Schedule of Events

TIME	EVENT	LOCATION
8:45	Lagoon Autopark (parking lot) opens	
9:30	Lagoon Main Gates to rides opens	Main Gate
9:00 - 11:00	School & teacher registration Main Gate	Main Gate
9:30 - 11:00	Contest registration & safety approval inspections	Davis Pavilion
10:00-11:00	Utah/Idaho FIRST Robotics Grudge Match—Semifinals	
10:00-2:00	Mindstorm Activities	Maple Terrace
10:00-2:00	MESA Arduino Clean Air Solutions and Mouse Trap Car	Oak Terrace
12:00 - 1:00	Faculty and staff complimentary lunch	Canyon Terrace
2:30 - 3:30	Contest winners are posted as judging is completed Prizes may be picked up then.	Davis Pavilion
2:00-2:45	Utah/Idaho FIRST Robotics Grudge Match—Finals	
2:30-3:45	Mindstorm Competitions	Maple Terrace
3:30	Awards Ceremony in Davis Pavilion	Davis Pavilion
9:30	All rides close	
10:00	Park closes	
Sky Drop Contest		
10:00-12:00	Registration for the Sky Drop is open	Drop Site
11:00-1:30	Eggs can be dropped from the Sky Coaster. Line will close at 1:00, or as soon as the line is finished.	Drop Site
2:30	Winners will be announced as soon as the contest is judged.	Drop Site
Colossus' Colossal G-Forces Contest		
9:30-10:30	Contest registration & safety approval inspections	Davis Pavilion
10:30-12:30	Colossus open for measurements	Colossus
2:00	Entry forms due	Davis Pavilion
Physics Bowl Competition (Bighorn Pavilion)		
9:30 - 10:30	Contest registration	Bighorn Pavilion
10:20	Rules Review/Contest Information/Round 1 time slots Drawing	Bighorn Pavilion
10:30 – 11:00	Preliminary Qualification Round in	Bighorn Pavilion
11:00 - 11:45	Round of thirty-two	Bighorn Pavilion
1:15 - 1:45	Round of sixteen	Bighorn Pavilion
1:45 - 2:15	Quarter-final round	Bighorn Pavilion
2:15 - 2:45	Semi-final round	Bighorn Pavilion
2:45 - 3:00	Consolation round	Bighorn Pavilion
2:45 - 3:00	Championship round	Bighorn Pavilion
3:30	Scholarships and prizes awarded	Davis Pavilion
Physics Demonstration, Lagoon: Ride Design and Physics Day Logo Design Contests		
9:30 - 11:00	Contest registration & safety approval inspections	Davis Pavilion
11:00 - 3:00	Judging	Davis Pavilion
11:00-2:00	Meet with Judges by appointment as arranged during registration	Davis Pavilion
USU Physics Day Photo Contest		
2:00	All photo entries due with ***#USUPhysicsDay***	Online
3:00	Contest winners posted ***@USUAggies***	Online
Student Workbook		
10:00 - 3:00	Workbooks Collected	Davis Pavilion
3:30	All entry forms due. Teachers can pick up solutions.	Davis Pavilion

All students who turn in their workbook to the table at Davis Pavilion by 3:30 can enter a random drawing to

Win Fabulous Prizes

Utah State University
DEPARTMENT OF PHYSICS

INL Idaho National Laboratory

30 High School Student Workbook 30

USU PHYSICS DAY

AT

Lagoon

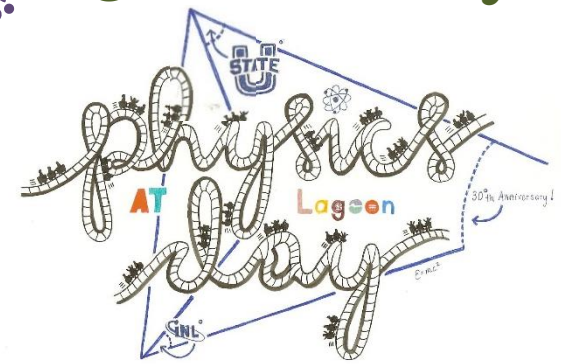
30 30

May 17, 2019

30 Years!

30th Anniversary

30 Years!



30 30 30

Artist-Sabrina Lin and Suzie Jo
School-Herriman High School
Advisor- Tony Romanello

30 Years!

STUDENT _____

TEACHER _____

SCHOOL _____

WELCOME TO PHYSICS DAY AT LAGOON

Thank you for coming to Lagoon for a day of physics and fun!

You are one of more than 10,000 physics students from more than 125 schools from five states here to enjoy a fun day experiencing Amusement Park Physics first hand.

This Student Workbook is for use in one of many activities that you can participate in today:

Student Workbook Physics Bowl Contest
Colossus' Colossal G-Forces Contest
Sky Drop (Egg Drop) Contest
Physics Demonstration Design Contest
Lagoon Ride Design Contest
Physics Day Logo Design Contest

The Physics Department at Utah State University and the Idaho National Laboratory are running today's activities.

The contests are sponsored by Aerostructures, Albany, Apogee, ARDUSAT, ASI, Boeing, Campbell Scientific, Eastern Idaho Regional Medical Center, Embry-Riddle, Hill Air Force Base, Idaho Virtual Academy, IM Flash Technologies, Lagoon, Micron, Northrop Grumman, Ophir-Spiricon, Parker-Hannifin Aerospace, Portage Environment, Rocky Mountain NASA Space Grant Consortium, Space Dynamics Laboratory, US Navy, USU College of Science, USU Emma Eccles Jones College of Education & Human Resources, USU Admissions Office, Utah Virtual Academy, and WiTricity.

More information about Physics Day is available at physicsday.usu.edu.
If you have questions or would like to find out more about physics at Utah State University (www.physics.usu.edu), please stop by the Davis Pavilion.
We will be glad to see you at Lagoon!

ABOVE ALL, HAVE A FUN AND SAFE DAY!!!

Table of Contents

GENERAL QUESTIONS

FILL IN THE BLANKS WITH THE TERMS IN THE GLOSSARY ON PAGES 4 & 5

1. When a roller coaster is at the top of a hill, it has the most _____ energy?
2. _____ of an object refers to its speed and direction.
3. When on a curve on Cannibal or on spinning rides, the riders feel an inward force known as _____ force.
4. To measure the acceleration throughout a roller coaster ride, riders can take an _____ on the ride.
5. The attractive force between two massive bodies, which causes Lagoon's roller coasters to run, is called _____.
6. Rides at Lagoon are all slowed down by this force: _____.
7. Riders on fast rides experience _____ _____, a type of frictional force, due to our atmosphere.
8. Lagoon riders have the same _____ both here on Earth and on the Moon, but their _____ is less on the Moon.
9. A push or pull felt on the Lagoon rides is known as a _____.
10. _____ is felt when rapid changes in speed or direction occur.
11. If two bumper cars collide and the net external force acting on the cars is zero, the total momentum is _____.
12. _____ causes riders on spinning rides to lean when going around a bend because their bodies resist changing direction.
13. As roller coaster riders descend down the top of the hill, their _____ energy is rapidly converted to _____ energy.
14. The_____ on roller coasters cause riders to feel heavier than normal when they ride through the loops.
15. The _____ of _____ states that within a closed system, _____ cannot be created nor destroyed, though it may change form.

FERMI QUESTIONS

Enrico Fermi was one of this country's greatest physicists. Among his accomplishments were the 1938 Nobel Prize for nuclear and particle physics and the title, "Father of the Atomic Age" for his role in building the first nuclear reactor. He had a rare talent as both a gifted theorist and experimentalist. One of his legacies is the "Fermi Question," an insightful question requiring both an understanding of physics principles and estimation skills. The Fermi Questions given below require information gathered for this workbook, estimation and some clever thinking.

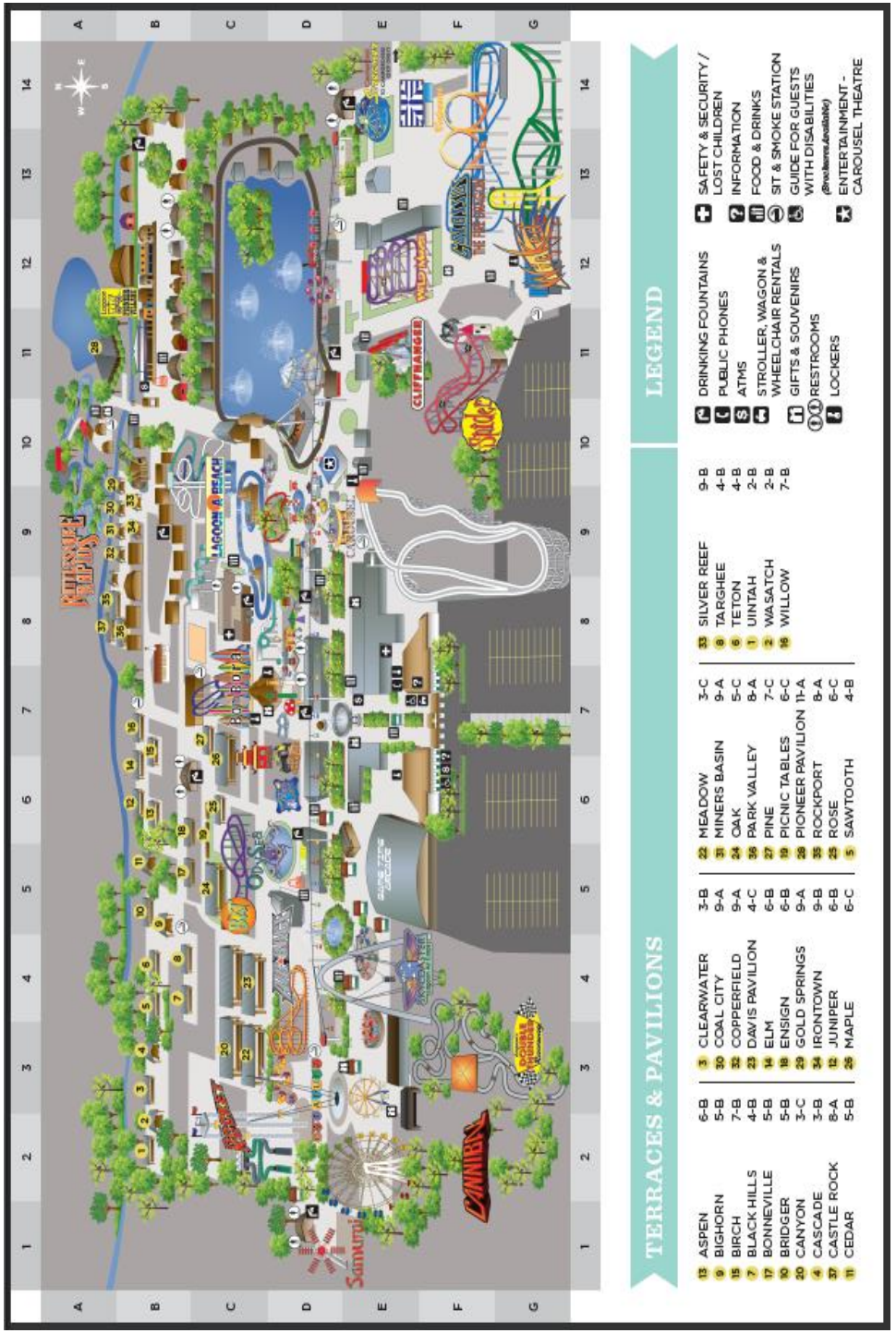
Enrico Fermi
1901-1954

a.) Estimate how many golf balls would be required to fill one of the Tipsy Tea Cups.

b.) Estimate how many water molecules it takes to fill Rattlesnake Rapids!

c.) If all the water molecules in Rattlesnake Rapids were actually golf balls, how many USU Maverick Stadiums could be filled?

LAGOON PARK MAP



Amusement Park Physics Glossary

Here are some physics concepts that you will encounter today. Most of them should be familiar to you after the exciting physics class you've been in this year.

ACCELERATION: How fast the velocity (either speed or direction) of motion changes with time.

ACCELEROMETER: A device to measure acceleration.

AIR RESISTANCE: Force resisting motion of a body through air due to the frictional forces between the air and body.

CENTRIPETAL FORCE: A force on an object pulling or pushing the object towards the center of its curved path.

DENSITY: The mass of a material per unit volume.

CHARGE: The amount of electric charge determines the force due to an electric field.

CONSERVATION OF MOMENTUM: The total momentum of a system is constant whenever the net external force on the system is zero.

CURRENT: The charge flow rate or amount of charge passing a certain point per unit time.

DENSITY: The mass of a material per unit volume.

ELECTRIC POTENTIAL (VOLTAGE): The potential energy of a body due to electric force, per unit charge.

FORCE: A push or pull. The time rate of change (direction and magnitude) of momentum.

FLOW RATE: The amount (or number) of something going past a certain point in a certain amount of time.

FLUX: The same as Flow Rate. The amount (or number) of something going past a certain point in a certain amount of time.

FRICTION: A retarding force that resists the motion of a body.

G-FORCE: Ratio of the magnitude of acceleration on a body to the acceleration of gravity at sea level on Earth ($g = 9.8\ m/s^2$).

GRAVITATIONAL POTENTIAL ENERGY: The potential energy of a body associated with its position due to the force of gravity

GRAVITY: Attractive force between two bodies, proportional to their masses.

IMPULSE: Product of the magnitude of a force on a body times the time over which the force acts on the body.

INERTIA: Tendency of a body to remain at rest or in uniform motion in a straight line.

Bored? Do some Physics on your Phone!

Scan QR code to load App

Physics Toolbox Sensor Suite

Your smart phone has a whole host of sensors built into it in order to make your life easier. There are a number of apps available to utilize these sensors to take real data.

g-Froce Meter – measures the ratio of normal force to gravitational force (F_N/F_g) in three dimensions.

Linear Accelerometer – The linear accelerometer measures acceleration in a straight line in three different dimensions.

Gyroscope – Changes in electric potential due to the difference in direction of the phone's vibration compared to a non-rotating system is interpreted as a rotational velocity.

Barometer – As the pressure increases or decreases within your phone a small resistor changes shape. That change of shape is interpreted as a change in atmospheric pressure.

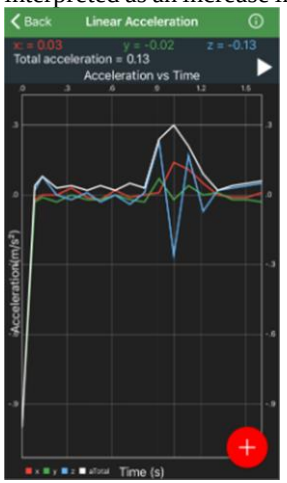
Proximter – When an object approaches the sensor, these light waves are reflected back toward the mobile device and absorbed by the infrared-detecting photodiode.

Magnetometer – Magnetometers are composed to permanent magnets in a circuit. As the magnet is exposed to external magnetic fields, the resistance of the magnet in the circuit changes.

GPS – By observing the relativistic time it takes for radio signals to arrive from satellites position is determined.

Inclinometer – When the mobile device is held parallel to the x, y, or z plane, such as when it is held flat, all of the gravitational force is sensed in a single direction. As force direction changes an incline is sensed.

Light Meter – The light meter is a photoresistor. As the number of light waves hitting the photoresistor increase, the current increases, and this is interpreted as an increase in light intensity



Color Detector – Your phone contains a number of photodiodes. The information received by these photodiodes can be organized and combined to determine the total combination color perceived by the human eye.

Sound Meter The sound meter sensor is composed of a capacitive microphone. The microphone is composed of a conductive membrane that flexes when it receives sound waves.

Tone Detector– A fast Fourier Transform decomposes an observed sound wave into its component sine waves of various amplitudes and frequencies. The most prominent frequency from the sound sample is displayed numerically.

Fun With Physics: FOOD

All this walking and riding is sure to make you hungry. Let the Physics continue as you refuel!

Assume you eat one hot dog (250 Calories) and a 16 oz coke (140 Calories). Remember that food Calories (written with a capital C) are 1000 physics calories (written with a small c). One physics calorie is 4.186 J.

a.) Estimate the number of joules you gain from your lunch.

b.) Estimate the number of joules you must use to get to the top of the Water Slide. (The slide is 60 m high). The energy needed to raise yourself a distance h against gravity is your mass (in kg) times the acceleration due to gravity (in m/s^2) times the height: Energy Change = mgh

Amusement Park Physics Glossary

KINETIC ENERGY: The energy of a body associated with its motion.

MASS: The amount of material a body contains. A quantitative measure of the inertia of a body.

MOMENTUM: The product of mass times velocity.

NEWTON'S LAWS OF MOTION: Physical laws governing the motion of bodies (at speed much less than the speed of light) expressed in terms of force, mass, and acceleration.

POTENTIAL ENERGY: Energy of a body associated with its position.

POWER: Rate of work done per unit time.

SPEED: The magnitude of velocity.

VELOCITY: The magnitude and direction of the time rate of change of position.

WEIGHT: A force proportional to the mass of a body. Measurement of the gravitational attraction of a body to the Earth.

WEIGHTLESSNESS: A condition under which a body feels no net force proportional to its mass.

WORK: Product of the magnitude of force on a body times the distance through which the force acts.

Useful Conversion Factors

1 m = 3.28 ft
1 hr = 3600 sec
1 m/s = 3.6 km/hr = 2.24 mi/hr
1 g = 9.8 m/s^2 = 32 ft/s^2
1in = 2.54 cm
1 km = 0.621 miles
1 kg = 2.2 lbs
1 N = 0.225 lbs
1 Cal = 1 kcal = 1000 cal = 4184 J

Common Densities (g/cm^3)

air	0.001
water	1
aluminum	2.7
iron	7.9
lead	11
plastic	0.9
wood	0.9

Helpful Equations

$PE_g = mgh$

$P = mv$

$KE = (1/2)\,mv^2$

$a = \Delta v/\Delta t$

$\omega = \Delta\theta/\Delta t$

$$V_{Average} = \frac{V_{Finalc} + V_{initial}}{2}$$

$$V_{Average} = \frac{\Delta distance}{\Delta time}$$

Fun With Physics: CAROUSEL

The Carousel or Merry-Go-Round at Lagoon was built in 1893! It is the only wooden carousel still in operation in Utah (see lagoonpark.com). And it is family and Physics friendly!

Using the formula $\omega=\Delta\theta/\Delta t$ answer the following questions. (Use your phone and determine the best way to obtain an angle measurement and time.)

ω: angular velocity
$\Delta\theta$: angular displacement
Δt: change in time

a.) What is the angular velocity of the carousel on the outside edge of the ride?

b.) The inside edge?

c.) Compare the answers from part (a) and (b).

d.) What is the period of the carousel (i.e., how long, on average, does it take for the carousel to make one complete rotation?)

Fun With Physics: BOOMERANG

The classic game of BUMPER CARS! Strap in and practice your driving skills. For these questions, you will need to use the Physics App "Physics Toolbox Sensor Suite" to complete the questions. Remember, DO NOT have your phone out while riding the ride. It must be in a secure place!

a.) Using the Physics Toolbox, measure the fastest speed that you can reach in your car.

Speed:_____m/s

b.) Run into another person's car. Calculate your acceleration assuming you attained full speed before coming to a full stop in approximately 1 second.

c.) Two identical bumper cars collide head on. Each bumper car is traveling 5 mph. How does the impact force on each car in this scenario compare to hitting a solid wall instead? (Hint: Newton's 3rd Law of Motion).

Fun With Physics: WILD MOUSE

You will need to use the Physics App "Physics Toolbox Sensor Suite" to complete the questions. Remember, DO NOT have your phone out while riding the ride. It must be in a secure place!

Are you ready for a crazy game of cat and mouse? The hills and turns on this ride give it a high thrill level. So strap in and let's do some PHYSICS!

a.) Using the Linear Acceleration Meter, find the Average Acceleration and each component A_x, A_y and A_z.

Average Acceleration:

A_x:

A_y:

A_z:

b.) Assuming an initial velocity of 0, use the equation $A_{Avg} = \frac{V_{Final} - V_{initial}}{time}$ to find the final velocity. (Estimate time from Linear Acceleration Meter).

c.) Find the average velocity: $V_{Average} = \frac{V_{Finalc} + V_{initial}}{2}$

d.) Find the total distance of the chase! $V_{Average} = \frac{\Delta distance}{\Delta time}$

Fun With Physics: TURN OF THE CENTURY

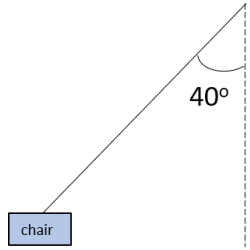
The Turn of the Century was built in honor of Lagoon's 100th birthday in 1987 (see lagoonpark.com). It is rated as extreme on the spinning scale so it's not for the weak of stomach!

So go take a look and ride if you can handle it. Then answer the questions below.

a.) As the ride speeds up, you and your chair begin to move outward: why?

b.) Create a Force Vector Diagram of the forces acting on you as you swing on this ride.

c.) Given that all of the swings are pulled outward at approximately 40 degrees, what is the tension acting on the rope (see diagram)?



Fun With Physics:
CENTENNIAL SCREAMER

Another ride meant for the thrill seekers, this ride begins spinning in the horizontal position, then as the speed increases, the ride is lifted up to a near-vertical position (see lagoonpark.com)!

Using the image and your knowledge of energy, answer the following questions.

a.) What is the kinetic energy at each of the points (A-D) on the Centennial Screamer?

A:
B:
C:
D:

b.) What is the gravitational potential energy at each of the points (A-D) on the Centennial Screamer?

A:
B:
C:
D:

More on the
CENTENNIAL SCREAMER

For these questions, you will need to ride the Centennial Screamer or find a friend willing to ride it for you. You will also need to use the Physics App "Physics Toolbox Sensor Suite" to complete the questions. Remember, DO NOT have your phone out while riding the ride. It must be in a secure place!

a.) What is a G-Force?

b.) Time to hop on the ride! Using the G-Force Meter in your App, find the total G-Force of the Centennial Screamer at each point, A-D.

c.) What does your answer to part (b) mean?