Cambridge (CIE) IGCSE Physics

Your notes

Earth & The Solar System

Contents

Your notes

Sun & Earth

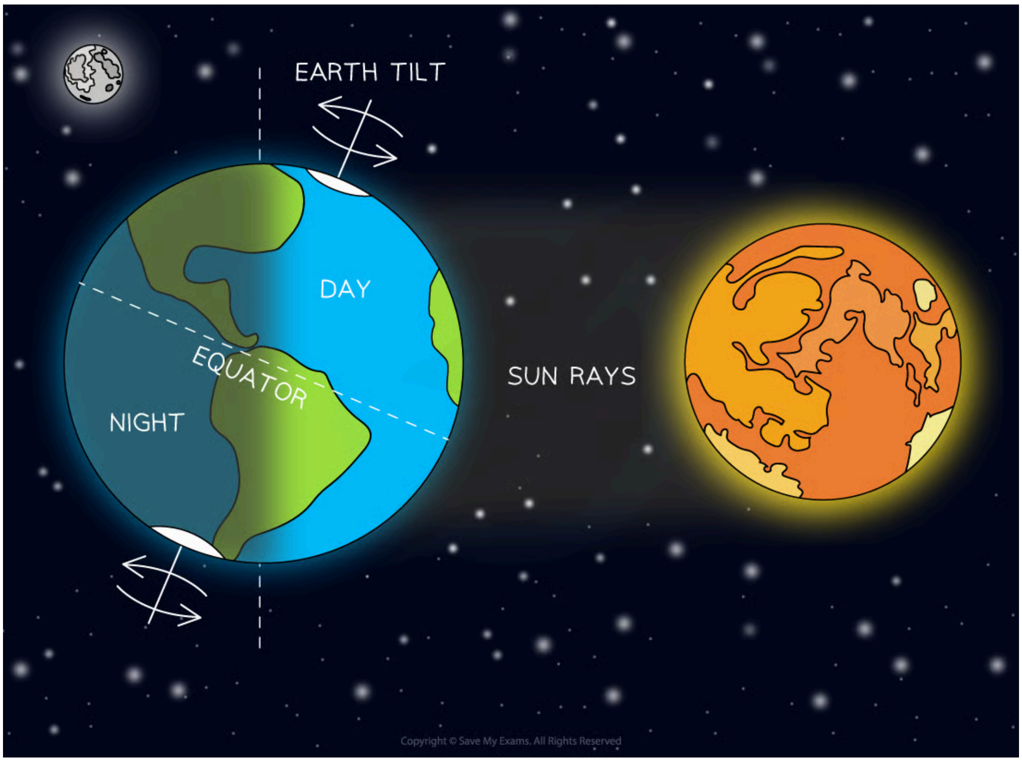
- The Earth is a **planet** that
  - rotates on its axis once every **24 hours**
  - orbits around the Sun once every **365 days**
- The Earth's **axis** is:
  - a line that passes through the North and South poles
  - tilted at an angle of approximately **23.5°** from the vertical
- The daily rotation of the Earth on its axis causes
  - the periodic cycle of **day** and **night**
  - the apparent daily **rising** and **setting** of the Sun

Day and night

- Day and night are caused by the Earth's **rotation** on its axis
- One full rotation takes approximately 24 hours, which means
  - the half of the Earth's surface facing the Sun experiences **day**
  - the other half of the Earth's surface, facing away from the Sun, experiences **night**

Day and night on Earth

Your notes

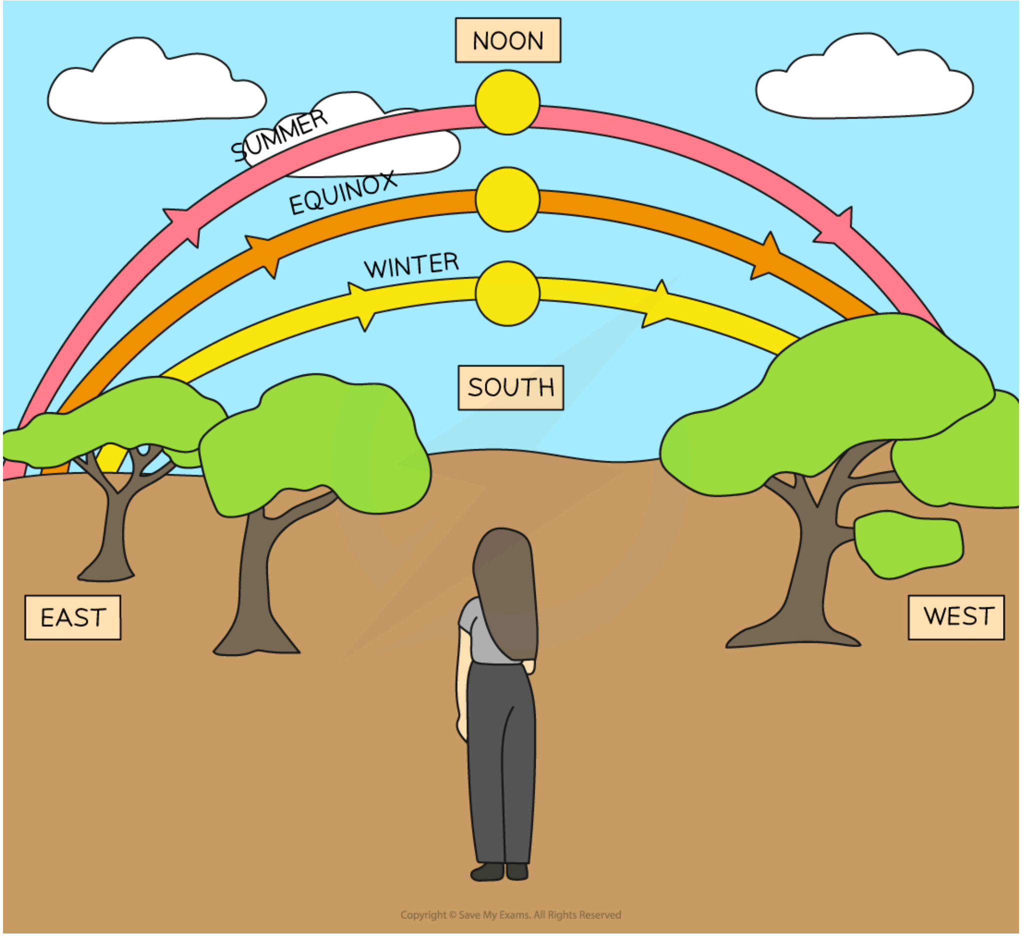


Day and night are caused by the rotation of the Earth on its axis once every 24 hours

The rising and setting of the Sun

- The apparent daily motion of the Sun is also caused by the Earth's **rotation** on its axis
- Each day, the Sun appears
  - to rise from the **east**
  - to set in the **west**
  - to reach its highest point above the horizon at **noon** (12 pm)
- The length of a day is
  - the number of hours a location receives sunlight, i.e. from the time the Sun **rises** to the time it **sets**
  - the **same** (about 12 hours) in locations near to the equator
  - **variable** in locations north and south of the equator

Apparent motion of the Sun



The Sun rises in the east and sets in the west. Its apparent motion across the sky changes throughout the year

- During **equinoxes** in both hemispheres:
  - day and night are approximately equal in length
  - the Sun appears to rise exactly in the east and set exactly in the west
- During the **summer**, the Sun appears:
  - to rise in the northeast and set in the northwest (in the **northern** hemisphere)
  - to rise in the southeast and set in the southwest (in the **southern** hemisphere)
  - to move higher above the horizon
  - to reach its greatest height above the horizon on the **summer solstice**, the day when daylight hours are the **longest**
- During the **winter**, the Sun appears:
  - to rise in the southeast and set in the southwest (in the **northern** hemisphere)
  - to rise in the northeast and set in the northwest (in the **southern** hemisphere)
  - to move closer to the horizon

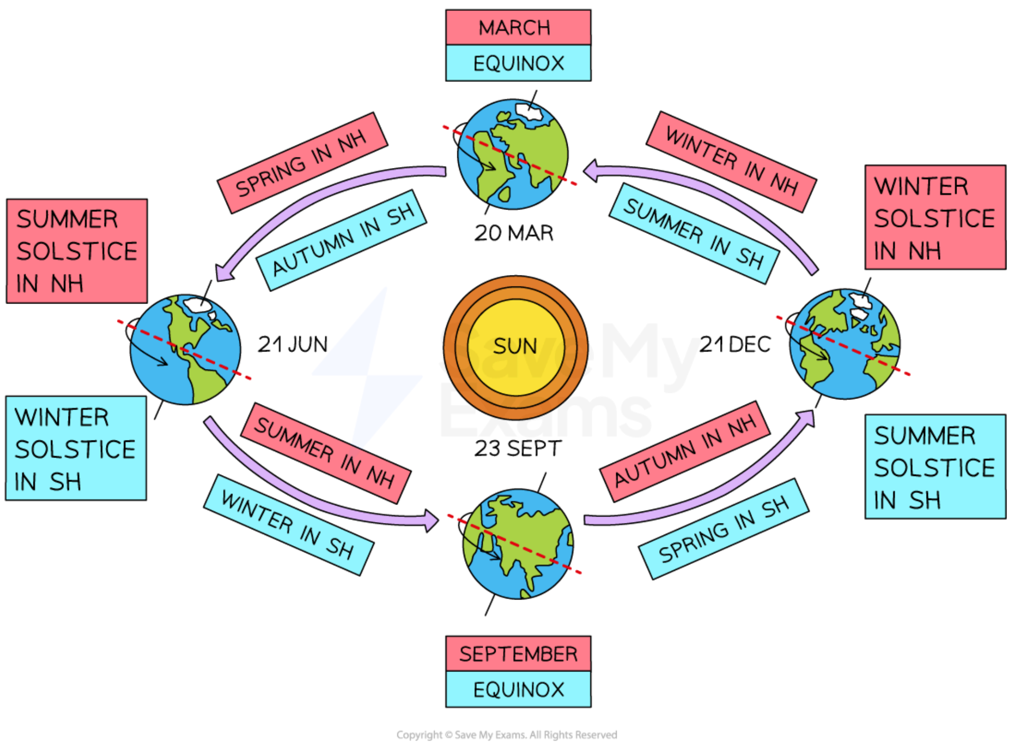
- to reach its lowest height above the horizon on the **winter solstice**, the day when daylight hours are the **shortest**

Your notes

The seasons

- Throughout the year, most locations on Earth experience **four** seasons; summer, autumn, winter and spring
- These seasons are caused by
  - the Earth's **orbit** around the Sun
  - the Earth's **tilted axis**
- The Earth's axis of rotation stays tilted at 23.5° throughout its orbit around the Sun, which means
  - one hemisphere tilts **towards** the Sun and receives **more** solar radiation
  - the other hemisphere tilts **away** from the Sun and receives **less** solar radiation
  - six months later, the hemispheres tilt in the **opposite** direction

Seasons on Earth



Seasons are caused by the tilt of the Earth and the orbital motion around the Sun. When it is summer in the northern hemisphere (NH), it is winter in the southern hemisphere (SH)

- When it is **summer** in the northern hemisphere
  - the northern hemisphere is tilted **towards** the Sun

    - the northern hemisphere receives a **greater** proportion of solar radiation
    - the southern hemisphere experiences **winter**
- When it is **winter** in the northern hemisphere
    - the northern hemisphere is tilted **away** from the Sun
    - the northern hemisphere receives a **smaller** proportion of solar radiation
    - the southern hemisphere experiences **summer**
- When it is **spring** or **autumn**, both hemispheres receive about the **same** amount of solar radiation

The effect of the Earth's tilt on solar radiation

The amount of solar radiation received by the northern hemisphere in winter is less than the amount of solar radiation received by the southern hemisphere in summer

- The variation in daylight hours throughout the year in the northern and southern hemispheres is shown below:

Seasons, equinoxes and solstices

When	Northern Hemisphere	Daylight hours	Southern Hemisphere	Daylight hours
20 Mar	(spring) equinox	**equal** hours of day and night	(autumn) equinox	**equal** hours of day and night
Mar, Apr, May	spring	days are **longer** than nights hours of daylight **increase**	autumn	days are **shorter** than nights hours of daylight **decrease**
21 Jun	(summer) solstice	**longest** hours of daylight	(winter) solstice	**shortest** hours of daylight
Jun, Jul, Aug	summer	days are **longer** than nights hours of daylight **decrease**	winter	days are **shorter** than nights hours of daylight **increase**
23 Sept	(autumn) equinox	**equal** hours of day and night	(spring) equinox	**equal** hours of day and night
Sept, Oct, Nov	autumn	days are **shorter** than nights hours of daylight **decrease**	spring	days are **longer** than nights hours of daylight **increase**

Your notes

21 Dec	(winter) solstice	**shortest** hours of daylight	(summer) solstice	**longest** hours of daylight
Dec, Jan, Feb	winter	days are **shorter** than nights hours of daylight **increase**	summer	days are **longer** than nights hours of daylight **decrease**

Your notes

Examiner Tips and Tricks

It is a common misconception that summer is warm because the Sun is closer to Earth and that winter is cold because the Sun is further away - this is not correct! The Earth does have a slightly elliptical orbit around the Sun, but this does not cause a significant temperature variation.

Remember that seasons are caused by the Earth's **tilted axis** of rotation and its **yearly revolution** around the Sun.

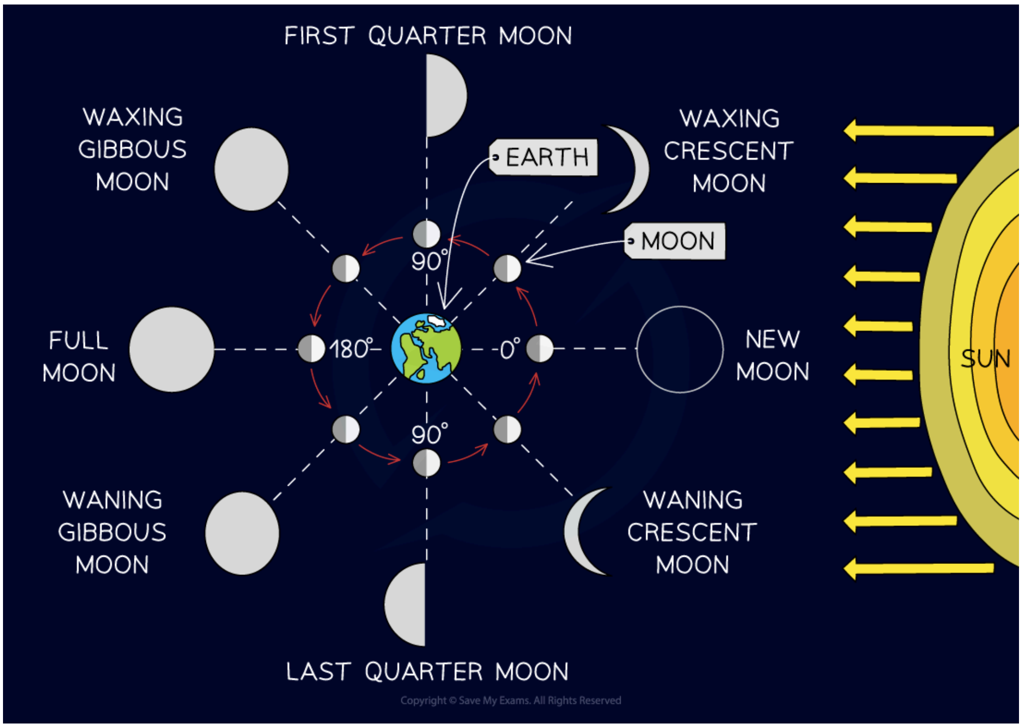
Moon & Earth

- The Moon is a **natural satellite** that
  - orbits around the Earth in a roughly circular orbit
  - takes about one month (28 days) to complete one orbit
  - rotates on its axis once every 28 days so the **same** side always faces the Earth

Phases of the Moon

- The Moon does not produce its own light
- It is visible in the night sky because it **reflects** the light from the Sun
- As it orbits around the Earth, it can be seen to undergo different **phases**

Motion of the Moon



Exactly half of the Moon is always illuminated by the Sun, but its appearance varies when viewed from Earth as it completes its monthly orbit

- On day 0, a **new moon** is observed, where:
  - the Moon is positioned between the Earth and the Sun
  - the side of the Moon facing **away** from Earth is fully illuminated
  - **none** of the Moon's surface is visible from Earth
- On day 7, the **first quarter** phase is observed
  - After the new moon, a thin **crescent** appears and becomes brighter (**waxes**)
  - After the first quarter moon, it continues to brighten (wax) into a **gibbous** shape
- On day 14, a **full moon** is observed, where:
  - the Earth is positioned between the Moon and the Sun
  - the side of the Moon facing **towards** the Earth is fully illuminated
  - **all** of the Moon's surface is visible from Earth
- On day 21, the **last quarter** phase is observed
  - After the full moon, it becomes dimmer (**wanes**) back into a **gibbous** shape
  - After the last quarter moon, it continues to dim (wane) into a **crescent**
- On day 29, a **new moon** is observed and the cycle starts again

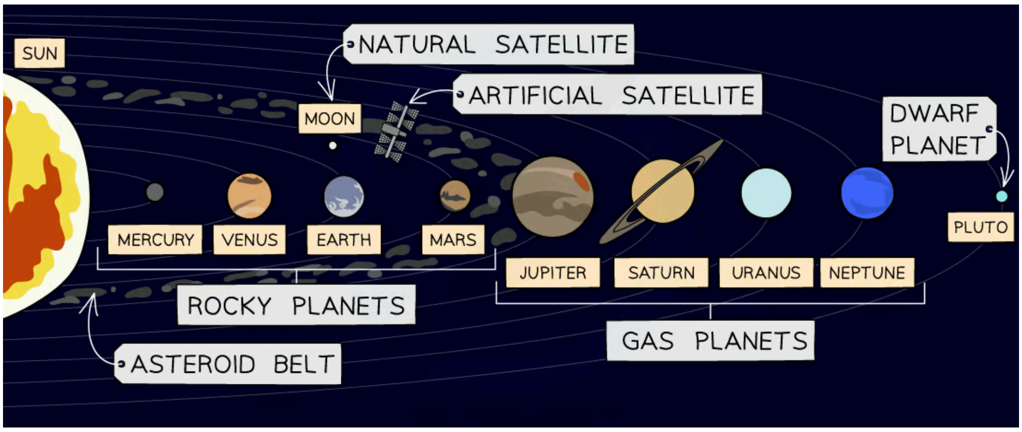
Your notes

Your notes

The Solar System

- The Solar System consists of:
  - the Sun
  - eight planets
  - natural and artificial satellites
  - dwarf planets
  - asteroids and comets

The Solar System



The Solar System consists of one star (the Sun) and the objects that orbit it, including the planets, moons, dwarf planets, asteroids and comets

The Planets

- There are **eight** planets which **orbit** the Sun
- In ascending order of the distance from the Sun, these are:

Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune

- The planets can be divided into two groups
  - the **inner** rocky planets
  - the **outer** gas giants

Dwarf Planets

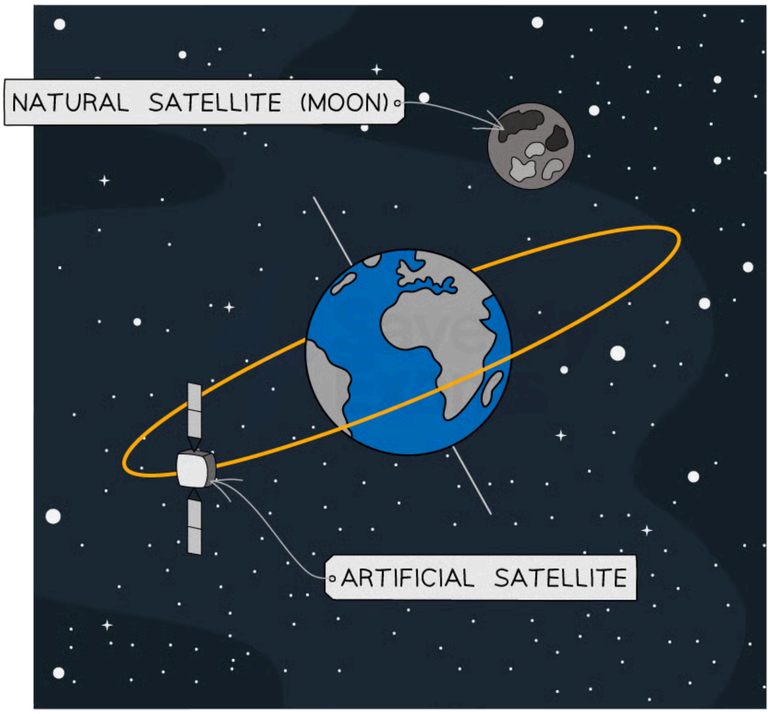
- A dwarf planet is an object similar to a planet, but much smaller

- The **gravitational field** around a planet is strong enough to pull in nearby objects (with the exception of natural **satellites**)
- Whereas, the gravitational field around a dwarf planet is **not strong enough** to pull in nearby objects

Satellites

- There are two types of satellites: **natural** and **artificial**

Natural and artificial satellites of Earth



The Moon is a natural satellite of the Earth. Many artificial satellites orbit around the Earth.

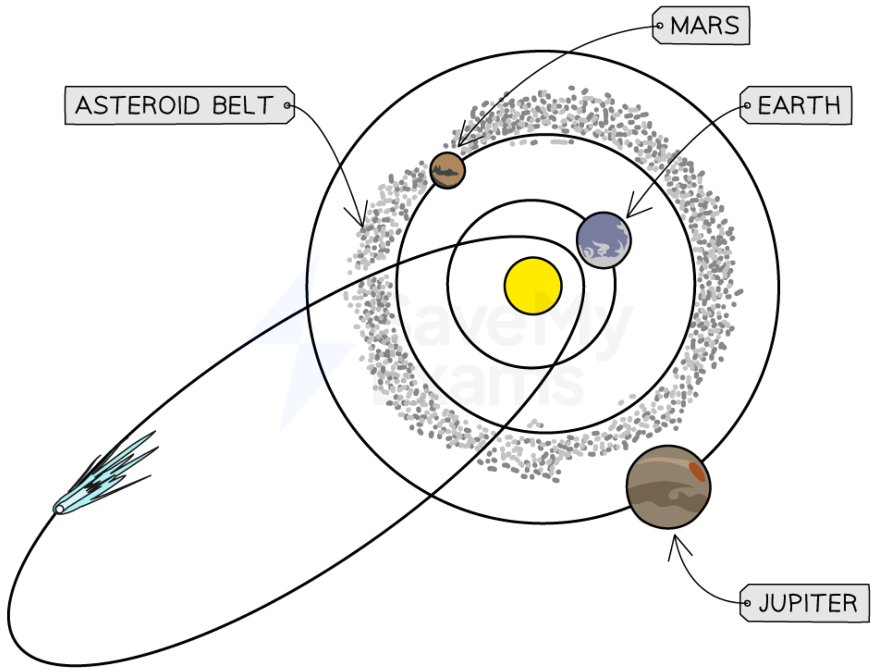
- Natural satellites are objects that orbit planets
- A **moon** is a type of natural satellite
- **Artificial satellites** are manmade objects that orbit another object in space
- The International Space Station (ISS) is an example of an artificial satellite that orbits the Earth

Asteroids and comets

- Asteroids and comets also orbit the Sun

Locations of asteroids and comets

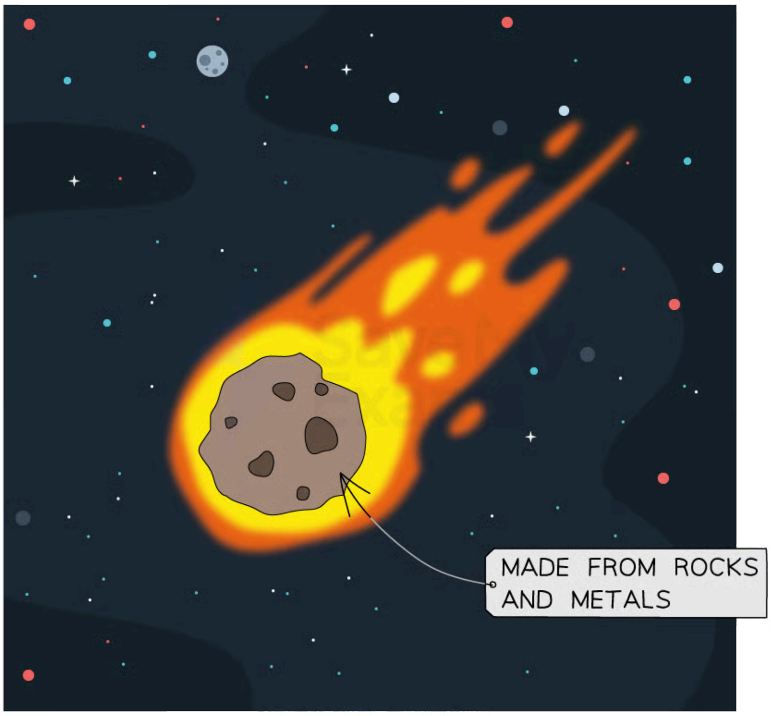
Your notes



Asteroids are found in the Asteroid Belt between Mars and Jupiter, whereas comets are usually found in the outer reaches of the Solar System due to their highly elliptical orbits

- An **asteroid** is a small **rocky object** which orbits the Sun
- The **asteroid belt** lies between Mars and Jupiter

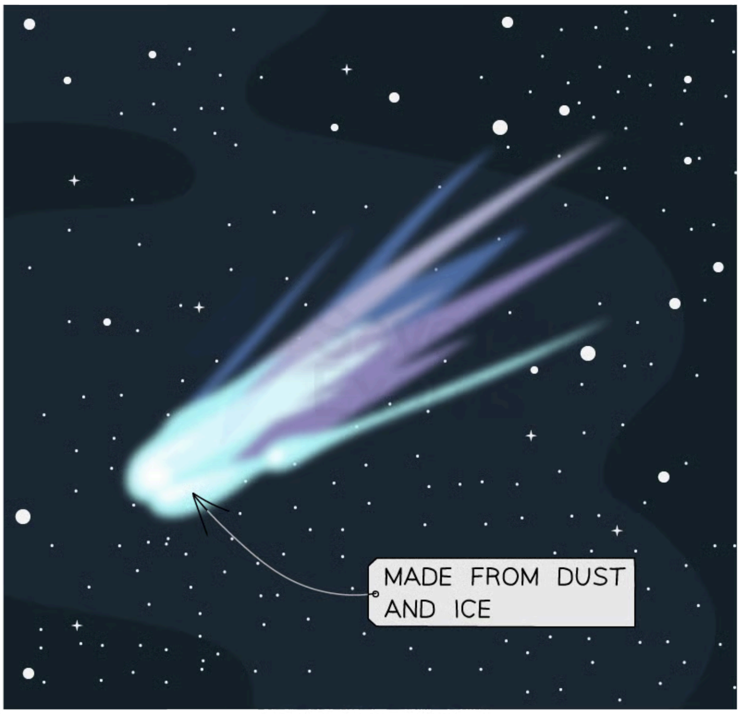
An asteroid



Asteroids are small, rocky objects which occupy the inner Solar System

- A **comet** is an object made of **dust and ice** which goes around the Sun in a highly elliptical (not a circular path with the Sun at the centre) path
- The ice melts when the comet approaches the Sun and forms the comet's **tail**

A comet



Comets are small, icy objects which occupy the outer Solar System

Orbiting bodies

- The Solar System is made up of many bodies which orbit around other bodies
- **Smaller** bodies **orbit** around **larger** bodies
  - For example, planets orbit the Sun and moons orbit planets
- The orbiting bodies in the Solar System are shown in the table below:

Table of orbiting bodies in the Solar System

orbiting body	body it orbits
planet	the Sun
moon	planet

Your notes

comet	can pass around the Sun
asteroid	the Sun
artificial satellites	the Earth

Your notes

Examiner Tips and Tricks

You need to know the order of the 8 planets in the Solar System. The following mnemonic gives the first letter of each of the planets to help you recall them:

My **V**ery **E**xcellent **M**other **J**ust **S**erved **U**s **N**oodles

Mercury, **V**enus, **E**arth, **M**ars, **J**upiter, **S**aturn, **U**ranus, **N**eptune

Analysing orbits

Extended tier only

- Over many years, data for the planets, moons and the Sun have been collected
- Some of this data is shown in the table below

Data for the planets in the Solar System

Planet	Mean distance from Sun (relative to Earth)	Orbital period (Earth years)	Mean surface temperature (°C)	Density (kg/m^3)	Diameter (10^3 km)	Mass (relative to Earth)	Surface gravity (N/kg)
Mercury	0.39	0.24	350	5429	4.9	0.06	3.7
Venus	0.72	0.60	460	5243	12.1	0.82	8.9
Earth	1	1	20	5514	12.8	1	9.8
Mars	1.5	2	–23	3934	6.8	0.11	3.7
Jupiter	5.2	12	–120	1326	143	320	23.1

Saturn	9.6	30	–180	687	121	95	9.0
Uranus	19	84	–210	1270	51	15	8.7
Neptune	30	160	–220	1638	50	17	11.0

- The data allows us to
  - make comparisons
  - identify trends and anomalies
  - make predictions
- Some examples of **comparisons** are:
  - Neptune is 30 times **further away** from the Sun than the Earth
  - Jupiter contains the **same** mass as 320 Earths
- An example of a **trend** is:
  - As the distance from the Sun **increases**, the time it takes to complete one orbit (orbital period) also **increases**
- An example of an **anomaly** is:
  - As the distance from the Sun increases, the temperature decreases, **except** for Venus which has a higher temperature than Mercury
- An example of a **prediction** is:
  - The temperature of a dwarf planet in the asteroid belt is **likely** to be around –100°C, but it could be anywhere between –63°C and –130°C as these are the temperatures of Mars and Jupiter

Examiner Tips and Tricks

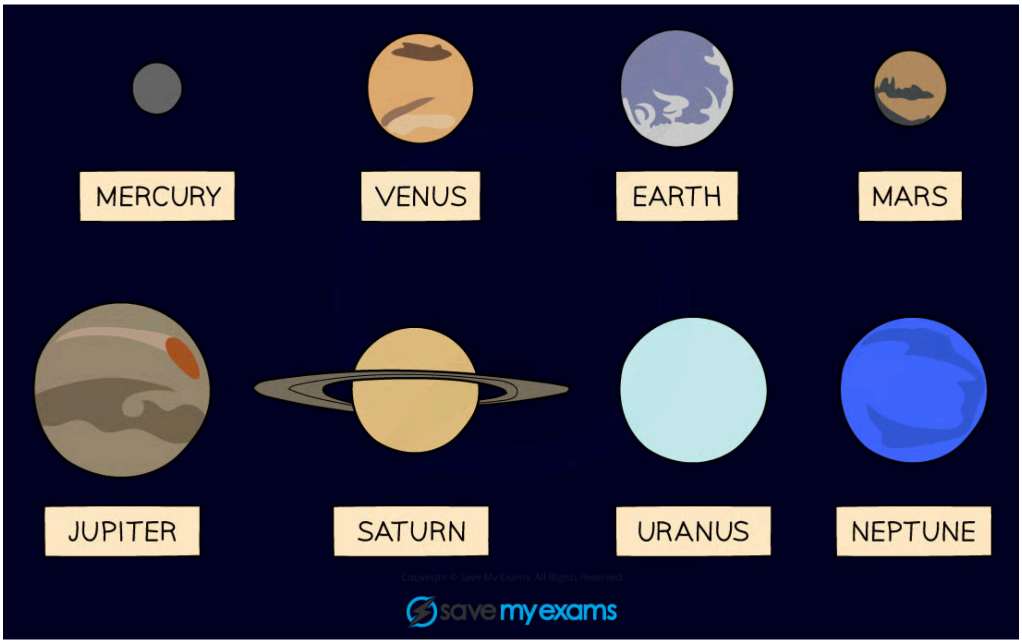
Don't panic when you see the large table of numbers - you don't need to memorise any of it, but you need to be able to analyse and interpret it confidently. Look for trends such as one variable increasing whilst the other decreases (or increases). Think carefully about why that may be with what you have already learnt about the planets from this topic. For example, what is the planet made of? What is its distance from the Sun and how does this affect it?

Your notes

Formation of the Solar System

- The 4 **inner** planets (nearest to the Sun):
  - are **rocky** and **small**
  - have **atmospheres** (except for Mercury)
- The 4 **outer** planets (furthest from the Sun):
  - are **gaseous** and **large**
  - are mostly composed of **hydrogen** and **helium** gas

The planets in the Solar System



The eight planets can be split into the four inner rocky planets and the four outer gas giants

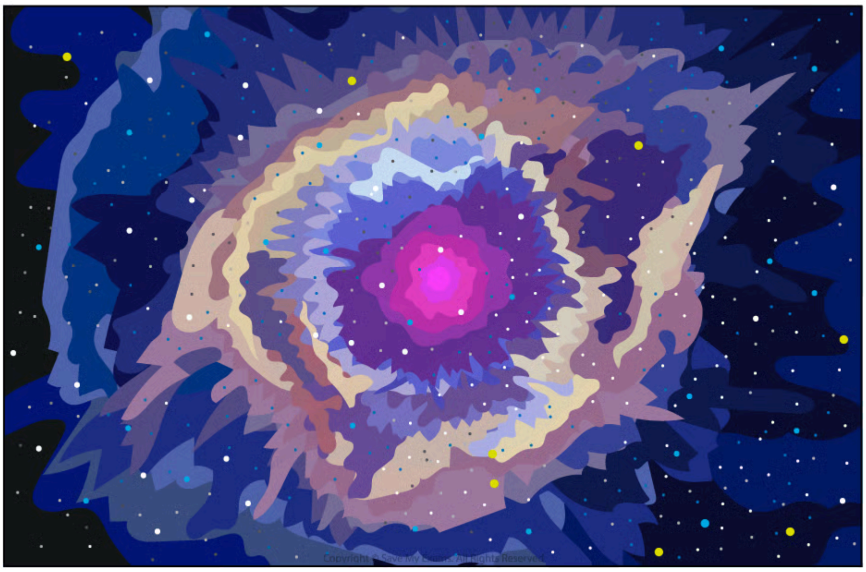
- The differences between the inner and outer planets can be explained using the **accretion model** for the formation of the Solar System

Distribution of elements in the Solar System

- The Sun and the planets in the Solar System formed from a **cloud of dust and gas** (nebula)
  - Gravity pulled this cloud together into a giant ball, which would eventually become the Sun
  - As the nebula collapsed, the Sun became **denser** and **hotter**

- The Solar System then formed around 4.5 billion years ago
  - The planets formed from the remnants of the matter left over from the nebula that formed the Sun
  - The nebula contained many elements that were created during a supernova explosion in the distant past
- As the early Sun became hotter, gaseous matter was pushed **further** out into the Solar System than solid matter

A nebula



A nebula is an interstellar cloud of gas and dust

Formation of the inner planets

- In the hotter regions, closer to the Sun, the temperature was too high for lighter elements to exist in a solid state
  - Therefore, the inner planets formed from materials with high melting temperatures such as metals (e.g. iron)
  - The original nebula contained only a small proportion of heavy elements, so the inner planets could not grow as significantly as the outer planets
- As a result, solids in the inner disc were pulled together by gravity to form solid planets
  - This is why the 4 planets nearest to the Sun (Mercury, Venus, Earth and Mars) are **rocky and small**

Formation of the outer planets

- In the cooler regions, further from the Sun, the temperature was low enough for the light molecules to exist in a solid state

Your notes

- Therefore, the outer planets formed from materials with low melting temperatures (e.g. hydrogen, helium, water and methane)
- The original nebula contained a large proportion of light elements, so the outer planets were able to become exceptionally large

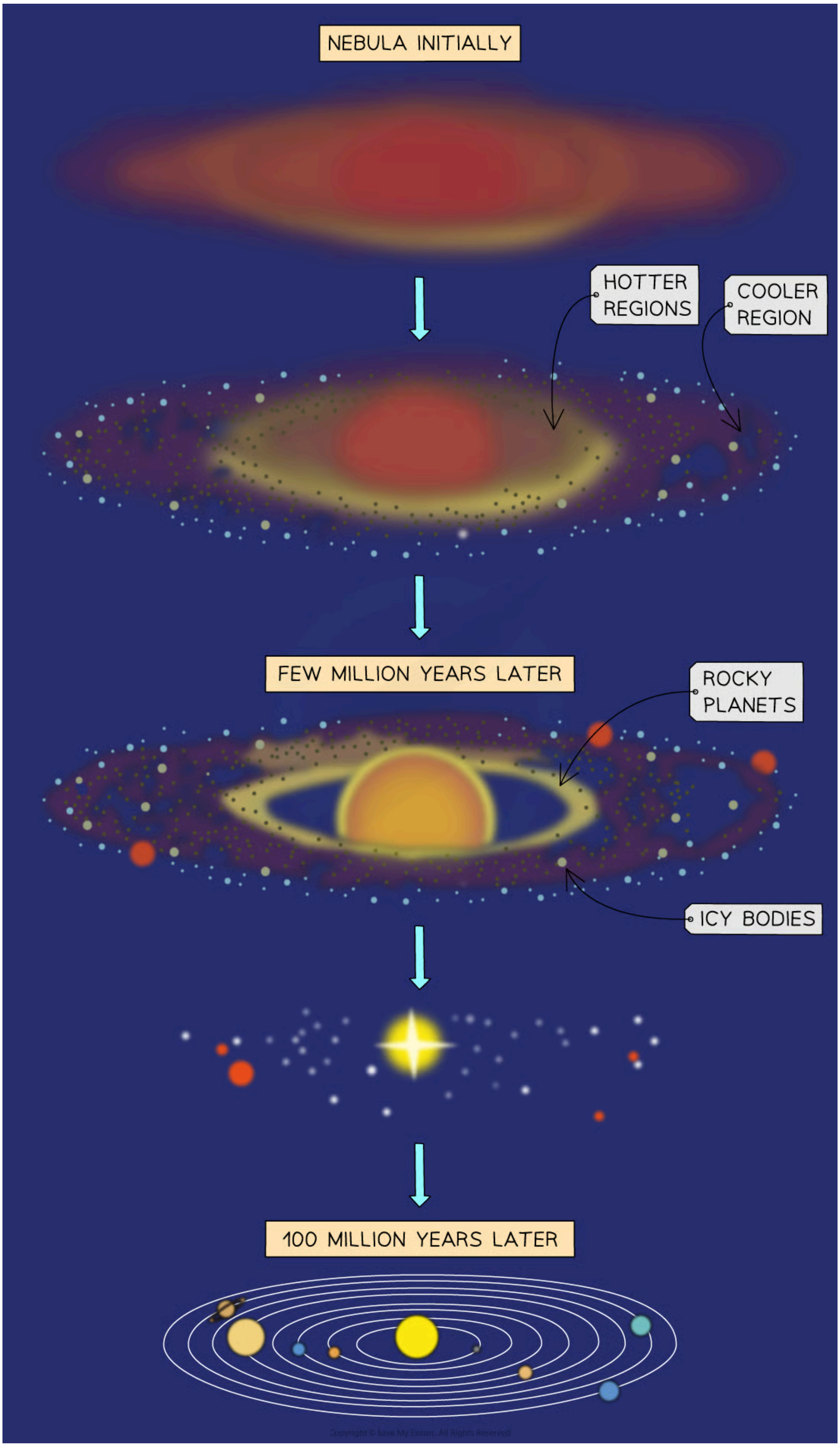
- As a result, gases in the outer disc were pulled together by gravity to form gaseous planets
  - This is why the 4 planets furthest from the Sun (Jupiter, Saturn, Uranus and Neptune) are **gaseous and large**

Formation of the accretion disc

- In the nebula, matter **accreted**
  - This means attractive gravitational forces between particles caused them to join together and grow into larger objects
- As the cloud collapsed under gravitational forces
  - it began to spin faster
  - it became hotter
  - it formed an accretion disc
- From the rotating **accretion disc**, the Sun and the planets emerged
  - The Sun formed at the centre
  - The planets formed in the accretion disc

Formation of the Solar System

Your notes


NEBULA INITIALLY
HOTTER REGIONS
COOLER REGION
FEW MILLION YEARS LATER
ROCKY PLANETS
ICY BODIES
100 MILLION YEARS LATER

Your notes

The Solar System formed from a nebula with the Sun in the centre, then solid planets closer to the Sun and gaseous planets further away

Your notes

Examiner Tips and Tricks

When writing about the formation of the Solar System, make sure you can:

- State where solid and gaseous matter gathered in the Solar System
- Explain how heavier elements became a part of the nebula
- Describe the role of gravity in pulling matter together and the formation of an accretion disc
- Explain the difference between the planets in terms of the accretion model

Your notes

Light speed calculations

- Light is a type of electromagnetic wave which travels at a constant speed of 3×10^8 m/s
- Objects in the Solar System are visible from Earth as they **reflect light** from the Sun
- It takes time for light to travel such large distances, for example:
  - it takes **8 minutes** for light from the Sun to reach Earth
  - it takes around **5 hours** for light from the Sun to reach the outer regions of the Solar System
  - it takes **4 years** for light from our nearest star (after the Sun) to reach Earth
- The Milky Way galaxy contains billions of stars, huge distances away, with the light taking even longer to be seen from Earth
- To carry out light speed calculations, we can rearrange the equation:

$$\text{average speed} = \frac{\text{total distance}}{\text{total time}}$$

- So, the time taken for light to travel a distance can be calculated using:

$$\text{time} = \frac{\text{distance}}{\text{speed of light}}$$

Worked Example

The radius of Mercury's orbit around the Sun is 5.8×10^{10} m.

The speed of light is 3.0×10^8 m/s.

Calculate the time taken for light from the Sun to reach Mercury.

Answer:

Step 1: List the known quantities

- Distance travelled = 5.8×10^{10} m
- Speed of light = 3.0×10^8 m/s

Step 2: State the equation for the time taken for light to travel a distance

$$\text{time} = \frac{\text{distance}}{\text{speed of light}}$$

Step 3: Substitute the values into the equation

$$\text{time} = \frac{5.8 \times 10^{10}}{3.0 \times 10^{8}} = 193 \text{ s}$$

- It takes about 193 s, or 3 min, for light from the Sun to reach Mercury

Examiner Tips and Tricks

The speed of light is **very** fast. This is why in our everyday life things like switching on a light seem to be instant. However, this is only because the light travels very fast and the distances are very small. In large, astronomical distances which can be millions or even billions of kilometres, the limit of the speed of light starts to have an effect.

For example, it takes light 8 minutes to travel from the Sun to the Earth. This means we are seeing the Sun as it was eight minutes ago. If the Sun was to disappear, we would not notice till eight minutes later. Although, by that time, time delay would be the least of our worries...

p.s.: The Sun is not going to vanish!

Gravitational field strength of a planet

- The strength of a gravitational field around a planet depends on
  - the mass of the planet
  - the distance from the planet

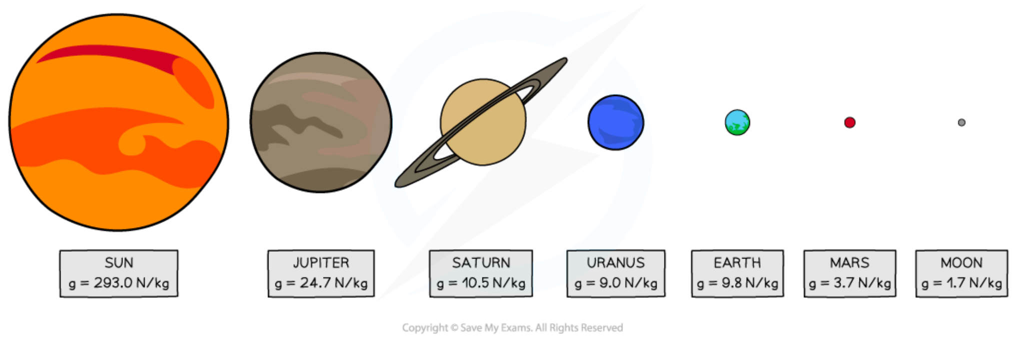
Gravitational field strength and mass

- The relationship between gravitational field strength and mass is:

The greater the mass of a planet, the greater the strength of the gravitational field at its surface

- The value of g (gravitational field strength) varies from planet to planet depending on their mass and radius

Gravitational field strength of bodies in the Solar System



The strength of the gravitational field at the surface of a planet depends on its mass and radius

Gravitational field strength and distance

- The relationship between gravitational field strength and distance is:

As the distance from a planet increases, the strength of the gravitational field decreases

- At the surface of a planet, the value of g (gravitational field strength) is constant, but it decreases with distance from the planet

Examiner Tips and Tricks

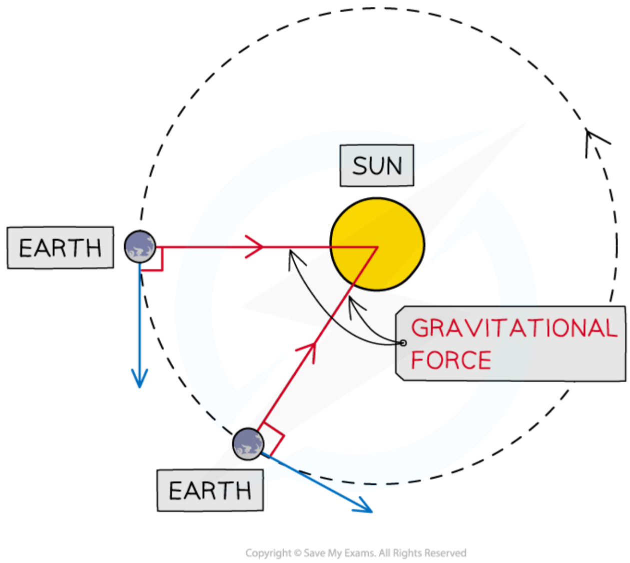
You do not need to remember the value of *g* on different planets for your exam, and the value of *g* for Earth is given on the front page of the exam paper.

Your notes

Gravitational attraction of the Sun

- Orbital motion is a result of the **gravitational force of attraction** acting between two bodies
- This gravitational force
  - always acts **towards the centre** of the larger body
  - causes the orbiting body to move in a **circular path**
- The Sun contains most of the mass (>99%) of the Solar System
- Therefore, for objects orbiting around the Sun
  - the Sun's **gravitational attraction** keeps them in orbit
  - the force is directed from the orbiting object to the centre of the Sun

Orbital motion of the Earth around the Sun



The Sun's gravitational force of attraction keeps the Earth in orbit around the Sun

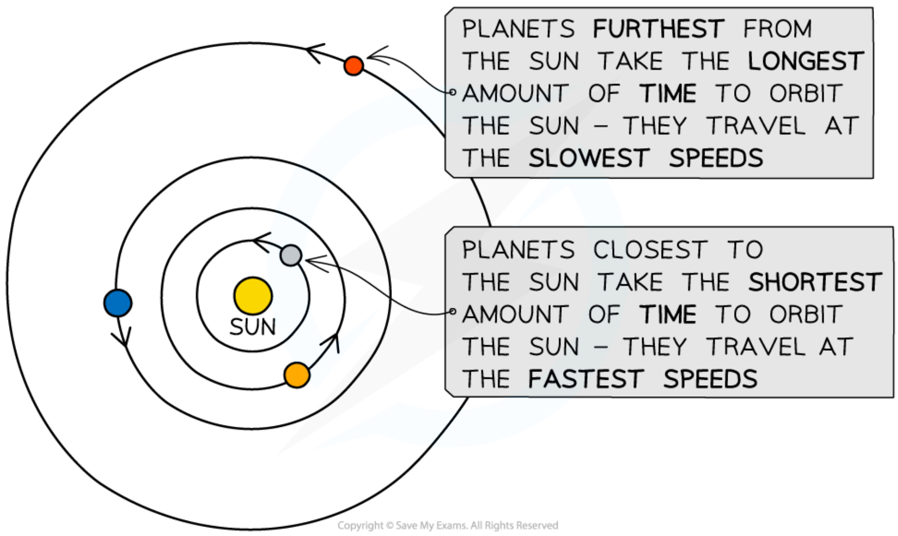
Orbital motion of planets

Extended tier only

- As the distance from the Sun increases:
  - the Sun's gravitational field strength **decreases**
  - the orbital speed of a planet **decreases**

- For an object to maintain a circular orbit, it must have a **centripetal force**
  - For planets orbiting the Sun, this force is the Sun's **gravitational attraction**
- Therefore, the centripetal force on a planet depends on
  - the strength of the Sun's gravitational field
  - the distance of the planet from the Sun
- The further away a planet is from the Sun, the **weaker** the strength of the Sun's gravitational attraction and the weaker the centripetal force
- The centripetal force on a planet is **proportional** to its orbital speed
- Therefore, the **further** a planet is from the Sun:
  - the **smaller** its orbital speed
  - the **longer** its orbital period

Orbital speed and distance



The closest planets to the Sun have the fastest orbital speeds, and the furthest have the slowest

- This trend in orbital speed and distance can be seen in the data of the planets in the Solar System:

Orbital radius, speed and period data

Planet	Orbital radius (million km)	Orbital speed (km/s)	Orbital period (days or years)
Mercury	57.9	47.9	88 days

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Venus	108.2	35.0	225 days
Earth	149.6	29.8	365 days
Mars	227.9	24.1	687 days
Jupiter	778.6	13.1	11.9 years
Saturn	1433.5	9.7	29.5 years
Uranus	2872.5	6.8	75 years
Neptune	4495.1	5.4	165 years

Your notes

Examiner Tips and Tricks

Be careful with your wording in this topic when talking about gravity. It is important to refer to the **force** of gravity as 'gravitational attraction', ' strength of the Sun's gravitational field' or 'the force **due to** gravity'. Avoid terms such as 'the Sun's gravity' or even more vague, 'the force from the Sun'.

Your notes

Orbital speed equation

Extended tier only

- When planets orbit around the Sun, or a moon moves around a planet, they move in **circular orbits**
- In one complete orbit, a planet travels a distance equal to the circumference of a circle
  - This is equal to $2\pi r$, where r is the radius of the circular path
- The relationship between speed, distance and time is:

$$\text{speed} = \frac{\text{distance}}{\text{time}} = \frac{\text{circumference of orbit}}{\text{orbital period}}$$

- The average orbital speed of an object can be defined by the equation:

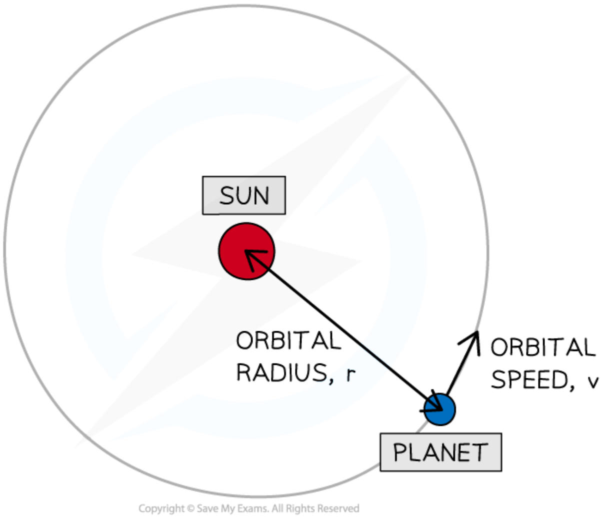
$$v = \frac{2\pi r}{T}$$

- Where:
  - v = orbital speed in metres per second (m/s)
  - r = average radius of the orbit in metres (m)
  - T = orbital period in seconds (s)
- This orbital period (or time period) is defined as:

The time taken for an object to complete one orbit

- The orbital radius r is always taken from the **centre** of the object being orbited to the object orbiting

Orbital speed of a planet



Orbital radius and orbital speed of a planet moving around a Sun

Your notes

Worked Example

The Hubble Space Telescope moves in a circular orbit. Its height above the Earth's surface is 560 km and the radius of the Earth is 6400 km. It completes one orbit in 96 minutes.

Calculate its orbital speed in m/s.

Answer:

Step 1: List the known quantities

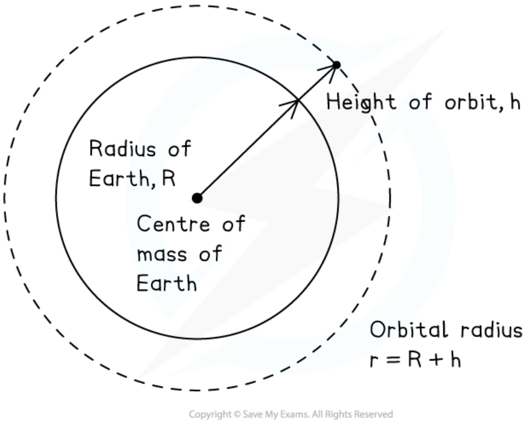
- Radius of the Earth, R = 6400 km
- Height of the telescope above the Earth's surface, h = 560 km
- Time period, T = 96 minutes

Step 2: Write the relevant equation

$$v = \frac{2\pi r}{T}$$

Step 3: Calculate the orbital radius, *r*

- The **orbital radius** is the distance from the **centre** of the Earth to the telescope



$$r = R + h$$

$$r = 6400 + 560 = 6960 \text{ km}$$

Step 4: Convert any units

- The time period needs to be in seconds

$$1 \text{ minute} = 60 \text{ seconds}$$

$$96 \text{ minutes} = 60 \times 96 = 5760 \text{ s}$$

- The radius needs to be in metres

$$1 \text{ km} = 1000 \text{ m}$$

$$6960 \text{ km} = 6\,960\,000 \text{ m}$$

Step 5: Substitute values into the orbital speed equation

$$v = \frac{2\pi \times 6\,960\,000}{5760} = 7592.18 = 7590 \text{ m/s}$$

Examiner Tips and Tricks

Remember to check that the orbital radius *r* given is the distance from the **centre** of the Sun (if a planet is orbiting a Sun) or the planet (if a moon is orbiting a planet) and not just from the surface. If the distance is a height above the surface you must add the radius of the body, to get the height above the centre of mass of the body.

Your notes

This is because orbits are caused by the mass, which can be assumed to act at the centre, rather than the surface.

Don't forget to check your units and convert any if required!

Your notes

Your notes

Elliptical orbits

Extended tier only

- The orbits of planets, minor planets and comets are **elliptical**
  - An ellipse is a 'squashed' circle
- Planets and minor planets have **slightly** elliptical orbits
  - Their orbits are approximately circular, so the Sun is generally considered to be at the centre
- Comets have **highly** elliptical orbits
  - The Sun is not at the centre of the orbit, it is at one of the two foci of the ellipse

Examiner Tips and Tricks

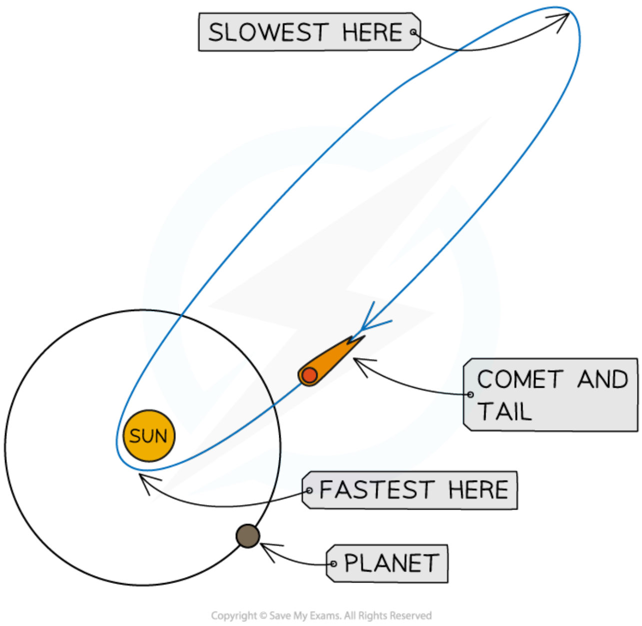
You will not be asked to do any calculations with elliptical orbits. If you are asked to calculate the time period, orbital speed or radius of an orbit, it can be assumed that it is circular.

Comet speed

Extended tier only

- An object in an elliptical orbit around the Sun travels at a **different** speed depending on its distance from the Sun
- Although these orbits are not circular, they are still **stable**
  - For a stable orbit, the **radius** must change if the comet's **orbital speed** changes
- As the comet approaches the Sun:
  - the radius of the orbit **decreases**
  - the orbital speed **increases** due to the Sun's strong gravitational pull
- As the comet travels further away from the Sun:
  - the radius of the orbit **increases**
  - the orbital speed **decreases** due to a weaker gravitational pull from the Sun

Speed of a comet in an elliptical orbit



Comets travel in highly elliptical orbits, speeding up as they approach the Sun

Conservation of energy in elliptical orbits

- When an object moves in an elliptical orbit, energy must be **conserved**
- Throughout the orbit, gravitational potential energy is **transferred** to kinetic energy, and vice versa
  - When a comet travels **closer** to the Sun, it has greater kinetic energy
  - When a comet travels **further** from the Sun, it has greater gravitational potential energy
- As the comet approaches the Sun:
  - it **loses** gravitational potential energy and **gains** kinetic energy
  - the increase in kinetic energy causes it to **speed up**
- As the comet moves away from the Sun:
  - it **gains** gravitational potential energy and **loses** kinetic energy
  - the decrease in kinetic energy causes it to **slow down**

Examiner Tips and Tricks

Remember that an object's kinetic energy is defined by: $\frac{1}{2}mv^2$ where *m* is the mass of the object and *v* is its speed. Therefore, if the speed of an object increases, so does its kinetic energy. Its gravitational potential energy therefore must decrease for energy to be conserved.

Your notes