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| A Visual Guide to Our Solar System [Infographic] - Earth How |
| The solar system  The intro to the system |
| |  |  |  | | --- | --- | --- | | Kintu Evans | 9/16/23 | physics | |

**Introduction to the Solar System:**

The solar system is a vast celestial system comprising the Sun and all celestial objects bound to it by gravity. It consists of eight planets, their moons, dwarf planets, comets, asteroids, and other celestial bodies orbiting the Sun.

**The Planets of the Solar System:**

**1. Mercury:**

* **Position:** Closest to the Sun.
* **Characteristics:**
  + Small, rocky planet with extreme temperature variations.
  + No atmosphere to retain heat, causing extreme hot and cold conditions.
* **Other Features:**
  + Craters on its surface from impacts.

**2. Venus:**

* **Position:** Second planet from the Sun.
* **Characteristics:**
  + Known for its thick, toxic atmosphere composed mainly of carbon dioxide.
  + High surface temperature, making it the hottest planet in the solar system.
* **Other Features:**
  + Dense cloud cover and a runaway greenhouse effect.

**3. Earth:**

* **Position:** Third planet from the Sun.
* **Characteristics:**
  + The only known planet to support life.
  + Diverse ecosystems, liquid water, and a life-friendly atmosphere.
* **Other Features:**
  + Home to a vast array of life forms and natural wonders.

**4. Mars:**

* **Position:** Fourth planet from the Sun.
* **Characteristics:**
  + Often called the "Red Planet" due to its reddish appearance from iron oxide.
  + Thin atmosphere and cold temperatures.
* **Other Features:**
  + Extensive canyon systems and the tallest volcano in the solar system, Olympus Mons.

**5. Jupiter:**

* **Position:** Fifth planet from the Sun.
* **Characteristics:**
  + Largest planet in the solar system, a gas giant.
  + Prominent cloud bands and the iconic Great Red Spot (a massive storm).
* **Other Features:**
  + A vast system of moons, including the four Galilean moons.

**6. Saturn:**

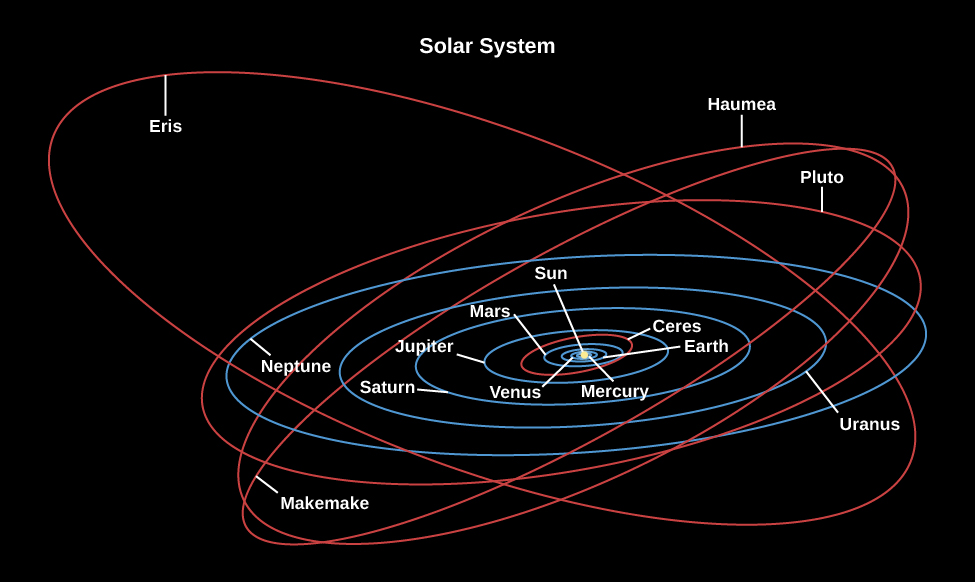
* **Position:** Sixth planet from the Sun.
* **Characteristics:**
  + Known for its spectacular ring system made of ice and dust particles.
  + Second-largest planet and a gas giant like Jupiter.
* **Other Features:**
  + A diverse set of rings, with stunning variations and patterns.

**7. Uranus:**

* **Position:** Seventh planet from the Sun.
* **Characteristics:**
  + An ice giant with a unique feature: it rotates on its side.
  + It has a faint ring system and a blue-green color due to methane in its atmosphere.
* **Other Features:**
  + A unique rotational tilt, possibly caused by past collisions.

**8. Neptune:**

* **Position:** Eighth planet from the Sun.
* **Characteristics:**
  + An ice giant similar to Uranus but with a vivid blue coloration.
  + Strongest winds in the solar system, reaching up to 2,100 kilometers per hour.
* **Other Features:**
  + Rings, a dynamic atmosphere, and a large moon called Triton.



| Name | Distance from Sun (  AU  )2 | Revolution Period (y) | Diameter (km) | Mass (1023 kg) | Densit (g/cm3)3 |
| --- | --- | --- | --- | --- | --- |
| Mercury | 0.39 | 0.24 | 4,878 | 3.3 | 5.4 |
| Venus | 0.72 | 0.62 | 12,120 | 48.7 | 5.2 |
| Earth | 1.00 | 1.00 | 12,756 | 59.8 | 5.5 |
| Mars | 1.52 | 1.88 | 6,787 | 6.4 | 3.9 |
| Jupiter | 5.20 | 11.86 | 142,984 | 18,991 | 1.3 |
| Saturn | 9.54 | 29.46 | 120,536 | 5686 | 0.7 |
| Uranus | 19.18 | 84.07 | 51,118 | 866 | 1.3 |
| Neptune | 30.06 | 164.82 | 49,660 | 1030 | 1.6 |

**1. Mercury:**

* **Position:** Closest to the Sun (about 57.9 million km or 36 million miles).
* **Size:** Smallest terrestrial planet, approximately 4,880 kilometers (3,032 miles) in diameter.
* **Rotation:** Slowest rotation, taking about 59 Earth days for one rotation.
* **Surface Features:**
  + Heavily cratered surface due to no atmosphere to protect against impacts.
  + Scarps or cliffs indicate surface shrinkage as its core cools.
* **Moons:** Mercury has no natural moons.
* **Atmosphere:** Extremely thin, primarily trace amounts of hydrogen, helium, oxygen, sodium, calcium, and potassium.

**2. Venus:**

* **Position:** Second planet from the Sun (about 108.2 million km or 67.2 million miles).
* **Size:** Similar in size to Earth, approximately 12,104 kilometers (7,521 miles) in diameter.
* **Rotation:** Slow and retrograde (clockwise), taking about 243 Earth days for one rotation.
* **Surface Features:**
  + Covered in volcanic plains, impact craters, and large shield volcanoes.
  + No visible plate tectonics, likely due to its thick, rigid crust.
* **Moons:** Venus has no natural moons.
* **Atmosphere:** Thick and dense, primarily carbon dioxide (about 96.5%), with clouds of sulfuric acid causing a greenhouse effect.

**3. Earth:**

* **Position:** Third planet from the Sun (about 149.6 million km or 92.9 million miles).
* **Size:** Fifth-largest planet, approximately 12,742 kilometers (7,918 miles) in diameter.
* **Rotation:** Completes one rotation every 24 hours, defining our day and night cycle.
* **Surface Features:**
  + Diverse landscapes including mountains, deserts, forests, and polar ice caps.
  + Dynamic crust with shifting plates due to plate tectonics.
* **Moons:** Earth has one natural moon, simply referred to as "the Moon."
* **Atmosphere:** Mainly nitrogen (about 78%) and oxygen (about 21%).

**4. Mars:**

* **Position:** Fourth planet from the Sun (about 227.9 million km or 141.6 million miles).
* **Size:** Approximately half the size of Earth, about 6,779 kilometers (4,212 miles) in diameter.
* **Rotation:** Rotates roughly every 24.6 hours, making its day length similar to Earth's.
* **Surface Features:**
  + Notable for Olympus Mons, the tallest volcano, and Valles Marineris, a vast canyon system.
  + Evidence of ancient riverbeds and potentially subsurface water ice.
* **Moons:** Mars has two small moons, Phobos and Deimos.
* **Atmosphere:** Thin, primarily carbon dioxide (about 95.3%), with trace amounts of water vapor and oxygen.

**5. Jupiter:**

* **Position:** Fifth planet from the Sun (about 778.5 million km or 483.8 million miles).
* **Size:** Largest planet, approximately 139,820 kilometers (86,881 miles) in diameter.
* **Rotation:** Fastest rotation, completing one rotation in about 9.9 hours.
* **Surface Features:**
  + Mostly composed of gas, no solid surface to have distinct features.
  + Prominent cloud bands and the Great Red Spot, a massive storm.
* **Moons:** Over 80 known moons, including the four largest Galilean moons: Io, Europa, Ganymede, and Callisto.
* **Atmosphere:** Mostly hydrogen (about 89.8%) and helium (about 10.2%).

**6. Saturn:**

* **Position:** Sixth planet from the Sun (about 1.4 billion km or 886 million miles).
* **Size:** Second-largest planet, approximately 116,460 kilometers (72,366 miles) in diameter.
* **Rotation:** Completes one rotation in about 10.7 hours.
* **Surface Features:**
  + Gas giant with no solid surface; features an iconic ring system made of ice particles.
* **Moons:** Over 80 known moons, including Titan, the largest and most notable moon.
* **Atmosphere:** Mostly hydrogen (about 96.3%) and helium (about 3.25%).

**7. Uranus:**

* **Position:** Seventh planet from the Sun (about 2.9 billion km or 1.8 billion miles).
* **Size:** Approximately four times the size of Earth, about 50,724 kilometers (31,518 miles) in diameter.
* **Rotation:** Rotates on its side, completing one rotation in about 17.2 hours.
* **Surface Features:**
  + No distinct surface features due to its gaseous composition and lack of a solid surface.
  + Unique rotational tilt, possibly caused by past collisions.
* **Moons:** 27 known moons, including Titania, Oberon, Umbriel, Ariel, and Miranda.
* **Atmosphere:** Predominantly hydrogen (about 82.5%) and helium (about 15.2%), with traces of methane, giving it a bluish-green appearance.

**8. Neptune:**

* **Position:** Eighth planet from the Sun (about 4.5 billion km or 2.8 billion miles).
* **Size:** Approximately four times the size of Earth, about 49,244 kilometers (30,598 miles) in diameter.
* **Rotation:** Completes one rotation in about 16.1 hours.
* **Surface Features:**
  + No solid surface, composed mainly of gas and icy materials.
  + Known for its deep blue coloration and fast, turbulent cloud movements.
* **Moons:** 14 known moons, including Triton, the largest and most significant moon.
* **Atmosphere:** Mainly hydrogen (about 80%) and helium (about 19%), with traces of methane.

Sun in kilometers (km) and astronomical units (AU):

| **Planet** | **Diameter (km)** | **Distance from Sun (km)** | **Distance from Sun (AU)** |
| --- | --- | --- | --- |
| Mercury | 4,880 | 57,909,227 | 0.39 |
| Venus | 12,104 | 108,208,930 | 0.73 |
| Earth | 12,742 | 149,597,870 | 1.00 |
| Mars | 6,779 | 227,943,824 | 1.38 |
| Jupiter | 139,820 | 778,340,821 | 5.20 |
| Saturn | 116,460 | 1,426,666,422 | 9.58 |
| Uranus | 50,724 | 2,870,658,186 | 19.22 |
| Neptune | 49,244 | 4,498,396,441 | 30.05 |

The distances from the Sun are in kilometers (km) and astronomical units (AU), with 1 astronomical unit (AU) being the average distance from the Earth to the Sun, approximately 149.6 million kilometers (92.9 million miles).

**Rotation of the Earth:**

Rotation refers to the Earth spinning on its axis, an imaginary line passing through its North and South Poles. Here are the key aspects of the Earth's rotation:

* **Direction and Speed:**
  + The Earth rotates in an eastward direction, meaning it spins from west to east.
  + The rotational speed varies with latitude; it's fastest at the Equator and gradually decreases to zero at the North and South Poles.
  + The rotational speed at the Equator is about 1,670 kilometers per hour (1,040 miles per hour).
* **Duration of Rotation:**
  + The Earth completes one full rotation approximately every 24 hours, defining a day and night cycle.
  + This 24-hour period is called a solar day, and it's based on the time it takes for the Sun to appear at the same position in the sky.
* **Consequences of Rotation:**
  + The rotation of the Earth causes the cycle of day and night.
  + The rotation also influences the Coriolis effect, deflecting moving objects (like wind and ocean currents) to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

**Revolution of the Earth:**

Revolution refers to the Earth's orbit around the Sun. Here's an in-depth look at the Earth's revolution:

* **Path of Revolution:**
  + The Earth follows an elliptical orbit around the Sun.
  + The average distance between the Earth and the Sun is approximately 149.6 million kilometers (92.9 million miles), known as one astronomical unit (AU).
* **Orbital Period:**
  + The Earth completes one revolution around the Sun in approximately 365.25 days, defining a year.
  + To account for the additional 0.25 day, we have a leap year every four years, adding an extra day (February 29th).
* **Effects of Revolution:**
  + Revolution is the reason for the changing seasons. As the Earth orbits the Sun, the tilt of its axis causes different parts of the Earth to receive varying amounts of sunlight at different times of the year.
  + The changing seasons occur due to this tilt, leading to variations in climate, daylight hours, and temperature.
* **Ecliptic Plane:**
  + The Earth's orbit lies in a plane known as the ecliptic plane.
  + This plane is important for understanding the positions of celestial objects in the sky and the occurrence of eclipses.

**The Moon and its Effects on Earth in Physics:**

**Gravitational Effects:**

* **Tidal Forces:**
  + The Moon's gravitational pull on the Earth leads to the phenomenon of tides in oceans and seas.
  + Tides are caused by the gravitational force being stronger on the side of the Earth facing the Moon and weaker on the opposite side, resulting in a bulging effect.
* **Tidal Locking:**
  + The gravitational interaction between the Earth and the Moon has caused the Moon to become tidally locked, meaning it always shows the same face (the near side) to the Earth.

**Phases of the Moon:**

The Moon goes through different phases as it orbits the Earth, due to the varying angles between the Earth, Moon, and Sun.

* **New Moon:**
  + The side of the Moon facing the Earth is not illuminated, appearing as a dark circle.
* **Waxing Crescent:**
  + A small part of the Moon's right side is illuminated and visible from the Earth.
* **First Quarter (Half Moon):**
  + The right half of the Moon is illuminated and visible from the Earth.
* **Waxing Gibbous:**
  + More than half of the right side of the Moon is illuminated but not yet fully visible.
* **Full Moon:**
  + The entire side of the Moon facing the Earth is illuminated and appears as a complete circle.
* **Waning Gibbous:**
  + More than half of the left side of the Moon is illuminated but not fully visible.
* **Last Quarter (Half Moon):**
  + The left half of the Moon is illuminated and visible from the Earth.
* **Waning Crescent:**
  + A small part of the Moon's left side is illuminated and visible from the Earth.

The cycle then continues back to the New Moon phase.

The Moon's phases are a result of the changing relative positions of the Moon, Earth, and Sun, which affect the amount of sunlight reaching the Moon's surface as observed from Earth.

**Solar Eclipses:**

A solar eclipse occurs when the Moon passes between the Sun and the Earth, blocking the Sun's light. There are different types of solar eclipses:

* **Total Solar Eclipse:**
  + The Moon completely covers the Sun, casting a shadow on Earth. It occurs when the Sun, Moon, and Earth are aligned in a straight line.
* **Partial Solar Eclipse:**
  + The Moon covers only a part of the Sun, and it looks like a dark shadow taking a bite out of the Sun.
* **Annular Solar Eclipse:**
  + The Moon covers the center of the Sun, leaving a ring-like appearance known as the "ring of fire."

**Lunar Eclipses:**

A lunar eclipse occurs when the Earth comes between the Sun and the Moon, causing the Earth's shadow to be cast on the Moon. Types of lunar eclipses include:

* **Total Lunar Eclipse:**
  + The Earth's umbra (central, darkest part of its shadow) covers the Moon completely, giving it a reddish hue during the eclipse, often referred to as a "Blood Moon."
* **Partial Lunar Eclipse:**
  + Only a part of the Moon enters Earth's umbra, causing a partial darkening of the Moon's surface.
* **Penumbral Lunar Eclipse:**
  + The Moon passes through Earth's penumbral shadow, resulting in a subtle darkening that can be challenging to observe.

Eclipses are fascinating celestial phenomena that provide insights into the movements and positions of the Sun, Moon, and Earth. The type and visibility of an eclipse depend on the alignment and distances between these celestial bodies

**1. Big Bang Theory:**

* **Explanation:**
  + The Big Bang Theory proposes that the universe originated from an extremely hot and dense point about 13.8 billion years ago. This point suddenly expanded, resulting in the formation of the universe we observe today.
* **Advantages:**
  + Successfully explains the observed cosmic microwave background radiation and the abundance of light elements in the universe.
  + Accounts for the large-scale structure of the universe and the redshift of galaxies, indicating an expanding universe.
* **Disadvantages:**
  + Does not explain what initiated the Big Bang or what happened at the exact moment of the singularity.
  + Fails to account for the observed homogeneity and isotropy of the universe on large scales.

**2. Steady State Theory:**

* **Explanation:**
  + The Steady State Theory suggests that the universe has no beginning or end and is continuously expanding while maintaining a constant density over time. New matter is created to keep the density constant.
* **Advantages:**
  + Maintains the perfect cosmological principle, which assumes the universe's properties are the same at all times and places.
  + Explains the observed uniformity of the universe on large scales.
* **Disadvantages:**
  + Contradicted by the discovery of the cosmic microwave background radiation, which strongly supports the Big Bang Theory.
  + Unable to explain the observed evolution of galaxies and the changing abundance of elements.

**3. Inflationary Theory:**

* **Explanation:**
  + The Inflationary Theory proposes that the universe experienced a rapid exponential expansion in its early stages, shortly after the Big Bang. This expansion helped explain the observed uniformity and isotropy of the universe.
* **Advantages:**
  + Provides an explanation for the observed flatness, homogeneity, and isotropy of the universe on large scales.
  + Explains the formation of large-scale structures and the patterns observed in the cosmic microwave background radiation.
* **Disadvantages:**
  + The details of the inflationary mechanism are not fully understood, and there are multiple variations of this theory.
  + The lack of direct observational evidence for the inflationary period raises some skepticism.

**Most Accepted Theory: Lambda-CDM Model (Concordance Model):**

* **Explanation:**
  + The Lambda-CDM Model is the current standard model of cosmology, combining the Big Bang Theory with the concepts of dark matter and dark energy. It explains the evolution of the universe from its early stages to the present.
* **Advantages:**
  + Consistently explains a wide range of observed phenomena, including the cosmic microwave background radiation, large-scale structure of the universe, and the accelerated expansion of the universe.
  + Fits well with observations from galaxy surveys and cosmic microwave background experiments.
* **Disadvantages:**
  + Requires the presence of unknown forms of matter and energy (dark matter and dark energy) constituting a majority of the universe, which are yet to be directly detected or understood.

The **Big Bang Theory** and the **Lambda-CDM Model** are currently the most accepted theories of the universe's origin and evolution. The Lambda-CDM Model, in particular, provides the most comprehensive and consistent explanation for the observations we have made, even though certain aspects of the universe remain enigmatic, such as the nature of dark matter and dark energy. Ongoing research and future observations aim to refine our understanding of the universe's origins and composition.

**1. Quasi-Scientific Theories:**

**a) Cyclic Universe Theory:**

* **Explanation:**
  + The cyclic universe theory posits that the universe goes through an infinitely repeating cycle of Big Bang, expansion, contraction, and another Big Bang.
* **Advantages:**
  + Offers a solution to the "origin" problem, suggesting that the universe has no true beginning.
  + Explains the large-scale uniformity and isotropy of the cosmos through successive cycles.
* **Disadvantages:**
  + Requires an unknown mechanism to trigger the bounce from contraction to expansion.
  + The entropy increase over each cycle may lead to an accumulation of disorder, challenging the idea of a truly cyclic universe.

**2. Metaphysical Theories:**

**a) Creationism:**

* **Explanation:**
  + Creationism asserts that the universe and all life forms were created by a divine, supernatural being or force. The nature of this creation varies among religious beliefs.
* **Advantages:**
  + Provides a purposeful and meaningful explanation for the origin of the universe based on religious teachings.
  + Offers a moral and ethical framework based on the divine creator's guidelines.
* **Disadvantages:**
  + Lacks empirical evidence and scientific support, making it unverifiable through the scientific method.
  + Raises questions about reconciling religious texts with scientific findings.

**b) Intelligent Design:**

* **Explanation:**
  + Intelligent Design (ID) suggests that certain features of the universe and living organisms are best explained by an intelligent cause, rather than natural processes.
* **Advantages:**
  + Raises philosophical and teleological questions regarding the complexity and order in the universe.
  + Stimulates critical thinking and discussion about the nature of life and the cosmos.
* **Disadvantages:**
  + Lacks empirical evidence and scientific consensus, making it difficult to integrate into mainstream science.
  + Often criticized for being a form of creationism repackaged to appear more scientific.

These quasi-scientific and metaphysical theories often rely on philosophical, religious, or supernatural explanations. Unlike conventional scientific theories, they may not follow the empirical, testable, and falsifiable criteria of the scientific method. As a result, they are not widely accepted within the scientific community but may hold importance in philosophical or spiritual discourse. It's essential to differentiate between scientific and metaphysical explanations while considering the origins of the universe, acknowledging their respective domains and approaches.