Suzie Is Riding A Merry-go-round That Is 3.5 M In Diameter. If She Travels 12 Revolutions In A Minute,

Suzie Is Riding A Merry-go-round That Is 3.5 M In Diameter. If She Travels 12 Revolutions In A Minute, it presents an interesting scenario to explore various concepts in physics and mathematics, particularly in the realm of circular motion, rotational speed, and related calculations. Understanding the dynamics of such a ride not only provides insight into fundamental physics principles but also enhances our comprehension of how to analyze real-world rotational systems. In this article, we will delve into the details of Suzie's merry-go-round ride, calculate key parameters such as the radius, circumference, linear speed, and angular velocity, and explain their significance in understanding rotational motion.

Understanding the Basics of Circular Motion

Before diving into specific calculations, it is essential to grasp the basic concepts involved in circular motion:

Key Terms and Definitions

- **Diameter (d):** The length of a straight line passing through the center of a circle, connecting two points on the circumference.
- **Radius (r):** Half of the diameter; the distance from the center to any point on the circle.
- **Circumference (C):** The total distance around the circle, calculated as $C = \pi d$.
- **Revolutions per minute (RPM):** The number of complete turns or revolutions the merry-go-round makes in one minute.
- **Linear speed (v):** The actual speed of a point on the edge of the merry-go-round, measured in meters per second (m/s).
- **Angular velocity (ω):** The rate at which the merry-go-round rotates, measured in radians per second (rad/s).

Calculating the Radius and Circumference

Given the diameter of the merry-go-round, we can easily find the radius:

Radius Calculation

- $d = 3.5$ meters
- $r = d / 2 = 3.5 / 2 = 1.75$ meters

Next, we calculate the circumference, which is the total distance Suzie travels in one revolution:

Circumference Calculation

- $C = \pi d \approx 3.1416 \times 3.5 \approx 10.9956$ meters

This means that with each complete revolution, Suzie travels approximately 11 meters along the edge of the merry-go-round.

Determining Rotational Speed and Linear Velocity

Since Suzie completes 12 revolutions per minute, we can now compute her rotational and linear speeds.

Revolutions per Minute to Revolutions per Second

- RPM = 12 revolutions/minute
- Revolutions per second (rev/sec) = RPM / 60 = 12 / 60 = 0.2 rev/sec

Calculating Angular Velocity (ω)

Angular velocity measures how quickly the merry-go-round spins in radians per second:

- One revolution = 2π radians
- $\omega = \text{rev/sec} \times 2\pi = 0.2 \times 2\pi \approx 0.2 \times 6.2832 \approx 1.2566$ rad/sec

Calculating Linear Speed (v)

Linear speed indicates how fast Suzie moves along the edge:

- $v = r \times \omega = 1.75 \text{ m} \times 1.2566 \text{ rad/sec} \approx 2.2 \text{ m/sec}$

Thus, Suzie’s linear speed on the merry-go-round’s edge is approximately 2.2 meters per second.

Additional Insights and Applications

Understanding these calculations provides a basis for exploring further concepts related to rotational motion and real-world applications.

1. Energy and Force Considerations

- The tangential (linear) acceleration experienced by Suzie depends on changes in speed or direction.
- The centripetal force required to keep her moving in a circle can be calculated if her mass is known.

2. Safety Parameters

- Knowing the linear speed helps in designing safety features, such as appropriate height and restraint mechanisms.
- The g-forces experienced during rapid rotation can be estimated to ensure rider safety.

3. Engineering Design

- Engineers use similar calculations to design amusement rides, ensuring structural stability and comfort.
- The rotational speed must be balanced with the size of the ride to prevent excessive forces.

Real-World Examples and Related Calculations

To deepen understanding, consider additional scenarios:

Calculating the Time for One Revolution

- Time per revolution = 1 / rev/sec = 1 / 0.2 = 5 seconds

- Suzie completes a full rotation every 5 seconds.

Total Distance Traveled in a Minute

- Distance per revolution ≈ 11 meters
- Number of revolutions per minute = 12
- Total distance traveled in one minute = 12 × 11 = 132 meters

Implications of Changing Rotational Speed

- Increasing the revolutions per minute increases linear speed, which affects rider experience and safety.
- For example, at 20 RPM:
- rev/sec = 20/60 ≈ 0.333
- $\omega \approx 0.333 \times 2\pi \approx 2.094$ rad/sec
- $v \approx 1.75 \times 2.094 \approx 3.67$ m/sec

Conclusion: The Physics of Merry-Go-Rounds Made Simple

The scenario of Suzie riding a merry-go-round with a diameter of 3.5 meters at 12 revolutions per minute illustrates fundamental principles of circular motion. By calculating the radius, circumference, angular velocity, and linear speed, we gain a comprehensive understanding of how rotational systems operate. These concepts are vital not only in amusement park ride design but also in various engineering and physics applications, from planetary orbits to mechanical systems.

Understanding the relationships between rotational speed, radius, and linear velocity empowers engineers and physicists to analyze and optimize rotational systems, ensuring safety, efficiency, and enjoyment. Whether for designing safer rides or studying celestial bodies, the principles highlighted in Suzie’s merry-go-round scenario serve as a foundational example of rotational dynamics in action.

Frequently Asked Questions

What is the circumference of the merry-go-round Suzie is riding?

The circumference is approximately 10.995 meters, calculated using $C = \pi d = 3.5 \times \pi \approx 10.995$ meters.

How many meters does Suzie travel in one minute?

Suzie travels approximately 131.94 meters per minute, since 12 revolutions per minute × 10.995 meters per revolution ≈ 131.94 meters.

What is Suzie's linear speed in meters per second?

Her linear speed is approximately 2.2 meters per second, calculated by dividing 131.94 meters by 60 seconds.

What is the angular velocity of the merry-go-round in revolutions per second?

The angular velocity is 0.2 revolutions per second, since 12 revolutions per minute divided by 60 equals 0.2 revolutions per second.

If Suzie continues riding at this speed, how far will she travel in 5 minutes?

She will travel approximately 659.7 meters in 5 minutes, as 131.94 meters per minute × 5 minutes equals 659.7 meters.

Additional Resources

Suzie Is Riding A Merry-go-round That Is 3.5 M In Diameter. If She Travels 12 Revolutions In A Minute, this scenario offers a fascinating window into rotational motion, circular dynamics, and the physics principles governing such movement. Whether you're a student delving into physics concepts or a curious enthusiast, understanding the details behind Suzie's merry-go-round ride reveals much about how circular motion works in real-world settings. This comprehensive guide aims to break down the problem step-by-step, exploring key concepts like circumference, speed, acceleration, and more, providing both clarity and insight into the physics at play.

Understanding the Basic Parameters of the Merry-Go-Round

Before diving into calculations, it’s crucial to understand the initial information provided:

- Diameter of the merry-go-round: 3.5 meters
- Revolutions per minute (rpm): 12 revolutions

From these, we can derive several important quantities, such as the radius, circumference, linear speed, and acceleration experienced by Suzie.

Calculating the Radius and Circumference

Diameter and Radius

The diameter (D) of the merry-go-round is given as 3.5 meters. The radius (r) is half of the diameter:

$$r = \frac{D}{2} = \frac{3.5\, \text{m}}{2} = 1.75\, \text{m}$$

Knowing the radius is essential for calculating the distance traveled in each revolution and other rotational parameters.

Circumference

The circumference (C) of the circle is the distance around the merry-go-round:

$$ C = 2 \pi r $$

Substituting the radius:

$$ C = 2 \pi \times 1.75\, \text{m} \approx 2 \times 3.1416 \times 1.75 \approx 10.9956\, \text{m} $$

For simplicity, we can approximate:

$$ C \approx 11.0\, \text{m} $$

This means Suzie travels approximately 11 meters with each complete revolution.

Determining Suzie’s Linear Speed

Revolutions per Minute to Revolutions per Second

Since the problem states 12 revolutions per minute, converting to revolutions per second helps with calculations:

$$ \text{Revolutions per second} = \frac{12\, \text{rev}}{60\, \text{s}} = 0.2\, \text{rev/sec} $$

Calculating Linear Speed

The linear speed (v) is the distance traveled per unit time along the circular path:

$$ v = \text{circumference} \times \text{revolutions per second} $$

$$ v = 11.0\, \text{m} \times 0.2\, \text{rev/sec} = 2.2\, \text{m/sec} $$

Therefore, Suzie’s linear speed is approximately 2.2 meters per second.

Exploring Rotational Speed and Angular Velocity

Angular Velocity (ω)

Angular velocity describes how fast the merry-go-round spins in terms of radians per second. One revolution corresponds to an angle of $ 2\pi $ radians.

$$ \omega = \text{revolutions per second} \times 2\pi $$

$$ \omega = 0.2\, \text{rev/sec} \times 2\pi \approx 0.2 \times 6.2832 \approx 1.257\, \text{rad/sec} $$

So, the angular velocity of the merry-go-round is approximately 1.257 radians per second.

Calculating Centripetal Acceleration

When riding in circular motion, Suzie experiences a centripetal acceleration directed toward the center of the merry-go-round. The formula for centripetal acceleration (a_n) is:

$$ a_c = \frac{v^2}{r} $$

Using the earlier calculated linear speed:

$$ a_c = \frac{(2.2)^2}{1.75} \approx \frac{4.84}{1.75} \approx 2.76\, \text{m/sec}^2 $$

This acceleration is what keeps Suzie moving along the circular path.

Understanding the Physical Implications

The Force Required to Maintain Circular Motion

The centripetal acceleration must be provided by the net inward force, which can be expressed as:

$$ F_c = m \times a_c $$

where m is Suzie's mass. The actual force depends on her weight and how much she weighs, but the key takeaway is that the force increases with her mass and the acceleration.

G-Forces Experienced During the Ride

The sensation of "being pushed outward" is due to the acceleration, even though the force is directed inward. The ratio of the centripetal acceleration to acceleration due to gravity ($g \approx 9.81\, \text{m/sec}^2$) gives a measure of the G-force:

$$ \text{G-force} = \frac{a_c}{g} \approx \frac{2.76}{9.81} \approx 0.28\, g $$

This means Suzie experiences roughly 0.28 times her body weight as a sideways force—relatively mild, typical for a merry-go-round ride.

Additional Considerations: Period and Frequency

Calculating the Period of One Revolution

The period (T) is the time taken for one complete revolution:

$$ T = \frac{1}{\text{revolutions per second}} = \frac{1}{0.2} = 5\, \text{seconds} $$

Understanding Frequency

The frequency (f) is the number of revolutions per second:

$$ f = 0.2\, \text{rev/sec} $$

which aligns with earlier calculations.

Practical Applications and Real-World Relevance

Understanding the physics of Suzie riding a merry-go-round isn't just academic; it has practical implications:

- Design of amusement rides: Engineers use these principles to ensure safety and comfort.
- Biomechanics: Analyzing G-forces helps determine safe ride parameters for different age groups.
- Education: Demonstrates fundamental physics concepts like circular motion, rotational speed, and acceleration.

Summary of Key Calculations

Parameter	Value
Diameter of merry-go-round	3.5 meters
Radius	1.75 meters
Circumference	approximately 11 meters
Revolutions per minute (rpm)	12 revolutions
Revolutions per second	0.2 revolutions
Linear speed (v)	approximately 2.2 m/sec
Angular velocity (ω)	approximately 1.257 rad/sec
Centripetal acceleration (a_c)	approximately 2.76 m/sec^2
Period for one revolution (T)	5 seconds

Final Thoughts

The physics behind Suzie riding a merry-go-round that is 3.5 meters in diameter and completing 12 revolutions per minute encapsulates core principles of rotational motion. By calculating the radius, circumference, speed, and acceleration, we gain a comprehensive understanding of the forces at play. Whether for amusement park safety, physics education, or simply satisfying curiosity, these calculations illuminate the fascinating dynamics of circular motion in everyday life.

Understanding these principles not only enhances our appreciation of amusement rides but also provides foundational knowledge applicable in various fields, from engineering to biomechanics. The next time you find yourself on a merry-go-round, remember the elegant physics that keeps the ride spinning smoothly!

Suzie Is Riding A Merry Go Round That Is 3 5 M In Diameter If She Travels 12 Revolutions In A Minute

Suzie Is Riding A Merry Go Round That Is 3 5 M In Diameter If She Travels 12 Revolutions In A Minute

Related Articles

- The Composite Figure Above Is Made From An Isosceles Triangle And A Rectangle. What Is The Area Of The
- True Or False: There Is A Function On The Interval [-1,1] That Does Not Have An Absolute Maximum Value
- Solve By Using Fluidsim SoftwareAt The Completion Of This Lab, The Student Will Be Able To: 1. Able To

Back to Home