Pilgrim Federation Key Stage 2



Learning Theme: Space

Links to Other Learning Themes:
This Learning Theme Links to: Explorers The Americas The Tudors The Ancient Greeks The Maya The Ancient Egyptians

Europe

KEY STAGE 2

To master the **'Space'** learning theme, Key Stage 2 pupils should move beyond simply naming planets. They need to understand the **mechanics** of our solar system—how things move, why we see what we see, and the scale of the universe. Here are the six fundamental questions every KS2 pupil should be able to answer:

1. How does the movement of the Earth lead to day and night?
Pupils should move away from the misconception that the Sun "moves" across the sky. They must understand that the Earth is a sphere that rotates on its own axis.

The Answer: As the Earth **rotates** (once every 24 hours), the part of the Earth facing the Sun experiences day, while the part facing away experiences night.
Key Concept: Rotation vs. Revolution.

2. Why does the Sun appear to move across the sky during the day?
This builds on the first question by looking at the observational evidence from our perspective on the ground.

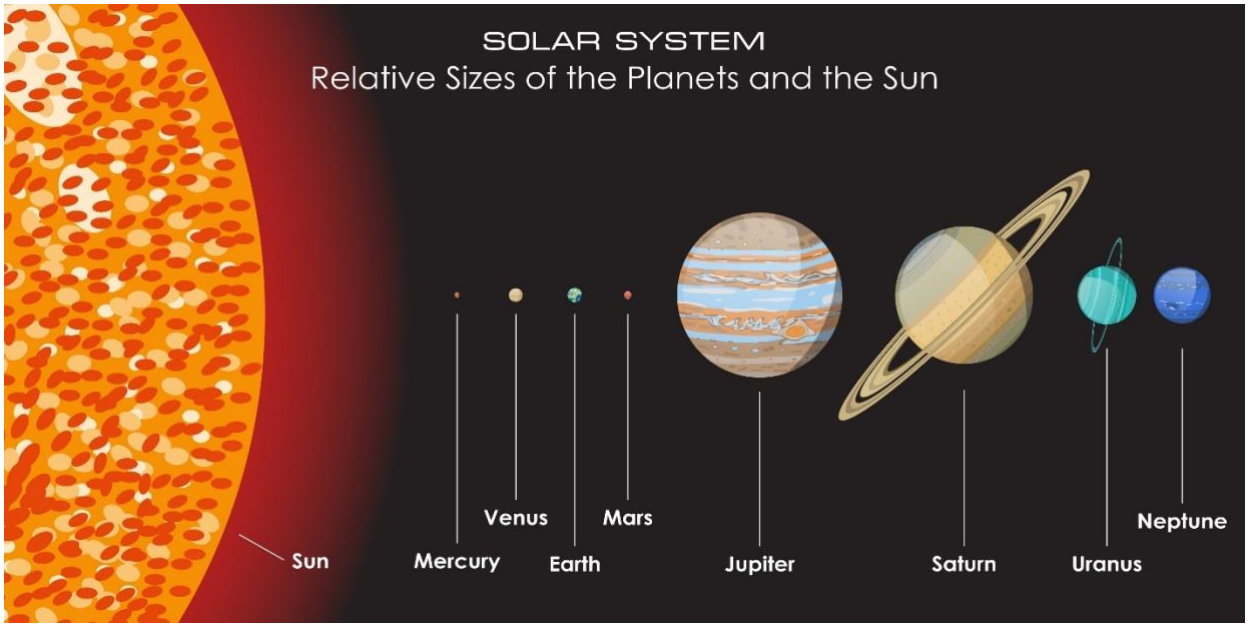
The Answer: Because the Earth is spinning toward the east, the Sun appears to "rise" in the east and "set" in the west. Pupils should be able to explain how the position and length of **shadows** change throughout the day as a result.
Key Concept: Apparent motion.

3. How does the Earth move in relation to the Sun, and how long does it take?
This question shifts focus from the 24-hour day to the calendar year.

The Answer: The Earth **orbits** (revolves around) the Sun in a slightly elliptical path. This journey takes approximately **365.25 days**.
Key Concept: The orbit and why we have a "Leap Year" every four years to account for that extra quarter-day.

4. What are the planets in our solar system, and how are they categorised?
Pupils should know the order of the planets from the Sun and the fundamental differences between them.

The Answer: Mercury, Venus, Earth, Mars (the **Rocky Planets**), and Jupiter, Saturn, Uranus, Neptune (the **Gas Giants**).
Key Concept: The Sun is a star at the centre, and everything else orbits it.



5. Why does the Moon appear to change shape?
This is often the most challenging concept for KS2. Pupils need to understand that the Moon does not produce its own light.

The Answer: The Moon orbits the Earth (roughly every 28 days). We see different amounts of the Moon's "lit side" depending on its position relative to the Earth and the Sun.
Key Concept: The **Phases of the Moon** (Crescent, Gibbous, Full, New).

6. What is the "Spherical Body" model, and how was it proven?
Pupils should understand that people haven't always known the Earth, Sun, and Moon were spheres.

The Answer: Long ago, people thought the Earth was flat. Scientists and explorers provided evidence (like ships disappearing over the horizon or satellite photos) to prove they are **approximately spherical bodies**.
Key Concept: Evidence-based scientific understanding.

Summary Checklist for Pupils

Question Focus	**Key Vocabulary to Include**
Day/Night	Axis, Rotation, 24 Hours.
Years	Orbit, Revolution, 365 Days.
Planets	Solar System, Celestial, Spherical.

Question Focus	Key Vocabulary to Include
The Moon	Phases, Reflect, Satellite.
Scale	Distance, Magnitude, Universe.

KEY STAGE 2 SPACE MASTERCLASS: BEYOND PLANET NAMES!

1. HOW DOES EARTH'S MOVEMENT CREATE DAY & NIGHT?



2. WHY DOES THE SUN APPEAR TO MOVE ACROSS THE SKY?



3. HOW DOES EARTH MOVE IN RELATION TO THE SUN, AND HOW LONG DOES IT TAKE?



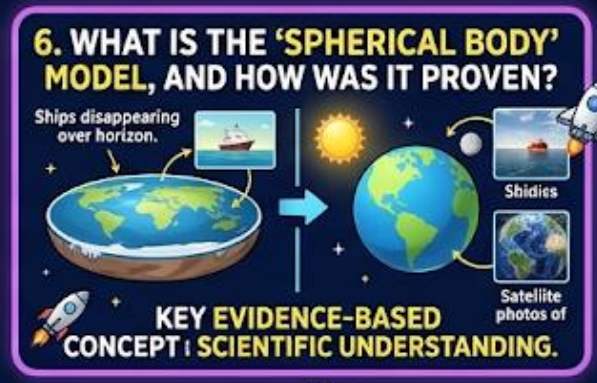
4. WHAT ARE THE PLANETS IN OUR SOLAR SYSTEM?



5. WHY DOES THE MOON APPEAR TO CHANGE SHAPE?



6. WHAT IS THE 'SPHERICAL BODY' MODEL, AND HOW WAS IT PROVEN?



MOVE BEYOND SIMPLE FACTS & MASTER THE SPACE THEME!

Vocabulary

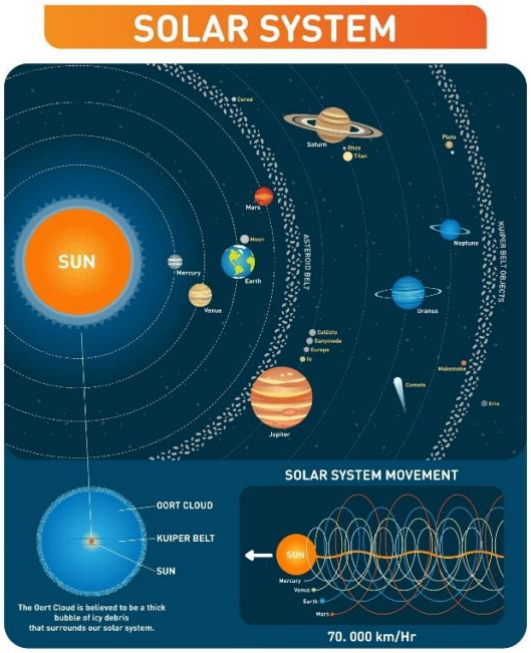
In the Key Stage 2 Science curriculum, vocabulary for the **'Space'** learning theme is divided into three "tiers." **Tier 1** are everyday words, **Tier 2** are academic words used across subjects, and **Tier 3** are the specific scientific terms required to explain the mechanics of the universe. To master this learning theme, pupils must move beyond naming the planets and begin using precise verbs to describe movement.

1. The Mechanics of Movement (Crucial Verbs)
The most common mistake at KS2 is confusing these three terms. Distinguishing between them is the "pass mark" for the unit.

Rotate: To spin on a central point or axis (Earth **rotates** to create day and night).
Orbit: The curved path of a celestial object around a star, planet, or moon (The Earth **orbits** the Sun).
Revolve: Often used interchangeably with orbit; the action of moving in a circular path around another object.

2. Celestial Bodies
These nouns categorise the different "things" found in space.

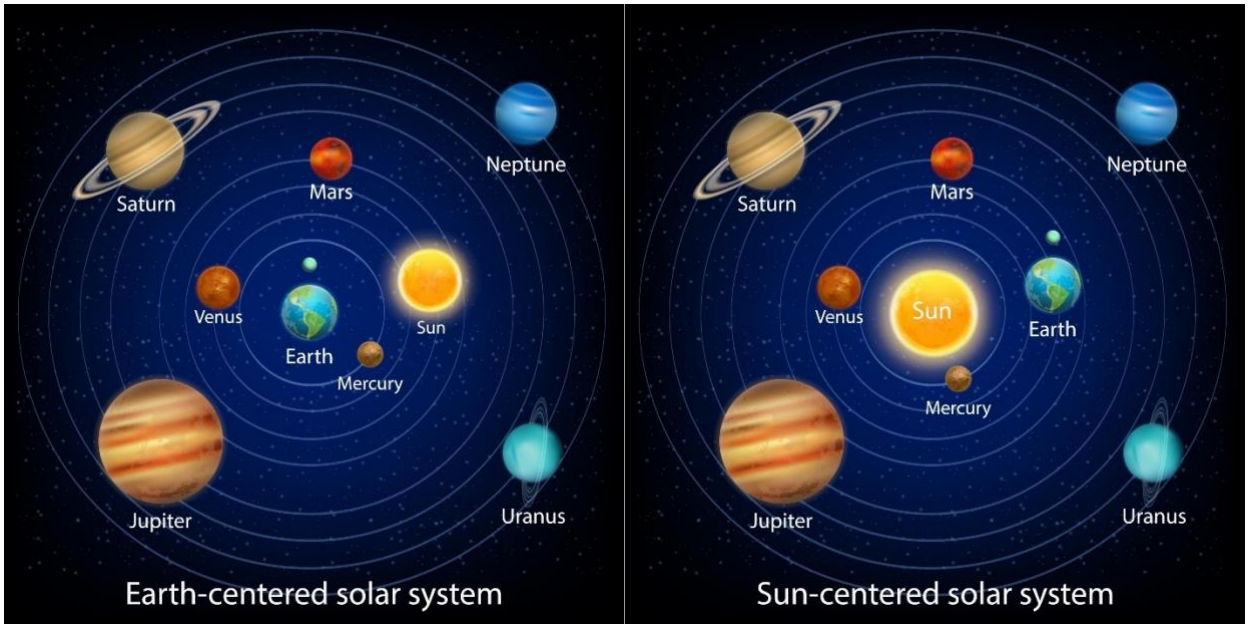
Spherical Body: An object shaped like a ball (Earth, Sun, and Moon are approximately spherical).
Satellite: An object that orbits a planet. This can be **natural** (the Moon) or **artificial** (the International Space Station).
Star: A giant ball of hot gas (plasma) that generates its own light and heat (The Sun).
Planet: A large spherical body that orbits a star and has "cleared its neighbourhood" of other objects.
Dwarf Planet: A body that orbits a star but is too small to be a planet (e.g., Pluto).
Asteroid: A small rocky body orbiting the sun, usually found in the "Asteroid Belt" between Mars and Jupiter.



3. The Solar System Structure
Words used to describe the "neighbourhood" we live in.

Solar System: The collection of eight planets and their moons in orbit around the sun.
Inner Planets (Terrestrial): The four rocky planets closest to the sun (Mercury, Venus, Earth, Mars).

Outer Planets (Gas Giants): The four large planets made mostly of gases (Jupiter, Saturn, Uranus, Neptune).
Axis: An imaginary line through the centre of an object, around which it rotates.
Geocentric: An outdated model where people believed the Earth was the centre of the universe.
Heliocentric: The proven model where the Sun is the centre of the solar system.



4. Light and Observation
Vocabulary used to explain what we see from Earth.

Reflect: How we see the Moon; it does not make its own light but "bounces" light from the Sun.
Phases: The changing shapes of the Moon as seen from Earth (Crescent, Gibbous, Full, New).
Waxing: When the visible lit part of the moon is getting larger.
Waning: When the visible lit part of the moon is getting smaller.
Shadow: An area of darkness created when an **opaque** object blocks light (essential for understanding day/night and eclipses).

Why This Vocabulary Matters
Accuracy Over Description
A pupil saying *"The Earth goes around the Sun"* is correct, but a pupil saying *"The Earth **orbits** the Sun on an **axis** tilted at **23.5 degrees**"* is demonstrating scientific literacy. Precision allows for better explanations of complex phenomena like seasons.

Correcting Misconceptions
Using words like **Rotate** vs. **Orbit** helps clear up the common misconception that the Sun "moves" to create day and night. It places the "action" on the Earth's movement, not the Sun's.
At KS2, pupils are expected to provide evidence. Using words like **Spherical Body** and **Satellite** allows them to argue *why* we know the Earth isn't flat, using the correct academic register.

The "Space" Vocabulary Quick-Check

Concept	Term to Use	Term to Avoid
Spinning	Rotate	Twirling
Path	Orbit	Circle
The Moon	Natural Satellite	Planet / Star
Shape	Spherical	Round / Circle

Art & Design

Substantive Knowledge

In Art & Design, **substantive knowledge** refers to the "stuff" pupils need to know: the specific facts about artists, the properties of different media, and the formal elements (line, shape, colour, etc.) used to create space-themed work. It is the foundation that allows them to move from "drawing a rocket" to "creating a cosmic composition."

1. The Formal Elements of "Space Art"
Substantive knowledge involves knowing how to manipulate the basic building blocks of art to represent the vacuum of space.

Value (Tone): Understanding how to use a gradient of light to dark to turn a flat circle into a **3D spherical body**. This includes knowing where the "light source" (the Sun) is located.
Colour Theory:
Cold vs. Warm colours: Using blues, purples, and silvers to represent the "cold" vacuum of space versus oranges and reds for stars or Martian landscapes.
Complementary colours: Using high-contrast pairs (like orange and blue) to make a celestial body "pop" against the darkness.
Texture: Knowing how to create the physical "feel" of space—from the smooth, metallic surface of a satellite to the gritty, cratered surface of the Moon.

2. Media, Materials, and Techniques
This is the knowledge of *how* to use tools to achieve specific cosmic effects.

Wet-on-Wet Watercolour: Knowing that applying wet paint to wet paper creates the soft, bleeding edges perfect for **nebulae and galaxies**.
Splatter Technique: Using a toothbrush or stiff brush to flick white paint (stars) onto a dark background, understanding the relationship between force and dot size.
Resist Techniques: Knowing that wax crayons or oil pastels will "resist" a watercolour wash, allowing stars or planet outlines to stay bright and clear.

Sgraffito: Layering oil pastels (black over colours) and scratching away the top layer to reveal the "glowing" colours beneath.

3. Knowledge of Significant Artists and Movements
Substantive knowledge includes studying how professionals have interpreted the night sky.

Vincent van Gogh: Analysing *The Starry Night* to see how **movement and expression** can be conveyed through thick, swirling brushstrokes (Impasto).
Peter Thorpe: Studying his abstract space art to see how rockets and planets can be combined with bold, non-literal backgrounds.
Astrophotography: Understanding that modern images (like those from the Hubble or James Webb telescopes) are a form of art, often involving "composition" and "colour balance" to make scientific data visible to humans.

4. Design and Digital Literacy
As we move into the "space age," art often involves technology.

Symmetry and Pattern: Knowing how to use radial symmetry when designing "alien" flora or futuristic space stations.
Digital Tools: Understanding that digital brushes and "layers" can mimic the depth of space in ways traditional paper sometimes cannot.

Why Substantive Knowledge Matters in Art
1. It Provides a "Visual Vocabulary"
Without knowing how to create **Value**, a child cannot make a planet look round. **Substantive knowledge** gives them the "words" (techniques) to say what they want to say visually.

2. It Encourages Intentionality
When a pupil knows about **Complementary colours**, they don't just pick a colour by accident; they choose it because they know it will create a "vibrant" effect. This moves them from "playing" to "composing."

3. It Builds Respect for Craft
By studying artists like Van Gogh or Thorpe, pupils realise that art isn't just "natural talent"—it involves specific choices, techniques, and hours of practice.

The Space Art "Knowledge Organiser"

Key Concept	Substantive Fact
Form	A sphere is a 3D version of a circle.
Wash	A thin, transparent layer of paint used for backgrounds.
Contrast	The difference between the brightest light and the darkest dark.

Medium	The material used (e.g., charcoal, pastel, watercolour).

Disciplinary Knowledge

In Art & Design, **disciplinary knowledge** for the **'Space'** learning theme involves the specific techniques and artistic lenses used to represent the vast, often invisible, or intangible nature of the universe. It moves beyond simply "drawing a planet" and focuses on how artists use **scale, light, and abstraction** to communicate the wonders of the cosmos.

1. Capturing Light and Luminosity
Disciplinary knowledge involves understanding how to represent light sources in a vacuum where there is no atmosphere to scatter light.

Chiaroscuro (Light and Dark): Using extreme contrasts to show the "sun-lit" side of a moon versus the absolute black of deep space.
Layering and Transparency: Using watercolours or diluted inks to create the gaseous, ethereal look of a **nebula**.
Medium Manipulation: Experimenting with "resist" techniques (like wax-resist or masking fluid) to create sharp, bright stars against a dark wash.

2. Perspective and Cosmic Scale
This involves the artistic discipline of showing distance and magnitude—how to make a 2D surface feel like infinite 3D space.

Relative Scale: Understanding how to position objects to show depth (e.g., a large, detailed moon in the foreground and a tiny, blurred planet in the background).
Atmospheric Perspective: While space is a vacuum, artists use "blurring" or "softening" of edges for distant galaxies to lead the viewer's eye through the composition.
Pointillism: Using dots of varying sizes and densities to represent the millions of stars in the Milky Way, teaching the discipline of patience and precision.

3. Abstracting the Invisible
Since many parts of space (like black holes, dark matter, or gravity) cannot be "seen" with the naked eye, pupils learn how artists use abstraction to represent scientific concepts.

Texture and Surface: Using "impasto" (thick paint) or mixed media (sand, foil, salt) to represent the cratered, rocky surfaces of Mars or the Moon.
Symbolic Colour: Understanding that colours in space images (like those from the James Webb Telescope) are often "false colour" added by scientists to represent different gases. Pupils use this discipline to choose colours based on **mood or temperature** rather than just reality.

4. Design and Functional Aesthetics (Space Tech)
This branch of **disciplinary knowledge** looks at the "Design" side of Art & Design—how form meets function in extreme environments.

Ergonomics in Zero-G: Considering how a space suit or a rover must be designed. It's not just about looking "cool"; it's about the **geometry of movement**.
Material Selection: Analysing why certain colours (like gold foil on satellites) are used for their reflective properties and how that creates a specific "technological" aesthetic.

Why Disciplinary Knowledge Matters in Art
1. It Bridges Science and Creativity
By using artistic techniques to represent space, pupils realise that Art and Science are partners. Scientists use "artistic" skills to visualise data, and artists use "scientific" observation to make their work believable.

2. It Develops Spatial Awareness
Learning how to layer a "space-scape" improves a child's understanding of **foreground, middle ground, and background**, which is a fundamental skill for all representational art.

3. It Encourages "Thinking Outside the Box"
Because space is so alien, it gives pupils permission to move away from literal drawing. It fosters **abstract thinking**, allowing them to focus on how a piece of art *feels* (the coldness of Pluto, the heat of the Sun) rather than just how it looks.

4. It Improves Observational Skills
To paint the Moon accurately, a pupil must actually *look* at the Moon. This develops the discipline of "active looking"—noticing the shadows in craters and the subtle variations in grey—which makes them better overall artists.

The "Space Artist" Success Criteria

Artistic Element	**Disciplinary Application**
Value	Can I use a range of tones to make a 2D circle look like a 3D sphere?
Texture	Can I use salt or sponges to create the "gassy" look of the Milky Way?
Composition	Can I use "overlapping" to show that one planet is behind another?
Inquiry	Can I explain why I chose certain colours to represent a distant star?

Learning Objectives
In Art & Design, the **'Space'** learning theme allows pupils to explore the intersection of **scientific observation** and **creative expression**. The **learning objectives** focus on using the "formal elements" of art to represent a subject that is often vast, distant, and intangible.

1. Using Value to Create Three-Dimensional Form
Objective: *To use a range of tones (values) to create the illusion of three-dimensional spherical bodies on a two-dimensional surface.*
The Focus: Moving from drawing flat circles to 3D spheres.
Key Skill: Shading and Light Source. Pupils identify where the "Sun" (the light source) is in their composition and apply highlights, mid-tones, and core shadows to their planets.
Outcome: Pupils can explain how light and shadow define the shape of celestial bodies.

2. Exploring Colour Theory and Mood
Objective: *To use warm and cool colours to express temperature and atmosphere in a cosmic landscape.*
The Focus: Using colour to represent the "feel" of space.
Key Skill: Colour Mixing and Selection. Using "cool" tones (purples, deep blues, blacks) for the vacuum of space and contrasting them with "warm" tones (oranges, reds, yellows) for solar flares or volcanic moons like Jupiter's Io.
Outcome: Pupils understand how **complementary colours** (e.g., an orange Mars against a dark blue sky) create high contrast and visual impact.

3. Mastering Texture and Medium Manipulation
Objective: *To experiment with different materials and techniques to recreate the physical textures of space.*
The Focus: Representing "gassy" nebulae versus "rocky" planets.
Key Skill: Mixed Media.
Wet-on-wet watercolour: To create the bleeding, ethereal edges of a nebula.
Resist techniques: Using wax or oil pastels to keep stars bright before applying a dark wash.
Splatting: Using stiff brushes to create a realistic field of distant stars.
Outcome: Pupils can select the appropriate medium to match the scientific texture of their subject.

4. Analysing Significant Artists and Movements
Objective: *To study how artists have interpreted the night sky across different periods and styles.*
The Focus: Learning from the masters.
Key Skill: Critical Analysis. Examining Vincent van Gogh's *The Starry Night* to understand how brushwork shows movement, or Peter Thorpe's abstract space art to see how geometry and colour can be used non-literally.
Outcome: Pupils can identify specific artistic techniques (like **impasto**) and apply them to their own work.

5. Designing for Function (Space Tech)
Objective: *To design a functional object for a space environment, considering both aesthetics and ergonomics.*
The Focus: The "Design" in Art & Design.
Key Skill: Prototyping and Annotation. Designing a rover, space suit, or satellite. Pupils must consider why certain shapes are used (e.g., **radial symmetry** for a satellite dish) and what materials (like reflective gold foil) are necessary.
Outcome: Pupils can explain the relationship between a product's appearance and its intended use in a low-gravity or extreme-temperature environment.

Why These Objectives Matter

1. They Visualise the Invisible
Space is mostly empty and dark. These **learning objectives** teach children how to use art to make the invisible forces (like gravity or light paths) visible and understandable.

2. They Develop Precision
Painting the Moon requires intense observation. This develops a pupil's "eye"—the ability to see subtle variations in grey and the jagged textures of craters—which is a fundamental skill for all representational art.

3. They Encourage Creative Problem Solving
How do you paint "nothingness"? How do you make a star look like it's glowing? These **learning objectives** force pupils to experiment with "happy accidents" in their media, fostering a growth mindset.

The best thing to do is to build these skills progressively. By the end of the half term, pupils won't just have a collection of "space pictures"; they will have a portfolio that demonstrates a deep understanding of artistic techniques and scientific observation.

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 Art & Design themed around **'Space'**. This unit covers core National Curriculum Art strands—**Drawing & Mark-Making, Colour Theory & Painting, Printmaking, 3D Sculpture, and Critical Analysis**—linking astronomical concepts like nebulae, lunar topography, planetary orbits, and constellation mythologies with iconic artists (e.g., Peter Thorpe, Vincent van Gogh, Alma Thomas, and Vija Celmins). It balances **substantive knowledge** (the formal elements: line, tone, shape, colour temperature, texture, form, and composition) with **disciplinary knowledge** ("Thinking & Acting Like an Artist"—sketchbook experimentation, evaluating artistic intent, refining techniques through iterative practice, and making critical judgements about visual choices).

Unit Title: Cosmic Vision: Light, Texture, Form, and Abstraction in Space
Duration: 6 Weeks (Approx. 1.5 hours per week)
Theme: Lunar Surfaces, Deep-Space Nebulae, Abstract Planets, and Constellation Sculptures.
Art Focus Areas:
Drawing & Tone: Stippling, cross-hatching, graphite grading (HB, 2B, 4B, 6B), and white charcoal on black grounds.
Colour Theory & Painting: Wet-on-wet watercolour blooming, acrylic blending, complementary colour contrast, and colour temperature (warm vs. cool).
Printmaking & Texture: Relief collagraph printing, impasto plaster/grit textures, and layered stamping.
3D Form & Sculpture: Wire wrapping, papier-mâché, clay modelling, and balance/armature construction.

Key Art Pillars
Substantive Knowledge (The Formal Elements):
Tone & Value: Using varying graphite pencil grades to build contrast and simulate 3D form on a 2D surface.
Colour: Understanding complementary pairs (blue/orange, purple/yellow) to create visual vibrancy; controlling pigment transparency in watercolours.
Texture & Surface: Distinguishing between visual texture (drawn patterns) and physical tactile texture (impasto, collagraph plates).
Form & Space: Translating 2D sketches into 3D free-standing sculptures with structural stability.
Disciplinary Knowledge ("Thinking Like an Artist"):
Sketchbook Practice: Utilising sketchbooks as personal testing grounds for colour swatches, mark-making experiments, and compositional thumbnails.

Critical Appraisal: Analysing how artists select specific mediums to evoke mood, depth, and spatial scale.
Refinement: Reviewing work during production, making deliberate choices to adjust tone, balance composition, or modify texture.

Weekly Progression Scheme
Week 1: Lunar Topography – Tone, Texture & Graphite Grading
Art Strand: Drawing, Tone & Surface Texture.
Focus Artist: Vija Celmins (Detailed lunar surface pencil drawings).
Substantive Knowledge:
LKS2: Graphite pencil grading (HB, 2B, 4B); basic shading techniques (hatching, stippling) to show light and shadow; texture techniques on white/black paper.
UKS2: Full tonal range (HB → 6B); controlling highlight value using white charcoal/chalk on dark grounds; rendering spherical 3D form via directional shading.
Disciplinary Knowledge:
Observation & Mark-Making: Analysing how density of marks creates variations in light intensity and topographical depth.
Practical Art Task:
LKS2 (Y3/4): *The Cratered Moon Surface.* Pupils use 2B and 4B pencils to create a series of directional shading and stippling swatches in their sketchbooks, applying these marks to draw a realistic lunar crater.
UKS2 (Y5/6): *Moonphobia on Black Ground.* Pupils work on black sugar paper using white charcoal and graphite pencils (2B-6B), rendering a close-up moon surface with extreme tonal contrast and cast shadows.

Week 2: Deep-Space Nebulae – Colour Temperature & Blending
Art Strand: Painting & Colour Theory.
Focus Artist: Chesley Bonestell (Space art pioneer) & NASA Hubble Imagery.
Substantive Knowledge:
LKS2: Primary and secondary colour mixing; wet-on-wet watercolour blooming; warm vs. cool colour temperature to create atmosphere.
UKS2: Acrylic paint blending on canvas/board; complementary colour placement (purple/yellow, blue/orange) to maximise visual vibration; opacity vs. transparency.

Disciplinary Knowledge:
Colour Intentionality: Choosing colour pairings deliberately to convey warmth, vast distance, or cosmic energy.
Practical Art Task:
LKS2 (Y3/4): *Watercolour Cosmic Clouds.* Pupils experiment in sketchbooks with wet-on-wet watercolour washes, dropping wet pigment onto wet paper to create bleeding nebulae, adding toothbrush star-splatters with white gouache.
UKS2 (Y5/6): *Acrylic Nebula Layers.* Pupils blend acrylic paints (ultramarine, magenta, cadmium yellow) directly onto dark backgrounds using sponges and dry brushes, applying glazes to build luminous cosmic clouds.

Week 3: Abstract Space Age – Peter Thorpe & Alma Thomas
Art Strand: Mixed Media, Composition & Abstract Expressionism.
Focus Artists: Peter Thorpe (Abstract rocket art) & Alma Thomas (Rhythmic pointillist colour fields).
Substantive Knowledge:

LKS2: Background vs. foreground layering; geometric shapes vs. organic abstract marks; pointillism techniques for colour field rhythms.
UKS2: Dynamic compositional angles; sharp graphic silhouettes overlaid on fluid abstract backgrounds; focal point placement using rule of thirds.
Disciplinary Knowledge:
Comparative Critique: Evaluating how Peter Thorpe combines sharp graphic lines with loose abstract paint to create energy compared to Alma Thomas's structured colour bands.
Practical Art Task:
LKS2 (Y3/4): *Alma Thomas Solar Flares.* Pupils create an abstract sun/star artwork using short, rhythmic brushstrokes of pure colour radiating outwards in concentric circles.
UKS2 (Y5/6): *Peter Thorpe Rocket Composition.* Pupils paint an expressive abstract background, designing a clean geometric rocket silhouette on black card and mounting it over the painting to build contrast.

Week 4: Relief Planets – Collagraph Printmaking & Tactile Surfaces
Art Strand: Printmaking & Tactile Texture.
Focus Art Movement: Mid-Century Relief Printmakers & Graphic Space Art.
Substantive Knowledge:
LKS2: Relief printing basics; creating a collagraph plate using collage materials (string, bubble wrap, textured card); applying ink evenly with a brayer (roller).
UKS2: Layered collagraph printing; registering multiple colours on one print; varying plate pressure to produce subtle tonal gradients.
Disciplinary Knowledge:
Iterative Printing: Printing a test proof, identifying areas of low ink transfer, and modifying the plate texture to improve print quality.
Practical Art Task:
LKS2 (Y3/4): *Textured Collagraph Planet.* Pupils construct a circular collagraph plate using cut card, string, and PVA glue, rolling printing ink across the raised surfaces to produce a 2-colour print of an alien planet.
UKS2 (Y5/6): *Multi-Plate Cosmic System.* Pupils build complex collagraph plates with layered sandpaper, burlap, and foil, printing a series of overlapping planets onto pre-painted nebula backgrounds.
Week 5: Constellations & Orbits – Wire Armatures & 3D Form
Art Strand: 3D Sculpture, Form & Spatial Awareness.
Focus Topic: Ancient Star Maps, Celestial Globes & Alexander Calder (Kinetic wire sculptures).
Substantive Knowledge:
LKS2: Translating 2D drawings into 3D wire forms; wrapping, twisting, and joining thin aluminium/copper wire; securing sculptures to a base.
UKS2: Kinetic balance; using armatures (wire/dowel) to support 3D hanging masses; integrating mixed media (beads, foil, clay) to represent celestial bodies.
Disciplinary Knowledge:
Structural Engineering in Art: Balancing weight and tension in wire to ensure a 3D sculpture stands independently without collapsing.
Practical Art Task:
LKS2 (Y3/4): *Wire Constellation Figures.* Pupils select a mythic constellation, shaping soft wire into the star pattern using pliers and wrapping joints with metallic thread, mounting the form on a painted wooden block base.
UKS2 (Y5/6): *Calder-Inspired Planetary Mobile.* Pupils design a kinetic 3D sculpture representing an orbital system, twisting wire arms and balancing light clay/foil planets so the structure moves freely in space.

Week 6: The Cosmic Gallery – Curating, Appraisal & Unit Synthesis
Art Strand: Critical Appraisal, Curation & Gallery Exhibition.
Substantive Knowledge:
LKS2/UKS2 Synthesis: Exhibiting a portfolio featuring lunar drawings, nebula paintings, collagraph prints, and 3D wire sculptures; writing formal artist statements.
Disciplinary Knowledge:
Artistic Self-Evaluation: Reflecting on technical progress across the unit using formal art vocabulary (*tone, texture, composition, armature, relief*).
Practical Art Task:
LKS2 & UKS2: *The Space Art Exhibition Showcase.*
Task 1: Pupils select their two strongest pieces, writing an "Artist Statement" card detailing their inspiration, chosen mediums, and technical achievements.
Task 2: Class curates a themed space gallery, grouping works by formal elements (Tone Zone, Colour Collision, 3D Form Station).
Plenary: A "Silent Gallery Walk" and peer review session where pupils evaluate peers' work using structured critique rubrics.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Applies pencil shading uniformly without demonstrating tonal contrast. • Mixes watercolour paints until colours become muddy or overly dilute. • Cuts collagraph materials without building varied surface heights. • Requires assistance to twist wire joints securely during 3D sculpture tasks.	• Uses 2B and 4B pencils to create clear light, medium, and dark tones. • Controls wet-on-wet watercolour washes to create blending without muddying pigments. • Constructs collagraph plates with distinct raised textures and prints clean impressions. • Shapes wire into stable 3D constellation structures mounted securely on a base.	• Explains how directional shading creates spherical volume and shadow depth. • Selects warm and cool colours purposefully to evoke mood and spatial perspective. • Combines multiple printmaking textures creatively to produce complex surface details. • Manipulates wire wire-wrapping techniques to add expressive decorative elements.
Upper Key Stage 2 *(Years 5 & 6)*	• Struggles to achieve smooth tonal gradients using full graphite ranges (HB-6B). • Paints abstract nebulae without layering opaque and transparent colour glazes.	• Uses graphite (HB-6B) and white charcoal to render realistic 3D lunar forms. • Blends acrylic paints smoothly and places complementary colours to create visual vibration.	• Demonstrates mastery over light sources, producing dramatic tonal contrast on dark grounds. • Evaluates artist styles (Peter Thorpe vs. Alma Thomas) to synthesise a unique personal aesthetic.

	• Prints collagraphs with uneven ink coverage due to poor roller distribution. • Builds wire sculptures that lack structural balance or independent support.	• Registers multi-layered collagraph prints accurately over painted backgrounds. • Engineers balanced 3D wire armatures that maintain kinetic stability independently.	• Experimentally modifies printmaking plates to produce varied tonal proofs. • Applies principles of kinetic balance (Alexander Calder) to construct complex multi-axis mobiles.

Other Information, Ideas and Resources

This is an alternative **6-week Art & Design sequence** for the **'Space'** learning theme:

Week 1: Mastering the Sphere (Value & Form)
Objective: To use shading to create 3D form.
Activity: Using charcoal or graphite pencils, pupils practice drawing "Moon Spheres." They must choose a consistent light source and apply a highlight, mid-tone, core shadow, and reflected light.
Outcome: A series of shaded spheres that look like they are "popping" off the page.

Week 2: The Ethereal Nebula (Wet-on-Wet Technique)
Objective: To explore colour blending and transparency.
Activity: Using watercolours, pupils use the "wet-on-wet" technique to create a nebula. They drop concentrated pigment into wet paper to see it "bloom."
Extension: Sprinkle salt onto the wet paint to create a "starburst" texture as the salt absorbs the moisture.

Week 3: Van Gogh's Moving Sky (Texture & Impasto)
Objective: To use brushwork to show movement and energy.
Activity: Study *The Starry Night*. Using thick acrylic paint or oil pastels, pupils recreate a small section of the sky using short, rhythmic strokes (**impasto**) to show the "flow" of cosmic energy.
Outcome: A textured study of movement in the night sky.

Week 4: The Abstract Rocket (Inspiration: Peter Thorpe)
Objective: To combine representational and abstract art.
Activity: Pupils use a "resist" technique (oil pastel or wax crayon) to draw a sharp, geometric rocket. They then paint an abstract, "messy" background using sponges and splattering to represent the chaos of a launch.
Outcome: A high-contrast piece combining sharp lines with abstract textures.

Week 5: Design a Mars Rover (Functional Aesthetics)
Objective: To design for a specific environment (Design).
Activity: Pupils act as "NASA Designers." They must draw a blueprint for a rover, annotating their choices. *Why does it have wide wheels? Why is it covered in reflective gold foil?*
Outcome: A technical drawing that balances "looking cool" with scientific necessity.

Week 6: The Final Frontier (Composition)
Objective: To apply all learned skills into a final composition.
Activity: Pupils create a final "Cosmic Landscape." They must include at least one 3D shaded planet (Week 1), a watercolour nebula background (Week 2), and use overlapping to show distance (Perspective).
Outcome: A finished "Masterpiece" for the portfolio.

Suggested Art Assessment Rubric

Level	Criteria
Emerging	Uses circles for planets; colours are flat; little use of shading.
Expected	Uses shading to make planets look 3D; uses watercolour techniques effectively; can explain light source.
Exceeding	Shows complex depth through overlapping; uses varied textures (salt/splatter) intentionally; work reflects an artist's style (e.g., Van Gogh).

Considerations for Implementation

Computing

Substantive Knowledge

In Computing, **substantive knowledge** for the **'Space'** learning theme involves the concrete facts about how computers work, the rules of programming languages, and the specific ways data is structured to help us explore the solar system. It's the "know-what" that allows pupils to build the simulations and control the robots that make space exploration possible.

1. Programming: The Language of Spacecraft
Substantive knowledge here centres on the building blocks of code used to automate space missions.
Sequence: Knowing that instructions must be in a specific order for a rocket to launch or a rover to move.
Selection (Conditions): Understanding how to use "If... Then... Else" statements (e.g., *If* the rover detects a rock, *then* turn left, *else* move forward).
Variables: Knowing how to use "placeholders" for data that changes, such as a countdown timer, a fuel gauge, or a distance-to-target readout.
Repetition (Loops): Understanding how to repeat a set of instructions, such as a satellite continuously orbiting or a sensor checking for light every 10 seconds.

2. Data Representation: Binary and Beyond
This is the knowledge of how "space" is turned into "information" that a computer can understand.

Binary Code: Knowing that all computer data (images of Mars, voice recordings from the ISS) is ultimately stored as **bits** (0s and 1s).
Image Pixels: Understanding that satellite images are made of a grid of pixels, where each pixel is assigned a number representing a colour.
Data Types: Distinguishing between different types of data used in space science, such as **integers** (number of planets), **strings** (names of stars), and **Booleans** (Is the landing gear down? True/False).

3. Computer Systems and Networks
Substantive knowledge of the hardware and "invisible" connections used in space.

Inputs and Outputs: Identifying the hardware on a space probe (Input: camera, thermometer; Output: radio transmitter, motor).
The Internet and Communication: Understanding that signals from space travel via **radio waves** to ground stations and are then routed through the internet to scientists' computers.
Packet Switching: Basic knowledge of how large files (like high-res photos of Jupiter) are broken into smaller "packets" to be sent across the vast distances of the solar system.

4. Modelling and Simulations
Knowledge of how we represent the physical laws of space in a digital environment.

Variables and Outcomes: Knowing that changing a numerical value (e.g., "Gravity = 1.6" for the Moon instead of "9.8" for Earth) will change how an object behaves in a simulation.
Computer Models: Knowing that a model is a simplified version of reality that helps us predict what might happen during a real mission.
Why Substantive Knowledge Matters in Computing

1. It Moves from "Play" to "Precision"
Knowing that a "Loop" is a specific programming structure allows a pupil to be efficient. Instead of writing "Move Forward" fifty times for a Mars simulation, they write it once inside a loop. This is the foundation of **computational thinking**.

2. It Explains the "Magic" of the Images
When pupils understand binary and pixels, they realise that the photos from the James Webb Telescope aren't "magic"—they are highly organised sets of data. This builds a realistic understanding of modern technology.

3. It Provides a Toolkit for Problem Solving
If a pupil knows about **Selection (Conditions)**, they can solve the problem: "How do I stop my rover from falling into a crater?" They have the specific "tool" (the IF statement) to fix the issue.

4. It Prepares for a Technical World
Understanding how data moves from a satellite to a smartphone is essential knowledge for a digital citizen. It helps pupils understand the infrastructure that powers our modern lives, from GPS to weather forecasting.

The "Space Tech" Knowledge Check

Computing Term	Space Application
Input	A rover's camera taking a photo of a rock.
Algorithm	The step-by-step landing sequence for a lunar module.
Debug	Finding an error in the code that caused a rocket to veer off course.
Simulation	Testing a flight path on a screen before launching the real rocket.

Disciplinary Knowledge

In Computing, **disciplinary knowledge** for the **'Space'** learning theme involves understanding how we use technology to observe, simulate, and navigate the universe. It moves beyond just using a computer to "find facts" and focuses on the logic of **programming**, the power of **simulations**, and the ethics of **data handling**.

1. Programming and Robotics (Physical Computing)

Disciplinary knowledge here involves understanding that robots (like Mars Rovers) are not "thinking" beings; they are machines following a precise sequence of instructions.

Algorithms for Navigation: Pupils learn to write and debug code to navigate a "rover" around obstacles. This involves using **sequences, selections (IF/THEN), and repetitions (loops)**.
Sensory Input: Understanding how computers "see" space. Pupils learn that a rover uses sensors (ultrasonic or infrared) to gather data and make decisions based on that input.
Latency: A key piece of **disciplinary knowledge** is understanding the "delay" in space communication. Coding a rover to move "forward 10 steps" is different when it takes 20 minutes for the signal to reach Mars.

2. Computer Simulations and Modelling
Since we cannot easily go to space, we use computers to build digital versions of it.

Predictive Modelling: Understanding that a simulation (like an Orrery app or a gravity simulator) is a mathematical model. Pupils learn that changing a variable (like the mass of a planet) will change the outcome (the orbit).
Virtual Environments: Using VR or AR to explore the solar system. The **disciplinary** focus is on understanding how 3D digital environments are constructed and how they differ from reality.

3. Data Handling and Interpretation
Space produces massive amounts of data. Pupils learn how computers help us make sense of it.

Binary and Image Processing: Understanding that the beautiful photos from the James Webb Telescope are actually sent to Earth as strings of **1s and 0s (binary)** and then reconstructed by software.
Database Analysis: Learning how to search and sort large databases of stars or planets using filters (e.g., "Show me all planets with a diameter larger than Earth").
Pattern Recognition: Using software to identify patterns in star charts or planetary movements, mimicking how real astronomers use AI to find new exoplanets.

4. Digital Literacy and Communication
This involves the "Netiquette" and ethics of sharing space-related information.

Fact-Checking and Credibility: In the age of "Flat Earth" theories on social media, pupils learn the discipline of verifying sources. Is the information from NASA/ESA or an unverified blog?
Collaborative Working: Using cloud-based tools to work as a "Mission Control" team, sharing documents and data in real-time to solve a problem.

Why Disciplinary Knowledge Matters in Computing
1. It Demystifies "Smart" Technology
By coding a mini-rover, pupils realise that complex space missions are built on simple, logical steps. It moves them from being passive users of tech to **active creators**.

2. It Teaches Resilience through Debugging
In space, a "bug" in the code can end a billion-dollar mission. This learning theme gives high stakes to the computing concept of **debugging**—finding and fixing errors becomes an essential survival skill.

3. It Connects Maths to Logic
Computing is "Maths in action." Calculating the timing for a lunar landing in a program requires an understanding of variables and operators, making abstract maths feel purposeful.

4. It Prepares for Future Careers
Space technology is one of the fastest-growing sectors. Understanding how data is sent across the void and how AI processes satellite imagery provides a direct link to modern STEM careers.

The "Space Programmer" Success Criteria

Skill Area	Disciplinary Application
Logic	Can I use a **Loop** to make a satellite orbit a planet?
Evaluation	Can I explain why a simulation might not be 100% accurate?
Data	Can I explain how a "False Colour" image is made from binary data?
Safety	Do I know how to check if a space-themed website is a reliable source?

Learning Objectives

In Computing, the **'Space'** learning theme allows pupils to transition from being consumers of technology to becoming **computational thinkers**. The **learning objectives** focus on using logic and data to solve the unique challenges of the final frontier.

1. Programming: Controlling a Lunar Rover
Objective: *To design, write, and debug programs that accomplish specific goals, including controlling or simulating physical systems.*
The Focus: Precise instructions for a remote environment.
Key Skill: Sequence and Selection. Pupils must write an algorithm to navigate a "rover" across a Martian landscape. They use **Selection** (IF/THEN statements) to help the rover make decisions, such as: *"If an obstacle is detected, then turn 90 degrees."*
Outcome: Pupils can identify and "debug" errors in their code when the rover doesn't reach its target.

2. Simulations: Modelling Gravity and Orbits
Objective: *To use sequence, selection, and repetition in programs; work with variables and various forms of input and output.*
The Focus: Using computers to predict reality.

Key Skill: Variables. Pupils use simulation software (like Scratch or specialised space models) to see what happens when they change a variable. *If I increase the mass of the Sun, what happens to Earth's orbit?*
Outcome: Pupils understand that a computer model is a digital representation of the physical laws of the universe.

3. Data Representation: Binary and Images
Objective: *To understand how data is represented digitally and how it can be transmitted.*
The Focus: How we "see" through the void.
Key Skill: Binary and Pixels. Pupils learn that images from the James Webb Telescope are sent as strings of **binary (1s and 0s)**. They explore how these numbers are translated into coloured pixels to create an image.
Outcome: Pupils can explain that computers don't "see" pictures, but process numerical data to reconstruct them.

4. Digital Literacy: Communication and Latency
Objective: *To understand computer networks including the internet; how they can provide multiple services, such as the world wide web.*
The Focus: The "invisible" connections to space.
Key Skill: Network Logic. Understanding how a signal travels from a Mars rover, through a satellite network, to a scientist's laptop on Earth. They explore the concept of **latency** (the delay caused by the speed of light).
Outcome: Pupils can describe how data is broken into packets to be sent across vast distances.

5. Search and Discernment: Evaluating Space Facts
Objective: *To use search technologies effectively, appreciate how results are selected and ranked, and be discerning in evaluating digital content.*
The Focus: Navigating the "black hole" of misinformation.
Key Skill: Evaluating Credibility. Pupils research "Moon Landing" or "Flat Earth" theories to learn how to distinguish between high-quality scientific sources (NASA/ESA) and unreliable websites.
Outcome: Pupils can cross-reference information to ensure its scientific accuracy.

Why These Learning Objectives Matter
1. It Makes Logic Physical
Coding a rover gives "weight" to an algorithm. If the code is wrong, the rover crashes. This teaches pupils that **precision** is vital in technology, especially when millions of miles away.

2. It Builds Resilience
Space missions are famous for "failed" attempts that lead to great discoveries. In Computing, this is **debugging**. Learning to find a mistake in a script and fix it mirrors the real-life work of NASA engineers.
3. It Prepares for the Future
Modern space exploration is almost entirely dependent on AI, machine learning, and data analysis. These **learning objectives** provide the foundational "alphabet" of the digital world your pupils will grow up in.

4. It Connects Subjects
Computing brings the Maths (variables) and Science (gravity) together. It proves that technology isn't a standalone subject, but the "glue" that helps us understand the other two.

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 Computing themed around **'Space'**. This unit connects core National Curriculum Computing strands—**Computer Science (Algorithms, Programming &**

Physical Computing), Information Technology (Data, Vector Graphics & CAD), and Digital Literacy (Search Engines, E-Safety & Space Communications)—with astronomical themes: mars rover algorithms, satellite data networks, vector space mission patches, 3D CAD lunar landers, and cosmic data logging. It balances **substantive knowledge** (variables, loops, conditional logic, vector layers, CAD 3D coordinates, database query syntax, and network packets) with **disciplinary knowledge** ("Thinking & Acting Like a Computer Scientist"—decomposing complex problems, systematically debugging code, evaluating algorithmic efficiency, questioning online source credibility, and designing digital artefacts for specific audiences).

Unit Title: Cosmic Code: Algorithms, Data, CAD, and Space Communications
Duration: 6 Weeks (Approx. 1 to 1.5 hours per week)
Theme: Mars Rover Programming, Satellite Telemetry, 3D Lunar Station Design, and Deep-Space Networks.
Computing Focus Areas:
Computer Science (Programming & Physical Computing): Scratch block algorithms, sequence, repetition, selection (if/then/else), variables, micro:bit sensor telemetry, and debugging.
Information Technology (Media Creation & Data): Vector graphics design, 3D Tinkercad modelling, branching databases, and flat-file space telemetry spreadsheets.
Digital Literacy & Communication: Web indexing/search algorithms, latency/packet transmission in deep-space networks, and online safety/misinformation.
Key Computing Pillars
Substantive Knowledge:
Programming Constructs: Sequences, count-controlled loops, conditional loops (repeat until), selection statements (if/then), and variables (storing score/fuel/distance).
Digital Media & 3D Design: Difference between raster (pixels) and vector (paths/shapes) graphics; 3D workspace navigation (X, Y, Z axes), grouping, and hole subtraction in CAD.
Data & Networks: How search engines index the web; data logging via micro:bit sensors (light/temperature); structure of flat-file databases; how packets travel across networks.
Disciplinary Knowledge ("Thinking Like a Computer Scientist"):
Decomposition & Abstraction: Breaking down complex game logic or 3D engineering models into smaller, manageable parts while ignoring irrelevant details.
Systematic Debugging*:* Predicting code outputs, tracing algorithm execution line-by-line, and diagnosing errors methodically.
Critical Evaluation: Assessing user interface usability, network security risks, and verifying the reliability of online astronomical data.

Weekly Progression Scheme
Week 1: Mars Rover Navigation – Algorithms, Loops & Selection
Computing Strand: Computer Science (Scratch Programming).
Substantive Knowledge:
LKS2: Sequence of commands; count-controlled loops (repeat 10); selection (if key pressed then move); sprite coordinates (X, Y).
UKS2: Conditional loops (repeat until sensor touched); nested conditional logic (if/then/else); broadcast messaging between sprites.
Disciplinary Knowledge:
Algorithmic Efficiency & Debugging: Testing pathfinding code, predicting movement errors, and refactoring redundant blocks into loops.
Practical Computing Task:

LKS2 (Y3/4): *Mars Rover Obstacle Avoidance.* Pupils program a Scratch Mars Rover sprite to navigate a Martian crater terrain, using arrow keys for steering and a repeat until loop to detect rocky obstacles.
UKS2 (Y5/6): *Autonomous Rover Probe.* Pupils program a self-driving rover sprite using sensor touch blocks and broadcast events to automatically collect mineral samples while avoiding hazard zones.

Week 2: Deep-Space Communications – Networks & Search Engines
Computing Strand: Digital Literacy & Computer Networks.
Substantive Knowledge:
LKS2: Difference between the World Wide Web and the Internet; how web crawlers build search indexes; key phrase optimisation.
UKS2: How data travels in digital packets across networks; signal latency (time delays in radio signals sent to Mars); identifying online misinformation regarding space discoveries.
Disciplinary Knowledge:
Information Evaluation: Analysing search results critically to distinguish between verified scientific space sources and clickbait or conspiracy media.
Practical Computing Task:
LKS2 (Y3/4): *The Web Indexing Challenge.* Pupils simulate search engine web crawlers, creating keyword index cards for space topics, testing how different search queries retrieve information.
UKS2 (Y5/6): *Deep-Space Packet Simulation.* Pupils model deep-space telemetry transmission, sending split packet messages across a simulated network with simulated packet loss and latency, verifying data integrity at the receiver end.

Week 3: Vector Mission Patches – Vector Graphics & Graphic Design
Computing Strand: Information Technology (Digital Media Creation).
Substantive Knowledge:
LKS2: Difference between raster images (pixels) and vector graphics (scalable shapes); combining geometric shapes; fill and stroke colour properties.
UKS2: Manipulating vector layers (bringing forward/sending backward); node editing to reshape curved lines; grouping and aligning complex objects.
Disciplinary Knowledge:
Design Optimisation: Evaluating how vector graphics maintain clarity at any scale factor compared to raster images when printed on physical space gear.

Practical Computing Task:
LKS2 (Y3/4): *Space Agency Badge.* Pupils use vector software (e.g., Inkscape or Google Drawings) to combine circles, stars, and polygons into a scalable astronaut mission badge.
UKS2 (Y5/6): *Custom Artemis Mission Emblem.* Pupils create a multi-layered vector logo, editing vector nodes to curve rocket paths and organising shape layers to design an official space crew emblem.

Week 4: Lunar Habitat Architecture – 3D CAD Modelling
Computing Strand: Information Technology (3D Design & CAD).
Substantive Knowledge:
LKS2: 3D coordinate space (X, Y, Z axes); rotating, scaling, and placing basic 3D primitives (cubes, cylinders, spheres).
UKS2: Grouping solids; converting shapes into "holes" to cut out hollow interiors (airlocks/windows); precise millimetre dimensioning.

Disciplinary Knowledge:
Decomposition in Engineering: Deconstructing a complex moon base structure into primitive 3D shapes before building the digital model.
Practical Computing Task:
LKS2 (Y3/4): *The Moon Village Module.* Pupils use Tinkercad to place, scale, and align 3D shapes to build a basic modular astronaut living dome.
UKS2 (Y5/6): *Complete Lunar Station & Airlock.* Pupils design a hollowed-out 3D lunar habitat using shape grouping and hole subtractions, aligning solar panels and docking ports using precise grid coordinates.

Week 5: Cosmic Data Logging – Physical Computing & Micro:bit Telemetry
Computing Strand: Computer Science (Physical Computing & Data).
Substantive Knowledge:
LKS2: Input device (micro:bit sensors) vs. output device (LED matrix); reading temperature/light level inputs; simple conditional triggers.
UKS2: Storing sensor data in variables; continuous data logging over time; exporting recorded data into flat-file CSV spreadsheets to generate graphs.
Disciplinary Knowledge:
Systematic Data Analysis: Interrogating environmental sensor data logged by micro:bits to draw conclusions about simulated space conditions.
Practical Computing Task:
LKS2 (Y3/4): *Astronaut Helmet Light Detector.* Pupils program a micro:bit to display warning icons on the LED matrix when light levels exceed safety thresholds inside a simulated space suit.
UKS2 (Y5/6): *Space Station Environmental Monitor.* Pupils program micro:bits as continuous data loggers, recording ambient temperature over an extended period, exporting the data into a spreadsheet to construct temperature line graphs.

Week 6: Space Mission Control Simulation – System Integration & Review
Computing Strand: Computer Science, IT & Unit Synthesis.
Substantive Knowledge:
LKS2/UKS2 Synthesis: Integrating Scratch programming, vector graphics, 3D CAD assets, and sensor telemetry into an interactive Mission Control showcase.

Disciplinary Knowledge:
Systematic Code Evaluation: User testing peers' interactive space systems, identifying logical bugs, and offering constructive feedback on interface accessibility.
Practical Computing Task:
LKS2 & UKS2: *The Mission Control Interactive Expo.*
Task 1: Pupils publish their final Scratch Space Game/Simulation, embedding their 3D CAD models and vector patch graphics into the user interface.
Task 2: Class conducts a peer-evaluation session, playing each other's space games, testing for edge-case bugs (e.g., score variables going negative), and writing bug report tickets.
Plenary: "Code Refactoring Plenary" where pupils share their most challenging programming bug and explain how they fixed it using systematic debugging steps.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Writes linear Scratch code without using repeat loops. • Identifies basic shapes in vector tools but struggles to change fill/stroke colours. • Moves shapes in CAD along 2 axes (X, Y) but struggles with Z-axis elevation. • Requires step-by-step assistance to upload code onto physical micro:bit boards.	• Programs Scratch algorithms using count-controlled loops and selection (if/then). • Combines geometric shapes to create scalable vector graphics without pixel distortion. • Navigates 3D CAD space (X, Y, Z axes) to position, scale, and align basic structures. • Programs micro:bit inputs (sensors) to trigger specific outputs (LED displays) correctly.	• Uses nested loops and variable blocks to create complex sprite interactions effortlessly. • Explains the technical benefits of vector path scaling over raster pixel graphics. • Groups multiple 3D primitives and aligns complex structures with precise grid accuracy. • Systematically debugs code errors in peer programs using line-by-line tracing.
Upper Key Stage 2 *(Years 5 & 6)*	• Uses Scratch selection blocks but struggles with nested if/then/else logic. • Creates vector images but fails to use layering or node manipulation tools. • Uses CAD software but struggles to create hollow shapes using hole subtractions. • Collects sensor data but cannot export or interpret CSV files in spreadsheet tools.	• Uses variables, broadcast messages, and repeat until loops to build interactive games. • Manipulates vector layers, node points, and grouping tools to build complex graphics. • Uses hole tools and grouping in 3D CAD to engineer precise hollowed structures. • Logs environmental data via sensors, exports to spreadsheets, and interprets line graphs.	• Designs modular, highly efficient code structures using custom functions (My Blocks). • Uses advanced vector tools (gradients, curves) to craft professional-grade UI elements. • Engineers complex, parameter-constrained 3D CAD models optimised for 3D printing. • Evaluates network packet loss, latency, and data integrity across simulated space networks.

Other Information, Ideas and Resources

Alternative Computing **lessons ideas** that move beyond just "searching for space facts" and focus on **computational thinking**—the logic, patterns, and programming that make actual space exploration possible.

1. Programming: The Mars Rover "Lost in Space"
The Concept: Algorithms, Sequencing, and Debugging.
The Activity: Use a block-based language like Scratch. Pupils must program a "Rover" sprite to navigate a Martian landscape to reach a specific crater.
The Twist: Introduce "obstacles" (space rocks) that require the use of **Selection** (*If* touching colour brown, *then* turn 90 degrees).

Disciplinary Skill: Debugging. Provide pupils with a "broken" script where the rover goes in circles and ask them to find the logical error.

2. Modelling: Gravity Simulator
The Concept: Variables and Simulations.
The Activity: Use a physics-based simulation tool (or a Scratch project with variables). Pupils experiment with two variables: **Mass** and **Distance**.
The Task: They must find the "perfect balance" to keep a satellite in orbit. If the velocity variable is too low, the satellite crashes; too high, and it flies off the screen.
Disciplinary Skill: Predictive Modelling. Pupils record their data in a table to predict how changing one variable affects the system.

3. Data Representation: Binary "Alien" Signals
The Concept: Binary and Image Processing.
The Activity: Explain that deep-space probes send images as 1s and 0s. Give pupils a 10x10 grid. Provide them with a string of binary code where 0 = white and 1 = black.
The Task: They must "decode" the string to reveal a hidden pixel image of a planet or a star.
Digital Literacy: Discuss why computers use binary (on/off switches) instead of human language to send data across millions of miles.

4. Digital Literacy: The "Fake Moon Landing" Detectives
The Concept: Evaluating Credibility and Search Technologies.
The Activity: Present pupils with two websites: one from NASA and one "conspiracy" or spoof site (like a "Flat Earth" blog).
The Task: Pupils must act as "Information Detectives" to rank the sites based on authority, currency, and purpose.
Disciplinary Skill: Critical Evaluation. Teach them how to use "Advanced Search" filters (e.g., site:.gov or site:.edu) to find the most reliable scientific data.

5. Physical Computing: The ISS Alarm System
The Concept: Inputs, Outputs, and Sensors.
The Activity: If you have access to **Micro:bits** or **Crumble kits**, challenge pupils to build a "Light Alarm" for the International Space Station.
The Logic: The alarm should trigger (Output: LED or Sound) only when the built-in sensor (Input: Light sensor) detects "Sunlight" as the ISS orbits the Earth.
Disciplinary Skill: Physical Systems. Understanding how hardware interacts with the physical environment via code.

Why These Ideas Matter

Skill	Real-World Space Parallel
Logic	NASA engineers must account for every possible "If/Then" scenario before a launch.

Data	The James Webb Telescope sends raw data that *must* be processed by computers to be seen.
Simulation	Astronauts spend hundreds of hours in VR simulations before ever stepping on a rocket.
Persistence	Coding, like space travel, requires "trial and error" and the resilience to try again.

The following guide is designed to help pupils build a functional **Mars Rover** that can navigate autonomously using basic AI logic.

🚀 **Mission: The Autonomous Martian Explorer (using Scratch) – example lesson**
Objective: Program your Rover to drive across Mars and automatically turn away if it hits a "Red Rock."

Step 1: Prepare the Martian Landscape
Choose a Backdrop: Select 'Moon' or **'Space'** from the Scratch library.
Choose a Sprite: Pick the 'Robot' or draw your own 'Rover.'
The Obstacle: Paint a new Sprite. Draw a simple **Bright Red** circle. Name it **"Red Rock."**

Step 2: The "Sequence" (Getting Moving)
We need to tell the Rover to start moving as soon as the "Launch" button (Green Flag) is clicked.
Go to **Events**: Drag out when green flag clicked.
Go to **Control**: Drag out a forever loop and snap it underneath.
Go to **Motion**: Inside the loop, snap move 3 steps.
Result: Your Rover should now drive off the edge of the screen! Drag it back to the start.

Step 3: The "Selection" (Avoiding Obstacles)
Now we add "AI" logic. We want the Rover to "see" the Red Rock and make a decision.
Go to **Control**: Drag an if < > then block and place it **inside** the forever loop (under the move block).
Go to **Sensing**: Drag touching [Red Rock]? and snap it into the diamond shape of the if block.
Go to **Motion**: Inside the if block, add:
move -20 steps (to back away).
turn clockwise 90 degrees.

Step 4: "Debugging" Your Mission
Scientists always test their code. If your Rover gets stuck, check these three things:
The Colour: Is the "touching" block looking for the exact colour of your rock?
The Order: Is your if block *inside* the forever loop? If it's outside, the Rover will only check for the rock once at the very start!
The Rotation: Click the 'Direction' box in the Sprite settings and select the **"Don't Rotate"** or **"Left/Right"** icon if your Rover is flipping upside down.

🌟 **Pro-Challenge: The Fuel Variable**
Want to make it harder? Let's add a **Variable**.
Go to **Variables** and click 'Make a Variable'. Name it Fuel.

At the start of your code (when green flag clicked), add set Fuel to 100.
Inside the forever loop, add change Fuel by -0.1.
Add a second if block: if < Fuel < 1 > then [stop all].

What this teaches
Substantive Knowledge: Pupils learn to use **Variables** (Fuel), **Selection** (If/Then), and **Loops** (Forever).
Disciplinary Knowledge: Pupils experience the **Latency** of code—the rover only reacts when the code reaches that specific line in the sequence.

Considerations for Implementation

Design & Technology

Substantive Knowledge

In DT, **substantive knowledge** for the **'Space'** learning theme involves the "technical toolkit"—the specific materials, components, and construction techniques used to build structures and systems that can withstand a "space" environment. It is the factual foundation that allows pupils to move from making "models" to building functional **prototypes**.

1. Materials and Their Properties
Substantive knowledge here is about knowing which "stuff" to use for which job based on its scientific characteristics.

Thermal Insulation: Understanding which materials prevent heat transfer (e.g., polystyrene, bubble wrap, or fabrics) to keep an astronaut or "space seedling" alive.
Reflective Materials: Knowing the properties of foils and Mylar in reflecting radiation and light.
Strength-to-Weight Ratio: Knowing that materials like corrugated cardboard, balsa wood, or thin plastics are "strong for their weight," which is vital for rocket efficiency.
Corrugated Structures: Understanding how the "wavy" middle layer of cardboard provides rigid strength without adding much weight.

2. Mechanical Systems
This is the knowledge of how to create movement within a space-themed product.

Levers and Linkages: Knowing how to use fixed and moving pivots to create a "robotic arm" for a rover.
Pulleys and Gears: Understanding how to transfer force to lift "moon rocks" or rotate a satellite dish.
Pneumatics: Knowing how to use air pressure (via syringes and plastic tubing) to create a powerful opening/closing motion, such as a landing gear or a lunar base door.

3. Electrical Systems and Monitoring
Substantive knowledge of the "brain" and "nervous system" of a space craft.

Series Circuits: Knowing how to build a basic circuit to power a "Cabin Light" or a "Landing LED."
Sensors (Inputs): Understanding the role of a **Light Dependent Resistor (LDR)** to detect the sun, or a **Thermistors** to monitor cabin temperature.
Programmable Components: Knowing how to use a microcontroller (like a Micro:bit) to write a simple code that controls an output based on a sensor reading.

4. Construction and Finishing Techniques
The practical knowledge of how to put things together so they don't fall apart during "launch."

Reinforcing Joints: Knowing how to use **triangulation**, gussets, or "L-shape" folds to make a chassis or rocket body stable.
Adhesives: Choosing the right "glue" for the job (e.g., knowing that a glue gun provides a fast, strong bond for structures, while masking tape is better for temporary prototyping).
Exploded Diagrams: Knowing how to draw a design so that someone else could build it, showing how the parts fit together.

Why Substantive Knowledge Matters in DT
1. It Eliminates Guesswork
If a pupil knows the **substantive** fact that **triangles are the strongest shape**, they won't build a wobbly square rover. They use engineering facts to make design decisions.

2. It Improves Safety and Quality
Knowing how to use a glue gun safely or how to strip a wire for a circuit ensures that the "doing" part of DT is both safe and professional.

3. It Bridges Theory and Practice
Substantive knowledge takes the Science (gravity, light) and turns it into a "buildable" reality. It proves that science isn't just a list of facts—it's a set of rules for building things.

The "Space Builder" Knowledge Check

Component	Function in a Space Project
Pivot	The point where a robotic arm rotates.
Gusset	A piece of material used to strengthen a corner joint.
LDR	A sensor that triggers a light when it gets dark.
Syringe	Used to create pneumatic pressure for landing gear.

Disciplinary Knowledge

In DT, **disciplinary knowledge** for the **'Space'** learning theme focuses on the functional logic and rigorous testing required for survival in extreme environments. It moves from "making things look like space" to "engineering things to work in space." Pupils learn to think like aerospace engineers, where every design choice is a matter of life or death (in simulation) and resources are finite.

1. Designing for Extreme User Needs
Disciplinary knowledge involves empathising with a user in an environment unlike Earth.

Environmental Constraints: Understanding how zero gravity, extreme temperature fluctuations, and lack of oxygen dictate design. Pupils must consider: *"How does an astronaut eat if their food floats away?"* or *"How do we handle waste in a sealed cabin?"*
Ergonomics in Space: Designing tools or interfaces that can be operated while wearing bulky pressurised gloves or in microgravity.
Psychological Design: Understanding that "well-being" is a design requirement—how can the interior of a space station be designed to prevent loneliness or sensory deprivation?

2. Structural Integrity and Mechanics
This involves the discipline of building structures that are both lightweight (to save fuel) and incredibly strong.

Material Science: Selecting materials based on properties like weight-to-strength ratio, thermal insulation, or radiation shielding. Pupils learn why we use **composites** or **reflective foils** rather than wood or heavy plastics.
Mechanism Selection: Choosing the right "moving parts" for a task. For example, using a **linkage** or **lever** to deploy a satellite dish or a **pulley system** to move heavy equipment in low gravity.
Pneumatics and Hydraulics: Exploring how air or liquid pressure can be used to move robotic arms or landing gear, mimicking the systems used in real lunar landers.

3. Systems and Control (Electronics)
In space, everything is controlled by systems. **Disciplinary knowledge** here focuses on the logic of automation.

Feedback Loops: Understanding that a design must respond to its environment. For example, a solar panel that "senses" the sun and rotates to follow it using a **light-dependent resistor (LDR)**.
Redundancy: Learning the engineering discipline of "Plan B"—designing systems that still work even if one component fails.
Monitoring: Using sensors to monitor "life support" (e.g., a moisture sensor for a space garden or a heat sensor for a cabin).

4. Iterative Testing and "Failure Analysis"
Space DT is defined by the rigorous testing of prototypes.

Destructive vs. Non-Destructive Testing: Pupils learn to test their designs to the point of failure (e.g., an egg-drop "Lander" challenge) to identify the weakest point.
The Design Loop: The discipline of **Evaluate → Improve →Retest**. In space engineering, the first version is never the final version.
Sustainability: Designing for a "Closed Loop" system where materials must be reused, repaired, or repurposed, reflecting the reality of life on the ISS.

Why Disciplinary Knowledge Matters in DT
1. It Shifts Focus to Functionality
It stops pupils from making "pretty" rockets that would actually fall apart. It teaches them that **Aesthetics** must follow **Function**, a core tenet of professional engineering.

2. It Teaches Resourcefulness
In space, you can't go to the shop for a spare part. This discipline encourages pupils to "hack" materials and find creative ways to solve problems with only the tools they have on hand.

3. It Prepares for Real-World STEM
By using sensors and mechanisms to solve space problems, pupils are practicing the exact skills used in modern industries like robotics, automotive design, and renewable energy.

4. It Values "Smart Failure"
In DT, a bridge collapsing or a rover stalling isn't a "fail"—it's **data**. This learning theme builds the resilience to look at a broken prototype and ask, *"Which specific part failed and why?"*

The "Space Engineer" Success Criteria

Engineering Skill	Disciplinary Application
Material Choice	I can explain why I chose foil to reflect heat away from my "Lander."
Mechanical Logic	I can use a linkage to make a "sampling arm" for my rover.
Systems Thinking	I can program a sensor to trigger an alarm if the "Cabin" gets too hot.
Critical Evaluation	I can identify the "weakest link" in my design after a test.

Learning Objectives

In DT, the **'Space'** learning theme provides a high-stakes environment for pupils to apply engineering principles. The **learning objectives** focus on the **Design, Make, and Evaluate** cycle, with a specific emphasis on **functionality** and **systems**—because in space, if a design doesn't work, the mission fails.

1. Research and Design Specification
Objective: *To identify and solve design problems in a specific environment, considering the needs, wants, and values of the user.*
The Focus: Empathising with an astronaut.
Key Skill: Annotation. Pupils must create design ideas for a "Lunar Base" or "Space Suit" and explain their choices. *"I used reflective foil here because it protects the user from solar radiation."*
Outcome: Pupils produce a design specification that lists exactly what their product must do to keep a human alive.

2. Structural Strength and Stability
Objective: *To understand how to strengthen, stiffen, and reinforce more complex structures.*
The Focus: Building for "Launch" and "Landing."
Key Skill: Triangulation. Pupils learn that triangles are more rigid than squares. They apply this when building the chassis of a Mars Rover or the legs of a Moon Lander to ensure they don't collapse on impact.

Outcome: Pupils can explain how they reinforced joints using gussets or L-shape folds to make their structure stable.

3. Mechanical Systems: Pneumatics and Linkages
Objective: *To understand and use mechanical systems in their products.*
The Focus: Creating movement for sampling or deployment.
Key Skill: Pneumatic Control. Using syringes and plastic tubing to move a "Rover Arm" or open a "Space Station Hatch." Pupils explore how air pressure can be used to transfer force across a distance.
Outcome: Pupils successfully integrate a moving part that performs a specific function, like a grabber for "Moon rocks."

4. Electrical Systems and Programming
Objective: *To understand and use electrical systems in their products (e.g., series circuits incorporating switches, bulbs, buzzers, and motors).*
The Focus: Life support and communication systems.
Key Skill: Monitoring. Using a microcontroller (like a Micro:bit) to create an "Oxygen Alarm." If a sensor (Input) detects a change, a buzzer (Output) sounds.
Outcome: Pupils build a functional circuit that responds to the environment, simulating a craft's internal computer system.

5. Iterative Testing and Evaluation
Objective: *To evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.*
The Focus: The "Mission Review."
Key Skill: Critical Analysis. Pupils test their "Egg-Lander" or "Rover" and record exactly where it failed. Did a wheel fall off? Did the circuit break?
Outcome: Pupils suggest specific improvements. They move from saying *"It broke"* to *"The mechanical link was too weak; next time I will use a double-pivot for strength."*

Why These Learning Objectives Matter
1. Function over Aesthetics
In Space DT, a "pretty" rocket is useless if it's too heavy to move. These **learning objectives** teach children that **good design is about solving problems**, not just making things look nice.

2. Resource Management
Space is an environment with zero "spares." These **learning objectives** encourage pupils to be sustainable—reusing materials and making sure their build is "right first time" because resources (like glue and cardboard) are limited.

3. Resilience and the "Failure Mindset"
Engineers rarely succeed on the first try. By focusing on **Evaluation and Improvement**, pupils learn that a broken prototype isn't a failure—it's a vital step in the scientific process of discovery.

The "Space Engineer" Progress Tracker

Skill	"Mission Ready" (Expected)	"Commander Level" (Exceeding)
Joining	Uses tape/glue to connect parts.	Uses gussets and triangles to reinforce joints.
Movement	Includes a simple moving part.	Uses pneumatics or linkages to create complex motion.
Logic	Includes a simple light circuit.	Uses a sensor and code to control an alarm.

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 DT themed around **'Space Exploration'**. This unit integrates core National Curriculum DT strands—**Structures & Mechanical Systems, Electrical Systems, Textiles, Food & Nutrition, and Product Design**—with real-world space engineering: pneumatic rover grabbers, motorised lunar buggies, wearable astronaut textiles, space station electrical circuits, and dehydrated astronaut nutrition. It balances **substantive knowledge** (pneumatics, mechanical advantage, gear ratios, series circuits, seam allowances, structural reinforcement, and nutrient preservation) with **disciplinary knowledge** ("Thinking & Acting Like an Engineer"—iterative design loops, functional testing, user-centred design criteria, material selection based on properties, and failure analysis).

Unit Title: Mission Engineering: Structures, Systems, Textiles, and Survival in Space
Duration: 6 Weeks (Approx. 1.5 hours per week)
Theme: Mars Rovers, Lunar Habitats, Astronaut Wearables, and Space Nutrition.
DT Focus Areas:
Mechanisms & Pneumatics: Syringe hydraulics/pneumatics, lever arms, pivot points, and mechanical advantage.
Electrical Systems: Series/parallel circuits, switches, solar panel cells, and DC motor gearboxes.
Structures & CAD: Triangulation, chassis reinforcement, axle joinery, and 3D housing design.
Textiles & Materials: Insulating layers, seam strength, fastening systems (Velcro/poppers), and protective suits.
Food & Nutrition: Freeze-drying principles, nutrient density, hygienic packaging, and meal planning for microgravity.
Key DT Pillars
Substantive Knowledge:
Mechanisms: How compressed air (pneumatics) converts pressure into mechanical movement via pistons; how gear ratios trade speed for torque in rover drive trains.
Structures & Electrical: How triangulation prevents structural shearing; how complete series/parallel circuits with switches power light and kinetic components.
Textiles & Food: Joining techniques (running stitch, backstitch) and seam allowances; understanding how moisture removal preserves food while retaining micro/macronutrients.

Disciplinary Knowledge ("Thinking Like an Engineer"):
User-Centred Design: Designing products against strict constraints (e.g., zero gravity, extreme thermal fluctuation, weight restrictions).
Iterative Prototyping: Testing mechanical links or electrical circuits under stress, identifying failure points, and modifying designs before final assembly.
Evaluative Testing: Measuring performance using quantifiable metrics (e.g., maximum load held, distance travelled per volt, thermal heat retention rate).

Weekly Progression Scheme
Week 1: Pneumatic Sample Collectors – Mechanisms & Fluid Power
DT Strand: Mechanical Systems (Pneumatics & Levers).
Substantive Knowledge:
LKS2: Simple pneumatic systems (air displacement through tubing); fixed vs. moving pivots; lever arms for linear-to-rotational motion.
UKS2: Dual-syringe mechanical advantage (changing syringe volume ratios to multiply force); 2-axis claw linkage systems.
Disciplinary Knowledge:
Iterative Testing: Testing pneumatic pressure limits and adjusting lever pivot distances to maximise claw grip strength.
Practical DT Task:
LKS2 (Y3/4): *Martian Soil Sampler.* Pupils assemble a single-piston pneumatic lever arm using plastic syringes, vinyl tubing, and card pivot points, testing its ability to lift a light rock sample.
UKS2 (Y5/6): *2-Axis Mechanical Rover Grabber.* Pupils design and construct a double-action pneumatic robotic claw with dual syringes (10ml →20ml ratio) to grip and lift irregular soil canisters.

Week 2: Motorised Lunar Rovers – Electrical Systems & Chassis Design
DT Strand: Electrical Systems & Structures.
Substantive Knowledge:
LKS2: Simple series circuits (battery, switch, motor); wheel and axle assemblies (fixed vs. free-spinning axles); chassis rigidity.
UKS2: Motor gearboxes (trading motor RPM for torque); drive belts vs. direct gears; incorporating solar panels or reverse-polarity switches for directional control.
Disciplinary Knowledge:
Failure Analysis: Diagnosing drive-train slipping, axle friction, or loose electrical contacts during test runs on rocky ramp terrains.
Practical DT Task:
LKS2 (Y3/4): *Battery-Powered Moon Buggy.* Pupils construct a rigid card-frame chassis with dowel axles and motor pulleys, wiring a simple circuit with a slide switch to drive across flat terrain.
UKS2 (Y5/6): *All-Terrain Motorised Rover.* Pupils engineer a high-torque chassis using motor gearboxes, building a double-pole double-throw (DPDT) switch to reverse direction and testing performance on incline ramps.

Week 3: Space Station Power & Alarm Systems – Advanced Electronics
DT Strand: Electrical Systems & Sensors.
Substantive Knowledge:
LKS2: Incorporating buzzers, LEDs, and pressure-plate switches into functional safety circuits.

UKS2: Parallel circuits (maintaining power to secondary components if one fails); reed switches (magnetic sensors) and light-dependent resistors (LDRs) in security monitoring.
Disciplinary Knowledge:
System Redundancy Design: Designing electrical layouts that maintain critical functions even when individual components are disconnected.
Practical DT Task:
LKS2 (Y3/4): *Airlock Hatch Safety Light.* Pupils design a circuit where closing a cardboard airlock door depresses a pressure switch, lighting a green safety LED inside a station wall model.
UKS2 (Y5/6): *Automated Space Station Intrusion/Damage Alarm.* Pupils wire a parallel system with a magnetic reed switch and buzzer that trips an emergency alarm whenever an external micrometeorite panel is detached.

Week 4: Astronaut Thermal Gloves & Suit Textiles – Materials & Joining
DT Strand: Textiles & Material Properties.
Substantive Knowledge:
LKS2: Measuring and cutting fabric accurately; basic hand stitching (running stitch, overcast stitch); functional fastenings (Velcro, press studs).
UKS2: Multi-layer thermal insulation (reflecting radiant heat vs. trapping air); pattern templates with seam allowances (1cm); backstitching for high-tension seams.
Disciplinary Knowledge:
Material Selection: Selecting textiles based on quantifiable testing (comparing felt, foil, bubble wrap, and fleece for thermal retention and flexibility).
Practical DT Task:
LKS2 (Y3/4): *Spacewalk Utility Wristband.* Pupils cut neoprene/felt fabric using a template, sewing a Velcro pocket designed to store small repair tools during simulated spacewalks.
UKS2 (Y5/6): *Multi-Layer Extravehicular Thermal Glove Patch.* Pupils design a 3-layer insulation patch (foil reflector, polyester wadding, nylon shell), constructing a backstitched seam sample and testing thermal retention over an ice block.

Week 5: Microgravity Space Nutrition – Food & Packaging Engineering
DT Strand: Food Technology, Nutrition & Hygienic Packaging.
Substantive Knowledge:
LKS2: Balanced nutrition for astronauts (high energy, vitamin stability); hygienic food handling; dehydration for shelf-life extension.
UKS2: Caloric density per gram constraints for space payload limits; modified atmosphere packaging principles; rehydration properties of freeze-dried/dehydrated food.
Disciplinary Knowledge:
Nutritional Optimisation: Designing an astronaut meal recipe that maximises nutritional value while adhering to zero-crumb and low-weight safety rules.
Practical DT Task:
LKS2 (Y3/4): *Dehydrated Space Fruit Packs.* Pupils select high-vitamin fruits, prepare thin uniform slices using safe bridge/claw knife grips, dehydrate them, and heat-seal them in vacuum pouches.
UKS2 (Y5/6): *Calorie-Dense Rehydratable Space Meal.* Pupils analyse macronutrient requirements for long-duration missions, formulation-testing a zero-crumb rehydratable oat, berry, and seed meal pack sealed in pouch packaging.

Week 6: Mission Design Review – Functional Testing & Evaluation
DT Strand: Evaluation, Product Testing & Synthesis.
Substantive Knowledge:
LKS2/UKS2 Synthesis: Evaluating completed prototypes against original design specifications; conducting rigorous stress, payload, and user-interface testing.
Disciplinary Knowledge:
Engineered Product Appraisal*:* Evaluating structural integrity, electrical reliability, and user ergonomic safety using standardised testing criteria.
Practical DT Task:
LKS2 & UKS2: *Space Systems Testing Fair.*
Task 1: Teams subject their rovers, suits, and food packs to the "Mars Simulation Rig" (incline driving, thermal drop test, and seal integrity check).
Task 2: Pupils complete a formal "Engineering Modification Report", identifying design flaws discovered during stress testing and detailing how they would modify the design for Production v2.0.
Plenary: Peer evaluation panel where teams pitch their engineered solutions to a "Mission Control Panel" of teachers/peers.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Assembles pneumatic tubing but struggles to secure leak-free connections. • Builds a simple circuit but needs help connecting motor drives to wheels. • Cuts textiles loosely without following pattern templates accurately. • Prepares food items without adhering consistently to safe hygiene practices.	• Connects pneumatic syringes and levers to achieve predictable movement. • Constructs a complete motor circuit and mounts axles cleanly to a chassis. • Measures, cuts, and joins fabric neatly using running stitch and Velcro fasteners. • Prepares and heat-seals dehydrated food safely using hygienic preparation routines.	• Modifies pneumatic mechanical advantage by altering pivot distances dynamically. • Troubleshoots electrical friction and gear alignment independently to improve speed. • Combines multiple textile materials to enhance product durability and function. • Evaluates caloric density and moisture content in space meal formulations systematically.
Upper Key Stage 2 *(Years 5 & 6)*	• Builds pneumatic claws with single syringes but struggles with dual-axis links. • Connects motors but cannot integrate DPDT reversing switches or gearboxes.	• Engineers dual-action pneumatic grippers using volume ratio advantage. • Integrates motor gearboxes and reversing switches into a high-torque rover chassis.	• Optimises pneumatic mechanical advantage using dual-piston volumetric calculations. • Designs dynamic parallel electrical systems with integrated sensor alarm triggers.

	• Sews basic seams but omits seam allowances, resulting in undersized textiles. • Follows recipes but struggles to evaluate nutritional metrics against payload limits.	• Constructs multi-layer insulating textiles with backstitched seams and precise allowances. • Formulates calorie-dense, rehydratable space food designed for microgravity safety.	• Conducts thermal retention experiments to justify multi-layer fabric selections. • Refines food formulations quantitatively to maximise nutrient-to-weight ratios for space flight.

Other Information, Ideas and Resources

In Design and Technology, **'Space'** is an ideal learning theme for moving pupils away from "junk modelling" toward **functional engineering**. These alternative lesson ideas focus on the mechanics of survival, the physics of landing, and the logic of automated systems.

1. The Egg-Lander Mission (Structures & Testing)
The Concept: Impact protection and structural integrity.
The Activity: Pupils must design and build a "Landing Module" that can protect a "Passenger" (a raw egg) from a high-altitude drop.
Engineering Focus: Triangulation. Pupils use straws or lolly sticks to build a frame. They must learn that triangles are more rigid than squares to prevent the structure from buckling.
Substantive Knowledge: Selecting materials for shock absorption (e.g., card springs, bubble wrap, or parachutes).

2. Pneumatic Moon-Crane (Mechanical Systems)
The Concept: Using air pressure to move heavy objects.
The Activity: Using syringes and plastic tubing, pupils build a mechanical arm for a Moon Base designed to lift "Lunar Rocks."
Engineering Focus: Pneumatics. One syringe acts as the "Input" and the other as the "Output." Pupils explore how trapped air can transfer force to create a powerful lifting or gripping motion.
Substantive Knowledge: Understanding how a **fixed pivot** and a **moving pivot** work together to create a linkage.

3. The "Solar-Tracking" Satellite (Electrical Systems)
The Concept: Monitoring environments using sensors.
The Activity: Using a Micro:bit and a small servo motor, pupils design a satellite dish that "finds" the sun.
Engineering Focus: Input/Output Systems. The Micro:bit uses its light sensor to detect where the brightest light is and tells the motor to rotate the dish toward it.
Substantive Knowledge: Understanding **Feedback Loops**—the system constantly checks the light level and adjusts itself to stay efficient.

4. Martian Greenhouse (Design for Survival)
The Concept: Thermal insulation and environmental control.
The Activity: Pupils are challenged to build a miniature greenhouse that can keep a seed warm in the "cold Martian climate."
Engineering Focus: Thermal Properties. Pupils test different materials (foil, cotton wool, corrugated card) to see which is the best insulator.

Substantive Knowledge: Creating an **Exploded Diagram** of their design to show the different layers of insulation required for life support.

5. Rover Wheel Prototypes (Evaluation & Iteration)
The Concept: Designing for specific terrains.
The Activity: Give pupils a "Mars" terrain (a tray of sand and jagged rocks). They must design and test three different wheel types (e.g., wide and smooth, thin and spiked, or "tracked").
Engineering Focus: Iterative Design. Pupils use a "Failure Log" to record how each wheel performs. They must evaluate which design has the most **friction** and **stability**.
Substantive Knowledge: Understanding that there is no "perfect" design, only the "best fit" for the environment.

Why These Lessons Matter in DT

Skill	Real-World Application
Pneumatics	Used in the landing gear and robotic arms of real space probes.
Insulation	Vital for spacesuits that must survive +120°C in sun and -150°C in shadow.
Triangulation	The reason rocket fairings and space stations don't collapse under pressure.
Evaluation	NASA engineers spend years testing "what could go wrong" before building the final version.

Considerations for Implementation

Geography

Substantive Knowledge

In Geography, **substantive knowledge** for the **'Space'** learning theme focuses on the Earth as a physical entity within the universe. It involves the "hard facts" about how our planet is mapped, how its movement creates global patterns, and how we use space-based technology to understand our own world.

1. The Earth's Grid and Position
Substantive knowledge includes the specific markers geographers use to organise the globe.

Lines of Latitude: Knowing that these horizontal lines (like the **Equator**, **Tropic of Cancer**, and **Tropic of Capricorn**) measure distance north or south of the Equator and define **climate zones**.

Lines of Longitude: Knowing that these vertical lines (including the **Prime/Greenwich Meridian**) measure distance east or west and are the basis for **Time Zones**.
The Hemispheres: Understanding the division of the Earth into Northern, Southern, Eastern, and Western halves.
The Arctic and Antarctic Circles: Identifying these as the polar regions and knowing their unique relationship with daylight (the Midnight Sun).

2. Global Patterns and Cycles
This is the factual link between the Earth's movement in space and the geography of our daily lives.

Day and Night: Knowing that the Earth's **rotation** on its axis causes the cycle of light and dark.
The Seasons: Understanding that the Earth's **tilt** (23.5°) as it orbits the Sun creates the seasons, and knowing that seasons are reversed in the Northern and Southern Hemispheres.
Time Zones: Knowing that because the Earth rotates 360° in 24 hours, the world is divided into 24 time zones, each representing one hour of the day.

3. Remote Sensing and Satellite Data
Substantive knowledge involves the "vocabulary" of modern geographical observation.

Satellite Imagery: Knowing that satellites take "top-down" photos of Earth to track environmental changes like deforestation, urban sprawl, or melting ice caps.
Digital Mapping (GIS): Understanding that tools like Google Earth or GPS rely on a network of satellites to provide real-time location data.
Physical vs. Human Features from Space: Being able to identify physical features (mountain ranges, oceans, deserts) versus human features (cities, highways, ports) in high-altitude imagery.

4. Human Geography: Space as a Territory
This covers how humans interact with the "place" of space.

International Borders in Space: Knowing that space is considered "international waters"—no single country owns the Moon or other planets (The Outer Space Treaty).
The "Space Race" History: Knowing the key geographical players (the USA and the USSR) and how their location on Earth influenced their launch sites (e.g., Florida's proximity to the Equator for extra "boost").
Resource Management: Knowing what humans need to establish a **settlement** (water, energy, shelter) and comparing Earth's resources to those available on the Moon or Mars.

Why This Knowledge Matters in Geography

Concept	Geographical Significance
Latitude	Explains why the tropics are hot and the poles are cold.
Time Zones	Explains why we can't call someone in Australia at 3 PM GMT without waking them up.

Satellites	Allows us to see the "Big Picture" of climate change that we can't see from the ground.
The Tilt	Is the reason our "summer" happens while Australia has "winter."

The "Space Geographer" Knowledge Check
True or False: The Equator is a line of Longitude. (False - it's Latitude).
Fact: The Earth is tilted at 23.5°.
Term: What do we call the line at 0° Longitude? (The Prime Meridian).
Concept: Why does the Sun rise in the East? (Because the Earth rotates toward the East).

Disciplinary Knowledge

In Geography, **disciplinary knowledge** for the **'Space'** learning theme involves understanding Earth's position as a planet within a physical system. It moves away from "looking up" at the stars and focuses on "looking down" or "looking across" to understand how planetary movements dictate human life, climate, and our map of the world. It is the study of **how the Earth works as a physical object** and how we use technology to observe it.

1. Map Skills and the Spherical Model
Disciplinary knowledge involves understanding how we represent a 3D sphere on a 2D map and the geographical markers we use to navigate it.
The Global Grid: Understanding that lines of **Latitude** and **Longitude** are not "real" lines on the ground, but a geographical tool used to locate any point on the planet.
The Equator and Hemispheres: Using the Earth's relationship with the Sun to understand why the Northern and Southern Hemispheres experience opposite seasons.
Time Zones: Understanding the **disciplinary** link between the Earth's **rotation** (Computing/Science) and the geographical concept of **Standard Time** (e.g., GMT). Why is it a different time in Australia?

2. Satellite Imagery and Remote Sensing
This is the study of "Geographical Information Systems" (GIS). It involves understanding how we use space technology to study the Earth's surface.

Aerial Perspective: Learning to interpret images taken from space. This involves recognising physical features (mountains, rivers, oceans) and human features (cities, deforestation, light pollution) from a vertical "bird's-eye" view.
Tracking Change: Understanding how geographers use satellite photos over time to observe environmental changes, such as the melting of polar ice caps or the growth of "megacities."
GPS Technology: Understanding that the "blue dot" on a phone map is a result of space-based geography—satellites measuring distance and location.

3. The Physical Geography of Earth vs. Other Planets
Disciplinary knowledge involves **comparative geography**—looking at Earth's features and comparing them to what we find elsewhere in the solar system.

Extreme Environments: Comparing Earth's deserts or volcanoes to the surface of Mars or Venus. Why is Earth "habitable" while others are not?

Planetary Landscapes: Understanding that the same physical processes we study on Earth (erosion, volcanism, tectonics) happen on other planets, but under different conditions (e.g., lower gravity or different atmospheres).
[Image comparing the topography of Earth's Grand Canyon with Valles Marineris on Mars]

4. The Human Impact: Space as a Resource
This branch of **disciplinary knowledge** looks at the "Human Geography" of space exploration.

The "Space Race" and Borders: Understanding how the quest for space was tied to international politics and the history of global superpowers.
Sustainability and Space Junk: Exploring the geographical impact of humans leaving the planet. Just as we have "pollution" on Earth, we now have "orbital debris" in the space around Earth.
Settlement and Colony: Using geographical knowledge of what a settlement needs (water, shelter, energy) to plan how humans might live on the Moon or Mars.

Why Disciplinary Knowledge Matters in Geography
1. It Explains the "Why" of Climate
Without understanding the Earth's tilt and orbit (Space), pupils cannot understand why we have different **Climate Zones** (Tropical, Arid, Polar). It connects the solar system to the weather outside their window.

2. It Modernises Map Skills
Traditional map reading is essential, but modern geographers use satellites. This learning theme teaches pupils how to use 21st -century tools like Google Earth to explore the planet.

3. It Builds Global Citizenship
Seeing the "Earthrise" (the famous photo of Earth from the Moon) helps pupils understand the "Small World" concept—that the Earth is a shared, fragile resource with no visible borders from space.

The "Geographer in Space" Success Criteria

Geographical Concept	Disciplinary Application
Locational Knowledge	Can I find the Arctic Circle and explain its relationship to the Sun?
Data Interpretation	Can I look at a satellite image and identify signs of human activity?
Cause and Effect	Can I explain how the Earth's rotation creates different time zones?
Place Comparison	Can I compare the "physical features" of an Earth desert to a Martian desert?

Learning Objectives

In Geography, the **'Space'** learning theme is less about the stars and more about **Earth's place in the universe**. The **learning objectives** focus on how the physical movements of our planet create the geographical patterns we experience every day, such as time, seasons, and climate zones.

1. Locational Knowledge: The Global Grid
Objective: *To identify the position and significance of latitude, longitude, the Equator, Northern and Southern Hemispheres, and the Tropics.*
The Focus: Using the "Space view" to map the Earth.
Key Skill: Navigation. Pupils learn to use coordinates to locate key space-related sites (like NASA in Florida or the Baikonur Cosmodrome in Kazakhstan). They understand that these lines are geographical tools for organising a spherical world.
Outcome: Pupils can explain why the Equator is 0° latitude and how the Tropics relate to the Sun's highest point in the sky.

2. Physical Geography: Cycles and Seasons
Objective: *To describe and understand the physical processes that cause day and night and the transition of the seasons.*
The Focus: Understanding the Earth as a moving object.
Key Skill: Scientific Geography. Pupils investigate how the 23.5° **tilt** of the Earth's axis causes the Northern and Southern Hemispheres to experience seasons at different times.
Outcome: Pupils can explain that "Summer" is not about being closer to the Sun, but about the angle of the Sun's rays hitting the Earth due to its tilt.

3. Human Geography: Time Zones and Global Links
Objective: *To identify the significance of the Prime/Greenwich Meridian and the use of time zones.*
The Focus: How Earth's rotation dictates human activity.
Key Skill: Calculation. Understanding that as the Earth rotates, different parts of the world face the Sun at different times. Pupils learn why the world is divided into 24 time zones.
Outcome: Pupils can calculate time differences between "Mission Control" in London (GMT) and various landing or launch sites across the globe.

4. Geographical Skills: Satellite Imagery and GIS
Objective: *To use satellite imagery to identify and observe physical and human features of the Earth.*
The Focus: Using space technology to "look back" at our planet.
Key Skill: Remote Sensing. Using digital tools like Google Earth to see how the Earth changes over time. Pupils might look at the receding of glaciers, the growth of cities, or the effects of natural disasters from a vertical perspective.
Outcome: Pupils can distinguish between "human" features (city lights, ports) and "physical" features (mountain ranges, river deltas) as seen from an orbital view.

5. Comparative Geography: Earth vs. Other Worlds
Objective: *To compare the physical features of Earth with those of other planets in the solar system.*
The Focus: Understanding what makes Earth a unique "place."

Key Skill: Comparison. Comparing the volcanic activity on Earth to that on Mars (Olympus Mons) or comparing Earth's atmosphere to the extreme conditions on Venus.
Outcome: Pupils can explain the geographical requirements for a "habitable" planet, such as liquid water and a protective atmosphere.

Why These Learning Objectives Matter
1. It Connects the "Big Picture" to the Local
It helps a child understand that the reason they need a coat in January is directly linked to the Earth's position in the solar system.

2. It Modernises Geography
By using satellite data, pupils learn that geography is no longer just about paper maps—it is a high-tech discipline that uses space-age data to solve Earth-bound problems like climate change.

3. It Builds Global Perspective
Seeing the "One World" view from space fosters a sense of global citizenship and environmental responsibility, showing that geographical issues (like pollution or deforestation) ignore national borders.

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 Geography themed around **'Earth from Space & Global Patterns'**. This unit connects core National Curriculum Geography strands—**Locational Knowledge, Place Knowledge, Physical Geography, and Geographical Skills & Fieldwork**—with astronomical and orbital perspectives: Earth's grid systems (Latitude/Longitude), Day/Night cycles, seasonal tilts, global climate biomes from orbit, satellite remote sensing, and human footprint analysis. It balances **substantive knowledge** (Lines of Latitude/Longitude, Equator, Tropics of Cancer/Capricorn, Prime Meridian, time zones, biomes, satellite spectral imagery, and global light pollution) with **disciplinary knowledge** ("Thinking & Acting Like a Geographer"—interpreting GIS satellite layers, calculating local solar times, analysing environmental changes over time, and questioning spatial scale and map projection distortions).

Unit Title: Earth from Orbit: Grid Systems, Climate Zones, and Remote Sensing
Duration: 6 Weeks (Approx. 1.5 hours per week)
Theme: Satellite Navigation, Global Time Zones, Orbital Biomes, and Earth Observation.
Geography Focus Areas:
Locational & Spatial Knowledge: Latitude, Longitude, Equator, Northern/Southern Hemispheres, Tropics, Arctic/Antarctic Circles, and Prime Meridian.
Physical Geography: Earth's axial tilt, day/night cycles, seasonal variations, global climate distribution, and biome patterns from space.
Human Geography & Environmental Impact: Urban light pollution, deforestation monitoring, ocean plastic tracking via satellites, and climate change patterns over time.
Geographical Skills & GIS: Satellite imagery interpretation, false-colour composite analysis, GIS layering (Google Earth/NASA Worldview), and time-zone calculations.

Key Geography Pillars
Substantive Knowledge:
Grid Systems & Time: How imaginary lines (Latitude and Longitude) pinpoint absolute spatial locations; how Earth's 15°hour rotation creates 24 global time zones around the Prime Meridian (0°).
Physical Systems: How Earth's spherical shape and 23.5° axial tilt dictate solar energy intensity, creating distinct equatorial, tropical, temperate, and polar biomes.

Remote Sensing & GIS: How satellites capture multispectral spatial data (visible, infrared, night-lights) to monitor physical processes and human footprints in real time.
Disciplinary Knowledge ("Thinking Like a Geographer"):
Spatial Scale & Projection Analysis: Understanding how observing Earth from space alters our perception of boundaries, scale, and geographic distortion compared to 2D flat maps.
Change Over Time (Temporal Analysis): Comparing historic vs. contemporary satellite imagery to evaluate land-use shifts, melting polar ice caps, or expanding urban centres.
Interconnection & Synthesis: Connecting orbital physical phenomena (solar radiation angles) directly to local human realities (agriculture, clothing, daily life across time zones).

Weekly Progression Scheme
Week 1: Mapping the Sphere – Latitude, Longitude & Global Grids
Geography Strand: Locational & Spatial Knowledge.
Substantive Knowledge:
LKS2: Identifying the Equator, Northern and Southern Hemispheres, North/South Poles; understanding lines of Latitude as horizontal ring measurements (0° → 90°N/S).
UKS2: Lines of Longitude (0° → 180°E/W); Prime/Greenwich Meridian (0°); Tropics of Cancer (23.5°N) and Capricorn (23.5°S); Arctic and Antarctic Circles.
Disciplinary Knowledge:
Coordinates & Spatial Precision: Explaining why 2D flat maps distort distance and shape near the poles compared to a 3D spherical globe view from space.
Practical Geography Task:
LKS2 (Y3/4): *The Inflatable Globe Grid.* Pupils use dry-wipe markers on inflatable globes to trace the Equator, labelling major oceans/continents relative to Northern and Southern Hemispheres.
UKS2 (Y5/6): *Astronaut Coordinate Tracking.* Pupils use global latitude/longitude coordinates to locate key spaceports (e.g., Baikonur 45.9°N, 63.3°E; Kennedy Space Center 28.5°N, 80.6°W) on globes and GIS digital maps.

Week 2: Day, Night & Global Time Zones – Earth's Rotation
Geography Strand: Physical Geography & Time Calculations.
Substantive Knowledge:
LKS2: Earth's anti-clockwise rotation on its axis every 24 hours creating day and night; sunrise in the East, sunset in the West.
UKS2: International Time Zones; Greenwich Mean Time (GMT/UTC); calculating time differences across global meridians (15°Longitude = 1Hour difference); International Date Line.
Disciplinary Knowledge:
Temporal Reasoning: Calculating live local times for international space stations and global ground control stations across different hemispheres.

Practical Geography Task:
LKS2 (Y3/4): *Day & Night Solar Lab.* Pupils use globes and focused light sources in a darkened room to demonstrate why it is midday in London while simultaneously midnight in Sydney.
UKS2 (Y5/6): *Mission Control World Clock.* Pupils create a time-zone converter wheel, calculating real-time delays for space communications between London (0°), Tokyo (+9hrs), Houston (-6hrs), and Auckland (+12hrs).

Week 3: Orbital Biomes – Solar Angles & Climate Distribution
Geography Strand: Physical Geography (Climate & Biomes).
Substantive Knowledge:
LKS2: Distribution of hot climate zones near the Equator and cold climate zones at the Poles; key physical biomes (Rainforest, Desert, Tundra).
UKS2: Earth's 23.5° axial tilt causing solar energy concentration variations; seasonal shifts in the Tropics vs. Polar regions (Midnight Sun / Polar Night); biome classification via orbital satellite imagery.
Disciplinary Knowledge:
Causation Analysis: Linking astronomical geometry (angle of solar incidence) directly to terrestrial vegetation patterns seen from orbit.
Practical Geography Task:
LKS2 (Y3/4): *Colouring Earth's Climate Belts.* Pupils map major global biomes onto a blank world projection, matching satellite imagery swatches (green rainforests, yellow deserts, white ice) to climate zones.
UKS2 (Y5/6): *Axial Tilt & Solar Angle Experiment.* Pupils measure solar beam spread on curved surfaces using graph paper and torches, analysing why direct equatorial sun delivers more heat per cm^2 than slanting polar sun.

Week 4: Earth at Night – Human Footprints & Light Pollution
Geography Strand: Human Geography & Environmental Impact.
Substantive Knowledge:
LKS2: Urbanisation signs from space (city clusters, transport networks); contrast between densely populated regions and uninhabited wildernesses.
UKS2: Analysis of NASA "Black Marble" night-light satellite datasets; energy consumption patterns; economic development indicators via spatial light density; light pollution impacts on astronomy.
Disciplinary Knowledge:
Pattern Recognition: Inferring human population settlement factors (coastal access, river valleys, natural resources) by analysing night-light satellite maps.
Practical Geography Task:
LKS2 (Y3/4): *Mapping Human Lights.* Pupils analyse night-time satellite photographs of Europe, identifying major capital cities by their bright light nodes and comparing them with daytime terrain maps.
UKS2 (Y5/6): *The Black Marble Investigation.* Pupils compare composite night-light maps of different continents (e.g., East Asia vs. Central Africa), evaluating relationships between energy access, population density, and dark sky reserves.

Week 5: Satellite Remote Sensing – Monitoring Earth's Changes
Geography Strand: Geographical Skills, GIS & Environmental Change.
Substantive Knowledge:
LKS2: How Earth observation satellites take photos from space; tracking natural hazards (hurricanes, volcanic ash plumes, wildfire smoke) in real time.
UKS2: Multispectral satellite imaging (false-colour infrared to highlight healthy vegetation vs. dry soil); GIS data layering; measuring environmental change over decades (deforestation, glacier retreat, reservoir shrinkage).
Disciplinary Knowledge:
GIS Interrogation: Layering digital maps to test geographical hypotheses about environmental destruction and human intervention.

Practical Geography Task:
LKS2 (Y3/4): *Eye in the Sky Hazard Tracking.* Pupils order a chronological series of satellite images depicting a hurricane approaching a coast, mapping its path and identifying vulnerable coastal settlements.
UKS2 (Y5/6): *Decade Time-Lapse GIS Study.* Pupils use tools like Google Earth Engine or NASA Worldview to measure the area loss of the Aral Sea or Amazon rainforest over 30 years, creating comparative land-use charts.

Week 6: The Planetary Expedition – Synthesis & Micro-Fieldwork
Geography Strand: Fieldwork, Synthesis & Spatial Presentation.
Substantive Knowledge:
LKS2/UKS2 Synthesis: Integrating spatial coordinates, climate data, satellite remote sensing, and human footprint analysis to present a comprehensive "Earth Audit" report.
Disciplinary Knowledge:
Geographical Inquiry: Formulating geographical questions, presenting complex spatial data accurately, and proposing sustainable environmental management strategies.
Practical Geography Task:
LKS2 & UKS2: *The Astronaut Geographical Mission.*
Task 1 (Micro-Fieldwork): Pupils perform a school-grounds spatial survey using hand-held compasses and GPS units/tablet apps to record school coordinates (Latitude/Longitude), land cover, and micro-climate temperatures.
Task 2: Pupils synthesise local fieldwork data with satellite views of their school town, producing an "Orbital Geographic Dossier" presenting local-to-global spatial linkages.
Plenary: "Planetary Defence & Stewardship Conference" where pupil groups present findings on how space-based geography helps protect Earth's future resources.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Identifies the Equator but struggles to distinguish Northern and Southern Hemispheres. • Explains day and night simply without referencing Earth's axial rotation. • Identifies basic hot and cold areas on a globe without naming biomes. • Locates major landmasses on satellite images with frequent guidance.	• Locates the Equator, Poles, and lines of Latitude accurately on globes and maps. • Explains how Earth's rotation produces 24-hour day/night cycles. • Matches major global biomes (rainforests, deserts, tundra) to their climate zones. • Uses satellite photos to identify major human and physical geography features.	• Explains how 2D map projections distort land sizes compared to 3D orbital globes. • Connects solar angles directly to local daily temperature changes in different hemispheres. • Evaluates how human activity alters natural biomes visible from space. • Interprets complex satellite imagery to deduce weather patterns and terrain features.

Upper Key Stage 2 *(Years 5 & 6)*	• Locates Prime Meridian but struggles to calculate time-zone differences. • Describes seasons but omits the role of Earth's 23.5° axial tilt. • Identifies urban light clusters on night-light maps but struggles to explain why. • Reads satellite images as simple photos without understanding GIS layers.	• Uses Latitude and Longitude coordinates (Degrees N/S/E/W) and calculates time-zone shifts. • Explains how Earth's axial tilt causes seasonal variations and polar solar phenomena. • Analyses night-light datasets to infer population density and economic energy use. • Uses GIS remote sensing tools to measure and evaluate environmental land-use change over time.	• Calculates precise solar time differences based on 15° longitude intervals mathematically. • Models solar irradiance concentration (W/m^2) across varying latitudes analytically. • Synthesises socio-economic data with satellite light patterns to identify global inequality. • Critically evaluates multispectral GIS false-colour layers to diagnose forest health and water depletion.

Other Information, Ideas and Resources

In Geography, the **'Space'** learning theme is best used to help pupils understand Earth as a physical object and a global system. These lessons move away from "looking up" at stars and instead use the perspective of space to "look down" at our planet.

1. The Time Zone Challenge (Human Geography)
The Concept: Earth's rotation and its impact on global time.
The Activity: Set up a "Mission Control" scenario. Pupils are given a list of international launch sites (e.g., Cape Canaveral, USA; Baikonur, Kazakhstan; Tanegashima, Japan).
The Task: If the rocket launches at 12:00 PM GMT in London, what time is it at the other sites? Pupils must use a time zone map to calculate the difference.
Substantive Knowledge: Understanding that the Earth rotates 360° every 24 hours, meaning it turns 15° every hour.
2. Satellite Detectives (Geographical Skills)
The Concept: Remote sensing and identifying physical vs. human features.
The Activity: Use Google Earth or high-resolution satellite printouts of different locations around the world (The Amazon Rainforest, New York City, The Nile Delta).
The Task: Pupils must act as "Satellite Analysts" to identify features from a vertical perspective. Can they spot a river? A bridge? Evidence of deforestation?
Substantive Knowledge: Distinguishing between **Physical Geography** (natural features) and **Human Geography** (man-made features) from an orbital view.

3. The Tilt and the Seasons (Physical Geography)
The Concept: Earth's axis and its effect on climate and day length.
The Activity: Using a globe and a powerful torch (the Sun) in a darkened room, demonstrate the Earth's 23.5° tilt.
The Task: Move the globe around the "Sun." Pupils observe which hemisphere is leaning *toward* the light at different points in the orbit.

Substantive Knowledge: Understanding that the tilt causes the seasons, and exploring the concept of the **Midnight Sun** in the Arctic Circle.
[Image showing Earth's axial tilt and its orbit around the Sun to explain the seasons]

4. Mapping the "Final Frontier" (Locational Knowledge)
The Concept: Latitude, Longitude, and the Equator.
The Activity: Pupils are given coordinates (Latitude and Longitude) for famous geographical landmarks and space-related sites.
The Task: They must plot these on a world map. Include the Equator and the Tropics.
The Discussion: Why are most rocket launch sites located close to the **Equator**? (Answer: The Earth spins fastest at the Equator, giving rockets an extra "boost" into orbit).

5. Planning a Mars Colony (Comparative Geography)
The Concept: Settlement requirements and resource management.
The Activity: Compare the physical geography of Earth with Mars. What does a "settlement" need to survive?
The Task: Pupils must design a colony on a map of Mars (using real topographical data from NASA's Curiosity rover). They must decide where to place their base based on access to potential frozen water (poles) or shelter (craters).
Substantive Knowledge: Identifying the essential geographical features needed for human life: water, energy, and shelter.

Why These Lessons Matter in Geography

Skill	Real-World Application
Grid References	Essential for GPS navigation and search-and-rescue missions.
GIS Skills	Used by scientists to track climate change and urban growth from space.
Time Calculation	Vital for international trade, travel, and global communication.
Place Comparison	Helps pupils value Earth's unique "habitable" geography.

Considerations for Implementation

History

Substantive Knowledge

In History, **substantive knowledge** for the **'Space'** learning theme involves the factual "content" of human exploration—the key names, dates, events, and shifts in human understanding of the universe. It is the narrative of how we moved from observing the stars from the ground to walking on the Moon.

1. Ancient Civilisations and Early Astronomy

Substantive knowledge begins with how the earliest humans understood the night sky.

Early Models: Knowing that ancient civilisations (like the Greeks and Egyptians) initially believed in the **Geocentric model** (that the Earth was the centre of the universe).
Stonehenge and Monuments: Understanding that ancient structures were often built as "astronomical calendars" to track the movement of the Sun and stars for farming and religious reasons.
The Islamic Golden Age: Knowing that medieval Islamic scholars made massive leaps in star mapping and invented tools like the **astrolabe** to navigate the Earth using the stars.

2. The Scientific Revolution (Renaissance)
This is the knowledge of the "Turning Point" in human history when our view of space changed forever.

Nicolaus Copernicus: The fact that he proposed the **Heliocentric model** (the Sun is at the centre).
Galileo Galilei: Knowing he was the first to use a telescope to prove Copernicus was right by observing the moons of Jupiter and the phases of Venus.
Isaac Newton: Understanding his "discovery" of gravity and how it explained why planets stay in orbit.

3. The Cold War and the "Space Race"
This is the modern history of the mid-20th century (1950s–1970s).

Sputnik 1 (1957): The fact that the Soviet Union launched the first man-made satellite into orbit, starting the "Space Race."
Yuri Gagarin (1961): Knowing he was the first human to travel into space.
Apollo 11 (1969): The details of the first Moon landing, including the names of **Neil Armstrong, Buzz Aldrin, and Michael Collins**.
The "Hidden Figures": Knowing about the crucial, often overlooked roles of women and people of colour, like **Katherine Johnson**, whose mathematical calculations made the missions possible.
4. Technological Continuity and Change
Understanding how the tools of history have evolved.

The Space Shuttle Era: Knowing that the 1980s saw the development of reusable spacecraft.
The International Space Station (ISS): Understanding how former rivals (the USA and Russia) began to cooperate in space during the 1990s.
Modern Exploration: Knowledge of Mars Rovers (Curiosity, Perseverance) and the James Webb Space Telescope as the current chapter of our history.

Why Substantive Knowledge Matters in History

Historical Fact	Significance
Heliocentric Theory	Shifted humanity's place from "centre of everything" to "one of many planets."
The Cold War	Explains why countries spent billions of dollars on space travel in such a short time.

Propaganda	Understanding that the Moon landing was a "victory" for one political system over another.
Spin-offs	Knowing that space history created the technology we use today (phones, GPS, laptops).

The "Space History" Knowledge Check
Name: Who was the first person in space? (Yuri Gagarin).
Date: In what year did humans first walk on the moon? (1969).
Concept: What does "Heliocentric" mean? (Sun-centred).
Event: Which country launched the first satellite, Sputnik? (The Soviet Union/USSR).

Disciplinary Knowledge

In History, **disciplinary knowledge** for the **'Space'** learning theme is about how we know what we know about the past. It moves away from just memorising the date of the Moon landing and focuses on how historians and archaeologists use evidence to construct an account of human exploration. It involves the "skills of the historian": analysing sources, understanding cause and effect, and recognising how interpretations of space have changed over time.

1. Evidence and Historical Enquiry
Disciplinary knowledge involves understanding the difference between **primary** and **secondary** sources in the context of the "Space Race."

Analysing Artefacts: How do historians use physical objects (like Neil Armstrong's spacesuit or the Rosetta Stone) to understand the technology and values of a specific time?
Oral History and Testimony: Understanding the importance of first-hand accounts, such as interviews with "Hidden Figures" (the mathematicians like Katherine Johnson) or the astronauts themselves.
Evaluating Reliability: Historians ask: *Is this NASA press release from 1969 a factual record, or was it also a piece of "propaganda" to show the world that the USA was winning the Cold War?*

2. Cause and Consequence
This is the study of *why* things happened and what changed as a result.

The Cold War Context: Understanding that the Space Race didn't happen in a vacuum. **Disciplinary knowledge** involves linking the "consequence" (landing on the Moon) to the "cause" (political tension between the USA and the USSR).
Technological Spinoffs: Exploring how the drive for space exploration resulted in consequences for everyday life on Earth (e.g., the development of scratch-resistant lenses, GPS, and water purification).

3. Change and Continuity
Disciplinary knowledge involves looking at how human understanding of space has evolved, but also what has stayed the same.

Shifting Worldviews: Comparing the **Geocentric model** (Earth at the centre) of the ancient Greeks to the **Heliocentric model** (Sun at the centre) of the Renaissance.

The Evolution of Technology: Tracking the change from ancient stone observatories (like Stonehenge) to the James Webb Space Telescope. What stayed the same? (The human desire to map the stars).

4. Historical Interpretations
This is the understanding that the "story" of space history can be told in different ways depending on who is telling it.

Perspective: How does the history of the Space Race look from a Soviet perspective versus an American one?
Diversity in History: Recognising that for a long time, space history focused on "Great Men." The **disciplinary** shift now includes the vital roles of women, people of colour, and international collaborators whose stories were previously marginalised.
Significant Individuals: Evaluating why certain people are remembered (like Yuri Gagarin) while others are forgotten, and how we decide who is "historically significant."

Why Disciplinary Knowledge Matters in History
1. It Encourages Critical Thinking
By looking at the 1960s Moon landing, pupils don't just "believe" what they see; they learn to ask, *"Who took this photo? Why was it shared? What was happening in the world at that moment?"*

2. It Connects Science to Society
It teaches pupils that "Discovery" is rarely just about a lone genius in a lab; it is a result of the social, political, and economic pressures of the time.

3. It Builds Empathy
Understanding the risks taken by early pioneers or the struggles of those who were ignored due to their race or gender helps pupils develop a more nuanced and empathetic view of human progress.

The "Space Historian" Success Criteria

Historical Skill	Disciplinary Application
Source Analysis	Can I identify if a newspaper from 1961 is a primary or secondary source?
Causality	Can I explain how the "Cold War" acted as a catalyst for the Moon landing?
Significance	Can I explain why the launch of Sputnik 1 changed the world forever?
Interpretation	Can I find two different viewpoints on whether the Space Race was a "waste of money"?

Learning Objectives

In History, the **'Space'** learning theme allows pupils to move from simply knowing "facts" to understanding how human knowledge has evolved and how political rivalry can drive rapid technological change. The **learning objectives** focus on **chronology**, **source analysis**, and **significance**.

1. Chronology: The Journey of Discovery
Objective: *To build a chronological narrative of human understanding of space, from ancient observations to modern exploration.*
The Focus: Placing key events on a timeline to see the "long view" of history.
Key Skill: Periodisation. Understanding that space history isn't just the 1960s; it includes the Scientific Revolution (Copernicus, Galileo) and ancient monument building (Stonehenge).
Outcome: Pupils can explain the transition from the **Geocentric** (Earth-centred) to the **Heliocentric** (Sun-centred) model and identify where the "Space Race" fits in the 20th century.

2. Source Analysis: Evidence of the Space Race
Objective: *To understand how our knowledge of the past is constructed from a range of primary and secondary sources.*
The Focus: Thinking like a detective.
Key Skill: Evaluating Reliability. Pupils look at 1960s newspaper headlines, TV footage of the Moon landing, and NASA memos. They ask: *Is this a factual report, or is it trying to make one country look better than another?*
Outcome: Pupils can distinguish between a **primary source** (a diary entry from an Apollo engineer) and a **secondary source** (a history textbook written in 2024).

3. Cause and Consequence: The Cold War Context
Objective: *To identify the causes of the "Space Race" and analyse its consequences for modern society.*
The Focus: Understanding the "Why?"
Key Skill: Causality. Recognising that the Moon landing was driven by the political tension between the USA and the USSR (the Cold War).
Outcome: Pupils can explain how competition led to rapid inventions (the consequence) that we still use today, such as satellite communication and GPS.

4. Historical Interpretations: Diverse Perspectives
Objective: *To recognise that the past is represented and interpreted in different ways.*
The Focus: Looking beyond the "famous few."
Key Skill: Perspective. Moving from the "Great Men" narrative to include the "Hidden Figures"—the women and people of colour (like Katherine Johnson or Margaret Hamilton) whose contributions were often left out of early history books.
Outcome: Pupils can discuss why certain people's stories are remembered more than others and how historical accounts can change over time.

5. Significance: Impact on the World
Objective: *To evaluate the historical significance of individuals and events in space exploration.*
The Focus: Deciding what "matters" most.
Key Skill: Judging Significance. Using criteria (e.g., *How many people did it affect? How long did the impact last?*) to debate which was more significant: the launch of **Sputnik 1** or the **Apollo 11** Moon landing.
Outcome: Pupils can argue a case for why a specific event is considered a "turning point" in human history.

Why These Learning Objectives Matter in History

Skill	Educational Benefit
Evidence	Teaches pupils to be sceptical of "fake news" by checking sources.
Empathy	Helps pupils understand the immense bravery and social struggles of early pioneers.
Context	Shows that science doesn't happen in a bubble; it is shaped by the world around it.
Continuity	Connects the ancient human desire to "know the stars" with our modern life.

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 History themed around **'The History of Space Exploration'**. This unit connects core National Curriculum History strands—**Chronology, Cause & Consequence, Historical Significance, Continuity & Change, and Historical Sources & Interpretations**—with humanity's journey beyond Earth: ancient stargazing civilisations, the invention of the telescope, the Cold War Space Race, moon landings, hidden figures in computing, and international cooperation on the ISS. It balances **substantive knowledge** (ancient astronomy, geocentric vs. heliocentric models, the Cold War geopolitical climate, Sputnik, Apollo missions, microgravity computing, and modern space station treaties) with **disciplinary knowledge** ("Thinking & Acting Like a Historian"—analysing primary source propaganda posters, evaluating historical significance using criteria like the **GREAT** model, interrogating source reliability, and understanding how historical narratives change over time as new voices are included).

Unit Title: Beyond Earth: The Race, Rivalry, and Realities of Space Exploration
Duration: 6 Weeks (Approx. 1.5 hours per week)
Theme: Stargazers, The Space Race, Moon Landings, Hidden Figures, and Space Cooperation.
History Focus Areas:
Chronological Understanding: Timeline construction from ancient Mayan/Greek astronomy through 20th-century geopolitical conflicts to modern deep-space missions.
Historical Enquiry & Sources*:* Critical evaluation of primary sources (propaganda posters, speeches, news footage, diary entries, technical logbooks).
Cause & Consequence: Understanding how political rivalry (The Cold War) accelerated technological innovation at breakneck speed.
Historical Significance & Interpretations: Assessing who gets remembered in history (e.g., Armstrong vs. Katherine Johnson, Margaret Hamilton, and Yuri Gagarin).
Key History Pillars
Substantive Knowledge:
Early Astronomy: Shift from geocentric (Earth-centred) to heliocentric (Sun-centred) models driven by Copernicus, Galileo, and early observation tools.

The Cold War Context: Post-WWII tensions between the USA and USSR; how space became a peaceful battleground for ideological dominance.
Milestones of Exploration: Sputnik (1957), Yuri Gagarin (1961), Apollo 11 (1969), Mir, and the International Space Station (1998–present).
Disciplinary Knowledge ("Thinking Like a Historian"):
Historical Interpretations: Analysing how space achievements were presented differently by American vs. Soviet media propaganda.
Significance Evaluation: Applying significance frameworks (**G**round-breaking, **R**emembered, **E**ffect on the future, **A**ffected many, **T**errific/terrifying) to historical figures.
Reconstructing Hidden Narratives: Examining why marginalised groups (such as female African American mathematicians) were omitted from early mainstream historical records and how historians uncover their contributions today.

Weekly Progression Scheme
Week 1: Ancient Stargazers to Galileo – The Shift in Cosmic Thinking
History Strand: Chronology, Historical Interpretations & Scientific Change.
Substantive Knowledge:
LKS2: Ancient Civilisations (Mayans, Egyptians, Greeks) mapping stars; Aristotle's geocentric model (Earth at the centre).
UKS2: Copernicus and Galileo Galilei developing the heliocentric model (Sun at the centre); the invention of the telescope (1609); religious and societal resistance to new scientific evidence.
Disciplinary Knowledge:
Evidence & Change: Analysing how technological tools (telescopes) challenge long-held societal beliefs and alter historical consensus over time.
Practical History Task:
LKS2 (Y3/4): *Ancient Observatory Mystery.* Pupils examine images of Stonehenge and Mayan pyramids, analysing how early societies used stone structures as astronomical calendars.
UKS2 (Y5/6): *Galileo on Trial.* Pupils role-play Galileo's trial before the Inquisition, using primary letter extracts to argue whether scientific observation or traditional doctrine should dictate historical truth.

Week 2: The Cold War Space Race – Propaganda & Rivalry
History Strand: Cause & Consequence, Historical Sources.
Substantive Knowledge:
LKS2: The launch of Sputnik 1 (1957) and Laika the space dog; Yuri Gagarin becoming the first human in space (1961); the initial Soviet dominance in space.
UKS2: Geopolitical context of the Cold War (USA vs. USSR rivalry); President JFK's 1962 "We choose to go to the Moon" speech; space exploration as a peaceful substitute for nuclear war.
Disciplinary Knowledge:
Source Bias & Propaganda: Comparing Soviet newspaper articles (*Pravda*) with American news broadcasts to evaluate how national bias shaped space race reporting.
Practical History Task:

LKS2 (Y3/4): *Space Race Timeline Cards.* Pupils construct a giant chronological timeline from 1957 to 1969, categorising milestones under USA or USSR flags.
UKS2 (Y5/6): *Propaganda Poster Analysis.* Pupils analyse Soviet and American propaganda posters, identifying visual symbolism, loaded language, and underlying ideological goals.

Week 3: Apollo 11 – "One Giant Leap" & Primary Sources
History Strand: Historical Significance, Eyewitness Sources & Artefacts.
Substantive Knowledge:
LKS2: The Apollo 11 mission (July 1969); Neil Armstrong, Buzz Aldrin, and Michael Collins; key mission phases (launch, landing, moonwalk, return).
UKS2: Technical risks of the Lunar Module landing; global television broadcasting impact (600 million viewers); the scientific and symbolic payload brought back (moon rocks, plaques).
Disciplinary Knowledge:
Evaluating Reliability: Cross-referencing astronaut diary entries, official flight logs, and 1969 newspaper headlines to construct an accurate historical account of the landing.
Practical History Task:
LKS2 (Y3/4): *Astronaut Eyewitness Accounts.* Pupils read simplified diary extracts from Buzz Aldrin, writing a first-person newspaper report on the feeling of stepping onto the lunar surface.
UKS2 (Y5/6): *The "In Event of Moon Disaster" Inquiry.* Pupils analyse President Nixon's secret prepared speech (written in case the astronauts were stranded), discussing how historians use contingency documents to understand risk.

Week 4: Hidden Figures – Uncovering Hidden History
History Strand: Diversity in History, Historical Interpretations & Representation.
Substantive Knowledge:
LKS2: The vital roles of mathematicians and computer programmers in space missions; Margaret Hamilton (lead Apollo software engineer).
UKS2: The "Human Computers" of NASA—Katherine Johnson, Dorothy Vaughan, and Mary Jackson; navigating racial segregation (Jim Crow laws) and gender discrimination while computing launch trajectories for John Glenn and Apollo 11.
Disciplinary Knowledge:
Historiography (Why Stories Get Left Out): Investigating why certain historical figures are celebrated immediately while others take decades to be recognised in mainstream historical narratives.
Practical History Task:
LKS2 (Y3/4): *Margaret Hamilton's Code Tower.* Pupils measure the famous photograph of Margaret Hamilton standing next to her stacked code printouts, writing a biographical profile on her contribution to Apollo 11.
UKS2 (Y5/6): *Restoring the Historical Record.* Pupils analyse historical NASA photos from the 1960s vs. modern accounts, producing a museum exhibit label highlighting the contributions of West Computing's female African American mathematicians.

Week 5: From Rivalry to Cooperation – Mir & The International Space Station
History Strand: Continuity & Change, Modern International Treaties.
Substantive Knowledge:
LKS2: The end of the Space Race; Apollo-Soyuz handshake in space (1975); the construction of long-term space stations (Mir, ISS).

UKS2: The 1967 Outer Space Treaty (space as a global commons, banning weapons in orbit); building the International Space Station (15 nations collaborating); Helen Sharman (first British astronaut, 1991) and Tim Peake (2015).
Disciplinary Knowledge:
Continuity vs. Change: Contrasting the fierce international secrecy of the 1950s/60s with the peaceful multinational collaboration of the late 20th and 21st centuries.
Practical History Task:
LKS2 (Y3/4): *The Space Handshake.* Pupils study photos of the 1975 Apollo-Soyuz docking, creating a drama freeze-frame depicting the shift from enemies to partners in space.
UKS2 (Y5/6): *Drafting the Outer Space Treaty.* Pupils examine clauses from the 1967 Outer Space Treaty, debating whether space should belong to individual nations, private corporations, or humanity as a whole.

Week 6: The Space History Museum – Curation & Unit Synthesis
History Strand: Historical Synthesis, Significance & Curation.
Substantive Knowledge:
LKS2/UKS2 Synthesis: Synthesising knowledge from ancient stargazers, Cold War rocketry, Apollo landings, hidden mathematicians, and ISS international treaties.
Disciplinary Knowledge:
Historical Significance Frameworks: Selecting historical artefacts and figures based on objective significance criteria (**GREAT** model) to curate a balanced museum display.
Practical History Task:
LKS2 & UKS2: *The Museum of Cosmic History.*
Task 1: Pupil groups curate a museum gallery station (e.g., ***Station 1:*** *Ancient Skywatchers*, ***Station 2:*** *The Cold War Battle*, ***Station 3:*** *The Code & Calculations*, ***Station 4:*** *Living Together in Orbit*).
Task 2: Pupils write formal museum artefact labels, justifying why each item/person was historically significant using disciplinary historical language.
Plenary: "Curator's Guided Tour" where pupils present their gallery displays to visiting parents or peer classes, answering historical questions using source evidence.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Places space events on a timeline with frequent chronological gaps. • Identifies Neil Armstrong but struggles to name other key space figures. • Reads historical accounts as simple facts without	• Orders key space events accurately on a timeline spanning ancient times to 1969. • Explains the roles of diverse figures (e.g., Gagarin, Armstrong, Margaret Hamilton).	• Explains how technology changed stargazing from ancient stone circles to early telescopes. • Evaluates how different people experienced the Space Race at the time.

	recognising source differences. • Describes the moon landing without explaining why it was historically significant.	• Uses primary source photos and quotes to gather information about past events. • Explains why the 1969 moon landing was a significant historical milestone.	• Identifies bias in simple historical pictures or news stories from the 1960s. • Uses historical terms (*chronology, milestone, eyewitness, source*) effortlessly in writing.
Upper Key Stage 2 *(Years 5 & 6)*	• Builds timelines but struggles to link space developments to Cold War politics. • Identifies Katherine Johnson but struggles to explain why her story was hidden. • Reads primary propaganda sources without identifying national bias or tone. • Explains historical significance using personal opinions rather than structured criteria.	• Analyses how political conflict (The Cold War) accelerated technological innovation. • Evaluates why historical narratives change as previously excluded figures are recognised. • Compares Soviet and American primary sources to identify bias, motive, and audience. • Applies significance criteria (**GREAT** model) to justify the impact of historical space events.	• Synthesises socio-political Cold War factors to explain the sudden shift toward the 1967 Outer Space Treaty. • Critically evaluates how media censorship influenced public perception of space disasters. • Deconstructs historiographical reasons why female/minority achievements were omitted from early accounts. • Formulates sophisticated historical arguments supported by cross-referenced primary and secondary sources.

Other Information, Ideas and Resources

Example Inquiry:
To help pupils step into the shoes of a historian, this enquiry focuses on the "Hidden Figures"—the mathematicians and engineers whose contributions were essential but often overlooked in the 1960s.

Lesson Title: The Scientists Behind the Suit
Key Question: Why are some people remembered in history while others are "hidden"?

1. The Starter: The "Famous Face" Test
Show three photos: **Neil Armstrong**, **Buzz Aldrin**, and **Katherine Johnson**.
Ask the class: *Who do you recognise? Why do you think you know the men but perhaps not the woman?*
Historical Concept: Significance. Discuss how "fame" in history is often influenced by the media and the prejudices of the time (gender and race).

2. The Enquiry: Primary Source Detective
Divide the class into small groups and provide "Evidence Packs" containing:
The Photograph: A photo of Katherine Johnson at her desk at NASA.
The Quote: John Glenn (Astronaut) saying: *"If she says they're good, then I'm ready to go,"* referring to her manual calculations for his orbit.
The Document: A copy of a complex mathematical trajectory sheet from the 1960s.
The Task: Pupils must fill in a "Detective Log" answering:
What is this person doing?
What tools are they using? (Pencils, paper—not electronic computers!)
Why was their job vital to the mission's success?

3. The Development: Continuity and Change
Discussion: In 1962, many computers were humans (mostly women) called "Calculators."
Compare a 1960s NASA office to a modern-day Mission Control.
Historical Concept: Change. How has the way we do science changed? How has the way we treat different groups of people changed since the 1960s?

4. The Plenary: Rewriting the Narrative
Task: Pupils write a 100-word "Hall of Fame" entry for Katherine Johnson, Dorothy Vaughan, or Mary Jackson.
Constraint: They must include *why* their work was a "turning point" for the Apollo missions.

🛠 **Resources for your Evidence Pack**

Source Type	Description for Pupils
Primary (Photo)	Katherine Johnson at NASA. Note the lack of a computer screen!
Primary (Audio/Quote)	Astronaut John Glenn's request for "the girl" to check the numbers.
Secondary (Text)	A short biography of the "West Area Computing" unit at Langley.

The "Big Picture"
This lesson addresses **Disciplinary Knowledge** by showing that history isn't just a list of names; it's an ongoing process of uncovering the truth. It challenges the "Great Man" theory of history and introduces the concept of **institutional prejudice** in a way that is accessible for Key Stage 2.

Considerations for Implementation

Modern Foreign Languages

Substantive Knowledge

In MFL, **substantive knowledge** for the **'Space'** learning theme consists of the specific vocabulary, grammatical structures, and cultural facts required to communicate about the solar system in a new language. It is the "building blocks" of the language—the words and rules that allow a pupil to describe a planet's appearance or an astronaut's mission.

1. Core Vocabulary: The Solar System
Substantive knowledge starts with the nouns used to label the universe.

The Planets: Learning the names of the eight planets in the target language (e.g., in French: *Mercure, Vénus, Terre, Mars, Jupiter, Saturne, Uranus, Neptune*).
Celestial Bodies: Words for *le soleil* (the sun), *la lune* (the moon), *une étoile* (a star), and *une planète* (a planet).
Exploration: Vocabulary for *un astronaute* (an astronaut), *une fusée* (a rocket), and *l'espace* (space).

2. Grammar: Describing the Cosmos
This is the knowledge of how to string words together correctly using the target language's unique rules.

Gender and Articles: Knowing whether a space-related noun is masculine or feminine.
Spanish example: **El** sol (masculine) vs. **La** luna (feminine).
Adjective Agreement: Knowing that colours and sizes must "match" the noun they describe.
French example: "La planète est **bleue**" (adding an 'e' because *planète* is feminine) vs. "Le soleil est **chaud**."
High-Frequency Verbs: Learning how to use "to be" (*être/ser/estar*) or "to have" (*avoir/tener*) in the context of space.
Example: "Mars **is** red" or "Saturn **has** rings."

3. Phonics and Pronunciation
Substantive knowledge of the specific sounds (phonemes) associated with the vocabulary.

Silent Letters: Knowing that the 'h' in the French *homme dans l'espace* is silent.
Vowel Sounds: Mastering the "u" sound in *la lune* or the "j" sound in the Spanish *Júpiter*.
Word Stress: Understanding which part of the word to emphasise (e.g., the final syllable in French vs. specific stress rules in Spanish).

4. Cultural Knowledge: Space "En Français" or "En Español"
This is the factual knowledge of how the target language is used in the real world of science.

Geography: Knowing that the **European Space Agency (ESA)** launches rockets from **Kourou, French Guiana** (a French-speaking territory in South America).
History: Learning about famous astronauts from that culture (e.g., Claudie Haigneré, the first French woman in space).
Cognates: Identifying "Near-Cognates"—words that look almost the same as English but have slight spelling differences (e.g., *le système solaire*).

Why Substantive Knowledge Matters in MFL

Linguistic Fact	**Why it Matters**
Genders (Le/La)	Essential for building correct sentences later on.

Cognates	Boosts confidence by showing pupils they already "know" some of the language.
Adjective Rules	Teaches the logic of the language—that words are connected to one another.
Phonics	Ensures that if a pupil speaks to a native speaker, they will be understood.

The "Linguistic Launchpad" Knowledge Check
French: Can you translate "The red rocket"? (*La fusée rouge*).
Spanish: Is "Sol" masculine or feminine? (*Masculine - El sol*).
German: How do you say "The Earth"? (*Die Erde*).
Phonics: How do you pronounce the 'e' at the end of the French word *planète*? (It's silent!).

Disciplinary Knowledge

In MFL, **disciplinary knowledge** for the **'Space'** learning theme isn't just about learning the names of planets. It focuses on the *mechanics* of language—how we use a new linguistic system to describe the unknown, express wonder, and communicate across borders. It is the study of **how a language works** to categorise the universe.

1. Grammatical Systems and Patterns
Disciplinary knowledge involves understanding the "rules" of the language through the lens of space.

Gender and Articles: In many languages (like French or Spanish), celestial bodies have genders. Pupils learn the discipline of matching articles: e.g., in French, *le soleil* (masculine) vs. *la lune* (feminine).
Adjective Agreement: Understanding that descriptors must change to match the noun. To describe a "big planet" vs. "big stars," pupils must apply the rules of pluralisation and gender agreement.
Prepositions of Place: Using the language to describe relative positions in the solar system (e.g., "The Earth is **between** Venus and Mars").

2. Linguistic Roots and Cognates
This involves the "detective work" of language—looking at where words come from.

Latin and Greek Roots: Understanding that many "Space" words are **cognates** (words that look and sound similar across languages). For example:
Planet (English)
Planeta (Spanish)
Planète (French)
Etymology: Recognising how ancient languages influence modern ones (e.g., "Astronomy" from the Greek *astron* for star). This builds the discipline of looking for patterns to decode unfamiliar words.

3. Phonics and Sound Patterns
The discipline of "Internalising" the sounds of a new language to speak clearly.

Sound-Spelling Links: Learning how to pronounce "space" phonemes that don't exist in English or are pronounced differently (e.g., the "u" in the French *lune* or the "j" in the Spanish *planeta Jupiter*).

Intonation for Impact: Using the language to express awe or "Space News" announcements, practicing the rhythm and flow of the target language.

4. Intercultural Understanding

Disciplinary knowledge in MFL also involves understanding how different cultures view and contribute to space exploration.

Global Collaboration: Realising that the International Space Station (ISS) is a multilingual environment.
Cultural Perspectives: Investigating how different cultures named the constellations or how French/Spanish-speaking scientists contributed to space history (e.g., the Guiana Space Centre in French Guiana).
Translation vs. Meaning: Understanding that some concepts don't translate literally and exploring how different languages describe the "void" of space.

Why Disciplinary Knowledge Matters in MFL

Skill	Linguistic Significance
Pattern Seeking	Helps pupils decode new words by looking for familiar roots (cognates).
Logic	Applying grammatical "maths" (Noun + Adjective Agreement) to create correct sentences.
Cultural Awareness	Moves language away from "flashcards" and into a real-world context of global science.
Confidence	Speaking about a "big" topic like Space builds the courage to use the language for complex ideas.

The "Space Linguist" Success Criteria

Grammar: I can correctly use "the" (le/la/el/la) for different planets.
Phonics: I can pronounce the names of the planets with the correct accent.
Patterns: I can spot words that are similar to English and explain why.
Communication: I can say one fact about a planet in the target language (e.g., *"Mars est rouge"*).

Learning Objectives

In MFL, the **'Space'** learning theme provides a high-interest context for pupils to move beyond memorised lists and begin manipulating the language. The **learning objectives** focus on **linguistic patterns**, **phonics**, and **grammatical logic**, using the solar system as the "testing ground."

1. Phonics and Pronunciation

Objective: *To explore the patterns and sounds of language through the names of planets and celestial bodies.*

The Focus: Accuracy in speaking.
Key Skill: Sound-Spelling Links. Pupils learn to pronounce specific phonemes that differ from English. For example, the French "u" in *la lune* or the Spanish "j" in *Júpiter*.
Outcome: Pupils can read aloud the names of the planets with correct intonation and accent, recognising that the same letter can make different sounds in different languages.

2. Grammatical Structures: Gender and Articles
Objective: *To understand and apply the concept of grammatical gender to space-related nouns.*
The Focus: The "logic" of the language.
Key Skill: Categorisation. In languages like French or Spanish, everything has a gender. Pupils must learn whether *the sun* or *the moon* is masculine or feminine and choose the correct article (*le/la* or *el/la*).
Outcome: Pupils can correctly identify the gender of celestial bodies and use the appropriate definite or indefinite article.

3. Adjective Agreement and Sentence Building
Objective: *To use simple adjectives to describe the appearance of planets and manipulate them to match the noun.*
The Focus: Describing the universe.
Key Skill: Morphology. If a planet is feminine (e.g., *la planète*), the adjective for "big" or "red" must often change its spelling (e.g., in French, *rouge* remains the same, but *petit* becomes *petite*).
Outcome: Pupils can construct a simple sentence such as *"Mars is a small red planet"* in the target language, ensuring the adjectives are in the correct position and form.

4. Reading and Decoding: Cognates
Objective: *To identify cognates and near-cognates to help decode a space-themed text.*
The Focus: Building confidence in reading.
Key Skill: Strategic Decoding. Many scientific words are similar across European languages (e.g., *le système solaire*, *l'astronaute*, *le télescope*).
Outcome: Pupils can read a short "Space Fact File" and deduce the meaning of the text without needing a dictionary for every word, using their knowledge of English and Latin roots.

5. Intercultural Understanding
Objective: *To recognise that the target language is used in global scientific collaboration.*
The Focus: Language in the real world.
Key Skill: Cultural Awareness. Exploring the role of the European Space Agency (ESA) or discovering that French is spoken at the rocket launch site in French Guiana.
Outcome: Pupils understand that the target language is a tool for international cooperation on the International Space Station (ISS) and not just a classroom subject.

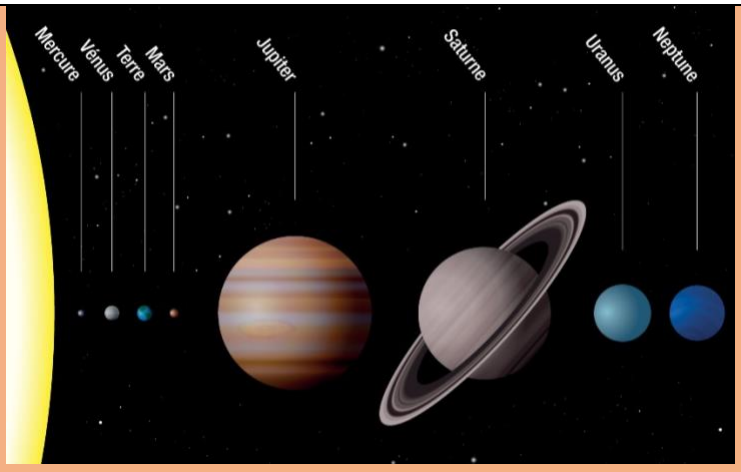
Why These Learning Objectives Matter in MFL

Skill	Linguistic Benefit
Logic	Teaches that language is a system of rules, similar to Maths or Science.
Decoding	Empowers pupils to tackle unfamiliar texts by looking for familiar patterns.
Recall	Using "Space" (a topic many children love) helps vocabulary stick in the long-term memory.
Perspective	Shows that "English" isn't the only language of science and discovery.

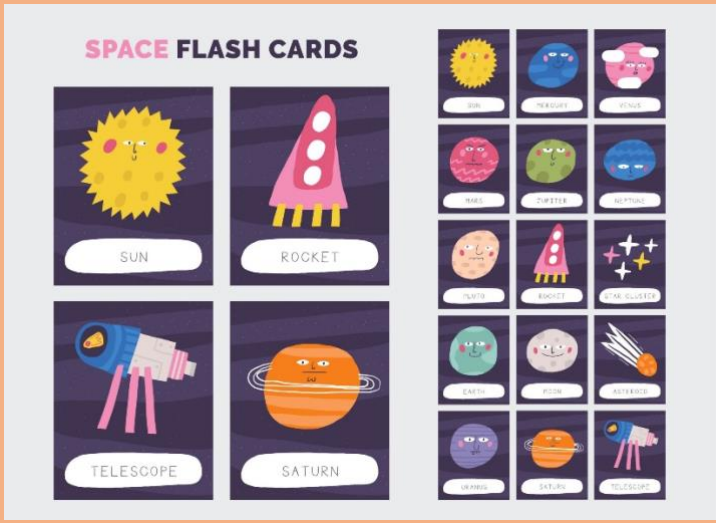
Lesson Ideas

This 6-week Medium-Term Plan for MFL—designed flexibly for **French** or **Spanish**—uses the captivating theme of 'Space' (*L'Espace* / *El Espacio*) to build real linguistic fluency across Key Stage 2. In modern primary languages, **substantive knowledge** consists of explicit phonics (Sound-Spelling Correspondences/SSCs), vocabulary (nouns, adjectives, verbs), and core grammar structures (gender, plural agreement, verb conjugations). **Disciplinary knowledge** represents "thinking like a linguist": decoding unfamiliar text using cognates, applying grammatical rules to generate original sentences, manipulating word order, listening for gist versus specific detail, and exploring cultural contexts (e.g., European Space Agency / ESA contributions).

Unit Title: Mission Space (*Mission Spatiale* / *Misión Espacial*)
Duration: 6 Weeks (Approx. 45–60 mins per week)
Target Languages: French / Spanish (adaptable for German/Italian)
Key Strands: Phonics & Pronunciation, Vocabulary Acquisition, Grammar & Syntax, Intercultural Understanding.
Core Pillars of Linguistic Knowledge
Substantive Knowledge:
Phonics (SSCs): French ch, ou, on, eau, silent word-endings (t, s); Spanish j (jota), ll, ñ, z/c, rolled rr.
Vocabulary: Celestial bodies, planetary characteristics (colours, sizes), distance/numbers (1–100), astronaut action verbs (*fly, observe, travel, live*).
Grammar: Indefinite vs. definite articles (*un/une/le/la* vs. *un/una/el/la*), adjective agreement and placement (size/colour), 1st person vs. 3rd person present tense (*I see/It is/Astronauts live*).
Disciplinary Knowledge ("Thinking Like a Linguist"):
Gist vs. Detail: Listening to native audio clips and isolating target information without needing to translate every word.
Grapheme-Phoneme Decoding: Applying explicit phonics rules to read aloud unfamiliar alien names or space words correctly.
Sentence Engineering: Using sentence builders/substitution tables to manipulate noun-adjective-verb structures independently.
Cognate Detective Work: Identifying true cognates (*la planète / la planeta*, *la galaxie / la galaxia*) vs. false friends.



Solar System Nomenclature & Gender (Articles, Cognates, and Noun Classes). Source: PeterHermesFurian / Getty Images



Visual Vocabulary Flashcards (Celestial Nouns, Adjectives, and Phonic Mapping). Source: NadineVeresk / Getty Images



Oral Presentation & Speaking Practice (Describing Alien Planets and Astronaut Routines). Source: SeventyFour / Getty Images

Weekly Progression Scheme

Week 1: Launching into Orbit – Nouns & Phonics
Target Vocabulary: Sun, Moon, planet, star, rocket, astronaut, space station (*le soleil/el sol*, *la lune/la luna*, *la planète/la planeta*, *la fusée/el cohete*, etc.).
Phonics Focus:
French: Silent final consonants (t in *la nuit*, s in *les étoiles*); nasal sound on (*le rayon*).
Spanish: Soft c/z (*la luna*, *el espacio*); double ll (*la estrella*).
LKS2 Focus: Labelling space items using accurate indefinite articles (*un/une*, *un/una*); oral repetition game "What's missing in space?".
UKS2 Focus: Sorting space vocabulary into masculine, feminine, and plural categories; identifying true cognates (*l'atmosphère / la atmósfera*).
Disciplinary Task: *Phonic Decoding.* Pupils receive pseudo-words (alien names containing target SSCs) and must pronounce them accurately to "unlock" the rocket launch code.

Week 2: Mapping the Solar System – Colours, Size & Adjective Agreement
Target Vocabulary: Colours (*rouge/rojo*, *bleu/azul*), sizes (*grand/grande*, *petit/pequeño*, *chaud/caliente*, *froid/frío*).
Grammar Focus: Adjective position and agreement rules (e.g., gender endings and plural additions).
French: *Une planète rouge* (noun + colour); *Le petit soleil* (BANGS adjective rule for size).
Spanish: *Un planeta rojo* (masculine noun ending in *-a* exception); *Una estrella grande*.
LKS2 Focus: Building 3-word noun phrases (*a red rocket*, *a cold moon*) using colour wheel cards.
UKS2 Focus: Constructing full comparative sentences (*Mars is smaller than Jupiter* / *Mars est plus petit que Jupiter* / *Marte es más pequeño que Júpiter*).
Disciplinary Task: *Grammar Manipulation.* Pupils correct intentional "alien grammatical errors" on planet fact cards where adjectives fail to agree in gender/number with their nouns.

Week 3: Planet Explorer – Numbers, Distance & Quantities
Target Vocabulary: Numbers 1–31 (LKS2) / Numbers 10–100+ & ordinal numbers (UKS2); measurement words (*kilomètres/kilómetros*, *température/temperatura*).
Grammar Focus: Asking and answering "How many?" (*Combien de...?* / *¿Cuántos/as...?*) and expressing values (*It has / It measures*).
LKS2 Focus: Counting stars, moons, and rings around planets; playing bingo with planetary data.
UKS2 Focus: Reading and transcribing multi-digit planetary statistics from native language audio tracks into numerical tables.
Disciplinary Task: *Selective Listening.* Listening to a simulated French or Spanish ESA weather report for different planets and recording temperature and moon counts without needing to translate narrative background filler.

Week 4: Life of an Astronaut – Verbs & Daily Routines
Target Vocabulary: Action verbs (*manger/comer*, *dormir/dormir*, *regarder/mirar*, *travailler/trabajar*, *flotter/flotar*).
Grammar Focus: Present tense 1st person (*I eat/I live*) vs. 3rd person singular/plural (*He floats /They work*).
LKS2 Focus: High-frequency 1st person sentences: *In space, I eat... In space, I sleep...* (*Dans l'espace, je mange.../En el espacio, yo como...*).
UKS2 Focus: Conjugating regular -er/-ar verbs in the present tense to contrast astronaut life on Earth vs. on the ISS (*On Earth I walk, but in space I float*).
Disciplinary Task: *Sentence Engineering.* Using a substitution grid (pronoun + conjugated verb + preposition + noun phrase) to write an astronaut's log entry.

Week 5: Alien Logbook – Reading & Decoding Unfamiliar Texts
Language Skill Focus: Reading comprehension, contextual guessing, and dictionary/glossary skills.
LKS2 Focus: Reading a simplified 4-sentence postcard from a friendly alien; matching descriptions to visual alien illustrations.
UKS2 Focus: Reading an extended short text describing a newly discovered exoplanet; using context clues to deduce unknown adjectives and verbs.
Disciplinary Task: *Textual Detective Work.* Pupils highlight known vocabulary in green, cognates in yellow, and use bilingual dictionaries *only* for pivotal unknown words highlighted in red. They then answer inference questions in English.

Week 6: Mission Control Presentation – Speaking & Synthesis
Language Skill Focus: Spoken production, fluency, intonation, and unit synthesis.
LKS2 Focus: *Alien Planet Show & Tell.* Pupils present an invented planet using a visual poster, speaking 3–4 memorised sentences covering name, colour, size, and moon count.
UKS2 Focus: *ESA Astronaut Broadcast.* Pupils record or perform a 1-minute live broadcast as an astronaut aboard the ISS, describing their planet views, daily routine, and mission objectives.
Disciplinary Task: *Peer Evaluation.* Classmates listen to presentations with an evaluation rubric, tallying target phonics sounds produced accurately and recording key facts delivered in the target language.

Assessment Matrix (Language Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Recalls 3–4 space nouns with prompting. • Requires teacher modelling to select correct articles (*le/la* or *el/la*). • Pronounces key words using English sound patterns. • Copies short phrases accurately from the board.	• Recalls 6–8 space nouns with correct gender articles. • Applies colour adjectives after the noun with guidance. • Accurately pronounces core unit phonemes (ou, ch/ll, j). • Constructs 3-part sentences using a writing frame (*C'est une planète rouge/Es un planeta rojo*).	• Independently identifies cognates without teacher prompting. • Correctly modifies adjectives for feminine nouns without prompts. • Speaks with confident intonation and clear phoneme reproduction. • Extends sentences using simple conjunctions (*et/y*, *mais/pero*).
Upper Key Stage 2 *(Years 5 & 6)*	• Matches basic space vocabulary to pictures. • Struggles with verb endings, using infinitives only. • Needs support to extract key facts from a spoken text.	• Manipulates adjectives for gender and plural agreement across complex descriptions. • Conjugates 1st and 3rd person present tense verbs accurately. • Extracts specific details (numbers, facts) from	• Spontaneously applies phonics rules to pronounce unfamiliar multi-syllabic language. • Manipulates word order fluidly when combining multiple adjectives. • Infers the meaning of unknown words using

	• Writes short disconnected sentences.	authentic audio/written sources. • Produces a coherent short paragraph combining nouns, adjectives, verbs, and connectives.	grammatical awareness and context. • Speaks spontaneously during presentations, adapting memorised structures to answer questions.

Other Information, Ideas and Resources

In MFL, the **'Space'** learning theme is perfect for practicing **description, gender logic, and phonics**. Since many scientific words are similar across European languages (cognates), it's also a fantastic way to boost "linguistic confidence."

1. The "Planet Profiles" (Grammar & Description)
The Concept: Noun-Adjective agreement and gender.
The Activity: Pupils are assigned a planet. They must create a profile card including its name, colour, and size in the target language.
The Linguistic Focus: Matching the adjective to the noun.
French: "Mars est une **petite** planète **rouge**." (Adding 'e' to *petit* because *planète* is feminine).
Spanish: "Marte es un planeta **rojo**." (Note: *Planeta* is a rare masculine noun ending in 'a'—a great "discovery" for pupils!)
Outcome: Pupils understand that adjectives are "flexible" and must change to suit the noun they describe.

2. "Astronaut Training" (Phonics & Imperatives)
The Concept: Listening skills and command verbs.
The Activity: A "Simon Says" style game (e.g., *Jacques a dit* in French) using astronaut actions.
The Task: The teacher gives commands like: *"Mangez!"* (Eat!), *"Dormez!"* (Sleep!), *"Marchez sur la lune!"* (Walk on the moon!), or *"Montez dans la fusée!"* (Get in the rocket!).
The Linguistic Focus: Phonics. Focusing on the "ez" or "ar/er" endings of verbs to ensure pupils recognise the sounds of instructions.

3. Cognate Detectives (Reading & Decoding)
The Concept: Recognising patterns between English and the target language.
The Activity: Provide a short text about a "Mission to Mars" written in the target language, filled with **cognates** (words that look/sound like English).
The Task: Pupils highlight all the words they think they already know.
Examples: l'astronaute, le système solaire, le télescope, futur, mission, explorer.
The Linguistic Focus: Building **decoding strategies**. Pupils learn they don't need to know every word to understand the "gist" of a sentence.

4. Alien Interviews (Speaking & Questions)
The Concept: Question words and first-person responses.
The Activity: One pupil plays an alien, the others are "Space Reporters."
The Task: Reporters ask simple questions: *"Comment t'appelles-tu?"* (What is your name?), *"Où habites-tu?"* (Where do you live?), *"Quelle est ta couleur préférée?"* (What is your favourite colour?).

The Linguistic Focus: Practicing **Question/Answer structures**. The "alien" practices the "I" form (*Je m'appelle... J'habite sur Saturne...*).

5. The "Intergalactic" Shopping List (Vocabulary & Numbers)
The Concept: Using numbers and high-frequency nouns.
The Activity: Pupils have to pack a suitcase for a trip to the Moon, but they have a "weight limit" or a specific list of items to bring.
The Task: *"Dans ma valise, il y a... trois pommes, cinq livres, et un casque."* (In my suitcase, there are... three apples, five books, and a helmet).
The Linguistic Focus: Combining **numbers, plurals, and nouns** into a list format.

Why These Lessons Matter in MFL

Skill	Linguistic Parallel
Logic	Matching colours to planets is like a "grammar puzzle" that builds accuracy.
Decoding	Space terminology shows pupils that they are already "global citizens" who share words with other cultures.
Confidence	Talking about "Aliens" and "Rockets" is high-engagement, lowering the "affective filter" (anxiety) of speaking a new language.
Phonics	Learning to say "Jupiter" or "La lune" correctly helps build the specific mouth muscles needed for that language.

Considerations for Implementation

Music

Substantive Knowledge

In Music, **substantive knowledge** for the **'Space'** learning theme involves the technical "building blocks" and vocabulary used to describe and create soundscapes. It focuses on the specific musical elements (the interrelated dimensions) that composers use to mimic the atmosphere, scale, and mystery of the universe.

1. The Interrelated Dimensions of Music
Substantive knowledge is the factual understanding of how these elements can be manipulated to create a "space" feel.

Pitch: Knowing that high-pitched sounds (glockenspiels, triangles) often represent stars or light, while low-pitched sounds (trombones, bass drums) represent the vastness or danger of a black hole.
Duration (Tempo): Understanding that slow tempos can create a sense of "weightlessness," while fast, driving rhythms simulate a rocket launch or a chase.

Dynamics: Using terms like **Crescendo** (getting louder) to build tension for a launch and **Diminuendo** (getting quieter) to simulate a craft drifting away.
Texture: Knowing the difference between a "thin" texture (a lone melody representing a solo astronaut) and a "thick" texture (many layers representing a busy galaxy).
Timbre (Tone Colour): Identifying the specific "sound quality" of instruments. For example, knowing that electronic synthesisers sound "futuristic" or "robotic" compared to the "warm" sound of a violin.

2. Structural and Compositional Knowledge
This involves knowing the "blueprints" for how space music is organised.

Graphic Notation: Knowing that music can be written using symbols, lines, and shapes rather than traditional notes on a stave to represent abstract space sounds.
Leitmotif: Understanding that a short, recurring musical phrase can represent a specific character or place (e.g., a "hero" theme for an astronaut).
Ostinato: Knowing that a continually repeated musical rhythm or phrase can create a sense of mechanical movement (like a satellite's orbit).

3. Historical and Repertoire Knowledge
This is the factual "canon" of music inspired by space.

Gustav Holst's *The Planets*: Knowing that this 1914-1916 suite uses different musical styles to represent the "character" of each planet (e.g., Mars as "The Bringer of War" using aggressive, clashing sounds).
Film Scores: Recognising the influence of composers like **John Williams** (*Star Wars*) or **Hans Zimmer** (*Interstellar*) and how they use orchestral and electronic sounds to define the "Sci-Fi" genre.
Modern Technology: Knowing that the invention of the **Theremin** and **synthesiser** provided the "eerie" and "space-age" sounds that we now associate with aliens and the cosmos.

4. Key Musical Vocabulary
Substantive knowledge includes the mastery of specific terms used during the "Appraisal" phase of a lesson:

Term	Definition in a Space Context
Dissonance	Clashing notes that create a sense of "unsettling" space or danger.
Consonance	Notes that sound "sweet" or stable, representing the beauty of the stars.
Reverb	An electronic effect that makes a sound "ring out," simulating a large, empty void.
Pizzicato	Plucking strings to create "pointy," star-like sounds.

Why Substantive Knowledge Matters in Music

1. It Moves Beyond "Guessing"
Instead of saying "it sounds spacey," a pupil with **substantive knowledge** can say, *"The composer used a high-pitched, thin texture with reverb to create a sense of loneliness."*

2. It Provides a Toolset for Composition
When a child is asked to "make a sound for a meteor," they don't just hit a drum; they decide to use a **descending glissando** (a slide down in pitch) to represent the meteor falling.

3. It Connects Art to Science
It shows that music isn't just "feelings"—it is the deliberate manipulation of sound physics to tell a story about the physical world.

Disciplinary Knowledge

In Music, **disciplinary knowledge** for the **'Space'** learning theme is about how we use sound to represent abstract concepts like "vastness," "emptiness," and "technology." It moves away from just playing notes and focuses on the **intention** behind the sound—how a composer "paints" a picture of the universe using the elements of music. It is the study of **how music creates atmosphere and narrative.**

1. Manipulation of the Inter-related Dimensions
Disciplinary knowledge involves understanding how to "stretch" or "compress" the elements of music to evoke a space-like feeling.

Pitch and Register: Understanding that very high pitches (like a glockenspiel or high violin) can represent "shimmering stars," while very low pitches (like a tuba or bass synth) can represent the "void of space."
Texture: Understanding the difference between a "thin" texture (a single solo flute representing a lonely satellite) and a "thick" polyphonic texture (a full orchestra representing a galactic battle).
Dynamics: Using **Crescendo** (getting louder) to represent a rocket launch or the approach of a comet, and **Diminuendo** (getting quieter) to represent drifting away into the distance.

2. Compositional Intention and Programmatic Music
This is the discipline of "storytelling" through sound without using words.

Leitmotifs: Understanding how a specific melody can represent a character or an idea (e.g., John Williams' themes in *Star Wars*).
Graphic Notation: Learning that space music is often too "abstract" for traditional staves. **Disciplinary knowledge** involves using symbols, shapes, and lines to map out a soundscape (e.g., a jagged line for a meteor shower).
Timbre (Tone Colour): Selecting specific instruments for their "spacey" quality. This includes exploring synthetic sounds (electronic music) vs. acoustic sounds (orchestral).

3. Critical Listening and Appraisal
The discipline of analysing how other composers have "solved" the problem of representing space.

Analysing Gustav Holst: Listening to *The Planets* (e.g., "Mars, the Bringer of War" vs. "Venus, the Bringer of Peace") to understand how a composer uses **Tempo** and **Metre** to change the "mood" of a planet.
Technological Context: Understanding how the invention of the synthesiser in the 20th century changed the "sound of space" in cinema and media.

4. Performance and Technology
Disciplinary knowledge involves using the tools of the modern musician to create sounds that aren't possible with a standard piano or recorder.

Acoustics and Effects: Understanding how **Reverb** and **Echo** can be used to simulate the vastness of a vacuum or a hollow space station.
Layering: Using Digital Audio Workstations (DAWs) or loop pedals to build "atmospheric pads" that provide a background "hum" for a space-themed composition.

Why Disciplinary Knowledge Matters in Music

Concept	Musical Significance
Silence	In space music, silence is as important as sound. It represents the vacuum.
Structure	Understanding that music doesn't have to be a "song" (verse/chorus)—it can be a "soundscape" with no fixed ending.
Emotion	Identifying how minor keys or "dissonant" (clashing) chords create a sense of tension or danger in a spacewalk.

The "Space Composer" Success Criteria
Analysis: I can explain why Holst used a 5/4 time signature in "Mars" to make it feel "unsettling."
Creation: I can create a graphic score that another musician could use to perform my "Meteor Shower" piece.
Terminology: I can use words like **Dynamics, Texture,** and **Timbre** to describe a piece of sci-fi film music.
Technology: I can use an app to add "Echo" to a sound to make it feel like it is in a huge galaxy.

Learning Objectives

In Music, the **'Space'** learning theme is an excellent vehicle for teaching **compositional intent**. The **learning objectives** focus on how to move from "making noise" to "painting with sound," using the vastness and mystery of the universe as a creative prompt.

1. Exploring the Interrelated Dimensions
Objective: *To understand and manipulate the interrelated dimensions of music (pitch, duration, dynamics, tempo, timbre, and texture) to create atmospheric effects.*
The Focus: Using the "physics" of music to match the environment of space.
Key Skill: Dynamic Control. Pupils learn to use extreme dynamics (from a *pianissimo* "distant star" to a *fortissimo* "supernova") to create a sense of scale.
Outcome: Pupils can explain how changing a specific dimension (e.g., thinning the texture) changes the "mood" of their space composition.

2. Composing with Graphic Notation
Objective: *To create and interpret musical ideas using non-traditional symbols and scores.*
The Focus: Visualising sound.

Key Skill: Symbolic Representation. Because space sounds are often abstract (whooshes, drones, pings), traditional notation is often insufficient. Pupils design their own "Space Map" or graphic score.
Outcome: Pupils can "conduct" a group performance based on a visual score they have designed, where a jagged line might mean a "clashing chord" and dots might mean "staccato notes."

3. Developing Musical Structure and Narrative
Objective: *To compose a soundscape with a clear beginning, middle, and end, representing a specific journey or event.*
The Focus: Storytelling without words.
Key Skill: Leitmotifs and Ostinatos. Pupils create a recurring rhythm (an ostinato) to represent a satellite's beep or a short melody (a leitmotif) to represent a hero astronaut.
Outcome: Pupils can perform a structured piece of music that tells the story of a "Rocket Launch" or "Drifting into a Black Hole," moving through different sections of tension and release.

4. Critical Appraisal of Repertoire
Objective: *To listen with attention to detail and recall sounds with increasing aural memory, identifying how composers represent space.*
The Focus: Learning from the masters.
Key Skill: Aural Analysis. Listening to Gustav Holst's *The Planets* or film scores by John Williams. Pupils identify *how* the composer made a planet sound "angry" (Mars) or "ethereal" (Venus).
Outcome: Pupils use appropriate musical vocabulary (e.g., *dissonance, legato, register*) to describe the effects they hear in professional recordings.

5. Technology and Timbre
Objective: *To explore how technology can be used to capture, manipulate, and create 'space-age' sounds.*
The Focus: The "Sound of the Future."
Key Skill: Timbre Selection. Using synthesisers, apps, or everyday objects to find sounds with a "metallic" or "hollow" quality.
Outcome: Pupils can choose the "right instrument for the job," such as selecting a triangle over a drum to represent a twinkling star because of its high-frequency timbre.

Why These Learning Objectives Matter in Music

Objective Category	Educational Impact
Listening	Builds a "vocabulary of sound" that children can draw from in their own work.
Composing	Encourages "divergent thinking"—there is no single "right" way to sound like an alien.
Performing	Teaches cooperation; a "Space Soundscape" requires every performer to listen to the group.

Notation	Demystifies music theory by showing that anyone can write music using their own symbols.

The "Space Musician" Success Criteria
Analysis: I can identify three instruments used in a space-themed piece and describe their *timbre*.
Creation: I can create a 4-beat *ostinato* that sounds like a mechanical rover.
Notation: I can draw a *graphic score* that shows when a sound should get louder or higher.
Evaluation: I can suggest one way to make my "Launch" music sound more exciting (e.g., "Add a *crescendo*").

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 Music themed around **'Space & Holst's Planets'**. This unit connects core National Curriculum Music strands—**Listening & Appraising, Performing (Vocal & Instrumental), Composing, and Musical Notation**—with astronomical themes: planetary characterisations, rocket launch ostinatos, deep-space soundscapes, and lunar graphic scores. It balances **substantive knowledge** (the inter-related dimensions of music: pitch, duration, dynamics, tempo, timbre, texture, structure, and graphic/standard notation) with **disciplinary knowledge** ("Thinking & Acting Like a Musician"—improvising with intentionality, evaluating how musical choices evoke mood, refining ensemble timing, and conducting peer reviews of graphic scores).

Unit Title: Cosmic Symphony: Pitch, Texture, Dynamics, and Graphic Notation
Duration: 6 Weeks (Approx. 45–60 mins per week)
Theme: Holst's *The Planets*, Rocket Launch Ostinatos, Deep-Space Textures, and Lunar Scores.
Music Focus Areas:
Listening & Appraising: Gustav Holst's *The Planets* suite (*Mars*, *Venus*, *Jupiter*), John Williams' *Star Wars* themes, and avant-garde 20th-century space music.
Performing (Voice & Instruments): Vocal warm-ups, rhythmic chants, tuned percussion (glockenspiels/xylophones) melody lines, and un-tuned percussion ostinatos.
Composing & Improvising: Pentatonic melodies, layering textures, creating soundscapes, and manipulating dynamics/tempo to match cosmic imagery.
Notation & Literacy: Graphic scores, grid notation, dot notation for duration, and reading basic pitch on a 5-line stave (C-G).
Key Music Pillars
Substantive Knowledge:
The Inter-related Dimensions of Music:
Pitch: High vs. low frequencies representing small asteroids vs. massive gas giants.
Dynamics: Crescendo (f) and decrescendo (p) simulating approaching/receding spacecraft.
Tempo & Time Signature: 5/4 pulse (driving rhythmic march in *Mars*) vs. 4/4 space march.
Timbre & Texture: Metallic vs. wooden percussion tones; thin monophonic soundscapes vs. dense polyphonic layers.
Notation: Reading graphic symbols for extended instrumental techniques; recognising basic rhythmic values (minim, crotchet, paired quavers).
Disciplinary Knowledge ("Thinking Like a Musician"):
Critical Listening: Identifying how composers use specific instruments and dynamic changes to paint visual scenes in the mind.

Ensemble Awareness: Maintaining a steady internal pulse while layering independent polyrhythmic ostinatos across an ensemble.
Iterative Composition: Experimenting with musical motifs, recording drafts, critiquing structural transitions, and refining performances.

Weekly Progression Scheme
Week 1: Mars, The Bringer of War – Pulse, Metre & Rhythmic Ostinatos
Music Strand: Listening, Appraising & Rhythmic Performance.
Focus Piece: Gustav Holst – *The Planets: Mars, the Bringer of War*.
Substantive Knowledge:
LKS2: Pulse vs. rhythm; simple 4/4 time signature; crotchets and quavers; untuned percussion timbres (snare, woods, metals).
UKS2: Complex pulse (5/4 time signature); ostinato patterns; accents and dynamic changes (p → ff crescendo).
Disciplinary Knowledge:
Rhythmic Precision: Maintaining a steady relentless tempo as an ensemble without accelerating during quiet sections.
Practical Music Task:
LKS2 (Y3/4): *The Rocket Countdown Ostinato.* Pupils learn a 4/4 rhythmic chant ("3, 2, 1, Blast off!"), performing it on woodblocks and hand drums with controlled dynamic changes.
UKS2 (Y5/6): *The 5/4 Martian March.* Pupils analyse Holst's 5/4 rhythm (1-2-3, 1-2), performing the layered rhythmic ostinato using snare drums, claves, and body percussion in tight ensemble sync.

Week 2: Venus & Jupiter – Pitch, Melody & Pentatonic Scales
Music Strand: Listening, Pitch Discrimination & Instrumental Performance.
Focus Piece: Holst – *Venus* (Serenity) & *Jupiter* (Joy / World in Union motif).
Substantive Knowledge:
LKS2: High vs. low pitch; pentatonic scale (C-D-E-G-A); playing simple melodies on glockenspiels/chimes.
UKS2: Major vs. minor tonality; melodic contour (ascending/descending pitch steps and leaps); stave notation basics (C-G).
Disciplinary Knowledge:
Melodic Intentionality: Choosing specific pitch ranges to evoke contrasting moods (e.g., high glockenspiels for cold stars vs. low xylophones for heavy planetary cores).
Practical Music Task:
LKS2 (Y3/4): *Starry Pentatonic Improvisation.* Pupils use a C-pentatonic scale on glockenspiels to improvise shimmering star motifs over a held low C-G bass drone.
UKS2 (Y5/6): *Jupiter Theme Performance.* Pupils read simple stave/grid notation to play the central lyrical theme from Holst's *Jupiter* on tuned instruments, balancing melody against accompaniment.

Week 3: Deep-Space Nebulae – Timbre, Texture & Extended Techniques
Music Strand: Composing, Sound Effects & Instrumental Exploration.
Focus Listening: György Ligeti – *Atmosphères*/Space Film Soundtracks.
Substantive Knowledge:
LKS2: Timbre identification (metallic, wooden, scraped, struck, shaken); monophonic (single line) vs. polyphonic (layered) texture.
UKS2: Extended instrumental techniques (cymbal scrapes, piano frame strikes, vocal glissandos); cluster chords and ambient soundscape layering.

Disciplinary Knowledge:
Textural Curation: Combining contrasting instrumental timbres deliberately to build suspense and simulate the vast vacuum of deep space.
Practical Music Task:
LKS2 (Y3/4): *Cosmic Timbre Sorting.* Pupils explore classroom instruments to find sounds matching space descriptors (e.g., "floating," "icy," "crackling"), building a 3-layer texture group piece.
UKS2 (Y5/6): *Cluster Chord Nebula.* Pupils improvise an ambient space soundscape using friction-scraped cymbals, wind chimes, glissando voices, and slow overlapping sustained chords on keyboards.
Week 4: Lunar Landscapes – Graphic Scores & Symbol Notation
Music Strand: Notation, Composition & Conducting.
Focus Topic: Avant-garde graphic scores (e.g., Cornelius Cardew, George Crumb).
Substantive Knowledge:
LKS2: Graphic notation basics; representing pitch height visually on a timeline grid (left → time axis); dynamic symbols (p, f).
UKS2: Advanced graphic score design; inventing a key/legend for non-standard playing techniques; conductor hand signals for cues and dynamic swells.
Disciplinary Knowledge:
Notation Translation: Translating abstract visual symbols into precise acoustic sounds during ensemble performance.
Practical Music Task:
LKS2 (Y3/4): *The Moon Crater Score.* Pupils write a 4-line graphic score using dots, squiggles, and lines to show crater jumps and solar flares, performing their score in small groups.
UKS2 (Y5/6): *Conducting the Cosmic Map.* Pupils compose a complex graphic score complete with a symbol legend, acting as pupil conductors to guide their ensemble through dynamic shifts and entry cues.

Week 5: Alien Contact – Structure, Form & Motifs
Music Strand: Composition & Musical Structure.
Focus Listening: John Williams – *Close Encounters of the Third Kind* (5-note alien communication motif).
Substantive Knowledge:
LKS2: Musical motif (a short repeating musical idea); A-B-A binary/ternary structure (Earth → Space → Earth).
UKS2: Leitmotifs; call-and-response structures; variation form (altering tempo, dynamics, or pitch of a core motif).
Disciplinary Knowledge:
Structural Cohesion: Arranging distinct musical sections smoothly so the overall composition tells a clear narrative arc.
Practical Music Task:
LKS2 (Y3/4): *The 4-Note Alien Call.* Pupils compose a short 4-note motif on tuned instruments, incorporating it into a call-and-response composition between a "Ground Control" group and an "Alien Ship" group.
UKS2 (Y5/6): *Ternary Space Suite (A-B-A).* Pupil groups compose a structured 3-part piece: Section A (Rocket Launch Ostinato), Section B (Floating Nebula Soundscape), Section A (Re-entry & Landing).

Week 6: The Intergalactic Concert – Performance & Appraisal
Music Strand: Ensemble Performance, Evaluation & Critical Review.
Substantive Knowledge:
LKS2/UKS2 Synthesis: Integrating rhythmic ostinatos, pentatonic pitch motifs, ambient timbres, and graphic scores into a finalised ensemble performance.

Disciplinary Knowledge:
Musical Self-Appraisal: Evaluating performances using formal music vocabulary (*pitch, dynamics, tempo, texture, timbre, structure*).
Practical Music Task:
LKS2 & UKS2: *The Space Suite Showcase.*
Task 1: Groups record their finalised "Space Suite compositions" using video or audio recorders while projected graphic scores display behind them.
Task 2: Class conducts a formal appraising session, completing peer feedback rubrics evaluating accuracy, ensemble synchronisation, and dramatic dynamic contrast.
Plenary: "Composer's Panel" where pupil groups explain how their musical choices directly reflected physical space phenomena.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Plays instruments without maintaining a steady pulse. • Identifies high and low pitch but struggles to play pentatonic patterns. • Chooses instruments randomly without considering timbre. • Follows graphic scores only with step-by-step teacher prompts.	• Maintains a steady pulse while performing 4/4 rhythmic ostinatos. • Plays simple pentatonic melodies on glockenspiels with accurate pitch. • Selects specific instrument timbres to match space imagery purposefully. • Creates and performs a clear 4-line graphic score from left to right.	• Leads ensemble tempo changes and dynamic crescendos effortlessly. • Improvises expressive pentatonic star melodies over held bass drones. • Combines 3+ distinct timbral layers to build dense sonic textures. • Uses standard dynamic markings (p, f, crescendo) inside graphic scores independently.
Upper Key Stage 2 *(Years 5 & 6)*	• Struggles to maintain internal counting in unconventional metres (5/4). • Reads basic grid notation but struggles with pitch on 5-line staves. • Creates compositions that lack structural transitions or section boundaries. • Evaluates performances using simple terms ("good", "loud") rather than music vocabulary.	• Performs complex 5/4 rhythmic ostinatos accurately within an ensemble. • Reads 5-line stave notation (C-G) to play lyrical themes on tuned instruments. • Composes a structured ternary (A-B-A) piece incorporating motifs and soundscapes. • Appraises compositions critically using musical terminology (*timbre, texture, pitch*).	• Conducts ensemble groups through complex metre changes and cue entries confidently. • Transposes short space motifs into different keys or pentatonic modes. • Engineers sophisticated cluster chord soundscapes with extended instrument techniques. • Writes detailed critical appraisals evaluating how compositional devices evoke mood.

Other Information, Ideas and Resources

Example lesson:
This lesson plan focuses on using the **interrelated dimensions of music** to create an atmospheric narrative. It moves pupils from exploring "strange sounds" to structuring a purposeful composition.

Lesson Title: The Voyager's Journey
Key Question: How can we use the "building blocks" of music to tell a story about the stars?

1. The Starter: The "Sound of the Vacuum"
Activity: Ask pupils to close their eyes. Play a 30-second clip of **Gustav Holst's *Neptune*** or the ambient "drones" from **Hans Zimmer's *Interstellar***.
The Task: Pupils describe the "Texture" and "Pitch." Is it thick or thin? High or low?
Musical Concept: Timbre. Discuss why the composer chose those specific instruments to sound "empty."

2. The Development: The "Space-Scale" Palette
Divide the class into small groups and provide a selection of classroom instruments (glockenspiels, shakers, drums, triangles).
The Task: Each group must find a sound for three specific space events:
A Twinkling Star: (High pitch, thin texture, quiet dynamics).
A Moving Meteor: (Glissando/sliding pitch, increasing tempo).
A Black Hole: (Low pitch, thick texture, dissonant/clashing notes).
Musical Concept: Dynamics and Pitch.

3. The Enquiry: Creating the Graphic Score
Activity: Instead of traditional notes, pupils draw a "Flight Map."
The Task: Groups draw a 4-panel comic strip of a space journey (e.g., *Launch → Deep Space → Meteor Shower → Landing*).
The Notation: Above each panel, they must draw symbols to represent the sounds (e.g., a big explosion shape for the launch, small dots for stars).

4. The Performance: The Mission Review
Activity: Groups perform their "Voyager's Journey" while their graphic score is displayed.
The Review: The "Audience" (the rest of the class) must use a "Musical Vocabulary Bank" to evaluate the performance.
*"I liked the **crescendo** during the launch!"*
*"The **pizzicato** sounds made the stars feel very bright."*

The "Space Composer's" Vocabulary Bank
Provide this on the board or as a handout to ensure **substantive knowledge** is reinforced:

Musical Dimension	**How to use it in Space**
Pitch	Use **high** for light/stars; **low** for gravity/danger.
Tempo	Use **slow** for floating; **fast** for engines/comets.

Texture	Use **thin** (one instrument) for loneliness; **thick** for a galaxy.
Dynamics	Use **Crescendo** to build tension for a take-off.
Silence	Use it to represent the vast, empty "vacuum" of space.

Success Criteria
To meet the **disciplinary knowledge objectives**, check that pupils are not just hitting instruments at random. They should be able to explain: *"We used the triangle for the star because its **timbre** is bright and its **pitch** is high."*

Considerations for Implementation

PE

Substantive Knowledge

In PE, **substantive knowledge** for the **'Space'** learning theme consists of the specific physical skills, movement patterns, and physiological facts that pupils must master. While Science looks at the planets, PE looks at how the human body functions as a "machine" in relation to the concepts of gravity, coordination, and spatial boundaries.

1. Movement Mechanics (Gymnastics & Dance)
This is the knowledge of how to perform specific body actions that mimic the environment of space.

Zero-Gravity Simulation: Knowing how to perform **sustained movements** (slow, fluid transitions) to mimic weightlessness.
Balance and Points of Contact: Mastering "Star" balances (using 1, 2, or 3 points of contact) and understanding how a wide **base of support** provides stability.
Flight and Landing: The technique of "take-off" and "landing" safely—essential for simulating rocket launches or landing on a lunar surface. This includes the "motor memory" of bending knees to absorb impact.

2. Spatial Awareness (Games)
This is the "mapping" knowledge of the physical environment.

Boundaries and Zones: Knowing the difference between "General Space" (the whole hall) and "Personal Space" (the bubble around the body).
Pathways and Directions: Understanding how to move in different patterns—**linear** (rocket flight), **curved** (orbiting), and **zigzag** (avoiding space debris).
Tracking: The skill of following a "moving object" (like a ball/meteor) through space and predicting where it will land.
3. Fitness and Physiology (Health)
The factual knowledge of how the body responds to physical exertion, framed through "Astronaut Training."

Heart Rate: Knowing that physical activity (the "Launch") increases heart rate and understanding why astronauts need high levels of cardiovascular fitness.

Muscle Groups: Identifying the major muscles used in "Space Training," such as the **core** (for balance) and **quadriceps** (for explosive jumps).
The Vestibular System: A basic understanding that our inner ear helps us keep our balance, which is challenged during spinning or rolling movements (simulating "G-force").
[Image showing the human heart rate increasing during physical exercise]

4. Collaborative Skills (OAA)
Outdoor and Adventurous Activities (OAA) provide the **substantive knowledge** of working within a "crew."

Instructional Language: Knowing specific directional vocabulary (North, South, East, West or Clockwise/Anti-clockwise) to guide a teammate.
Resource Use: Understanding how to use physical equipment (hoops as "airlocks," mats as "space stations") to solve a "Mission" without touching the "void" (the floor).

Substantive Knowledge Overview

Skill Category	Key Fact/Terminology
Dynamics	Knowing that **Staccato** movements are sharp/robotic and **Legato** movements are smooth/fluid.
Levels	Understanding that **High** levels involve jumping/reaching and **Low** levels involve floor work.
Spatial Concepts	Knowing that **"Open Space"** is an area of the court with no defenders/obstacles.
Body Shape	Mastering the five basic shapes: **Tuck, Pike, Straddle, Star, and Straight.**

The "Mission Readiness" Knowledge Check
Gymnastics: Can you name three shapes used to represent stars? (*Star, Straddle, Straight*).
Games: What is the difference between "Personal Space" and "General Space"?
Fitness: Why does an astronaut's heart beat faster during a launch? (*To pump oxygen to the muscles*).
Dance: What type of movement would you use to show you are walking on the Moon? (*Sustained/Slow-motion*).

Disciplinary Knowledge

In PE, **disciplinary knowledge** for the **'Space'** learning theme isn't about learning facts about the solar system; it is about how we use the body as a medium to express abstract concepts and how we adapt physical movement to simulated environments. It involves the "discipline" of **choreography, physical control, and tactical spatial awareness.**

1. Aesthetic and Expressive Movement (Dance)

Disciplinary knowledge in dance involves understanding how to translate the "feeling" of space into physical motifs.

Dynamics of Movement: Understanding how to manipulate speed and tension to mimic "Space" physics. For example, using **slow-motion (sustained)** movements to represent zero gravity or **sharp (staccato)** movements to represent robotic machinery.
Levels and Planes: Using the "space" around the body. Exploring **high levels** (leaping, reaching for stars) versus **low levels** (crawling on a lunar surface).
Motif Development: Taking a simple "space" action (like a moonwalk or a star-jump) and varying it through repetition, retrograde (backwards), or changes in size.

2. Spatial Awareness and Navigation (Games)
The discipline of "Space" in a games context is about understanding the geometry of the playing area.

Creating and Finding Space: Understanding how to move into "open space" to receive a pass, mimicking how satellites or planets maintain orbits without colliding.
Boundary Awareness: Recognising the limits of the "habitable zone" (the court or pitch).
Pathways: Exploring different ways to travel across a "terrain"—moving in zig-zags (avoiding meteors), curves (orbiting), or straight lines (rocket trajectories).

3. Physiological Adaptation (Health & Fitness)
This involves understanding how the human body reacts to extreme environments and the "discipline" of physical preparation.

Balance and Centre of Gravity: Understanding how our "vestibular system" (balance) works on Earth and how we must compensate for a loss of balance in a simulated "low gravity" obstacle course.
Core Stability: Recognising that "Space" movement requires immense core strength to control slow, deliberate transitions.
Coordination: The discipline of moving different body parts independently (e.g., "patting the head and rubbing the tummy" as a simulation of complex astronaut tasks).

4. Problem Solving and Teamwork (OAA)
Outdoor and Adventurous Activities (OAA) use the **'Space'** learning theme to build the discipline of "Mission Cooperation."

Trust and Communication: Working in pairs where one is the "Astronaut" (blindfolded) and the other is "Mission Control" (giving verbal directions) to navigate a "crater field."
Resource Management: Using equipment (mats, hoops, benches) to cross an "acid river" or "lunar ravine" without touching the floor.
Why Disciplinary Knowledge Matters in PE

Concept	Physical Significance
Control	Moving slowly is often harder than moving fast. Space PE builds "body mastery."

Imagery	Using the "Space" metaphor helps children visualise the *quality* of their movement (e.g., "move like you're in honey" for zero-G).
Collaboration	Teaches that a "Mission" (a game or dance) only works if everyone understands their place in the space.

The "Space Athlete" Success Criteria
Expression: I can use my body to show the difference between "Heavy Gravity" and "Zero Gravity."
Tactics: I can find "open space" in a game so my teammate can pass the "energy cell" (ball) to me.
Balance: I can hold a "Star Pose" for 5 seconds without wobbling.
Cooperation: I can follow verbal instructions from "Mission Control" to navigate an obstacle course safely.

Learning Objectives

In PE, the **'Space'** learning theme is less about astronomy and more about **Spatial Awareness** (how we move in a physical area) and **Creative Expression** (using the body to simulate space-related concepts). The **learning objectives** focus on moving from simple coordination to complex, purposeful movement.

1. Spatial Awareness and Navigation
Objective: *To understand the difference between personal and general space and to move safely within a shared environment.*
The Focus: Navigating the "void" without colliding.
Key Skill: Changing Direction. Pupils learn to travel in different pathways—linear (rocket), curved (orbit), or zigzag (avoiding meteors)—while maintaining awareness of others.
Outcome: Pupils can find and move into "open space" during games, understanding that "space" is a tactical resource.

2. Dynamic Movement and Physical Control
Objective: *To develop control and fluency in movement by exploring different speeds, tensions, and weights.*
The Focus: Simulating different gravities.
Key Skill: Sustained Movement. Learning to move in "slow-motion" to mimic zero-G. This requires significant core strength and muscular control.
Outcome: Pupils can demonstrate the difference between "heavy" gravity (strong, weighted steps) and "weightlessness" (light, fluid, sustained transitions).
3. Composition and Choreography (Dance)
Objective: *To create, remember, and perform a sequence of movements that tells a space-themed narrative.*
The Focus: Artistic storytelling.
Key Skill: Motif Development. Taking a "space action" (e.g., a "star jump" or an "airlock turn") and varying it by changing the level (high/low) or the speed.
Outcome: Pupils can work in a "crew" (small group) to perform a synchronised "Space Walk" or "Alien Discovery" dance routine with a clear beginning, middle, and end.

4. Balance and Body Shape (Gymnastics)
Objective: *To master a range of static and dynamic balances, focusing on the quality and "extension" of the shape.*
The Focus: Creating "Celestial" shapes.

Key Skill: Base of Support. Understanding how a wide base (like a tripod) helps stability on an "unstable lunar surface."
Outcome: Pupils can hold "Star" or "Satellite" balances for 5 seconds with "tension" (pointed toes and straight arms), showing clear body lines.

5. Teamwork and Problem Solving (OAA)
Objective: *To work cooperatively within a team to solve "missions" and navigate unknown terrains.*
The Focus: Communication under pressure.
Key Skill: Trust and Guidance. One pupil might be the "Astronaut" (limited vision) while the other is "Mission Control" (giving verbal directions) to navigate an obstacle course.
Outcome: Pupils can successfully complete a "Lunar Mission" by listening to teammates and using equipment (mats, hoops) to cross a "space ravine."

Why These Learning Objectives Matter in PE

Skill Area	Educational Benefit
Agility	Helps pupils dodge obstacles, essential for both "Space" games and playground safety.
Core Strength	"Slow-motion" movement is a fantastic way to build functional strength and balance.
Cognitive Loading	Following "Mission Control" instructions while moving builds listening and processing skills.
Creativity	Using "Space" imagery allows children who are less confident in sports to engage through storytelling.

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 Physical Education themed around **'Space Exploration & Astronaut Training'**. This unit connects physical movement strands—**Dance (Movement Composition & Motif Development), Gymnastics (Flight, Balance & Landing), and Fitness/Athletics (Agility, Balance & Coordination / ABCs)**—with cosmic concepts: zero-gravity movement, planetary re-entry forces, lunar rover agility, and spacewalk teamwork. It balances **substantive knowledge** (physical skills, movement rules, dynamic qualities, biomechanics of landing, spatial awareness, and physiological responses to exercise) with **disciplinary knowledge** ("Thinking & Acting Like an Athlete/Choreographer"—analysing performance quality, choreographing structured movement phrases, evaluating peer technique, and applying tactics/strategies in space-themed physical challenges).

Unit Title: Mission Physical: Flight, Motion, and Microgravity
Duration: 6 Weeks (Approx. 1–1.5 hours per week)
Theme: Astronaut Conditioning, Zero-Gravity Dance, Rocket Launch Gymnastics, and Lunar Explorers.
PE Focus Areas:

Dance & Movement Composition: Motif development, dynamic qualities (floating, sharp, heavy, fluid), unison/canon, and narrative performance.
Gymnastics & Body Control: Balances (points and patches), safe landing mechanics (toe-heel-bend), flight/vaulting, and roll progressions.
Athletics, Agility & Fitness: Cardio-respiratory endurance, core strength, reaction speed, spatial orientation, and teamwork tactics.
Key PE Pillars
Substantive Knowledge:
Physical Mechanics & Movement:
Body Control: Core stability required to freeze high/low balances and simulate weightlessness.
Landing Biomechanics: Absorbing force by landing ball-of-foot to heel, flexing knees to 90°, keeping chest upright to protect joints.
Dynamic Qualities: Manipulating speed, tension, and level to reflect physical concepts (e.g., explosive thrust vs. slow microgravity float).
Physiology: Recognising how heart rate, respiration, and muscle fatigue adapt during astronaut circuit training.
Disciplinary Knowledge ("Thinking Like an Athlete & Choreographer"):
Choreographic Devices: Applying canon, unison, contrast, and retrograding (reversing a movement motif) to structure space narrative dances.
Performance Analysis: Using specific criteria (extension, tension, timing, flow) to observe, evaluate, and refine peer performances.
Tactical Adaptation: Modifying team strategies during spatial agility games to simulate navigating unpredictable space debris or terrain.

Weekly Progression Scheme
Week 1: Blast Off! – Explosive Power & Flight Mechanics (Gymnastics)
PE Focus: Flight, Explosive Take-offs, and Safe Landings.
Substantive Knowledge:
LKS2: Two-foot to two-foot jumps; star, tuck, and pike shapes in the air; basic "motorcycle landing" stance.
UKS2: Vaulting take-offs off springboard/bench; height and distance control; absorbing force safely from elevated surfaces.
Disciplinary Knowledge:
Biomechanical Evaluation: Analysing the "toe-heel-knee bend" landing sequence to explain how muscles absorb impact force.
Practical PE Task:
LKS2 (Y3/4): *Rocket Launch Leaps.* Pupils practice explosive jumps off low benches onto landing mats, holding a rock-solid 3-second "Space Landing" stance without wobbling.
UKS2 (Y5/6): *Re-Entry Vaulting.* Pupils combine a hurdle-step take-off, explosive vault over a block/horse (rocket separation), and a controlled landing with clear body extension in flight.

Week 2: Zero-Gravity Spacewalk – Expressive Movement & Dynamics (Dance)
PE Focus: Motif Development, Dynamic Qualities & Levels.
Substantive Knowledge:
LKS2: Contrast between heavy (high tension) and weightless (fluid, sustained) movements; travelling across low, medium, and high levels.
UKS2: Complex motif construction; isolating body parts in motion; manipulating tempo to create tension.
Disciplinary Knowledge:
Choreographic Intention: Choosing movement dynamics deliberately to communicate the feeling of floating in a vacuum vs. fighting heavy gravitational pulls.
Practical PE Task:
LKS2 (Y3/4): *The Microgravity Float.* Pupils create a 4-count "floating" movement motif using sustained arms and slow-motion travel, transitioning smoothly between high and floor levels.
UKS2 (Y5/6): *Gravitational Shift.* Pupils choreograph an 8-count phrase that transitions abruptly from weightless zero-G floating to heavy planetary high-gravity walking, focusing on muscle tension and control.

Week 3: Astronaut Candidate Circuit – Conditioning & Physiology (Fitness & Athletics)
PE Focus: Agility, Core Stability, Cardio-Respiratory Endurance & Physiology.
Substantive Knowledge:
LKS2: Agility ladder footwork; plank/core holds; identifying heart rate increases during exertion.
UKS2: Aerobic vs. anaerobic energy systems during space training; pacing techniques; core stabilisation under fatigue.
Disciplinary Knowledge:
Physiological Monitoring: Tracking heart rate recovery times post-circuit to evaluate cardiovascular fitness improvements.
Practical PE Task:
LKS2 (Y3/4): *Space Station Agility Grid.* Pupils navigate a 4-station astronaut circuit (Agility Ladder "Ladder Climb", Hoop "Moon Craters", Core "Orbiter Hold", Cone "Debris Sprint").
UKS2 (Y5/6): *EVA Endurance Challenge.* Pupils complete a timed high-intensity interval circuit (HIIT), measuring resting vs. immediate post-exercise pulse rates and graphing class stamina trends.

Week 4: Solar Flare Navigation – Spatial Awareness & Team Tactics (Games)
PE Focus: Dodge, Evasion, Spatial Orientation & Tactical Teamwork.
Substantive Knowledge:
LKS2: Dodging technique (low centre of gravity, plant-and-cut footwork); spatial scanning to avoid obstacles/taggers.
UKS2: Team defensive zones; communication under pressure; tactical sacrifice and decoy runs.
Disciplinary Knowledge:
Tactical Analysis: Evaluating spatial positioning in evasion games to maximise team survival against tagging threats.
Practical PE Task:
LKS2 (Y3/4): *Asteroid Belt Evasion.* Tag-based evasion game where "rovers" must navigate across a designated space floor without being tagged by moving "asteroids" throwing soft foam balls.
UKS2 (Y5/6): *Solar Storm Rescue.* Team invasion strategy game where pupils work in small squads using visual signals and spatial positioning to retrieve "space pod equipment" while evading defenders.

Week 5: Moon Rover Exploration – Balance, Rolls & Sequences (Gymnastics)
PE Focus: Inverted Balances, Roll Variations & Partner Matching.

Substantive Knowledge:
LKS2: Point balances (3 or 4 points of contact) vs. patch balances (large body areas); log roll, egg roll, and barrel roll.
UKS2: Advanced rolls (forward roll, shoulder roll); inverted balances (headstand prep/tripod); partner counter-balances.
Disciplinary Knowledge:
Sequence Flow: Linking static balances and fluid rolls seamlessly with aesthetic transitions.
Practical PE Task:
LKS2 (Y3/4): *Rover Terrain Sequence.* Pupils build a 3-part mat sequence: *Rover Balance* (3-point contact) → *Crater Roll* (barrel roll) → *Solar Panel Stretch* (patch balance).
UKS2 (Y5/6): *Lunar Exploration Duet.* Pupil pairs perform a synchronised gymnastics floor routine incorporating a counter-balance (supporting weight), a forward/shoulder roll transition, and an inverted balance hold.

Week 6: The Intergalactic Showcase – Choreography & Performance Appraisal (Synthesis)
PE Focus: Performance Synthesis, Group Choreography & Peer Evaluation.
Substantive Knowledge:
LKS2/UKS2 Synthesis: Integrating dance motifs, gymnastic flight/balances, and teamwork into a final group space performance.
Disciplinary Knowledge:
Performance Appraisal: Observing peer performances and offering constructive feedback based on extension, synchronisation, spatial alignment, and expression.
Practical PE Task:
LKS2 & UKS2: *The Mission Control Showcase.*
Task 1: Groups of 4–6 combine their Week 1 flight landings, Week 2 zero-G dance motifs, and Week 5 gymnastic balances into a complete 2-minute "Space Odyssey" performance routine using music.
Task 2: Pupils use peer assessment rubrics to film, review, and evaluate another group's performance, focusing on clarity of movement shapes, timing, and dynamic contrast.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Heavy landings with straight legs. • Moves erratically without expressing weightlessness or tension. • Struggles to maintain balance for 3 seconds. • Follows group movement without spatial awareness.	• Lands safely off equipment using "motorcycle stance" (flexed knees, toe-to-heel). • Demonstrates clear dynamic changes between fast/explosive and slow/floating movements. • Holds 3-point and patch balances securely for 3+ seconds. • Works cooperatively to build a 3-part	• Executes jumps with crisp flight shape definition and flawless landing absorption. • Varies levels and directions fluently to enhance choreographic narrative. • Transitions smoothly between balances and rolls without losing flow. • Offers specific biomechanical feedback to

		gymnastic/dance sequence.	peers to improve landing safety.
Upper Key Stage 2 *(Years 5 & 6)*	• Vaults with inconsistent foot placement or low take-off height. • Performs dance motifs without dynamic contrast or isolated body control. • Loses core stability during high-intensity agility tasks. • Relies on teacher structure to build group routines.	• Vaults with explosive hurdle take-offs and controlled extension in flight. • Choreographs complex dance phrases using unison, canon, and retrograding. • Maintains core stability and high footwork precision under physical exertion. • Evaluates peer performances using technical PE vocabulary (*extension, dynamic, canon*).	• Adjusts flight angle and force application intuitively to adapt to different apparatus heights. • Uses subtle dynamic shifts and dramatic tension to create compelling choreographic work. • Analyses physiological recovery trends to optimise individual pacing strategy. • Leads small group choreography independently, adapting movements for different group abilities.

Other Information, Ideas and Resources

To turn your PE hall into a "Launchpad," this circuit combines **cardiovascular fitness** (the launch), **core stability** (zero-G), and **spatial awareness** (navigation).

Lesson Title: The Astronaut Selection Program
Key Question: Do you have the physical control and fitness to survive a mission to Mars?
1. The Warm-Up: "G-Force Training"
The Game: Pupils move around the hall in "General Space."
The Commands:
Ignition: Jogging on the spot, getting faster.
Blast Off: A huge explosive "Star Jump."
Orbit: Run in a wide circle around the perimeter.
Space Debris: Drop to the floor and make a "tuck" shape (to be as small as possible).
PE Objective: Improving **heart rate** and **reaction time**.

2. The Main Event: The Lunar Circuit
Set up 4 stations around the hall. Divide the class into "Flight Crews."

Station A: The Moonwalk (Dynamics & Control)
The Task: Move from one side of the mats to the other in "Slow Motion."
The Challenge: You must never stop moving, but every step must take at least 5 seconds.
Focus: Sustained movement and **core strength**.

Station B: The Satellite Array (Gymnastics Balances)
The Task: Using benches or floor mats, create a "Satellite" balance with a partner.
The Challenge: The balance must be held for 5 seconds. One person must be at a "High Level" and one at a "Low Level."
Focus: Extension, tension, and levels.

Station C: Asteroid Belt (Agility & Spatial Awareness)
The Task: A zig-zag course of cones or hurdles.
The Challenge: Run through the belt as fast as possible without touching a single "asteroid."
Focus: Agility and **changing direction** at speed.

Station D: The Repair Mission (OAA & Coordination)
The Task: One pupil is blindfolded (the "Robot"). The other is "Mission Control."
The Challenge: Mission Control must guide the Robot to pick up 3 "Energy Cells" (beanbags) and place them in a "Storage Bin" (hoop) using only verbal commands.
Focus: Communication and **trust**.

3. The Cool Down: Re-Entry
The Activity: Pupils lie on their backs (in their "cockpits").
The Task: Systematic muscle relaxation. "Tense your feet like you're bracing for impact... now relax." Move up to the legs, stomach, and hands.
The Visual: Imagine the parachute opening and the capsule drifting slowly back to Earth.
PE Objective: Lowering the **heart rate** and reflecting on physical sensations.

🛠 **Success Criteria for the "Flight Log"**

Skill	I can...
Control	Move in slow-motion without falling over or stopping.
Agility	Navigate the asteroid belt without colliding with objects.
Teamwork	Give clear, calm instructions to my "Robot" teammate.
Safety	Land from a "Blast Off" jump with bent knees and a stable base.

Considerations for Implementation

Science

Substantive Knowledge

In Science, **substantive knowledge** for the **'Space'** learning theme involves the core facts and concepts about the Earth, the Sun, the Moon, and the wider solar system. At Key Stage 2, the focus is on moving away from the idea that the Earth is a flat, stationary object and understanding it as a spherical body moving in a complex system of cycles.

1. Earth, Sun, and Moon as Spherical Bodies
The Fact: The Earth, Sun, and Moon are approximately spherical bodies.
Understanding Scale: Knowing that the Sun is a star (a massive ball of gas) and is significantly larger than the Earth, while the Moon is a natural satellite of the Earth and is much smaller.
Historical Correction: Recognising that while the Earth *looks* flat to us on the ground, scientific evidence (satellite photos, ships disappearing over the horizon) proves it is a sphere.

2. The Solar System
The Fact: The Earth is one of eight planets that orbit the Sun.
The Sun's Role: Knowing the Sun is at the centre of our solar system and that everything else orbits around it (Heliocentric model).
The Planets: Identifying the eight planets in order from the Sun: **Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.**
Classification: Distinguishing between "rocky" planets (the inner four) and "gas giants" (the outer four).

3. Earth's Rotation: Day and Night
The Fact: The Earth rotates on its axis once every 24 hours.
The Cause of Day/Night: Knowing that day and night are caused by the Earth spinning, not the Sun moving. The side facing the Sun experiences day; the side facing away experiences night.
Apparent Motion: Understanding that the Sun *appears* to move across the sky from East to West because the Earth is rotating in the opposite direction.
Shadows: Knowing that the position and length of shadows change throughout the day because of this rotation.

4. Earth's Orbit: The Year and Seasons
The Fact: The Earth orbits the Sun once every 365.25 days (one year).
Orbit vs. Rotation: Distinguishing between the Earth spinning on its axis (rotation = day) and traveling around the Sun (orbit = year).
The Tilt: Understanding that the Earth's axis is tilted (at 23.5°). This tilt, combined with the orbit, is what causes the seasons.
The Moon's Orbit: Knowing that the Moon orbits the Earth approximately every 28 days.

5. The Moon and its Phases
The Fact: The Moon does not produce its own light; it reflects the light of the Sun.
Phases: Understanding that we see different "shapes" of the Moon (Crescent, Gibbous, Full, New) because we only see the part of the Moon that is currently being lit by the Sun as it orbits us.
Cycles: Recognising the predictable 28-day cycle of the lunar phases.

Substantive Knowledge Summary

Concept	Key Fact to Remember
The Sun	A star at the centre of the solar system.
Day/Night	Caused by Earth's **rotation** (24 hours).
The Year	Caused by Earth's **orbit** around the Sun (365 days).
Gravity	The force that keeps planets in orbit and pulls objects toward the Earth.
Moonlight	Actually reflected sunlight.

The "Space Science" Knowledge Check
Question: Does the Sun move around the Earth? (*No, the Earth orbits the Sun*).
Question: Why do we have a Leap Year every four years? (*Because an orbit takes 365 and a quarter days*).
Question: Which force keeps the Moon orbiting the Earth? (*Gravity*).
Question: What is the name of the path a planet takes around the Sun? (*An orbit*).
In Science, the **'Space'** learning theme falls under the **"Earth and Space"** category of the

Disciplinary Knowledge

In Science, **disciplinary knowledge** (often referred to as "Working Scientifically") is about how scientists actually do their jobs. For the **'Space'** learning theme, this is unique because pupils cannot "touch" the subject matter. Unlike a chemistry experiment in a beaker, space science relies on **observation, modelling, and evidence-based reasoning** to understand things that are millions of miles away.

1. Using Models to Explain Systems
Because we cannot bring the Solar System into the classroom, **disciplinary knowledge** involves using scale models to understand reality.
The Discipline: Understanding that a model is a representation of a complex system.
Scientific Skill: Pupils use spheres of different sizes to represent the relative scale of the Sun, Earth, and Moon. They learn that a model can explain a process (like an eclipse) even if it isn't the "real thing."
Critical Thinking: Recognising the limitations of models (e.g., "In our model, the distances aren't to scale because the Moon would be in the next classroom!").

2. Evidence-Based Reasoning and Theory
Disciplinary knowledge involves understanding how scientific ideas have changed over time based on new evidence.

The Discipline: Distinguishing between an observation and an inference.
Scientific Skill: Comparing the **Geocentric** (Earth-centred) and **Heliocentric** (Sun-centred) models. Pupils look at the evidence that changed the consensus, such as Galileo's observation of the moons of Jupiter using a telescope.

Historical Context: Understanding that science is a "living" subject where new data (like photos from the James Webb Telescope) can refine what we think we know.

3. Pattern Seeking and Systematic Observation
Since we cannot perform "fair tests" on planets, we rely on observing patterns over time.

The Discipline: Collecting data over long periods to identify cycles.
Scientific Skill: Recording the **phases of the moon** over 28 days or tracking the length of shadows throughout a day to "prove" the Earth is rotating.
Data Handling: Using tables and line graphs to show how the position of the Sun changes in the sky, and using that data to predict future patterns.

4. Predicting and Concluding
This involves using scientific laws (like gravity) to predict how objects will behave in space.

The Discipline: Making "If... then..." statements based on physical laws.
Scientific Skill: If the Earth is tilted away from the Sun, what will happen to the temperature and day length? Pupils use their knowledge of the Earth's orbit to predict the arrival of seasons.
Conclusion: Drawing "causal" links—e.g., "The Earth's rotation causes the Sun to *appear* to move across the sky, even though it is the Earth that is turning."
Why Disciplinary Knowledge Matters in Science

The "Doing" of Science	The Pupil Outcome
Observation	Learning to look closely at the night sky and record changes accurately.
Argumentation	Debating whether Pluto should be a planet based on specific scientific criteria.
Representation	Drawing diagrams of the Earth/Sun/Moon system to explain day and night.
Research	Using secondary sources (NASA data, books) to find out about planetary conditions.

The "Space Scientist" Success Criteria
The Model: I can explain why I used a football and a marble to show the Earth and the Moon.
The Evidence: I can explain how the movement of a shadow proves the Earth is spinning.
The Argument: I can use the word "evidence" to explain why we no longer believe the Sun moves around the Earth.
The Inquiry: I can identify which questions can be answered by an experiment (like "Which rocket fin shape works best?") vs. which require research (like "How hot is Venus?").

Learning Objectives

The **learning objectives** transition pupils from a local perspective of the world to a "system-thinking" perspective of the universe.

1. Describing Celestial Bodies
Objective: *To describe the movement of the Earth, and other planets, relative to the Sun in the solar system.*
The Focus: The Heliocentric Model.
Key Skill: Identifying the Sun as a star at the centre of the system and knowing the order and characteristics of the eight planets.
Outcome: Pupils can list the planets and explain that they all travel in orbits around the Sun.

2. Explaining Day and Night
Objective: *To use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky.*
The Focus: The mechanics of a spinning Earth.
Key Skill: Understanding that the Sun does not "move"—the Earth spins on its axis once every 24 hours.
Outcome: Pupils can use a globe and a torch to demonstrate why one half of the Earth is in shadow (night) while the other is lit (day).

3. The Moon's Orbit and Phases
Objective: *To describe the movement of the Moon relative to the Earth.*
The Focus: Earth's natural satellite.
Key Skill: Recognising that the Moon orbits the Earth (not the Sun) approximately every 28 days.
Outcome: Pupils can describe how the Moon's position changes and how this results in us seeing different phases (crescent, half, full).

4. Modelling Shapes and Scale
Objective: *To identify and describe the Sun, Earth, and Moon as approximately spherical bodies.*
The Focus: Understanding three-dimensional shape in space.
Key Skill: Moving away from 2D "circle" drawings to 3D "sphere" concepts.
Outcome: Pupils can explain why the Earth is a sphere and use physical objects (like different-sized balls) to represent the relative sizes of the Earth, Moon, and Sun.

5. Investigating Change Over Time
Objective: *To record and analyse the movement of shadows throughout a day to provide evidence for the Earth's rotation.*
The Focus: Working Scientifically.
Key Skill: Observation and data collection. By measuring a shadow every hour, pupils gather physical proof that the Earth is turning.
Outcome: Pupils can plot a graph showing shadow length or position and use it to reach a scientific conclusion about the Earth's spin.

Why These Learning Objectives Matter in Science

Objective Area	Scientific Impact
Mechanics	Teaches the difference between **rotation** (spin) and **revolution** (orbit).
Evidence	Shows that what we see with our eyes (the Sun "moving") isn't always scientific fact.
Scale	Helps pupils grasp the vastness of the universe, which builds a foundation for Physics.
Cycles	Introduces predictable natural cycles that govern life on Earth, like seasons and time.

The "Space Scientist" Success Criteria
I can name the eight planets in order from the Sun.
I can explain that the Sun stays still while the Earth spins.
I can describe why the Moon looks different at different times of the month.
I can use a diagram to show how the tilt of the Earth creates different seasons (Advanced).

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 Science themed around **'Space Science & Astronomy'**. This unit connects core National Curriculum Science strands (**Earth & Space, Forces & Magnets, Light, and Working Scientifically**) with key astronomical concepts: planetary orbits, night and day rotation, moon phases, gravity and air resistance, light reflection, and solar system scale models. It balances **substantive knowledge** (spherical bodies, geocentric vs. heliocentric models, relative sizes and distances, day/night mechanisms, lunar cycles, gravity as an attractive force) with **disciplinary knowledge** ("Working Scientifically"—constructing scaled physical models, recording shadow data systematically over time, evaluating historical scientific evidence, controlling variables in gravity drops, and identifying patterns in secondary data).

Unit Title: Earth, Orbit, and the Physics of Space
Duration: 6 Weeks (Approx. 1.5–2 hours per week)
Theme: Earth and Space, Planetary Orbits, Gravity, Day & Night, and Lunar Cycles.
Science Focus Areas:
Earth & Space*:* Spherical bodies, planetary order, Earth's rotation (day/night), heliocentric solar system, lunar phases.
Forces: Gravity as an attractive force pulling objects towards Earth's centre, atmospheric air resistance during re-entry.
Light: How light travels in straight lines from the Sun, how celestial bodies reflect light, shadow formation and movement.
Working Scientifically: Pattern seeking, fair testing, model evaluation, systematic observation over time, and presenting secondary data.
Key Science Pillars
Substantive Knowledge:

Earth, Sun, & Moon: The Sun is a star at the centre of our solar system; the Earth and other planets orbit the Sun; the Moon orbits Earth as a natural satellite. All three are roughly spherical bodies.
Day and Night: The Earth turns on its axis every 24 hours. The Sun does not move across the sky; Earth's rotation creates the illusion of solar movement and changes shadow lengths/angles.
Forces in Space: Gravity is a non-contact force pulling objects towards Earth's centre. Weight is the force of gravity on mass (W = m x g).
Disciplinary Knowledge ("Working Scientifically"):
Scientific Modelling & Limitations: Evaluating physical and digital models (e.g., using balls and torches) to identify what they accurately represent and where they fail (e.g., scale inaccuracy).
Systematic Data Collection: Measuring shadow lengths and angles at set intervals using gnomons/shadow sticks and plotting line graphs.
Fair Testing & Variables: Controlling surface area and mass when investigating air resistance on descending space capsules or parachutes.

Weekly Progression Scheme
Week 1: Spheres in Space – The Earth, Sun, and Moon
Science Strand: Earth & Space / Scientific Modelling.
Substantive Knowledge:
LKS2: The Sun, Earth, and Moon are approximately spherical bodies; distinguishing between stars, planets, and natural satellites.
UKS2: Historical shift from flat Earth theories to spherical Earth evidence (ship horizons, lunar eclipse shadows); relative sizes of Sun, Earth, and Moon.
Disciplinary Knowledge:
Evaluating Models: Comparing physical spherical models (peppercorns, peppercorn-to-basketball ratios) to understand scale limitations.
Practical Science Task:
LKS2 (Y3/4): *Spherical Sorting Enquiry.* Pupils sort various 3D shapes and spherical objects by scale, constructing a simple comparative model of the Earth-Moon-Sun system.
UKS2 (Y5/6): *Scale Model Investigation.* Pupils use playdough, callipers, and measuring tapes to construct an accurately scaled 3D model comparing Earth's diameter (12,742km) to the Moon (3,474km) and Sun (1,392,700km).

Week 2: Day, Night, and Shadow Tracking – Earth's Axis
Science Strand: Earth & Space / Light / Pattern Seeking.
Substantive Knowledge:
LKS2: Shadows change position and length throughout the day due to the apparent movement of the Sun.
UKS2: Earth spins on its axis once every 24 hours creating day and night; Earth's axis is tilted (23.5°); the Sun appears to rise in the East and set in the West due to Earth's counter-clockwise rotation.
Disciplinary Knowledge:
Systematic Time-Series Recording: Measuring shadow lengths and angles using a shadow stick (gnomon) and protractor every hour, identifying mathematical patterns.
Practical Science Task:
LKS2 (Y3/4): *Shadow Stick Investigation.* Pupils measure the shadow length of a fixed stick on the playground at 9 AM, 11 AM, 1 PM, and 3 PM, plotting a simple bar chart.

UKS2 (Y5/6): *Day & Night Darkroom Simulation.* Pupils use globes marked with sticky figures and bright torches in a darkened room to demonstrate how rotation causes day/night, plotting shadow line graphs to prove Earth's rotation speed.

Week 3: Planetary Orbits & The Solar System
Science Strand: Earth & Space / Secondary Data Analysis.
Substantive Knowledge:
LKS2: The 8 planets in our Solar System in order from the Sun (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune); rocky vs. gas giant planets.
UKS2: The heliocentric model (Copernicus/Galileo) replacing the geocentric model; planetary orbits are elliptical; orbital duration increases with distance from the Sun.
Disciplinary Knowledge:
Pattern Identification in Secondary Data*:* Analysing scatter plots comparing planetary distance from the Sun against orbital period (Earth years) and surface temperature.

Practical Science Task:
LKS2 (Y3/4): *Human Solar System.* Pupils act out planetary orbits on the school hall floor, moving at different speeds to show how inner planets orbit faster than outer planets.
UKS2 (Y5/6): *Planetary Data Analysis.* Pupils analyse NASA secondary dataset cards, graphing the relationship between planetary distance (AU) and orbital duration (years) to draw scientific conclusions.

Week 4: Phases of the Moon – Reflective Light & Natural Satellites
Science Strand: Earth & Space/Light/Observation over Time.
Substantive Knowledge:
LKS2: The Moon does not produce its own light; it reflects light from the Sun; the Moon takes approximately 28 days to orbit the Earth.
UKS2: The changing appearance of the Moon (phases: New Moon, Waxing Crescent, First Quarter, Waxing Gibbous, Full Moon, Waning) is caused by its position relative to Earth and the Sun.
Disciplinary Knowledge:
Observation over Time: Recording real-time lunar observations using a 28-day Moon diary and matching observations to theoretical phase diagrams.
Practical Science Task:
LKS2 (Y3/4): *Reflected Light Experiment.* Pupils use mirrors and dark boxes to demonstrate how light from a torch reflects off non-luminous "lunar" surfaces to enter the human eye.
UKS2 (Y5/6): *The Oreo Moon Phase Model.* Pupils model the 8 moon phases by scraping cream on biscuits, then verifying their model using a ping-pong ball on a stick rotated around an observer's head illuminated by a single lamp source.

Week 5: Gravity and Atmospheric Friction – Forces of Space & Re-entry
Science Strand: Forces & Magnets/Fair Testing.
Substantive Knowledge:
LKS2: Gravity pulls objects toward the centre of the Earth; pushing and pulling forces affect object movement.
UKS2: Gravity acts without contact; weight (N) is gravitational attraction on mass (kg); air resistance acts as a friction force opposing motion through Earth's atmosphere.
Disciplinary Knowledge:

Controlling Variables in Fair Testing: Setting up a controlled drop experiment to measure how surface area impacts descent speed while keeping mass, fall height, and drop method constant.
Practical Science Task:
LKS2 (Y3/4): *Gravity Drop & Weight Force.* Pupils measure forces in Newtons (N) using force meters (Newton meters) on various "space equipment" masses.
UKS2 (Y5/6): *Space Capsule Re-entry Parachute Investigation.* Pupils design cupcake-liner or polythene parachutes with varying surface areas, measuring drop time with stopwatches to calculate terminal velocity and evaluate air resistance.

Week 6: Space Mission Inquiry – Scientific Synthesis & Presentation
Science Strand: Working Scientifically Synthesis/Communication.
Substantive Knowledge:
LKS2/UKS2 Synthesis: Integrating concepts of Earth's rotation, orbital mechanics, light reflection, gravity, and atmospheric forces into a cohesive space mission scenario.

Disciplinary Knowledge:
Communicating Scientific Claims: Using evidence gathered across Weeks 1–5 to answer a complex scientific question and present findings using scientific vocabulary.
Practical Science Task:
LKS2 & UKS2: *The Mars Rover/Moon Base Feasibility Report.*
Task 1: Pupil teams receive a simulated mission scenario (e.g., "Designing a base that can harvest solar power continuously while surviving extreme gravitational conditions").
Task 2: Pupils construct a multi-media presentation or scientific poster combining physical models, shadow graph data, force diagrams with labelled vector arrows (Gravity ↓, Air Resistance ↑), and planetary data tables.
Plenary: "Scientific Peer Review Panel" where pupil groups present their findings to peer panels who question their conclusions using scientific evidence.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Identifies the Earth, Sun, and Moon as round shapes. • States that night happens when the Sun goes away. • Names 2–3 planets in the solar system. • Measures drop time with help but does not control variables.	• Describes the Sun, Earth, and Moon as roughly spherical bodies. • Explains that shadows change length/direction due to Earth's apparent sun movement. • Names the 8 planets in correct order from the Sun. • Records measurements accurately in tables and draws simple bar charts.	• Explains the difference between stars (light producers) and planets/moons (light reflectors). • Uses shadow data to prove the Sun's position changes relative to Earth throughout the day. • Explains how inner rocky planets differ from outer gas giants using data. • Evaluates limitations of physical models (e.g.,

			globe vs. actual Earth scale).
Upper Key Stage 2 *(Years 5 & 6)*	• Knows Earth orbits the Sun once a year. • Describes day and night using the Earth spinning but confuses axis tilt. • States that gravity pulls things down without using Newton units. • Identifies variables in an experiment with teacher guidance.	• Explains day and night as a result of Earth's rotation on its axis every 24 hours. • Explains how the heliocentric solar system model operates. • Differentiates between mass (kg) and weight force (N) driven by gravity. • Conducts fair tests by systematically isolating independent and controlled variables.	• Explains how Earth's 23.5° axial tilt causes changing day length and seasons alongside rotation. • Explains the apparent visual changes of moon phases using geometry and light reflection. • Analyses complex non-linear secondary data graphs to justify scientific conclusions. • Evaluates experimental anomalies in air resistance trials and proposes precise methodological refinements.

Other Information, Ideas and Resources

Science lessons for the **'Space'** learning theme are most effective when they move from **observation** (what we see) to **modelling** (why it happens). Since we can't visit the planets, these ideas focus on bringing the mechanics of the solar system into the classroom.

1. The "Shadow Stick" Investigation (Earth's Rotation)
The Concept: Proving that the Earth spins on its axis.

The Activity: Place a metre ruler or a stick vertically in the ground on a sunny day. Every hour, pupils mark the end of the shadow with chalk or a pebble and measure its length.
Scientific Discovery: Pupils will observe the shadow moving in a curve and changing length.
The Conclusion: It isn't the Sun moving across the sky; it's the Earth rotating.

2. Pocket Solar System (Scale and Distance)
The Concept: Understanding the vast distances between planets.

The Activity: Give each pupil a strip of till-roll (receipt paper) about 1 metre long. Using a specific scale, they mark the position of the Sun at one end and Pluto/The Kuiper Belt at the other.
The Task: They fold the paper to find the midpoints where planets sit.
Surprise Factor: Pupils often realise that the four "rocky" planets are all huddled extremely close to the Sun, while the "Gas Giants" are spaced incredibly far apart.
Scientific Skill: Modelling and understanding relative distance.

3. Moon Phase Oreos (The Lunar Cycle)
The Concept: Describing the movement of the Moon relative to the Earth.

The Activity: Use sandwich cookies (like Oreos). Pupils twist them apart and scrape away the cream to represent the different phases: New Moon (no cream), Full Moon (all cream), and Crescent/Gibbous (partial cream).
The Task: Arrange the cookies in a circle to show the 28-day cycle.
Scientific Skill: Identifying patterns and understanding that the Moon's appearance changes based on its position relative to the Sun and Earth.

4. "The Great Orbit Race" (Revolution vs. Rotation)
The Concept: Understanding that different planets take different amounts of time to orbit the Sun.

The Activity: Take the class to the playground. One pupil is the Sun (centre). Others represent planets at different "orbital distances."
The Task: On "Go," everyone walks at the same pace in their orbit.
The Discovery: The "Earth" pupil finishes their year quickly, while the "Neptune" pupil (further out) takes much longer to complete one circle.
Scientific Skill: Understanding the relationship between distance from the Sun and the length of a "year."

5. Heliocentric vs. Geocentric Debate (Working Scientifically)
The Concept: How scientific ideas change over time.

The Activity: Provide pupils with "Evidence Cards." Some cards support the old idea that everything moves around the Earth (e.g., "The Sun looks like it rises and sets"). Other cards support the modern Sun-centred view (e.g., "Galileo saw moons orbiting Jupiter, not Earth").
The Task: Pupils must sort the evidence and "argue" like historical scientists.
Scientific Skill: Using **evidence** to support or refute a theory.

Summary of Scientific Skills Used

Lesson	Disciplinary Skill	Substantive Knowledge
Shadow Stick	Systematic Observation	Earth's rotation causes day/night.
Pocket System	Using Scale Models	Relative distances of planets.
Oreo Moons	Identifying Patterns	The 28-day lunar cycle.
Orbit Race	Modelling Processes	Orbits and the length of a year.

Considerations for Implementation

English
Book/Text Ideas
https://www.booksfortopics.com/booklists/topics/science-maths-computing/space-ks2/ For Key Stage 2, space-themed reading should span **fiction**, **non-fiction**, and **poetry** to build a comprehensive vocabulary. Here is a curated selection of texts categorised by genre and how they link to the curriculum goals. **1. Narrative Fiction (Storytelling & Empathy)** Fiction helps pupils imagine the "human" side of space travel and alien encounters. **"The Iron Man" by Ted Hughes:** While often seen as a nature story, the final chapters involving the **Space-Bat-Angel-Dragon** from the stars provide a fantastic "otherworldly" perspective for descriptive writing. **"Cosmic" by Frank Cottrell-Boyce:** A hilarious story about a very tall boy who accidentally ends up in space. It is excellent for exploring **character voice** and the concept of "responsibility" in a high-stakes environment. **"Phoenix" by SF Said:** A high-octane "space opera" with incredible illustrations. It explores themes of stars, power, and mythology, perfect for higher-attaining Year 5/6 readers. **2. Non-Fiction (Substantive Knowledge)** These texts provide the hard facts needed for your Science and History curriculum. **"Hidden Figures (Young Readers' Edition)" by Margot Lee Shetterly:** As we discussed in the history section, this tells the true story of the Black female mathematicians at NASA. It is vital for teaching **historical significance**. **"The Darkest Dark" by Chris Hadfield:** Written by a real astronaut, this picture book (suitable for lower KS2) describes Chris's childhood fear of the dark and how watching the Apollo 11 moon landing changed his life. **"Professor Astro Cat's Frontiers of Space" by Dominic Walliman:** A beautifully designed book that explains complex physics (gravity, orbits, and the big bang) using a graphic-novel style that appeals to visual learners. **3. Poetry (Imagery & Figurative Language)** Space is a highly metaphorical subject, making it perfect for practicing poetic devices. **"Space Poems" edited by Gaby Morgan:** A collection covering everything from the planets to the stars. **"The Moon" by Robert Louis Stevenson:** A classic poem that looks at the Moon from a terrestrial perspective, useful for comparing **historical views** of space vs. modern scientific views. **"Ten Things Found in a Wizard's Pocket" (Space Variant):** Encourage pupils to read Ian McMillan's style and write their own version: *"Ten things found in an Astronaut's locker."* **Recommended Reading List by Year Group**

Year Group	Text Title	Focus Area
Year 3/4	*The Darkest Dark*	Biography / Overcoming Fear
Year 3/4	*The Way Back Home* (Oliver Jeffers)	Creative Writing / Fantasy
Year 5/6	*Cosmic*	Humorous Fiction / Space Mechanics
Year 5/6	*Curiosity: The Story of a Mars Rover*	Non-fiction / Robotics & Engineering
Year 6	*Space Maps* (Lara Albanese)	Geography / Navigating the Stars

How to use these in class:
Guided Reading: Use a chapter of *Cosmic* to practice "Retrieval" and "Inference" skills regarding how the characters feel about being weightless.
Comparative Analysis: Read a non-fiction account of the Moon Landing alongside *The Darkest Dark* to see how facts are woven into a story.
Vocabulary Extension: Use *Professor Astro Cat* to find "Tier 3" technical words (e.g., *supernova, light-year, vacuum*) to add to your science display.

Substantive Knowledge

In English, **substantive knowledge** for the **'Space'** learning theme consists of the factual "content" of the language itself—the specific vocabulary, the structural conventions of different genres, and the grammatical rules required to communicate effectively about the cosmos.

1. Vocabulary: Tier 2 and Tier 3 Words
Substantive knowledge involves the "word bank" pupils must master to move from general descriptions to precise communication.

Tier 3 (Subject-Specific): Technical words that are essential to the topic.
Examples: Orbit, celestial, gravity, atmosphere, vacuum, light-year, spherical, trajectory, astronomical.
Tier 2 (Academic): High-frequency words used across subjects to describe processes or scale.
Examples: Vast, significant, eerie, infinite, hostile, sequence, observation, evidence.
Etymology: Knowing that many space words come from Greek or Latin (e.g., *'astron'* meaning star; *'sol'* meaning sun).

2. Reading: Genre Conventions
This is the knowledge of how different types of space-themed texts are organised.

Non-Fiction (Explanatory/Information): Knowing that these texts use subheadings, bullet points, glossaries, and diagrams to help the reader navigate facts.
Science Fiction: Recognising the tropes of the genre—futuristic technology, alien settings, and the "hero's journey" in an unknown environment.
Biographies: Understanding the chronological structure used to recount the lives of astronauts or scientists (e.g., Katherine Johnson).
Poetry: Identifying structures such as haikus about stars or "kenning" poems about planets.

3. Writing: Grammatical Building Blocks
To write about space, pupils need to know how to use specific grammatical tools to create tone and clarity.

Fronted Adverbials of Time and Place: Used to guide the reader through a mission.
Example: "**Beyond the moon's orbit,** the stars shone brighter." or "**After three months of travel,** the crew arrived."
The Passive Voice: Often used in formal scientific reporting to sound objective.
Example: "The rocket **was launched**" rather than "The men launched the rocket."
Expanded Noun Phrases: To create vivid imagery of the unknown.
Example: "The **swirling, violent storms of Jupiter's Great Red Spot**."
Relative Clauses: To add detail to celestial bodies.
Example: "The Sun, **which is a massive ball of gas,** provides heat for the Earth."

4. Oracy: Rhetorical and Conversational Fact
The "rules" of spoken language used during space-themed discussions.

Standard English: Knowing when to switch from "slang" to formal Standard English during a presentation (e.g., a Mission Briefing).
Debate Structures: Knowing the formal ways to agree or disagree with a peer.
Example: "I understand your point regarding the cost of space travel, however, I believe the scientific benefits outweigh the expense."
Cue Cards and Signposting: Knowledge of how to use prompts to keep a speech on track (e.g., using "First," "Secondly," and "In conclusion").

Substantive Knowledge Summary

Area	**Key "Fact" to Master**
Spelling	Mastering tricky technical words like *'environment'* or *'vacuum'*.
Punctuation	Using brackets or dashes for parenthesis (adding extra space facts).
Structure	Knowing that an "Explanation Text" explains *how* (e.g., how a rocket works).

Style	Knowing that a "Journal Entry" is written in the first person (I).

The "English Astronaut" Knowledge Check
Grammar: Can you turn the sentence "Mars is red" into an **expanded noun phrase**? (*"The dusty, iron-rich surface of Mars..."*).
Vocabulary: What is the difference between an **astronaut** and an **astronomer**? (*An astronaut travels; an astronomer observes*).
Genre: Which feature would you always find in a non-fiction book about planets but rarely in a storybook? (*An Index or Glossary*).
Oracy: What is a "rhetorical question" you could use to start a speech about Mars? (*"Is there anyone truly alone in the universe?"*).

Disciplinary Knowledge

In English, **disciplinary knowledge** for the **'Space'** learning theme is about how we use language to convey the "extraordinary." It focuses on how writers and speakers adapt their style to suit different purposes—whether they are explaining a scientific fact, creating an atmosphere of suspense in a story, or debating a controversial historical event. It is the study of **how we communicate complex ideas effectively.**

1. Reading: Analysis and Critical Evaluation
Disciplinary knowledge in reading involves looking *past* the plot to see how a text is constructed.

Authorial Intent: Understanding *why* an author chose specific words to describe space. (e.g., Why use "the silent, cold vacuum" instead of just "space"?).
Evaluating Evidence: In non-fiction, the discipline of distinguishing between fact, opinion, and bias—especially when reading about the "Space Race" or the search for alien life.
Structural Analysis: Recognising how different "Space" genres are built. For example, how a sci-fi novel uses "cliff-hangers" versus how a NASA report uses "subheadings" and "glossaries."

2. Writing: Crafting for Impact
The discipline of writing is about selecting the right linguistic tools for the "mission."

Vocabulary Precision (Tier 3 Words): Knowing when to use technical terminology (e.g., *spherical, orbit, trajectory*) to sound authoritative in a report.
Figurative Language: Using metaphors and similes to describe things that are hard to imagine. (e.g., "The rocket was a silver needle piercing the velvet sky").
Grammatical Logic: Using **cohesive devices** (e.g., *furthermore, consequently, as a result*) to link scientific ideas together in an explanation of how seasons work.
Editing and Redrafting: The discipline of "polishing" a piece of writing to ensure the tone remains consistent—shifting from a formal astronaut's log to an informal letter home.

3. Oracy: Presence and Rhetoric
Disciplinary knowledge in Oracy involves using the voice and body to command an "audience."

Formal vs. Informal Registers: Knowing how to speak like a scientist during a presentation versus how to speak like a character in a drama.
Rhetorical Devices: In a debate about whether we should colonise Mars, using the "Rule of Three" or "Rhetorical Questions" to persuade an audience.
Active Listening: The discipline of responding to a peer's scientific theory with "building" or "challenging" stems (e.g., *"I hear what you're saying about gravity, but have you considered..."*).
Pace and Projection: Using silence and volume to mimic the drama of a rocket launch countdown.

Why Disciplinary Knowledge Matters in English

Aspect	The "Space" Application
Reading	Moving from "decoding words" to "interpreting the mysteries" of a text.
Writing	Moving from "telling a story" to "constructing a world."
Oracy	Moving from "talking" to "communicating with purpose."

The "Master Communicator" Success Criteria
📖 Reading
I can identify three "Space" technical terms and explain their meaning using the text.
I can explain how the author creates a sense of "awe" in the opening paragraph.

✍ Writing
I can use **fronted adverbials** to show the passage of time in a mission log. (e.g., *"After three months in zero-G..."*).
I can choose the most effective adjective to describe a planet's atmosphere.

🗣 Oracy
I can present a "Mission Briefing" using a clear, formal tone.
I can participate in a "Socratic Circle" debate, using evidence to back up my claims about space exploration.

Learning Objectives

In English, the **'Space'** learning theme allows pupils to explore the tension between **factual precision** and **imaginative wonder**. The **learning objectives** focus on adapting language for different audiences—moving from the cold, technical tone of a NASA report to the emotive, descriptive language of a science fiction novel.

1. Reading: Comprehension and Analysis
Objective: *To identify how language, structure, and presentation contribute to meaning in space-themed texts.*
The Focus: Understanding the "mechanics" of a text.
Key Skill: Inference. Using clues in a story to understand how an astronaut feels during a launch, even if the author doesn't explicitly state they are "scared."

Outcome: Pupils can compare a non-fiction text about the Moon with a poem about the Moon, identifying how the **purpose** (to inform vs. to entertain) changes the vocabulary used.

2. Writing: Transcription and Composition
Objective: *To draft and write by selecting appropriate grammar and vocabulary, understanding how such choices can change and enhance meaning.*
The Focus: Precision and Imagery.
Key Skill: Cohesion. Using fronted adverbials (e.g., *"Beyond the stratosphere,"* or *"After three days of radio silence,"*) to link ideas and guide the reader through a celestial journey.
Outcome: Pupils can write a formal "Mission Report" using the passive voice (e.g., *"The lunar samples were collected"*) and a descriptive "Alien Setting" narrative using expanded noun phrases.

3. Oracy: Speaking and Listening
Objective: *To explain and discuss their understanding of space concepts, maintaining focus and using notes where necessary.*
The Focus: Confidence and Rhetoric.
Key Skill: Adapting Register. Learning to switch between a "Scientific Presentation" (formal/standard English) and a "Roleplay" as an alien or astronaut (informal/emotive).
Outcome: Pupils can participate in a formal debate on a topic like *"Should we spend billions exploring Mars?"*, using evidence to back up their points and responding politely to "counter-arguments."

4. Vocabulary and Morphology
Objective: *To use subject-specific (Tier 3) vocabulary accurately and explore the etymology of space-related words.*
The Focus: The "Language" of the Universe.
Key Skill: Etymology. Understanding that 'astronomy' comes from the Greek *astron* (star) and *nomos* (law).
Outcome: Pupils can use a glossary to define technical terms and then deploy those words correctly in their own creative writing.

Why These Learning Objectives Matter in English

Skill Area	Educational Benefit
Retrieval	Searching for facts in a "Space Encyclopaedia" builds research speed.
Editing	Checking "Mission Logs" for spelling (e.g., *environment, vacuum*) reinforces accuracy.
Performance	Reading "Space Poetry" aloud helps pupils master pace and intonation.
Critical Thinking	Assessing "Is this a real news story or a sci-fi snippet?" builds digital literacy.

The "English Mission" Success Criteria
I can write a description of a black hole that uses a **simile** to create a sense of danger.

I can use **bullet points** and **subheadings** to organise my "Guide to the Planets."
I can explain the difference between a **fact** (Earth is a sphere) and an **opinion** (Space travel is boring).
I can present a 1-minute speech about my favourite planet using a loud, clear voice.

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 English (**Oracy, Reading, and Writing**) themed around **'Space Exploration & Discovery'**. This unit integrates core National Curriculum English strands using high-quality space literature—including **narrative fiction** (*The Jamie Drake Equation*/*Cosmic* by Frank Cottrell-Boyce), **biographical non-fiction** (*Counting on Katherine* by Helaine Becker/*Hidden Figures*), and **persuasive/argumentative writing** (arguments for space exploration vs. Earth conservation). It balances **substantive knowledge** (genre conventions, tier-2/3 vocabulary, formal register, passive voice, relative clauses, cohesive devices, rhetorical tropes, and phonics/etymology) with **disciplinary knowledge** ("Thinking Like an Author, Reader & Speaker"—interrogating authorial intent, adjusting spoken tone for audience, analysing reader impact, structural editing, and evaluating persuasive rhetoric).

Unit Title: Words in Orbit: Narrative, Biography, and Space Rhetoric
Duration: 6 Weeks (Approx. 4–5 hours per week)
Theme: Space Exploration, Hidden Figures, Deep-Space Narratives, and Planetary Debates.
Core Text Inspirations:
Narrative Fiction: The Jamie Drake Equation (Christopher Edge)/*Cosmic* (Frank Cottrell-Boyce).
Non-Fiction Biography: Counting on Katherine (Helaine Becker)/*Astronaut Handbook* (Meghan McCarthy).
Persuasive Texts: Authentic speeches, ESA press releases, and space exploration commentary.
Core Pillars of English Knowledge
Substantive Knowledge:
Vocabulary: Tier 2 (*impenetrable, celestial, infinite, trajectory, pioneer*) & Tier 3 (*microgravity, orbit, atmospheric, telemetry, launch pad*). Etymology: Latin root *aster/astro* (star), *naut* (sailor).
Grammar & Punctuation:
LKS2: Fronted adverbials of time/place (*Beyond the stratosphere,...*), expanded noun phrases (*the vast, ink-black void*), inverted commas for direct speech.
UKS2: Relative clauses using *who/which/where*, passive voice (*The telemetry was calculated by...*), formal modal verbs (*must, ought to, shall*), colon/semicolon for independent clauses.
Oracy Conventions: Physical (posture, eye contact), Linguistic (rhetorical questions, formal register), Cognitive (structuring points, countering arguments).
Disciplinary Knowledge ("Thinking Like a Reader, Writer & Speaker"):
Reader: Inferring character motivation, analysing how authors build suspense through short sentence structures, evaluating non-fiction text layouts.
Writer: Emulating mentor texts, planning structural arcs (Opening → Build-up → Climax → Resolution), proofreading for cohesion.
Speaker: Adapting vocal projection and pacing for formal broadcast speeches vs. collaborative paired exploratory talk.

Weekly Progression Scheme
Week 1: Arrival at Mission Control – Setting Descriptions & Suspense (Narrative Focus)
Reading Focus: Analysing extracts from *The Jamie Drake Equation*/*Cosmic*. Identifying sensory language, figurative devices (similes, personification of space), and sentence length variations used to create tension.
Oracy Focus: *Exploratory Talk.* Paired discussion analysing how space is portrayed (welcoming vs. hostile environment), using evidence quotes to justify views.
Writing Outcome: A descriptive narrative passage capturing a rocket launch or deep-space view.

Substantive Grammar:
LKS2: Expanded noun phrases (*the blinding, golden ignition trail*); prepositions (*above the atmosphere, beneath the capsule*).
UKS2: Relative clauses (*The ISS, which orbited 400km above Earth, shimmered...*); personification (*The void swallowed the radio signal*).
Disciplinary Task: *Authorial Mimicry.* Pupils annotate a mentor text for "show, don't tell" emotion, then re-write the passage changing the mood from awe-inspiring to terrifying by swapping verbs and prepositions.

Week 2: Lost in the Stratosphere – Dialogue & Character Tension (Narrative Focus)
Reading Focus: Inferring character thoughts and relationships through dialogue extracts during critical space emergency scenes.
Oracy Focus: *Hot-Seating.* Pupils take on the persona of an astronaut in distress or Mission Control flight director, answering peer questions under pressure.
Writing Outcome: A complete 4-part narrative scene: *Approaching orbit → System failure emergency → Problem solving via dialogue → Safe resolution.*
Substantive Grammar:
LKS2: Direct speech punctuation (inverted commas, commas after reporting clauses, capital letters).
UKS2: Integrating dialogue with action to advance plot without relying on repetitive verbs (*"Mayday," whispered Mission Control, jamming the kill-switch*).
Disciplinary Task: *Structural Editing.* Pupils edit a draft dialogue passage to remove "filler talk" and replace generic verbs (*said, yelled*) with precise action descriptions that reveal internal character fear.

Week 3: Unsung Pioneers – Reading & Analysing Biographies (Non-Fiction Focus)
Reading Focus: Examining biographical mentor texts (*Counting on Katherine*/*Hidden Figures*). Identifying structural features (chronological order, subheadings, temporal connectives) and language features (formal tone, past tense).
Oracy Focus: *Jigsaw Reading Presentation.* Expert groups read different sections of a pioneer's life (childhood, education, breakthrough at NASA) and present key findings back to home groups.
Writing Outcome: Biographical profile plan and notes on a prominent space pioneer (e.g., Katherine Johnson, Mae Jemison, Yuri Gagarin).
Substantive Grammar:
LKS2: Temporal conjunctions (*Meanwhile, Shortly after, Years later*); third-person pronouns (*she, her, they*).
UKS2: Passive voice to emphasise scientific achievements (*The orbital trajectory was calculated by Katherine*); parenthesis (brackets, dashes, commas) for extra biographical facts.
Disciplinary Task: *Fact vs. Opinion Interrogation.* Pupils highlight biographical texts in two colours: factual objective data vs. subjective authorial appraisal of the pioneer's impact.

Week 4: Written History – Drafting & Publishing Space Biographies (Non-Fiction Focus)
Reading Focus: Proofreading and evaluating peer non-fiction drafts against formal register criteria.
Oracy Focus: *Author's Chair Read-Aloud.* Reading biographical drafts aloud with deliberate emphasis on formal vocal tone, pausing at key chronological transitions.
Writing Outcome: A published non-fiction biography featuring subheadings, archival photos with captions, and a cohesive formal structure.
Substantive Grammar:
LKS2: Paragraphing around key life phases; heading and subheading alignment.

UKS2: Cohesive devices across paragraphs (adverbials such as *Consequently, As a direct result of these calculations, Furthermore*).
Disciplinary Task: *Cohesion Audit.* Pupils map the flow of ideas between paragraphs using cohesive arrows to ensure smooth thematic transitions from childhood talent to NASA achievement.

Week 5: The Great Space Debate – Persuasive Rhetoric & Oracy (Persuasive Focus)
Reading Focus: Analysing persuasive speeches and articles discussing: *"Should governments spend billions exploring Mars, or spend those funds solving climate change on Earth?"*
Oracy Focus: *Formal Town Hall Debate.* Structured debate using formal discourse markers (*"I acknowledge my opponent's point, however...", "The evidence clearly demonstrates that..."*).
Writing Outcome: A formal persuasive speech or balanced argumentative essay outlining positions on space exploration funding.
Substantive Grammar:
LKS2: Rhetorical questions (*How can we ignore the mysteries of the universe?*); modal verbs of obligation (*must, should*).
UKS2: Formal subjunctive mood (*If Earth were to face extinction...*); colon to introduce expanded arguments; rhetorical rule of three.
Disciplinary Task: *Rhetorical Device Identification.* Pupils colour-code a famous speech (e.g., JFK's "We choose to go to the Moon") identifying pathos (emotional appeal), ethos (authority), and logos (logical statistics).

Week 6: Mission Broadcast Showcase – Performance & Publication (Synthesis)
Reading & Writing Focus: Refining, polishing, and performing final written pieces.
Oracy Focus: *The NASA Press Conference/Podcast Broadcast.* Presenting a polished speech or audio-reading of narrative extracts into microphones/recording devices with expressive pitch, pace, and projection.
Substantive Synthesis: Integrating narrative sensory imagery, formal biographical structures, and persuasive rhetorical devices mastered across Weeks 1–5.
Disciplinary Task: *Peer Review & Evaluation.* Classmates evaluate broadcasts using a structured English rubric, assessing vocabulary precision, grammatical accuracy, and vocal delivery effectiveness.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Uses basic space vocabulary (*rocket, moon, big*). • Punctuates sentences with full stops but misses inverted commas in speech. • Writes short, narrative sequences without clear paragraph transitions. • Speaks audibly but relies heavily on teacher prompts during debates.	• Uses expanded noun phrases and prepositions to build sensory space settings. • Accurately uses inverted commas and reporting clauses for narrative dialogue. • Writes structured biographies using chronological paragraphs and temporal connectives. • Delivers formal speech during debates using	• Employs varied sentence openers and precise Tier 2/3 vocabulary choices. • Integrates dialogue to show character emotions rather than telling the reader directly. • Seamlessly links non-fiction paragraphs using fronted adverbials of time/cause. • Adapts spoken register fluently, spontaneously

		rhetorical questions and clear projection.	countering peer debate arguments.
Upper Key Stage 2 *(Years 5 & 6)*	• Writes narrative scenes with basic plot progression but limited suspense. • Attempts relative clauses but introduces punctuation errors. • Uses third-person in biographies but shifts tense inconsistently. • Participates in debates but uses informal language during formal turns.	• Manipulates sentence length and relative clauses to build tension in narrative scenes. • Uses the passive voice accurately to maintain formal register in space biographies. • Organises persuasive essays using cohesive devices across paragraphs (*Consequently, Furthermore*). • Uses formal discourse markers and rhetorical devices (*rule of three, modal verbs*) in debates.	• Crafts narrative pace masterfully, blending description, action, and subtle dialogue. • Uses parenthesis, semicolons, and colons precisely to vary clause structures. • Shifts fluidly between active and passive voice to manipulate reader emphasis. • Delivers compelling persuasive speeches with controlled vocal cadence, posture, and rhetorical elegance.

Other Information, Ideas and Resources

These **lesson ideas** move from the technical "NASA style" of writing to the imaginative "Sci-Fi" style, ensuring pupils cover both formal and informal registers.

1. Writing: The "Mission to Mars" Log (Narrative & Formal)
The Concept: Using fronted adverbials and the first person (I) to create a sense of time and place.
The Activity: Pupils act as an astronaut on a 6-month journey to Mars. They write three diary entries: one at launch, one in deep space, and one as they land.
The Focus: Using **fronted adverbials of time** (*"After three months of silence..."*) and **adverbials of place** (*"Beyond the small window..."*) to guide the reader.
Substantive Knowledge: Correct use of first-person perspective and chronological structure.

2. Reading: The "Planet Brochure" (Persuasive & Non-Fiction)
The Concept: Identifying how presentation and language choices influence a reader.
The Activity: Provide pupils with travel brochures for Earth and a "hostile" planet like Venus or Neptune.
The Task: Pupils highlight **persuasive techniques** (alliteration, superlatives like "the hottest," and "the most beautiful") and identify how subheadings and bullet points make the text easier to read.
Disciplinary Knowledge: Evaluating how an author adapts their tone to "sell" a destination, even one that is impossible to visit.

3. Oracy: The "Great Space Debate" (Rhetoric & Argument)
The Concept: Using evidence to support an opinion and responding to others politely.
The Topic: *"Should the UK government spend £5 billion on a mission to Mars, or should that money be spent on Earth?"*
The Activity: Split the class into "Pro-Exploration" and "Pro-Earth." Give them **sentence stems** to help their debate (*"While I understand your point about the cost, I would argue that..."*).

The Focus: Using a formal register and maintaining eye contact during a presentation.

4. Writing: "The Creature from Sector 7" (Descriptive Imagery)
The Concept: Using expanded noun phrases and figurative language.
The Activity: Pupils design an alien and write a descriptive "Field Report."
The Task: They must avoid boring adjectives. Instead of "green skin," they might write: *"The **shimmering, emerald-green scales** of the creature's back."*
The Focus: Using **similes** to describe alien features (*"Eyes like burning coals"*) and **metaphors** for the setting.

5. Reading & Oracy: "Space Kenning" Poetry
The Concept: Using figurative language to describe celestial bodies.
The Activity: Read classic "Kennings" (a two-word metaphorical name for something).
The Task: Pupils create a Kenning poem for the Sun, Moon, or a Black Hole.
Example for the Sun: Light-bringer, Shadow-maker, Planet-warmer, Golden-giant.
The Performance: Pupils perform their poems using **intonation and volume** to represent the power of the object they are describing.

🛠 **Summary of English Skills Used**

Lesson	Focus Area	Key Grammatical/Oracy Tool
Mission Log	Composition	Fronted Adverbials / First Person
Planet Brochure	Reading	Subheadings / Persuasive Adjectives
Space Debate	Oracy	Formal Register / Argument Stems
Alien Report	Vocabulary	Expanded Noun Phrases / Similes
Kenning Poetry	Reading/Oracy	Metaphor / Performance Skills

Considerations for Implementation

Maths

We use the White Rose Maths Scheme. The information below is for enhanced provision purposes and do not replace the WRM lessons.

Substantive Knowledge

In Mathematics, **substantive knowledge** for the **'Space'** learning theme involves the specific facts, formulas, and numerical concepts pupils must master. At Key Stage 2, this is where the abstract science of the universe meets the concrete "tools" of arithmetic, geometry, and statistics.

1. Number and Place Value (Large Numbers)

Substantive knowledge involves the ability to read, write, and manipulate numbers up to 10,000,000.

Large Scale: Knowing how to read distances like 149,600,000km (the distance to the Sun).
Rounding: Using rounding to estimate planetary data (e.g., rounding the diameter of Jupiter to the nearest 10,000km).
Powers of 10: Understanding how multiplying or dividing by 10, 100, or 1,000 changes the position of a planet on a scale model.
2. Geometry: Properties of Shape
Moving from 2D representations to 3D celestial realities.

Spheres: Identifying the Earth, Sun, and Moon as **spheres**, not circles. Knowing the properties of a sphere (one curved surface, no edges).
Angles: Knowing that a full orbit is 360° and a half-orbit is 180°.
The Earth's Tilt: Knowing the specific value of the Earth's axial tilt (23.5°) and being able to measure or draw this angle using a protractor.

3. Measurement (Time and Distance)
Calculating the "when" and "where" of space travel.

Time Conversions: Knowing the relationship between seconds, minutes, hours, days, and years.
Example: Calculating that a "Leap Year" occurs because an orbit is 365.25 days (365 days and 6 hours).
Metric Units: Converting between metres (m) and kilometres (km) when calculating rocket altitudes.
Mass vs. Weight: Knowing that **Mass** (measured in kg) stays the same in space, but **Weight** (measured in Newtons, N) changes depending on gravity.

4. Statistics (Data Handling)
Interpreting the "Information Age" of space exploration.

Line Graphs: Interpreting graphs that show "Temperature vs. Distance from the Sun" or "Shadow Length over Time."
Tables: Reading and extracting information from a "Planetary Fact File" table (e.g., comparing the number of moons or orbital periods).
Mean and Average: Calculating the "average" temperature of a planet or the "mean" distance of a satellite's orbit.

5. Ratio and Proportion
The mathematical foundation of "Scale Modelling."

Scale Factors: Knowing that if a model is 1:100, every 1cm in the classroom represents 100cm (or 1m) in reality.
Relative Size: Understanding that if the Earth has a diameter of roughly 13,000km and the Moon is 3,500km, the Moon is approximately 1\4 the size of Earth.

Substantive Knowledge Summary

Topic	Key Mathematical Fact
Orbits	A complete revolution is a 360° turn.
Day/Night	Earth rotates 15° every hour (360\24).
Scale	A ratio expresses the relationship between a model and reality.
Gravity	Weight = Mass x Gravity (understanding the variable nature of N).

The "Space Maths" Knowledge Check
Arithmetic: If a rocket travels at 40,000km/h, how far does it travel in 10 hours?
Geometry: What 3D shape best describes the Moon?
Statistics: Looking at a table, which planet has the most moons (the "Mode")?
Time: How many minutes are in one full day on Earth? (24 x 60 = 1,440).

Disciplinary Knowledge

In Mathematics, **disciplinary knowledge** for the **'Space'** learning theme is about how we use numbers and geometry to make sense of things we cannot physically measure. It involves the "discipline" of **scaling, estimation, and using mathematical models** to represent the universe. It is the study of **how we apply mathematical logic to understand the vastness of the cosmos.**

1. Proportional Reasoning and Scale
Disciplinary knowledge involves understanding that the Solar System is too big to draw at full size, so we must use "ratio" and "proportion" to represent it.

Scaling Down: Understanding that if 1 cm represents 1,000,000 km, we can map out distances between planets.
Relative Size: The discipline of comparing volumes—recognising that if Earth were the size of a cherry, Jupiter would be the size of a watermelon.
The Power of 10: Understanding how our number system (place value) allows us to talk about thousands, millions, and billions accurately.

2. Geometry and Shape in Three Dimensions
The discipline of moving from "flat" 2D shapes to "spatial" 3D thinking.

Spherical Geometry: Understanding that "circles" in space are actually **spheres**.
Orbits as Ellipses: Recognising that a "perfect circle" is rare in space; the discipline involves identifying and drawing **ellipses** (ovals) to show how planets move.
Angular Movement: Understanding that as a planet orbits, it moves through **degrees (360°)**. This links to telling time and calculating parts of a year.

3. Data Handling and Interpretation

Space science generates huge amounts of data. **Disciplinary knowledge** involves knowing how to organise and "read" this data.

Line Graphs: Tracking the change in shadow length over 12 hours or the change in temperature as you move further from the Sun.
Time Calculations: The discipline of working with **non-decimal time** (60 minutes in an hour, 24 hours in a day, 365 days in a year) to calculate travel times between planets.
Identifying Anomalies: Looking at a data set of planetary temperatures and spotting the "outlier" (e.g., Venus being hotter than Mercury despite being further away).

4. Measurement and Estimation
The discipline of "Fermi Estimation"—making educated guesses about very large numbers.

Standard vs. Non-Standard Units: Knowing when to use kilometres (km) and when those units become too small, requiring the "discipline" of using Light Years or Astronomical Units (AU).
Mass and Weight: Understanding the mathematical difference between mass (how much "stuff" is in an astronaut) and weight (the pull of gravity on that mass).

Why Disciplinary Knowledge Matters in Maths

Concept	Mathematical Significance
Precision	In space travel, a 1° error in an angle at launch leads to missing a planet by millions of miles.
Patterns	Recognising that orbits and moon phases are **sequences** that repeat predictably.
Abstraction	Being comfortable working with numbers so large (150,000,000km) that they can no longer be visualised.

The "Space Mathematician" Success Criteria
Scale: I can explain why my model uses a 1:100 ratio to fit the planets on the playground.
Geometry: I can use a protractor to measure the 23.5° tilt of the Earth's axis.
Data: I can interpret a bar chart showing the number of moons each planet has and identify the mode.
Time: I can calculate how many days are in 2.5 Earth years using multiplication.

Learning Objectives

In Maths, the **'Space'** learning theme provides a real-world (or out-of-this-world) context for mastering **large numbers, geometry, and ratio**. The **learning objectives** focus on moving from concrete calculations to understanding the relationship between different scales and measurements.

1. Number and Place Value
Objective: *To read, write, order, and compare numbers up to 10,000,000 and determine the value of each digit.*
The Focus: Visualising the scale of the universe.

Key Skill: Rounding. Taking the precise diameter of a planet (e.g., Saturn at 116,460 km) and rounding it to the nearest 10,000 or 100,000 to make comparisons easier.
Outcome: Pupils can successfully order the eight planets based on their distance from the Sun (km) or their mass (kg).

2. Geometry and Angles
Objective: *To recognise, describe, and build 3D shapes and to measure/draw specified angles.*
The Focus: The shape of orbits and axes.
Key Skill: Measuring Angles. Using a protractor to understand the Earth's 23.5° tilt and how it relates to the seasons.
Outcome: Pupils can identify the Sun, Earth, and Moon as **spheres** (3D) rather than circles (2D) and can draw the elliptical paths of orbits.

3. Ratio and Proportion
Objective: *To solve problems involving the relative sizes of two quantities where missing values can be found by using integer multiplication and division facts.*
The Focus: Scale modelling.
Key Skill: Scaling Down. If a model uses a scale where 1 cm = 1,000 km, pupils calculate how many centimetres are needed to represent the Earth (12,742km\1,000 = approx. 12.7cm).
Outcome: Pupils can create a "playground solar system" where the distances between planets are mathematically proportional to the real distances in space.

4. Measurement and Time
Objective: *To use, read, write, and convert between standard units, converting measurements of length, mass, and time.*
The Focus: The mechanics of a "Year" and a "Day."
Key Skill: Time Conversion. Calculating the number of hours in a Martian year or minutes in a lunar cycle.
Outcome: Pupils can convert between kilometres (km) and metres (m) for rocket altitudes and understand that **Mass** (kg) is constant while **Weight** (N) changes with gravity.

5. Statistics and Data Handling
Objective: *To interpret and construct pie charts and line graphs and use these to solve problems.*
The Focus: Analysing planetary data.
Key Skill: Interpreting Trends. Looking at a line graph of "Surface Temperature vs. Distance from the Sun" to identify patterns and anomalies.
Outcome: Pupils can calculate the **mean** (average) temperature of a group of planets or the **range** of moon counts across the solar system.

Why These Learning Objectives Matter in Maths

Skill Area	Educational Benefit
Arithmetic	High-stakes context: "If the fuel calculation is wrong, the rocket misses!"
Problem Solving	Encourages multi-step thinking (e.g., converting distance to time using speed).
Visualisation	Helps pupils grasp abstract concepts like "A Million" or "A Billion."
Accuracy	Teaches the importance of precision in measurement and degree.

The "Mission Control" Success Criteria
I can read a 9-digit number and identify the value of the millions digit.
I can convert 3.5 days into hours (3.5 x 24 = 84hours).
I can explain why a 1:10 scale model of the Moon is smaller than the real Moon.
I can use a line graph to find the temperature of a planet at a specific distance.

Lesson Ideas

Here is a complete, 6-week Medium-Term Plan for Key Stage 2 Mathematics themed around **'Space Exploration & Astrophysics'**. This unit connects core National Curriculum Mathematics strands (**Place Value & Large Numbers, Four Operations & Problem Solving, Measurement & Time conversions, Geometry & Angles, and Statistics & Data Interpretation**) with astronomical contexts: distance to planets, rocket launch trajectories, light-year calculations, and orbital velocity graphs. It balances **substantive knowledge** (mathematical facts, formal written algorithms, place value structure, conversion formulas, geometric properties, and graph axes) with **disciplinary knowledge** ("Thinking & Reasoning Like a Mathematician"—identifying mathematical patterns, selecting efficient calculation strategies, evaluating model accuracy, testing conjectures, and interpreting real-world astronomical data).

Unit Title: Cosmic Numbers: Scale, Trajectories, and Astronomical Data
Duration: 6 Weeks (Approx. 5 hours per week)
Theme: Planetary Distances, Rocket Launch Ballistics, Space Station Timetables, and Deep-Space Data.
Maths Focus Areas:
Number & Place Value: Reading, writing, comparing, and rounding numbers up to 10,000 (LKS2)/10,000,000 (UKS2); working with negative numbers (space temperatures).
Calculations (Four Operations): Addition, subtraction, formal long multiplication, and division in contextual multi-step word problems (payload mass, fuel usage).
Measurement, Time & Rates: Time conversions (24-hr, time zones, orbital countdowns), metric conversion of planetary scales (m, km, AU).
Geometry & Position: Angles of launch trajectories, 3D coordinate grids (x, y, z space mapping), rotational symmetry of space stations.
Statistics & Data: Interpreting line graphs (telemetry curves, temperature shifts) and two-way tables (satellite launch schedules).
Key Mathematics Pillars
Substantive Knowledge

Place Value Structure: Understanding powers of 10, canonical partitioning of multi-digit numbers, and rounding to varying degrees of accuracy (100, 10,000, 1,000,000).
Computational Algorithms: Formal written methods for addition, subtraction, short/long multiplication, and short division with remainders.
Geometric & Temporal Conversions: 1 hour = 60 minutes = 3,600 seconds; full turn = 360°; coordinates expressed as (x, y) in 4 quadrants.

Disciplinary Knowledge ("Thinking Like a Mathematician"):
Pattern Seeking & Conjecturing: Testing hypotheses regarding planetary distances and orbital speeds (e.g., "Do planets further from the Sun always take longer to complete an orbit?").
Strategy Selection: Choosing between mental strategies (e.g., compensation for rounding distance numbers) and formal written algorithms for precision.
Data Interpretation: Extrapolating trends from non-linear telemetry line graphs and identifying measurement anomalies in real-world space datasets.

Weekly Progression Scheme
Week 1: Scale of the Solar System – Large Numbers & Place Value
Maths Strand: Number & Place Value / Rounding.
Substantive Knowledge:
LKS2: Numbers up to 10,000; 4-digit place value (Thousands, Hundreds, Tens, Ones); rounding to the nearest 10, 100, or 1,000.
UKS2: Numbers up to 10,000,000; powers of 10; rounding large distances to the nearest 100,000 or 1,000,000; negative numbers in temperature context (-150°C).
Disciplinary Knowledge:
Mathematical Estimation: Justifying when rounded astronomical figures are appropriate versus when exact calculations are required for launch safety.
Practical Mathematics Task:
LKS2 (Y3/4): *Moon Distance Partitioning.* Pupils read, write, and compare 4-digit distances between Earth, the Moon, and inner satellites using place value counters and number lines.
UKS2 (Y5/6): *Interplanetary Order.* Pupils analyse a database of planetary distances from the Sun (in km), order numbers into the millions, calculate negative temperature differences between Mercury and Neptune, and round distances for a scaled hallway display.

Week 2: Rocket Payload & Logistics – Multi-Step Addition & Subtraction
Maths Strand: Four Operations / Word Problems.
Substantive Knowledge:
LKS2: Formal column addition and subtraction with 4-digit numbers; inverse operation checking.
UKS2: Multi-step column addition/subtraction with numbers of any size, including decimals (kg of fuel, payload mass allowances).
Disciplinary Knowledge:
Problem Solving & Representation: Using bar models to represent multi-step fuel/mass allocation problems before executing written calculations.
Practical Mathematics Task:
LKS2 (Y3/4): *Cargo Mass Allocation.* Pupils calculate total rocket payload mass (kg) across 3 supply modules, using column subtraction to ensure the total does not exceed maximum thrust capacity.

UKS2 (Y5/6): *Mission Budgeting.* Pupils solve a multi-step space mission financial problem, balancing a budget of £45,500,000 across fuel, astronaut life support, and scientific equipment using formal column operations and bar modelling.

Week 3: Orbital Speed & Fuel Consumption – Multiplication & Division
Maths Strand: Multiplication & Division / Scaling.
Substantive Knowledge:
LKS2: Multiplying 2-digit and 3-digit numbers by a 1-digit number using formal grid/short multiplication; division with remainders.
UKS2: Formal long multiplication (4-digit x 2-digit); short and long division (4-digit ÷ 2-digit); scaling quantities up/down.
Disciplinary Knowledge:
Efficiency Evaluation: Comparing grid methods against formal column algorithms to determine the most accurate, rapid method for calculating space travel variables.
Practical Mathematics Task:
LKS2 (Y3/4): *Fuel Consumption Rate.* Pupils calculate the total litres of rocket propellant needed for multi-day trips by multiplying daily usage rate (348 litres/day) by duration (6 days).
UKS2 (Y5/6): *Light-Speed Calculation.* Pupils use long multiplication to calculate distances travelled by radio signals over multiple seconds (299,792km/s) and long division to determine how many orbits an ISS crew completes over a 30-day mission.

Week 4: Mission Control Telemetry – Time, Timetables & Conversions
Maths Strand: Measurement / Time & Unit Conversions.
Substantive Knowledge:
LKS2: 12-hour vs. 24-hour digital clocks; converting between minutes and seconds, hours and minutes; reading analogue clock faces.
UKS2: Converting between metric units of length (m, km) and time (seconds, hours, days); reading complex 24-hour two-way international time zone timetables.
Disciplinary Knowledge:
Systematic Time Calculation: Calculating duration across midnight/time zone barriers without falling into 100-minute decimal traps.
Practical Mathematics Task:
LKS2 (Y3/4): *Countdown Timers.* Pupils calculate launch countdown times and landing arrivals using analogue/digital time conversion lines (14:35 → 17:10).
UKS2 (Y5/6): *ISS Docking Timetable.* Pupils analyse authentic two-way communication timetables between NASA (Houston, CST), ESA (Germany, CET), and the ISS, calculating elapsed flight durations and orbital window schedules across time zones.

Week 5: Launch Trajectories & Constellations – Angles, Coordinates & Grid Mapping
Maths Strand: Geometry & Position/Direction.
Substantive Knowledge:
LKS2: Acute, right, and obtuse angles; measuring angles in degrees (°); identifying lines of symmetry in geometric shapes.

UKS2: Angles on a straight line (180°) and around a point (360°); coordinates in all four quadrants; translating and reflecting shapes on a grid.
Disciplinary Knowledge:
Geometric Reasoning: Predicting final shape positions after translation/reflection across axes to model satellite orbital adjustments.
Practical Mathematics Task:
LKS2 (Y3/4): *Trajectory Protractor Practice.* Pupils measure launch entry angles on rocket flight charts, classifying trajectories as acute, right, or obtuse.
UKS2 (Y5/6): *Deep-Space Grid Mapping.* Pupils plot constellation star positions on a 4-quadrant coordinate grid, translating satellite path vectors (+4, -6) and calculating missing internal angles of orbital satellite arrays.

Week 6: Space Data Laboratory – Statistics, Line Graphs & Analysis (Synthesis)
Maths Strand: Statistics & Data Handling.
Substantive Knowledge:
LKS2: Interpreting bar charts, pictograms, and simple tables showing space data.
UKS2: Constructing and interpreting continuous line graphs (temperature drop during re-entry, altitude vs. time); calculating the mean as an average.
Disciplinary Knowledge:
Statistical Critique: Identifying misleading graph axes scales and drawing evidence-based conclusions from trend curves.
Practical Mathematics Task:
LKS2 & UKS2: *The Mission Control Data Briefing.*
Task 1: Pupils construct a continuous line graph tracking a rocket's altitude (km) over time (seconds), choosing appropriate scales for both axes.
Task 2: Pupils calculate the mean distance travelled across 5 simulated test launches and answer complex data interpretation questions.
Plenary: "Flight Director Briefing" where pupil pairs present their statistical graphs to justify whether a simulated rocket mission met safety standards.

Assessment Matrix (Progression Indicators)

Phase	Working Towards	Expected Standard	Greater Depth
Lower Key Stage 2 *(Years 3 & 4)*	• Reads 3-digit numbers but struggles with 4-digit place value. • Makes errors when regrouping during column addition/subtraction. • Identifies hours and minutes but struggles with 24-hour conversions. • Misreads protractor scales when measuring launch angles.	• Reads, writes, compares, and rounds 4-digit numbers accurately. • Uses formal column addition and subtraction to solve multi-step mass problems. • Converts fluently between 12-hour and 24-hour clock times. • Measures acute and obtuse launch angles accurately using a protractor.	• Explains place value relationships when multiplying/dividing by 10 or 100 in scale context. • Uses inverse operations flexibly to check calculations and find missing mass values. • Calculates complex elapsed time intervals across hour boundaries mentally.

			• Solves multi-step geometric missing-angle problems independently.
Upper Key Stage 2 *(Years 5 & 6)*	• Orders numbers to 100,000 but struggles with millions. • Uses short multiplication but makes positional errors in long multiplication. • Plots coordinates in Quadrant 1 only. • Reads points on a line graph but struggles to interpolate values between intervals.	• Reads, writes, rounds, and compares numbers up to 10,000,000. • Solves complex multi-step problems using formal long multiplication and division. • Plots, translates, and reflects coordinates across all 4 quadrants accurately. • Constructs continuous line graphs with appropriate scales and interprets multi-variable data.	• Demonstrates deep understanding of place value by converting fluidly between astronomical units (AU) and metres using standard form/powers of 10. • Evaluates alternative mathematical methods to select the most efficient strategy for multi-step calculations. • Calculates missing coordinates after multiple complex translations and reflections mathematically. • Identifies anomalies in secondary telemetry data and explains statistical trends using mean averages.

Other Information, Ideas and Resources

To make Maths engaging within a '**Space'** learning theme, there is a move from the abstract "big numbers" to concrete **problem-solving** and **geometry**. These ideas focus on the precision required for space travel and the scale of the universe.

1. The "Toilet Roll" Solar System (Scale & Ratio)
The Concept: Understanding the vast distances between planets using a physical scale model.
The Activity: Using a single square of toilet paper to represent a set distance (e.g., 10,000,000km).
The Task: Pupils calculate how many "squares" they need to roll out to reach each planet from the Sun.
Mercury: 5.8 squares
Earth: 15 squares
Neptune: 450 squares (You'll need the whole corridor!)
Maths Skill: Ratio and Proportion, and multiplying/dividing by powers of 10.

2. Weight on Other Worlds (Mass, Weight & Decimals)
The Concept: Understanding that gravity is a variable multiplier.
The Activity: Provide a table of "Gravity Factors" for different planets (e.g., Moon = 0.16, Jupiter = 2.4).
The Task: Pupils weigh everyday classroom objects (a book, a shoe) in grams (g). They then multiply that mass by the gravity factor to find the "Weight" on that planet.
The Challenge: "If an astronaut weighs 80kg on Earth, what is their weight on Mars (0.38 gravity)?"
Maths Skill: Multiplying decimals and understanding **measures**.

3. Mission Control: Rocket Angles (Geometry)
The Concept: Using protractors to calculate trajectories and the Earth's tilt.
The Activity: Pupils are given a "Launch Map." They must use a protractor to draw specific angles for a rocket to avoid "Space Debris" (obstacles on the paper) and reach a target planet.
The Task: Measure and draw the Earth's axial tilt (23.5°) and explain how a 180° (half-orbit) or 360° (full-orbit) turn looks.
Maths Skill: Measuring and drawing angles with a protractor.

4. Planetary Fact-File Data (Statistics)
The Concept: Interpreting and presenting complex data sets.
The Activity: Give pupils a raw data table containing the number of moons, day length (hours), and surface temperature of all eight planets.
The Task:
Create a **Bar Chart** for the number of moons per planet.
Create a **Line Graph** showing the relationship between distance from the Sun and temperature.
Find the **Mean** (average) number of moons for the inner vs. outer planets.
Maths Skill: Data interpretation, Mean/Average, and Graph construction.

5. The "Alien Time" Challenge (Time Conversions)
The Concept: Working with non-decimal time units.
The Activity: Different planets have different day lengths (e.g., a day on Mars is roughly 25 hours; a day on Jupiter is only 10hours).
The Task: Pupils calculate how many Earth minutes are in a "Jupiter Day" or how many "Earth Days" have passed during one "Saturn Year."
Maths Skill: Converting units of time and multi-step word problems.

Summary of Maths Skills Used

Lesson	Topic Area	Key Mathematical Tool
Toilet Roll Scale	Ratio & Proportion	Scaling and division.
Planetary Weights	Number	Multiplying decimals.
Rocket Angles	Geometry	Using a protractor (°).
Fact-File Data	Statistics	Line graphs and averages.
Alien Time	Measurement	Converting hours/minutes/days.

Considerations for Implementation

Courageous Advocacy

Courageous Advocacy in a **'Space'** context is about moving beyond just learning facts to **taking action** on global or ethical issues that space exploration highlights. It encourages pupils to think about how we treat our own planet and the ethics of how we explore others.

1. "Mission: Earth First" (Environmental Advocacy)
The Concept: Using the "Overview Effect" (the shift in perspective astronauts have when seeing Earth from space) to advocate for local environmental change.
The Action: Pupils create a "Letter to the Future" or a campaign for the local community.
The Message: "If our planet is a tiny 'blue marble' in a vast vacuum, we must protect it because there is no 'Planet B'."
Activity: Write to the local council or school governors advocating for more green spaces or a reduction in single-use plastics, using satellite imagery of deforestation or melting ice caps as evidence.

2. "Dark Skies" Campaign (Light Pollution)
The Concept: Advocating for the "Right to see the Stars."
The Action: Researching how light pollution affects local wildlife (like owls or bats) and human well-being.
The Message: "Excessive artificial light wastes energy and disconnects us from the wonder of the universe."
Activity: Create "Starry Night" posters for the local neighbourhood, encouraging people to use downward-facing outdoor lights or turn off lights during peak migration seasons for birds.

3. "Hidden Figures" Justice (Diversity in STEM)
The Concept: Highlighting the contribution of marginalised groups in space history (e.g., Katherine Johnson, Margaret Hamilton, or Mae Jemison).
The Action: Identifying "gaps" in the school library or curriculum.
The Message: "Space belongs to everyone, regardless of gender, race, or background."
Activity: Pupils audit the school's science books. If they find a lack of diversity, they can run a bake sale or a "sponsored space-walk" (daily miles) to raise money to buy books that feature diverse scientists and engineers.

4. "Space Junk" Ethics (Global Responsibility)
The Concept: Discussing the 30,000+ pieces of debris currently orbiting Earth.
The Action: Raising awareness about "Sustainable Space."
The Message: "We must not treat the Solar System the way we have treated our oceans."
Activity: Pupils create a "Code of Conduct for Space" and send it to the UK Space Agency or a private space company (like SpaceX), asking what they are doing to ensure they aren't leaving "litter" behind for future generations.

🛠 Skills for the "Courageous Advocate"

Advocacy Skill	How it applies to Space
Critical Thinking	Questioning the cost of space travel vs. solving poverty on Earth.

Persuasion	Using "The Blue Marble" photo to move people to tears or action.
Research	Finding data on NASA's website about climate change.
Global Citizenship	Realising that from space, there are no borders—only one human race.

The Advocacy "Launch" Reflection
What is the problem? (e.g., We are losing our view of the stars).
Why does it matter? (e.g., It affects our mental health and nocturnal animals).
What can we do? (e.g., Ask the school to install motion-sensor lights).
Who can help? (e.g., The Campaign to Protect Rural England - CPRE).

Developing Spirituality

In the context of Key Stage 2, **Spirituality** isn't necessarily about religion; it's about the **"Windows, Mirrors, and Doors"** approach: looking out at the world (Windows), looking inward at oneself (Mirrors), and moving forward with a new perspective (Doors). **'Space'** is perhaps the most powerful learning theme for this, as it naturally evokes a sense of "Awe and Wonder."

1. The "Window": Awe and Wonder
The Concept: Realising the sheer scale and beauty of the universe.
The Activity: "The Hubble Gallery." Dim the lights and show high-definition images of nebulae, star clusters, and deep space galaxies.
Spiritual Reflection: Ask the "Big Questions" that have no easy answers.
"If the universe is infinite, where does it end?"
"How can something so beautiful exist so far away where no one can see it?"
The Goal: To move pupils from "I know the facts" to "I feel the wonder."

2. The "Mirror": The "Pale Blue Dot"
The Concept: Reflecting on our place in the universe and our unique value.
The Activity: Show the famous "Pale Blue Dot" photograph taken by Voyager 1. Explain that every human who ever lived is on that tiny speck.
Spiritual Reflection: * **Perspective:** "If we are so small, do our problems matter?" (The idea that our worries can feel smaller when compared to the stars).
Uniqueness: "Out of all the billions of planets we've found, this is the only one we know that has *you* on it."
The Goal: To build a sense of self-worth and a connection to the rest of humanity.

3. The "Door": Silence and Stillness
The Concept: Using the "Silence of Space" to practice mindfulness.
The Activity: "The Astronaut's Meditation." Have pupils lie on the floor in total darkness (or under "star" projectors). Play ambient, cinematic space music (like Hans Zimmer or Brian Eno).
The Task: Ask them to imagine they are drifting safely away from Earth. Tell them to "leave their heavy worries" on the ground and feel "weightless."
The Goal: To provide a rare moment of peace and internal quiet in a busy school day.

4. Connection: The "Stardust" Theory
The Concept: Understanding our physical connection to the cosmos.
The Activity: Explain the scientific fact that the iron in our blood and the calcium in our bones were created inside dying stars billions of years ago.
Spiritual Reflection: "We are not just *in* the universe; we are *of* the universe."
The Task: Create "Stardust Jars" (water, glitter, and food colouring). As the glitter settles, pupils reflect on a person they feel connected to, acknowledging that we are all made of the same "star stuff."

The Four Elements of Space Spirituality

Element	The "Space" Experience
Self	Realising my life is a tiny but precious miracle in a vast cosmos.
Others	Seeing that from space, there are no borders—we are one human family.
World	Developing a deep desire to protect our fragile "Oasis" in the dark.
Beyond	Being comfortable with the "Mystery"—accepting that we don't know everything.

A "Spiritual Minute" for the Classroom
At the end of a Science or English lesson, try this 60-second reflection:
Close your eyes.
Think of one thing you learned today that made your brain feel "too small" to hold it.
Think of one person on this planet you are glad is on this journey with you.
Take a deep breath and remember: you are made of stars.

Other

Extra-curricular activities allow pupils to dive deeper into the "awe and wonder" of space without the constraints of the National Curriculum. These ideas range from low-cost school clubs to community-wide events.

1. The "After-School Astronomy" Club
A weekly club where pupils move from "Stargazers" to "Space Experts."

Star Charts & Apps: Use free apps like *Stellarium* or *SkyView* on tablets to identify constellations in real-time.
Telescope Training: Partner with a local secondary school or astronomy society to bring in a telescope for a "Star Party" evening with parents.
Space News Bureau: Pupils create a monthly newsletter or a "Space Minute" podcast for the school website, reporting on real NASA/ESA missions (like the James Webb Telescope's latest photos).

2. The "Rocketry & Engineering" Challenge
A hands-on STEM club focused on the physics of flight.

Water Rockets: Use plastic bottles, water, and a foot pump to launch rockets on the school field. Pupils compete for the "Highest Altitude" or "Safest Recovery" (using handmade parachutes).
Egg-stronaut Re-entry: A classic engineering task where pupils build a "landing capsule" for a raw egg. It must survive a drop from a high window or play equipment.
Lunar Rover Construction: Using recycled materials and basic motors (or simple friction power), pupils design a vehicle that can travel over "craters" (an obstacle course of PE mats).

3. "Space Camp" Sleepover
An immersive, one-night event in the school hall that pupils will remember for years.

Astronaut Food Tasting: Sample dehydrated fruits or "space ice cream" to discuss how diet changes in microgravity.
Night-time Navigation: A torch-lit "Moon Mission" around the school grounds using a compass or star map to find "Moon Rocks" (painted stones).
Cinema under the Stars: Project a space-themed movie (like *Wall-E* or *Hidden Figures*) onto a large screen with "Space Snacks."

4. Community "Planet Walk"
Create a permanent or semi-permanent scale model of the Solar System in your local area.

The Trail: Calculate a scale (e.g., 100 metres = 1 million km) and place "Planet Plaque" stations along a local walking route or around the school boundary.
QR Codes: Each station features a QR code created by the pupils. When scanned, it plays a video of a pupil explaining a "Cool Fact" about that planet.
Launch Event: Invite the local community to "Walk the Solar System" on a Saturday morning, led by pupil "Tour Guides."

5. Young Enterprise: "The Galaxy Gift Shop"
Combining Maths, Art, and Business.

The Product: Pupils create space-themed merchandise, such as "Galaxy Jars," hand-painted "Nebula T-shirts," or 3D-printed planet keyrings.
The Market: Sell the items at a school fair or a "Space Exhibition" evening.
The Cause: All profits go toward a local environmental charity (linking to "Mission: Earth First") or to buy a high-quality telescope for the school.

Summary of Extra-Curricular Benefits

Activity	Primary Benefit
Astronomy Club	Science capital and digital literacy.
Rocketry Challenge	Practical engineering and resilience (trial and error).
Space Sleepover	Wellbeing, independence, and social bonding.
Planet Walk	Physical activity and community engagement.
Galaxy Gift Shop	Financial literacy and creative arts.