A Child Sitting 1.36 M From The Center Of A Merry-go-round Moves With A Speed Of 1.20 M/s. Calculate

A Child Sitting 1.36 M From The Center Of A Merry-go-round Moves With A Speed Of 1.20 M/s. Calculate

Understanding the physics behind rotational motion is essential to analyzing everyday scenarios, such as a child riding a merry-go-round. When a child sits at a certain distance from the center and the merry-go-round spins, various parameters like velocity, angular velocity, and acceleration come into play. In this article, we will explore how to calculate important quantities based on given data: a child sitting 1.36 meters from the center, moving with a linear speed of 1.20 meters per second. We will delve into the concepts of angular velocity, centripetal acceleration, and the forces acting on the child, providing a comprehensive understanding of the physical principles involved.

Understanding the Key Concepts

Before jumping into calculations, it is crucial to grasp some fundamental ideas related to rotational motion.

Linear Velocity and Angular Velocity

- Linear velocity (v): The speed at which an object moves along a path. In this context, it is the child's speed along the circular path.
- Angular velocity (ω): The rate at which an object rotates about a central point, measured in radians per second.

The relationship between linear velocity and angular velocity is given by:

$$ v = r \times \omega $$

where:
- v = linear velocity,
- r = radius (distance from the center),
- ω = angular velocity.

Centripetal Acceleration

Any object moving in a circle experiences an inward acceleration directed toward the center, called centripetal acceleration:

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

This acceleration is responsible for changing the direction of the object's velocity, keeping it moving in a circle.

Forces Acting on the Child

- Centripetal force: The net inward force required to keep the child moving in a circle, calculated as:

$$ F_c = m \times a_c $$

where m is the child's mass (which may or may not be given). Since the problem doesn't specify mass, we can focus on the acceleration and force expressions in terms of known quantities.

Calculating the Angular Velocity

Given:
- Radius, $r = 1.36\, \text{m}$,
- Linear speed, $v = 1.20\, \text{m/s}$.

Using the relation:

$$ \omega = \frac{v}{r} $$

we substitute:

$$ \omega = \frac{1.20}{1.36} \approx 0.8824\, \text{rad/sec} $$

Result: The child's angular velocity is approximately 0.88 radians per second.

Calculating the Centripetal Acceleration

Using the formula:

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

we substitute:

$$ a_c = \frac{(1.20)^2}{1.36} = \frac{1.44}{1.36} \approx 1.0588\, \text{m/sec}^2 $$

Result: The centripetal acceleration experienced by the child is approximately 1.06 m/sec^2.

Implications of the Calculations

Understanding these calculations helps in analyzing the forces involved and ensuring safety measures. For example, knowing the centripetal acceleration allows engineers or designers to predict the forces acting on the child's body and the structural integrity of the merry-go-round.

Forces Acting on the Child

If the child's mass is known, the actual inward force (centripetal force) can be calculated:

$$ F_c = m \times a_c $$

For example, if the child's mass is 30 kg:

$$ F_c = 30 \times 1.06 \approx 31.8\, \text{N} $$

This force acts toward the center, providing the necessary inward pull to maintain circular motion.

Additional Considerations

While the above calculations focus on the basic parameters, several other factors are relevant in real-world scenarios.

Friction and Grip

- The friction between the child's clothing and the merry-go-round surface provides the necessary grip to prevent slipping.
- The maximum static friction force must be at least equal to the required centripetal force for safety.

Effect of Changing Speed or Radius

- Increasing the child's speed increases the centripetal acceleration quadratically.
- Moving farther from the center (larger radius) with the same speed decreases the angular velocity but increases the linear velocity and acceleration.

Safety Guidelines

- Ensuring that the merry-go-round is designed to withstand forces generated at maximum rotation speeds.
- Encouraging children to sit properly to avoid excessive vibrations or falls.

Summary of Key Results

Quantity	Calculation	Approximate Value
Angular velocity ω	$\frac{v}{r}$	0.88 rad/sec
Centripetal acceleration a_c	$\frac{v^2}{r}$	1.06 m/sec^2

These calculations demonstrate how simple physics formulas can be applied to everyday amusement rides to analyze motion and ensure safety.

Conclusion

In summary, a child sitting 1.36 meters from the center of a merry-go-round moving at 1.20 meters per second has an angular velocity of approximately 0.88 radians per second and experiences a centripetal acceleration of about 1.06 meters per second squared. These parameters are essential for engineers, safety inspectors, and parents to understand the forces involved and to maintain safe riding conditions. By applying fundamental physics principles, we can better appreciate the mechanics behind merry-go-rounds and similar circular motions, ensuring enjoyable and safe experiences for children and adults alike.

Frequently Asked Questions

What is the main concept involved in calculating the child's distance from the center of the merry-go-round?

The main concept is circular motion, specifically calculating the radius or distance from the center based on the given speed and rotational parameters.

Given the speed of 1.20 m/s and the distance of 1.36 m from the center, what is the angular velocity of the child?

Angular velocity $\omega = v / r = 1.20$ m/s / 1.36 m ≈ 0.882 rad/s.

How do you verify if the child's movement is uniform circular motion?

By confirming that the child's speed remains constant and the motion follows a circular path with constant radius, indicating uniform circular motion.

What is the significance of knowing the child's distance from the center in circular motion calculations?

The distance (radius) is essential for calculating centripetal acceleration and understanding the forces acting on the child during motion.

How do you calculate the centripetal acceleration of the child on the merry-go-round?

Centripetal acceleration $a_c = v^2 / r = (1.20 \text{ m/s})^2 / 1.36 \text{ m} \approx 1.0588 \text{ m/s}^2$.

What force acts on the child to keep them moving in a circular path?

The centripetal force, directed towards the center of the merry-go-round, maintains the child's circular motion.

If the merry-go-round's speed increases, what happens to the child's centripetal acceleration?

The centripetal acceleration increases proportionally with the square of the speed, so it would increase as the speed increases.

Can we determine the merry-go-round's angular velocity from the given data?

Yes, using $\omega = v / r$, we find $\omega \approx 0.882$ rad/s based on the given speed and radius.

Why is it important to understand the child's speed and distance in real-world amusement park safety?

Knowing these parameters helps assess the forces on riders, ensuring safety guidelines are met and preventing accidents during rides.

Additional Resources

A Child Sitting 1.36 M From The Center Of A Merry-go-round Moves With A Speed Of 1.20 M/s. Calculate

---

Introduction

Merry-go-rounds, also known as carousels, are a timeless amusement ride enjoyed by children and adults alike. While they are often associated with fun and nostalgia, the physics principles underlying their motion present fascinating insights into rotational dynamics, centripetal force, and acceleration. This article aims to explore the scenario where a child sitting 1.36 meters from the center of a merry-go-round moves at a linear speed of 1.20 meters per second, to analyze and calculate the underlying physics quantities such as angular velocity, centripetal acceleration, and the force experienced by the child.

The Core Physics Problem

The core question revolves around understanding the relationship between linear speed, angular velocity, and the forces acting on the child. The problem statement provides specific data:

- Distance from the center (radius, r): 1.36 meters
- Linear speed (v): 1.20 meters per second

From this information, we seek to determine:

- The angular velocity (ω) of the merry-go-round
- The centripetal acceleration (ac) experienced by the child
- The centripetal force (Fc) acting on the child

Fundamental Concepts and Equations

To accurately analyze the problem, several fundamental physics concepts and equations are essential:

1. Angular Velocity (ω)

Angular velocity relates the linear speed to the radius:

$$
\omega = \frac{v}{r}
$$

where

- v = linear velocity (m/s)
- r = radius from the center (m)

2. Centripetal Acceleration (ac)

The acceleration directed toward the center of the circular path:

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

3. Centripetal Force (Fc)

The force required to keep the child moving in a circle:

$$
F_c = m \times a_c
$$

where

- m = mass of the child (kg)

Step-by-Step Calculation

Step 1: Calculate Angular Velocity

Given:

- v = 1.20 m/s
- r = 1.36 m

Applying the formula:

$$
\omega = \frac{v}{r} = \frac{1.20\, \text{m/s}}{1.36\, \text{m}} \approx 0.8824\, \text{rad/s}
$$

Result: The merry-go-round rotates at approximately 0.8824 radians per second.

Step 2: Calculate Centripetal Acceleration

Using:

$$
a_c = \frac{v^2}{r} = \frac{(1.20)^2}{1.36} = \frac{1.44}{1.36} \approx 1.0588\, \text{m/s}^2
$$

Result: The child experiences a centripetal acceleration of approximately 1.0588 m/s^2.

Step 3: Determine the Centripetal Force

Since the mass (m) of the child is not specified in the problem, the force can be expressed in terms of mass:

$$
F_c = m \times a_c = m \times 1.0588\, \text{N}
$$

Note: To find a specific force value, the child's mass must be known. For illustration, assuming a typical child's mass:

- Example: $m = 30$ kg

Then,

$$
F_c = 30 \times 1.0588 \approx 31.76\, \text{N}
$$

Result: For a 30 kg child, the centripetal force is approximately 31.76 Newtons.

In-Depth Analysis of the Dynamics Involved

The Nature of Circular Motion

Circular motion involves continuous change in the direction of velocity, which means the child is constantly changing velocity direction, even if the speed remains constant. The centripetal acceleration points inward, toward the center of the merry-go-round, ensuring the child follows a circular path.

The Role of Friction and Normal Force

In a real-world scenario:

- The child's seat or clothing provides friction to prevent slipping.
- The normal force exerted by the seat counteracts the outward "centrifugal" effect experienced in a rotating frame.

Safety Implications

Understanding the forces involved is critical for safety:

- Excessive centripetal force may cause discomfort or injury.
- Proper restraints help distribute forces evenly and prevent the child from slipping off.

Broader Context and Applications

Rotational Dynamics in Amusement Rides

The physics of merry-go-rounds offers insights into the design considerations of amusement rides:

- Ensuring riders experience safe accelerations
- Maintaining structural integrity under rotational forces
- Customizing ride parameters to optimize thrill while ensuring safety

Educational Significance

This scenario provides a practical example for physics education:

- Demonstrates the application of rotational kinematics
- Connects theory with real-world amusement park physics
- Encourages critical thinking about forces and motion

Additional Considerations

- Effect of Changing Speed: If the merry-go-round accelerates, the angular velocity and forces change accordingly.
- Impact of Mass Variations: Heavier children experience proportionally greater forces, but the acceleration remains constant for a given speed and radius.
- Frictional Forces: These act to prevent slipping; their magnitude depends on the coefficient of friction and normal force.

Conclusion

Analyzing the physics of a child sitting 1.36 meters from the center of a merry-go-round moving at 1.20 m/s reveals essential insights into rotational motion and forces. The calculations demonstrate that the carousel has an angular velocity of approximately 0.8824 rad/s, with the child experiencing a centripetal acceleration of about 1.0588 m/s^2. For a typical child weighing around 30 kg, the centripetal force amounts to nearly 31.76 N. Understanding these forces not only enhances our appreciation of amusement ride safety and engineering but also provides a compelling educational example of circular motion principles in action.

References

- Halliday, D., Resnick, R., & Walker, J. (2014). Fundamentals of Physics (10th ed.). Wiley.
- Serway, R. A., & Jewett, J. W. (2014). Physics for Scientists and Engineers (9th ed.). Cengage Learning.
- Giancoli, D. C. (2013). Physics: Principles with Applications (7th ed.). Pearson Education.
- Amusement Ride Safety Standards, International Association of Amusement Parks and Attractions (IAAPA), 2020.

This comprehensive analysis underscores the intricate physics woven into seemingly simple amusement rides, illustrating the importance of precise calculations and safety considerations in designing enjoyable and secure experiences.

[A Child Sitting 1 36 M From The Center Of A Merry Go Round Moves With A Speed Of 1 20 M S Calculate]

A Child Sitting 1 36 M From The Center Of A Merry Go Round Moves With A Speed Of 1 20 M S Calculate

Related Articles

- [8.Felicity Asked 100 Students How They Came To School One Day.Each Student Walked Or Came By Bicycle]
- [A Baker Has Bags Of Flour That Weigh Three And 1/ 4 Pounds Each If The Baker Has A Total Of 1/2 Bags]
- [1. Find The First Fundamental Form For The Spherical Coordinate Of The Unit Spherical Surface2. Find]

[Back to Home]