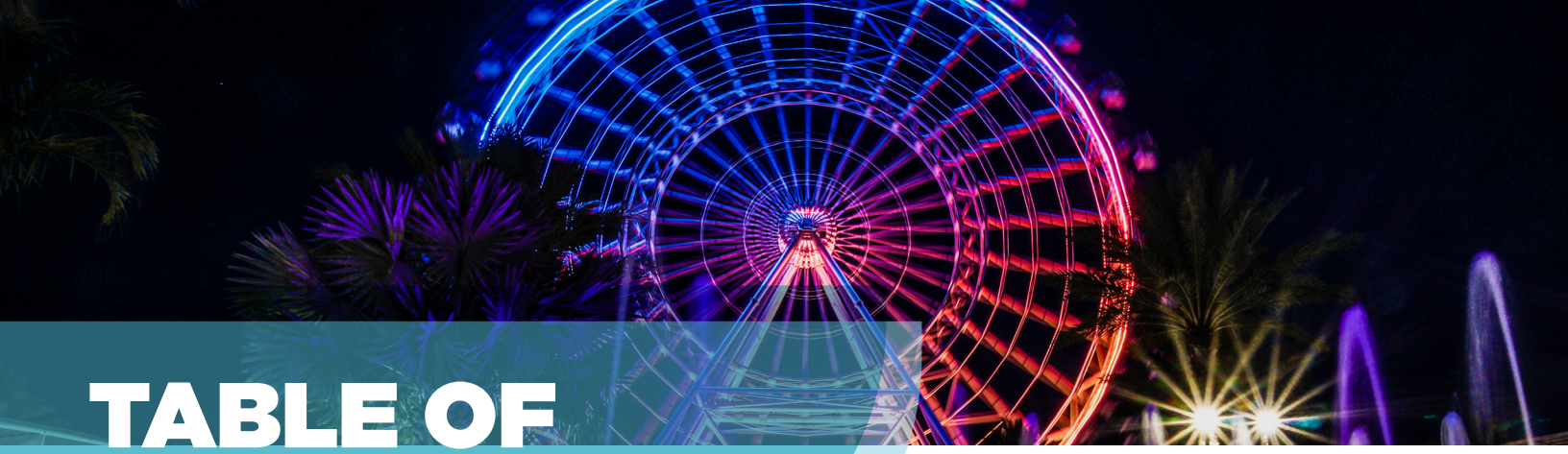
Teacher Resource Guide

Grades 3-5

to complement the Wonders of the Wheel audio script

The Orlando Eye™
by Merlin Entertainments



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PLANNING YOUR TRIP

DIRECTIONS

The Orlando Eye is located at:
8375 International Drive
Orlando FL 32819.

Parking for cars is FREE in ICON Park's covered parking garage right on property. The garage can be accessed via International Drive or Universal Boulevard.

For buses, the parking lot and student drop off area are both safely and conveniently located on the east side of The Wheelhouse. This parking lot is accessed via Universal Boulevard.

MAKE YOUR RESERVATION

So we can be prepared to make your visit to The Orlando Eye all that it can be, group reservations must be made at least two weeks in advance. All reservations must be made online through our secure Online Booking Portal. Group tickets are timed and dated. Payments must be made at time of booking with a credit card. Once the order has been processed, an order confirmation number will be provided to you for your records. **You will need this confirmation number the day you arrive.** If you require a different payment method to book your reservation, we'll be happy to discuss other options, please contact us at OrlandoSales@merlinentertainments.biz

ACCESSIBILITY

The Orlando Eye is fully accessible to guests with disabilities. A guest may use their own wheelchair, and our pods can accommodate electric wheelchairs. For your safety, our staff will stop The Orlando Eye for loading and unloading of a wheelchair. A service animal (a dog that has been individually trained to do work or perform tasks for an individual with a disability) may ride on The Orlando Eye. Service animals must be under the control of the owner at all times and should remain on a leash or in a harness. Our staff are not allowed to take control of service animals.

LESSON PLANS

At the back of this Teacher Resource Guide, you will find lesson plans to complement *The Wonders of the Wheel* audio that will play during your trip around The Orlando Eye. These plans align with the *Next Generation Sunshine State Standards (NGSSS)* as well as *B.E.S.T. Standards*.

WELCOME ABOARD!

ARRIVAL AND ENTRY

Gather your students in the walkway between the parking garage and the building and then walk along the walkway to The Wheelhouse, the building at the base of The Orlando Eye. Once inside The Wheelhouse, the Guest Services desk will be right in front of you. Someone from our team will personally greet you near the Guest Services desk. Please have your confirmation number available so we can easily provide you with your tickets.

RESTROOMS

Public restrooms are located inside The Wheelhouse. The trip around The Orlando Eye takes about 20 minutes, plus the time it may take waiting in line to board. Please make sure your students have used the restroom before entering the loading platform area.

SAFETY

Your safety is our main priority. You will ride The Orlando Eye in a freshly cleaned, air-conditioned pod, offering plenty of time to soak up Central Florida's most spectacular views in a safe environment. To have the best field trip adventure possible, please abide by all safety precautions posted and given by our staff. If you have any questions during your experience, please speak to any member of our team.

LUNCH

Please keep in mind that the dining tables inside The Wheelhouse are only for Wheelhouse Market customers. You will find both full service and casual dining locations around ICON Park. Weather permitting, seating will be available on the ground of the front lawn for groups who bring their own lunch or snacks.

LESSONS: THE WONDERS OF THE WHEEL

By completing the lessons set forth in this guide, you will be addressing each of the following standards.

Next Generation Sunshine State Standards

- **SC.3.P.8.3 – Properties of Matter** – Compare materials and objects according to properties such as size, shape, color, texture, and hardness.
- **SC.4.P.12.1 – Motion of Objects** – Recognize that an object in motion always changes its position and may change its direction.
- **SC.5.P.10.4 – Forms of Energy** – Investigate and explain that electrical energy can be transformed into heat, light, and sound energy, as well as the energy of motion.
- **MAFS.3.MD.1.2 – Measurement and Data** – Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units.
- **MAFS.3.OA.1.1 – Operations and Algebraic Thinking** – Interpret products of whole numbers, e.g., interpret 5 × 7 as the total number of objects in 5 groups of 7 objects each.
- **MAFS.4.OA.1.2 – Operations and Algebraic Thinking** – Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.
- **MAFS.5.NBT.2.5 – Numbers and Operations in Base Ten** – Fluently multiply multi-digit whole numbers using the standard algorithm.
- **LAFS.3.RI.1.1 – Reading Standards for Informational Text** – Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- **LAFS.4.RI.1.1 – Reading Standards for Informational Text** – Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- **LAFS.5.RI.1.1 – Reading Standards for Informational Text** – Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

Benchmarks for Excellent Student Thinking (B.E.S.T.) Standards

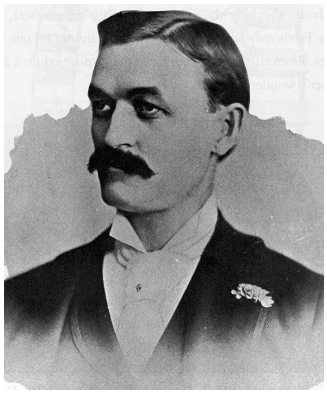
- **MA.3.M.1.2** – Solve real-world problems involving any of the four operations with whole-number lengths, masses weights, temperatures or liquid volumes.
- **MA.3.AR.1.2** – Solve one- and two-step real-world problems involving any of four operations with whole numbers.
- **MA.4.NSO.2.2** – Multiply two whole numbers, up to three digits by up to two digits, with procedural reliability.
- **MA.4.M.1.2** – Convert within a single system of measurement using the units: yards, feet, inches; kilometers, meters, centimeters, millimeters; pounds, ounces; kilograms, grams; gallons, quarts, pints, cups; liter, milliliter; and hours, minutes, seconds.
- **MA.5.M.1.1** – Solve multi-step real-world problems that involve converting measurement units to equivalent measurements within a single system of measurement.
- **ELA.3.R.2.2** – Identify the central idea and explain how relevant details support that idea in a text.
- **ELA.4.R.2.2** – Explain how relevant details support the central idea, implied or explicit.
- **ELA.5.R.2.2** – Explain how relevant details support the central idea(s), implied or explicit.

In 1893, the Chicago World's Fair: Columbian Exposition marked the 400th anniversary of Columbus' arrival in the Americas. This is a photo of the Ferris Wheel showing the 36 tricked out railroad cars carrying passengers.

BACKGROUND

When you and your students ride on The Orlando Eye, the audio track that will play is titled "The Wonders of the Wheel." This 20-minute experience gets riders thinking about wheels in general and introduces them to the history and construction of the original Ferris Wheel. As they ride, they'll learn a little bit about the forces of gravity and inertia that make big wheels work, and with a little prompting will experience the difference in the concepts of mass vs. weight. Finally, they'll hear statistics about The Orlando Eye as well as the energy and engineering it takes to make it operate.

With a little bit of preparation before they come, students can get much more out of their trip around The Orlando Eye. The following background information was prepared to help you better understand how you can make that happen.



History

In 1893, there was to be a World's Fair in Chicago. In 1890, the man in charge of making this fair something special was Daniel Burnham. He told his group of designers and engineers to "make no little plans." He wanted this exposition to be better than the 1889 World's Fair in Paris where the famous Eiffel Tower was constructed as the entrance to the fairgrounds there.

George Washington Gale Ferris, Jr. was one of Burnham's designers. Ferris' company was hired to test all of the steel used to construct this special fair. Ferris came up with a big idea. He drew a big wheel made of steel and shared his idea with Burnham, but Burnham scoffed. He thought it would be too fragile and therefore, dangerous.

George Ferris disagreed. He found investors, and he hired other engineers who drew up detailed plans and did safety tests. His final wheel design measured 250 feet in diameter, and carried 36 tricked-out railroad cars, each capable of holding 60 people. On December 16, 1892, his wheel design was chosen and constructed over the next several months. On June 21, 1893, the first Ferris Wheel launched.

References for more information:

- https://www.smithsonianmag.com/history/history-ferris-wheel-180955300/
- https://www.observationwheeldirectory.com/ferriswheelarticles/ferris-wheel-history/
- Great animation for younger students: https://www.youtube.com/watch?v=01f8PFAyl6c

Image Source (Ferris Wheel): https://commons.wikimedia.org/wiki/File:Ferris-wheel.jpg
Image Source (George Washington Gale Ferris, Jr): https://commons.wikimedia.org/wiki/File:GWFerris.jpg

Science

While riding The Orlando Eye, the audio that plays will introduce your students to many science terms as well as a little-known fact about big wheels, and that is...you might actually feel lighter at the top of The Orlando Eye than at the bottom!

It's true, and we are going to explore why in a moment, but first, let's review a few science terms you'll need to introduce to your students to help them better understand what they hear while they are riding The Orlando Eye.

MASS
is the amount of matter (or "stuff") in an object.

VELOCITY
is the rate and direction of an object's movement.

INERTIA
is the tendency to do nothing or to remain unchanged.

SPEED
is the rate at which an object is moving along a path.

WEIGHT*
is the measure of the gravitational force between an object (or a person!) and the earth.

CENTRIPETAL FORCE
is the force that is necessary to keep an object moving in a curved path and that is directed inward toward the center of rotation.

GRAVITY
on earth, is the force that pulls us toward the center of the earth. The more mass an object (or a person) has, the more the force of gravity acts on them...pulling them what we refer to as "down," but it is more properly stated as pulling toward the earth's center.

APPARENT WEIGHT*
is a measure of downwards force: it is the sum of your true weight and a fictitious force associated with your acceleration.

CENTRIFUGAL FORCE
is the apparent (but not real) force that is felt by an object moving in a curved path that acts outwardly away from the center of rotation. It is known as a fictitious or pseudo force because it is really the result of inertia.

FORCE
is a push or pull upon an object resulting from the object's interaction with another object.

So...why do you feel lighter at the top of The Orlando Eye than at the bottom? To begin to understand why your apparent weight is less at the top of The Orlando Eye, let's look at Newton's Laws of Motion. At this age, students don't need an in-depth explanation, but to answer their questions or help them research some answers, you might find this information helpful!

Newton's First Law of Motion (or Law of Inertia) states that if a body is at rest or moving at a constant speed in a straight line, it will remain at rest or keep moving in a straight line at constant speed unless it is acted upon by a force.

Simply stated, objects at rest want to STAY at rest, just like objects that are in motion want to stay in motion. Either way, a force is needed to make a change. In order to overcome this inertia (or resistance to change in motion), Newton's First Law is important to consider if you want to get a big wheel moving. It's also important when you want to maintain its rotational motion. When talking about Newton's Laws with students, it's helpful to give them an example they have all experienced. Have them imagine they are sitting in a car. The car accelerates quickly.

**Prior to Grade 3, the term weight it generally used instead of mass. By grade 3, the term mass should be used instead of weight.*

Ask them to show you what their body will do when that happens. (They will feel pushed back into their seat.) Why? Newton's First Law...Inertia.

If you're sitting in a car facing forward and you start accelerating forward in a straight line, your body wants to stay put so it feels like you are being pushed back into your seat. In fact, if your seat were facing backward in the car, acceleration of the car forward would make you feel like you were being pushed out of your seat. Still, it's just your body trying to stay put while the seat is moving forward. In actuality, the seat is exerting a force on your body. The seat is moving forward; this makes it feel like you are being pushed backward. Whether it's sitting still or whether it's moving, your body wants to keep doing what it's doing. That's inertia. Once the car is moving at a constant speed, you don't really feel the movement. Your mass eventually becomes one with the mass of the car.

NEWTON'S SECOND LAW OF MOTION

states that the acceleration of an object depends on the mass of the object and the amount of force applied.

In science terms, this equates to

Force = Mass x Acceleration

For The Orlando Eye to overcome inertia and get moving, it takes quite a bit of force! The Orlando Eye spins like a bicycle wheel, but unlike a bike, the hub in the middle only provides structure; it doesn't actually turn The Orlando Eye. The Orlando Eye rotates from the bottom pushed by several tires that run against its rim that act like gears. The tires are powered by fourteen electric motors. Each motor runs on just 6.6 kilowatts of electric power. Altogether, the motors produce about 123 horsepower. That's the same as an average car engine, making The Orlando Eye's operation super-efficient! Speaking of energy...just a side note...

THE LAW OF CONSERVATION OF ENERGY

states that energy can neither be created nor destroyed; instead, it is merely transformed or transferred into another kind of energy.

When riding on The Orlando Eye, you can look out the East window of your pod and see the Stanton Energy Center. It uses burning coal (chemical energy) to make steam (thermal energy) that drives a turbine (kinetic energy) that produces electrical energy. Then, that electrical energy powers the motors on The Orlando Eye that turns it producing kinetic energy (as it moves)... thermal (heat) energy as the motors work and as friction builds up where the tires meet the rim...sound energy in the form of the audio track you hear as you travel...and light energy as it powers the 63,000 LED lights on the outside of The Orlando Eye. That's an example of the concept of conservation of energy! Energy doesn't go away; it just changes form.

Now back to Newton. Unlike in our car example, when you're on The Orlando Eye, you don't move in a straight line. Instead, you travel around in a circle...albeit at a very slow speed compared to when you ride in a car. Speed is the rate at which an object is moving along a path, while velocity is the rate and direction of an object's movement. On The Orlando Eye, a rider's velocity (speed and direction) is constantly changing (because they are traveling in a circle around The Orlando Eye), and a changing velocity means riders are accelerating on their circular journey...and that means there is a net force. This net force is called centripetal force. Centripetal means "center seeking." The centripetal force always points toward the center of the circle. In fact, centripetal force is what keeps the moon from flying off in a straight line away from the earth!

Gravity is also at play. Gravity is always pulling you toward the center of the earth. Centripetal force is always pulling you toward the center of The Orlando Eye. But, we also need to consider Newton's Third Law now.

NEWTON'S THIRD LAW OF MOTION

states that for every action (force) in nature there is an equal and opposite reaction.

As opposed to centripetal force, you may be more familiar with the term **centrifugal force.**.. which turns out, is actually what is known as a **fictitious or inertial force.** It's called fictitious because it isn't a force at all. It's actually just the result of inertia trying to keep you moving in the direction of the rotation. *The centripetal force pulls you toward the center of The Orlando Eye, and it's opposite, the inertial force wants to hurl you tangentially straight away from the circle.* In this circular frame of reference, you feel this "force" much like you sense that the car accelerating in a straight line is pushing you backward. It's not. It just feels like it is! Fortunately, these opposing forces are mostly balanced, but there is slight difference in these opposing forces that causes a change in your apparent weight as you move around The Orlando Eye.

Obviously, Newton's Third Law is important in the design of a Ferris Wheel. The centripetal force must be balanced out by an equal and opposite force from the objects you are spinning in your wheel. Otherwise, if the carts or capsules on the outside don't contain enough weight, it could collapse to the center. Likewise, if the outside factors exert a force greater than the inward centripetal force of the wheel's center, (for example, if spun too quickly and the wheel suddenly stops), the objects (aka the people on the ride) will fly right off! So, you must incorporate Newton's Third Law when considering what the maximum speed of the ride needs to be.

As your students take a trip around The Orlando Eye, their mass doesn't change. That is, even young kids can reason that they still have all the same mass (or "stuff") inside them regardless of whether they are at the bottom or the top of The Orlando Eye. However, their apparent weight does change depending on whether they are at the bottom or the top. The Orlando Eye is going pretty slow, so they aren't likely to be able to feel this difference. If The Orlando Eye were traveling much faster than it does, one would likely be able to notice the difference in apparent weight, just as you do when you go up or down in an elevator; but since The Orlando Eye travels so slowly (less than one mile per hour) the difference is negligible. Still, because of changing angular velocity (and hence, acceleration,) your apparent weight is different depending on where on The Orlando Eye you are even though your mass stays constant.

If you want a more in-depth explanation of why you feel lighter at the top of the wheel (along with the science and math to prove it), you will find this article from Wired magazine interesting: https://www.wired.com/story/why-do-you-feel-lighter-at-the-top-of-a-ferris-wheel/

LESSON IDEAS

Before you go on your field trip, some simple lessons in the classroom will help your students get so much more out of their experience on The Orlando Eye.

MASS VS WEIGHT

- Together as a class, watch the following video as an introduction to the terms mass vs. weight: https://www.youtube.com/watch?v=glbgO3dI58c
- Assign the students this video to watch to help them understand how to use a balance: https://www.floridastudents.org/PreviewResource/StudentResource/185973
- After watching the videos, allow your students to experiment using a balance. Provide metric weights (gm and kg) and some small objects with similar sizes but different masses to measure. After they have measured several objects, ask them: What do you estimate the mass of this next object to be? Reinforce the use of metric units to refer to an object's mass as opposed to "x pounds of weight."

TYPES OF ENERGY

- Assign the students this interactive lesson to watch: https://www.floridastudents.org/PreviewResource/StudentResource/126698
- Discuss the terms: potential, kinetic, thermal, light, sound, and electrical energy.
- Ask your students to give examples of each type of energy and how one type transforms into another type.

CENTRIFUGAL AND CENTRIPETAL FORCE

- To inform yourself and older students, watch the following video: https://www.youtube.com/watch?v=zHpAifN_2Sw
- Assign your younger students this video to watch: https://www.youtube.com/watch?v=KvCezk9DJfk
- Demonstrate the following experiment for the class and discuss what is happening.
    - First, gather materials.
        - A clear plastic food container. One like a sliced pineapple container in the produce department in will work well.
        - About 60 cm (24 in) of rope of twine
        - A golf ball
        - A ping pong ball
    - Assemble the materials.
        - Poke two small holes in the bottom of the container.
        - Feed the twine through the two holes and knot it to itself.
        - Insert the ping pong ball in the container.
        - Secure the lid.
    - Swing the container around in a circle as in the second video above.
- Ask your students the following questions:
    - What keeps the container moving in a circle? (the tension on the string and its constant acceleration) Where is the ball located inside the container? (toward the outside edge)
    - What would happen if I stopped swinging the container? (It would stop moving in a circle.)
    - What would happen if I let go of the string? (The container would move tangentially away from the circle in a straight line until gravity pulled it down to the floor.)
- Repeat the experiment using the golf ball. Are the results any different? (Since the golf ball has more mass, you must swing it faster to get it to move in a circle and for the ball to move to the outside edge of the container.)

READING FOR INFORMATION

- Have your students complete the worksheet "The First Ferris Wheel."
- As an alternative, read the story to them, and ask them to write their answers on their own paper.

MATHEMATICS

- Have your students complete the worksheet "Math on The Orlando Eye."
- As an alternative, have them use the "Fast Facts" sheet and create (and solve) their own word problems.

FAST FACTS

- At 400 feet, The Orlando Eye is the tallest observation wheel on the North American east coast.
- The Orlando Eye is constructed of hardened steel for structural stability.
- The Orlando Eye weighs about 3,000,000 pounds, which is equivalent of over 12 fully loaded space shuttles.
- It took over 150 forty-foot trailers to ship all The Orlando Eye components to be installed on site.
- The company Intamin Amusement Rides (which is located in the smallest European country of Liechtenstein) designed The Orlando Eye, but parts were built all over the world.
- The Orlando Eye has eight legs, and they extend more than 20 feet underground.
- The Orlando Eye has thirty spokes (instead of cables) and thirty pods.
- Each pod can carry ten (10) passengers.
- Each pod weighs 6,600 pounds, that's about the same weight as an Indian Elephant or Baby Blue Whale.
- The glass covering the pod was crafted in Turkey, and then each pod was assembled in Hungary.
- The Orlando Eye is lit by over 63,000 LED lights.
- The pods feature redundant (two) A/C units; color changing LED lights; Bose audio system for music/narration, and iPads that allow you to use your own play lists.
- The inner part, called the wheel hub, is structural only. It doesn't turn The Orlando Eye.
- The wheel hub weighs about 180,000 pounds, which is more than a Boeing 737 airplane.
- The Orlando Eye is powered by 14 electric motors, each using only 6.6 kilowatts of city power.
- Altogether, the motors produce about 123 horsepower, which is about the same as a small car.
- The motors keep The Orlando Eye moving at a constant rate.
- The maximum rate The Orlando Eye can turn is about .33 meters per sec. It's slowed down to about .25 meters per second when people ride on it.
- It takes only 2.5 seconds for the motors to get The Orlando Eye moving at its operational speed.
- The Orlando Eye can do a complete rotation in about 17 minutes. When people are on it, it is run at the slower speed which takes about 20 minutes.
- The Orlando Eye can rotate in a clockwise or counterclockwise direction.

Name: _____

Answer each question. Show your work.

The Orlando Eye by Merlin Entertainments

THE FIRST FERRIS WHEEL

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George Washington Gale Ferris, Jr. was one of Burnham's designers. Ferris' company was hired to test all of the steel used to construct this special fair. Ferris came up with a big idea. He drew a big wheel made of steel and shared his idea with Burnham, but Burnham scoffed. He thought it would be too fragile and therefore, dangerous.

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1. In what city was the first Ferris Wheel built? _____
2. Who designed it? _____
3. What famous attraction in Paris was he trying to beat? _____
4. Who thought the wheel would be too dangerous? _____
5. What carried the passengers around the first Ferris Wheel? _____
6. How many people could ride in each car? _____
7. When did the first Ferris Wheel launch? _____

Name: _____

Answer each question. Show your work.

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MATH ON THE EYE

1. The Orlando Eye has 30 pods. Each pod can carry 10 people. How many people can ride on The Orlando Eye at the same time?

2. The Orlando Eye has 30 pods. Each pod has a mass of 2,994 kg. What is the total mass of all 30 pods?

3. The Orlando Eye weighs about 3,000,000 pounds total. If the hub in the middle weighs about 180,000 pounds, how much does the rest of The Orlando Eye weigh?

4. The Orlando Eye weighs about 3,000,000 pounds total. There are 2,000 pounds in a ton. How many tons does The Orlando Eye weigh?

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THEORLANDOEYE.COM