IMAX NASCAR

Science, Speed & Safety: Rev Up Your Knowledge

A Comprehensive Educator's Resource Guide

Lessons and activities to help you bring the thrilling and educational side of NASCAR into your classroom.

The speed, passion and excitement...

ABOUT THE FILM

The speed, passion and excitement might be what makes NASCAR one of the most popular spectator sports with 75 million fans, but it takes more than just some quick laps around a track to keep a stock car moving. Every day, hundreds of engineers and car specialists work together to make a NASCAR stock car that is faster, safer and more efficient.

NASCAR: The IMAX Experience will transport your classroom directly behind the driver's seat to explore a behind-the-scenes look at NASCAR. Watch engineers smooth down the car's hood to eliminate any extra wind resistance before it's put to the test in the wind tunnel. Learn how the cars are designed and tested for performance and safety. Join the pit crews on the track as they hone their teambuilding skills to ensure maximum efficiency. Experience first-hand how aerodynamics can play a role in the outcome of a race. There is no doubt that science, engineering, technology and teamwork play a major role in NASCAR stock car racing and help make the sport more exciting.

Seeing real-world applications of science and math in such a dynamic setting is sure to make a positive, lasting impression on your students. In addition, this exciting film will provide you with activities, knowledge and ideas to enhance your students' education.

EDUCATION

IMAX films are designed to educate and enlighten as much as they are to entertain. They offer educators a powerful teaching tool that is easily integrated into existing curriculum. And, in addition to meeting recognized educational standards, they provide students with unique and exciting opportunities to explore new worlds and new ideas.

THE IMAX EXPERIENCE®

With breathtaking, crystal-clear images up to eight stores high and 12,000 watts of digital surround sound, The IMAX Experience takes you to places only imagined. The highly specialized and precise projectors employ a unique system that ensures outstanding clarity and brightness. The IMAX Experience is completed by a specially designed sound system, ensuring that each viewer receives the same sound quality. Only IMAX technology lets you feel as if you're really there.

More than 700 million people around the world have been mesmerized and educated by The IMAX Experience. Technically advanced and visually stunning, The IMAX Experience continues to be the world's most immersive theatre entertainment.

IMAX invites your students to think big.™

IMAX®
think big™

A MESSAGE TO EDUCATORS

Thank you for choosing to enrich your students' science and math curriculum with a spectacular and thrilling educational experience. Since the very beginning, IMAX has been dedicated to education, providing educator's guides, such as this one, free to teachers who bring students to an IMAX film.

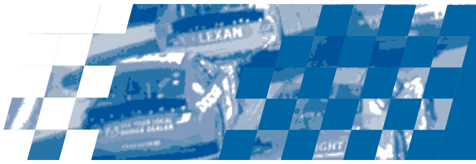
NASCAR: The IMAX Experience is a behind-the-scenes look at the physics and technology of NASCAR stock car racing, bringing to life the math, science and engineering that keeps the sport moving full speed ahead. IMAX has joined forces with the educational experts at Weekly Reader to create this comprehensive educator's resource guide, **Science, Speed & Safety: Rev Up Your Knowledge**. The guide will educate students about the science behind the safety and design features of stock cars; the math, physics and formulas engineers incorporate into their car designs; and the life skills necessary to work as part of a close-knit NASCAR team. Through the activities, students will learn how the science and math used in NASCAR can be applied to the lessons in the classroom. This program features a set of national standards-based lessons for students in grades 4 to 6 and another set for students in grades 7 to 9, as well as extension activities, background information, directions for preparation, presentation and evaluation and a recommended reading list. The reproducible activities are designed for students with a wide range of abilities and can be adapted to meet the needs of your students.

We hope you and your students enjoy the program as you extend the IMAX NASCAR film into your classroom. Although these materials are copyrighted, they may be reproduced for educational purposes. Please feel free to share this resource guide with your colleagues and encourage them to book field trips to NASCAR: The IMAX Experience.

We look forward to seeing you and your students again at your local IMAX Theatre for the next educational IMAX film.

IMAX® NASCAR®

TABLE OF CONTENTS



Teacher's Guide

Activity One: Gearing Up for Math

This activity focuses on strengthening students' math skills through word problems and computation.

Before beginning the activity, lead a class discussion about the different modes of transportation — cars, buses, trains, airplanes, bicycles, subways, etc. Ask students to think about the different speeds of each. Copy and distribute Activity One and direct students to solve the word problems. Ask students if the top speeds of cars, airplanes and trains surprised them.

To extend the activity, ask students how long it takes them to get to school and how they get there (walking, bus, car, bike). Ask students to determine the distance they have to travel to school and have them calculate their speed to school in miles per hour. *Remember: speed = distance/time.*

Answers:

1.) 130 mph; 120 mph

2.) 51.75 mph; 155.25 miles; 39 knots

3.) *car* – 2807/403 = 6.97; 0.97 x 60 = 58.2 ≈ **6 hours 58 minutes**;
plane – 2807/4534 = 0.62; 0.62 x 60 = 37.2 ≈ **37 minutes**;
train – 2807/320 = 8.77; 0.77 x 60 = 46.2 ≈ **8 hours 46 minutes**

4.) 200 laps; 166.67 mph

Extension Activity

- Incorporate geography into your lesson by having students use a map to locate the cities and states where NASCAR races are held. Have students calculate the total number of miles between all of the cities to see how far NASCAR teams have to drive in a season to compete in races. (Race locations and dates can be found at www.NASCAR.com/races) Have students calculate how long it would take to drive the total distance if traveling 65 miles per hour, and if driving the racing speed of 180 mph. How long would it take if flying on the fastest plane or traveling by the quickest train?

Activity Two: The Future of Cars

This activity focuses on strengthening students' analytical skills and reading comprehension.

Activity Two is designed to educate students about the evolution of cars and how future cars are being designed to use fuel sources other than gasoline. Scientists want to develop a car that does not use gas as fuel, because gasoline is a byproduct of oil, a nonrenewable resource that is being depleted.

Before beginning the activity, discuss with your students the changes cars have been through in their lifetime — changes to cars' design and shape, safety features and luxury features, such as CD players, global positioning systems, etc. Copy and distribute the activity and ask students to read about the evolution of cars during the past 100 years. Instruct students to fill in the graph to compare the changes in cars. Then, ask them to draw or write about what they think cars will look like in the future.

Answer key below.

Extension Activity

- Ask students to research the history of the NASCAR stock car and how it has progressed into the shape and standards that NASCAR uses today. Lead a class discussion about which models students like best and why.

Activity Three: Safety Behind the Wheel

This activity is designed to strengthen students' reading comprehension while educating them on the science involved in car safety.

Safety is the driving force behind most sports' rules and regulations. NASCAR is no exception. Begin this activity by asking students what NASCAR drivers need to stay safe during a race and write their answers on the chalkboard. Copy and distribute Activity Three and direct students to read the safety facts and answer the multiple-choice questions. Compare the students' answers on the board to the facts on the activity sheet. How many did the students name correctly? Which safety features did they learn about?

The last part of the activity asks students to create their own safety rules and equipment for a fictional sports game. Remind students to include time limits, a points system and what the players would wear for protection.

Answers:

1. B 2. D 3. C 4. A 5. D

Extension Activity

- Ask students to write down what they wear for safety when riding a bicycle or a skateboard, or when in-line skating. How does it compare to what a driver wears when racing? How does it compare to what a football player or a hockey player wears for safety? Ask students to brainstorm why athletes need certain equipment for safety and lead a class discussion about sports safety.

Activity Two Answer Key

	Type of Engine	Brakes	Safety Features	Fuel
Car circa 1910	Internal combustion	Drum	Headlights	Gas
Present Day	Internal combustion	Hydraulic	Airbags, seatbelts, anti-lock brakes	Gas
Hybrid	Internal combustion/electric motor	Hydraulic	Airbags, seatbelts, anti-lock brakes	Gas/electricity
Fuel Cell	None	Computer-operated	Airbags, seatbelts, large windshield	Hydrogen fuel cells

During a pit stop, seven people all work together as a pit crew, each with a specific job, to change four tires and refuel a car in less than 15 seconds.

Activity Four: It's a Team Effort

This activity is designed to strengthen students' team building skills.

This activity is designed to teach students about the importance of being able to work together as a team. Copy and distribute Activity Four and direct students to read the paragraph about NASCAR pit crews and answer the questions. **Answers will vary.**

Ask students to name other jobs where it is important for people to work together, such as a firefighter, a teacher or a doctor. Next, divide students into groups of five or six and designate each group as a "pit crew." Give each pit crew the same job to do — putting a puzzle together, building a design out of blocks, or putting together a "car." For the car, use cardboard rolls for the wheels, a large sheet of construction paper for the body, a straw for the antenna and two pieces of duct tape for the front and rear bumpers. Direct students to draw in the car's doors, windows, windshields and lights in the appropriate places on the construction paper. Next, have them shape the construction paper into the car's body and staple, glue or tape the body to the cardboard rolls. Then, have them tape the straw to the back of the car and add the bumpers using the duct tape. Time the pit crews and compare results.

Extension Activity

- Pit stops are usually 15 seconds long. Ask students to time themselves to see how many activities they can do in 15 seconds (i.e., tie shoes, clean desk, walk around the classroom, write their name, etc.). What can they do as a team in 15 seconds?

Extension Activity

- Before a new car is put out on the streets, car manufacturers want an idea about what it will look like. So, after a new car design is drawn, but before it is made into an actual car, engineers build the car out of clay to see how it will look. The clay models allow engineers and manufacturers to determine whether or not the car is practical, and if it is aerodynamic.

  This activity allows your students to be car designers for the day. Have students mold their favorite car or design their own car creation with clay you (or another adult) can make. Please keep in mind, you will need a stove to heat the ingredients in this recipe.

  Ingredients:

  - 1 cup cornstarch
  - 1 ¼ cups cold water
  - 2 cups baking soda

How to make it:

- Combine cornstarch and baking soda in a small saucepan.
- Add water and stir until the mixture is smooth.
- Heat mixture for five minutes over medium heat. Stir until it begins to thicken and turns to dough.
- Remove dough from saucepan and allow it to cool.
- Knead cooled dough two to three minutes.
- Shape dough into car creation. Let finished car models air-dry until hard.

To add color to the clay, add 7–10 drops of food coloring before heating.

Add a teaspoon of fine glitter while kneading dough to give your designs some sparkle.

Extension Activity

- All of the student activity pages feature facts about science, NASCAR or speed along the bottom of the page. Use the facts to jumpstart discussions and see what other science and NASCAR facts your class can come up with!

Name ______________________________

Date ______________________________

Gearing Up for Math

Drive down the street and it's obvious how many different types of cars there are. There are sports cars, small and packed with power; there are sports-utility vehicles, designed to carry large amounts of equipment; and there are family vehicles, with extra seating and plenty of room for everyone. These are just a few of the cars driven today. NASCAR stock cars have the same body and frame as a typical family car, but underneath the hood, a stock car has a bigger, more powerful engine built for racing.

We all know a NASCAR stock car can travel at high speeds. Airplanes, boats, and trains can also move at high rates of speed. The questions below compare the different types of transportation and their speeds.

Read and answer each question below. Use the back of this page if you need more room to show your answers.

1. **A stock car travels at 180 miles per hour. A sports car can reach speeds of 120 mph. A mini-van can go 90 mph. What is the average speed of the three vehicles? What is the median?** ______________________

____

2. **A boat's speed is measured in knots. One knot is equivalent to 1.15 miles per hour. If a boat is traveling at 45 knots, what is the speed of the boat in mph? How many miles could the boat travel in three hours? How many knots is a boat traveling if its speed is 45 miles per hour?** ______________________

____

3. **The fastest car was recorded traveling at 403 miles per hour, the fastest plane at 4,534 mph and the fastest train at 320 mph. How long will it take each to travel 2,807 miles from San Francisco to New York?** ______________________

____

4. **If a race car is participating in a 500-mile race and the race track is 2.5 miles, how many laps does the car have to do to complete 500 miles? If a driver completes the race in three hours what was the car's average speed?** ______________________

____

HERE'S A HINT:

To find out how much time it takes an object to travel a certain distance, divide the distance traveled by the object's speed. The whole number represents the hours. The decimal represents the minutes. To convert the decimal to minutes, multiply it by 60 (since there are 60 minutes in an hour and the speed is measured in miles per hour). Then round your answer to the nearest hundredth.

Now that you know how fast the fastest plane, train and car travel, pick a destination within your continent and determine how far (in miles) it is from where you live.

How long would it take you to get there by the fastest car?

____

How long would it take you if you drove a car traveling 65 miles per hour?

____

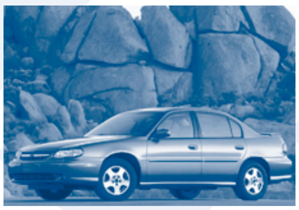
The fastest human has been timed running at a speed of 22 miles per hour. This is still a lot slower than the fastest land animal — the cheetah can run up to 62 mph!

Name ______________________________

Date ______________________________

The Future of Cars

Cars have come a long way since they first appeared more than a century ago. They have evolved from slow, square-shaped vehicles to sleek, speedy machines. With all the changes cars have been through, there's no telling what cars will look like in the future.



Photos courtesy of GM

Car circa 1910 Cars in 1910 were revolutionary for their time. People were able to put aside their horse-drawn carriages and drive. The automobile's early success was due to the ***internal combustion engine***, meaning the fuel burned inside the engine, rather than outside. The cars depended on gasoline to make the vehicle run. They were not the safest cars, though. Early automobiles did not have sturdy roofs or seatbelts. The tires were thin and popped easily. Drum brakes, which slowed or stopped the tires by pressing down the brake drum attached to the wheel, were incorporated into cars, but the braking system did not allow cars to stop quickly. Luckily, they were not yet able to travel at high rates of speed!

Present-day car Cars have evolved during the past 100 years. Most of today's vehicles still use the internal combustion engine and run on gasoline, but safety has improved. Vehicles now have seatbelts, airbags, hydraulic brakes that use air to help drivers stop quickly, and wider, more resilient tires. Today, cars are run by internal computers and have automatic features, such as power locks and windows. Sunroofs, stereo systems, televisions and DVD players have also been added to cars!

Hybrid car Scientists and car engineers have designed ***hybrid cars*** — automobiles that run using an electric motor powered by batteries, and a gasoline-powered internal combustion engine (though both engines are not used at the same time). These vehicles have most of the same internal and external features as other present-day vehicles. However, the cars are designed to switch from the internal combustion engine to the electric motor, so that less gasoline is being used.

Fuel cell car The three previous vehicles all run on gasoline and an internal combustion engine in one form or another. Gasoline is a by-product of oil, which is a fossil fuel. Oil and other fossil fuels are nonrenewable resources, meaning they cannot be replaced. Scientists believe the world's supply of oil will diminish in the next 50 years. Therefore, scientists and car engineers are busy working on a new type of vehicle — one that runs on a hydrogen-powered fuel cell. Fuel cells create power for an electric motor through a hydrogen-oxygen chemical reaction. Oxygen is available in the air we breathe and hydrogen is the most abundant element on earth. Combining these two elements produces electricity that powers the car's motor. Fuel cell vehicles do not use gasoline and eliminate the need for an engine! Today's version of fuel cell cars look like gas-powered cars, but they have a larger windshield, increasing the driver's visibility. They also have many of the same safety and luxury features, but the features, including the brakes, are controlled by the car's internal computer and hand-held control unit.

Use the information you learned about cars to fill in the chart below.

	Type of Engine	Brakes	Safety Features	Fuel
Car circa 1910				
Present Day				
Hybrid				
Fuel Cell				

Now that you have an idea about what a future car could be like, try drawing or writing about your own future car. What would it look like? What would it use as fuel? What would you include for safety? What luxury items would you add?

Without the need for an engine, scientists are designing fuel cell cars that do not have foot pedals or steering wheels. Drivers steer the vehicle using the driver control unit, similar to the control pad of a video game, which can be moved anywhere in the vehicle!

Name ______________________________

Date ______________________________

Activity 3 Grades 4–6

Safety Behind the Wheel

Race cars are not only built to be fast, they are also built to be safe. NASCAR employs dozens of engineers, mechanics and car designers to study, analyze and test NASCAR stock cars in an effort to make them safer.

Here are some of the safety features stock car racing officials have implemented. How do they compare with the safety features in a passenger vehicle?

- The vehicle does not feature any doors — drivers must enter the vehicle through the driver's-side window. This eliminates the opportunity for the doors to swing open. A net made of nylon webbing covers the window.
- The seat is more like the seat you would find in a fighter jet, rather than the one featured in a passenger vehicle. The seat wraps around the driver's rib cage and shoulders to offer support.
- The safety belt is a five-point harness. Two straps come down over the shoulders, two wrap around the waist and one comes up between the legs.
- The windshields are made out of a material called Lexan. This is the same material that is used to make bulletproof glass. It does not shatter.
- All drivers wear a helmet and a fireproof suit, gloves and shoes. The suits are made with materials that can withstand temperatures up to 2,000 degrees Fahrenheit.
- The roof hatch is designed to provide a second exit for the driver. To exit, the driver pulls a latch to open the hatch and exits the car through the roof.

Use the information on the left to answer the following questions. Circle your answers.

1. The windshield is made out of Lexan to help prevent:

A. glare **B. shattering**

C. tinting **D. scratching**

2. A race car driver can use the __________ as a second exit out of the car.

A. trunk **B. door**

C. window **D. roof hatch**

3. A race car driver wears a ______-point harness to strap himself to the seat.

A. 3 **B. 2**

C. 5 **D. 4**

4. A race car driver enters his vehicle through _____________.

A. the window **B. the sunroof**

C. the driver-side door **D. the passenger-side door**

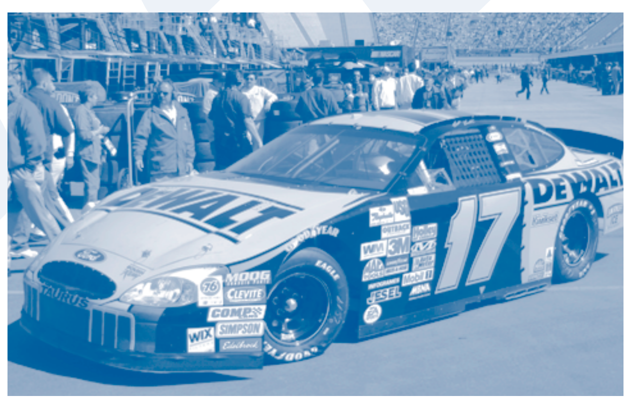
5. A race car has this many doors:

A. one **B. two**

C. four **D. none**

Safety is an important feature in sports. Like NASCAR, all sports require safety rules and regulations to protect athletes. Imagine that you have developed a new sport that requires participants to put a ball through a hoop while in-line skating within designated boundaries. Your job is to create the rules and safety equipment for your new sport. How would you determine a winner? What is the points system? How many players are on a team? What do participants have to wear for safety?

Write out your rules and safety equipment on a separate sheet of paper and share them with your class when you are done.



As an additional safety feature, NASCAR stock cars fill their tires with nitrogen instead of air. This is because unlike nitrogen, air contains moisture, which can change the shape of the tire when heated during a race.

Name ______________________________

Date ______________________________

Activity 4 Grades 4–6

It's a Team Effort

It's important to learn how to work well with others. The ability to work effectively with others as part of a team is necessary in sports, in school and at home. Most jobs require that you work with other people. Your job will be easier if you are able to work well within a group.

In NASCAR stock car racing, some of the most successful teams are the ones that work well together. The most prominent example of teamwork in racing is the pit crew. Seven people all work together, each with a specific job, to change four tires and refuel a car in less than 15 seconds. Pit crews have to be able to work together quickly and effectively. Otherwise, they jeopardize the driver's chance to win by taking too much time during a pit stop.

The seven-member pit crew consists of two ***tire changers***, two ***tire carriers***, a ***jackman***, a ***gas person*** and a ***catch can person***. Sometimes race officials will allow an eighth person on the crew if the weather conditions are extreme. If an extra person is allowed, he or she can provide the driver with water or clean the windshield.

The ***tire changers*** replace the tires, starting with the right side and moving to the left. ***Tire carriers*** bring the 75-pound tires to the car's right side and then remove the used tires from the pit area. The same thing happens on the left side. The ***jackman*** carries the 45-pound hydraulic jack to lift the car's right side as the tires are changed. When the right side is done, the jackman lowers the right side and proceeds to the left side to lift the car. The ***gas person*** pours two 11-gallon cans of fuel into the 22-gallon gas tank, called a fuel cell. The ***catch can person*** holds a container to catch gas that overflows during refueling. The catch can person is also in charge of signaling (with a hand in the air) when refueling is complete.

Can you imagine? All that in 15 seconds!

Since the driver with the fastest time wins, pit stops have to be quick so that the driver can get back onto the track and in the race. A good pit crew can do its job in 12 to 15 seconds. That's what counts when the clock is ticking. Use your NASCAR knowledge to answer these questions:

1. Why is it important for members of a pit crew to work well together? ______________________________

____

____

2. Why is it important for people to work well with others? ______________________________

____

____

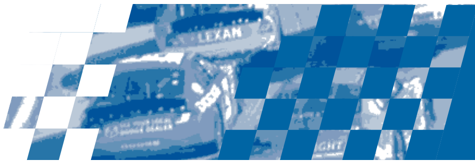
3. What qualities do you need to help you work effectively as part of a group? ______________________________

____

____

Now that you know how teams should work together, try putting your skills to the test. Work with your "team" of classmates to put together a project as your teacher times you to see how you do. Does your team have what it takes to work together successfully?

Pit crew members spend time between races watching videotapes of their "performances" so they can learn how to improve for the next pit stop!



Activity One: Full Speed Ahead

This activity will focus on speed, velocity and acceleration, and how to calculate the formulas for each.

Speed and acceleration play integral parts in the outcome of a NASCAR race. The driver needs to maintain high speeds and accelerate quickly at the start of a race and when passing another car. Begin the activity by asking students the differences between speed, velocity and acceleration. Activity One explains that ***speed*** is the rate at which an object travels; ***velocity*** is the speed and direction in which an object travels; and ***acceleration*** is the rate at which an object changes velocity. The formulas are provided for each. Direct students to answer the word problems using the physics formulas.

Answers (Answers are rounded to the nearest hundredth):

1.) 500/15 = **33.33 m/s**; 33.33/15 = **2.22 m/s^2**

2.) 35 minutes/60 minutes = 0.58; 140/0.58 = **241.38 mph**

3.) 120,000/3,600 = 33.33 m/s; 33.33 x 16 = **533.33 meters**

4.) 3 minutes/60 minutes = 0.05 hours; 1 mile/0.05 = **20 mph – No**

Activity Two: How Many Horses?

This activity will strengthen students' math skills through word problems, while educating them about Isaac Newton's Laws of Motion, force, work and power.

In Activity Two students will learn physics formulas to calculate each element. In addition, students will explore how the work they do in real life can be measured in horsepower and watts.

Copy and distribute the activity sheet. The activity provides students with the formulas needed to calculate the word problems. You may choose to do this part of the activity as a class or have students work on their own.

Answers:

1.) 20/746 = **0.027 hp**

2.) 725 x 746 = 540,850; 200 x 746 = 149,200; 540,850 – 149,200 = **391,650 watts**

3.) 68.04 x 8 m/s^2 = 544.32 N; 63.50 x 9 m/s^2 = 571.50 N; the **140-pound engine**

4.) 1,609.34/18 = 89.41; 89.41/18 = 4.97 m/s^2; 1,400 x 4.97 = 6,958 newtons; 6,958 x 1,609.34 = **11,197,787 joules**

5.) 5 x 12 = **60 joules**; 60/120 = 0.5 watts; 0.5/746 = **0.00067 hp**

Extension Activity

- A car is considered to be a "high-performance" vehicle if it has a lot of horsepower relative to the weight of the car. The power-to-weight ratio is determined by dividing horsepower by the weight of the vehicle. Ask students to research "high performance" vehicles and determine their power:weight ratio. For example, a Ferrari with 375 horsepower and a weight of 2,975 pounds has a power:weight ratio of 0.126. Based on the theory that the higher the ratio number, the better the car's power, which car is the best?

Activity Three: Turns & Tires

This activity is designed to strengthen students' knowledge of friction and how it affects vehicles while turning.

Wheels are one of the most important features on a car. The tires use friction to grip the road so a car can move, turn and stop. Activity Three focuses on explaining the importance of tires on a race car, how friction makes a car move and turn and how race tracks incorporate bankings to help drivers turn. Bankings are gradual extensions of race tracks located at the turns. They are measured in degrees. Copy and distribute the activity sheet. Direct students to read the paragraph and finish the activity by using a protractor to measure the angles provided, and answer the questions. To extend the activity, bring a bicycle to class, if possible, and have students observe the tires while turning the bike (outdoors, of course). What do the tires do when the rider makes a sharp turn? Why?

Answers:

1.) A (22°)

2.) C (10°)

3.) Daytona, because of its length and high bankings.

Extension Activity

- If possible, take students outside to observe the tires on various vehicles. Do they notice any differences between the patterns and treading? Ask students how the differences in the tires affect the friction and how the car handles.

Activity Four: The Air Around Us

This activity will focus on the effect air has on moving vehicles, such as drag, resistance and flow.

This activity focuses on the effect air has on moving objects, and how car designers and athletes try to reduce air resistance. The force air uses to push back on a moving object is air resistance, or drag. The more air resistance an object has to fight, the slower the object will move. That is why car designers spend hours testing the air flow patterns over vehicles. A streamlined car will have less drag, so the vehicle is able to travel faster, an important factor during a race. Copy and distribute Activity Four. Direct the class to read about air resistance and draw a vehicle with minimal air resistance.

Next, work with students to test airflow patterns. You will need a toy car or truck for this activity. To test the air flow pattern, take the toy car and tape small pieces of string to the hood, windshield, side doors, trunk and roof. Make sure the tape is at the edge of one end of the string. Place the toy car in front of a fan and turn the fan on. Observe the directions and patterns that the strings blow in. Do the shape and features of the car increase or decrease its drag?

Extension Activity

- Migrating birds and geese also follow the same airflow theory, with the lead bird taking on the most air resistance to make traveling easier for the birds following. Study why birds fly in a "V" formation and how the birds' wind resistance is affected by the V formation. Compare the V formation to the straight line in which NASCAR stock cars travel. Which allows for the least amount of resistance?

Name ______________________________

Date ______________________________

Full Speed Ahead

When the green flag waves, NASCAR drivers have to accelerate their vehicles from the pace lap speed of 65 miles per hour to race speeds that average 180 miles per hour as quickly as possible.

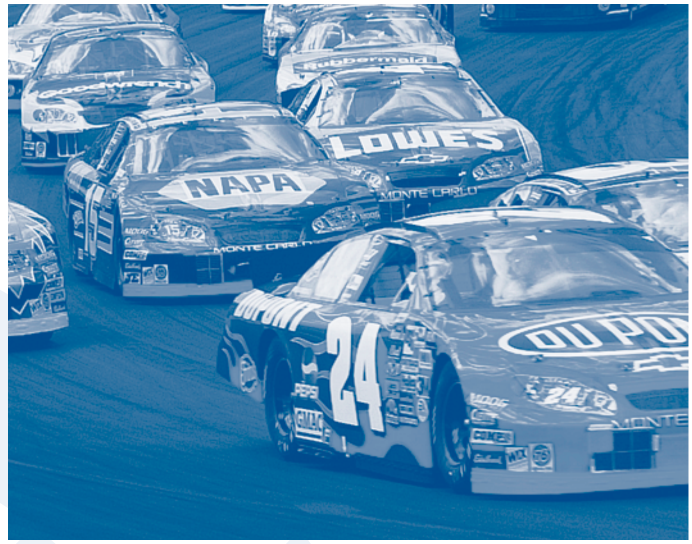
To calculate how fast a car accelerates, you should know that ***speed*** is the distance an object travels in a certain time; ***velocity*** is the speed and the direction in which the object is traveling; and ***acceleration*** is the rate at which an object's velocity changes.

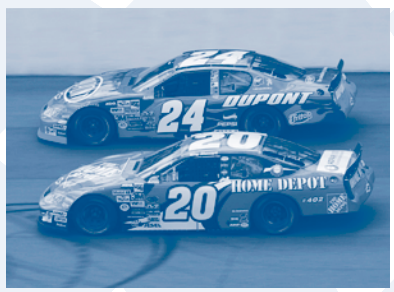
They are determined by the following formulas:

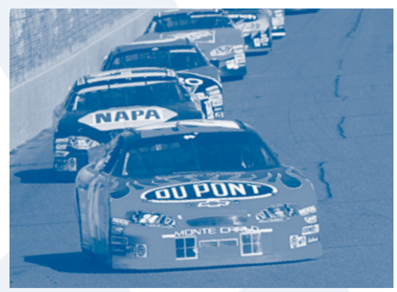
Velocity (speed) = distance/time
v = d/t (velocity is expressed as meters/second; m/s)

Acceleration = change in velocity/time
a = Δv/t (acceleration is expressed as m/s^2)

Distance is measured in meters.







Use the formulas to help you answer these questions (round your answers to the nearest hundredth):

1. **At the start of a race, a NASCAR stock car travels 500 meters in 15 seconds. What is the car's velocity? What is its rate of acceleration?** ______________________________
____

2. **If a car travels 140 miles in 35 minutes, what is its speed in miles per hour?** ______________________________
____

3. **Your car travels at a speed of 120 kilometers per hour for 16 seconds. How many meters will it travel in that timeframe? (Hint: 1 km = 1,000 m; 1 hour = 3,600 seconds)** ______________________________
____

4. **If a car travels one mile in three minutes, and the speed limit is 25 miles per hour, is the car speeding?** ______________________________
____

The driver who qualifies with the fastest time is allowed to start the NASCAR race at the front of the pack, called the "pole position."

Name ______________________________

Date ____________________________

How Many Horses?

Force. Work. Power. All are involved in making a NASCAR engine move. But how are they measured? Let's start with the basics — Isaac Newton's laws of motion. Newton (1642–1727) was an English physicist and mathematician who devised the formulas and laws on gravity and motion. His three laws of motion are:

1.) ***An object at rest tends to stay at rest, and an object in motion tends to stay in motion.*** For example, a NASCAR stock car will stay in motion until another force interferes, such as when the driver applies force on the brakes to stop the tires.

2.) ***The effect of a force is in proportion to the strength and magnitude of the force.*** If you want to inflate a car's tires, a large electric pump with more power will work faster than a small hand pump.

3.) ***To every action, there is an equal and opposite reaction.*** As a NASCAR vehicle drives around a track, air resistance is pushing against the car and the car is pushing back with the same force.

The formula for ***force*** is derived from the second law of motion. ***Mass*** is the measure of the amount of matter an object possesses, and the object's inertia. ***Inertia*** is an object's tendency to resist change in motion. For instance, an airplane would be able to resist a change in motion, such as braking, easier than a car would because the plane is larger and by definition, has more mass. So, more force has to be applied to stop a plane than to stop a car. ***Acceleration*** is the change in an object's velocity.

Work that is done by an engine is measured differently than the work that is done by a person. The amount of work an engine exerts is measured in horsepower (hp). It was developed by James Watt (1736–1819) after he observed horses working and wanted a way to measure their power. He devised a measurement to show how much weight a horse can move a given distance, divided by the amount of time it took to move the weight. ***Work*** is a measure of force and distance. ***Power*** is a measure of how much work was done (how much force was moved a certain distance) over a specific amount of time. Power is measured in watts and ***746 watts equals one horsepower***.

The top speed reached by a car is 403 mph, set by Donald Campbell in 1964.

Use the formulas below to answer the following questions. Use a separate sheet of paper or the back of this page if you need more room to show your work.

1. **20 watts is equivalent to how many horsepower?**

   ____

2. **A NASCAR engine exerts approximately 725 hp. The engine in a passenger vehicle exerts 200 hp. What is the difference between the two engines in watts?**

   ____

3. **Which would require a greater force, accelerating a 150-pound (68.04 kg) engine at 8 m/s^2 or a 140-pound (63.50 kg) engine at 9 m/s^2?**

   ____

4. **How much work is being done to drive a NASCAR stock car that weighs 1,400 newtons around a one-mile (1,609.34 m) track in 18 seconds?**

   ____

5. **On your way to class, it takes you two minutes to carry books weighing five newtons a distance of 12 meters up a flight of stairs. How much work are you performing? What is the power in horsepower?**

   ____

Velocity (speed) = distance/time
v = d/t (velocity is expressed as meters/second; m/s)

Acceleration = change in velocity/time
a = Δv/t (acceleration is expressed as m/s^2)

Force = mass x acceleration
F = ma (force is measured in newtons, N)

Work = force x distance
W = Fd (work is measured in joules, J)

Power = work/time
P = W/t (power is measured in watts, w)

Distance is measured in meters.

Time is measured in second(s).

Mass is measured in kilograms.

Name ______________________________

Date ______________________________

Turns & Tires

Friction is the resisting force between two objects when they come into contact. Turning is a force that requires friction. A car's tires need to "grip" the road to turn, causing friction between the tires and the road. The tires use friction to stop, turn and accelerate. All NASCAR vehicles use the same type of tires. The only difference in teams' tires is the air pressure. NASCAR teams can choose to over inflate or under inflate their car's tires. The tires' air pressure is determined by how the car is handling. Under inflation allows for more friction, because more of the tire's surface area is in contact with the road, but it decreases the life span of the tire.

Tires on a passenger vehicle have treading to allow the tire to gain better traction and grip the road in all types of weather. NASCAR racing tires do not have treading. They use "bald" tires that allow more tire area to come into contact with the road, and they are wider.

All of these tire factors are important when a driver is taking a curve at 180 miles per hour. Drivers depend on the tires to stay in contact with the road in order to maintain control of their vehicle. If you try taking a sharp turn while riding a bike, the tires may not be able to grip the road, reducing the friction between the road and tires and causing the tires to "slide." The same is true on wet or sandy pavement. The liquid or sand reduces the tires' contact with the road so that the tires lose their traction.

Race track designers have added a feature to some racetracks to help cars turn at such high rates of speed. Each turn or curve has a banking, a gradual extension of the race track toward the outer wall that is measured in degrees. The degree of the banking refers to the height of a track's slope at the outside edge. Bankings increase the surface area of the turn, reducing its sharpness so drivers do not need to slow down as much for turns.

Members of the IMAX® film crew survey the bankings on a NASCAR racetrack.

When building a track, racetrack designers can vary the degrees of bankings to manipulate drivers' speed. The bigger the slope of the bankings, the more surface area there is, so drivers can turn at high rates of speed. There is no set rule on the degree of bankings a race track must have. If track designers want speed to be the major factor in a race, they'll design a long track with high bankings. If designers want a closely-run race, they'll design a short track with low bankings that will force drivers to slow down.

Race tracks generally come in three sizes: ***short tracks***, which are less than one mile in length; ***speedways***, which are more than one mile around, but less than two miles; and ***super speedways***, which are more than two miles around.

The longer the track, the more speed drivers can pick up on the straightaways, the long strips of pavement between turns. Shorter tracks force drivers to brake more and slow down for curves, unless there are generous bankings on the turns.

NASCAR tire

Close-up of a NASCAR tire

Use a protractor to measure the angles to the right and label the degree of each angle.

1. Which would allow drivers to make turns without braking? _______

2. Which would cause drivers to slow down for curves? ___________

3. Which of the following NASCAR race tracks would allow drivers to maintain high rates of speed around a race track?

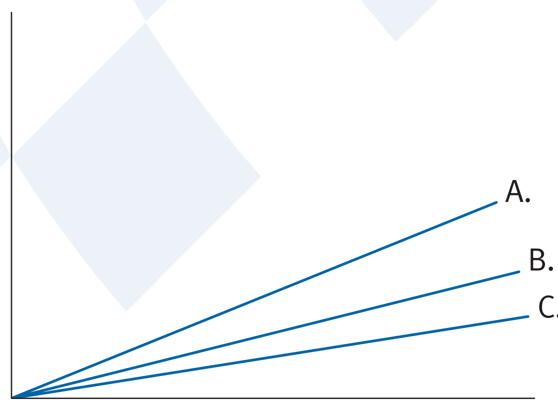
__ **Martinsville Speedway** 0.526 miles; 12 degree bankings

__ **Daytona International Speedway** 2.5 miles; 31 degree bankings

__ **Bristol Motor Speedway** 0.533 miles; 36 degree bankings

__ **Indianapolis Motor Speedway** 2.5 miles; 9 degree bankings

Why? ____



NASCAR teams inflate their tires with nitrogen instead of air. Nitrogen does not contain moisture and can withstand the hot racing temperatures better than air can. It does not change its properties as easily as air, so the tires are able to maintain their true shape.

Name ______________________________

Date ______________________________

The Air Around Us

Any object moving through the air has to push the air aside. But the air doesn't give up that easily — the air pushes back with a force called ***air resistance***, or ***drag***. Objects that are ***aerodynamic*** are shaped to create the least amount of drag possible.

Speed skaters wear body-hugging uniforms with hoods to cut down on air resistance. Airplanes have a long, slim, pointed front fuselage to help the air flow over the body of the plane more easily. Car engineers and designers are constantly working to decrease the amount of drag on a vehicle, which can slow it down. NASCAR engineers know that reducing the air resistance on a vehicle can shave seconds off the clock, which could mean victory in a close race.

Designing a streamlined car is one way to cut down on air resistance. Another way drivers fight drag is to use it to their advantage. In a race, drivers use the airflow coming off the car in front of them to "pull" them along. The airflow between the two cars creates a vacuum that causes the front car to pull the car behind it, so the second car can go just as fast as the lead car, without having to use as much power and fuel because of the decreased resistance.

There are exceptions when NASCAR teams don't mind a little extra drag on their cars. During a race on a short track (an oval track less than one mile) engineers use drag to create as much downforce as possible. Downforce is created when the air pushes down onto the car, pressing it tightly against the ground. This allows the car's tires to grip the track with more force, allowing the car to go around the tighter turns more quickly.

In the box provided below, design a streamlined vehicle that would create the least amount of drag possible. Keep in mind that the car has to be practical for travel and must hold at least two passengers. Which features on your car help reduce air resistance?

To test the air flow pattern on a vehicle, take a toy car and tape small pieces of string to the hood, windshield, side doors, trunk and roof. Make sure the tape is at the edge of one end of the string. Place the toy car in front of a fan and turn the fan on. Observe the directions and patterns that the strings blow in. Do the shape and features of the car increase or decrease its drag?

The only way to completely get rid of drag is to fly in space, where there isn't any air to provide resistance!

Additional Information

Glossary of Terms

Acceleration – the rate at which an object's velocity changes

Air resistance – the force created when air pushes on an object (also called drag)

Banking – a gradual extension of a race track toward the outer wall that is measured in degrees (usually located at the turns on a race track)

Downforce – the force created when air pushes down onto an object

Friction – the force between two objects when they rub together

Inertia – an object's tendency to resist change in motion

Mass – the measure of the amount of matter an object possesses (measured in kilograms)

Speed – the distance an object travels divided by the amount of time it took to travel that distance (distance is measured in meters and time is measured in seconds)

Velocity – the speed and the direction in which an object is traveling

Formulas

Velocity (speed) = distance/time
$v = d/t$ (velocity is expressed as meters/second; m/s)

Acceleration = change in velocity/time
$a = \Delta v/t$ (acceleration is expressed as m/s^2)

Force = mass x acceleration
$F = ma$ (force is measured in newtons, N)

Work = force x distance
$W = Fd$ (work is measured in joules, J)

Power = work/time
$P = W/t$ (power is measured in watts, w)
746 watts = one horsepower

Recommended Reading List

General

Big Book of Cars, by DK Publishing — Features and performances of popular and unusual cars.

The Kids' World Almanac of Transportation: Rockets, Planes, Trains, Cars, Boats and Other Ways to Travel, by Barbara Stein — Information about the different modes of transportation.

Cars, Planes, Ships and Trains, by Ian Graham — Information on transportation.

Auto Racing

Tradin' Paint: Raceway Rookies and Royalty, by Terry Bisson — Information on today's NASCAR drivers.

Around the Track: Race Cars Then and Now, by Steven Otfinowski and Paul Otfinowski — Surveys the world of race cars from the early years to present day.

Auto Racing: A History of Cars and Fearless Drivers, by Mark Stewart — The origins and evolution of auto racing, as defined by key events and personalities.

Grades 4–6

Uncover a Race Car: An Uncover It Book, by Paul Beck, Dane Dunford and Stephen Kuhn — A look at the design and build of a race car.

Henry Ford: Young Man with Ideas, by Hazel B. Aird — Story of the early life of the automotive pioneer who developed the assembly-line production method.

Experimental and Concept Cars, by John Coughlan — Unusual cars and cars of the future.

Green Cars: Earth-Friendly Electric Vehicles, by John Coughlan — Exotic and unusual cars, environmental-friendly cars of the future.

Eddie Rickenbacker: Boy Pilot and Racer, by Kathryn Cleven Sisson — The boyhood story of a WWI flying ace and Medal of Honor winner who became a race car driver.

Grades 7–9

The Car, by Gary Paulsen — An orphaned teen builds his own car and heads across the country to find his uncle.

Amelia Hits the Road, by Marissa Moss — A young girl sets out on a road trip to explore the West with her mother and sister.

The Beetle and Me: A Love Story, by Karen Romano Young — A teenage girl restores her dream car, an old, purple Volkswagen Beetle.

The Automobile and the Environment, by Maxine Rock — A look at the automobile's effect on the environment.

Around the World in Eighty Days, by Jules Verne — The tale of a young man trying to win a bet by traveling around the world in less than 80 days.

Bibliography

www.nascar.com NASCAR Web site

www.imax.com IMAX Web site

www.daytonausa.com Web site for Daytona USA, an interactive NASCAR attraction. Visit the Geared for Learning section for educational information.

www.howstuffworks.com How Stuff Works informational Web site

www.riverdeep.com Web site for Riverdeep, Inc., an educational software company

www.bn.com Barnes & Noble Web site

www.si.edu Smithsonian Institution's Web site

www.nasm.si.edu Web site for the Smithsonian Institution's National Air & Space Museum

www.americanhistory.si.edu Web site for the Smithsonian Institution's National Museum of American History

http://jayski.thatsracin.com Stock car racing Web site

www.gm.com General Motors Web site

www.bodydynamicsracing.com Stock car racing Web site

www.geocities.com/nascarsafety Stock car racing Web site

Beven, Roy Q. *Move With Science: Energy, Force & Motion*. National Science Teachers Association, 1998.

Kuhn, Karl F. *Basic Physics: A Self-Teaching Guide*. Second Edition, John Wiley & Sons, Inc., 1996.

WARNER BROS. PICTURES

WWW.IMAX.COM

WEEKLY READER®