2020

STEAM RACE CAR CHALLENGE

SONOMA RACEWAY

Kid Scoop News®

Friedman's HOME IMPROVEMENT

SONOMARACEWAY.COM/STEAM

STEAM RACE CAR CHALLENGE
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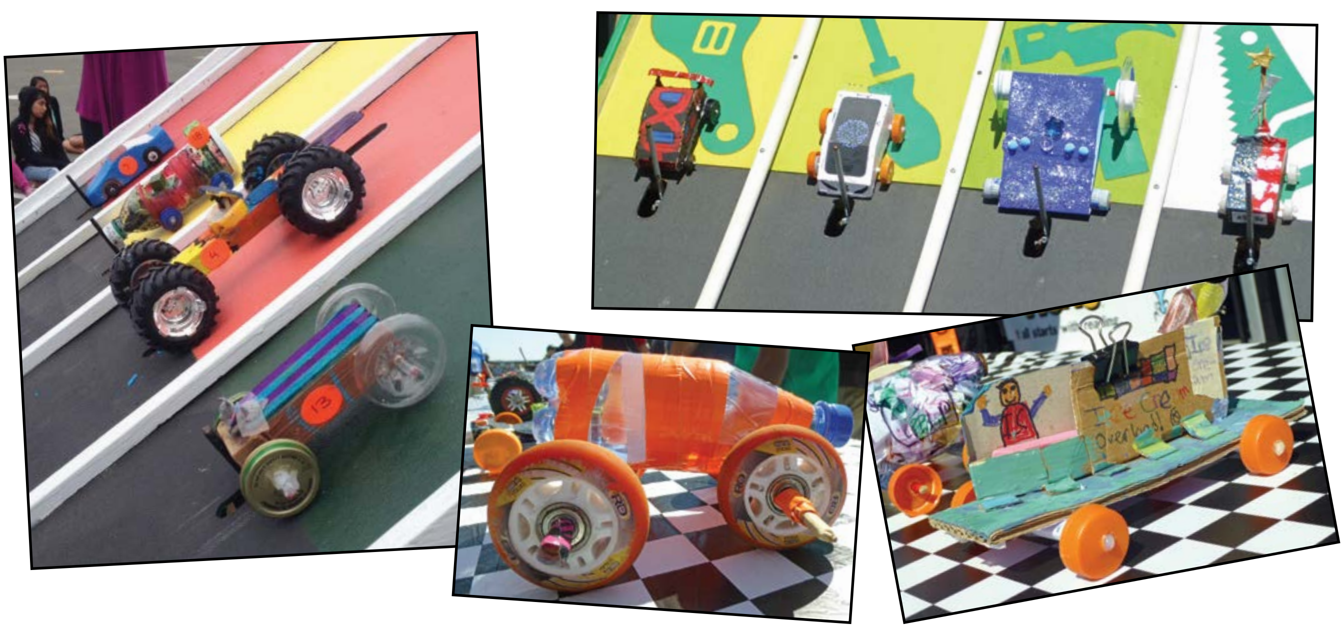
Sonoma Raceway, *Kid Scoop News* and Friedman's Home Improvement have partnered up to get students thinking in high gear with a gravity-powered car challenge.



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SONOMA RACEWAY

STEAM RACE CAR CHALLENGE
INTRODUCTION

Children are natural born engineers. Watch them play, and you will observe their innate curiosity to build things and take them apart to see how they work. From linking blocks emerge colorful towers, sturdy houses or imaginative zoos to showcase stuffed animals. Sand transforms into a magical castle on the beach. A shoe box or discarded wood scraps become backyard birdhouses or ships that float in a tub. When children have a chance to construct and solve problems using objects, they are engineers!

21st Century classrooms build on this natural curiosity by ramping up the focus on science, technology, engineering, arts and mathematics—known as STEAM—to make learning fun and connected to the world. Engineering at school happens best when children combine math and science and apply what they know to a project. Learning becomes a joyful byproduct of student motivation to resolve a challenge.

Jumping on board with STEAM, *Kid Scoop,* Sonoma Raceway and Friedman's Home Improvement formed a partnership to encourage students using car building as the medium. The STEAM Race Car Challenge looks at something fun—race cars—from a scientific perspective. This connects students to life and occupations in a way that is instructive and engaging.

Most children learn best through hands-on projects. This is at the heart of the STEAM Race Car Challenge. From cardboard, rubber bands, straws, buttons and an array of other objects will emerge a car powered by gravity alone. Design features that address efficient aerodynamics, reduce drag, minimize friction, increase speed and maximize distance make lessons in physics stick.

In addition, this project is a practical venue to develop and reinforce 21st Century skills essential for career success in today's workplace. Students are posed with questions like "What is the best design to make a car move faster?" or "What materials should I use that are durable but allow for maximum speed?" they have to be critical and creative thinkers to solve the challenge. Creative problem-solving is the essence of successful 21st Century careers.

By drafting designs, constructing and assembling race cars, students *become* mechanical engineers. Students experiment to discover how well their design works, *take on the role* of scientists with methods to test hypotheses and record information. Technical adjustments, researching terms and using the right tools to gauge speed and performance *introduce* young learners to the world of technology. Collecting, analyzing and interpreting data gives a *real context* to mathematics.

So, rev up your engines and drop the checkered flag as we take off and drive home the value of STEAM in a student's education, and its potential impact on a career choice and our nation's future!

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LESSON 1
GRAVITY POWER

OBJECTIVES

Your child will:

- Discover the Sonoma Raceway STEAM activity through a letter
- Build content vocabulary (gravity, drag, friction) and oral language skills
- Determine accuracy of text-dependent claims
- Calculate sums and differences
- Think critically about physical forces
- Practice letter writing

You will need:

- Challenge Letter from Sonoma Raceway
- Gravity Power *Kid Scoop News* Worksheet
- Engineer's Journal—have your child use a notebook or make one by stapling blank pages together.

START YOUR ENGINES!

ASK: *If I told you we were going outside today to have "races," what kind of races might we have?* (Chart responses—relay races, running races, hopping races, jumping races, skipping races, etc.)

Create a blank **WHO, WHAT, WHEN, WHERE, WHY** chart. Do a second chart with answers (see below).

SAY: *I have received an interesting letter from your friends at Sonoma Raceway that has a challenge for you for a different kind of race. Listen carefully for the answers to "WHO, WHAT, WHEN, WHERE and WHY," while I read their letter to you.*

	SAMPLE ANSWERS FROM LETTER
WHO	Your friends at Sonoma Raceway
WHAT	Invites students to design and build the fastest car that runs only on gravity.
WHEN	Spring 2020
WHERE	At home. (Talk with your child about where you could race your car. See tips for building a ramp, page 31)
WHY	To discover how science, technology, engineering and math affect a car's speed!

ASK your child to help you complete the chart. Review responses. **SAY:** *Are you ready to start your engines and take up the challenge?*

GO!

SAY: *Here is a question to guide your work: How can you design and build the fastest gravity-powered car?*

SAY: *Let's begin by finding out what you already KNOW about NASCAR racing and gravity and what you NEED to KNOW to complete this project.* (Allow time to brainstorm; chart responses on a piece of paper. The "Need to Know" elements will be answered during the project.)

KNOW	NEED TO KNOW
Example: *NASCAR race cars are low to the ground.*	Example: *Why are they built so low?*

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LESSON 1

GRAVITY POWER

REVIEW Gravity Power Worksheet

READ the "claims" on the chart below. Predict whether they are TRUE or FALSE. Then complete the worksheet.

SAY: *As you read and complete the worksheet, decide if these claims from the reading are TRUE or FALSE.*

CLAIMS	TRUE	FALSE
a. Gravity can pull a car down a ramp.		
b. Gravity has the same pull on all cars in a race.		
c. Friction causes gravity.		
d. A car moving through air causes friction.		
e. A car shaped like a box has less drag than a car that is streamlined and smooth.		
f. Sonoma Raceway is a "road course" with hills and different directions.		
g. Race cars are designed to have more drag.		

ANSWERS: a. TRUE, b. TRUE, c. FALSE, d. TRUE, e. FALSE, f. TRUE, g. FALSE

VICTORY LANE!

1. **Chat it UP!** Explain the difference between *gravity* and *drag*. Discuss why it is important to understand these forces to design the best race car.

2. **Imagin-eer!** In your Engineer's Journal, draw two cars—one with lots of drag and another with very little drag. Describe the features of your car with less drag. What makes it a better design?

3. **Write On!** Write a letter in reply to Sonoma Raceway and the Publisher of *Kid Scoop News*. Tell them your feelings about the project and some of your initial plans.

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SONOMA RACEWAY

LESSON 1
CHALLENGE LETTER

Rev up your engines and discover the fun of science, technology, engineering and math!

Dear Students,

The famous Sonoma Raceway has a challenge for you. Sonoma Raceway is a place where professional drivers compete in races with cars that are designed by top engineers to meet the challenges of speed and sharp racetrack turns.

But today we have a different challenge!

Sonoma Raceway is looking for young engineers to help design the *ultimate* fuel-efficient race car—so efficient that it runs on *no fuel at all*—only gravity! Are you up for this challenge?

We'd like to invite you to "think like an engineer" and design a small gravity-powered car *completely out of clean trash*. Your small car will be not only fuel-efficient but will re-use trash that might otherwise have been headed to the landfill.

This STEAM Family Learning Guide will assist you through every step of the process while teaching you key Science, Technology, Engineering and Math (STEM) concepts. And, because you will be using unusual items to build your car, it's a chance to show off your artistic skills as well. That makes this a STEAM (Science, Technology, Engineering, ART and Math) project!

Begin the challenge by completing these eight lessons that will help you understand the dynamics of race car design including creation of a "cereal box" car of your own! Then turn to the ULTIMATE CHALLENGE to think outside the "cereal box" to build your unique car ready for NASCAR racing on an inclined ramp that *makes gravity do the work!* You may need to make some adjustments to your design, but that's all part of the learning fun—and seeing what doesn't work is how real engineers make their designs better.

But, don't stop there! Once you're finished, we want to see what you've created! Take pictures and videos of your cars, go to sonomaraceway.com/STEAM and send them to us. If we do schedule our annual gravity-powered racing event at the track, you'll be ready to roll.

We look forward to seeing your cars and discovering your clever ideas on how to make a gravity-powered car zip down the track. So … rev up your engines as you discover how much fun the combination of creativity, science, and engineering can be, and how it's part of our lives each and every day!

Sincerely,

Your Friends at Sonoma Raceway

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STUDENT NAME: ____

Race cars without engines?

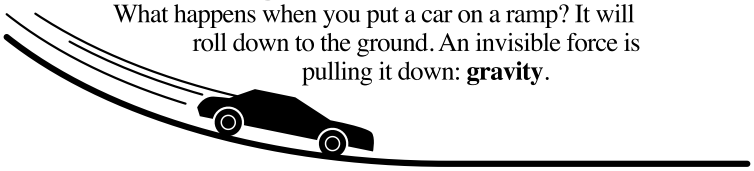
"Drivers start your engines!" is something you normally hear at an automobile race like NASCAR or the Indy 500.

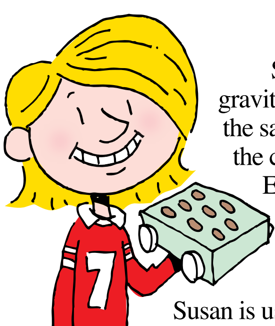
But, what if a car had no engine? How would it move? Could it still be a race car?

The answer is "YES!" if you know your science!

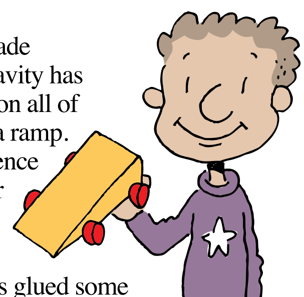
Gravity Power

What happens when you put a car on a ramp? It will roll down to the ground. An invisible force is pulling it down: **gravity**.

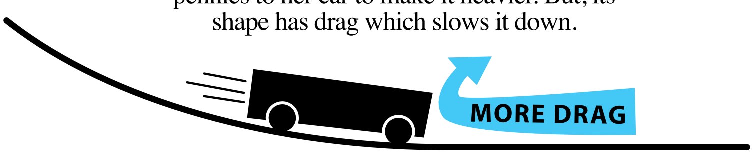




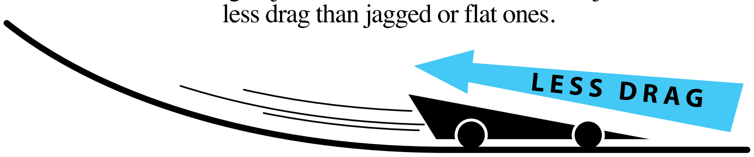
Susan and Taylor made gravity-powered cars. Gravity has the same amount of pull on all of the cars in a race down a ramp. Each kid is using science to make his or her car go faster.



Susan is using **weight**. She has glued some pennies to her car to make it heavier. But, its shape has drag which slows it down.



Taylor has engineered his car to have less **drag**. When a car moves through the air, it causes **friction**. Friction causes drag, a force that slows a moving object. Streamlined and smooth objects have less drag than jagged or flat ones.



Science at Sonoma Raceway

The track at Sonoma Raceway is different from other race tracks. Other tracks are large, sloped ovals. Sonoma Raceway is a "road course." That means it turns in different directions and travels up and down over small hills. This makes understanding gravity a part of how a driver decides to drive the course.

A Note to Parents
Discuss with your child how understanding gravity is important for a race car driver on a track that changes elevation.

Sonoma Raceway

Fast Facts

Do the math to discover the facts about the unique track at Sonoma Raceway!

Sonoma Raceway features more than 100 + 20 + 40 = ____ feet of elevation change from its highest to lowest points.

The highest point is Turn 3a. It is 75 + 25 + 74 = ______ feet in elevation.

The lowest point, Turn 10, is just 7 + 7 = ______ feet in elevation.

What is the difference between Turn 3a and Turn 10? ________ feet!

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OBJECTIVES

Your child will:

- Understand the relationship between friction and motion
- Compare smooth and rough surfaces
- Build content vocabulary (friction, burnout)
- Determine cause and effect
- Think critically about physical forces

You will need:

- Balls (playground, tennis, golf, etc.)
- Friction *Kid Scoop News* Worksheet
- Engineer's Journal (see Lesson 1)

LESSON 2

FRICTION

START YOUR ENGINES!

ASK: *Will a ball roll farther on the grass, on the playground or on the sidewalk?* Discuss. *Let's go outside and experiment.* Allow time to experiment rolling balls on different surfaces. *Why is there a difference how far the ball rolls?* (Allow time to speculate.)

SAY: *The ball rolled farther and faster on a smooth surface because there was less friction between the ball and the surface. This is an important principle to understand in drag racing. Let's learn more about friction and what it means for our gravity-powered race cars.*

GO!

Give your child the "Friction" Worksheet.

SAY: *Look at the two ramps—"A" and "B"—at the top of the page.* **ASK:** *How are the ramps alike? How are they different? Why will the car travel faster down the smooth ramp?* (A: less surface friction)

Create a chart like the one below to help guide the discussion about Friction. Leave the answer section blank and have your child write his/her own answers after reading the section "What is Friction?" Look for answers to the questions on the chart while you read.

QUESTIONS	ANSWERS
What is friction?	
What does it do to moving things?	
Why does a rolling ball eventually stop?	

ANSWERS: What is friction? *Friction is when two things rub against each other.*
What does it do to moving things? *Friction slows or stops moving things.*
Why does a rolling ball eventually stop? *Friction between the ball and the ground make it stop.*

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LESSON 2
FRICTION

SAY: *Read the Section "Fun with Friction." Why would race drivers complete a burnout BEFORE the race?*

WRITE *"Cause" phrases on a piece of paper in a "T-Chart."* **ASK** students to help you complete the "Effect" side. (Answers are shown.)

CAUSE	EFFECT
Because Ramp B has a rough uneven surface …	
Because there is friction when two moving things rub against each other …	
Because the drag racers spin the car's wheels while the car stays still (a "burnout") …	

ANSWERS: Because Ramp B has a rough uneven surface … *it creates more friction when the car travels over it*. Because there is friction when two moving things rub against each other … *moving things will eventually slow or stop*. Because the drag racers spin the car's wheels while the car stays still (a "burnout") … *the tires heat up and smoke.*

VICTORY LANE!

1. **Chat it UP!** Explain the relationship between friction and motion to a family member or friend. How will this information make you a better engineer?

2. **Imagin-eer!** In your Engineer's Journal, design two ramps with very unique and different surfaces (e.g., mirror vs. eggshells, gravel vs. tin foil, etc.) Describe which surface will be better for racing your car and why. Use all five of these words in your explanation: smooth, rough, friction, ramp, gravity.

3. **Write On!** Imagine you're a news reporter covering your first burnout at the drag strip. Describe what happens before, during and after. Use *who, what, when, where* and *why* format. Submit your news coverage story to steam@sonomaraceway.com

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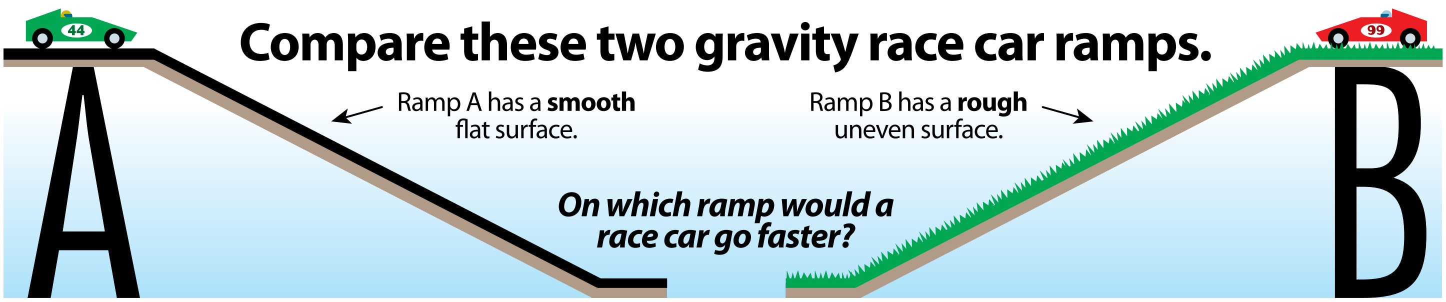
STUDENT NAME: ____________________________________

THE SCIENCE OF RACING

FRICTION: IT CAN REALLY SLOW YOU DOWN

Compare these two gravity race car ramps.



When a car goes down a smooth surface like ramp A, it will travel more quickly because it has less surface friction.

Ramp B has a rough surface, which creates more friction when the car travels over it, making it go much slower than the car on ramp A.

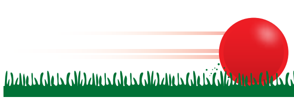
What is friction?

Friction is what happens when two things rub against each other. Friction slows or stops moving things. A rolling ball eventually stops because friction between the ball and the ground brings it to a stop.

See Friction in Action!

Roll a ball from one end of a basketball court to the other. Pretty easy, right?

Now try to roll the ball that same distance on grass or gravel. Friction makes that a lot harder to do!



FUN WITH FRICTION

Before racing down the **Sonoma Raceway** drag strip, drag racers complete a **burnout**, which spins the car's wheels while the car stays still. This causes the tires to heat up and smoke due to friction.

Drag racing tires perform better at higher temperatures. A burnout is the quickest way to raise tire temperature immediately prior to a drag race.

Photo: RCrampton.MFinnegan

Have you ever fallen and scraped your knee? Ouch! Friction between the skin on your knee and the hard ground is what made it hurt!

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LESSON 3

AERODYNAMICS

OBJECTIVES

Your child will:

- Understand the basic concept of aerodynamics and Greek origin of the word
- Practice "close reading"
- Compare similarities and differences in race car designs
- Build content vocabulary (aerodynamics, drag, wind resistance)
- Complete simple cause and effect statements

You will need:

- Aerodynamics *Kid Scoop News* Worksheet
- Engineer's Journal (see Lesson 1)

START YOUR ENGINES!

ASK: *How many different kinds of man-made objects can you name that move quickly through the air?* (e.g., balls, jets, helicopters, drones, kites, rockets, etc.)

SAY: *One thing these objects all have in common is they are designed to move through the air efficiently. The study of how objects move through air is called "aerodynamics." Engineers think about aerodynamics when designing objects that move quickly through air—including race cars!*

GO!

Give your child the "Aerodynamics" Worksheet

SAY: *Today we are going to practice "close reading" for the section "What a Drag" because scientific reading requires paying close attention to the words and sentences in order to understand the meaning.*

SAY: *Read the Section "What is Drag" three times following this pattern:*
1. First read: Read to "get the gist."
2. Second read: Circle new words; underline interesting parts or make notes in the margin.
3. Third read: Read smoothly and fluently and think about the meaning.

Read the "Cause" phrases on the "T-Chart" below. Complete the "Effect" side after the third read.

CAUSE	EFFECT
Moving air …	
Very strong moving air …	
A race car uses gasoline …	
A car with less drag …	

ANSWERS: Moving air … *can slow you down.*
Very strong moving air … *can stop you.*
A race car uses gasoline … *to speed up.*
A car with less drag … *moves faster.*

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LESSON 3
AERODYNAMICS

Golf on the Moon:
SAY: *The air on the moon is very, very thin. What do you PREDICT would happen if you hit a golf ball on the moon?* (Record answers on a sheet of paper). *Read the next section of the worksheet to find out.*

Science at Sonoma Raceway:
SAY: *Look at the two different shaped cars for NASCAR and NHRA Drag Racing. Complete the chart comparing similarities and differences among the designs:*

SIMILARITIES	DIFFERENCES

VICTORY LANE!

1. **Chat it UP!** Take a field trip to a parking lot. Observe the different shapes and designs of cars. Discuss which cars you claim are more aerodynamic. Defend your claim with evidence. Use these words to describe your observations: aerodynamics, drag, wind resistance.

2. **Imagin-eer!** Use the computer and a search engine to research "aerodynamics for kids." Find and conduct a simple experiment. Write up your findings in your Engineer's Journal using the scientific format: hypothesis, materials, process, findings, and conclusion.

3. **Write On!** How many words can you make from the letters in A-E-R-O-D-Y-N-A-M-I-C-S? Record your list in your Engineer's Journal.

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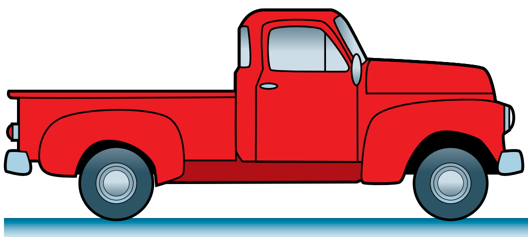
STUDENT NAME: ______________________________

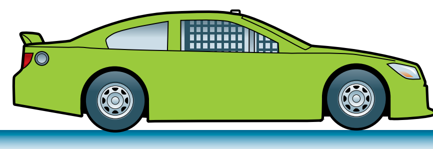
AERODYNAMICS
THE POWER OF AIR

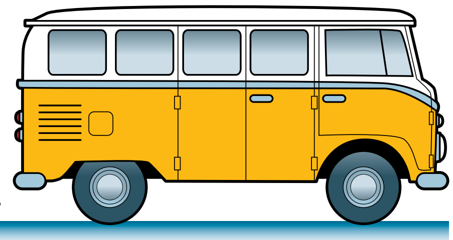
The word aerodynamics comes from two Greek words:

aeros: of the air
dynamis: power, strength, force



This racecar has a powerful engine, but why is its shape another reason it can go faster than these other vehicles?





What is aerodynamics?

Aerodynamics is about the power of air and the way it moves around an object. Understanding the power of air is how engineers have learned to make airplanes fly and racecars go faster!

What a drag!

Have you ever felt the wind on your face when running or riding a bike? That is the power of air moving against you. Moving air slows you down. It can even stop you in your tracks, if it is strong enough. This is called **wind resistance** or **drag**.

A racecar uses the energy of gasoline in its engine to speed up. But moving through the air slows it down. This is the force called drag. In order to go faster, a car should have less drag.

Look at the car shapes at the top of the page again. Which ones do you think will have the least drag?

This car's smooth, aerodynamic shape allows air to flow over it easily with very little drag.

This van's boxy shape creates more drag.

Golf on the Moon

Air slows down moving objects. So what would happen if you hit a golf ball on the moon where the air is much thinner than on earth?

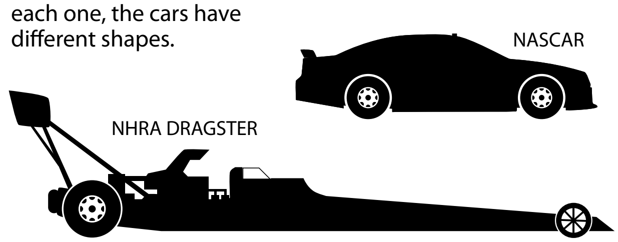
Astronaut Alan Shepard got the chance to find out when he walked on the moon on Feb. 6, 1971. Even wearing a bulky space suit, he hit a ball that traveled 400 yards (366 meters). On earth the average golfer can hit a ball about 200 yards (183 meters).

SCIENCE AT SONOMA RACEWAY:

Which cars are more aerodynamic?

There are two big car race events at Sonoma Raceway. They are NASCAR and NHRA Drag Racing. For each one, the cars have different shapes.

Look at the two cars. Which one is more aerodynamic?



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OBJECTIVES

Your child will:

- Understand how an axle enables rotation
- Build content vocabulary (axle, low friction, wheel)
- Identify a problem and a solution
- Understand how a simple diagram can illustrate a complex idea
- Practice oral and written language skills
- Illustrate construction of an axle

You will need:

- As the Axle Turns sheet
- Engineer's Journal (see Lesson 1)

LESSON 4

AS THE AXLE TURNS

START YOUR ENGINES!

SAY: *Imagine you race outside to ride your new bike, but discover that a large branch has fallen from the oak tree in your yard and is stuck right through the spokes and hub! Do you think your wheels can turn anyway? Why not?* (A: The branch prevents the wheels from spinning!)

SAY: *What if the wheels were glued on to a car? Could the wheels spin then?*

EXPLAIN: *Wheels—and tires—can't move without being able to spin from the center. Where is the center on your bike wheel?* (A: The hub in the middle) *The "hub" is an "axle" for the wheel. Car wheels work the same way and need an axle to spin. But what is an axle? Today we will help Engineer Gerry figure out a solution to a problem he's having with wheels that won't spin.*

GO!

Give your child the "As the Axle Turns" Worksheet

SAY: *As you read, identify Gerry's problem and solution.*

Have your child copy the chart below in their Engineer's Journal.

PROMPT	ANSWERS
What is Gerry's **problem?**	
What is Gerry's **solution?**	

ANSWERS: What is Gerry's **problem?** *Wheels won't turn; he glued on wheels so they can't rotate or spin.* What is Gerry's **solution?** *Build an axle using a straw and skewer so the wheels can spin.*

DISCUSS: *What does the straw do?* (A: Provides a "casing" so the axle can rotate.) *What does the skewer do?* (A: Connects to the wheels so they can rotate.) *Are there other materials you could use to make an axle?*

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LESSON 4

AS THE AXLE TURNS

VICTORY LANE!

1. **Chat it UP!** Discuss why gluing wheels to the side of a toy car won't work. Describe a better option that will make the wheels spin. Explain exactly how it works using the words straw, skewer, wheels, axle and rotate.

2. **Imagin-eer!** In your Engineer's Journal, illustrate the construction of the axle for your car including a sketch of the car, wheels, straw and skewer. Label parts.

3. **Write On!** Write a letter to a friend or family member telling them what you learned today. Explain the axle problem and solution in detail. (Be sure to use the five parts of a friendly letter: date, greeting, body, closing and signature! Sample below.)

Today's Date

Greeting,

Body

Closing,
Signature

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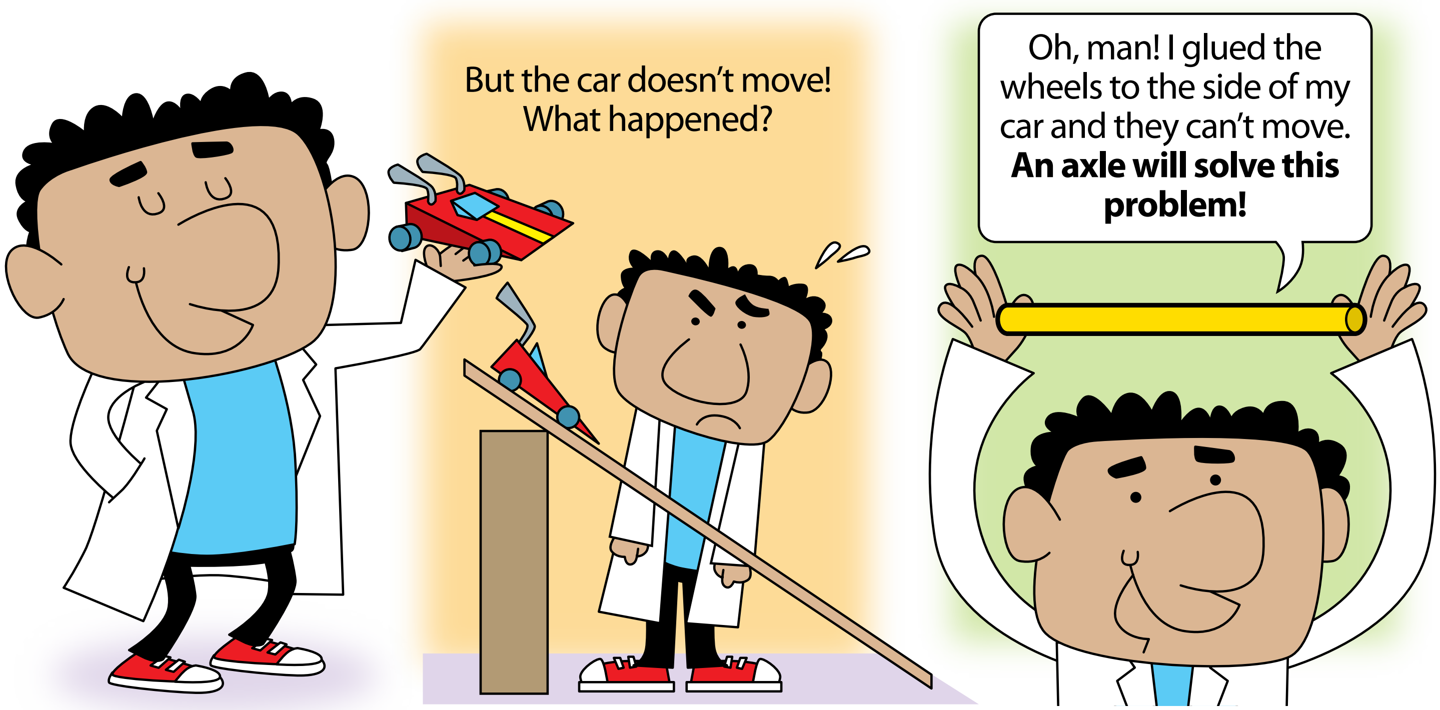
STUDENT NAME: ______________________________

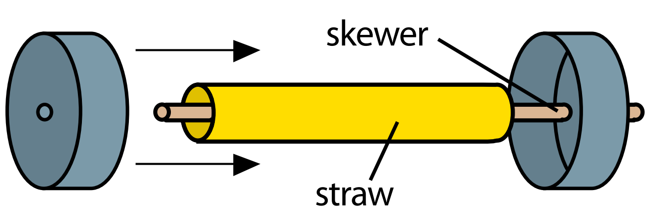
As The Axle Turns

When making a gravity-powered car that will roll quickly down a ramp, you usually add wheels to the vehicle.

Gerry built his gravity-powered racecar, added wheels and put it on the top of the ramp.

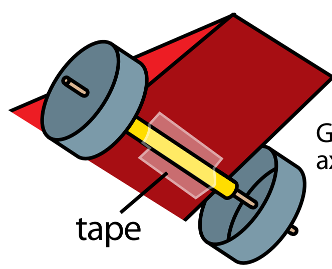


An **axle** is a long cylinder, or rod, that runs through the car to connect the wheels.



Gerry uses a straw and a skewer to make an axle for his gravity-powered racecar!

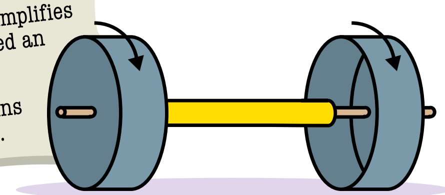
The inside of the straw has low friction, so the skewer can spin easily as gravity pulls the car downward and the tires spin.



Gerry used tape to attach the axle to the underside of the car

Wheel: a round tool that simplifies work by rotating. They need an axle to work efficiently.

Axle: a rod or bar that runs through a hole in a wheel.



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SONOMA RACEWAY

Friedman's HOME IMPROVEMENT

OBJECTIVES

Your child will:

- Understand the physics behind racecar drafting
- Build content vocabulary
- Illustrate drafting principle
- Practice "close reading"
- Answer "text dependent" questions

You will need:

- Drafting *Kid Scoop News* Worksheet
- Engineer's Journal (see Lesson 1)

LESSON 5

DRAFTING

START YOUR ENGINES!

ASK: *What does it feel like on your face when your ride in a car with the windows down?* (Make a list of responses on a piece of paper.)

SAY: *The wind blowing your face and hands has force as your car moves through the air. The same thing happens at Sonoma Raceway as cars move around the track. As cars push through clean air, the "draft" passes over the car and creates turbulent—or "dirty air"—behind the car. This dirty air can slow down the driver in the rear. But if he can "piggyback" on the car in front of him, he can get caught in the "draft" and move faster. Let's read more to see how this works.*

GO!

Give your child the NASCAR Drafting Worksheet. Before reading, review questions on the chart below.

SAY: *As you read "closely" today, underline the answers to the questions in each section. Notice how the section headers make it easier to locate information.*

SECTION	QUESTIONS	ANSWERS
Drafting—Not Tailgating	What two things does drafting do to help racecar drivers?	
Replace the Missing Vowels	What does the front car do?	
	What does the trailing car do?	
	What two things happen to both cars as a result?	

ANSWERS: What two things does drafting do to help racecar drivers? *Drafting helps cars get more speed and better gas mileage.*
What does the front car do? *The front car reduces resistance on the car behind it.*
What does the trailing car do? *The trailing car pushes high-pressure forward.*
What two things happen to both cars as a result? *Both cars have less drag and go faster.*

SAY: *Racecar driving is not the only sport that can take advantage of "drafting." What other kinds of races might benefit from this principle?* (Answers: bicycle, motorcycle, motocross, speed skaters, cross country skiers and swimmers are examples.)

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SONOMA RACEWAY

LESSON 5

DRAFTING

VICTORY LANE!

1. **Chat it UP!** Working together, come up with your own explanation of the aerodynamic relationship between "clean air," "resistance," "drafting" and "dirty/turbulent air." How does this knowledge make racecar drivers behave on the track?

2. **Imagin-eer!** In your Engineer's Journal, illustrate the concept of drafting. Draw one car and label with "clean air," "draft," and "dirty air/turbulent air." Then draw three cars "drafting" and show how the front car cuts through the clean air with the draft passing over all three before becoming turbulent. Under your illustration, write the explanation.

3. **Write On!** Imagine you're Jeff Gordon holding off Mark Martin in 1999 by 0.197 seconds. You have been asked to write a statement for the newspaper telling about your feelings during the last part of the race. What might Jeff Gordon say in his statement?

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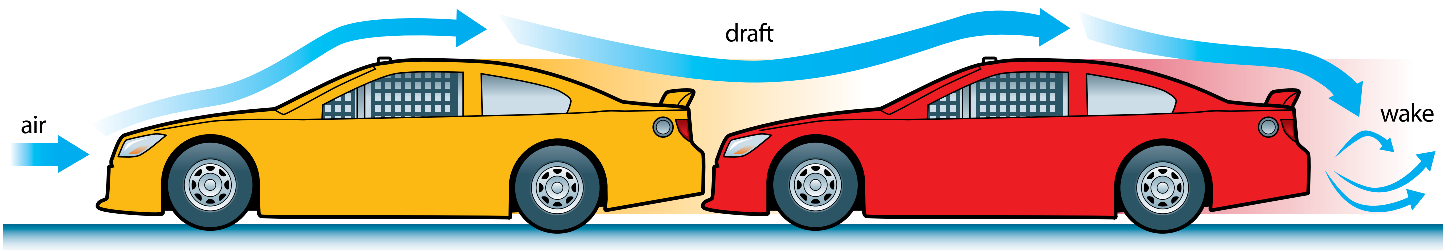
STUDENT NAME: ________________________________

NASCAR DRAFTING

NASCAR drivers race around Sonoma Raceway's track at 95 miles per hour. It takes a lot more than a heavy foot on the gas pedal to be a winner. ***It takes an understanding of science!***



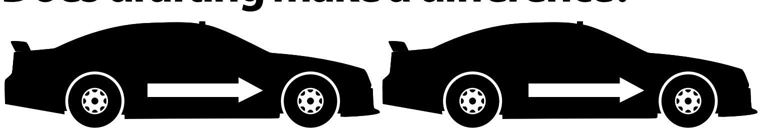
Wake Up!

When a car in front of a pack in a race speeds down the track, it pushes through and disturbs the air, creating a wake behind it.

Drafting – Not Tailgating

A talented driver will slip a car into the wake of the car in front of it. It may look like the car is tailgating, but it is actually doing something called **drafting**. Drafting helps cars to get more speed and better gas mileage.

Does drafting make a difference?



It sure does! When two cars remain bumper to bumper, they can both travel faster than if they were alone.

The low pressure behind the car in front reduces the aerodynamic resistance on the car behind it. The trailing car pushes high-pressure forward.

Both cars have less drag and both cars go faster. How much faster? Replace the missing vowels to reveal the answer!

Dr_ft_ng all_ws r_cec_rs to tr_vel thr_ _ to f_ve m_les p_r h_ _r f_st_r!

SCIENCE AT SONOMA RACEWAY:

Raceway Records

The Sonoma Raceway record for the closest margin of victory in an NASCAR race occurred in 1999 when Jeff Gordon held off Mark Martin by just .197 seconds.

NASCAR driver Kyle Larson holds the track qualifying record at Sonoma Raceway. Larson covered the 12-turn, 1.99-mile road course in just one minute, 14.186 seconds at a top speed of 96.568 mph.

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LESSON 6

FRICTION AND TIRE PRESSURE

OBJECTIVES

Your child will:

- Understand the relationship between friction and air pressure
- Learn academic vocabulary (friction, air pressure, molecules, nitrogen) in lesson context
- Determine cause and effect
- Read expository text closely to cite evidence that supports claims

You will need:

- Friction and Tire Pressure Worksheet
- Engineer's Journal (see Lesson 1)

NOTE: Vocabulary words and definitions for the crossword puzzle are in bold. Check for understanding of the vocabulary as you facilitate this lesson.

START YOUR ENGINES!

ASK: *What happens when you rub your hands together quickly for 15 seconds?* (Allow students time to experiment and respond.) *Do you think the same might happen if you rub your finger back and forth on your forehead?* (Allow time to speculate and experiment.) *Why do you think this happens?*

SAY: *FRICTION is the action when one surface of an object rubs against another.* *Scientists have known for a long time that friction always causes heat. In racing, heat affects the way a car turns and handles the curves. Today we're going to learn why this happens, why it is a concern and what* ***PIT CREWS—mechanics who take care of a race car for a driver****—do about it.*

GO!

Give your child the "Friction and Tire Pressure" Worksheet

SAY: *Look at the bold headings on this sheet. What do they say?*
(A: Friction and Tire Pressure, High Temp Tires and Pit Crew Pressure).
As you read the first two sections, "Friction and Tire Pressure" and "High Temp Tires," you will read about the science that happens inside the **TIRE*—or rubber part of a car's wheel*** *—as drivers complete their* **LAPS *(loops around the race track).*** *Let's use a chart as a graphic organizer to record the connections between cause and effect.*

Have your child copy the chart in their Engineer's Journal. Write the first words (shown in **bold**) on the effect side.

ASK your child to complete the "Effect" side as they read the first two sections.

CAUSE	EFFECT
Because the tires move on the track surface …	
Because the tire heats up …	
Because the molecules move faster and with more force …	

ANSWERS: Because the tires move on the track surface … ***friction*** *is created and heats up the tire.*
Because the tire heats up … ***molecules*** *inside move faster and with more force.*
Because the molecules move faster and with more force … ***air pressure****—a steady force upon a surface—increases inside the tire.*

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SONOMA RACEWAY

LESSON 6
FRICTION AND TIRE PRESSURE

SAY: *Let's learn more about molecules.* **TECH OPTION:** Use the internet to answer the questions: *What is a molecule? What is an atom? What is friction?* Allow time to explore and review definitions.

SAY: ***A MOLECULE is the smallest possible amount of a certain substance that has all the properties of that substance.*** *For example, a molecule of water is the smallest unit that is still water. An air molecule is the smallest unit of air that is still air. Molecules are created when two or more atoms stick together. Let's use the information in this graphic to show the cause/effect relationship in a different way:*

Tires racing on track surface create friction

Friction heats up the tire

Friction makes air molecues inside tire move faster & with more force

SAY: *As you read the section, "Pit Crew Pressure," find evidence to determine if the following claims are true or false.*

CLAIM	T OR F	EVIDENCE
Air pressure is a critical factor in racing.		
Race car tires are filled with oxygen.		

ANSWERS: Air pressure is a critical factor in racing. ***TRUE.*** *Affects how a tire grips curve and handles.* Race car tires are filled with oxygen. ***FALSE.*** *Filled with* ***nitrogen—a gas with no color or smell.***

EXPLAIN: *In "Do the Math" 1,100 is the total number of turns in 110 laps.* Have your child solve the problem. Underline the question, then circle the information needed to answer the question.

VICTORY LANE!

1. **Critical Thinking and Talking!** Discuss the relationship between friction, molecules and air pressure. Why is this important in racing?

2. **Imagin-eer!** In your Engineer's Journal, illustrate what happens to molecules inside a cool tire and a hot tire. Label your illustrations.

3. **Write On!** Imagine you're a molecule of nitrogen inside a tire on race day. Write about your experience from the molecule's point of view.

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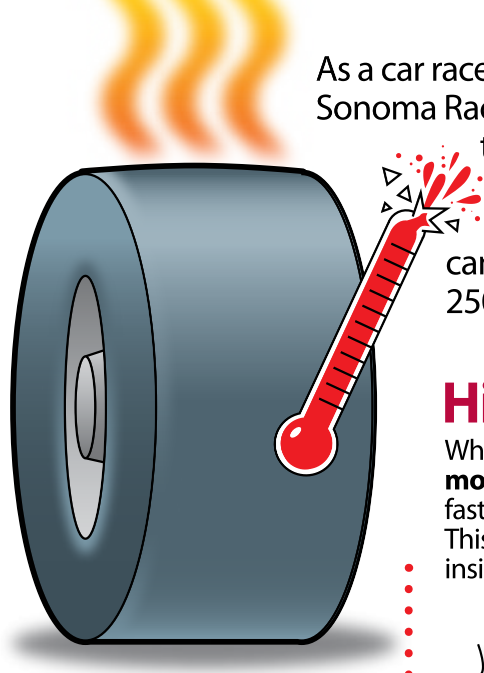
STUDENT NAME: ____________________________________

SCIENCE AT SONOMA RACEWAY:

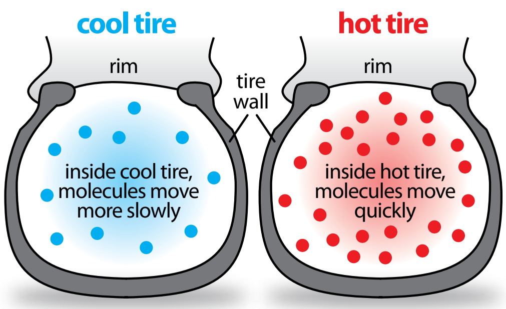
Friction and Tire Pressure



As a car races around the track at Sonoma Raceway, the **friction** of the tire as it rides over the ground heats up the tire. In fact, during a race, tires can reach temperatures of 250° to 325° Fahrenheit!

High Temp Tires

When the tires heat up, the air **molecules** inside the tire move faster and with more force. This causes the air pressure inside the tire to increase.



Sonoma Raceway Fun Facts

The **NASCAR**® configuration of the Sonoma Raceway road course is lined with 1,000 tire packs made up of 25,000 tires, 90,000 screws, 90,000 clips and 180,000 washers.

Do the Math

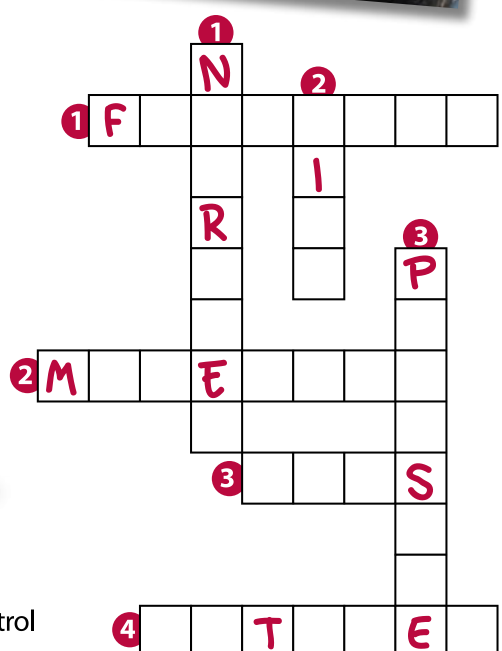
Drivers who complete the Toyota/Save Mart 350 NASCAR Cup Series race will make 1,100 turns around the road course. The race spans 110 laps. How many turns will they make each lap?

____

Pit Crew Pressure

Race car drivers and **pit crews** want to control how much **air pressure** is in the tire. Air pressure affects how well a car grips the curves and handles.

Race car tires are filled with **nitrogen gas** instead of air. Nitrogen is a drier gas and gives the race team more control over how fast the air pressure builds in the tires.



Across

1. The action of one surface or object rubbing against another
2. The smallest unit of a substance that has all of the properties of that substance
3. One complete circuit, or loop, of a race track. (plural)
4. The workers who take care of a race car for a driver (two words)

Down

1. A gas with no color or smell that is one of the earth's elements, it replaces air in a race car tire
2. The rubber part of a car's wheel
3. A steady force upon a surface

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SONOMA RACEWAY

Friedman's HOME IMPROVEMENT

OBJECTIVES

Your child will:

- Practice collaboration, communication and critical thinking skills
- Solve math problems using a variety of Common Core Mathematical Practices

You will need:

- *Race Track Math*
- Scratch paper for working solutions

LESSON 7

RACE TRACK MATH

START YOUR ENGINES!

ASK: *Tell your child what the letters STEAM stand for? (Science, Technology, Engineering, Arts and Math)*

SAY: *STEAM skills help prepare you for your future. Many jobs in the 21st century require knowledge in these areas—as well as being able to work with a team, think creatively, communicate well in writing and speech and solve tricky and challenging problems. You've worked hard to fine tune your science, technology, and engineering skills as you completed this unit. Now it's time to strengthen your math muscle as we race around the track solving problems in adding, subtracting, multiplying or dividing!*

REVIEW the Mathematical Practice chart below.

SAY: *Strong mathematicians use certain skills or practices to help them solve problems. Let's review these skills together. Today you will use many of these skills to win the race.*

	MATHEMATICAL PRACTICES	KID FRIENDLY VERSION
1	Make sense of problems and persevere in solving them	I try different ways to solve a problem
2	Reason abstractly and quantitatively	I solve problems in my head and on paper
3	Construct viable arguments and critique the reasoning of others	I explain my math thinking and talk with others about their thinking
4	Model with mathematics	I use symbols and numbers to solve problems
5	Use appropriate tools strategically	I know how to choose the best tool to help me solve problems
6	Attention to precision	I check my work to see if it is correct. I use labels and am accurate
7	Look for and make use of structure	I look for patterns to help me solve problems
8	Look for and express regularity in repeated reasoning	I see when patterns repeat and look for short cuts

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SONOMA RACEWAY

LESSON 7

RACE TRACK MATH

GO!

Give your child the "Race Track Math" Worksheet

PIT CREW OPTION:

If possible, have your child work with a friend or family member over the phone or other from of connection.

SAY: *To win this race, you'll need the help of the pit crew. Just like NASCAR drivers, you can't do it on your own. Work with others to solve the math problems and challenges.*

PRACTICE PROBLEM

WRITE: 34 cars are ready for the race! Each car has a driver and a pit crew of five mechanics. How many total drivers and mechanics are ready to race? (A: 204)

SAY: *Let's read the problem together. What are we trying to answer?* (A: How many total drivers and mechanics are ready to race?) *Let's underline the question. What are key pieces of information in the problem that we need to use?* (A: 34 cars each with 1 driver and 5 mechanics) *Let's circle the key information.*

Draw a picture as you read so your child can see a car with 1 driver and 5 mechanics for a total team of 6.

REVIEW answers and discuss different approaches to finding the solution.

ASK: *Which Mathematical Practices did you use to solve this problem?*

SAY: *Are you ready to begin the race? Then start your engines and go!*

ALLOW time to complete the worksheet.

REVIEW answers. **ASK:** *Which problems were easiest to solve? Which were the most difficult? Which Mathematical Practices did you use?*

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SONOMA RACEWAY

LESSON 7

RACE TRACK MATH

VICTORY LANE – BEYOND THE RACE!

1. **Tally and Graph!** Tally the Mathematics Practices your child used. Graph the results in a bar graph. Which practice is used most often?

2. **Race On!** Ask your family and friends to create race track word problems and create their own Race Track Math game board.

3. **Write On!** Ask your child to respond in their journals to the following prompt: Which is more important: Being strong in mathematical skills (adding, subtracting, multiplying and dividing) or being strong in mathematical practices? Are they both important? Why?

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STUDENT NAME: ________________________________

STEAM AT SONOMA RACEWAY:

SONOMA RACEWAY MATH CHALLENGE

The Toyota/Save Mart 350 at Sonoma Raceway is a challenging NASCAR® race that's very different from the normal oval-shaped track. It takes incredible skill and concentration to finish in first place.

Are you ready for a challenge? Use your math skills to make your way around the Sonoma Raceway track. After you complete each word problem, color in that segment of the track. How quickly can you make your way around the track?

If you get stuck on a problem, get help from your pit crew (family members).

START:

1. A professional driver raced 36 times last year. If he won ¼ of the time, how many total races did he win?

2. Ace enters 20 races during the season. He wins 15 times. What is his winning average?

3. 4 cars are ready for the race. Each car has a driver and a pit crew of 5 mechanics. How many total drivers and mechanics are ready to race?

4. If one racecar has 4 tires, how many tires are there on 7 cars?

5. A racetrack is 2.5 miles long. How many feet long is the track? (Remember that 5,280 feet = 1 mile.)

6. Jim has twice as many racecars as Cora and half as many racecars as Jeff. If Cora has four racecars, how many does Jeff have?

7. Boomer crosses the finish line after 1 hour and 27 minutes. How many total minutes did Boomer race?

8. One lap around the track takes 40 seconds. How many laps in 200 seconds?

9. The racetrack asphalt measures 100° F. The temperature in the stands is 89° F. How much warmer is the track than the stands?

10. A gallon of racing fuel weighs 6 pounds. If a racecar has a 12 gallon gas tank, how much weight will a full tank of gas add to the car?

11. A race is 350 miles long. If Roberto drives 100 miles per hour, how many hours will it take him to finish the race?

FINISH:

12. 315 fans paid $1.50 each to see their favorite driver race today. How much money was collected at the gate?

TOYOTA | The SAVE MART COMPANIES 350

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SONOMA RACEWAY

Friedman's HOME IMPROVEMENT

LESSON 8

MAKE YOUR OWN GRAVITY RACER

BEFORE YOU BEGIN

NOTE TO PARENTS/CAREGIVERS: Here are some ideas for a successful activity:

- Have all materials gathered before you begin including pennies to add weight.
- Only adults should use the hot glue gun.
- Allow for experimentation, innovation, and mistakes. Your child will have opportunities to make adjustments to the design. That's the fun of learning!
- Have a ramp set up for a test run if possible. Ramps can be constructed from a cardboard box, piece of wood, or even the leaf of a table. Stairs or books can be used to add height on one end.

TIPS:

- You are the "coach" or "guide on the side." It's important to let children do the work themselves as much as possible.
- Your child will come up with ideas that don't work. Finding out what doesn't work is an important learning experience. In fact, when real-world scientists and engineers spend their time trying to solve problems, they experience a lot of trial and error. Let your child know when they encounter frustrations and ideas that don't work, they are acting like a real scientist or engineer.

FOR A SMALL GROUP: If you have more than one child, each can build their own race car, or together they can build a "team" car. If building a team car, it's important to divide up the tasks. The following roles can be combined depending on the number of children:

- Supply Engineer: gathers materials to build the Gravity Racer
- Chief Engineer: reads directions
- Design Engineer: lays out all the pieces for construction and selects materials
- Construction Engineer: makes sure all steps are followed in the right order

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SONOMA RACEWAY

LESSON 8

MAKE YOUR OWN GRAVITY RACER

OBJECTIVES

Your child will:

- Build on vocabulary and concepts from the previous 7 lessons!
- Follow written directions and illustrations to build a race car
- Learn about the effect of weight and distance on speed

You will need:

- "Make Your Own Gravity Racer" Kid Scoop News worksheet
- Materials for constructing Gravity Racer (see worksheet)
- Engineer's Journal

START YOUR ENGINES!

ASK: *What kind of cars do we have in our family? What parts of all cars are the same? What parts are different?* **OPTION:** Bring your child to the front window and identify things that are the same or different about the cars they see parked or passing by?

SAY: *There are certain features that are the same for all cars—a body, engine, wheels, and windows—and things that are different— size, color, shape, and style. Today you will begin building and testing your own Gravity Racer!*

FIND the "Make Your Own Gravity Racer" worksheet. **Do not distribute materials yet!**

USE the chart below to look for answers (shown here) to the questions as you read the first section of the worksheet. Read each question aloud and have your child circle or underline answers as they find them.

QUESTIONS	ANSWERS
What do *engineers* do?	*Invent, design and create things*
What materials do you need?	*See list*
How many steps to build your Racer?	*Seven*
What can you use to add weight to make your car roll farther down the ramp?	*Pennies or other weights*

GO!

SAY: *Now that you've read how to make your racer, let's get started. What do you need to do first?*

FOLLOW the seven steps.

PROVIDE 30 to 45 minutes to complete the initial design and testing.

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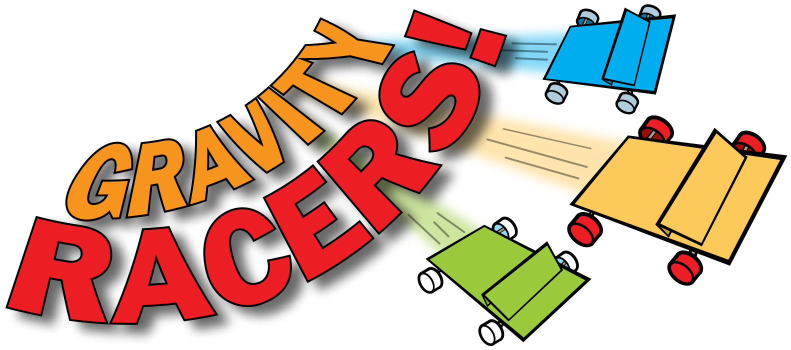
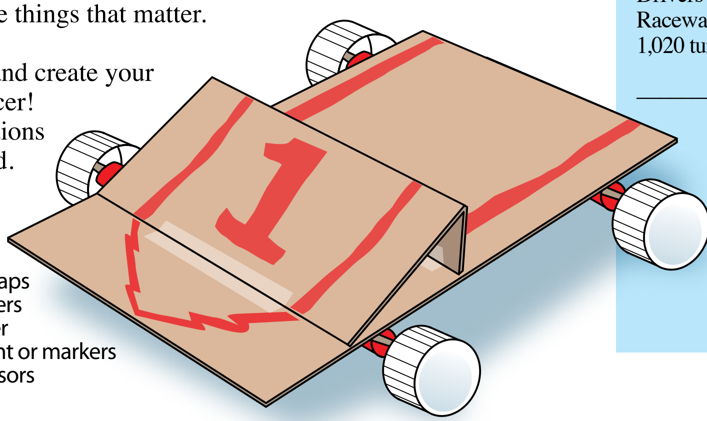


THE SCIENCE OF RACING

Make your own Gravity Racer!

The **E** in **STEAM** is for **engineering**. Engineers are changing the world all of the time. They dream up creative, practical solutions and work with other smart, inspiring people to invent, design and create things that matter.

Be an engineer and create your own Gravity Racer! Here are instructions to get you started.



YOU'LL NEED:

- ❑ cereal box
- ❑ 4 plastic bottle caps
- ❑ 2 bamboo skewers
- ❑ 2 straws
- ❑ ruler
- ❑ hot glue
- ❑ paint or markers
- ❑ tape
- ❑ scissors

STEAM at Sonoma Raceway

A Note to Parents
Help your child build Gravity Racers for the whole family and have a night of races.

The **M** in **STEAM** stands for **math**. Race car drivers think a lot about math. Here is a race car driver challenge for you, straight from Sonoma Raceway!

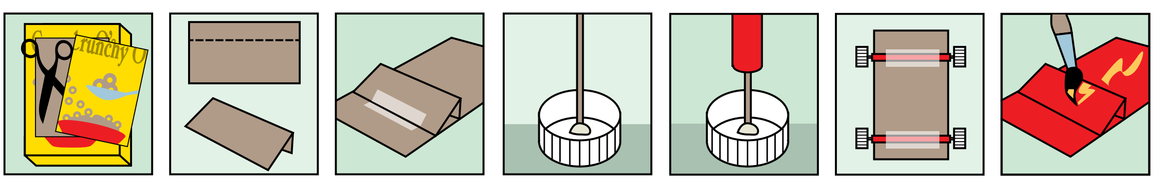
Drivers who complete the Toyota/Save Mart 350 at Sonoma Raceway will make 85 laps around the race course with a total of 1,020 turns. **How many turns is that per lap?**

__________ turns per lap

Sonoma Raceway Math Challenge

A driver will travel nearly 215 miles by the end of the race. If the average speed was 80 mph, about how long will it take to complete the race?

_____ hours _____ minutes



1. Cut a 6″ x 9″ rectangle out of a cardboard cereal box.
2. Cut another rectangle, 6″ x 4″ and fold as shown.
3. Tape the angled hood onto the larger rectangle.
4. Hot glue a bamboo skewer to the inside center of a plastic bottle cap.
5. Insert skewer through straw to create an axle. Hot glue bottle cap to other end of skewer.
6. Tape straw axles to bottom of car body. Make sure the wheels spin freely.
7. Decorate your Gravity Racer.

Engineering Success

Roll your gravity racer down a ramp. Measure how far it rolls. What happens if you add weight to your racer, such as taping pennies to it? What else can you do to make it roll farther?

Thank you to Ed Sobey for ideas on how to make a Gravity Powered car.

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SONOMA RACEWAY

STEAM RACE CAR CHALLENGE
ULTIMATE CHALLENGE

Now that you've built and tested your own Gravity Racer, it's time to think creatively and go wild with a design of your own! Use the guidelines below and let your creativity and scientific exploration explode! **We would love to see your car(s). Go to sonomaraceway.com/STEAM and post your pictures and videos.**

MATERIALS

Your gravity-powered race car should be built from recycled materials using "clean trash." Here are some things you might use to stock your home "Pit Stop" area:

cardboard	construction paper	tissue paper	milk cartons	¼" dowels
paper clips	pipe cleaners	straws	wheels	glue
tape	small weights	styrofoam trays	spools	scissors
craft sticks	bottles	bottle caps	cds	lids
sandpaper	wooden wheels	toothpicks	axle & wheels from a toy car	

SPECIFICATIONS FOR VEHICLES

- WIDTH: Overall width of the vehicle is not to exceed 9 inches.
- LENGTH: Overall length of the vehicle is not to exceed 12 inches.
- HEIGHT: Clearance between the chassis and the track should be a minimum of ⅜ of an inch.
- WEIGHT: The weight of the vehicle is not to exceed 8 ounces.

RESTRICTIONS

- The race car must have 4 wheels.
- The race car shall not ride on springs.
- Decorations and attachments may be added providing they are securely fastened and do not exceed the maximum length and width specifications.
- Race cars are subject to inspection by an official inspection committee to determine eligibility and safety.

CHALLENGE BUILDING GUIDELINES

- If race cars are built by more than one child, only one child will be identified as the "official driver" of the vehicle.
- Race cars should have wheels securely attached to the body or have the body securely attached to a wheeled platform.
- Measure your car to make sure the overall size meets the requirements. Being disqualified can be very disappointing!
- Race cars must be entirely student built. Adults may assist with drilling and electrical tools used in the making of the cars.

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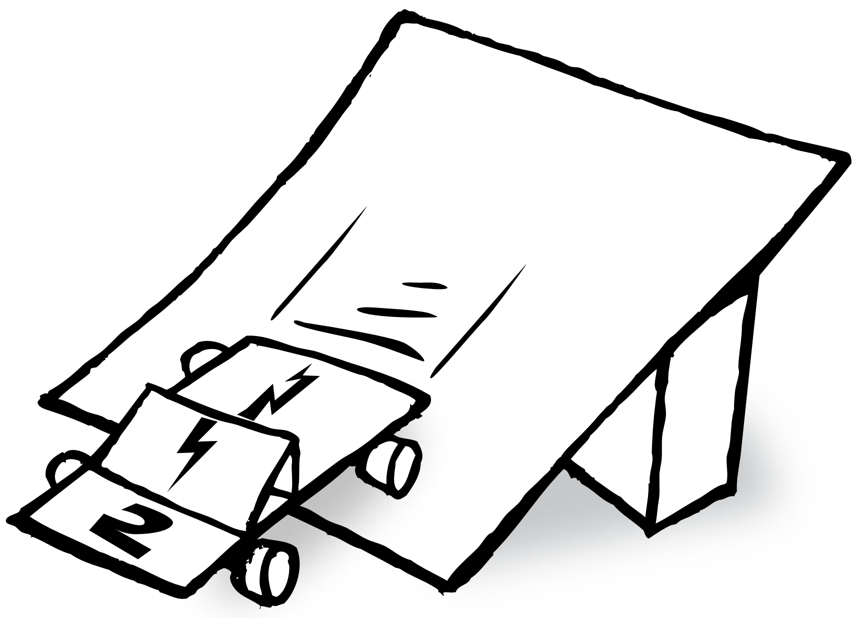
STEAM RACE CAR CHALLENGE

ULTIMATE CHALLENGE

TRACK INFORMATION

A track is a ramp with enough of an incline for cars to move downwards, powered by gravity and with wheels to help them move.

- A cardboard box on a set of stairs
- A plank of wood held up on one end with some books. Try changing the incline of the plank to see how it affects the race car's speed.
- Leaf of a table propped up on a chair, or other raised object
- Experiment and share your ideas at sonomaraceway.com/STEAM



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