Studies in Philosophy of Science and Education
Homepage: https://scie-journal.com/index.php/SiPoSE
Email: sipose@scie-journal.com

p-ISSN: 2722-3523; e-ISSN: 2721-9267
SiPoSE, Vol. 2, No. 2, July 2021: 25-35
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Analysis of the Use of Circular Motion Physics Concepts on Game Rides in Jawa Timur Park 1

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Article Info

Article history:

Received April 22, 2021
Revised June 17, 2021
Accepted July 20, 2021
Available Online July 21, 2021

Keywords:

Circular Motion
Centrifugal Force
Concept Analysis
Games in Jatim Park 1
Sentripetal Style

ABSTRACT

In general, physics has been widely spread well in everyday life, one of which is used as a concept in holiday destinations in Indonesia. In East Java, Jatim Park group has been established by a combination of education and entertainment, resulting in the concept of learning while playing. Jawa Timur Park 1 is one of the eduparks in Indonesia with the first playground in the East Java area, especially Batu City. This research aims to analyze the use of circular motion physics concepts on Sky Swinger, Superloop Coaster, Enterprise, Tornado and Pendulum 360 in Jawa Timur Park 1, Batu. Research is carried out using literature study methods by outlining the problems discussed clearly and in detail related to the concepts of physics contained in the game rides. The data collection method used in this study used review and observation journals. Observation is done using social media in the form of Youtube. In this study, it was concluded that in the Pendulum 360, Sky Swinger, Enterprise, Tornado, and Superloop Coaster Rides at Jatim Park 1 Batu there is a physical concept in the form of circular motion, and there is centripetal force, centrifugal force, and centripetal acceleration.

https://doi.org/10.46627/sipose

INTRODUCTION

Physics is one of the subjects that provide knowledge of the universe to practice thinking and reasoning. Through the reasoning ability of a person who continues to be trained so that it develops, the person will increase his thinking power and knowledge (Nurmaulidina & Bhakti, 2020). In general, learning physics has a tendency to (1) lack of real-life perception and often teaches calculations, (2) the assumption that physics lessons are difficult so that students become fearful and uncomfortable in learning, (3) lack of encouragement for students to think critically and creatively, (4) rarely practice solving problems that are around them and do not instill the value of local wisdom around students. (Sholahuddin & Admoko, 2021).

Physics learning is generally often done in the classroom by applying various equations causing physics to be less desirable to students (Damayanti et.al, 2018). and decreased student learning motivation (Piliang et al., 2021). The variety of playgrounds as well as education, both modern and traditional (Asra et al., 2021) is one of the efforts to attract students in learning with learning and playing methods (Marheny et al., 2021). The method of playing is a way or approach by playing in learning to achieve the expected goal. (Basri & Akhmad, 2018).

Rides is a vehicle, tool or means to achieve the goal while the game is an activity carried out with a physical or psychic that is fun and encouraging (Nuriyana et al., 2021). Game rides not only serve as entertainment, but are expected to contain educational elements in accordance with the concept (Kusumawardani, 2019). Learning does not have to always be in the classroom, through game rides also learning can also be applied (Indratno, 2017) currently many game rides that apply learning concepts such as edupark (Emafri & Rifai, 2019). Edupark is an educational

https://doi.org/10.46627/sipose.v2i2.107

park that is used for learning facilities or learning resources to achieve educational goals. (Sari & Rifai, 2020). Jatim Park 1 is one of the eduparks in Indonesia. Jatim Park 1 has many rides (Suprapto et al., 2019) including Sky Swinger, Superloop Coaster, Enterprise, Tornado dan Pendulum 360.

In physics learning there are some concepts that are difficult to display for real (Rahmawati et al., 2020) in other terms are said to be abstract concepts, so it is not easy for students to understand (Raharja et al., 2020), one example is circular motion. Circular motion is an object's motion trajectory in the form of a circle and surrounds a certain point (rotary axis point) (Serevina & Khofiya, 2021) While regular circular motion is the movement of objects whose trajectory of motion is in the form of a circle (Azizah, 2019) with constant speed and the direction of speed perpendicular to the direction of acceleration (centripetal acceleration) (Tarisalia et al., 2020) the concept of circular motion can be seen in the game rides (Ristiani et al., 2018) especially the game Sky Swinger, Superloop Coaster, Enterprise, Tornado dan Pendulum 360 in Jatim Park 1. This game rides apply the concept of circular motion where there is a style called centripetal force.

In circular motion there is a force called centripetal force whose direction is always towards the center of the circle (Rahman, 2020). Centripetal style is a physical force or style in the true sense is because the centripetal force is just a term for the types of forces that function to make objects move circularly (Nasution & Rahmawati, 2019). Centripetal force causes an object to move in a circle. When a person moves in a circle while riding a game rides it means that there is a centripetal force that works on the person, but what that person feels that his body feels pushed outside not inward (Kusuma, 2018). Some game rides apply the concept of physics in their movements, one of which is the concept of centripetal force applied to the game Sky Swinger, Superloop Coaster, Enterprise, Tornado and Pendulum 360 in Jatim Park 1. Reviewing the concepts of physics applied to game rides is able to be a solution and innovation in overcoming the difficulties of students understanding physics concepts.

RESEARCH METHOD

The research method used in this research is the method of literature study. Through the literature study method, researchers can decipher the problems discussed in more clearly and in detail (Nurhidayat et al., 2020) related to the concept of physics contained in the game vehicle. Using this method, data is collected for analysis and then presented in the results and discussions and a conclusion is obtained. (Nana, 2018)

The method of data collection used in this study is with a journal review and observation. Observations are made to get a real picture of real events or events (Agung Mahardini, 2020) and to find out the conditions in the field (Rozi & Kristari, 2020) namely on sky swinger rides, Superloop Coaster, Enterprise, Tornado dan Pendulum 360 in Jatim park 1, Batu using social media, namely Youtube. The data obtained will then be analyzed (Astuti & Bhakti, 2021) and adjusted to the topic of study used (Sholahuddin & Admoko, 2021) so that the results of analysis from various sources are summarized and become interesting findings related to the concept of physics on several toy rides in Jatim Park I.

Figure 1. Demonstrate the procedure of the flow of research methods related to the analysis of physical concepts in the game at Jatim Park 1.

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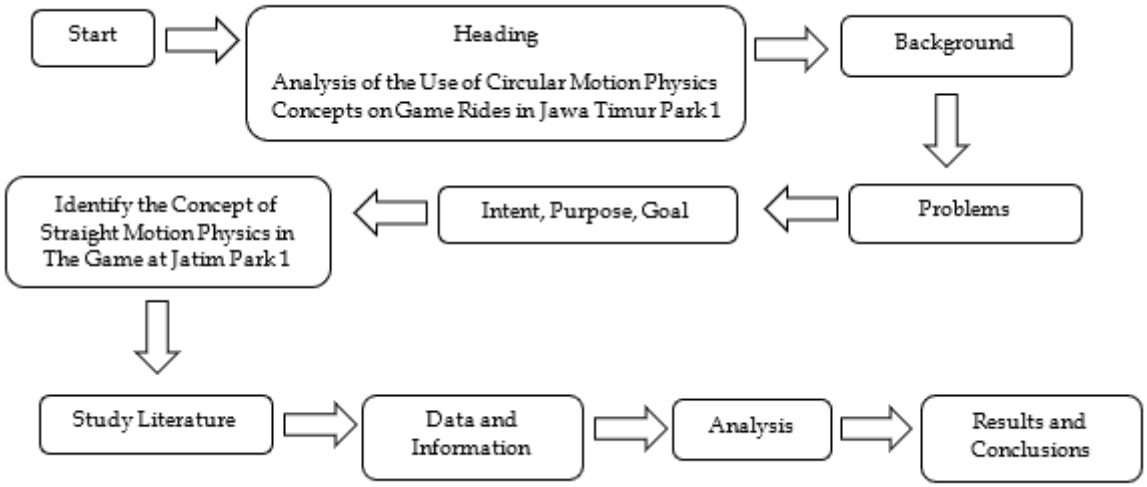


Figure 1. Research flow

RESULTS AND DISCUSSION

This research was conducted to find out the concepts of physics contained in several games in Jatim Park 1, including: Sky Swinger, Superloop, Enterprise, Tornado dan Pendulum 360. In Jawa Timur Park 1, Batu there are several games that have physical concepts in it.



Figure 2. Pendulum game 360
(Source: Jawa Timur Park, 2016)

Figure 2 it shows that in the game pendulum 360 there is a concept of physics, especially in circular motion matter in the form of centripetal forces and centrifuges. The vehicle moves sideways to the right and left by 360°. In pendulum 360, the centripetal force causes an object to move circularly. When riding the ride, our body will feel pushed out due to the centrifugal force. Centripetal motion pada, when an object is tied with a string and then rotated horizontally then the force component that works in the radial direction (squeezed with the radius of the circle) is the strain force of the rope. The direction of the tension force of this rope is always towards the center of the circle, then the tension force of the rope is what makes the object move circularly. The event corresponds to the following centripetal force equation:

$$\sum F = m.as \quad \text{.... (i)}$$

Because $as = \frac{v^2}{R} = \omega^2 R$ Then equation (1) can be written as follows:

$$\sum F_s = \frac{m\,v^2}{R} \quad \text{.... (ii)}$$

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or

$$\sum F_s = m\ \omega\ .2R \quad \text{…. (iii)}$$

Information:
F_s = Centripetal force or force component in radial direction (N)
m = Mass of things (kg)
as = Centripetal acceleration (m/s^2)
v = Linear speed (m/s)
ω = Angular speed (rad/s)
R = The radius of the trajectory (m)



Figure 3. Sky swinger games
(Source: Jawa Timur Park, 2016)

Figure 3 it shows that in the sky swinger game there is a concept of physics, especially in circular motion matter. Sky Swinger is a giant swing game with a height of 15 meters. The game rests on the center (middle) as a rotating axis. Around it are hung seats with different distances from each other or distances to their rotary axis. On the Sky Swinger machine will make the pedestal move circularly and people sitting in chairlifts will be pushed out.

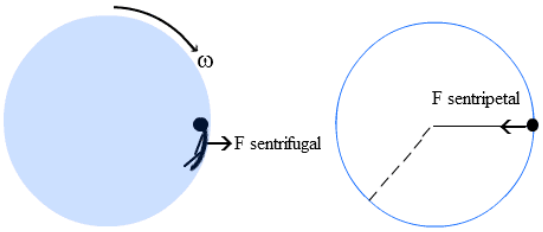


Figure 4. Illustration of centrifugal and centripetal forces

Figure 4, described that people sitting in a rotated chairlift will get a centrifugal force that is different from each other. The direction of the centrifugal force always stayed away from the center of the circle. The function of centrifugal force to compensate for centripetal force so that the object carrying out circular motion is in a balanced state. This event corresponds to the following equation:

$$F_{sf} = \frac{mv^2}{R} \quad \text{…. (iv)}$$

Information:
F_{sf} = Centrifugal force
m = Mass

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v = Centrifugal speed
r = Segment

As for someone who sees from afar without riding the ride, the person will see that the Sky Swinger has a centripetal style. The existence of centripetal acceleration perpendicular to the movement towards the center and forming a centrifugal force whose direction is towards the center of the circle. In the game Sky Swinger a centripetal force that produces its direction into the center of the round. This is in accordance with Newton's first law, where it tends to maintain its starting position so as to get a force that goes in the direction into the center of the circle, and the person sitting will feel the force out to maintain the starting position.



Figure 5. Enterprise games
(Source: Jawa Timur Park, 2016)

Figure 5, shows that in enterprise games there are physical concepts, especially in circular motion materials. Enterprise rides are games that rest on the center (middle) as a rotary axis. Enterprise rides rotate at a speed of 50 km/hour for approximately 3 minutes. In addition to the parallel rotation, the Enterprise vehicle will also rotate in a slope of 80°. When riding the vehicle, there is no seat belt in it, as a safety there is only a fence on the right and left side of the car. To ride this Enterprise ride, there are several things that need to be considered, namely a height of at least 120 cm and a maximum weight of 75 kg / person. That way, when the vehicle rotates at a speed of 50 km/h in approximately 3 minutes and with a slope of 80° makes someone inside feel thrown to the side. So, with this event, it can be known that in the Enterprise vehicle there is a concept of physics, namely circular motion.

On Enterprise vehicle there is a centripetal acceleration process, where the acceleration will be accelerated which always leads to the center of the circle. The centripetal acceleration equation can be written as follows:

$$a_s = \frac{v^2}{R} \text{ or } a_s = \omega^2 . R \quad \text{.... (v)}$$

With
a_s = Centripetal acceleration (m/s^2)
R = The radius of the trajectory circle (m)
v = Linear speed (m/s)

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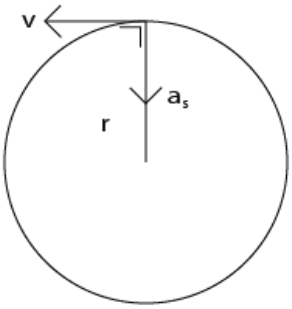


Figure 6. Sentripetal acceleration direction

According to Figure 6. Directions from centripetal acceleration will go to the center of the track and always perpendicular to the velocity vector.

In the Enterprise vehicle there is also a centripetal force, where the force is directed towards the center of the circle. So, with the acceleration of the centripetal and centripetal force is what causes a person who is in the vehicle will tend to do circular motion because the direction of these 2 components leads to the center of the track.



Figure 6. Tornado games
(Source: Jawa Timur Park, 2016)

Figure 7. Tornado rides are games that rely on the center point (middle) as a rotary axis. Where, the rotating axis is on the right and left of the seat. Tornado games have a driving source in the form of a special electric motor. The wheel mechanism is used to regulate its rotation which covers 360°. In the Tornado vehicle there is a concept of circular motion including centripetal force and centrifugal force.

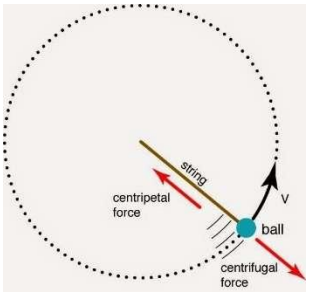


Figure 7. Centripetal style illustration

When the game starts to run faster and faster, the body will feel pushed out and a sense of loss of weight, which occurs due to the rotation of tornado rides. The working principle of tornadoes gives acceleration to the user of the probe, which affects the effect of gravitational pull.

https://doi.org/10.46627/sipose.v2i2.107



Figure 8. Superloop coaster
(Source: Jawa Timur Park, 2016)

Figure 9. Featuring the Italian-made Superloop Coaster ride with a 355-meter rail track that is traveled at a speed of 500 km/h that can accommodate 28 people. This game shows the existence of physical concepts in circular motion matter. The concept of Superloop Coaster is almost similar to roller coasters in general which include potential energy, kinetic energy, roller coaster dynamics, gravitational force, energy conservation, centripetal force, mechanical force, and centrifugal force. There is a change in speed to the time where the speed will increase when moving downhill, and vice versa Superloop Coaster will experience a slowdown when it will move up. The application of the concept of physics to the superloop game is shown in Figure 10.

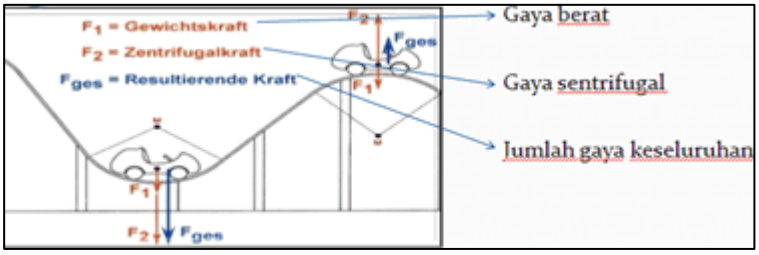


Figure 9. Concepts of physics on the superloop

On the Superloop Coaster rides formed a cornering track so that the centrifugal force that works is on the rider. The centrifugal force causes the weight of the passenger to increase or decrease. When the Superloop Coaster moves lowering then the heavy force will be in the direction of the centrifugal force, causing the overall force to increase (the unidirectional force will be added up). Passengers will feel pressured to the carry inversely proportional when moving up then the heavy force will be in the opposite direction to the centrifuge, so that the overall force will be reduced. This causes the hitchhiker as if there is an interesting style pull upwards.

Table 1. Literature review

Author	Purpose	Interesting Findings
(Khodizah, 2018)	(1) Developing a physics learning media in the form of a physics ludo game on the subject of circular motion (2) Knowing the response of validators to the physics learning media in the form of physics ludo games on the subject of circular motion (3) Knowing the feasibility of physics learning media in the form of physics ludo games on the subject of circular motion.	Centripental acceleration is the acceleration of objects towards the center of the circle, the presence of this friction gives rise to a centripental force. The impact if there is a change in speed, there will be acceleration.

https://doi.org/10.46627/sipose.v2i2.107

Author	Purpose	Interesting Findings
(Afkarina et al., 2021)	Analyzing the concept of physics in traditional games of kereweng neatness as a physics teaching material.	Centripental force is a force whose speed leads to the center of the circle, because the object moves circularly regularly with a constant speed, this is because the direction of speed always alludes to the trajectory whose speed will change every time the object changes position.
(Nasution & Rahmawati, 2019)	Create an experimental kit to determine the centripetal force based on microcontrollers. From the results of measurements of angular velocity, radius and mass.	Centripetal force will be of great value where if the greater the angular velocity value is tested with its mass and radius.
(Raharja et al., 2020)	Produce a circular motion practicum module and know its feasibility for high school students to use.	The distance of the object is directly proportional to the centripetal acceleration, where the farther the distance of the object to the central point, the greater the centripetal acceleration value.
(Deni et al., 2020)	Describes the validity of microcontroller-based rotation speed practicum tools on regular circular motion materials.	Centripetal acceleration is the acceleration that seeks its center.
(Annisa et al., 2019)	Identify students' understanding of concepts and student misconceptions on regular circular motion materials.	Centripetal acceleration in regular circular motion perpendicular to the speed of the object so that it goes to the center of the circle. The fingers will affect the centripetal acceleration.
(Apriyato et al., 2021)	Provide knowledge on how to apply the ball throwing device to the DKI Jakarta volleyball team.	The rotation of the wheel in the game of volleyball will produce two styles, namely centrifugal and centripetal forces. Centripetal force is a force that approaches the center of the circle.
(Lestari, 2019)	Increase students' learning motivation towards physics subjects, especially circular motion by utilizing "RIA SEPEDA"	Centripetal acceleration arises when an object moves around a regular loop that travels steadily in a changing direction.
(Fatmawati & Ishafit, 2021)	Utilize TVA software to identify the relationship of oil to travel time and the conversion value of oil to kinetic energy.	The centripetal force on oiled *otok-otok* vessels is affected by kinetic energy.
(Supriyanto, 2020)	Applying outbound learning methods to improve student learning outcomes on the subject matter of circular motion.	In improving students' understanding of circular motion, outbound methods are used that are able to encourage students' understanding through ambient observation.
(Negoro, 2019)	Develop students' science process skills through assisted inquiry learning centripetal style props to improve learning outcomes.	Centripetal force props used are props intended to find out among others the variable relationship of angular speed, linear speed, angular acceleration, linear acceleration, centripetal acceleration, and friction force in circular motion phenomena.

In Table 1. It is explained that the centripetal style is a style whose squirting is stretched to the center of the circle. There are also other centripetal styles, namely in the game of *otok-otok* ships, and ludo games. Centripetal style is also found in the sport of volleyball. Where in previous

research, Afkarina (2021) said that the centripetal force itself is a force whose perception leads to the center of the circle.

CONCLUSION

From the research conducted, it was concluded that on the Pendulum 360, Sky Swinger, Enterprise, Tornado, and Superloop Coaster rides at Jatim Park 1 Batu there is a physical concept, namely circular motion in the form of centripetal force, centrifugal force, and centripetal acceleration.

ACKNOWLEDGEMENTS

We say to Mr. Dr. Binar Kurnia Prahani, M.Pd. and Mr. Drs. Dwikoranto, M.Pd. as lecturers of physics edutainment courses who have guided in making this article as well as friends who have supported in the process of making this article.

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