	Apr 21/15
Eta Aquarids	Apr 21 – May 25	May 4/20
June Lyrids	June 10 – 21	Jun 15/20
Delta Aquarids	Jul 14 – Aug 18	Aug 13/20
Perseids	Jul 23 – Aug 22	Aug 12
Orionids	Oct 15 – 29	Oct 21/30
South Taurids	Oct 18 – Nov 27	Nov 3/15
Leonids	Nov 13 - 20	Nov 17/40
Geminids	Dec 6 – 19	Dec 13/50
Ursids	Dec 17 - 25	Dec 22/15

*The MAX/ZHR column denotes the date maximum occurs on, and what the highest number of meteors per hour can be seen. Thus for the Quadrantids, maximum occurs on January 4th, with a Zenith (highest point in the sky) Hourly Rate of about 40 meteors per hour.
The best time to actually see meteors is after local midnight, as this is when the dark side of Earth is facing most directly into the dust stream responsible for the shower.

RECORDING METEORS

Some people throughout the world take meteor watching seriously. They record them by sight and by sound. Results and data from observers around the world is collected to give more accurate readings of the source of the shower, such as showing the movement of a comets tail over a period of time. Using slightly sophisticated equipment, they can listen for when a meteor has passed through the atmosphere. To a lesser extent, you can too. Any FM receiver can pick up meteor bursts. The type where you attach an external aerial increases the pickup on the receiver. Good quality radios may also pick up these bursts.

YOUR MISSION

What you have to do is select a frequency on the FM band where no stations are broadcasting. Chances are, if a bright or heavy meteor burns in the atmosphere, its ionised tail will bounce radio signals back to ground. Thus, you will hear a short burst of a radio broadcast. But can you tell where it is coming from?

Of course, the other option is to record on paper (or on a dictaphone by voice recording your observations). All you need for this is an easy chair, a clipboard with a copy of the Meteor Observers Log sheet on it, a pencil (pen ink will freeze on a cold night), and a red low power flashlight.

When you have reached your location for meteor observing, take about 10 to 15 minutes to observe the heavens. The darker the location the better, as you be able to see more faint meteors than if you are in built up/light polluted areas. It can take your eyes about 25 minutes to fully adjust to very dark surroundings. So taking this time to let your eyes adjust before you start recording can give a more accurate representation of your findings.

The model below demonstrates how to use and fill in the Meteor Observers Log sheet.

Note: to guess the length of a meteors tail, it is best to read over the ***Astronomical Aids To The Casual Novice*** section on how to judge apparent distances against the sky.

METEOR OBSERVING LOG

NAME: SEAN MORRIS DATE: 17/7/04 LOCATION: TULLAMORE

LIMITING MAGNITUDE	TIME (hh:mm)	EST MAG	CONSTELLATION	COMMENTS				
				BRIGHT (Y/N)	COLOUR	TAIL (Est Length)	DURATION (seconds)	NOTES
+5	23-47	+1	URSA MAJ	Y	white	10 deg	3	nice white tail, slightly thick
		+4	" "	N	white	—	1	faint - hazy air
	23:49	-2	Perseus	Y	white/green	15 deg	5	AMAZING! Fireball??
		+1	CASIOPEIA (??)	Y	blue?	< 5 deg	1	looked like had large head
	23-53	+3	Perseus	N	white	—	—	slow moving but no tail

METEOR OBSERVING LOG

NAME: _____ DATE: _____ LOCATION: _____

LIMITING MAGNITUDE	TIME (hh:mm)	EST MAG	CONSTELLATION	COMMENTS				
				BRIGHT (Y/N)	COLOUR	TAIL* (Est Length)	DURATION (seconds)	NOTES

***TAIL length written in degrees.**

METEOR OBSERVING LOG

NAME: _____ DATE: _____ LOCATION: _____

LIMITING MAGNITUDE	TIME (hh:mm)	EST MAG	CONSTELLATION	COMMENTS				
				BRIGHT (Y/N)	COLOUR	TAIL* (Est Length)	DURATION (seconds)	NOTES

***TAIL length written in degrees.**

METEOR OBSERVING LOG

NAME: _____ DATE: _____ LOCATION: _____

LIMITING MAGNITUDE	TIME (hh:mm)	EST MAG	CONSTELLATION	COMMENTS				
				BRIGHT (Y/N)	COLOUR	TAIL* (Est Length)	DURATION (seconds)	NOTES

***TAIL length written in degrees.**

METEOR OBSERVING LOG

NAME: _____ DATE: _____ LOCATION: _____

LIMITING MAGNITUDE	TIME (hh:mm)	EST MAG	CONSTELLATION	COMMENTS				
				BRIGHT (Y/N)	COLOUR	TAIL* (Est Length)	DURATION (seconds)	NOTES

***TAIL length written in degrees.**

METEOR OBSERVING LOG

NAME: _____ DATE: _____ LOCATION: _____

LIMITING MAGNITUDE	TIME (hh:mm)	EST MAG	CONSTELLATION	COMMENTS				
				BRIGHT (Y/N)	COLOUR	TAIL* (Est Length)	DURATION (seconds)	NOTES

***TAIL length written in degrees.**

METEOR OBSERVING LOG

NAME: _____ DATE: _____ LOCATION: _____

LIMITING MAGNITUDE	TIME (hh:mm)	EST MAG	CONSTELLATION	COMMENTS				
				BRIGHT (Y/N)	COLOUR	TAIL* (Est Length)	DURATION (seconds)	NOTES

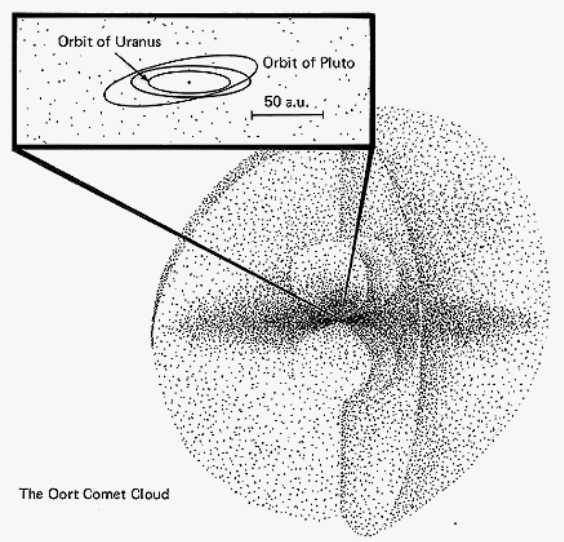
***TAIL length written in degrees.**

COMETS

Sometimes also called interplanetary dirty snowballs, comets always bring awe and wonder when they can be seen by the naked eye. For thousands of years, recorded history has shown that comets were met with mixed emotions of impending doom, and great luck.

DIRTY SNOWBALLS

Comets are small, fragile, irregularly shaped bodies composed of a mixture of non-volatile grains and frozen gases. They have highly elliptical orbits that bring them very close to the Sun and swing them deeply into space, often beyond the orbit of Pluto to a region called the Oort Cloud. This cloud is the outer remnants from the formation of the Solar System.



The Oort Cloud is a massive thin halo surrounding the sun. It is all that is left from the cloud of gas and dust from which the Solar System was born.

Comet structures are diverse and very dynamic, but they all develop a surrounding cloud of diffuse material, called a coma, that usually grows in size and brightness as the comet approaches the Sun. Usually a small, bright nucleus (less than 10 km in diameter) is visible in the middle of the coma. The coma and the nucleus together constitute the head of the comet.

As comets approach the Sun they develop enormous tails of luminous material that extend for millions of kilometers from the head, away from the Sun. When far from the Sun, the nucleus is very cold and its material is frozen solid within the nucleus. Over half of their material is ice. When a comet approaches within a few AU's of the Sun, the surface of the nucleus begins to warm, and volatiles evaporate. The evaporated molecules boil off and carry small solid particles with them, forming the comet's coma of gas and dust.

When the nucleus is frozen, it can be seen only by reflected sunlight. However, when a coma develops, dust reflects still more sunlight, and gas in the coma absorbs ultraviolet radiation and begins to fluoresce. At about 5 AU from the Sun, fluorescence usually becomes more intense than reflected light. This is how we see comets that are physically small from such a great distance.

FOLKLORE

People did not always know what comets were. In ancient times, people thought comets were "power rays" of supernatural beings. They thought comets contained fire because they were so bright in the sky.

Some people in ancient times thought that a comet was a curse. To save himself from the "curse of the comet," Emperor Nero of Rome had all possible successors to his throne executed.

In 1910, people panicked when a comet passed through Earth's path around the Sun. In Chicago, people sealed their windows to protect themselves from the comet's poisonous tail. Others committed suicide. Special "Comet Protecting Umbrellas," gas masks, and "anti-comet pills" were sold.

Not everyone saw comets as bad luck. Some thought they brought good luck. They also believed that comets carried angels through the heavens.

Halley's Comet nucleus, taken by the European craft *Giotto* in March 1986.

BIG AND FAMOUS

On July 23, 1995, Alan Hale of New Mexico and Thomas Bopp of Arizona saw an unusually large and bright comet outside of Jupiter's orbit. Careful analysis of Hubble Space Telescope images suggested that its intense brightness was due to its exceptionally large size. While the nuclei of most comets are about 1.6 to 3.2 km (1 to 2 miles) across, Hale-Bopp's was estimated to be 40 km (25 miles) across. It was visible even through bright city skies, and may have been the most viewed comet in recorded history. Comet Hale-Bopp holds the record for the longest period of naked-eye visibility - an astonishing 19 months. It will not appear again for another 2,400 years.

Comet Halley is perhaps the most famous comet in history. It was named after the British astronomer Edmund Halley, who calculated its orbit. He determined that the comets seen in 1531 and 1607 were the same objects that followed a 76-year orbit. Unfortunately, Halley died in 1742, never living to see his prediction come true when the comet returned on Christmas Eve in 1758.

Each time this comet's orbit approaches the Sun, its 15-km (9-mile) nucleus sheds about 6 m (7 yards) of ice and rock off its surface into space. This debris forms an orbiting trail that, when falling to Earth, is called the Orionids meteor shower. Comet Halley will return to the inner Solar System in the year 2061.

THEY COME AND GO

There are many comets with periodic orbits round the sun, and even some of the planets. You might remember the comet Shoemaker-Levy 9, which collided with Jupiter in 1994. This comet came from the Oort Cloud, went round the sun, but on its return to the Oort Cloud was captured by Jupiters gravity. It was then locked, and its fate sealed with a spectacular fireworks display in Jupiters atmosphere. It is the only time a comet has been observed crashing into a planet.

Most periodic comets unfortunately are too faint to be seen with the naked eye. And some of the best naked eye periodic comets have long duration periods. Some of the best comets seen in the past century have been newly discovered comets like Hale-Bopp, West, Huyakutake, and Kohoutek. Unfortunately we will not see these again in our lifetime!

More recently, newly designed automated tracking stations have found new comets as part of the Near Earth Tracking programme. Comets NEAT and LINEAR have been the high points of comet chasing in 2004 to date. Comet Tabur (discovered by an amateur astronomer) was a short live bright comet in April 2004, as was Encke earlier. With a few months to go till the start of 2005 (at the time of print), who knows how many more might be discovered

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Did You Know…

Ancient texts around the known old world often associated naked eye comets with a change in luck – most of it bad! Different cultures often used this symbol to give the comet a word. While in native tongues this word was different from place to place, the symbol was the same - and most of these cultures never even knew the other existed.

YOUR MISSION

This will be the challenge – first, to actually see a comet! Most periodic comets are difficult to spot with the naked eye. As improved automated tracking stations come online around the world looking for near Earth objects, we may see an increase in new comets in the coming years. As we have seen, 4 new comets were discovered in 2004 – and all were easily visible at some stage.

We have included a chart for you to fill in if you see a comet. With the frequency of how they come and go to be seen with the naked eye, we think this section will be a novice in itself! The chart is divided into 2 sections – for 2 nights observing of your choice, but at least 5 nights apart. The chart is for 1 comet. You must draw the sky where the comet is in view 1 night, then draw it again 5 days or more later. Have you noticed a difference in brightness? How far has it moved across the sky during the two observations? Is the comet following a straight path?

RECORD A COMET

As this can be a rare event, it is only a supplementary part of the *Novice Astronomer Observing Challenge*. Nonetheless, if you do see a comet, and you are able to properly observe it, it can be an experience never to be forgotten!

NAME: _____ **DATE:** _____

LOCATION: _____ **NAME OF COMET:**_____

VIEWING CONDITIONS: _____

NOTES:

NAME: _____ **DATE:** _____

LOCATION: _____ **NAME OF COMET:**_____

VIEWING CONDITIONS: _____

NOTES:

ATMOSPHERIC PHENOMENA

This is purely for the Novice Astronomer! In this section, we hope it will enhance your awareness of even the small things that happen in the skies above your head. Aurora, Noctilucent Clouds, Sun Pillars, Zodiacal Light, and Moon Halo's are all considered atmospheric phenomena. Most clear nights can offer you the chance to see any of these, and at different times of the year too. Lets look at each one briefly.

AURORA

The source of this phenomena is the sun. The sun constantly ejects thousands of tonnes of material into space every second. Sometimes, when a large flare erupts, and even explodes, it ejects more than normal amount of material into space in the form of plasma (charged electrons) and hot gas. This makes it strong enough to reach Earth, if thrown in our direction.

When these particles enter Earth's magnetic field, they are attracted towards the North and South Poles. For this reason they are also know as the Northern Lights or aurora borealis, and the aurora australis. They then interact with charged particles in Earth's upper atmosphere as they are channelled through, and become excited. What is seen is a colourful display akin to an electric charge exciting molecules in a tube – like a glowing neon sign you see over the door of many fast food joints!

The intensity and amount of particles determines the strength of the colour as the light is diffracted through the atmosphere. Sometimes, it is faint and light coloured with greens and shady yellows. Stronger displays show reds, purples, and strong bright indigos. They can last for a few hours, and depending on the mass of the flare ejected in our direction, can even last for days.

NOCTILUCENT CLOUDS

Sometimes on clear summer nights as you wait for the sky to darken, you should keep an eye out for a rare cloud phenomena called Noctilucent Clouds.
These clouds form as high as clouds can in the atmosphere. It is believed that they are made up of very fine ice coated dust. This dust is also believed to possibly come from meteor trails, as these clouds form so high up (over 40 miles up).

Noctilucent Clouds by Keith Geary, Cavan

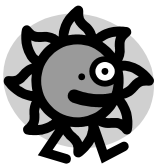
The treat comes as the sun has really set, it is almost pitch black, and the last of the suns rays being bent by the atmosphere reflect off these crystals. What is seen is a fairly bright, feathery display of criss-cross lines shining light blue and white. This does not happen every night during summer, but have a greater chance of being seen during long dry sunny spells.

SUN PILLARS

These are mostly seen during winter months, and mostly occur at sunrise and mostly at sunset. The name speaks for itself.

An early morning Sun Pillar by Keith Geary, Cavan

As the sun has set just below or approaches towards the horizon, a beam of sunlight can be seen stretching upwards. It happens when ice crystals high in the atmosphere are aligned in such a way that the sunlight is reflected a particular way, and from your observing location you can see this reflected light take the form of a pillar of light.



ZODIACAL LIGHT

This is even a more rare phenomena than Noctilucent Clouds, as this appears outside of Earths atmosphere. Zodiacal light is distant moon or sunlight reflected of dust thousands of miles away behind Earth, on the opposite side to the moon or sun. Thus, it happens along the ecliptic, and because of this, through the signs of the Zodiac – hence the name.

Usually, it will lie close to the horizon as a very faint glow. You can see from the long duration exposure photo above how long it took to show the Zodiacal Light.

Did You Know…

Over the centuries countless individuals have been fooled into thinking the Zodiacal Light was the first vestige of morning twilight? In fact, the Persian astronomer, mathematician and poet Omar Khayyam, who lived around the turn of the 12th Century, made reference to it as a "false dawn" in his one long poem, *The Rubaiyat*.

MOON HALO

That breathtaking vision in the night sky is the result of ice crystals refracting the light of the moon.

The halo forms around the moon when high, thin cirrus clouds made up of millions of these crystals cover the sky. The moon's light enters into the hexagonal-shaped ice structures and is bent before passing out another side of the crystals, causing a ring of light to appear around the moon. But this phenomenon is not limited to the moon – if given the right conditions, you can spot a sun halo as well.

Halos typically appear as a ring of white light around the moon or the sun, but they can also appear in colour patterns. The most common type of halo is the 22-degree halo, so-called because the ice crystals refract the light of the moon or sun at an angle of 22 degrees. A less-common type of halo is the 46-degree variety, which has a larger diameter than the 22-degree but is also fainter.

Did You Know…

According to folklore, a moon halo indicates that bad weather is on the way? There may be some truth to this, since high altitude cirrus clouds that precede a warm front usually cause a halo. These clouds are often associated with a possible oncoming storm.

YOUR MISSION

This is more of a graphic record of your observations than plotting on graph templates. All you have to do is when you see any of these phenomenae, take a photo or draw a picture. It is not an art competition, but it will provide you with a good record of an event or events that are hard to spot. When you have your picture, stick it into any of the templates with tape or glue, and fill in the required fields.

NOTE: Photographs and drawings will be returned with the handbooks at the star parties you have submitted this handbook for. If you are unavailable to collect it, simply send a stamp self-addressed envelope to the author after that star party and it will be posted back.

This section is **not compulsory** to be filled in as part of the *Novice Astronomer Observing Challenge*. But, it will make a nice addition to look back on in the future – to remember your first proper aurora recording, or a record of only a handful of times in 1 year you can see Noctilucent Clouds. Good Luck!

RECORDING ATMOSPHERIC PHENOMENA

Use this template to record any of the atmospheric phenomena you see as described, or any others you observe. Either draw your observation with pencil within the box provided here, or draw it on a separate sheet and stick it to this page. You may also stick any photographs (in 6" X 8" size) taken by a digital or film camera in the same manner. Please fill in the required fields.

NAME: _____ **LOCATION:** _____

DATE: _____ **TIME START:** _____ **TIME END:** _____

VIEWING CONDITIONS: _____

EST LIMIT MAGNITUDE: _____

OBJECT(S) OBSERVED: _____

NOTES: _____

_____

_____

_____

RECORDING ATMOSPHERIC PHENOMENA

Use this template to record any of the atmospheric phenomena you see as described, or any others you observe. Either draw your observation with pencil within the box provided here, or draw it on a separate sheet and stick it to this page. You may also stick any photographs (in 6" X 8" size) taken by a digital or film camera in the same manner. Please fill in the required fields.

NAME: _____ **LOCATION:** _____

DATE: _____ **TIME START:** _____ **TIME END:** _____

VIEWING CONDITIONS: _____

EST LIMIT MAGNITUDE: _____

OBJECT(S) OBSERVED: _____

NOTES: _____

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NAME: _____ **LOCATION:** _____

DATE: _____ **TIME START:** _____ **TIME END:** _____

VIEWING CONDITIONS: _____

EST LIMIT MAGNITUDE: _____

OBJECT(S) OBSERVED: _____

NOTES: _____

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RECORDING ATMOSPHERIC PHENOMENA

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NAME: _____ **LOCATION:** _____

DATE: _____ **TIME START:** _____ **TIME END:** _____

VIEWING CONDITIONS: _____

EST LIMIT MAGNITUDE: _____

OBJECT(S) OBSERVED: _____

NOTES: _____

_____

_____

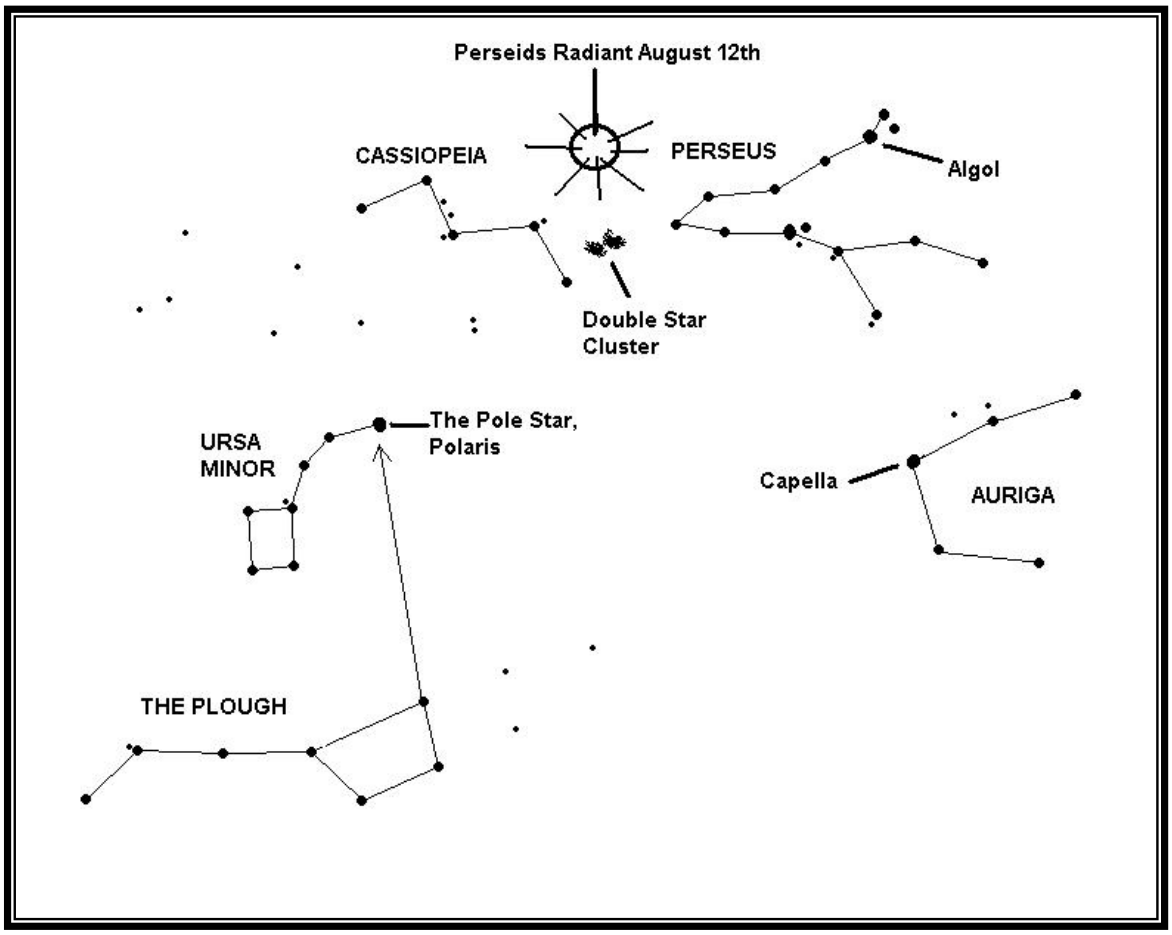
_____

‘YOUR NOTES’ SECTION & APPENDICES

Use this section to add any additional notes you may want to record. Use this as part of your observations - there is an additional section on the last page for you to include your comments or feedback about this handbook.

APPENDIX A – PERSEIDS LOCATOR MAP

With reference to the ***METEORS*** section, this is the map showing the location of one of the most brilliant annual meteor shower radiants, The Perseids.



APPENDIX B – THE GREEK ALPHABET

Many stars within constellations are identified by a Greek letter. Generally, they appear in decreasing order of brightness, with alpha being the brightest.

Our Letter	Greek Letter	Name		Our Letter	Greek Letter	Name		Our Letter	Greek Letter	Name
A	Αα	Alpha		J	ϑφ	Phi		S	Σσ	Sigma
B	Bβ	Beta		K	Kκ	Kappa		T	Tτ	Tau
C	Χχ	Chi		L	Λλ	Lambda		U	Υυ	Upsilon
D	Δδ	Delta		M	Μμ	Mu		V	ϛϖ	
E	Εε	Epsilon		N	Νν	Nu		W	Ωω	Omega
F	Φϕ			O	Οο	Omicron		X	Ξξ	Xi
G	Γγ	Gamma		P	Ππ	Pi		Y	Ψψ	Psi
H	Ηη	Eta		Q	Θθ	Theta		Z	Ζζ	Zeta
I	Ιι	Iota		R	Ρρ	Rho				

APPENDIX C – LUNAR OCCULTATIONS THROUGH TO END OF 2005

The following data is based on an observers point in Dublin, Ireland. Nearly all of the events depicted should be visible throughout almost all of Ireland. This will therefore be a good source for a naked eye challenge on recording a lunar occultation. While the prefixes of the stars are given, most are not known by name. Therefore, you will have to consult your star atlas to pinpoint the exact star to be occulted.

DATE	TIME	STAR OCCULTED	MAG.	CONSTELLATION
Oct 5th 2004	03:51	136 Tauri	4.6	Taurus
Oct 20th	18:52	59 Sagittarii	4.5	Sagittarius
Nov 1st	05:39	Rho Arietis	4.5	Aries
Nov 2nd	22:25	47 Geminorum	5.8	Gemini
Nov 30th	20:40	76 Geminorum	5.3	Gemini
Nov 30th	07:50	47 Geminorum	5.8	Gemini
Dec 17th	22:33	Psi Aquarii	4.2	Aquarius
Dec 25th	17:10	112 B. Aurigae	5.8	Auriga
Mar 14th 2005	21:28	Delta Arietis (Botein)	4.3	Aries
Mar 17th	22:21	136 Tauri	4.6	Taurus
Apr 1st	05:49	Omega Sagitarii	4.7	Sagittarius
Jun 19th	22:17	42 Librae	5.0	Libra
Jul 2nd	02:50	Delta Arietis (Botein)	4.3	Aries
Jul 11th	21:49	Sigma Leonis (Shang Tseang)	4.1	Leo
Aug 8th	20:33	Beta Virginis (Zavijava)	3.6	Virgo
Aug 21st	03:26	Chi Aquarii	4.9	Aquarius
Sep 22nd	03:06	Zeta Arietis	4.9	Aries
Sep 24th	22:47	136 Tauri	4.6	Taurus
Oct 10th	22:56	Chi Aquarii	4.9	Aquarius

APPENDIX D – RECOMMENDED READING

Here is a list of recommended books and publications often quoted by amateur astronomers as being very good sources of astronomical knowledge and information. All are available in Ireland from good bookshops.

Stars & Planets* Ian Nicolson (Gen. Editor). Copyright © 2002 The Foundry

The Backyard Astronomers Guide Terence Dickinson & Alan Dyre (Authors). Copyright © 2002 Firefly Books Ltd

Stars And Planets Ian Ridpath (Author). Copyright © 2001 Princetown University Press

Astronomy For Dummies* Stephen P. Maran (Editor). Copyright © 1999 Wiley Publishing Inc.

The Kingfisher Book Of Space Martin Redfern (Author). Copyright © 1998 Kingfisher Publications Plc.

The Greenwich Guide To Astronomy In Action Carole Stott (Author). Copyright © 1990 George Phillip

Phillips Star Chart* Large Atlas & Chart of the Night Skies. ISBN: 0-540-01211-4

A * denotes a recommended favourite by the author of this handbook.

ONE FINAL THING

If you have completed this logbook (or as close to), you are only a few steps away from qualifying for a prestigious *IFAS Novice Observing Certificate*! Please fill in the following sections, put this booklet into an A4 envelope, and post to the IFAS Novice Representative below:

Sean Morris, 'ANSTEE', Daingean Rd., Tullamore, Co. Offaly.

Be sure to fill in the sections below, and post in time before your intending Star Party. Please send at least 3 weeks (21 days) prior to your intending Party.

Your Personal Details:

NAME: _____

ADDRESS: _____

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EMAIL: _____ **TEL:** _____

AGE GROUP: **UNDER 18** ☐ **36-49** ☐

18-35 ☐ **OVER 50** ☐

IFAS MEMBER CLUB(S): _____

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You must be a member of an Irish astronomical society or club that is part of the Irish Federation of Astronomical Societies. If you want to take part, but don't know where to join, see www.irishastronomy.org for a list and contact details of member clubs and societies.

How would you like to receive your certificate?:

Please tick the relevant box OR number in preference, from 1 being the highest:

Presentation At Whirlpool (Birr)	YES ☐	NO ☐
Presentation At Galway	YES ☐	NO ☐
Presentation At Cosmos (Tullamore)	YES ☐	NO ☐
Postal Delivery	YES ☐	NO ☐

IFAS Use:

Name of Participant: _____

Signature of IFAS Observing Certificate Representative: _____

Date Received: _____ Complete? YES ☐ NO ☐

GIVE US YOUR COMMENTS

During the course of your time taken in completing this logbook, we hope it has helped you in ways you never knew. Of course, improvements can always be made. If you have any tips to give us, please do so. Take the time to fill in the following section if you have any comments – feedback is *always* appreciated:

Thank You for taking up the challenge of being a Novice Astronomer – we hope you have enjoyed it!

The IFAS Observing Certificates Team
August 2004

Content Acknowledgements
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