GC01 — The Universe & Solar System

🌍 Physical Geography – GC01 CDS Level ★ High Priority

📌 **CDS Focus:** Questions are primarily **factual and direct** — planet order, unique features, Earth's movements, Big Bang, and time zone calculations appear regularly. Focus on: (1) planet order and classification, (2) Earth's unique features, (3) effects of rotation vs. revolution, (4) latitude/longitude and IST, and (5) differences between comets, meteors, and asteroids.

1. Origin of the Universe

Topic A

Three Theories of Universe Origin

CDS Direct Questions

Big Bang **Most accepted theory (Georges Lemaître, 1927; Hubble's observational evidence).** Universe began ~13.8 billion years ago from an extremely hot, dense singularity. Evidence: cosmic microwave background radiation (CMB), redshift of galaxies, expanding universe.

Steady State **Proposed by Fred Hoyle (1948).** Universe looks the same at all times (Perfect Cosmological Principle). New matter continuously created as universe expands. **Largely disproved** by CMB discovery.

Oscillating **Cyclic / Pulsating model.** Universe alternates between expansion (Big Bang) and contraction (Big Crunch) in an infinite cycle. Not widely accepted currently.

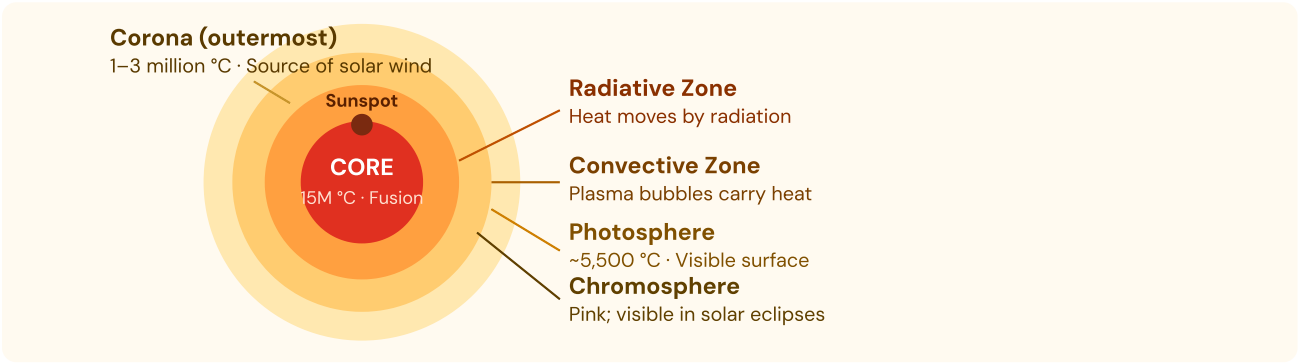
💡 **Mnemonic — 3 Universe Theories:** **B**ig Bang · **S**teady State · **O**scillating = **BSO**. Big = most accepted; Steady = disproved by CMB; Oscillating = cyclic alternate.

⚠️ **CDS Trap:** Big Bang was proposed by **Georges Lemaître** (Belgian priest-scientist), not Einstein. "Pulsating universe" and "oscillating universe" are the same theory — different names, same concept. Direct CDS question: Which is most widely accepted? → Big Bang.

THE SUN

2. The Sun — Structure & Energy

FIG. 2.1 — SUN'S INTERNAL STRUCTURE (CORE OUTWARD)



Topic B

Sun — Key Facts

Structure **Core → Radiative Zone → Convective Zone → Photosphere → Chromosphere → Corona.** The corona (outermost) is paradoxically hotter (1–3 million °C) than the photosphere (5,500°C) — called the "coronal heating paradox."

Energy **Nuclear fusion** in the core — hydrogen fuses to form helium, releasing energy ($E = mc^2$). Core temperature ~15 million°C. Converts ~4 million tonnes of mass to energy per second.

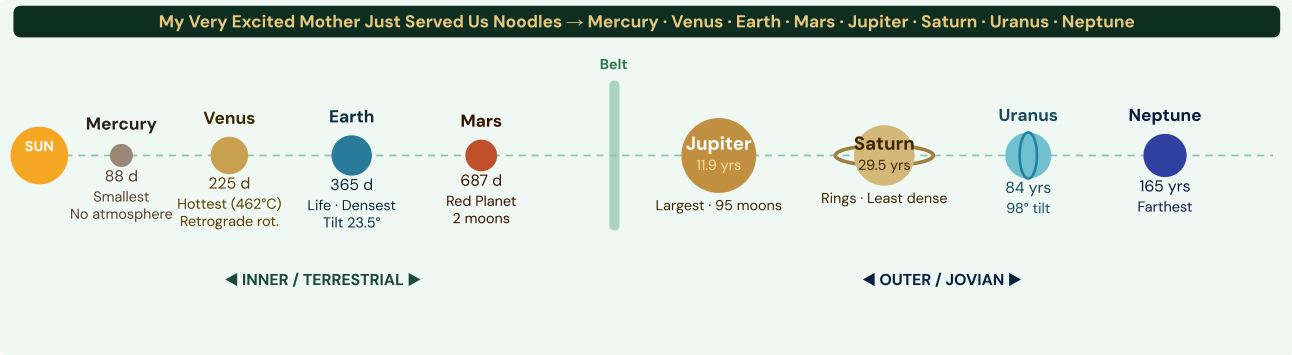
Key Data Diameter: **1.4 million km** (109× Earth). Distance from Earth: **~150 million km = 1 AU**. Light reaches Earth in **8 min 20 sec**. Composition: ~73% hydrogen, ~25% helium. Age: ~4.6 billion years.

Phenomena **Sunspots** — dark cooler regions (11-year cycle). **Solar wind** — charged particles; causes **Aurora Borealis** (north) and **Aurora Australis** (south). **Solar flares** — sudden radiation bursts.

PLANETS OF THE SOLAR SYSTEM

3. Planets — Classification & Key Features

FIG. 3.1 — SOLAR SYSTEM: PLANET ORDER, TYPE & REVOLUTION PERIOD



🪨 Terrestrial (Inner) Planets

- Rocky, dense, solid surface
- Closer to Sun; smaller size
- Fewer or no moons
- **Mercury, Venus, Earth, Mars**
- Separated from outer by Asteroid Belt

🌌 Jovian (Outer/Gaseous) Planets

- Composed mainly of gas and ice
- Farther from Sun; giant size
- Many moons and ring systems
- **Jupiter, Saturn** = Gas Giants
- **Uranus, Neptune** = Ice Giants

☿ Mercury

Terrestrial · 1st from Sun

- Smallest planet; no atmosphere, no moons
- Extreme temp range: −180°C to 430°C
- Fastest revolution: **88 days**
- Slowest rotation (among planets)

♀ Venus

Terrestrial · 2nd from Sun

- **Hottest planet** (~462°C) — greenhouse CO_2
- Retrograde rotation → Sun rises in **West**
- "Evening Star" / "Morning Star"
- No moon; "Earth's twin" in size

🌍 Earth

Terrestrial · 3rd from Sun

- Only planet with known life
- 75% surface water ("Blue Planet")
- Axial tilt **23.5°** → causes seasons
- **Densest planet** in solar system

♂ Mars

Terrestrial · 4th from Sun

- "Red Planet" — iron oxide surface
- 2 moons: **Phobos & Deimos**
- Tallest volcano: **Olympus Mons** (27 km)
- Longest canyon: Valles Marineris

♃ Jupiter

Jovian · 5th from Sun

- **Largest planet** (1,300 Earths)
- Great Red Spot = storm >300 years old
- Fastest rotation: ~10 hours
- **Ganymede** = largest moon in solar system

♄ Saturn

Jovian · 6th from Sun

- Prominent ring system (ice & rock)
- **Least dense planet** — floats on water
- 146 moons; **Titan** = largest (has atmosphere)

♅ Uranus

Ice Giant · 7th from Sun

- Rotates on its side: **98° axial tilt**
- Coldest atmosphere: −224°C
- 27 moons; **Titania** = largest
- Blue-green colour (methane atmosphere)

♆ Neptune

Ice Giant · 8th from Sun

- Farthest planet from Sun
- Strongest winds: up to 2,100 km/h
- 16 moons; **Triton** = largest (retrograde orbit)
- Takes **165 years** to orbit Sun

⚠️ **CDS Planet Traps:** (1) Venus is **hottest**, not Mercury — dense CO_2 greenhouse effect. (2) Venus rotates **east to west** → Sun rises in the West on Venus. (3) **Ganymede** (Jupiter's moon) is largest moon in the solar system — larger than Mercury. (4) Saturn is **least dense** — would float on water. (5) There are **8 planets** — Pluto was reclassified as dwarf planet in **2006 by IAU**.

DWARF PLANETS, COMETS & METEORS

4. Dwarf Planets & Smaller Bodies

Body	Description	Key CDS Fact
Dwarf Planets	Orbit Sun; have not cleared neighbourhood	**Pluto** (largest), Ceres, Eris, Makemake, Haumea

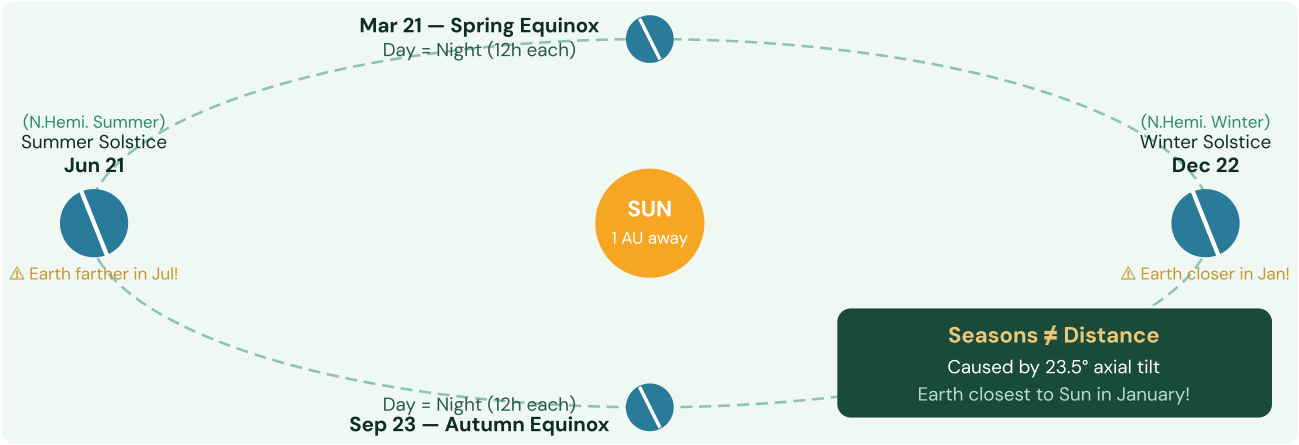
Body	Description	Key CDS Fact
Asteroids	Rocky/metallic bodies; mostly in Asteroid Belt (Mars–Jupiter)	Ceres = largest asteroid and only dwarf planet in Asteroid Belt
Comets	Icy bodies; develop coma & tail near Sun; **tail always points away from Sun**	Halley's Comet — period ~76 years; last seen 1986, next 2061
Meteoroid → Meteor → Meteorite	In space → burning in atmosphere ("shooting star") → reaches surface	A meteor that survives and hits Earth = Meteorite

💡 **Comet Tail:** Always points **away from the Sun** (pushed by solar wind). When approaching the Sun the tail trails behind; when moving away the tail leads ahead. A classic CDS tricky question.

EARTH — MOVEMENTS & COORDINATES

5. Earth — Rotation, Revolution & Seasons

FIG. 5.1 — EARTH'S REVOLUTION & SEASONS (CAUSED BY 23.5° AXIAL TILT, NOT DISTANCE FROM SUN)



🔄 Rotation (Daily Motion)

- Rotates **West to East** on its axis

🌍 Revolution (Annual Motion)

- Elliptical orbit around Sun

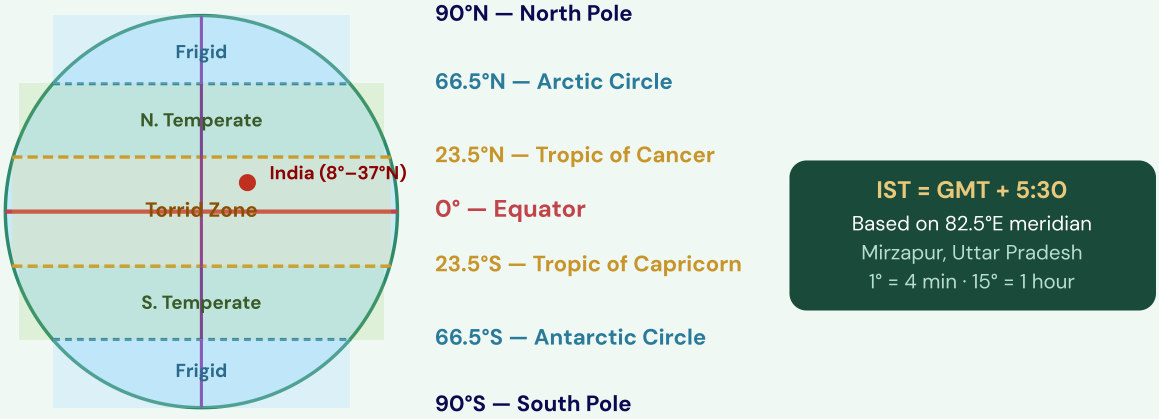
- Period: **23 hrs 56 min 4 sec** (sidereal day)
- Equatorial speed: ~1,670 km/h
- **Effects:** Day & Night; apparent Sun movement; Coriolis effect; tidal patterns

- Period: **365 days 5 hrs 48 min**
- Speed: ~29.8 km/s
- **Perihelion** (closest): ~Jan 3 · **Aphelion** (farthest): ~Jul 4
- **Effects:** Seasons (due to axial tilt); variation in day length

⚠️ **Rotation vs Revolution Traps:** (1) **Seasons are caused by Earth's 23.5° axial tilt**, NOT by distance from Sun. (2) Earth is **closest to Sun in January** (perihelion) — yet Northern Hemisphere has winter! (3) Leap year century rule: century years must be divisible by **400** (e.g., 2000 = leap year; 1900 = not).

6. Latitudes, Longitudes & Time Zones

FIG. 6.1 — IMPORTANT PARALLELS, MERIDIANS & HEAT ZONES OF EARTH



Topic F — Latitude, Longitude & Time

Latitude — **Horizontal parallels.** 0° (equator) to 90°N/S. Key ones: Equator (0°), Tropic of Cancer (23.5°N), Tropic of Capricorn (23.5°S), Arctic Circle (66.5°N), Antarctic Circle (66.5°S). India: 8°N to 37°N.

Longitude — **Vertical meridians.** 0° (Prime Meridian, Greenwich) to 180°E/W. **IDL (International Date Line)** ≈ 180° with deviations to avoid splitting island nations. Cross IDL East→West: add a day. West→East: subtract a day.

IST **Indian Standard Time = GMT + 5 hours 30 minutes.** Based on the **82.5°E meridian** passing through **Mirzapur, Uttar Pradesh.** One time zone for entire India despite spanning ~29° of longitude. 1° = 4 minutes; 15° = 1 hour.

📐 Formula Sheet — GC01 Key Numbers

Time Zone Formula

1° longitude = **4 minutes**
15° longitude = **1 hour**
IST = GMT + **5h 30 min (82.5°E)**

Earth Measurements

Equatorial radius: **6,378 km**
Polar radius: **6,357 km**
Circumference: **~40,075 km**

Earth's Movements

Rotation: **23h 56m 4s** (W→E)
Revolution: **365d 5h 48m**
Axial tilt: **23.5°**

Sun & Moon Data

Sun distance: **150M km = 1 AU**
Light travel: **8 min 20 sec**
Moon (sidereal): **27.3 days**

Key Dates

Perihelion: **Jan 3** (closest to Sun)
Aphelion: **Jul 4** (farthest)
Summer Solstice N.H.: **Jun 21**

Important Parallels

Tropic of Cancer: **23.5°N**
Tropic of Capricorn: **23.5°S**
Arctic / Antarctic Circle: **66.5°**

📝 Topic-Wise PYQs & Tricky Questions — GC01

Q1. Which of the following is the most widely accepted theory about the origin of the universe? CDS PYQ

(a) Steady State Theory (b) Big Bang Theory (c) Oscillating Universe Theory

(d) Nebular Hypothesis

✓ Answer: (b) Big Bang Theory

Proposed by Georges Lemaître (1927), supported by Hubble's expanding-universe observations. Key evidence: Cosmic Microwave Background (CMB) radiation and redshift of galaxies. Steady State (Fred Hoyle, 1948) was disproved by CMB discovery. Nebular Hypothesis relates to solar system formation, not origin of universe.

Q2. Which planet has the highest surface temperature in the Solar System? CDS PYQ

(a) Mercury (b) Mars (c) Venus (d) Jupiter

✓ Answer: (c) Venus

Classic CDS trap. Mercury is closest to the Sun but has no atmosphere, so heat is not retained — temperatures swing from -180°C to 430°C. Venus has a dense CO_2 atmosphere creating an extreme greenhouse effect, keeping surface temperature at a steady ~462°C — making it the hottest planet.

Q3. IST (Indian Standard Time) is based on which meridian? CDS PYQ

(a) 75°E (b) 80°E (c) 82.5°E (d) 90°E

✓ Answer: (c) 82.5°E

IST is based on the 82.5°E meridian, passing through Mirzapur, Uttar Pradesh. 82.5° ÷ 15° = 5.5 hours = GMT + 5h 30min. India maintains a single time zone despite spanning ~29° of longitude (68°E to 97°E).

Q4. On which planet does the Sun rise in the West? Tricky

(a) Mars (b) Jupiter (c) Uranus (d) Venus

✓ Answer: (d) Venus

Venus rotates East to West (retrograde/clockwise from above north pole), opposite to Earth. This means the Sun rises in the West on Venus. All other planets rotate West to East (except Uranus which has 98° tilt making it a special case).

Q5. The largest moon in the Solar System is: Tricky

(a) Titan (Saturn) (b) Moon (Earth) (c) Ganymede (Jupiter) (d) Triton (Neptune)

✓ Answer: (c) Ganymede (Jupiter)

Ganymede is larger than even Mercury (though less massive). Common confusion: Titan is notable for its thick nitrogen atmosphere — the only moon with a significant atmosphere — but it is smaller than Ganymede. Triton orbits Neptune in retrograde direction.

Q6. The tail of a comet always points: Tricky

(a) Towards the Sun (b) In the comet's direction of travel (c) Away from the Sun

(d) Opposite to comet's direction of travel

✓ Answer: (c) Away from the Sun

A comet's tail is pushed away from the Sun by solar wind and radiation pressure — regardless of which direction the comet is moving. When approaching the Sun, tail trails behind; when moving away, the tail leads ahead of the comet's body.

Q7. Earth is closest to the Sun (Perihelion) around: Tricky

(a) June 21 (b) December 22 (c) January 3 (d) July 4

✓ Answer: (c) January 3

Perihelion (closest to Sun ~147M km) occurs around January 3. Aphelion (farthest ~152M km) occurs around July 4. This is counterintuitive — January is Northern Hemisphere winter. Seasons are caused by axial tilt (23.5°), not Earth-Sun distance.

🧠 Quick Memory Chart — GC01

🌞 Planet Superlatives

- Largest: **Jupiter**
- Smallest: **Mercury**
- Hottest: **Venus** (462°C)
- Coldest atm.: **Uranus** (-224°C)
- Farthest: **Neptune**
- Fastest rev.: **Mercury** (88d)
- Fastest rot.: **Jupiter** (~10h)
- Least dense: **Saturn**

🌍 Earth Key Numbers

- Axial tilt: **23.5°**
- Rotation: **23h 56m 4s**
- Revolution: **365d 5h 48m**
- Equatorial radius: **6,378 km**
- IST meridian: **82.5°E**
- IST offset: **GMT +5:30**
- Perihelion: **Jan 3**
- Aphelion: **Jul 4**

🌙 Moons to Know

- Jupiter: **Ganymede** (largest in SS)
- Saturn: **Titan** (has atmosphere)
- Mars: **Phobos, Deimos**
- Neptune: **Triton** (retrograde)
- Uranus: **Titania** (largest)
- Mercury, Venus: **No moons**

⚡ Time Calculations

- 1° = **4 minutes**
- 15° = **1 hour**
- East = ahead in time
- IST = GMT + 5:30

🌡️ Heat Zones

- Torrid: between **23.5°N & 23.5°S**
- N.Temperate: **23.5°N – 66.5°N**

⚠️ CDS Common Traps

- Hottest = Venus (not Mercury)
- Sun rises West on Venus

- IDL cross E→W: **add day**
- IDL cross W→E: **subtract day**
- Leap century: divisible by **400**

- S.Temperate: **23.5°S – 66.5°S**
- N.Frigid: **66.5°N – 90°N**
- S.Frigid: **66.5°S – 90°S**
- India: entirely in **Torrid + Temperate**

- Largest moon = Ganymede
- Perihelion = Jan (NH winter!)
- IST = 82.5°E (not 80° or 75°)
- 8 planets (Pluto = dwarf, 2006)
- Seasons = tilt, not distance

📝 Mock Tests | 🎯 Subject Quiz | ✈️ Telegram