FORCES AND MOTION

Natural forces and the Laws of Motion
Based on the SMART coordination by NAD

BY Rebecca K. Fraker

Dear Teachers,

Please try to do as much hands-on as you can! These are FORCES. They are deadly dull and boring if all you do is read!

That being said, there are two sites that you should explore:
Exploratorium at http://www.exploratorium.edu/ which has thousands of clips, experiments, pictures, simulations, etc. Their digital library can be downloaded and played later. They can be transferred on CDs or flash drives! If you can't do it get one of the students to do this.

The second site is **Fear of Physics** at
http://www.fearofphysics.com/index1.html
This also has little things that can be done on the computer. If you only have one computer, gather everybody around. Or maybe you could borrow a projector and shine them on the wall.

It can be done!

Becky Fraker

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NAD SMART Correlation Grades 1 to 8

This unit follows the SMART Curriculum guide. It coordinates all grades on the same topic.

SCIENCE CURRICULUM MAP: GRADES 1-4

	Cycle 1 Lower	Cycle 2 Lower	Cycle 3 Lower	Cycle 4 Lower
1st Qtr Life Science	Living Things Characteristics Classification Animals Fish Birds Reptiles/Amphibians Mammals Ecology Environmental Issues Natural Resources Careers and Service	Human Body Organization Sense Organs Teeth, Skeletal/Muscular System Respiratory/Circulatory System Immune System Digestive/Excretory System Careers and Service	Cells Animals Growth/Development/Behavior Organisms Invertebrates/Worms Insects/Arthropods Arachnids Careers and Service	Plants Classification Structure/Function/Importance Growth/Life Cycle Photosynthesis Reproduction Ecology General Information/Food Chain Communities/Population Careers and Service
2nd Qtr Health	Mental/Emotional Health Decision Making Self-Concept Emotions Stress Family/Social Health Family Structure Communication Careers and Service	Nutrition Nutrients Food Pyramid Dietary Guidelines Education Safety/First Aid Public Safety Recreational Safety Careers and Service	Drugs Decision Making Effects Medicines Health Principles Biblical Principles Natural Laws Careers and Service	Consumer Health Health Care Preventative/Curative Community Health Education/Resources Communicable Diseases/ Immune System Disease Transmission Careers and Service
3rd Qtr Physical Science	Heat Energy/Waves Sound Light Careers and Service	Magnetism Electricity General Information Static Electricity Current Electricity Careers and Service	Force Friction/Gravity/Mass/Weight Motion Careers and Service	Chemistry Matter Atomic Structure Mixtures/Compounds Basic Energy Simple & Compound Machines Careers and Service
4th Qtr Earth and Space Science	Meteorology General Information Weather Elements Seasons Climate Atmosphere Water (Hydrologic) Cycle Careers and Service	Geology Earth's Features Genesis Flood Earthquakes/Volcanoes Minerals/Rocks Erosion Soil Pollution Careers and Service	Origin of the Universe Astronomy History Space Exploration Solar System General Information Sun/Stars Moon Asteroids, Meteoroids & Comets The Universe Constellations Careers and Service	Creation & Evolution Geology Fossils Dinosaurs Ecology Natural Resources Environmental Issues Careers and Service

SCIENCE CURRICULUM MAP: GRADES 5-8

	Cycle 1 Upper	Cycle 2 Upper	Cycle 3 Upper	Cycle 4 Upper
1st Qtr Life Science	Science Inquiry Living Things Characteristics Classification Animals Fish Birds Reptiles/Amphibians Mammals Animal Behavior Careers and Service	Science Inquiry Cells Cell Theory & Characteristics Structure Processes Human Body Organization Sense Organs Skeletal, and Muscular Systems Integumentary System Respiratory & Circulatory Systems Nervous System Careers and Service	Science Inquiry Simple Animals Invertebrates Sponges, Cnidarins & Worms Mollusks & Echinoderms Arthropods General Characteristics Insects & Arachnids Centipedes/Millipedes & Crustaceans Monerans (Bacteria) Protista Fungi Viruses Genetics Nucleus & Genetic Engineering Heredity Careers and Service	Science Inquiry Plants Classification Structure & Function Processes Reproduction Responses Ecology General Information Adaptation Food Chains Careers and Service
2nd Qtr Health	Personal Mental Health Personality Self-Concept Emotional Health Conflict Management Development Conception to Birth Puberty Reproductive System Sexual Behavior Careers and Service	Human Body Digestive System Excretory System Nutrition Nutrients Food Pyramid & Dietary Guidelines Eating Disorders Mentally/Physically Challenged Safety/First Aid Careers and Service	Drugs General Information Effects Decision Making Human Sexuality Sexual Feelings God's Plan & Sexual Issues Sexual Behavior Careers and Service	Preventative/Curative Health Care Community Health Education & Resources Teen Health Risks Risk Factors & Challenges Diseases Communicable Diseases Immune System Disease Transmission STDs & HIV/AIDS Careers and Service
3rd Qtr Physical Science	Heat Energy/Waves General Information Electromagnetic Spectrum Sound Light General Information Colors Mirrors/Lenses/Lasers Careers and Service	Magnetism Electricity Static & Current Electricity Safety, Generation & Measurement Applications Circuits, Cells/Batteries & Electronics Careers and Service	Force Basic Force Gravity Mass/Weight Elastic, Nuclear & Electric/Magnetic Friction Motion Basic Motion Laws of Motion Careers and Service	Chemistry Matter Atomic Structure Atomic Nucleus Mixtures Compounds Chemical Reactions Acids/Bases Potential/Kinetic Energy Work/Power, Machines & Mechanical Advantage Careers and Service
4th Qtr Earth and Space Science	Meteorology Weather & Climate Weather Elements Climate Atmosphere Global Warming Water (Hydrologic) Cycle Oceanography Environments Resources Tides/Currents/Waves Careers and Service	Geology Earth's Features Genesis Flood & Ice Age Tectonics Earthquakes & Volcanoes Minerals/Rocks Erosion & Weathering Careers and Service	Origin of the Universe Space Exploration Solar System General Information Planets Moon Asteroids, Meteoroids & Comets Sun The Universe Stars Galaxies and Constellations Careers and Service	Creation Evolution Earth's Age Geologic Column, Fossils & Dinosaurs Ecology Natural Resources Environmental Issues Careers and Service

Motions and Forces—Basic Force

Essential Learning Elements:

(1-8) Describe and compare types of force and motion.
Define and apply understanding of gravity, mass and weight.

Learning Points:

1. Define force.
2. Define gravity.
3. Identify several forces active in the Universe.
4. Identify the forces that affect gravitational attraction.
5. Explain the center of gravity.
6. Understand the value of natural laws.

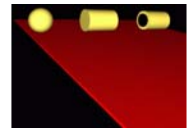
Spiritual Applications:

1. Matthew 5:41, Ephesians 6:12
2. Education, p. 29
3. Some forces are not obvious. Examine the subtle spiritual and social forces influencing our lives, as well as the "force" with which we influence others.
4. Discuss the force of the will – a power given to us by God. Steps to Christ, p. 47

Resources: *Explore God's World*, chapter 13, p. 295-298
Scott Foresman Science, '03, Unit B, chapters 2 & 3

Resources.

http://www.fearofphysics.com/Race/race.html Three round objects are at the top of ramp: a solid ball, a solid cylinder, and a hollow cylinder. They are all made out of the same material, have the same radius, and have the same mass.



Starting at the same point on the ramp, they are allowed to roll down. **Here's the question: Which one will make it down first? Second? Last? Or will they all arrive at the bottom at the same time?**

http://www.fearofphysics.com/index1.html

Speed and Acceleration
The science behind how something moves.

Collisions: Light, Heavy, Same.
What happens when two things crash into each other?

Roller Coasters: Free Rides.
Sure they're fun...and loaded with Physics too!

Cart Throws Ball
If a cart throws a ball, where will the ball land?

Sun, Earth, Moon: Orbit, Eclipses, On Moon, On Sun, Moon Phases
Stuff involving these three heavenly bodies.

Things that Spin: The race, Wheel (still), Wheel (spinning).
Strange things can happen when things spin.

Sound: 2D, How we hear, Play sounds.
What is sound anyway?

Einstein's Relativity: The house.
What happens when you move very very fast?

Ball on a String
A ball is twirled on a string. Then the string is cut....

What is an Atom?: Orbits, Quantum, The Atom.
We can't see them, so what does an atom look like?

What is Friction?: An Experiment
Friction doesn't really want you to move; ever.

Why things fall: Fall Video.
What is "the pull" in "the pull of gravity?"

Why Satellites Don't Fall
How is it that they stay up there?

Make your Jump Shot: Video, Ball Ride.
The science behind making a shot in basketball.

Seesaws
Can you help two kids ride a seesaw?

First one Down
Throw one ball and drop another. Which one lands first?

Swinging Pendulums: Different starts.
Strange facts about things that swing back and forth.

The Doppler Effect: Why, Hear it.
Sometimes we don't hear what we're supposed to.

Zero g: Zero g Video, A Pendulum.
How can you make gravity go away?

Shake it!
Why earthquakes can be so destructive.

Strange Writings: A Problem, Deciphered
How a physicist would solve a problem.

Opening Lesson 1: Defining Force and Mass

There is a Facts for Forces Powerpoint

Have each student put a heavy object such as a book on a level surface. Have the students stare at their objects. Point out that the object does not move.

Now, have the students use their hand to move the object. Help them to come to the conclusion that they either had to "push" or "pull" the object. This is the definition of **force: a push or pull on any object.**

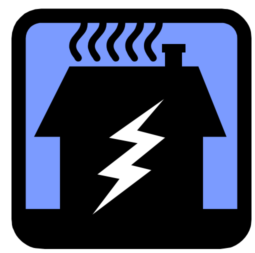
Force created by muscles, or mechanical muscles, is called **mechanical force**.

Swinging a bat, using a robotic arm, opening a can with a can opener, sawing a board: these all take mechanical force.

We are familiar with mechanical force because we experience it every day. We also experience other forces. Think about it. What other forces can you think of?

Teacher Demonstration of forces:

Drop a book to the floor (gravity).
Rub hands together (friction).
Turn a light or flashlight on and off (electrical).
Use a magnet to pick up something (magnetic).



Force is measured in a unit called **Newtons**, after the scientist Isaac Newton. The symbol **N** is used to identify this. Various types of scales can be used to measure force. Later in this unit we will use spring scales.

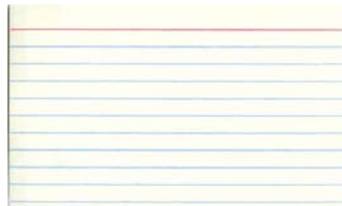
In pairs, quickly brainstorm answers to the following question:
What are the differences between a model car and a full-sized car?

(After discussion of size, etc., steer the conversation to the idea of "**Mass**"—**the amount of material that is in something.**)

Force is a push or pull on any object.

Mass is the amount of material that is in something.

Investigation:


Supplies needed: ruler, scissors, 1 plastic cup, 1 index card, 1 quarter for each student.

Procedure:

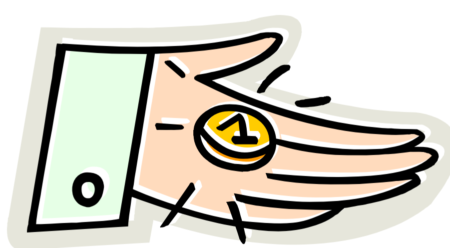
1. Cut the index card so that it is a square about 6 cm on each side. It must cover the top of the cup.
2. Cover the cup with the card as centered as possible and put the quarter in the center of the card.
3. Flick the card on the side so the card flies off the cup. The coin should fall in the cup.
4. Now place the card and the coin on the palm side end of your index finger. (The coin should be on the top of the card.)
5. Now flick the card sideways so the coin stays on the end of your finger.

What causes the coin to drop into the cup when the card is flicked?

What causes the coin to stay on the end of your finger when the card is flicked away?

What would happen if the card were pulled slowly?

Is there more than one force at work here?



Investigation: How much force does it take to break spaghetti?

Supplies needed: Small electronic scale that measure Newtons.
Spaghetti uncooked pieces: thicker will work better
Ruler
Recording chart
Calculator

Procedure:

1) Divide into groups of three: one to press the spaghetti down, one to watch and read the scale, and one to record the results. Each group will need a small electronic scale, raw spaghetti, a ruler, and a calculator.

2) Make a recording chart. It should have columns for length of strand, force,and average.

3) Begin by carefully pushing a stick of uncooked spaghetti straight down on the scales until it breaks. Record the force at which the spaghetti broke. Try it three more times and then take the average of the four attempts.

4) Now measure and break some strands of spaghetti in half. Again, measure the breaking force on four half-strands, and average.

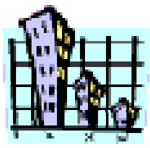
5) Next, measure the force on quarter-strands, and average.
* If it is possible, try it on strands that are only an eighth of a strand long.

6) Now, compare the results from one length of spaghetti to the next.

You should discover that as the length gets shorter, it takes much more force to break the strand. Each time you cut it in half it takes 4 times the force to break it! This is known as an inverse square law.

More on Force and Spaghetti

Pretend the spaghetti was a beam. Notice that when you cut this beam in half, it took four times the force to break it.



This is an inverse square law. In mathematical terms, the force it takes to break a beam is proportional to the inverse square of the length of the beam. This law of beam collapsing was discovered by Leonard Euler, and so is called Euler buckling.

If you were building a building to hold a lot of weight, should you use short or long beams? The answer, of course, is that shorter beams are stronger. It is difficult to build tall buildings. Gravity pulls down on the tall buildings, and they are easier to break.

About kilograms and force

Scales are calibrated to measure mass in kilograms or grams. They actually measure the force of gravity on a mass. The force on one kilogram is found by multiplying the mass by the acceleration of gravity which is 9.8 m/s^2. So the force on one kilogram is really 9.8 Newtons. Since this activity is about ratios of forces we can use units of mass and get the correct answers.

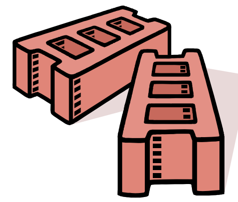
More Spaghetti Fun

Try different thicknesses of spaghetti and checking the breaking force. Try taping several pieces together in the center. Then construct some spaghetti buildings and see how much weight they will hold before they break.

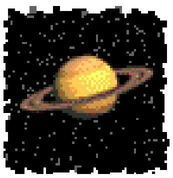
For serious papers on the subject, see
http://www.math.psu.edu/belmonte/spaghetti.html
http://www.lmm.jussieu.fr/spaghetti/index.html

FACT SHEET

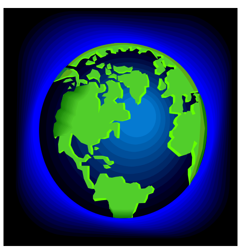
FORCE—a push or pull on an object.



MASS—the amount of matter that makes up an object.
Under normal conditions mass does not vary.



GRAVITY—the pull of matter on matter.
The greater the mass of an object, the greater the gravitational attraction it exerts on another object.

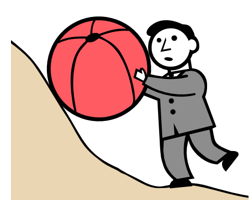


Small mass=small gravitational attraction
Large mass=large gravitational attraction

The closer an object is to another object's center of gravity, the greater the gravitational attraction it exerts.

WEIGHT—a measure of the force of gravitational attraction.

An object's weight varies (unlike mass) depending on its mass and the distance between it and the center of gravity of another object.



At the top of the mountain the ball weighs 9 kg.

At the bottom it weighs 10 kg.

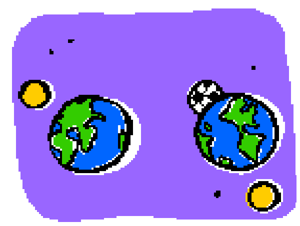
LESSON Day 2: Gravity

As a baby, you discovered that if you tripped you fell DOWN. You threw food and toys off your high chair, and they fell DOWN. You rolled your little cars DOWN little ramps. In short, although as a baby you didn't know its name, you discovered a lot about **gravity**.

Gravity is more than what the Earth does.

Gravity (or gravitational attraction) is the force of attraction that exists between any two objects.

The amount of gravity between two objects depends on two things: their masses and the distance they are apart.

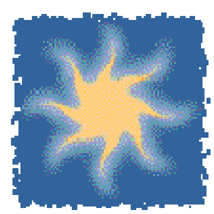


An object's mass is the amount of matter it has. The greater the mass an object has, the greater the force of gravity between it and another object. Since a book you are holding is fairly light weight, you don't really notice the gravitational attraction between the two of you. Since the Earth's mass is much greater than your mass, the book will fall from your hands to the floor. The Earth's mass is large enough to attract you to it and keep you from floating off.

Earth is so large that it has more gravity than any object on its surface.

The sun, however, has a million times more mass than Earth, and so it has even more gravity. The moon is much smaller and has less mass, so it has only one-sixth the Earth's gravity.

If the sun is so huge, why aren't we pulled into it?



Isaac Newton discovered that distance matters also in the gravitational pull between two objects. **The closer the objects, the greater the gravitational pull. The farther away the objects, the less the gravitational pull.**

Our distance from the sun is so great that its pull on us is weaker than the Earth's pull on us. But it is great enough on the larger-mass Earth and planets to keep them in orbit around the sun.

Investigation: Center of Mass

Collect a number of long objects such as a screwdriver, hammer, yardstick, pencils, pens, sticks, etc.

Gravity not only helps us keep planets in orbit around the sun, and us stuck to the Earth, but it also enables us to balance things.

Take one of the long objects. Hold out your hand and balance the object. Now roughly sketch the object and show the balancing point. Share these with each other. (Students should discover that they must shift back and forth to find the balancing point, and that the balancing point isn't necessarily the "center" of the object.)

When you balance an object, you have found the **center of its mass.** At this point, gravity is pulling on one side as hard as it does on the other side. This point of balance is called the **center of gravity.**

*******You would weigh less on the top of Mt. Everest than you would weigh in Death Valley, which is below sea level. Can you tell why? If you were a long jumper, do you think you would jump farther at a high elevation or a low elevation? Why? Check the records from 1920 and record the location and length. Then check some other locations of the Olympics.*

Any object that balances must be positioned so that its center of gravity is directly above or below the point on which it is balancing. For you to balance on one foot, you must shift your body so that your center of gravity is directly above your toes. Experiment with holding heavy books out at arm's length and notice how you have to shift your body in order to balance on one foot.

Fun Experiment for a group:
Take six rulers or metersticks and stake them any way you wish to get one of them to extend as far as possible over the edge of a desk or table without falling.

If you would go to the moon you would discover that you weigh less. If you went to Jupiter you would weigh more. Why? Because weight is a measurement of the pull of gravity. On the moon the gravity pulls less, because the moon has less mass than the Earth. Jupiter has far more mass than Earth. So its gravitational pull on your body is more, and you weigh more.

Lesson Day 3: Systems of Mass and Weight

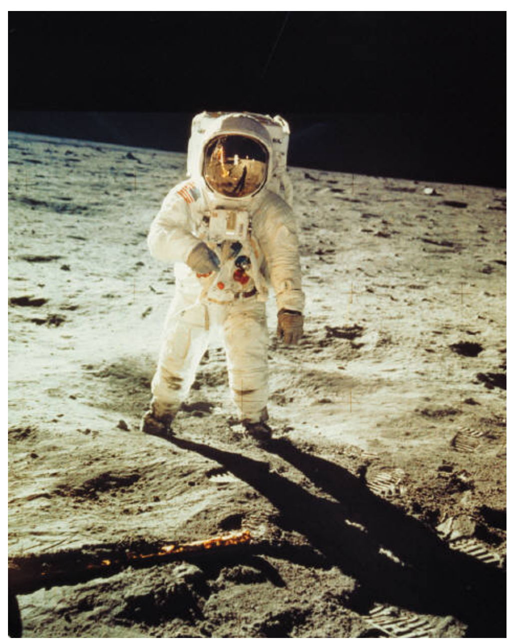
There are two systems used to measure mass and weight.

SI System: Mass is measured by kilograms, Weight by newtons.

English System: Mass is measured by slugs, Weight by pounds.

On Earth you can convert kilograms to pounds by multiplying by 2.2. But that only works here on Earth. To find weight from mass, you must multiply the mass of an object times gravity. On Earth, gravity is expressed as 10 N/kg. This means that for every kilogram there is a gravity force of 10 Newtons acting on it. Therefore, if the mass of an object is 5 kg., its weight is 5 x 10 N/kg, or 50 Newtons. So if your mass here is 80 kg., your weight here would be 800 Newtons.

On the moon, the gravity would be 1.7 N/kg. Therefore, your 80 kg. mass would have a weight of 136 N on the moon.



Gathering and Interpreting Data

Name: ________________

Scientists constantly collect data. This data may be characteristics and observations of an object or situation, or it may be mathematical data. To be meaningful, the data then needs to be interpreted.

In the following formula **F = m x g**

F is the force determined in N (newtons)
m is the mass measured in kilograms (kg)
g is the gravity measured in N/kg

Use the numbers in the table below and determine the unknown force in each case. Then use this data to answer the questions. You will have to THINK!!

Trial	M (Mass)	g (Gravity)	F (Force) **F = m x g**
1	2.0 kg	10.0 N/kg	
2	10.5 kg	10.0 N/kg	
3	8.1 kg	10.0 N/kg	
4	18.0 kg	10.0 N/kg	
5	18.0 kg	6.0 N/kg	

THINK !!

1. If gravity is constant, what happens to the force if the mass of the object increases?

2. When the mass remained the same but the gravity decreased, what happened to the force?

3. If a person moves from one planet to another planet of a lower gravity, what will happen to his or her <u>weight ?</u>

4. If the force was equal to 25 N and the mass was 15 kg, what would the pull of gravity be? (Use the formula.)

5. If you had a mass of 50.2 kg and a gravity pull of 5.0 N/kg, what would the force be? (Use the formula.)

6. If you had a pull of gravity of 3 N/kg and a force of 150 N, what would the mass be?

Gathering and Interpreting Data **KEY** Name: ___________________

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Trial	M (Mass)	g (Gravity)	F (Force) **F = m x g**
1	2.0 kg	10.0 N/kg	**20 N**
2	10.5 kg	10.0 N/kg	**105 N**
3	8.1 kg	10.0 N/kg	**81 N**
4	18.0 kg	10.0 N/kg	**180 N**
5	18.0 kg	6.0 N/kg	**108 N**

THINK !!
1. If gravity is constant, what happens to the force if the mass of the object increases?
The force increases.
2. When the mass remained the same but the gravity decreased, what happened to the force? ***The force decreases.***

3. If a person moves from one planet to another planet of a lower gravity, what will happen to his or her weight ? ***It will be less.***

4. If the force was equal to 25 N and the mass was 15 kg, what would the pull of gravity be? (Use the formula.) ***1.7 N/kg***

5. If you had a mass of 50.2 kg and a gravity pull of 5.0 N/kg, what would the force be? (Use the formula.) ***251 N***

6. If you had a pull of gravity of 3 N/kg and a force of 150 N, what would the mass be?
50 kg

Motion and Forces: Friction/Inertia/Gravity/Mass/Weight

Essential Learning Elements:

1. Define and apply understanding of gravity, mass and weight.
2. Explain and describe types of friction.

Learning Points:

1. Define friction.
2. Explain the effects of friction.
3. Define gravity.
4. Describe how gravity affects matter.
5. Compare the gravitational attraction of objects of varying mass.
6. Define inertia.
7. Describe the effects of inertia.

Spiritual Applications:

1. Ephesians 3: 17-19
2. Colossians 1:23
3. Hebrews 12: 5-8

Resources:

Explore Gods' World: Chapter 13

http://www.learner.org/interactives/parkphysics/

FearofPhysics
Physics. Explained. Finally.

http://www.fearofphysics.com/Friction/friction.html Here's the situation: you're driving and there's a traffic jam up ahead. Make your selections, and see if you can stop your vehicle right behind the traffic, without running into it.

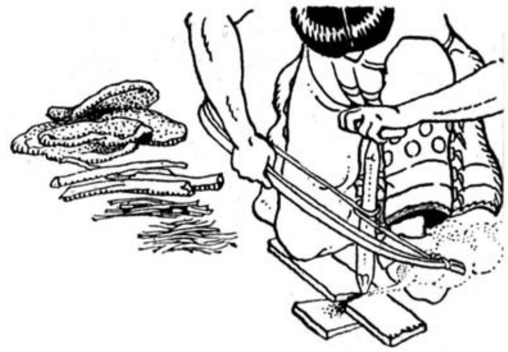
http://www.fearofphysics.com/index1.html

Lesson 4: Friction

Sometimes we wish that we could push something and get it to move forever. Think of the money we could save if we gave our cars gigantic pushes, and then they kept on going!

But sooner or later in our world we want to make something STOP. Things like our bikes or cars or skateboards. What forces in our world help us to stop things?

Don't answer "brakes," because brakes actually use this force. The force we are talking about is called **friction. Friction is the opposing motion between two objects that are in contact.**



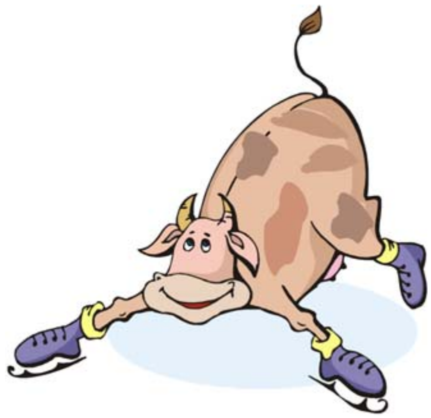
Friction does more than stop us. It keeps our feet from slipping out from under us. It allows you to pick up objects, your bike tires to stop your bike, the lead in your pencil to rub off onto your paper when you write. Life would be very difficult without this force.

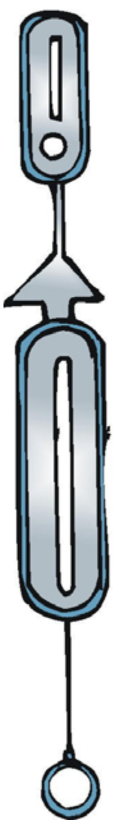
Scientists identify three types of friction: **static friction, sliding friction, and rolling friction.** *(see chart under* ***Resources****).*

Many times we want to reduce friction. Friction causes heat and wear. In a car engine, we try to reduce friction. Substances that reduce friction in this way are called **lubricants.** They are mostly oils, greases, and waxes. Engineers are constantly trying to find new and better lubricants.

Friction can also be reduced by making surfaces smoother by sanding, putting on smooth paint, or polishing an object. Sometimes even a thin coat of water or other liquid will reduce the friction. And reducing the force also reduces friction.

Other times we want to increase friction. Have you ever fallen on an icy walk? We use sand, salt, ashes, and other de-icers to increase friction so that we don't slip. We use metal studs on tires, and different treads on tires and shoes. More force and coarser sandpaper will increase friction when we sand wood.





In 1678, **Robert Hooke** announced the invention of the **spring scale** and the relationship for elastic materials that is now known as Hooke's Law.

When an object is acted upon by a force, it can be compressed, stretched or bent. If when the force is removed, the object returns to its original shape, it is said to be elastic. Solids that do not return to their original configuration once they have been distorted are categorized as plastics.

Hooke discovered that not only are certain materials (steel bars, rods, wire, springs, diving boards, and rubber bands) elastic, but the stretch they experience is directly proportional to the load that they support.

Investigation: Using a Spring Scale

Today we are going to explore friction and lubricants with spring scales, which are based on Hooke's Law.

Exploring:

Materials needed: several blocks or pieces of wood, two for each child or group. *Samples of lubricants* such as bar soap, liquid soap, vegetable oil, car oil. *Samples of friction* reducers such as sand, salt, sandpaper, rubber mats.

Spring scales. (These can be purchased online for $5-$8.)

Procedure: Begin by rubbing two blocks together to get a feel for the friction level. Use a spring scale to measure the amount of force needed. Now experiment with each example and decide which is the best lubricant and which is the best friction reducer.

If you have a spring scale, attach it to the upper block as you pull it. This will give you numbers that can be charted.

If you do not have a spring scale, you will have to judge which one takes more force to move.

Types of Spring Scales

Lesson 5: Other Forces

Although mechanical force, gravity and friction are three common forces, they are not the only forces at work in the Universe. On the popular *Star Wars* series, the actors referred to "The Force". It became popular to say to people "May the Force Be With You." They usually meant "May God Be With You."

But the Christian God is not a faceless, nameless "force." He has a personality, and He knows each of His creatures. He is very personal. As you read the Bible, especially the accounts of Jesus, notice how very real He is. He is not "a Force" but the one who keeps all the other forces going. Natural forces operate day after day and year after year. He made the Laws and Forces of our Universe so that we could use one force against another so that we could get heavier-than-air planes into the air.

Other forces in our Universe include **elastic force, nuclear force, electrical force, and magnetic force.**

Study the chart <u>Other Forces</u>. Review what each one of them does.

Split into groups and give at least three examples of uses of each of these forces. Then share with the other groups.

Uses of These Forces

Elastic ____

Electrical ____

Nuclear ____

Magnetic ____

Lesson 6: Assessment

Choose a method of assessment for these concepts. A traditional worksheet follows for those who wish a worksheet type thing. **Chapter 13 of _Explore God's World_** contains a test, as well as the binder to the series.

Student Projects:

Easy:

(1) Create a poster with a picture of a bicycle on it. Draw lines to different parts and label each part with the type of simple machine that it is.

(2) Build a mouse trap car. Use your imagination in building the famous "mouse-trap machine". Construct a car or mount a mouse trap on an old plastic car so that as the mouse trap springs closes, the car moves ahead.

Hard:

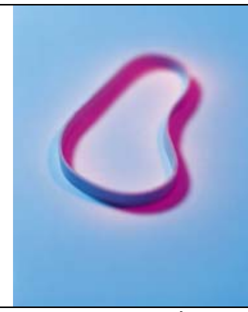
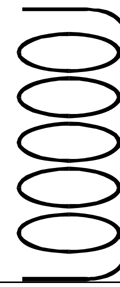
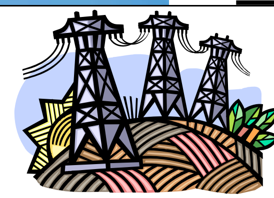
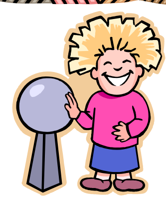
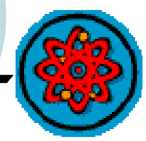
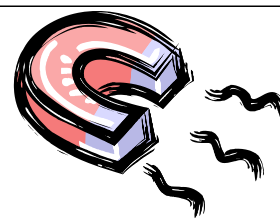
(3) Engineers must design structures to overcome the forces that act on them on the Earth. Snow, wind, weight of vehicles, and so on all affect a structure. Design and construct a bridge out of popsicle sticks that will support a mass of 45 kg (100 pounds). Make the bridge so that it spans a distance of 38 cm (15 inches).

(4) Build a model rocket. Research information so that you can determine how high it will go, what forces are acting on the rocket, and the effect of the design (shape, size, material, etc.) on the rocket.

(5) Investigate and write a report on Henry Cavendish, the English scientist who discovered the density of the Earth.

OTHER FORCES

Fact Sheet

Elastic Force Created by objects that are stretched, bent, twisted, or compressed and that return to their original shape. *Example: stretch a rubber band or a coiled spring and release it.*	 
Electrical Force The force of attraction between electrons and protons that holds the atom together. Responsible for producing electrical effects (electricity). *Electrical force causes static cling, static electricity, as well as current electricity for running lights and appliances.*	 
Nuclear Force Holds the protons in the nucleus of an atom together. When an atomic nucleus is split, large amounts of energy are released, showing the enormous strength of the nuclear force. When nuclear energy is released all at once, a nuclear explosion occurs. When nuclear energy is released under controlled conditions, it can be used to generate electrical energy.	 
Magnetic Force The attraction that occurs between two magnetic objects. It occurs in magnetite, a naturally occurring, iron-bearing mineral. Iron-containing material can be magnetized by aligning the atoms of the material, using a magnetized object or electrical current. It is present in electromagnets only when supplied with current electricity.	 

Assessment/Worksheet/Research Name: ___________________________

1. A force is:
2. What type of force is created by muscles and machines?
3. Define the term gravity.
4. What is mass?
5. Earth has six times more mass than the moon. *Which has more gravity, and why?*
6. Newton found that when the distance between two objects increased, their pull toward each other ________
7. What are the two names for the point of balance of an object?
8. What is weight?
9. When you travel from the Earth to the Moon, what changes—your mass or your weight? Why?
10. Which planet has the weakest gravity, and why?
11. In the metric (SI) system, what unit would you use to refer to your mass?
12. In the metric (SI) system, what unit would you use to refer to your weight?
13. What is friction?
14. How does friction help you when walking?
15. What are three types of friction?
16. Which type of friction holds things in place?
17. Which type of friction can be increased?
18. Which type of friction creates heat and wear?
19. How can friction be reduced?
20. What is one way friction can be increased?
21. What is electrical force?
22. How are static and current electricity different?
23. What is elastic force?
24. What is nuclear force?
25. What is magnetic force?
26. What type of force is involved in each of the following?
    a. spring-wound clock
    b. flashlight battery
    c. atomic explosion
    d. bicycle brake
    e. shooting an arrow
    f. nuclear reactor
    g. hydroelectric plant
    h. paper cutter
    i. Earth orbiting the sun
    j. Directional compass

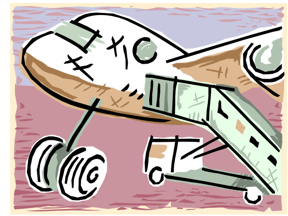
Assessment/Worksheet/Research KEY Name: ________KEY___________

1. a push or a pull on any object
2. mechanical
3. the pull of an object on any other object
4. Mass is the amount of matter an object contains.
5. Earth, because the more mass an object has, the more its gravitational attraction.
6. decreased
7. center of mass and center of gravity
8. the measure of the pull of gravity on an object
9. Weight. Because the moon has less mass than Earth, it has weaker gravitational pull. Therefore you weigh less.
10. Pluto. It has the smallest mass.
11. Kilogram
12. Newton
13. The force that resists motion.
14. Friction keeps your foot from slipping.
15. Friction keeps the tires pushing against the road.
16. static, sliding, rolling
17. static
18. sliding and rolling
19. using lubricants, sanding, etc.
20. By applying more pressure and by making the surface rougher.
21. the force created by the movement of electrons.
22. Current electricity is a continuous flow of electrons; static is a sudden flow like lightning of static shock.
23. The force created when stretched objects return to their original shape.
24. The force that holds protons together in the nucleus.
25. The attraction between two magnetic objects.
26. a. elastic b. nuclear/electrical c. nuclear d. mechanical/friction

e. elastic f. nuclear g. electrical/mechanical/magnetic h. mechanical

i. gravitational j. magnetic

FORCES—Part 2
Motion and Forces: Basic Motion



Essential Learning Elements:

1. Define and use correctly the terms of motion.
2. Describe and compare types of force and motion.
3. Explain the operation of a single mechanical device and its relation to work and power.
4. Describe and compare types of force and motion.
5. Define and use correctly the terms of motion: velocity, speed, acceleration, momentum.

Learning Points:

1. Define motion.
2. Distinguish between balanced and unbalanced forces.
3. Distinguish between distance and displacement.
4. Explain the difference between speed and velocity.
5. Explain acceleration.
6. Identify momentum.

Resources and Instructional Ideas:

1. *Explore God's World*, ch.14, 310-326

Spiritual Applications: **These have not been fully developed.

1. Genesis 1:1,7
2. *Testimonies for the Church*-pg. 69
3. Elastic force: God draws Him to us like elastic force: John 12:32
4. Nuclear force: God put great force in the small atom. Review the story of David and Goliath.
5. Magnetism: the drawing/attracting power of God's love.
6. Electricity: We should be good "conductors" of His spirit in us.
7. Jesus the way and direction. Velocity is speed over time in a certain direction. Acceleration is how fast we speed up. Our surrendering to Him determines how quickly we grow spiritually, how fast we become like Him, and the direction we go.
8. Spiritually, we need to continue in the right direction without outside influence.

Lesson 6: Basics of Motion— Displacement and Distance

Introduction: Have each student take an object (perhaps a pencil) and move it back and forth in front of him/herself while watching it. Does the object appear to be moving? (yes)

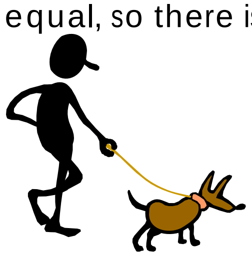
Now take the same object; hold it in front of you as you walk a short distance. Keep your eye on the object. Does it still appear to be moving? (No) Yet you know it has moved.

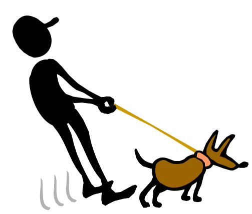
You experience the same phenomenon in the car. You see trees and fence posts moving by. They appear to be moving, and yet you know that it is YOU who are moving.

When an object changes position in relation to another object or point, the object is said to be moving or in motion. Motion is not always as it appears. It depends on your frame of reference. In fact, the objects all around you that appear to be motionless are moving nearly 1600 km/hr due to Earth's rotational speed.

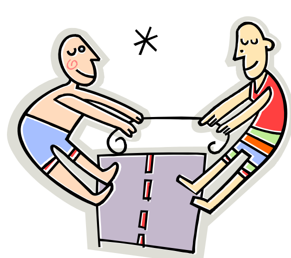
All motions results from a force, either a push or a pull that moves an object. Basketballs move from a throwing push force. Soccer balls move because they are kicked. Balls can roll downhill from the force of gravity pulling them down.

Have you ever played tug-of-war? If both teams are equally matched, nobody will move, and the pulling involved is balanced. Balanced forces pull in opposite directions but are equal, so there is no motion.





If one team pulls with a greater force, though, the pulling becomes unbalanced. Unbalanced forces can also pull in opposite directions, but if the forces are unequal, there is a change in motion. Airplanes and cars use unbalanced forces to move.



Besides moving, there are two other aspects of motion. These are a change in distance and displacement. Distance is the total length of travel.

Suppose you start at the front door of the school and run around it, coming back to the door. You ran maybe 500 yards. You definitely went a distance. But you ended back where you started. You haven't gone anywhere. Your displacement is zero. Displacement is the span between the starting and finishing point along a straight line.

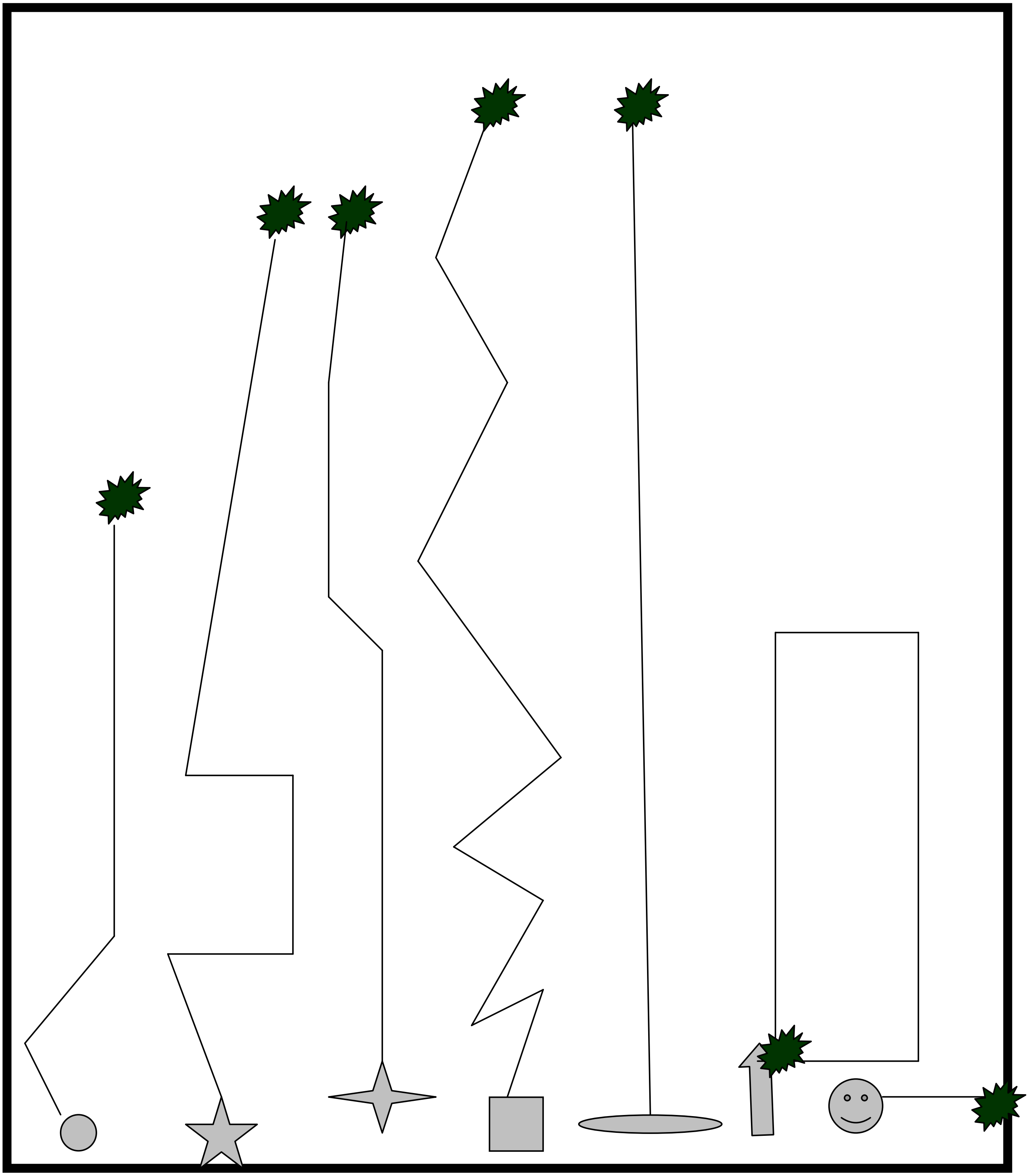
Use a centimeter/millimeter ruler to measure both distance and displacement. You should notice that distances can be the same, but displacement can be very different. The shortest distance between two points is a straight line.

Find out what Galileo discovered about the rate of falling objects and how he measured it. How did he use the Leaning Tower of Pisa, Italy?

Pg. 321, *Explore God's World.*

DISPLACEMENT and DISTANCE name:____________________

For each pathway, find the displacement and the distance in centimeters and millimeters.



Lesson 7: Measuring Motion

Speed is the rate of motion, which is calculated by dividing the distance by the time it took to go that distance. You use it all the time: the speed limit is 55 miles (the distance) per hour (the time).

The mathematical formula is **Speed = distance / time**

Please be careful to always keep the units. Because speed can be inches per minute or miles per second or centimeters per hours. There must be a distance unit AND a time unit.

SPEED EQUATION Example:
June went 5.7 miles in 30 minutes. What was her speed?

Speed = distance/time = 5.7 miles / 30 minutes = .19 miles per minute.

All moving objects have a speed that can be measured. Another measurement is **Velocity**. **Velocity is both the speed and the direction that an object is moving.** So while 55 mph is the speed, 55 mph northeast is a velocity because it has a direction.

You may be interested in owning a car that can go from zero to 60 in 3 seconds. That means that the car can go from a stop or from very slowly to very fast rapidly. This is called acceleration. Any change to a faster speed is called acceleration. It is calculated by the following:

Acceleration = change in speed / Time

ACCELERATION EQUATION Example:
Max went from 10 mps to 25 mps in 5 seconds. What was his acceleration?

Acceleration = change in speed/time = 25-10/5 = 15 meters per second/5 sec. = 3 meters per second

Faster, Faster

Name: ____________________

Investigation: How does the height of release affect the speed of a marble?

Supplies: A ramp made from corner molding at least 1.5 meters long. (You can use a ruler with a track in the center, but it is much harder to catch the movement.)

Clay and something to raise the ramp.
Meterstick
Marbles
Stopwatch
Calculator
Record sheet

Procedure:

1. Form a group of four students. One member will raise the ramp, one will release the marble, one will use the stopwatch, and one will measure the distance the marble rolls in two seconds. Find a hard surface that provides a level distance that will allow the marbles to roll quite a distance.
2. Use the corner molding to construct a ramp that is 2 cm. high. Clay can be used to stabilize it .
3. From the top of the ramp, roll the marble down onto the level surface. Determine the distance the marble rolls FROM THE BOTTOM OF THE RAMP in 2 seconds. Record.
4. Repeat each trial two more times and record.
5. Figure the distance and the speed, and then average.
6. Next, raise the ramp to 4 cm. and repeat.
7. Finally, lower the ramp to a height of 1 centimeter and repeat.

DATA Chart: Remember, the time is 2 seconds.

Ramp Height	**Distance**	**Speed**
2cm—Trial 1		
Trial 2		
Trial 3		
2 cm—average		
4 cm—Trial 1		
Trial 2		
Trial 3		
4 cm--average		
1 cm—Trial 1		
Trial 2		
Trial 3		
1 cm--average		

Use your results to answer the following questions on the following page.

Faster, Faster Questions Based on Data

Name: ____________________

1. What was the marble's slowest speed?

   ____

2. What was the marble's fastest speed?

   ____

3. What is the overall average speed of the marble? (Average the three averages.)

   ____

4. If you leave the height of the ramp the same, what could you do to increase the speed of the marble?

   ____
   ____
   ____
   ____

5. Based on your data, predict what would happen to the distance and speed if you raised the ramp height to 10 cm.

   ____
   ____
   ____

6. In this experiment, what three factors remained the same?

   ____
   ____

7. For an experiment to be valid, all factors except one must remain the same. Only one factor can change. Which factor changed in this experiment?

   ____

8. If you would build a wheelchair ramp, you would want the wheelchair to go down slowly. If you built a skateboard ramp, you would probably want more speed. Based on your observations, which ramp should be higher (steeper) and which one should be lower (flatter)?

   ____
   ____
   ____
   ____

Faster, Faster Questions Based on Data

Name: _____KEY_________

1. What was the marble's slowest speed? Answers will vary
2. What was the marble's fastest speed? Answers will vary.
3. What is the overall average speed of the marble? (Average the three averages.)____________________Answers will vary____________________________
4. If you leave the height of the ramp the same, what could you do to increase the speed of the marble? _______________reduce friction somehow by waxing the ramp or sanding or shellacking the ramp. ______________________________
5. Based on your data, predict what would happen to the distance and speed if you raised the ramp height to 10 cm. The distance and the speed should increase.
6. In this experiment, what three factors remained the same? The lenghth of the the ramp, the marble, the timing.
7. For an experiment to be valid, all factors except one must remain the same. Only one factor can change. Which factor changed in this experiment? _The height (slope) of the ramp.____

8. If you would build a wheelchair ramp, you would want the wheelchair to go down slowly. If you built a skateboard ramp, you would probably want more speed. Based on your observations, which ramp should be higher (steeper) and which one should be lower (flatter)?

____A wheelchair ramp should not be high or steep. A skateboard ramp should be higher for greater speed and distance. _________

Lesson 8: Momentum

Another measure of motion is called momentum. Momentum depends on the mass of an object and its velocity. For example, if a ping-pong ball with a velocity of 30 m/sec strikes your hand, it bounces off rather harmlessly. But if a baseball going the same velocity of 30 m/sec strikes your hand, it causes pain.

The different effects are caused by the different mass of each object. If instead of hitting your hand, they both hit a window, the ping-pong ball would bounce off, but the baseball would break the glass.

The baseball has more momentum than a ping-pong ball. Due to its greater mass, it takes more force to get the baseball up to speed than it does for the ping-pong ball.

MOMENTUM EQUATION
Mass x velocity = momentum

Examples:
Ping-pong ball. 0.005 kg. x 30 m/sec = 0.15 kg m/sec
Baseball 0.140 kg x 30 m/sec = 4.20 kg m/sec

SPEED ZONE

Name: ___________________________

Investigation: How speedy is the class?

- **Materials**:
  - A 50 meter course laid out with a start and finish line. ***(You may use a different length for the course as long as you know what it is.)***
  - Stopwatch
  - Record sheet with the names of the class
  - The students in the class

Procedure: Record the **running times** for the course for each member of the class. These can be done several at a time if you have enough stopwatches.

Record the **fast walking times** for the course for each member of the class.

Data: distance is 50 meters (or your number)

Determine each person's speed by using the speed equation:

Speed (S) = time (T) / distance (D)

Student	Time	Speed

1. How is speed calculated?
2. Generally speaking, who had the best times, boys or girls? Older or younger students?
3. What was the different between the average speed walking and the average speed running?
4. What was the fastest running speed?
5. What was the slowest running speed?
6. What was the fastest walking speed?
7. What was the slowest walking speed?
8. Suppose the course was longer. What do you think would have happened to the speeds?
9. Suppose the course was shorter. What do you think would have happened to the speeds?

Vocabulary Development

Name: ____________________

Match the vocabulary word with its definition:
This can be done on a sheet or cut them into "sticks" and match the sticks.

Vocabulary word:	Definition:
a. acceleration	_____ 1. the rate of motion
b. balanced force	_____ 2. Newton's third law
c. displacement	_____ 3. both the speed and direction
d. distance	_____ 4. equal and opposite, no motion
e. law of action/ reaction	_____ 5. any change in speed
f. law of acceleration	_____ 6. occurs when any two objects change position relative to each other.
g. law of inertia	_____ 7. distance from starting point to ending point when an object travels
h. law of the conservation of momentum	_____ 8. unequal and opposite, cause motion
i. momentum	_____ 9. depends on the mass of an object and its velocity
j. motion	_____10. Objects are lazy. They want to keep doing what they are already doing.
k. speed	_____ 11. Total length of an object's travel
l. unbalanced force	_____ 12. A boy pushes a sailboat; it would accelerate and move away.
m. velocity	_____ 13. Momentum is not lost, only transferred.

Vocabulary Development KEY

Match the vocabulary word with its definition:
This can be done on a sheet or cut them into "sticks" and match the sticks.

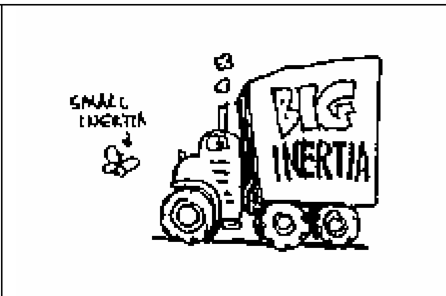
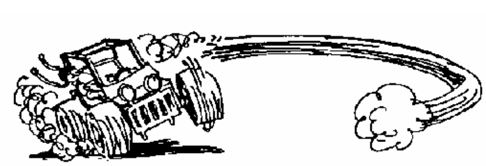
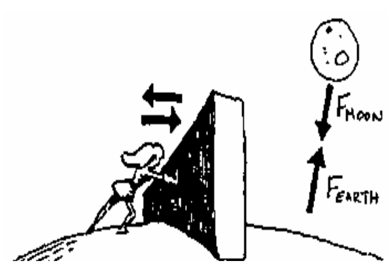
Vocabulary word:	Definition:
n. acceleration	__k___ 1. the rate of motion
o. balanced force	___e__ 2. Newton's third law
p. displacement	__m__ 3. both the speed and direction
q. distance	__b___ 4. equal and opposite, no motion
r. law of action/reaction	___a__ 5. any change in speed
s. law of acceleration	__j___ 6. occurs when any two objects change position relative to each other.
t. law of inertia	__c__ 7. distance from starting point to ending point when an object travels
u. law of the conservation of momentum	___l__ 8. unequal and opposite, cause motion
v. momentum	__g__ 9. depends on the mass of an object and its velocity
w. motion	___d__10. Objects are lazy. They want to keep doing what they are already doing.
x. speed	__f___ 11. Total length of an object's travel
y. unbalanced force	__h__ 12. A boy pushes a sailboat; it would accelerate and move away.
z. velocity	_____ 13. Momentum is not lost, only transferred.

Lesson 9: The Laws of Motion

Note: There is a powerpoint available: "Newton's Three Laws of Motion".

In 1665, Sir Isaac Newton discovered three different laws of motion to help describe how moving objects behave.

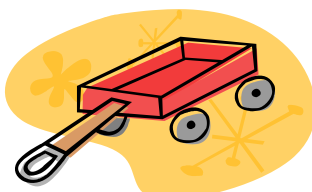
The laws of motion

Law of Inertia (Law 1)	Moving objects keep moving, and resting objects remain at rest unless acted upon by an unbalanced force.	
Law of Acceleration (Law 2)	The acceleration of an object is determined by its mass and the size of the unbalanced force.	
Law of Action and Reaction (Law 3)	For every action, there is an equal and opposite reaction.	

The Laws of Motion

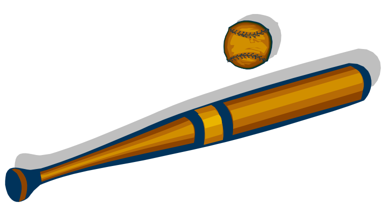
The **law of inertia** is also known as the **first law of motion.** It states that unless an object at rest is acted upon by an unbalanced force, it will stay at rest. And an object in motion will remain in motion.

This property of matter is called **inertia.** Objects act as if they are lazy. They want to keep on what they are already doing. They want to keep going in a straight line. It takes a harder push to get an object moving than to keep it in motion. Inertia also depends on its mass. It takes a lot more force to pull a car than a little red wagon!



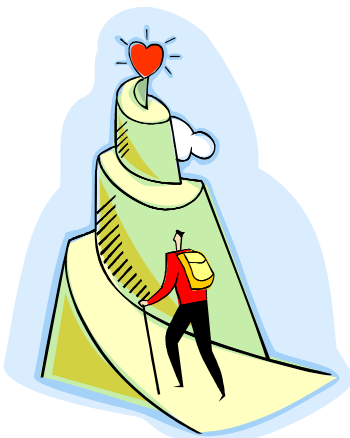
The **law of acceleration** is the **second law of motion.** This states that acceleration of an object depends on the ***mass*** of the object and the ***size of the force*** acting on the object. **Acceleration can be increased by either increasing the force or by decreasing the mass.**

Think of ways this applies to real life. You can't change the weight of a baseball, but you can get a stronger baseball pitcher. If you want a car to go faster, you can either increase the force (bigger engine) or reduce its mass.



The **third law of motion** is called the **law of action/reaction**. For every action there is an equal and opposite reaction. If you kick a boulder, you will learn about this law. When your foot kicks that boulder, the boulder kicks back.

When you walk, your foot pushes against the ground, and the ground pushes back. This allows you to move. When you walk in sand, though, the sand will slip and collapse until it is compacted enough to push back with a force equal to your weight.



Remember, there are always other forces at work. You may think that your muscles are providing the force needed to propel your bike. However, your bike is also being acted upon by friction, gravity, wind resistance, etc.

Suppose you want to design a rocket to hit a target in the sky. You must work with the mass of the rocket, the three laws of motion, the movements of the Earth, the drag of the air, the gravity pulling down, the movement of the target, predictions of position……it takes a lot of science and mathematics to hit that target!

Another Law: The law of the conservation of momentum.

This law states that momentum is neither gained nor lost during a collision of two or more objects. When dealing with several objects bouncing off each other (for example, when playing pool), the total momentum just after the collisions is split among the different objects, but it totals the same. However, in many cases gravity or friction will make objects slow down or stop. A small amount of momentum will be transferred elsewhere. So there may be a slight difference in momentum before and after.

Newton's Cradle

Resources: These resources are found at the following site, or by going through homeschooling.about.com. They are quite good.

The easy way to check out these links is to open this document in Word, click on the link and the CTRL button, and it will to right to the site. If not, find this page at the following place:

http://homeschooling.about.com/od/freeprintables/ss/newtonlawsprint.htm

Printables

- Newton's Laws of Motion Printable Pages - Have fun learning about Newton's Laws of Motion with these worksheets and activity pages.

Lessons

- Newton's Laws - Newton's Laws of Motion are presented in this online physics tutorial complete with animations and questions to check understanding.

Music

- Ballad Of Sir Isaac Newton - This song is from a collection of Singing Science Records from the 1950's/1960's provided by Jef Poskanzer.

Games

- Acceleration - Watch as you fill out the chart to see how mass, force, and acceleration are related. When you are done see if you can write a rule.
- 3 Puck Cluck - A game of collisions and decisions.
- 3 Ball Football - Try your hand at some real world collisions and decisions.

Projects

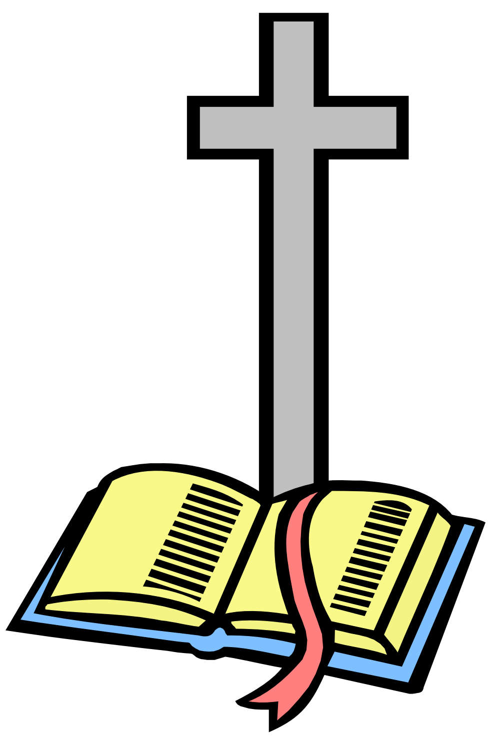
- Marble on the Move - Make a maze and use a marble to investigate Newton's laws of motion.
- Bumper Cars - Newton's third law of motion comes into play on the bumper cars.

RESEARCH these questions:

1. When does an object have no momentum?
2. How do seat belts help to balance forces?
3. Can a moving object have velocity but no accelerations?
4. Why is the gas pedal of a car called the accelerator?
5. In order for a moving bowling ball and a moving ping-pong ball to have the same momentum, what must happen to the speed of both balls?
6. When would you use your muscles in an unbalanced way?
7. Why is displacement usually less than distance?
8. If two objects move together, is there any motion?
9. Is deceleration a type of acceleration?

10. How are velocity and speed different?
11. What could you do to have your muscles create balanced forces?
12. Suppose you and your best friend travel from Boston, MA. To San Diego. You make the trip by car. Your friend makes the trip by train. Who travels the greatest distance? Who has the greatest displacement? Draw a sketch and explain.
13. Recite, illustrate, or write the three laws of motion.
14. Recite, illustrate, or write the law of the conservation of momentum.

BIBLE AND WORSHIP



Bible: **ANT POWER**

Proverbs 6: 6-8

"Go to the ant, you sluggard, consider its ways and be wise! It has no commander, no overseer or ruler, yet it stores its provisions in summer and gathers its food at harvest."

OBJECTIVE: Students will learn that God encourages us to work hard and to cooperate with each other.

MATERIALS: Bibles, dictionaries, ant pictures, honey or sugar, a box for each small group, sheets of newspaper, tape for each group.

BEFORE CLASS: If possible, locate an anthill outside and pour some sugar or honey around it.

Divide the class into small groups. Each group needs Bibles and dictionaries.

Show a picture of an ant. Who can tell me what this is?

The Bible talks about ants. **Turn to Proverbs 6: 6-8**. If possible, read the verses in several different versions. Now have each group define the following terms: **sluggard, overseer, provisions, and harvest.** Then share the definitions with the class.

How many of you have ever watched an ant work? Many of us have. This Bible verse tells us that God wants us to spend some time watching ants. (If possible, at this point go outside and watch the ants where you have put the sugar or honey.)

Does one ant tell the others to work or where to go?
Are there groups of ants that just stand around and watch?
How do ants work?

Ants spend all summer gathering and storing food for the winter. In the winter they gather together, sleep, clean, repair their tunnels, and eat the food they stored. What would happen if the ants sat around all summer relaxing and didn't store food?

What are some lessons we can learn by watching ants work?
(working together, preparing for emergencies or less fortunate times, cooperation gets a job done, don't be lazy)

Distribute boxes, a pieces of newspaper, scissors, and tape to the groups.

. . . Ant Power

Instructions: Put one hand behind your back and leave it there. At the word GO, your group will wrap the package in the newspaper as fast as you can. Work together, but you may only use ONE of your hands.

What were some of the difficult things about wrapping the box?
How did it feel to work together? Did it get easier the longer you worked?
Could you have wrapped the box totally by yourself?

Ant hills can contain hundreds to thousands of ants. Imagine if the ants didn't work together, and only a few ants did all the work. The ant colony would not survive. There are times in our lives for working, and times for relaxing and having fun. Don't mix the two up! And remember, working steadily and together gets a lot more done.

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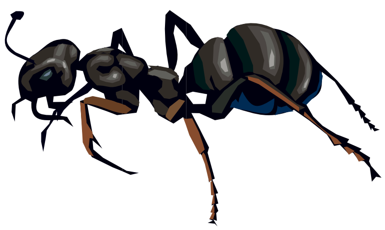
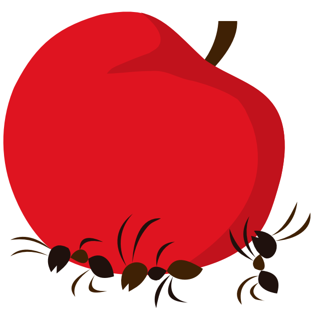




SOME ANT FACTS

Ants range from one inch in size down to size of a printed "I".

Ants can carry loads many times heavier than themselves.

More ants live on earth than any other insect.

Ants live in groups called colonies. Thousands of ants live in one ant hill.

Ants help to turn over soil and break it up. They also kill other insect pests such as termites and aphids.

Queen ants are females that lay the eggs. Usually a colony has only one queen, but some may have two or three. They are the largest ants in the family.

Male ants usually have wings. They do not do the work; their only job is to mate with the queen. They live only a few weeks.

Female ants: Most female ants are workers. They serve as nurses, food gatherers and soldiers.


mongabay.com

Bible: **Red and White Power**

Isaiah 1:18

"Though your sins are like scarlet, they shall be as white as snow."

Objective: Students will ponder how completely God forgives our sin through Jesus' death on the cross.

Materials: Bible, white cotton cloth, squirt bottle with bleach in it labeled "Jesus," iodine.

The Bible says that every person on Earth has sinned. Read Romans 3:23. This verse is telling you that no matter how good you think you have been, you have sinned. Our pastor has sinned. Your mother and father and sisters and brothers have sinned. Sin makes our lives dirty and unholy. Sin keeps us from knowing God like we could.

(Make sure that each student can see what you do next. Lay out the cloth. You will want to put a tray or plate under it.)

I am going to use this red coloring to represent sin. Can you name some sins?
(Each time a child names a sin, put a spot of color on the white cloth. Iodine works the best, although you can try red food coloring. Do about five. An alternative would be to use spots representative of each child: "This is Kari's sin, this is Tommy's sin.")

God has an answer to sin. He sent His son, Jesus Christ, to the earth to be born as a baby. Jesus didn't sin. He didn't lie, steal, or kick his pets. He is the only person who ever lived who never committed a sin.

Then He died on the cross to pay for our sins. We cannot remove our sins. But Jesus can. When we ask God to forgive our sins, Jesus makes our lives clean and pure again, and we become one of His children.

Now, let's see what happens when we use this bottle called "Jesus."
(Squirt some bleach at a place where there is no stain, so that the students can see that it is clear. Now start squirting it on the stains. They should start to disappear.)

No matter how stained your life has become, or how many times you have sinned, Jesus can always make you clean again.

Bible: ***Steps to Christ,*** **p. 47-48, topic: Human Will**

"Many are inquiring, *"How* am I to make the surrender of myself to God?" You desire to give yourself to Him, but you are weak in moral power, in slavery to doubt, and controlled by the habits of your life of sin. Your promises and resolutions are like ropes of sand. You cannot control your thoughts, your impulses, your affections. The knowledge of your broken promises and forfeited pledges weakens your confidence in your own sincerity, and causes you to feel that God cannot accept you; but you need not despair. What you need to understand is the true force of the will. This is the governing power in the nature of man, ***the power of decision, or of choice***. Everything depends on the right action of the will. ***The power of choice God has given to men; it is theirs to exercise. You cannot change your heart, you cannot of yourself give to God its affections; but you can choose to serve Him. You can give Him your will; He will then work in you to will and to do according to His good pleasure.*** Thus your whole nature will be brought under the control of the Spirit of Christ; your affections will be centered upon Him, your thoughts will be in harmony with Him.

Desires for goodness and holiness are right as far as they go; but if you stop here, they will avail nothing. Many will be lost while hoping and desiring to be Christians. They do not come to the point of yielding the will to God. They do not now *choose* to be Christians.

Through the right exercise of the will, an entire change may be made in your life. By yielding up your will to Christ, you ally yourself with the power that is above all principalities and powers. You will have strength from above to hold you steadfast, and thus ***through constant surrender to God*** you will be enabled to live the new life, even the life of faith."

Bible Memory Verse
Matthew 5:41, 42

41 And whosoever shall compel you to
go a mile, go with him two.

42 Give to him that asks you,
and from him that would borrow
of you turn not away.

Bible: Memory Verse

Ephesians 6:12†(NIV)

12 For our struggle is not
against flesh and blood,
but against the rulers,
against the authorities,
against the powers
of this dark world and
against the spiritual forces of evil
in the heavenly realms.

WORSHIP/BIBLE

Genesis 1:1, 7

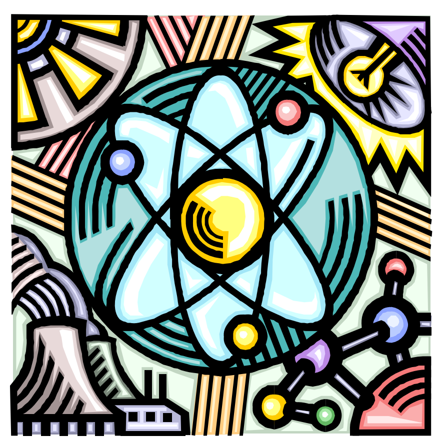
"In the beginning God created the heavens and the earth....And God made the expanse, and separated the waters which were below the expanse from the waters which were above the expanse, and it was so."

Physics is the study of the interaction among the forces built into our Universe. On first glance these forces appear simple: throw a ball into the air and it will come back down. But the interplay of these forces is incredibly complex.

In the 1930s, scientists discovered that the atom was tied together with enormous power. Reluctantly, scientists such as Einstein worked on a way to release this energy in order to defeat Nazi Germany. This research culminated when two atomic bombs were dropped on Japan in 1945. The enormous energy generated by this atom-splitting brings forth the question: "How great is a God who can squeeze all that energy into a few atoms?"

Although we have been able to use nuclear energy for peaceful purposes such as electricity, we still don't know much about it. We have not been able to use it without terrible risks and danger.

Somehow God works with this energy without explosions or radiation. Perhaps some day He will allow you to discover some of its secrets to be used for peaceful purposes such as heating, lighting, and transportation.



BIBLE: Memory Verse/worship

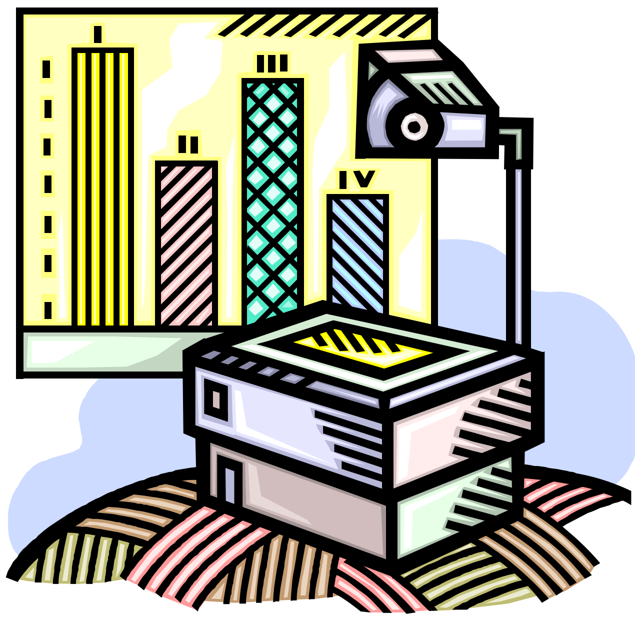
"And I, if I be lifted up from the earth, will draw all men to Myself."
John 12:32

Glimpses of Jesus can be found throughout His creation. His love for us will expand and stretch like elastic. This love for us is a powerful magnet drawing us to Him, if we will not resist. Like a good electric line, we should conduct His Spirit to others.

Jesus is the way and gives direction to our lives. Speed over time in a certain direction is called velocity. Acceleration is going faster and faster. When we surrender to Him we begin to quickly grow spiritually. Our direction changes to move us toward Him.

Our walk with Jesus may sometimes seem narrow and unpleasant, but in the end it is the best way. Jesus is the ONLY way to live with real peace and love. His Lordship and control over the forces in our world show only a small fraction of the power that He can demonstrate in your life if you let Him.

POSTERS

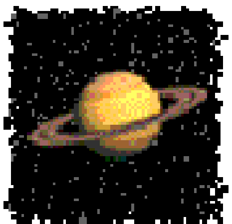


Resource posters for the Unit

FACT SHEET

FORCE—a push or pull on an object.

MASS—the amount of matter that makes up an object.
Under normal conditions mass does not vary.




GRAVITY—the pull of matter on matter.
The greater the mass of an object, the greater the gravitational attraction it exerts on another object.

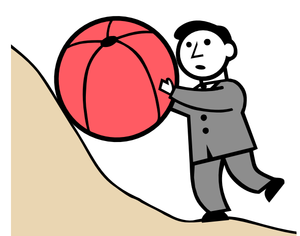
Small mass = small gravitational attraction
Large mass = large gravitational attraction

The closer an object is to another object's center of gravity, the greater the gravitational attraction it exerts.

WEIGHT—a measure of the force of gravitational attraction.
An object's weight varies (unlike mass) depending on its mass and the distance between it and the center of gravity of another object.

At the top of the mountain the ball weighs 9 kg.

At the bottom it weighs 10 kg.

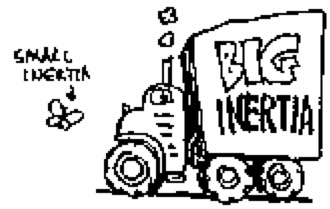
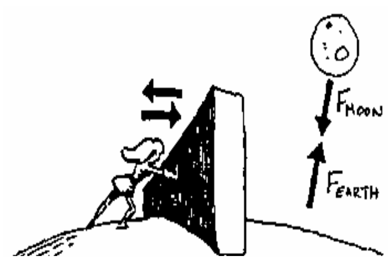


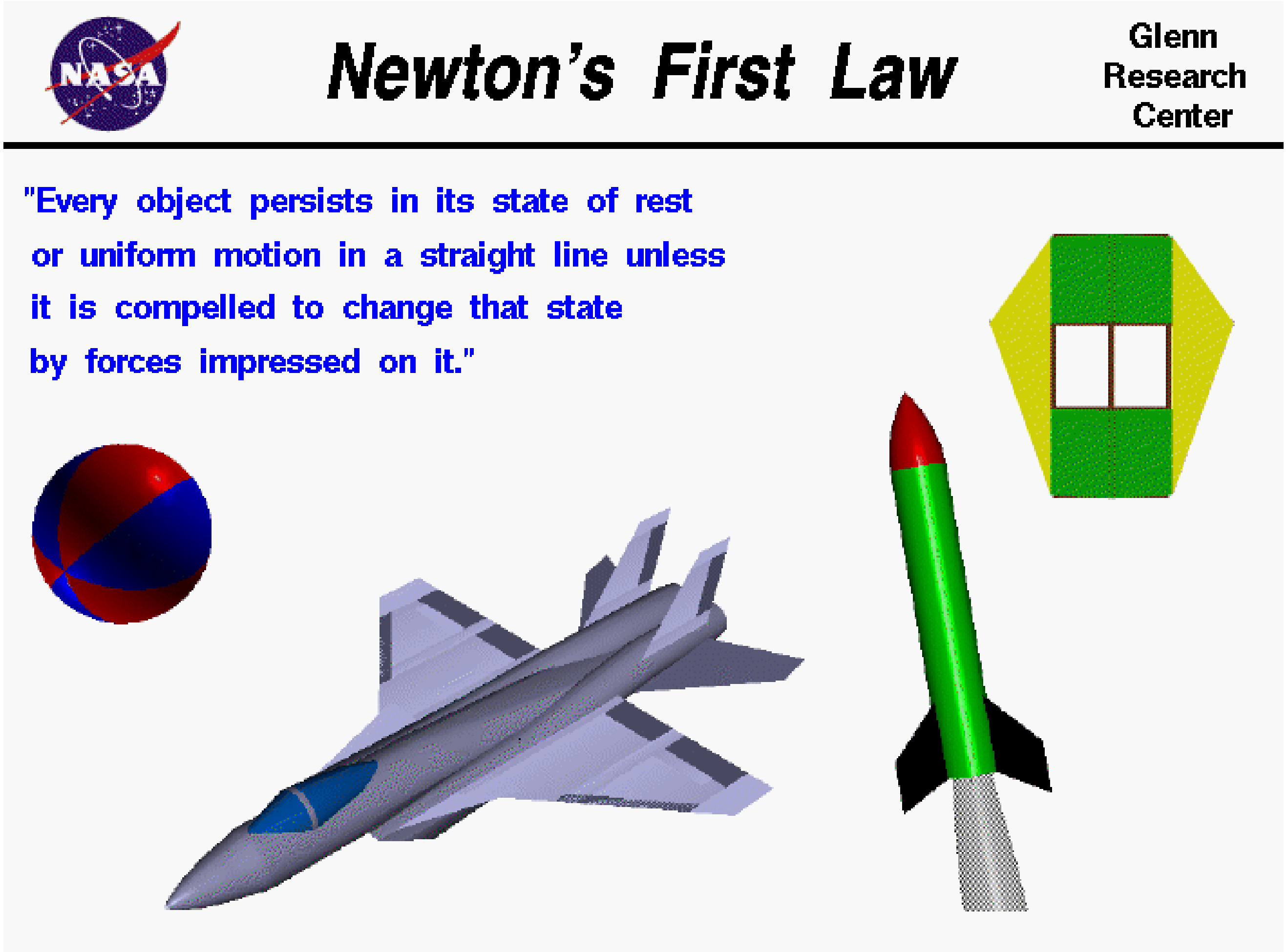
TYPES OF FRICTION

Fact Sheet

	**STATIC FRICTION** Created when two nonmoving surfaces are in contact. Holds things in place.
	**SLIDING FRICTION** Created when two surfaces slide past one another. Caused by any sliding motion. Creates heat and wear.
	**ROLLING FRICTION** Created when the surface of a round object rolls over any other surface. Caused by any rolling motion. Creates heat and wear.

The laws of motion

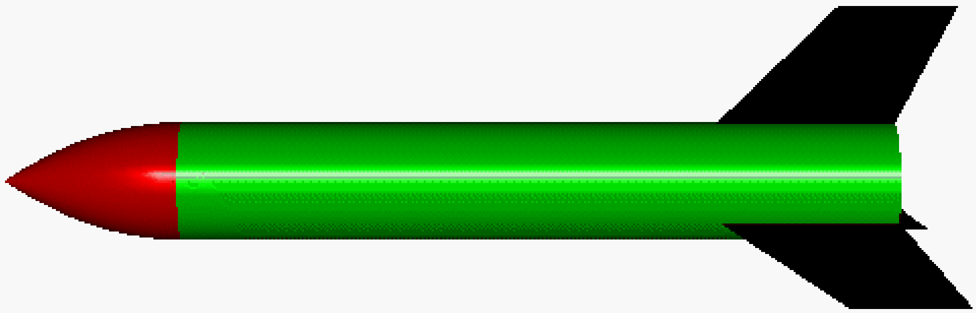
Law of Inertia (Law 1)	Moving objects keep moving, and resting objects remain at rest unless acted upon by an unbalanced force.	
Law of Acceleration (Law 2)	The acceleration of an object is determined by its mass and the size of the unbalanced force.	
Law of Action and Reaction (Law 3)	For every action, there is an equal and opposite reaction.	



1st Law: A body in motion tends to stay in motion, and a body at rest stays at rest, unless acted upon by an outside force. This is called inertia.

Newton's Second Law

Definitions



Differential Form: Force = change of momentum with change of time $F = \frac{d(mv)}{dt}$

or:

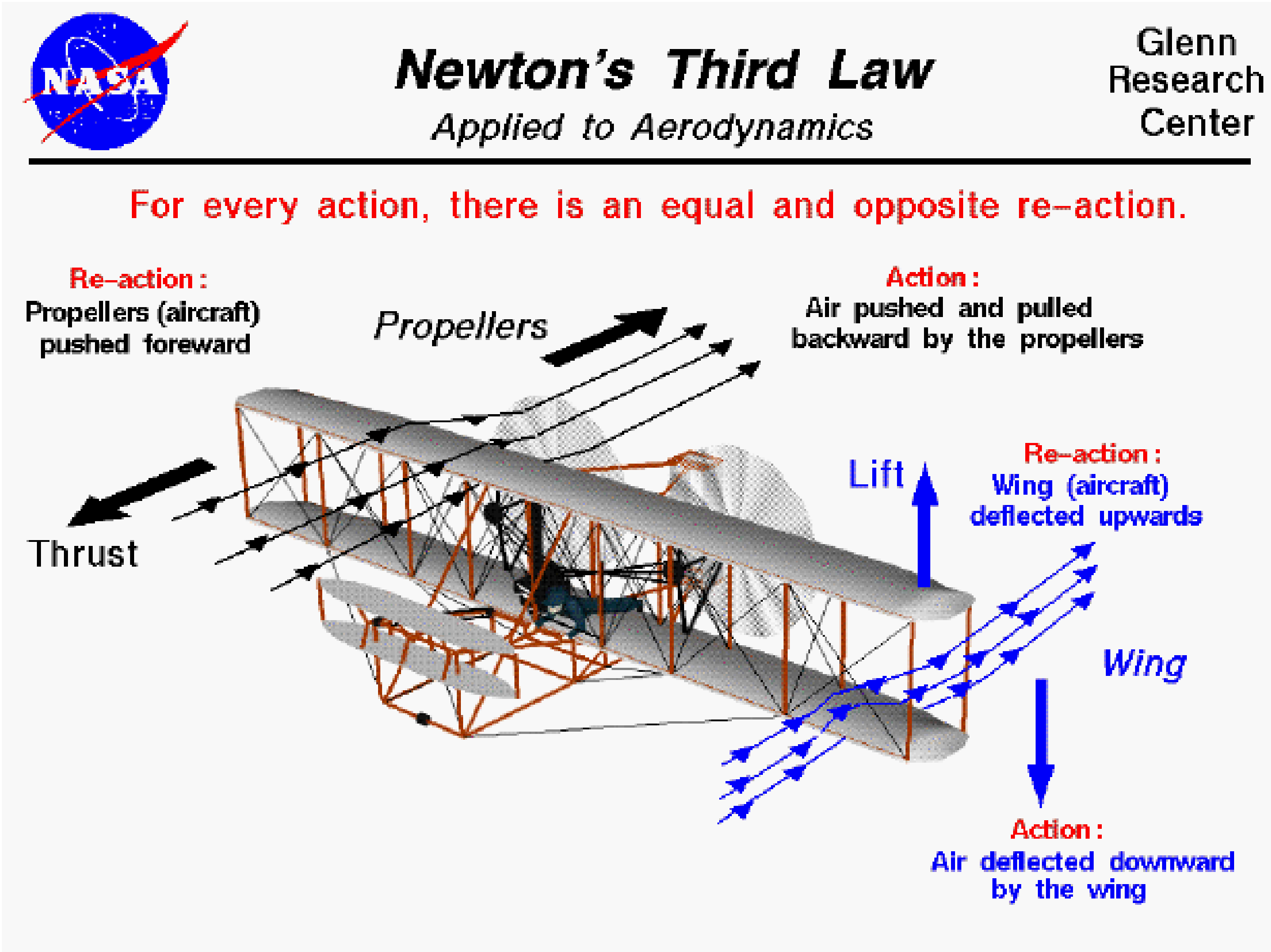
Force = change in mass X velocity with time $F = \frac{(m_1V_1 - m_0V_0)}{(t_1 - t_0)}$

With mass constant: Force = mass X acceleration $F = m\,a$

Force, acceleration, momentum and velocity are all vector quantities.

Each has both a magnitude and a direction.

2nd Law: The acceleration of an object is determined by its mass and the size of the unbalanced force.



3rd Law: For every action, there is an equal and opposite reaction.