# The Network Notebook

## LESSON 4: Fast Earnie_Physical Science

## FORCES AND MOTION


Includes Character Lesson on Teamwork

# Lesson 4: Fast Earnie Lives Newton's Laws…And So Do You!

**Physical Science: Forces and Motion**

Fast Earnie, and racecar drivers in general, have a need for speed, but without Newton's Laws none of it could be possible! In the following experiments you'll discover Newton's three laws using the "Zephyr" aero-racer car kit. This model is the world's fast rubber band racer. To order the "Zephyr" kit, go to the Learning Center on the Eccentric Racing Network Website or click here. If you want to get started right away, look for the "Kit Alternative" suggestion at the end of each experiment.

## Experiment 1 – Newton's First Law

Introduction: In this experiment you'll be racing your car on different surfaces to discover the Newton's first law. For this experiment you will need your car and two different surfaces either found in your home, or outside. Remember, if you go outside let your parents know where you are. We recommend doing this experiment on a smooth floor like you might find in the kitchen and outside on some rough, but level, concrete.

**Experiment and Collect Data:**
Test 1: Take your fully constructed kit car and find two different surfaces in the house or outside to race the car on.
Wind the propeller of the car up 50 rotations.
Release the car.
Note how long and how far your car traveled.

Test 2: Take your kit to the other location you've chosen.
Repeat the experiment in Test 1 and record your results.
Compare your data.

**Conclusions:**
What did you notice about the distances the car traveled in each test?
In which test was the car faster?
In which test did the car go farther?
In the slower test, what was it that slowed the car down?
What would it be like if you found a surface smoother than the smoothest runway you tested?
What if you did your car on ice?
What if you ran your car in the grass?
What if you ran your car in sand?

**Explanation:** Newton's first law is, "Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it." Sometimes this is simply called the "Law of Inertia". But what does this mean?

Well, let's take the first of two conditions that this law describes. The first thing that this law means is if your car is just sitting there not moving, your car will continue to just sit there (uniform motion) unless you apply a force to it. So what applied force got your car moving? That's right! The propeller provided thrust to your car.

The second condition that this law describes is a little more difficult to see, but let me explain. This second condition described by Newton's first law is that your car would keep moving once it was moving (uniform motion) if it weren't for air resistance and friction. How can we see this? The rougher surface provides a lot more friction and slowed the car down. Now recall the less rough surface you chose. The car traveled much farther before it slowed to a stop.

Can you imagine how your car would travel if you could find a surface that had less friction (like ice covered)? Even if you had brakes on your car you would just keep going! Breaks create more friction.

Now imagine you had no friction at all? What would your car do? That's right, it would just keep going (uniform motion)!

Of course the same is true for when your car isn't moving (after you've crashed) now you need to apply a force to get it moving again. So objects will maintain uniform motion unless some force acts upon that object. "Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it."

Fast Earnie Says: "I'll stay put when I'm not racing, and even when I am racing, frictional forces will slow me down. Yet, if I was to race in a frictionless environment, like in space, I could keep going with only one rev (thrust) of my engine!"

**Extension:** For an extra challenge you can find more than the two surfaces that you started with. Now that you have three or more surfaces repeat the same tests as listed above. When you're done measuring the distances, can you gage the relative fictional force of the various surfaces? What do you notice about the different surfaces? Can you make a statement about the relationship between surfaces and frictional forces?

**Kit Alternative:** Instead of using the kit recommended, you could use a toy car of any sort. During each test do your best to apply the same amount of force on the car.

**Experiment 2 – Newton's Second Law**

Introduction: In this experiment we'll be winding your car up to provide different amounts and seeing how that effects your car's movement. Be sure that wherever you test your car that you do all of your testing on the same surface. For this experiment you will also need two quarters and some tape.

**Experiment and Collect Data:**
**Test 1:** Pick your testing surface. This surface will be used for all testing.
First wind your kit car up to 25 rotations on the propeller.
Release and record the distance the car traveled.
Now, place the car back at the starting point and wind the propeller to 50 rotations.
Release the car and record the distance it traveled.

**Test 2:** Now repeat the procedures of Test 1, but tape 2 quarters either side of the frame of your car.
Record your findings.

**Conclusions:** In the first test which run went farther?
In the second test which run went farther?
Which test and run went the farthest of all?
Which test and run went the least distance of all?

**Explanation: Newton's second law is** "The relationship between an object's mass m, its acceleration a, and the applied force F is F = ma. Acceleration and force are vectors (as indicated by their symbols being displayed in slant bold font); in this law the direction of the force vector is the same as the direction of the acceleration vector. " OR EASIER SAID - _"The rate of acceleration of a body is proportional to the resultant force acting on the body and is in the same direction." Huh?! What?! …Let's simplify this!

If we rearrange the formula using our algebraic skills to look like this a=F/m, we can start to really understand this law. If you applied twice as much force your car would accelerate more and therefore travel farther (Test 1). If you used the same amount of force on your car, but increased the mass the car would not accelerate as much and would therefore travel less than without the extra mass (Test 2). More simply said, if you increase the mass, you decrease the acceleration. If you increase the force, you increase the acceleration. (We could add some calculation examples if you like)

Fast Earnie Says: "If I want to accelerate to a higher speed, I've got to apply more force through my engine. But if I take a passenger I'll slow down…unless I balance it out by applying more force! Since I'm stuck here on Earth I'll need to keep my engine strong and my weight light!"

**Extension: Option 1:** In what ways do air resistance and the shape of an object influence its acceleration and speed? Tape a 3x5 card to the front of you car and conduct the trials again. How did air resistance change the distance traveled?

**Option 2:** Now wind the car's propeller at intervals of 25 winds per trial (increase the force). Graph the distance the car travels vs the number of winds. What do you notice about your graph?

**Kit Alternative:** If you don't have the kit car, this testing is a little more difficult, but you can still do it using any ordinary toy car. In the first test, just be sure to clearly apply more force to the second trial than you do in the first. For the second test you can tape the quarters to the top of the car.

**Experiment 3 – Newton's Third Law**

**Introduction:** In this experiment you'll be using your car as you've done in the other tests, but paying close attention to the propeller.

**Experiment and Collect Data:** In this experiment I want you to wind up the propeller and hold it near your face.
Release the propeller and feel the wind.
Now wind up your car again.
Place it down on the floor.
Observe and record the motion, by creating a diagram showing car direction and wind direction.

**Conclusions:**
Which direction did the wind blow?
Which direction did the car go?

**Explanation: Newton's third law is** "For every action there is an equal and opposite reaction."

All change of motion (acceleration) requires a force to be applied to an object. We've learned that in the previous two experiments, but did you know that for every force that is applied there is an equal and opposite force?! Think about it. When you want to walk forward you push down and back on the ground. Believe it or not the ground pushes back and forward on you. When anyone walks they push down and back and another force pushes forward and up! These are called force pairs and this is what Newton was talking about. Your car is no different. Your propeller thrust back and the car went forwards.

Fast Earnie is no different either. As his tires push on the ground, the ground pushes back and the car accelerates forward. The more force Earnie can apply to the track an equal and opposite force will be applied to him to win the race. You car also see this law in Earnie's adventures in space. Be sure to check out those lessons too.

Whenever you apply a force on something, the same amount of force is applied to you! This is exactly why you don't go around kicking boulders and why Fast Earnie always avoids crashing into other cars. You and Earnie will get hurt on the process!

Fast Earnie Says: " If I pop my clutch, I'm gonna to fly forward as long as my tires are grab the track!"

**Extension:** Try winding your cars propeller the opposite direction. Feel the wind and notice the motion of your car.

**Kit Alternative:** Using any toy car, lay the car on the track and now flick your car with your finger. Did you feel a force applied to your finger? Now go flick that car again, but harder! Did you feel it more than the first?

**VOCABULARY**

**acceleration**

Definition: The rate of which an object changes it velocity

Context: Acceleration can be positive or negative depending on whether the object is speeding up or slowing down.

**force**

Definition: A push or a pull exerted on an object

Context: The ball was hit with enough force to send it into the bleachers.

**friction**

Definition: A force that resists motion between two bodies in contact

Context: Rougher surfaces create more friction than smooth ones when an object comes in contact with them.

**gravity**

Definition: The natural force that attracts any two objects with mass toward each other

Context: Earth's gravity pulls on anything that is not held up by some other force.

**speed**

Definition: The rate of motion

Context: The speed of the ball is determined by measuring how far it travels in a certain amount of time.

**velocity**

Definition: The speed of an object moving in a specific direction

Context: The car's velocity was 55 miles per hour, eastbound.

**California Standards Addressed in the Fast Earnie Lessons:** The wording is taken directly from the website. It is not presented in the same format as the national standards.

**Grade 5 CA - Investigation and Experimentation**
6) Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
c) Plan and conduct a simple investigation based on a student-developed question and write instructions others can follow to carry out the procedure.
e) Identify a single independent variable in a scientific investigation and explain how this variable can be used to collect information to answer a question about the results of the experiment.
g) Record data by using appropriate graphic representations (including charts, graphs, and labeled diagrams) and make inferences based on those data.
h) Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.
i) Write a report of an investigation that includes conducting tests, collecting data or examining evidence, and drawing conclusions.
Grade 6 CA- Investigation and Experimentation
7) Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
a) Develop a hypothesis.
b) Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.
c) Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.
d) Communicate the steps and results from an investigation in written reports and oral presentations.
e) Recognize whether evidence is consistent with a proposed explanation.

**National Standards Addressed in the Fast Earnie Lessons:** The wording is taken directly from the website. It is not presented in the same format as the CA standards are.

**Content Standards Grade 5-8 Physical Science**
CONTENT STANDARD B: As a result of their activities in grades 5-8, all students should develop an understanding of Motions and forces
DEVELOPING STUDENT UNDERSTANDING
In grades 5-8, the focus on student understanding shifts from properties of objects and materials to the characteristic properties of the substances from which the materials are made. In the K-4 years, students learned that objects and materials can be sorted and ordered in terms of their properties. During that process, they learned that some

# CHARACTER LESSON 4: Fast Earnie_Physical Science

**Teamwork**

**Activity 1**

Boil It Down

Here are some statements about the story. Fill in the correct answers.

The main character's name is ______________________________________________

He is from the planet named_________________________________________

He gets lost and finds himself on a strange planet called______________________

He can do something no on else can do, which is___________________________

One scientist wants to find out how he works but he gets away by____________________

_____________________________________________________________

While watching a NASCAR race, he becomes_________________________________

but discovers that his team has found a way to ____________________________

**Activity 2**

NASCAR Races

While the driver gets all the attention and recognition, every one of them will tell you that their success is a result of great teamwork. Watch all or part of a NASCAR race. Besides the driver, whom do you see working in the "pits" as members of the team? List three or four.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

**Activity 3**

Quote Board

*"You don't win with cars. You don't win with tricks as X's and O'x in football. You win with people. If you get the right people together – the guys that are willing to sacrifice their own individual goals for the goals of the team, you're gonna win."* – Joe Gibbs

*"There is no substitute for teamwork."* – W. Edwards Deming

*"Teamwork is the key to success in this country."* - Dick Lyles, author

*"The most important four letter work in the English language is TEAM."* – John Wooden, former basketball coach

*"Two heads are better than one."* – Author unknown

**Activity 4**

Who are the team members in your life?

At home____________________________________________________________

In class_____________________________________________________________

In sports____________________________________________________________

In your social life____________________________________________________

**Activity 5**

What skills do you think you and others need to be a productive member of every team you are on?

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

**Activity 6**
What does teamwork look like? Write a slogan or saying or comment about teamwork on the front of the T-shirt. What would you write on the back of the shirt?

**Front**

**Back**