

• Welcome to Introduction to Optical Astronomy

- It is a fascinating hobby at any age.
- There is much to see using only your eyes alone
- Many objects can be seen even in the big city
- But you can see more in a dark place away from electric lighting!
- In this introduction we will cover the things you can see with an unaided eye (more difficult objects can follow in a later class)
- Astronomy is a safe hobby – except for one thing you must never try to look at. The Sun. I will give a quick warning next – before we move on.

Astronomy – an Introduction

- **The sun is dangerous. NEVER attempt to view it. The reason is – it can damage your eyes forever.**
- It is not even safe to view the sun with an unaided eye.
- The use of a telescope or binoculars to view the sun can cause instant blindness – for the rest of your life
- It is unimaginably hot and bright and your eyes cannot be replaced
- **Never** attempt to view the sun
- Your parents should supervise you if a telescope or binoculars are used
- A telescope must only be available after sunset and before sunrise. It is best put away safely in daylight.
- Your eyes cannot be repaired or replaced ever!
- Be very careful if you are lucky enough to get the chance to see a solar eclipse!
- Blindness is for life and there is no cure
- Now this warning is given, let us move on and have fun!!!

A warning!!!

- The moon is our nearest neighbour
- It is 'only' 384,400 km or 238,855 miles away from the Earth
- It is believed to have formed when the Earth was young
- It is the only body (apart from the Earth!) people have visited yet
- It has 'phases' as it orbits (goes around) the Earth
- A lunar eclipse happens when it passes into the shadow of Earth
- A solar eclipse happens when it passes between the Sun & Earth
- The NASA missions took about 3 days to get to the moon & back
- It 'shines' by reflecting the sun's light, which takes 1 ½ seconds to reach us
- At 'new moon' the side lit by the sun faces away from us – so we cannot see it – see next slide...
- At full moon, all of the area lit by the sun faces towards us on Earth, and it appears round!.



The Moon, our closest neighbour

- The cycle takes 27 days
- Can be seen in daylight
- This happens near quarter moon.
- Some other planets have moons
- Same side faces Earth always.
- It has no atmosphere at all
- Gravity 1/6th of Earth's
- It is easier to jump than walk there!
- No air = no weather!



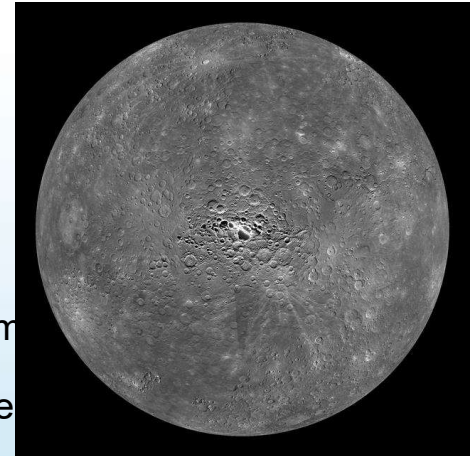
Phases of the moon

- The picture was taken from the Mariner 10 space probe.
- It comes closer to Earth than any other Planet, at 38 million km
- Until probe missions, the surface was a mystery, cannot see surface!
- It was thought possible life might exist there
- It is close in size to Earth, and mass (similar gravity).
- But its surface temperature averages 462 degrees C!
- Pressure at surface is 90 times Earth. And the clouds?
- They are made of Sulphuric acid! We cannot survive there.
- Have you heard of climate change? On Venus the dense atmosphere is 96% carbon dioxide. 4% Nitrogen
- Our atmosphere is 400 parts per million – but we add more carbon dioxide each passing year!
- It is the brightest object in our sky, (except for the sun and moon!)
- It is very visible around sunrise and sunset, often called the morning star or evening star
- But it is not a star at all!



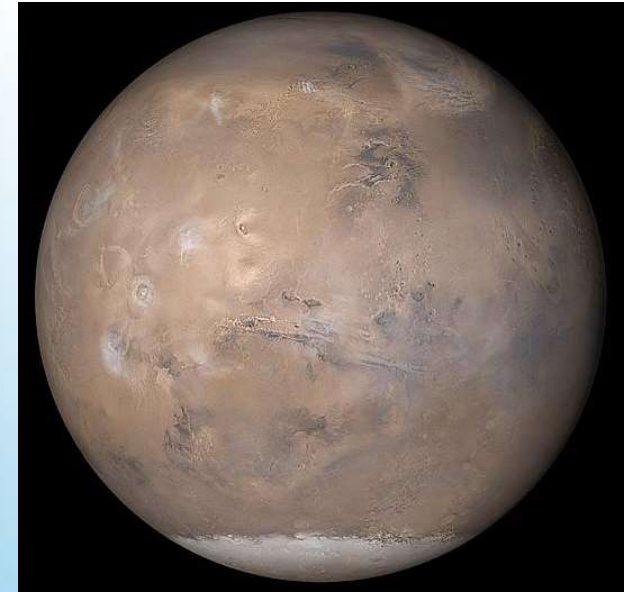
Venus

- The image shows the south pole of Mercury.
- Mercury is very like the moon, without an atmosphere. But it is slightly larger.
- It has a very large iron core for its size. But why is this? Here is a theory:
- A collision is believed to have lost most of the mantle billions of years ago
- It takes just 88 Earth days to orbit the sun at an average distance of 58 million km
- It reaches 430 degrees C by day, but falls to -180 at night! Due to no atmosphere
- Few people have seen Mercury, as it orbits close to the sun
- It is always within 17 degrees of the Sun, as seen from Earth. This makes it hard to see from Earth
- It is visible only just before sunrise, or just after sunset. If you want to see it take care (**eye safety!**)...
- Do not search with a telescope unless the sun is below the horizon – remember my warning about the sun!
- Its poles are never lit by the sun, so ice can even be found in craters here – in fact these are among the coldest places in the solar system, and are colder than Neptune!



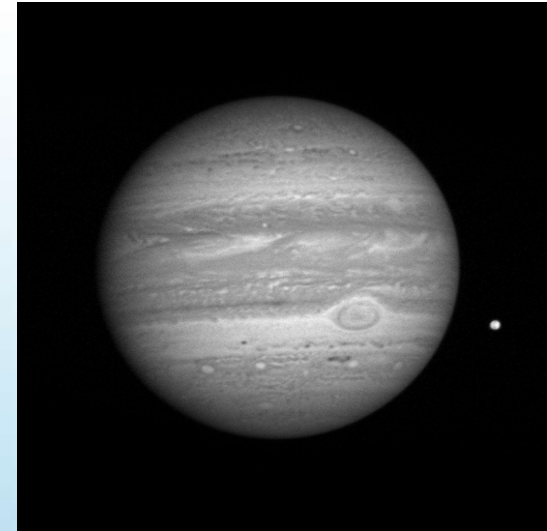
Mercury

- Mars is roughly half the diameter of Earth, and appears red.
- The colour is due to Iron Oxide (rust). It has an atmosphere.
- The atmosphere is about 1% of the density of Earth's
- Its composition is largely carbon dioxide with some nitrogen and others
- But the wind can still cause huge dust storms!
- Water cannot remain liquid on most of the surface due to low pressure
- But water exists frozen below ground in many places
- It has little magnetic field -solar wind removed much of the atmosphere
- Even so it is the place most like earth and microbial (single celled) life is thought possible underground
- It is the most likely planet to be colonised by humans in the future.
- It has two small moons, Phobos and Deimos, they are probably captured asteroids
- Its day is 24.6 hours (very similar to Earth's!), but its year is longer, 687 Earth days
- I hope to see a manned mission to Mars in my lifetime! Naas's current goal is in around 2030.



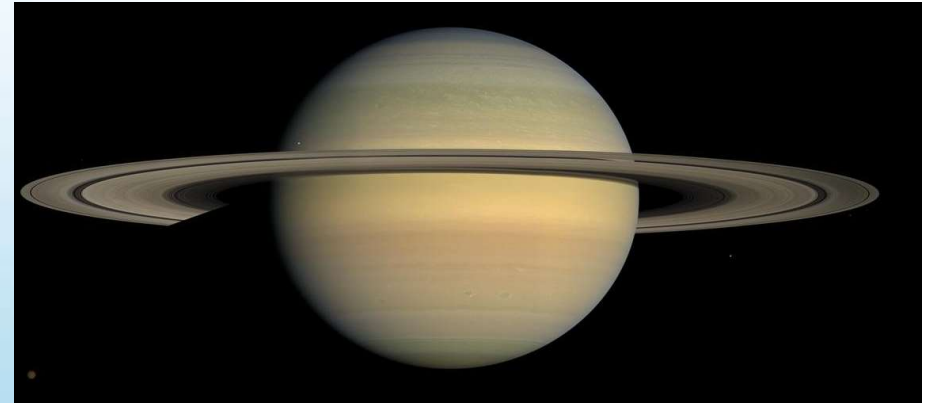
Mars, the Red planet

- Until now, the planets mentioned are terrestrial – they have a solid surface
- But there is a second type, the 'gas giants'. Made almost 100% of gas
- They are mainly composed of hydrogen, with some other gases
- The gas inside is under *huge* pressures, is liquid and in the centre, solid!
- At the core, hydrogen is a metallic solid which conducts electricity
- This creates a huge magnetic field and auroras like the Earths.
- Jupiter has 53 named moons – with more being discovered all the time
- The largest are the The Galilean Moons (discovered by Galileo)
- These are Io, Europa, Ganymede and Callisto, a small telescope reveals these easily
- The clouds are made of ammonia, and Jupiter orbits the sun in 12 Earth years
- There are zonal winds and huge storms, including the 'Great red spot' which has lasted at least 300 years!
- At approximately 12000 miles depth, the pressure is 2 million times Earth and hydrogen is a metallic solid
- The polar aurorae are larger than the entire Earth, as are the storms! They emit deadly radiation
- Jupiter has more mass than all the other planets combined! It is believed to have formed first too



Jupiter

- Saturn is the most photogenic planet due to the ring system
- The rings are believed to be made from moons that collided
- Saturn has 82 known moons at time of writing...
- The largest is Titan. The only moon with an atmosphere!
- Titan has seas of liquid methane and methane rain!
- Saturn has the lowest average density of all planets
- Saturn has an average density lower than water – it would actually float.
- It orbits at 886 million miles, or 1.4 billion km, from the sun in 29 earth years
- It is made mainly from hydrogen and helium, hence the low density
- It is the furthest planet which can be seen with the unaided eye, discovered before telescopes invented
- Cassini orbited Saturn 294 times between 2004 and 2017, outliving its expected lifetime before retirement
- Pioneer 11 and Voyagers 1 and 2 flew past Saturn
- Distance from Earth is around 1 billion miles! Light and radio signals take 1 ½ hours to reach us!
- The rings and the largest moon, Titan can be seen in a three inch refractor telescope



Saturn

- There are two planets missing from the list, Uranus and Neptune were not discovered before telescopes were invented. They too are made from gas and have moons in orbit.
- But Uranus can barely be seen with the unaided eye, Neptune not at all
- There are also the asteroids in a belt lying (mostly) between the orbits of Mars and Jupiter
- Dwarf planets exist, notably Pluto. They are not classed as planets as they have no independent orbit
- Comets are frozen debris, visible only when near enough the sun to evaporate, producing a tail
- Meteorites are rocks of various sizes. The larger ones can reach the Earth's surface!
- But the odds against being hit by one are huge – you are far more likely to win the lottery!!!
- But - are there other planets *outside the solar system*? YES! In 1995 the first 'extrasolar' planet was discovered. It was long expected (– but they are hard to detect – stars are millions of times brighter!)
- Extrasolar planets orbit a star other than our sun, and thousands are now known. For a future class??
- Extrasolar planets are indeed the potential topic of a planned future lesson – as are many other topics
- These other topics include the greatest question of our time – might life exist elsewhere, and if so, where?
- And I plan future lessons covering objects which lie well beyond unaided eye astronomy.
- But for today, we will finish by taking a brief look at stars

Other solar system objects

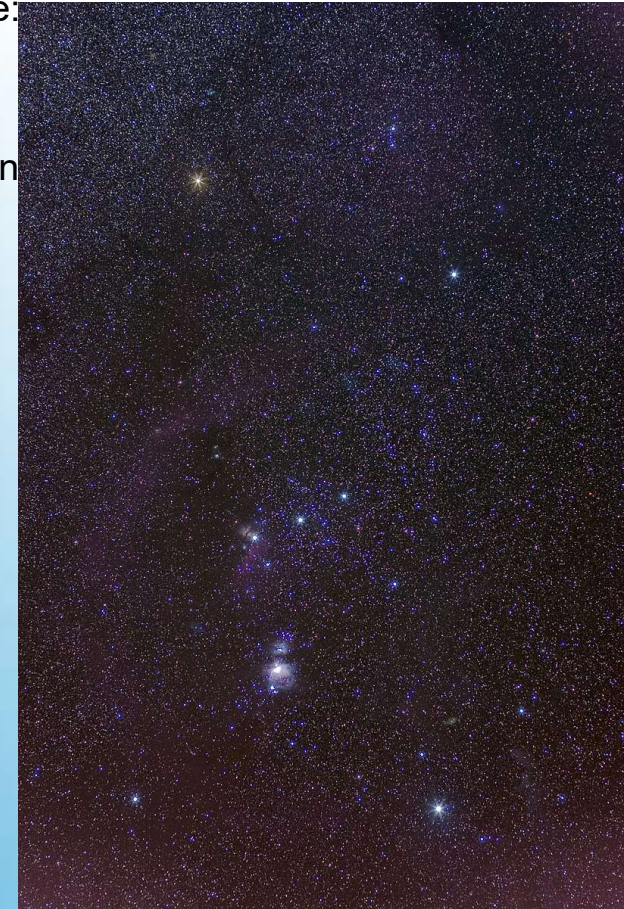
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Other solar system objects

- In ancient times, it was believed that the other planets orbited the Earth, we know today they orbit the Sun!
- We well know today that the moon is the only natural satellite of the Earth, other planets have more than one.
- It was also once believed that the stars lay just beyond Saturn. But we know today this is very wrong!
- Distances to the other planets take minutes to hours to reach at the speed of light. But...
- Even the next nearest star beyond the sun is four light YEARS away - *about six trillion miles!*
- Even our own galaxy is 100,000 light years across – yes it would literally take that long!
- But constellations do not reveal the distance of stars from us. Only their direction and apparent brightness.
- Stars range hugely in size, colour, surface temperature and lifespan.
- Our sun is only slightly above average mass, and will live for 12 billion years, it is currently 4.5 billion years old. And the lifecycle of stars might be the subject of a future lesson.
- The smallest stars are 10000 times dimmer than our sun and live for trillions of years, known as red dwarfs
- The largest are thousands of time brighter, live only millions of years and explode as a supernova
- And believe it or not, the red stars are the coolest! From 3000 C at the surface, our sun is around 6000
- Here is the best most familiar constellation, Orion up next...

Brief look to the stars!

- Orion is the most distinctive constellation. It has 8 bright stars these are:
- Betelgeuse, Rigel, Bellatrix, Mintaka, Alnilam, Alnitak, Saiph, Meissa.
- A constellation is a group of stars which make up a recognisable pattern
- A lot of ancient myths and stories are based on them.
- But the patterns are just random arrangements of stars
- In another part of the galaxy, the constellations would not be familiar!
- But there are far more stars than can be seen with the unaided eye
- How bright a star appears depends on its distance and true brightness
- But these are the topic of future lessons
- And that's the end of the introduction today.
- And the future...



Orion

- Well I hope you found today interesting. And I thought I might give you some hints at what I might offer in future... Possible future lessons might include:
- The history and future of the universe
- Extrasolar planets
- Life must follow the rules of biology, which depend on the laws of physics and chemistry. Sorry sci-fi fans
- What life on other planets may look like (based on science fact, not fiction!)
- The history and future of planet Earth
- Why you cannot travel faster than light (or even quite reach it!) - apologies to Star Trek fans...
- Is time travel a possibility?
- **And of course, I am open to any questions or suggestions from students and their parents also! If there are any topics which you, (or your parents or teachers) might like to request, then you know where I am.**

**Possible future lesson topics? –
Feel free to make suggestions!**