

The Space Shuttle Orbits With An Average Speed Of 17600 Miles Per Hour. Calculate The Time (in Hours)

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The space shuttle has been a hallmark of human space exploration, symbolizing technological advancement and international cooperation in exploring the cosmos. One of its most impressive features is its incredible speed during orbit, typically averaging around 17,600 miles per hour. This rapid movement allows it to circle the Earth in a remarkably short amount of time. But how long does it take for a space shuttle to complete one orbit around our planet? In this comprehensive guide, we'll explore the details behind the shuttle's speed, orbital mechanics, and the calculations needed to determine the time it takes for the shuttle to orbit Earth at this velocity.

Understanding the Space Shuttle's Orbital Mechanics

The Basics of Orbital Speed

The speed at which a spacecraft orbits Earth depends primarily on its altitude and the laws of physics governing orbital motion. The key principles include:

- **Gravity's Role:** Earth's gravity provides the centripetal force needed to keep the shuttle in orbit.
- **Orbital Velocity:** The minimum speed required for a stable orbit at a given altitude.
- **Altitude and Speed Relationship:** Higher orbits require slightly lower speeds, but generally, the orbital velocity around low Earth orbit (LEO) is around 17,500 mph.

The space shuttle primarily operates in low Earth orbit, roughly 200 to 400 miles above the Earth's surface, where its orbital speed hovers near 17,600 miles per hour.

The Orbit's Circumference

To determine the time to complete one orbit, we need to know the length of the orbit—the circumference of the path it follows around Earth. It depends on:

- **Earth's Radius:** Approximately 3,959 miles (6,371 km).
- **Orbital Altitude:** The height of the shuttle above Earth's surface.

The total radius of the orbit equals the Earth's radius plus the orbital altitude. For a typical low Earth orbit at about 300 miles above Earth's surface, the orbital radius is approximately:

1. Earth's radius: 3,959 miles
2. Orbital altitude: 300 miles
3. Orbital radius: $3,959 + 300 = 4,259$ miles

The circumference, then, is calculated by:

$$\text{Circumference} = 2 \pi \times \text{Orbital radius}$$

Calculating the Orbital Circumference

Step-by-Step Calculation

Using the approximate orbital radius of 4,259 miles:

1. Calculate the circumference:

$$C = 2 \pi r$$

where $r = 4,259$ miles and $\pi \approx 3.1416$.

$$C = 2 \times 3.1416 \times 4,259 \approx 2 \times 3.1416 \times 4,259$$

2. Perform the multiplication:

$$C \approx 6.2832 \times 4,259 \approx 26,753.3 \text{ miles}$$

So, the shuttle travels approximately 26,753 miles in one complete orbit at this altitude.

Determining the Orbit Time Based on Speed

Using the Basic Formula

To find the time (T) it takes to complete one orbit, use the fundamental relation:

$$T = \frac{\text{Distance}}{\text{Speed}}$$

Where:

- Distance = Orbit circumference (~26,753 miles)
- Speed = 17,600 miles per hour

Calculation

Plugging in the values:

$$T = \frac{26,753}{17,600}$$

Calculating:

$$T \approx 1.52 \text{ hours}$$

This means it takes approximately 1 hour and 31 minutes for the space shuttle to orbit Earth once at this speed and altitude.

Factors That Affect Orbital Time

While the calculation above provides a good estimate, several factors can influence the actual time:

Orbital Altitude Variations

Different orbits involve varying altitudes:

- Lower orbits (closer to Earth's surface): Slightly faster, shorter orbit time.
- Higher orbits (more than 400 miles): Slightly slower, longer orbit time.

Orbital Eccentricity

Most spacecraft use nearly circular orbits, but any deviation can affect the speed and circumference.

Orbital Perturbations

External influences such as atmospheric drag, gravitational influences from other celestial bodies, and Earth's oblateness cause minor variations in orbit time.

Comparison with Other Space Missions

Understanding the orbital period of the space shuttle helps put it into context with other space missions:

- **International Space Station (ISS):** Orbits Earth approximately every 90 minutes, traveling at about 17,500 mph.

- **Geostationary Satellites:** Orbit at about 22,236 miles altitude, taking 24 hours for a full orbit.
- **Hubble Space Telescope:** Completes an orbit roughly every 95 minutes, similar to the ISS.

The shuttle's orbit duration of about 1.5 hours is consistent with low Earth orbit objects moving at high speeds.

Conclusion: How Long Does the Space Shuttle Take to Orbit Earth?

Based on its average speed of 17,600 miles per hour and an orbital radius of approximately 4,259 miles (for about 300 miles altitude), the space shuttle completes one orbit around Earth in roughly 1 hour and 31 minutes. This rapid orbit time highlights the incredible engineering and physics behind space travel, enabling humans to observe our planet from a vantage point that's both awe-inspiring and scientifically invaluable.

Understanding these calculations provides insight into the complexity of space missions and the precision required to navigate Earth's orbit efficiently. Whether for scientific research, international cooperation, or future exploration missions, the space shuttle's orbital capabilities continue to serve as a testament to human ingenuity and our quest to explore beyond our planet.

FAQs About Space Shuttle Orbits and Speed

What is the typical altitude of the space shuttle during orbit?

The space shuttle usually orbited at altitudes between 200 and 400 miles above Earth's surface.

How fast does the space shuttle travel in orbit?

On average, about 17,600 miles per hour.

How long does it take for the shuttle to complete one orbit?

Approximately 1 hour and 31 minutes, depending on the altitude and orbital parameters.

Can the orbital period vary significantly?

Yes, slight variations can occur based on altitude, atmospheric drag, and other factors, but it generally remains around 90 minutes for low Earth orbits.

Why is the orbital speed so high?

High orbital speeds are necessary to counteract Earth's gravity and maintain a stable orbit without falling back to the surface.

By understanding the relationship between speed, orbit radius, and orbital period, one gains a deeper appreciation for the complexities of space travel and the remarkable achievements of human spaceflight.

Frequently Asked Questions

How long does it take for the Space Shuttle to complete one orbit around the Earth at an average speed of 17,600 miles per hour?

It takes approximately 1.5 hours for the Space Shuttle to complete one orbit around the Earth at an average speed of 17,600 miles per hour.

What is the formula to calculate the orbital period of the Space Shuttle given its speed and Earth's circumference?

The orbital period (time) can be calculated using the formula: $\text{Time} = \text{Circumference of Earth's orbit} / \text{Speed of the Shuttle}$.

If the Earth's equatorial circumference is about 24,901 miles, how long does the Space Shuttle take to complete one orbit at 17,600 mph?

Using the formula, $\text{Time} = 24,901 \text{ miles} / 17,600 \text{ mph} \approx 1.41 \text{ hours}$, so approximately 1 hour and 25 minutes.

Why does the Space Shuttle orbit the Earth so quickly at 17,600 miles per hour?

The high speed is necessary to counteract Earth's gravity and achieve a stable orbit, allowing the Shuttle to continuously fall around the Earth without crashing.

How does the orbital speed of 17,600 mph compare to other satellites orbiting Earth?

The Shuttle's orbital speed of 17,600 mph is similar to many low Earth orbit satellites, which typically orbit between 17,000 and 18,000 mph.

What factors influence the time it takes for the Space Shuttle to orbit the Earth?

Factors include the Shuttle's orbital altitude, Earth's circumference at that altitude, and its orbital velocity, which together determine the orbital period.

Can the orbital period of the Space Shuttle be calculated if the orbital radius is known?

Yes, using the orbital circumference ($2\pi r$) and dividing it by the Shuttle's speed (17,600 mph), you can calculate the orbital period.

What is the significance of knowing the orbital period of the Space Shuttle?

Knowing the orbital period helps in mission planning, scheduling of operations, and ensuring synchronization with ground stations for communication and data transfer.

Additional Resources

The Space Shuttle Orbits With An Average Speed Of 17,600 Miles Per Hour: Calculating The Orbital Time

The awe-inspiring image of the Space Shuttle gracefully orbiting Earth at incredible speeds has long captured the imagination of scientists, engineers, and space enthusiasts alike. Among the many factors that define the Shuttle's performance, its orbital velocity holds particular significance. With an average speed of approximately 17,600 miles per hour, the Shuttle completes an entire orbit around Earth in a remarkably short time. But just how short is it? To answer this, we need to delve into the physics of orbital mechanics, understand Earth's dimensions, and perform precise calculations.

In this comprehensive review, we examine the implications of the Shuttle's average orbital speed, detail the process of calculating its orbital period, and explore the broader context of space travel dynamics.

Understanding Orbital Velocity and Orbital Period

Before embarking on the calculations, it's essential to clarify key concepts:

What Is Orbital Velocity?

Orbital velocity is the minimum speed an object must attain to stay in a stable orbit around a celestial body without falling back due to gravity or escaping into space. For low Earth orbit (LEO), this velocity balances gravitational pull with the centrifugal force from the orbital motion.

What Is Orbital Period?

The orbital period is the time it takes for an object to complete one full orbit around the Earth. It is directly related to the orbital radius and velocity, governed by Newtonian mechanics.

Earth's Dimensions and Orbit Parameters

Accurate calculations require precise data about Earth's size and the altitude at which the Shuttle orbits.

Earth's Radius and Diameter

- Average radius: approximately 3,959 miles (6,371 km)
- Diameter: approximately 7,918 miles (12,742 km)

Orbital Altitude of the Space Shuttle

The Shuttle typically orbited at altitudes between 150 miles and 350 miles. For simplicity, we will assume an average altitude of 200 miles (about 322 kilometers).

Calculating the Orbital Radius

The total radius of the orbit (distance from Earth's center to the Shuttle) is:

- Orbital radius (r) = Earth's radius + altitude
- $r = 3,959 \text{ miles} + 200 \text{ miles} = 4,159 \text{ miles}$

Calculating the Orbital Circumference

The path of the Shuttle is approximately circular, so the orbital circumference (the distance traveled in one orbit) is:

- Circumference (C) = $2 \times \pi \times r$

Using $r = 4,159$ miles:

- $C = 2 \times 3.1416 \times 4,159 \approx 2 \times 3.1416 \times 4,159 \approx 26,128$ miles

This means that in one orbit, the Shuttle travels roughly 26,128 miles around Earth.

Determining the Orbital Period

Given the orbital speed and the circumference, the period (time for one orbit) can be calculated using the fundamental relation:

- Time (T) = Distance / Speed

The Shuttle's average orbital speed is approximately 17,600 miles per hour (mph).

Applying the values:

- $T = 26,128 \text{ miles} / 17,600 \text{ mph} \approx 1.484$ hours

Converting to minutes:

- $0.484 \text{ hours} \times 60 \text{ minutes/hour} \approx 29$ minutes

Therefore, the Space Shuttle completes one orbit around Earth in approximately 1 hour and 29 minutes.

Implications of the Orbital Period

This orbital period aligns well with historical data from Shuttle missions, which typically completed orbits in about 90 minutes. This rapid orbiting allows astronauts to view Earth's surface from different

perspectives within a short span, enabling multiple passes over specific regions during a single mission.

Why Does the Orbital Speed Matter?

Understanding the Shuttle's orbital velocity is crucial for mission planning, fuel calculations, and ensuring the spacecraft maintains a stable orbit. Any deviation from the necessary speed could result in the spacecraft spiraling inward or drifting away from Earth.

Factors Affecting Orbital Period

While our calculation assumes a circular orbit and average altitude, real-world conditions include:

- Slight variations in orbital altitude
- Earth's gravitational field irregularities
- Atmospheric drag at lower altitudes (though minimal at typical Shuttle altitudes)

Broader Context: Orbital Mechanics and Spaceflight Efficiency

The calculation exemplifies the relationship between orbital speed, radius, and period, which is fundamental in astrophysics and space engineering.

Kepler's Third Law

Kepler's Third Law states that the square of the orbital period (T) is proportional to the cube of the semi-major axis (r):

- $T^2 \propto r^3$

For Earth satellites, this law underpins mission design, ensuring that orbital parameters meet scientific and operational requirements.

Energy Considerations

Achieving and maintaining the Shuttle's velocity requires substantial energy, primarily from onboard fuel. The initial launch phase involves accelerating the spacecraft to reach orbital velocity, after which minimal propulsion is needed to stay in orbit.

Conclusion: The Speed of Human Spaceflight and Its Temporal Footprint

The impressive feat of reaching an average orbital speed of approximately 17,600 miles per hour allows the Space Shuttle to circle Earth roughly every 1 hour and 29 minutes. This rapid orbiting capability is a testament to the engineering marvels of spaceflight, combining physics, technology, and precision timing.

By understanding and calculating the orbital period from the Shuttle's average speed, we gain insight into the complexities of space travel and the remarkable efficiency of low Earth orbit missions. As humanity continues to push forward into deeper space exploration, these fundamental principles remain central to the design and success of future endeavors.

Key Takeaways:

- The Space Shuttle's average orbital speed is approximately 17,600 mph.
- Assuming an average altitude of 200 miles, the orbital radius is about 4,159 miles.
- The orbital circumference is approximately 26,128 miles.
- The Shuttle completes one orbit in about 1 hour and 29 minutes.
- These calculations highlight the physics behind human spaceflight and the rapid pace of orbital missions.

Understanding these dynamics not only satisfies scientific curiosity but also enhances our appreciation of the technological achievements that make space exploration possible.

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