DON'T TRY THIS AT HOME!

Teacher Resource Manual

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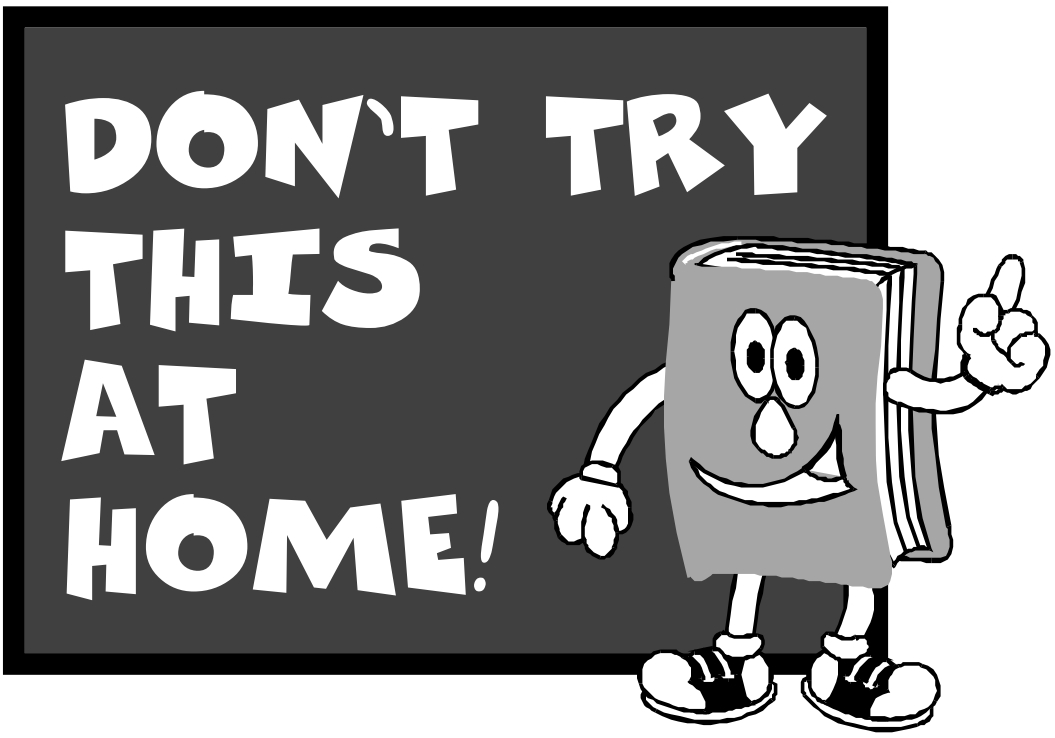


Teacher Resource Manual

Forward

The Mad Science Group® has been providing live, interactive, exciting science experiences for children throughout the world for over 12 years. Founded in Montreal, Canada, Mad Science currently has over 120 offices throughout the world. It specializes in combining textbook theory with dazzling spectacles of sight and sound.

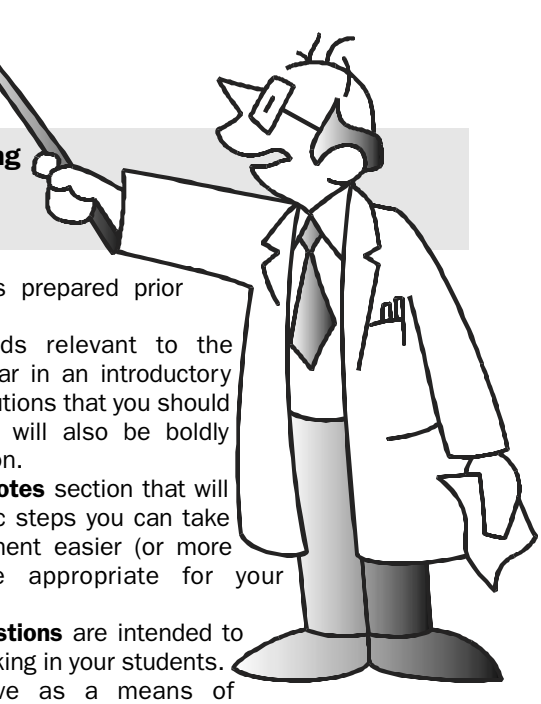
Mad Science Productions, a division of the Mad Science Group, remains faithful to the vision of advancing scientific literacy among today's youth. Our commitment to science education is what has encouraged us to provide this supplemental educator handbook.

We hope that you will find this manual a useful educational tool for you and your students. Our goal is to make our science shows a truly enriching experience.

Happy Science Teaching!

Kathy Siciliano
Marketing and Sales Coordinator
Mad Science Productions

How to best use this manual



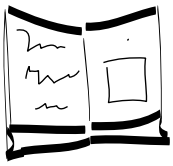
The Teacher Resource Manual is a handbook that defines lesson plans relating to our show's concept. Written with the elementary school child in mind, it offers theoretical science concepts and complete hands–on activities.

The Teacher Resource Manual is specifically designed to help you, the educator, enhance the teaching of chemistry and physics units in your classroom. The experiments presented along with the ones that you saw on stage, will capture the attention of your students so that they can become genuinely interested in learning about chemistry and physics and how theyaffect their lives and the ever-changing world around them.

Lesson Plans

In each section you will find complete lesson plans, which include introductions to the subject matter, educational objectives, vocabulary words and fun facts, experiments, explanations and background information. All of these will help you teach a thorough and well-developed lesson. These lessons are set up so that all the materials that you need are in the manual.

Educational Objectives



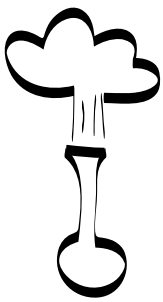
Each lesson plan outlines an educational objective which correlates the National Science Education Standards and the Canadian Common Frameworks of Science Learning Outcomes. They have been referenced at the end of the manual for your convenience.

Vocabulary and Fun Facts

The definitions in the vocabulary section are written so that you (the teacher), may provide background information related to chemistry and physics. Adapt them as you see fit depending upon the level and ability of your students. The main vocabulary section at the beginning of the lessons has vocabulary words that pertain to the entire unit. You will also find a list of vocabulary words that are relevant to each experiment.

In addition to the definitions of the technical terms, we have also provided some fun facts for specified words. These will provide additional information for your students and will make your science lesson more fun

Experiments



You will find a series of experiments grouped with their appropriate lesson which contain the following information:

1.) Each experiment outlines the estimated **Time** the experiment will take (this can always be adapted depending on the amount of explanation you want to provide or whether you want to demonstrate the experiment or have all the children experiment).
2.) A **Materials** list will help you to supply the appropriate materials prepared prior to class.
3.) **Vocabulary** words relevant to the experiment will appear in an introductory list. Any safety precautions that you should be concerned about will also be boldly outlined in this section.
4.) There is also a **Notes** section that will inform you of specific steps you can take to make the experiment easier (or more difficult) and more appropriate for your students' abilities.
5.) **Introductory Questions** are intended to stimulate critical thinking in your students. They will also serve as a means of engaging them in the scientific process, because science is about asking questions and discovering answers.
6.) The **Procedure** will provide step-by-step instructions on how to do the experiment.
7.) **Wrap-up Questions** are intended to ensure that your students understood the experiments by identifying any concepts that were unclear.
8.) The **Simple Explanation** explains the experiment in simple and precise terminology.
9.) The **Extended Explanation** is designed to provide additional information not only about the experiment, but also for a broader understanding of the concepts presented.
10.) The **Concept Emphasis by Age** section of each experiment will help to develop age appropriate lessons by indicating activities for different grade levels.

Background Information

This section of the manual provides additional knowledge about the general subjects of chemistry (Molecules and More) and physics (Fabulous Physics). Use the background information section as a resource to aid in answering questions that the students, or even you, may have.

Extension Ideas

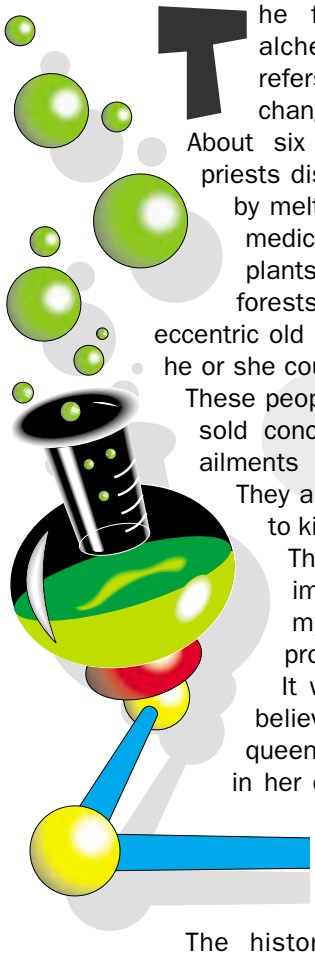
Here you will find ideas to expand a science unit on chemistry and physics into other subject areas such as language arts, math, art, and social studies.

Content Standards

In this section you will see how the Mad Science Productions show "Don't Try This At Home" in combination with this Teacher Resource Manual, helps you to fulfill content standards based on both the National Science Education Standards by the National Research Council in the USA and the Canadian Common Frameworks of Science Learning Outcomes by the Council of Ministers of Education in Canada. Use these lessons and the correlations to reach your classroom goals and objectives.

Lesson One: Molecules And More

Introduction



The first chemists were called alchemists. The word alchemy refers to the ancient art of trying to change ordinary metals into gold. About six thousand years ago, some priests discovered how to produce gold by melting gold ore. They also made medicines from herbs and roots of plants which they gathered in the forests. An alchemist was usually an eccentric old person living alone, convinced he or she could perform magic.

These people relied on superstitions and sold concoctions to cure all kinds of ailments from warts to bad wounds. They also made poisons from plants to kill vermin that destroyed crops. They wrote and sold spells to improve the harvest, and bottled mysterious potions that promised eternal youth.

It wasn't just common folk who believed in the alchemist. Even the queen (Elizabeth I) had an alchemist in her court - but he could not have been very successful, because records show that he ended up in the Tower of London.

The history of chemistry essentially started with these alchemists who tried in vain to transform everything imaginable into gold. All of their efforts to produce gold failed. These so-called "mad scientists" are the forefathers of experimentation. In fact, even today, just a mention of the word chemistry too often conjures up the image of a "mad scientist" hovering over strange, bubbling flasks, or that of someone trying to create Frankenstein.

The study of matter, atoms, and molecules is nothing new in science. Medieval artists pictured the first "chemists" as wizened old magicians and witches stirring mixtures of bats' brains, frogs' eyes and lizards' tongues in bubbling potions, muttering strange peculiar spells.

Again, matter is any substance that has mass and occupies space. It is made up of atoms. Thus, gases, liquids and solids are all different forms of matter.

Scientific progress has led to an increasingly deeper understanding of the structure of matter. During the 19th century, the atomic theory of matter was developed. According to this theory, all matter is composed of tiny, indivisible entities called atoms. The study of chemical reactions led to the discovery of atoms as more fundamental building blocks of matter. Water was found to be a molecule composed of two atoms of hydrogen and one atom of oxygen. Currently 92 distinct, natural elementary atoms exist which can bind together to form a myriad of different molecules.

Atoms themselves are composed of subatomic particles. With the discovery of the electron, proton, and finally–in 1932–the neutron, it was thought that knowledge of the atom was complete. Beginning in the 1940s, though, a vast array of new particles was discovered, produced by high-energy particle accelerators. Most of these particles are unstable. They play a role in the internal structure of the nucleus.

By using the following vocabulary and experiments, students will begin to realize the fascinating world of chemistry that is all around them. Use these demonstrations and hands-on activities to spark chemistry curiosity.

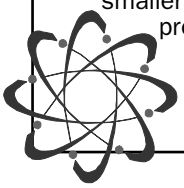
Educational Objectives:

The experiments in Section 1: "Molecules in Motion" introduce children to the structure of atoms and molecules, how they move, and how their movement affects their phase (whether they are a solid, liquid, or a gas). Through a hands-on approach, students will learn and observe what a chemical reaction is. This lesson provides an opportunity to develop scientific skills through inquiry based instructional methods.

VOCABULARY AND FUN FACTS

MOLECULES & MORE

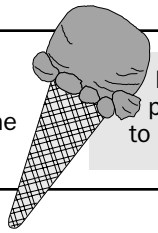
■ ***Atom:*** The smallest part of an element. Atoms are made up of smaller particles called electrons, protons, and neutrons.



FF ▸▸ In order for two surfaces to stick together (this is what makes tape sticky) the atoms must be able to get extremely close to each other so no other molecules or atoms can get between them.

FF ▸▸ An atom is very small. If it were blown up so that the nucleus was the size of a small marble, its diameter would be the size of the Houston Astrodome.

■ ***Calcium Chloride:*** A molecule made up of an atom of calcium and two atoms of chlorine ($CaCl_2$).



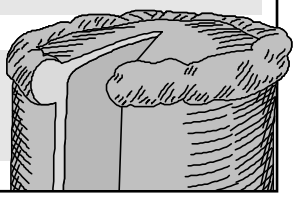
FF ▸▸ Calcium chloride is used to lower the freezing point of water. You have probably used it to add to the ice to make ice cream or put it on your driveway to melt the ice in the winter.

■ ***Carbon Dioxide:*** A molecule made up of one atom of carbon and two atoms of oxygen (CO_2). Carbon dioxide is produced from the chemical reaction of baking soda and vinegar.

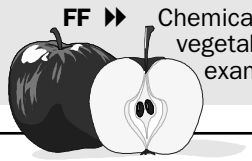
FF ▸▸ When you open a can of soda, hundreds of tiny bubbles come bursting out the top of the can and make a fizzing noise. These bubbles are actually carbon dioxide that is dissolved in the soda.

FF ▸▸ Carbon dioxide gives soda its unique taste, prevents it from spoiling, and also makes the drink sparkle. There are over 72 billion carbonated soft drinks produced every year in the USA.

FF ▸▸ Adding baking soda to cake and cookie mixes will produce carbon dioxide when they bake. The bubbles of carbon dioxide bubble up through the cake to make it light and spongy.

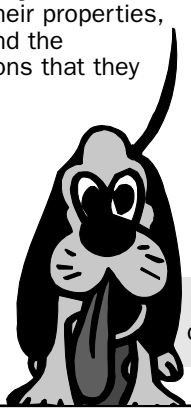


■ ***Chemical Reaction:*** When two or more different chemicals are mixed together to produce a substance with different properties.



FF ▸▸ Chemical reactions occur all around us. The browning of fruit and vegetables or even our own brain's process of thinking are examples of chemical reactions.

■ ***Chemistry:*** The study of chemicals: their properties, structures and the transformations that they undergo.



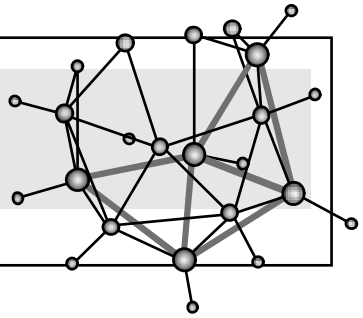
FF ▸▸ Your sense of smell and taste are both based on chemicals. Your nose detects chemicals carried through the air and your tongue detects chemicals that it touches. A strawberry smell consists of 35 chemicals. Our nose is even sensitive enough to pick up whether strawberries are over ripe or crushed. Coffee actually has 103 separate chemicals that are carried through the air to our nose to detect.

FF ▸▸ Dogs and cats have different chemical receptors in their tongues. Cats don't like sweets because they cannot detect sugar, whereas dogs' tongues can taste the chemical sugar.

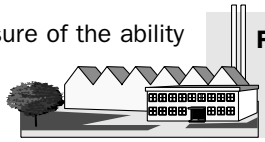
FF ▸▸ A Canadian invention called the Supersniffer detects small quantities of various chemicals. It is over a hundred times more sensitive to chemical smells than a dog's nose.

■ ***Element:*** A substance containing only one kind of atom. It cannot be divided into simpler substances.

FF ⏩ Right now there are only 92 different types of natural elements. This means that everything in the world is made up of different combinations of these 92 natural elements.



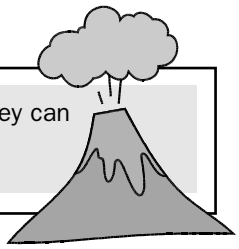
■ ***Energy:*** A measure of the ability to do work. Energy is changed from one form to another.



FF ⏩ If humankind can ever create energy by nuclear fusion, one gram of heavy hydrogen would release energy equivalent to burning 8000 kg of coal. That's pretty amazing!

■ ***Exothermic:*** A chemical reaction that produces energy in the form of heat.

FF ⏩ Volcanoes produce tremendous amounts of heat so that they can melt rock. This happens because of all the exothermic chemical reactions that occur.



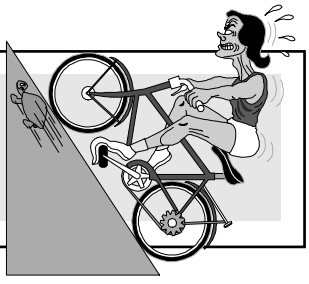
■ ***Fluid Displacement:*** The amount of water that moves out of a container into another due to the addition of an object.

FF ⏩ A submarine can either float or sink depending on how much water it displaces. In order to sink, a submarine actually takes on water thereby displacing more water. To float, the submarine will get rid of all the water it has taken on, thus displacing less water.

■ ***Gas:*** A fluid (such as air) with no independent shape or volume that can expand indefinitely.

■ ***Heat:*** A form of energy that we know as how hot or cold something is.

FF ⏩ Your body sweats or perspires as a way of cooling you down. The heat that our bodies produce along with the hot air, add energy to the sweat and it evaporates into the air.

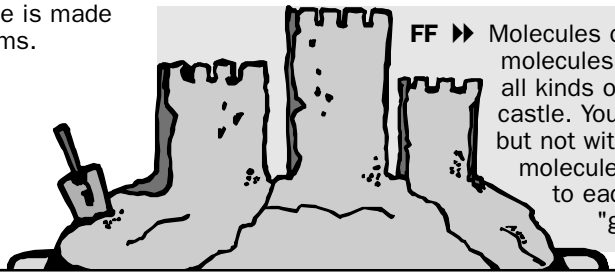


■ ***Liquid:*** A substance (such as water) that is free flowing, takes the shape of its container and has a definite volume.

FF ⏩ Water is a liquid, but a watermelon is a solid. A watermelon is approximately 93 % water. A really large watermelon could weigh 100 pounds (45 kg) and be made up of 93 pounds (42 kg) of water. That might even be more than you weigh!

■ ***Matter:*** The substance that things are made of. Matter has mass and takes up space.

■ ***Molecule:*** A molecule is made up of a combination of atoms.



FF ⏩ Molecules can be attracted to each other. When molecules are attracted to each other, they can do all kinds of things. Think about building a sand castle. You can build a sand castle with wet sand, but not with dry sand. This is because the water molecules and the sand molecules are attracted to each other. By adding water to dry sand, it "glues" the sand together.

■ ***Motion:*** Movement of an object from one place to another.

■ ***Observation:*** The act of noting and recording something.

■ ***Physical Property:*** A property of matter that may be observed without changing the chemical composition of the substance.

■ ***Pressure:*** The amount of force spread over a specific area.

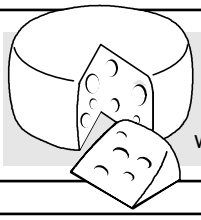
FF ⏩ Artificial diamonds are made by putting pure carbon under extreme pressure.

FF ⏩ Water can actually be stronger than rock when it is forced through a nozzle at a pressure of hundreds of kilograms per square centimeter. The stream of water can then blast away chunks of rock.

■ ***Solid:*** A substance that has the ability to resist forces that can change it. It keeps definite size and shape under ordinary conditions.

FF ⏩ Believe it or not, the strength and speed of wind from a tornado has taken a single piece of straw and forced it through the side of a wood barn.

■ ***Temperature:*** The measure of how hot or cold something is.

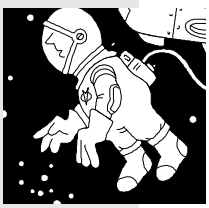


FF ⏩ Our sense of taste is effected by the temperature of our food. Have you ever tasted the difference between the way cheese tastes when it is cold from the refrigerator compared to when it is warm from sitting out on a table?

■ ***Volume:*** The amount of space occupied by an object.

■ ***Weight:*** The force of gravity that Earth exerts on an object resting on its surface.

FF ⏩ Because astronauts are basically weightless in space (and the fact that there is no friction in space) they tend to keep moving until they bump into something that helps to slow them down or completely stop them.



FF ⏩ When snow piles up on top of itself, its weight helps to turn the snow into ice. This is one way that glaciers are formed.

Experiment 1 - Molecules on the Move

Help your students visualize what molecules are all about!

Time: 15 minutes

Materials: 1 small box,
marbles (or small balls),
1 pair of scissors

Vocabulary: Molecule
Motion
Solid
Liquid
Gas
Observation

Notes: Do this experiment individually or in groups depending on the materials that you have available.

Safety Warnings: None

Introductory Questions:

? Have you ever tried to walk quickly through a crowded shopping mall or grocery store? What was it like? (These types of questions are intended to help the students begin thinking about the way in which molecules move).

Procedure:

1. Place a layer of marbles in the box so that you cannot fit any more in without stacking them one on top of each other.
2. Slide the box back and forth while observing how the marbles move.
3. Remove 1-2 rows of marbles.
4. Slide the box back and forth faster than the last time while observing how the marbles move.
5. Remove even more marbles so that only a few remain in the box.
6. Slide the box back and forth faster than the last time while observing how the marbles move.
7. Now, cut a section out of each side of the box (large enough for the marbles to fit through).
8. Slide the box back and forth quickly while observing what is happening to the marbles.

Wrap-up Questions:

What did you observe when you were sliding your boxes back and forth? How do the marbles in your boxes relate to molecules?

Explanation:

Simple Explanation:

This is an excellent model of molecules in motion! It is a particularly effective activity when each of your students works with their own box and set of marbles. Initially, the marbles represent a solid substance where the molecules are moving minimally. Removing some marbles allows more movement, and a good representation of molecules in a liquid form. Taking out even more marbles allows them to move with increased freedom and represents molecules in a gas. Cutting the sides out of the box explains what happens when molecules move extremely fast – they break away from a substance. An example of this is the steam coming out of a kettle. It is important to reinforce to students that the molecules never change, but the form of the substance does.

Extended Explanation:

All matter is made up of atoms which are the smallest part of an element. Atoms are made up of smaller particles called electrons, protons, and neutrons. When groups of atoms combine they form molecules. The world would be boring and dull if there were only one type of atom, because everything would look, feel, smell, and be the same. Lucky for us there are 92 different types of atoms, called natural elements. You are familiar with some of them. For example, there is gold and silver and hydrogen and oxygen. The number of elements continues to change over the years as scientists discover and actually create more and more elements.

Atoms are positively microscopic. A hundred million atoms in a row would only be an inch long! Molecules are a little bigger depending on the type of molecule. Atoms join together to form molecules. With 92 different types of atoms, there are billions of different possible combinations.

Molecules and atoms are constantly moving. How fast they move will determine a lot about the specific molecule or atom. For example, if the molecules are moving very slowly, they will probably be in their solid phase. If the molecules are moving a little faster, they would be a liquid and if they are moving really quickly, then they would be a gas.

Concept Emphasis by Age:

K-2:
- Everything is made up of atoms.
- Molecules are groups of atoms.
- Molecules are always moving.

3-6:
- Everything is made up of molecules that are in constant motion.
- Gas molecules move more quickly than molecules in a liquid.
- Molecules in a solid move the slowest.

Experiment 2 - States Of Matter

Look at three states of matter: solids, liquids, and gases.

Time: 20 minutes

Materials: liquids (such as milk, water, oil, juice, syrup)
solids (such as a block, a ball, school supplies)
gases (such as balloons filled with air, balloons filled with helium)
cans of soft drinks
several bags

Vocabulary: Weight
Volume
Solid
Liquid
Gas
Physical Properties
Observation

Notes: Do this experiment in groups.

Safety Warnings: None

Introductory Questions:

? Have you ever had a glass of water with ice cubes outside in the summer and the ice cubes slowly began to change? What happened? What would happen if you took that glass of water and then put it in the freezer to cool it again? How can water change into so many different things? (Be sure to emphasize that the water is changing states rather than confusing concepts with your students. You do not want them to think that you are discussing melting and freezing rather than the states of matter).

Procedure:

1. Package up your liquids, solids, and gases. For instance, put liquids into clear, sealed containers, and inflate the balloons.
2. Create "grab" bags by including a variety of solids, liquids, gases, and a canned soft drink for each group.
3. Break students into groups and give each group one of the "grab" bags.
4. Have students list and describe each of the things that they retrieve from their "grab bag". You can have them list characteristics in the following columns:
   - Takes up space
   - Has weight
   - Has shape of its own
   - Takes shape of container
   - Has definite volume
   - Does not have definite volume

Wrap-up Questions:

You were given a collection of items in a bag. What did you discover? This will be an excellent opportunity for you to identify what they have understood and those concepts that are still unclear. You can ask further questions such as: What did you learn about solids? How did you classify the items in your bag? What was the process you used? You can end the lesson with a discussion of what life might be like if water, for example, was constantly changing states. Would this cause any problems for them?

Explanation:

Simple Explanation:

This is an excellent introduction to three states of matter: solids, liquids, and gases. Including the canned soft drink is sure to spark a great discussion. The soft drink contains all three states: the can is a solid, the soft drink is a liquid, and the bubbles found in the soft drink are a gas.

Grade 3-6: Be sure to ask your students if they listed their "grab bag", and what it contained after everything was taken out! The "grab bag" is a solid and since it contains air once it is empty, it is holding a gas.

Extended Explanation:

A solid, a liquid, and a gas have specific properties. If you look at a solid, the molecules will be moving very slowly and they will be huddled very close together. In a liquid, the molecules will be spread apart a little bit and they will take the shape of the container that they are in. For example, a liquid will fill up a cup and the molecules of the liquid will move into every part of the cup, whereas a solid's molecules will stay in the shape that they were originally placed, like a block of wood. In a gas, the molecules want to spread as far apart from each other as possible. Therefore, the molecules of a gas will eventually fill an entire room. Have you ever been in a room where perfume was just sprayed and you can smell it completely across the room? That's because the molecules of the perfume spread out into the entire room.

Concept Emphasis by Age:

K-2:
- Objects can be put into categories in terms of their physical properties.
- Three states of matter that are being explored are solids, liquids, and gases.

3-6:
- Objects can be put into categories in terms of their physical properties.
- Three states of matter that are being explored are solids, liquids, and gases.

Experiment 3 - Poppin' Tops!

Experience how a simple chemical reaction can make your top blow off!

Time: 20 minutes

Materials: (per Group)
1 aluminum pie plate
1 film canister
1 Alka-Seltzer" tablet
approx. 50 mL (1/4 cup) water

Vocabulary:
Chemical Reaction
Gas
Observation

Notes: **K-2:** You may want to demonstrate first and then break up into groups.

Safety Warnings: Alka-Seltzer" is a form of medicine—please be cautious when using it with the children.

Introductory Questions:

? Ensure that your students understand the difference between a chemical reaction and a physical reaction. A physical change occurs when there is a change in the size or shape of an object (for example a piece of paper that is ripped in half). If the paper is lit on fire and burns, then a chemical change has occurred because heat, smoke and ash were produced and we do not have a piece of paper anymore. Once you have introduced chemical changes, ask if anyone can think of any other examples of a chemical change? Examples you can provide are cooking eggs in a hot pan, lighting a piece of wood in the fire or mixing up the ingredients for cookies and baking them.

Procedure:

1. Divide the class into groups for this activity.
2. Hand out the materials to each group.
3. Instruct the students to pour the water into the pie plate until there is about 1 cm (1/2 in.) in the bottom of the plate.
4. As soon as the tablet starts to fizz put the film canister down over top of the tablet.
5. Observe what happens.
6. Try to see how many times you can put the film canister back on top of the fizzing tablet so that it still pops off.

Wrap-up Questions:

What did you observe? What have you learned about chemical changes from this experiment?

Explanation:

Simple Explanation:

When the Alka-Seltzer" tablet and the water come in contact with each other a chemical reaction occurs. You observe the chemical reaction because the tablet is giving off a gas (bubbling in the water). The production of a gas is a sign of a chemical reaction. The gas tries to escape but you have placed the film canister on top of it. The gas builds up inside the film canister until it has enough force to pop.

Extended Explanation:

When a chemical reaction occurs, the starting products and the final products are not the same. For example, if I were to burn a piece of paper, the paper would turn into 3 different things – ash, heat, and smoke. The paper is no longer paper, but three completely new and different items. Chemical reactions and physical reactions are different. In a physical reaction, only the state or the shape of the item has changed. For example, if I tear a piece of paper in half, the final product is still paper, it is just in two separate pieces. Listed below you will find a list of items that are physical reactions and others that are examples of chemical reactions.

Physical Reactions

- Tearing a piece of paper
- Scratching a nail on a piece of wood
- Mixing gravel and sand together
- Popping a balloon

Chemical Reactions

- Burning a piece of paper
- Placing a tack into a corkboard
- Baking chocolate cookies
- Toasting Bread

Concept Emphasis by Age:

K-2:
- A gas is given off.
- Production of a gas is a sign of a chemical reaction.

3-6:
- A chemical reaction is happening since a gas is given off.
- The gas builds up inside the film canister.
- The gas "forces" the film canister to pop up into the air.

Experiment 4 - Move On Over

Watch the water "move" from the jar as a gas is produced by a simple chemical reaction.

Time: 20 minutes

Materials: (per Group)
shallow bowl
1 tablespoon baking soda
1 square of toilet paper
vinegar
tall thin glass

Vocabulary: Chemical Reaction, Gas, Displace, Carbon Dioxide, Observation

Notes: **K-2:** You may want to demonstrate. This experiment can be a little messy.

Safety Warnings: **None**

Introductory Questions:

Ensure that your students understand the difference between a chemical and physical change (See Experiment 3 for a brief explanation). Reiterate to the students the concepts you have learned. For example, "Now that we have learned about physical and chemical changes can anyone hypothesize about what they think might happen if we add some baking soda to vinegar? What type of change do you think will occur? Why?"

Procedure:

1. Break the children up into groups and distribute the materials.
2. Instruct the students to lay the square of tissue paper out onto the tabletop.
3. Have them place about 1 tablespoon of baking soda into it and fold the paper into a ball around the baking soda.
4. Fill the tall thin glass almost completely to the top with vinegar.
5. In one quick step, place the baking soda square into the tall thin glass, turn the empty bowl upside-down over the glass, and turn both the bowl and glass over.
6. Watch as the baking soda reacts with the vinegar. The vinegar will actually move out of the tall thin jar.

Wrap-up Questions:

What did you observe? What type of change do you think occurred? Why? Can you think of any other chemical changes that happen everyday in your kitchen?

Explanation:

Simple Explanation:

The baking soda produces carbon dioxide gas when it reacts with the vinegar. The gas "moves" or displaces the vinegar from the tall jar actually forcing it out of the jar and lowering the vinegar level.

Extended Explanation: The baking soda in the above reaction is a base and the vinegar is an acid. When acids and bases mix together a chemical reaction usually occurs. When we mixed the vinegar and the baking soda a gas was produced. This is a classic example that a chemical reaction has occurred.

Acids don't burn things, they dissolve things. There are many different types of acids. Carbonated soft drinks contain carbonic acid, and the hydrochloric acid in your stomach helps to digest your food. Car batteries are filled with sulfuric acid. Although these are all acids, they are not all the same strength. Carbonic acid is very weak and makes your soda fun to drink, but sulfuric acid is very strong and can seriously hurt us if we touch it. If you fill a car battery with cola, it certainly won't make enough electricity to start the engine. If you put sulfuric acid in your soda, it would be too dangerous to drink! They all have their proper places and uses based on how strong they are.

Here are some examples of acids and their relative strengths from weakest to strongest

Examples of Acids and their Relative strengths

Weak Acids:
Acetic Acid, found in vinegar
Citric Acid, found in lemonade & orange juice
Carbonic Acid, found in soda water
Lactic Acid, found in sour milk
Oxalic Acid, found in spinach
Malic Acid, found in apples

Strong Acids:
Nitric Acid, used in industry
Sulfuric Acid, found in car batteries
Hydrochloric Acid, found in stomachs

Just like there are strong and weak acids, there are also some strong and weak bases. Baking soda (sodium bicarbonate) is a weak alkali (base) used in cooking. Sodium hydroxide is a strong alkali that can clean baked-on grease from inside an oven. We wouldn't want to get them mixed up!

Examples of BASES and their Everyday Uses

Aluminum Hydroxide, found in deodorant & antacid
Ammonium Hydroxide, found in household cleaners
Magnesium Hydroxide, found in laxatives & antacids
Sodium Hydroxide, found in drain cleaners & soap

Concept Emphasis by Age:

K-2:
- A gas is given off.
- The gas "moves" the vinegar out of the tall thin jar.
- Production of a gas is a sign of a chemical reaction.

3-6:
- A chemical reaction is happening since a gas is given off.
- The gas that is given off is carbon dioxide.
- The carbon dioxide "moves" or displaces the vinegar from the tall thin jar.

Experiment 5 - Leaking Cups

Hot water races against cold water. Who will win, and more important why?

Time: 15 minutes

Materials: 2 paper cups
1 pin
2 small glasses
water (hot and cold)
ice cubes

Vocabulary: Observation
Molecule

Notes: Do this experiment as a demonstration or have students do it in groups. Set up (and explain) this experiment, then come back to it after a couple of minutes. This will allow some time for the water to leak out.

Safety Warnings: Be careful with the hot water; it can cause burns.

Introductory Questions:

? Introductory Questions: If I have two glasses of water and one is hot and the other is cold, do you think that one will move faster than the other? Does anyone have any hypotheses (or their best guesses)?

Procedure:

1. Make a few very small pin holes in the bottoms of each of the cups.
2. Rest one cup on the top of each small glass.
3. Fill one of the paper cups with very cold water and place a couple of ice cubes in it.
4. Fill the other paper cup with very hot water from the hot water tap.
5. Observe how quickly each of the glasses fills up.

Wrap-up Questions:

What did you observe? What do your observations tell you about the molecules in hot and cold water?

Explanation:

Simple Explanation:

You will see the hot water leak from the cup faster than the cold water (if the holes in the bottom of the cups are the same size). If the cold water is extremely cold, it will not leak out at all. This is a great experiment because it explains why the hot water tap is the tap that always leaks in your house! The molecules in the hot water are moving much faster, making it easier for them to slip by each other and as a result, leak out of the cup.

Extended Explanation:

The atoms and molecules that constitute all matter are rambunctious, restless particles – they are constantly in motion, vibrating back and forth. This continuous motion and vibration produces heat energy because the molecules are constantly bumping into each other causing a small amount of friction each time they hit. All this friction adds up and heat energy is created. The hotter the object, the faster its molecules move. So when heat energy is added to an object, the molecules speed up and bump into each other even more. When heat energy is removed and the object cools, the molecules slow down and don't bump into each other quite as much.

Concept Emphasis by Age:

K-2:
- Molecules move more quickly when heated.

3-6:
- Heating and cooling causes changes in the properties of substances.
- The molecules in the hot water are moving much faster than in the cold water.

Experiment 6 - Popcorn

Popcorn in your science class is sure to be a hit!

Time: 15 minutes

Materials: a popcorn popper
popcorn
1 sharp knife
1 balance

Vocabulary: Observations
Liquid
Gas
Molecule
Pressure
Observation

Notes: Do this experiment in groups.

Safety Warnings: Do NOT distribute hot popcorn kernels to the students; they can burn.

Introductory Questions:

Ensure that the popcorn is popping while the students are entering the classroom. Ask if anyone has any hypotheses (or their best guesses) as to how popcorn can change from a kernel into the popcorn that we eat? After you have discussed their ideas for a few minutes tell the class that they are going to have the opportunity to explore popcorn kernels and popcorn to see if they can figure out why popcorn pops.

Procedure:

1. Cut open enough of the popcorn kernels so that all students can examine them. Make sure some are cut lengthwise, as well as crosswise, in order to see the inside of the kernel from all angles.
2. Have popcorn popping as students enter the classroom.
3. Pass out some popcorn to each student.
4. Have students examine and make observations of the popped corn and the unpopped kernels that have been cut.
5. Based on their observations, make a list of what could possibly make the popcorn pop.
6. Grades 3-6: Weigh the popcorn before and after it has been popped and compare the weight.

Wrap-up Questions:

What did you observe? Why do popcorn kernels pop?

Explanation:

Simple Explanation:

The core of the popcorn kernel is hollow and this space contains water. When heat is applied, the water changes from a liquid to a gas (steam) and the movement of these molecules increases. The movement is very rapid and since the molecules are contained in a very small space, the pressure increases on the sides of the kernel. This pressure forces the kernel to pop!

Grades 3-6:

Weigh the kernel and note that the popped kernel weighs less. This is due to the loss of the water.

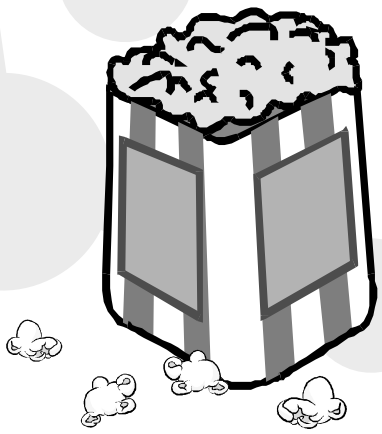
Extended Explanation:

Refer to the "Leaking Cups" extended explanation for more information on what happens to molecules when they are heated.

Concept Emphasis by Age:

K-2:
- Water is found on the inside of the popcorn kernel.
- When heated, water changes from a liquid to a gas.
- Gas molecules move more quickly than molecules in a liquid.

3-6:
- When heated, water changes from a liquid to a gas.
- Gas molecules move more quickly than molecules in a liquid.



Experiment 7 - Hot Hands

Exothermic reactions are truly HOT!

Time: 15 minutes

Materials: zip-lock bag (small)
approx. 1 c. Water
thermometer
1 Tbsp. calcium chloride

Vocabulary: Chemical
Reaction
Exothermic
Temperature
Calcium Chloride
Energy
Heat
Observation

Notes: Do this experiment as a demonstration.

Safety Warnings: Don't pass the bag around. Have the kids come and feel the amount of heat that is being given off.

Introductory Questions:

Review with the class the differences between physical and chemical changes. Step 1 provides introductory questions to stimulate their thinking on this topic.

Procedure:

1. Remind the kids of the Foam Factory Experiment from the "Don't Try This at Home" Mad Science Show they saw. Ask them what type of reaction the foam factory was? Right, exothermic!
2. Pour the water into your Zip-lock, bag.
3. Have a volunteer come up to take the temperature of the water.
4. Pour the calcium chloride into the Zip-lock, bag.
5. Take the temperature again and compare.

Wrap-up Questions:

What did you observe? What type of change do you think occurred? Why?

Explanation:

Simple Explanation:

When the calcium chloride mixed with the water, a chemical reaction occurred and heat was produced. The temperature of the water went up after the calcium chloride was added because it is an exothermic reaction – just like the foam factory experiment in the show. Exothermic means to release energy in the form of heat.

Extended Explanation:

There is an "imaginary" force that holds atoms together. These forces are called bonds. The type of bond is determined by the number of electrons in the outermost shell of an atom.

There are basically two different types of bonds and they happen between different types of atoms, based on the number of electrons they have in their outer shell.

Ionic bonding occurs between atoms that like to become ions. The ions do not like to share their outer shell electrons, but actually transfer their electrons to another atom. Table salt (NaCl) has an ionic bond between the sodium atom (Na) and the chlorine atom (Cl). It is a relatively strong bond, but the bond can easily be broken by placing the salt in water. The bond breaks and positively charged sodium atoms float around in the same solution as negatively charged chlorine atoms. Another example of a bond that is ionic is calcium chloride (CaCl2). It is used as ice cream salt or the salt that is placed on sidewalks and driveways in the wintertime.

Covalent bonding occurs between atoms that do not like to become ions, but like to share their outer-shelled electrons with other atoms. Hydrochloric acid is an example of a bond that is covalent. Other covalent bonds that you would be familiar with are in hydrogen peroxide (H2O2), oxygen (O2), and hydrogen (H2).

Chemical reactions can either produce energy in the form of heat or they can remove energy in the form of heat. Here is information about exothermic and endothermic reactions.

Exothermic Explanation: An exothermic reaction is a chemical reaction that releases heat into its surroundings. Chemical bonds are broken when two reactants combine to form a new product which results in the liberation of energy in the form of heat. The burning of graphite (carbon) to from carbon dioxide is an example of an exothermic reaction as is the reaction of calcium chloride and water. Calcium chloride is used on roads to melt ice in the winter because when it reacts with water it is able to break the bond between the ice and the surface. This is an exothermic reaction at work. It melts 5 times more ice than regular rock salt at -15˚C. This is the opposite of an endothermic reaction.

Endothermic Explanation: A chemical reaction that absorbs heat is endothermic. The change in the heat content of a substance after a chemical reaction occurs is called the heat of reaction. Energy is required to break a bond between two atoms. The reverse reaction is bond making and it releases energy. Therefore, bond breaking is endothermic and bond making is exothermic. If a chemical called ammonium nitrate, which can be used as a fertilizer, combines with water, bonds are broken and the temperature of the solution drops significantly. It drops below the freezing point of water 0˚C (32˚F).

Concept Emphasis by Age:

K-2:
- The temperature of the water changed – it got hotter.
- Production of heat is a sign of a chemical reaction.
- This is an exothermic reaction.

3-6:
- A chemical reaction is happening since heat is given off.
- This is an exothermic chemical reaction because heat was released.
- Both this chemical reaction and the "Foam Factory" from the show are exothermic.

Experiment 8 - Cork Poppers!

Watch the cork pop as a chemical reaction occurs.

Time: 15 minutes

Materials: (per Group)
1L soda bottle
1 cork (that fits the soda bottle)
1/2 package of dry yeast (approx. 2-3 tablespoons)
warm water

Vocabulary:
Observation
Chemical Reaction
Energy
Gas

Notes: You can use the entire package of yeast and 2 tsp. of sugar if you have a larger bottle or are doing this as a demonstration.

Safety Warnings: None

Introductory Questions:

? Do you think that I will be able to get the cork off the top of this bottle without using my hands? Do you have any ideas about how I could get the cork off without using my hands?

Procedure:

1. Pour about half a package of dry yeast into the empty soda bottle.
2. Fill the bottle about half full with warm water.
3. Add about 1 teaspoon of sugar.
4. Place your thumb into the bottle's mouth and shake.
5. Place the cork on top of the bottle.
6. Place the bottle on the ground.
7. Observe.

Wrap-up Questions:

What did you observe? How did the cork come off the bottle? What type of change caused the cork to come off the bottle?

Explanation:

Simple Explanation:

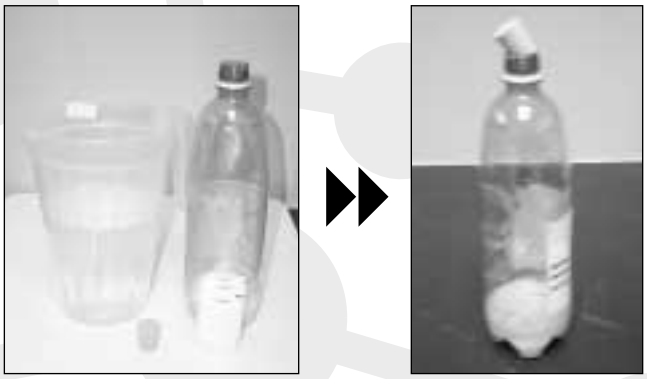
The cork will pop off the bottle because the chemical reaction that is happening between the yeast and the sugar creates energy. This energy propels the cork into the air. This is similar to the line rockets that you saw in the show. The chemical reaction that happens within the line rockets produces so much energy that the rockets move, just like the cork.

Extended Explanation: Refer to the Extended Explanation for "Move on Over" for more information on chemical reactions.

Concept Emphasis by Age:

K-2:
- Energy was given off because of the production of a gas.
- The sugar and yeast created a chemical reaction.
- The energy made the cork pop off.

3-6:
- A chemical reaction occurred because energy was created by the production of a gas.
- The yeast and the sugar reacted to produce this energy.
- The energy propelled the cork into the air.
- This is a similar reaction to the line rockets that were seen in the show – the chemical reactions gave off enough energy to actually move an object.



BACKGROUND INFORMATION

Chemistry is the physical science that deals with the composition, structure, and properties of substances and also the transformations that these substances undergo. Because the study of chemistry encompasses the entire material universe, it is central to the understanding of other sciences.

A basic chemical theory has been formulated as the result of centuries of observation and measurement of the various elements and compounds. According to this theory, matter is composed of minute particles called atoms. The more than 100 different kinds of atoms that are known are called chemical elements. Atoms of the same element or of different elements can combine together to form molecules and compounds. The atoms are held together by forces, primarily electrostatic, called chemical bonds. In a chemical reaction two or more molecules can undergo various changes to form different molecules by means of breaking and making the chemical bonds.

Physical Chemistry deals with the structure of matter and the energy changes that occur during physical and chemical changes of matter. This field provides a theoretical basis for the chemical observations of the other subdivisions. Analytical Chemistry deals with the identification of chemical substances, the determination of the amounts of substances present in a mixture, and the separation of mixtures into their individual components.

Astrochemistry is the interdisciplinary physical science that studies the origin and interaction of the chemical constituents, especially interstellar matter, in the universe. Geochemistry concentrates on chemical aspects of geology - for instance, the improvement of ore processing, coal utilization, shale oil recovery - and the use of chemicals to extract oil from wells that are considered dry by ordinary standards.

Nuclear Chemistry deals with natural and induced transformations of the atomic nucleus. Studies in this field now center on the safe and efficient use of nuclear power and the disposal of nuclear wastes. Radiochemistry deals with radioactive isotopes of chemical elements and the utilization of those isotopes to further the understanding of chemical and biochemical systems. Environmental Chemistry is a subdivision that studies the impact of various elements and compounds on the ecosphere.

Chemistry is a precise laboratory science, and the equipment of a chemical laboratory is usually involved with measurement. The balance is used to measure mass, the pipette and burette to measure volume, and the thermometer to measure temperature changes. Advances in electronics and computer technology have enabled the development of scientific instruments that determine the chemical properties, structure, and content of substances accurately and precisely.

Chemistry is closely associated with four basic needs of humans: food, clothing, shelter, and medical services. The applications of chemistry usually bring to mind industries engaged in the production of chemicals. A significant portion of the chemical industry is engaged in the production of inorganic and organic chemicals, which are then used by other industries as reactants for their chemical processes. In the United States, the great majority of the leading chemicals being produced are inorganic, and their manufacture is a multi-billion dollar industry.

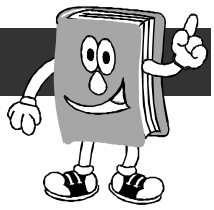
The chemistry of polymers - large molecules made up of simple repeating units linked together by chemical bonds - includes plastics, resins, natural and synthetic rubber, synthetic fibers, and protective coatings. The growth of this segment of chemistry has been phenomenal since the late 1930s. The fabrication of natural rubber and coatings (paints, varnishes, lacquers, and enamels) derived from natural agricultural products has been a mainstay of the chemical industry for more than 150 years.

Much of the future of chemistry will lie in providing answers to such technological problems as the creation of new sources of energy and the eradication of disease, famine, and environmental pollution. The improvement of the safety of existing chemical products, for example pesticides, is another challenge. Research into the chemical complexities of the human body may reveal new insights into a variety of diseases and dysfunctions. The improvement of industrial processes will serve to minimize the use of energy and raw materials, thereby diminishing negative environmental effects.

Chemistry is the study of the ways various substances are constructed, and their reactions under different conditions. It is a science that involves all of one's senses: seeing, hearing, tasting, feeling, and smelling.

The basic building blocks of matter are the elements. Elements cannot be broken down into simpler matter. Whether in nature or in the laboratory, two or more elements combine chemically to form a compound. The combined form may have different properties from the original elements. For example, when the element oxygen, a gas, combines chemically in one way with the element hydrogen, also a gas, one compound that can be formed is water. As a liquid, it looks and behaves differently from the gaseous forms of hydrogen and oxygen. A chemical change has caused this difference.

Extension Ideas



Math

✓ Integrate chemistry vocabulary into word problems. For example, "I am composed of one oxygen atom and four times the number of days in a week minus twenty six hydrogen atoms. What molecule am I?"
✓ To teach about the states of matter go outside after it has rained and draw circles with chalk around puddles. Revisit the puddles at different times during the day and continue to outline the water with chalk. The students will be able to see the differences once the water evaporates.
✓ Challenge your students to use molecule models to create patterns.
✓ Explore the units of measurement that are used for the three states of matter. You may want to discuss that gas is measured by the amount of space it occupies. Liquids are measured by pouring them into measuring cups and solids can be weighed.

Language Arts

✓ Challenge your students to create stories about molecules, atoms, physical and chemical changes. There is a lack of fictional stories that relate to this topic so their stories can be published and added to your classroom library.
✓ Place vocabulary words in an envelope and have the students select a couple of words and write stories about them.
✓ Ask the class to write their name and then think of a solid, liquid or gas that begins with each letter of their name. Have them integrate these words into a poem.
✓ Have the students write a guide for a visitor to the planet who does not know anything about the three states of matter. Challenge them to include examples of the states of matter that they encounter every day. For example, what happens if you leave your ice cream cone outside on a hot summer day?

Social Studies

✓ Study the history of chemistry and the people involved in the development of this interesting field. Chemistry is intertwined with an interesting field called alchemy, which is a search to turn ordinary objects into gold.
✓ Challenge your students to research the history of scientific discoveries related to the three states of matter.
✓ Have the class investigate the ways in which innovations in the field of chemistry are helping the environment. For example, companies like Dupont or 3M are continually finding new ways to create and use plastic to replace disposable items, thereby reducing waste.

Art

✓ Fill some film canisters or small containers half way with water and add a couple of drops of food coloring to each. You can now paint with the results of the physical change you created.
✓ Provide your students with Styrofoam balls, pipe cleaners, clay, toothpicks, etc. and challenge them to create their own molecule models.
✓ Add food coloring to water and make ice cubes. Once the water has frozen crush the ice into tiny pieces and have the students make pictures with the ice on paper, paper towel or a coffee filter. Place their creations on the windowsill and see the wonderful creations made once the ice melts.

Field Trip Suggestions

✓ Visit a Science Center and concentrate on the Chemistry Section
✓ Invite a chemist to visit the classroom.
✓ Visit a plant that makes Silly Putty® or Play Doh®
✓ Invite Mad Science into the classroom to present a workshop all about chemistry. All workshops are age appropriate and curriculum relevant. Visit our website **www.madscience.org** or call toll free **1-877-900-7300** to learn more.

Reference Books

Title: Eyewitness Science: Chemistry
Author: Ann Newmark
Publisher: DK Publishing
ISBN: 1564582310
Description: This book explores the world of chemical reactions and illustrates the important role that chemistry plays in everyday life. It is full of excellent diagrams and colorful photographs and as a result is appropriate for children in Grade 1 to 6, though it's reading level is for Grades 4 and above.

Title: The Visual Dictionary of Chemistry
Author: Jack Challoner
Publisher: Stoddart
ISBN: 0773729364
Description: This is an advanced reference book but has great background information for teachers related to chemical reactions, atoms and molecules. It is recommended for ages 11 and older.

Experiments and Activities

Title: Simple Chemistry Experiments with Everyday Materials
Author: Louis V. Loeschnig
Publisher: Sterling Publications
ISBN: 0806906898
Description: This book is full of exciting experiments with materials that can be gathered from around the house and emphasize the basic principles of chemistry. It is suited for children in Grades 4 to 6.

Title: Cool Chemistry
Author: Jim Sukach and Lucy Corvino
Publisher: Sterling Publishing
ISBN: 0806963492
Description: Experiments that utilize everyday materials illustrate the basic concepts of chemistry in this book that is intended for students in Grades 4 to 6.

Title: Experiments with Chemistry
Author: Helen J. Challand
Publisher: Children's Press
ISBN: 0516011510
Description: This book provides an introduction to chemistry and the basics of this scientific field, such as atoms, molecules and chemical changes. It also includes simple experiments that are appropriate for children in Kindergarten to Grade 3.

Title: Exploring the World of Chemistry: Try This!
Author: George Burns
Publisher: Franklin Watts
ISBN: 0531201198
Description: This book suggests simple experiments and activities that explore chemistry and the substances that make up our world. It is appropriate for students in Grades 4 to 6.

Title: Adventures with Atoms and Molecules: Chemistry Experiments for Young People
Author: Robert Mebane and Thomas Rybolt
Publisher: Enslow
ISBN: 0894906062
Description: This book contains thirty experiments that employ everyday materials to demonstrate basic chemical principles. The writing study encourages children in Grades 3 to 6 to make observations and draw conclusions.

Storybooks

Title: The Magic School Bus Gets Baked in a Cake: A Book About Kitchen Chemistry
Author: Joanna Cole
Publisher: Scholastic Press
ISBN: 0590222953
Description: This book combines a fictional story with facts to teach children about chemistry. Another in this popular series of Ms. Frizzle and her class is suitable for students in Grades 3 to 4.

Title: Horrible Science: Chemical Chaos
Author: Nick Arnold
Publisher: Scholastic
ISBN: 0590108859
Description: This book covers all types of chemistry with a bizarre twist that children love. It is in a chapter book format with black and white cartoon illustrations that are appropriate for students in Grades 3 to 6.

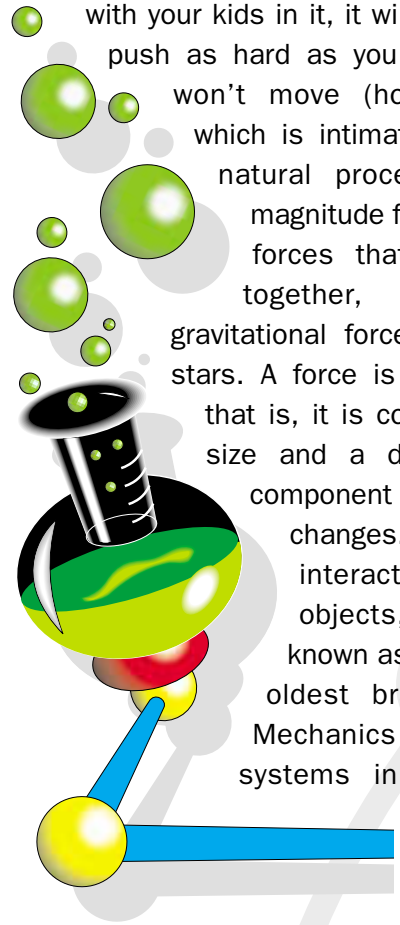
Teacher Resources

Title: Teaching Chemistry with Toys: Activities for Grades Kindergarten to 9
Author: Jerry Sarquis, Mickey Sarquis and John Williams
Publisher: McGraw-Hill
ISBN: 00760647224
Description: This is a teacher resource guide that provides complete instructions and teacher techniques for teaching chemistry through simple activities using popular toys. Activities are grouped by Kindergarten to Grade 3, Grades 4 to 6 and Grades 7 to 9.

Lesson Two: Fabulous Physics

Introduction

In physics, force is any kind of push or pull. When a force is exerted on an object, the object may or may not actually move. For example, if you pull a wagon with your kids in it, it will move. But, if you push as hard as you can on a wall, it won't move (hopefully?!). Force, which is intimately involved in all natural processes, ranges in magnitude from tiny subatomic forces that keep the atom together, to the great gravitational forces of planets and stars. A force is a vector quantity, that is, it is composed of both a size and a direction. If either component changes, the force changes. The study of the interaction of forces, objects, and motion, known as mechanics, is the oldest branch of physics. Mechanics includes force systems in equilibrium, the mathematics of motion, and the relationship of force and motion.



A very important force that occurs in nature is gravity. Gravity allows us to stay "attached" to our planet, along with a lot of other things. One thing that gravity affects is our weight. It is important to distinguish between mass and weight. Our mass does not change wherever we go in the universe. All matter has mass, including us. Our weight is simply our mass and the effect of gravity acting on it. For example, if we fly to the moon, our weight will change because the gravity is different on the moon. Our mass will stay the same.

In the following lesson, the students will learn about the fundamental concepts of physics and the roll it plays in their everyday lives.

Educational Objectives:

The experiments in Section 2: Fabulous Physics introduce children to the study of the physical sciences and provides a vivid and concise understanding of what makes the "world go 'round": inertia, forces, friction, and motion. Through a hands-on approach, students will learn and observe pendulums and the power of friction. This lesson provides an opportunity to develop scientific skills through inquiry-based instructional methods.

Vocabulary And Fun Facts

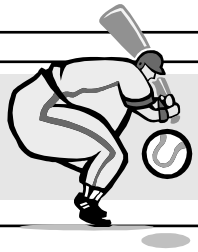
Fabulous Physics

■ ***Distribution of Weight:*** How the weight of an object is spread out over a specific surface.

FF ⏩ An egg can actually withstand up to 200 pounds of weight because of its shape. The double dome shape of an egg distributes the weight evenly so the egg does not crack.

■ ***Estimate:*** To make a rough estimate by guesswork.

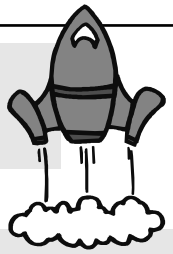
■ ***Force:*** Any kind of push or pull.



FF ⏩ The Earth, walls, the floor- all exert forces on us. Some forces allow us to walk, hit a baseball, or spin like a ballerina.

■ ***Friction:*** The force that resists the sliding or rolling of one solid object over another.

FF ⏩ You use friction to walk. If there was no friction then your feet would slip out from underneath you.



FF ⏩ When the Space Shuttle returns to Earth, the friction of the air on the shuttle, heats up the outside of the spacecraft.

FF ⏩ Shooting stars are also caused by the heat created by friction in the atmosphere. As the meteors fall towards the surface of the Earth, the heat of the friction is so great that most of the meteors are vaporized before they even make it to the ground.

■ ***Gravity:*** An invisible force that makes something that you let go of fall to the ground.

FF ⏩ The moon has much less gravity than the Earth. When an astronaut starts moving in space, they have to skid to a stop similar to if they were on ice.

FF ⏩ Roots of trees and plants always grow down because of the force of gravity acting on them. When you try to grow plants in space, the roots actually curl around in all directions since there is relatively no gravity in space.

■ ***Inertia:*** Inertia is the tendency of an object to remain at rest or in constant motion in a straight line, until an outside force acts on it.

FF ⏩ You don't fall out of your seat when you go upside-down in a roller coaster because your body wants to keep moving in a straight line while the roller coaster curves up and over. The inertia of your body is enough to keep you in your seat.

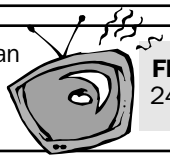
FF ⏩ Magicians use inertia to pull a tablecloth out from underneath a stack of dishes.

FF ⏩ When people are in a car accident, most of them get injured because the inertia of their body keeps moving even after the car has stopped.

■ ***Mass:*** A measure of how much matter there is in an object.

FF ⏩ When a person falls through ice, rescuers lie down on top of the ice to distribute their mass evenly. This way they do not exert enough pressure on the ice to break it.

■ ***Motion:*** Movement of an object from one place to another.



FF ⏩ When you are watching a movie or television, you are actually watching 24 to 30 individual pictures that are in motion, in one second.

■ ***Newton's 1st Law of Motion:*** An object at rest stays at rest unless an outside force acts upon it and an object in motion remains in motion in a straight line unless an outside force acts upon it.

FF ⏩ Newton's First Law of motion is why you are able to turn upside down in a roller coaster.

■ ***Observation:*** The act or noting or recording something.

FF ⏩ Many scientific discoveries have been made because of the tremendous observational skills of scientists. For example, Newton observed an apple fall from a tree. He was observing gravity.

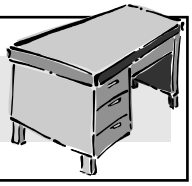
■ ***Pendulum:*** A weight hanging from a thread, chain, or rod that can swing back and forth. An example of a pendulum is a Grandfather clock.

FF ⏩ The first long-running clocks were powered by pendulums. Pendulum clocks need to be tall since they have to account for the pendulum swinging back and forth. The "grandfather clocks" which first appeared in 1670 were powered by pendulums.

■ ***Period:*** The length of time it takes for the pendulum to make a complete swing.

■ ***Physics:*** The study of how matter and energy are related. Physicists discover things about space, matter, energy, heat, light, sound, electricity, and magnetism.

FF ⏩ Physics studies everything that is in the universe -from the energy of the sun to the matter that makes up your desk.

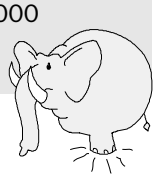


■ ***Prediction:*** The process of making an educated guess as to why something will happen.

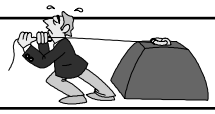
■ ***Pressure:*** The force or thrust exerted over a surface divided by its area.

FF ⏩ The atmosphere exerts pressure on everybody and everything. When the atmospheric pressure drops or is low, it usually indicates that it is going to rain.

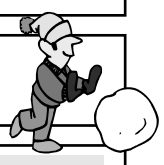
FF ⏩ A 50 kg woman standing on one stiletto high heel exerts 5 times more pressure than a 9000 kg elephant standing on one leg.



■ ***Pull:*** To move an object by bringing it closer to you.



■ ***Push:*** To move an object by moving it away from you.



■ ***Weight:*** The force of gravity that Earth exerts on an object resting on its surface.

FF ⏩ Your weight on the moon would be 1/6th of what it is here on Earth because of the differences in gravity. If you weighed 60 pounds on Earth, you would only weigh 10 pounds on the moon.

Experiment 1 - Objects In Motion

A first look at inertia.

Time: 15 minutes

Materials: 1 book
1 string (1 meter/3 feet long)
1 rubber band

Vocabulary: Inertia
Newton's First Law of Motion
Motion
Push
Pull
Force

Notes: Do this experiment in groups.

Safety Warnings: None

Introductory Questions:

? What do you think will happen if I try and pull this book with a string? What do you think will happen if I try and pull the book with a rubber band? Do you think there will be any difference between the two?

Procedure:

1. Tie the string around the book. Leave one end of the string short, and the other end long.
2. Attach the rubber band to the longer end of string.
3. Lay the book on a carpeted floor. Pull on the rubber band in order to drag the book across the floor.

Wrap-up Questions:

What did you observe? Why do you think the book moved quicker and further with the string rather than the rubber band?

Explanation:

Simple Explanation:

This experiment is all about inertia. Newton's First Law of Motion deals with inertia (an object in motion tends to stay in motion, and an object at rest tends to stay at rest, unless acted on by an outside force). The rubber band is stretched to a greater degree when starting off, which shows the book had to be pulled harder to get it moving.

To keep it moving, the rubber band does not have to be stretched as much since the book is already in motion. Look at the length of the rubber band when you begin dragging the book, and once you have gotten it moving. The rubber band stretches as you get the book moving. When the book continues to be pulled, the rubber band is still stretched, but not as much.

Extended Explanation:

Isaac Newton, a very famous and important scientist, figured that an object will either stay at rest or in constant motion unless an outside force acts on that object to change it in some way. This is Newton's First Law, commonly referred to as the Law of Inertia. Inertia is the resistance of objects to any change in their speed (even if the speed is zero) or their direction. In short, every object is just plain lazy. It wants to keep doing what it's already doing and keep going (if it is moving) in the direction it's going – a straight line.

Everything has inertia – the amount of inertia depends on the object's mass. The greater an object's mass, the greater its inertia (or the more lazy it is.) For example, if you roll a ball down the street it will continue to roll in a straight line until an outside force acts on it to change it's direction or speed in some way. This could be a stone the ball strikes that changes its direction, so it is no longer rolling in a straight line. This could be friction that will eventually stop the ball from rolling. This could be you, as you pick up the ball which both stops it and stops it from continuing to roll in a straight line. This could be your dog that races out to steal the ball and take it back to its doghouse.

Similarly, a book sitting on a table has inertia (because it has mass). It will continue to sit just there until an outside force acts upon it. This outside force could be someone that walks by and bumps it off the table. This outside force could be the librarian who places it back on the shelf where it belongs.

To make it simpler, a force changes one or more of the following: a) the direction an object is traveling, b) the speed an object is traveling, or c) the shape of an object. If you throw a ball to me and I catch it, several forces have acted on the ball. We both changed the ball's speed and direction in different ways.

Concept Emphasis by Age:

K-2:
- Objects at rest want to stay at rest.
- Pushing or pulling will move an object.

3-6:
- Objects at rest want to stay at rest.
- A force is needed to get an object moving.

Experiment 2 - Shape Secrets

This activity will give you a new appreciation for the common egg!

Time: 5 minutes

Materials: 4-8 raw eggs
4-8 egg cups
books
optional: wax Paper
optional: Scotch tape

Vocabulary: Weight
Distribution of Weight

Notes: K-2: For students in Kindergarten to Grade 2 this activity would be most beneficial as a demonstration.

3-6: Students in grades 3 – 6 should be able to do this activity in groups. Ask them to predict how many books four eggs should be able to hold.

Safety Warnings: None

Introductory Questions:

? Do you think I can balance one book on top of 4 raw eggs without breaking them? How about two or three? Encourage your students to explain the logic and reasoning behind their answers.

Procedure:

1. Show the students a raw egg.
2. Set four raw eggs in four eggcups.
3. Support a book on top of the four eggs.
4. Try adding additional books to test out the strength.
5. After you test the eggs, delight the students by breaking the raw eggs in a bowl and proving there was no "magic" to the eggs or the experiment.

Wrap-up Questions:

What did you observe? Why were we able to balance the books on the raw eggs without them cracking? Make sure that you reinforce that it is the shape of the egg and not its composition that allowed the eggs to support the weight of the books.

Explanation:

Simple Explanation:

The shape of the egg is the secret to this experiment. There is not one single point in the dome-shape of the egg that supports the entire weight of the books. The weight of the books is equally distributed along the entire curved wall of the egg to the wider middle.

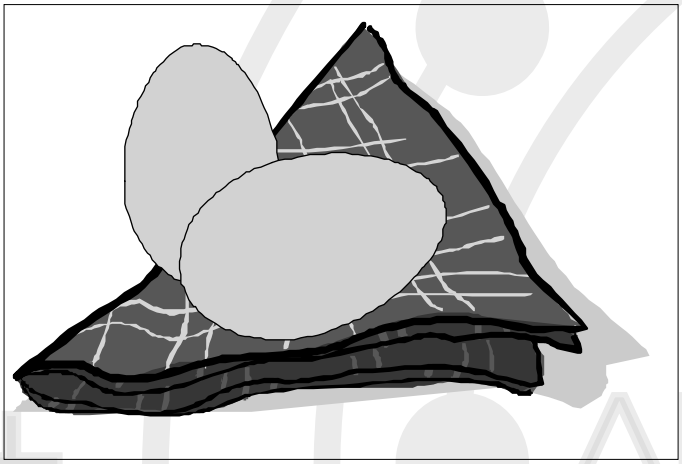
Extended Explanation:

The egg is similar in shape to an arch. The arch was originally made by the Romans and therefore is usually referred to as the Roman arch. The semicircular arch was used in creating aqueducts and bridges. The arch is remarkably strong. This is because the shape of the arch and the bricks that make up the arch takes the pressure from above and shares the pressure with all the blocks of the structure.

Concept Emphasis by Age:

K-2:
- The shape of an object is important in finding out whether it can support weight.
- A dome or arch is one of the strongest shapes.

3-6:
- In a dome (arch) shaped object, there is not one single point that supports the weight.
- The weight of an object is equally distributed along the shape of a domed (arch shape) object such as an egg.



Experiment 3 - Foucault's Folly

Make a model of the United Nations' Pendulum.

Time: 20 minutes

Materials: (per group)
Styrofoam balls (approx. 10 cm in diameter)
pencils
nylon fishing line
tape
paper
crayons

Vocabulary:
Push
Pendulum
Inertia
Motion

Notes: The teacher can do this activity as a demonstration with volunteers as assistants.

Safety Warnings: None

Introductory Questions:

Do not ask any questions to begin this activity because it is an excellent opportunity for the students to explore and investigate how pendulums work.

Procedure:

1. Divide your class into groups for this activity.
2. Distribute a Styrofoam ball, a pencil, 3 meters (9 feet) of fishing line, some tape, a piece of paper and a crayon to each group.
3. Instruct a volunteer in each group to push the pencil into the Styrofoam ball. Have another student attach the fishing line to the end of the pencil.
4. Help each group to attach their "pendulum" to the ceiling or to an area that will allow it to swing freely.
5. Have the groups draw a line on their piece of paper and tape it directly under the pencil.
6. Start each pendulum swinging back and forth, following the line on the paper. What happens after an hour has passed? After 2 hours have passed?

Wrap-up Questions:

What did you observe? Why do you think the pencil moved? Do you think it would move differently if you used a pen, pencil, marker or crayon?

Explanation:

Simple Explanation:

The pendulum is kept swinging in the same place due to its inertia. Inertia (in reference to moving objects) is the tendency of an object in motion to stay in motion. However, it no longer swings over the same crayon line because the Earth has moved. The Earth is constantly rotating on its axis and therefore, everything else follows this path of rotation, even the pendulum. If this pendulum kept moving for a period of 24 hours, you would be able to demonstrate the rotation of the Earth in a day! There is a pendulum in the United States at the United Nations building in New York City that is in constant swing to demonstrate this rotation of the Earth.

Extended Explanation:

The Foucault pendulum is used to demonstrate the rotation of the earth and is named after the French physicist Jean Bernard Leon Foucault. The pendulum consists of a heavy bob suspended on a long wire. After the pendulum is set in motion so that it swings back and forth in a single plane, the rotation of the earth causes the orientation of the back-and-forth motions of the pendulum to slowly rotate with respect to the ground underneath the pendulum. This effect is most pronounced at the North Pole, where the pendulum rotates once every 24 hours. The rate of the pendulum's rotation with respect to the where it is on the earth will decrease the closer it gets to the equator. At the equator the pendulum does not rotate at all.

Concept Emphasis by Age:

K-2:
- A pendulum is a weight hanging from a string, chain or rod that swings freely.
- The Earth is constantly rotating which causes the pendulum swing to change.

3-6:
- Inertia is the tendency of an object in motion to stay in motion.
- The rotation of the Earth about its axis is reflected in the changing pattern of the pendulum's swing.

Experiment 4 - Friction Fun

One of the reasons that a moving object can slow down is due to the force of friction. Test out this theory in this fun activity!

Time: 10 minutes

Materials: (per group)
1 nickel
1 quarter
1 sheet of paper

Vocabulary:
Observation
Force
Friction

Notes: This activity can also be related to a lesson on the force of gravity.

Safety Warnings: None

Introductory Questions:

? Which of the objects do you think will hit the ground first if we release them from the same height at the same time? Ensure that your students thoroughly explain their reasoning and reinforce that these are their hypotheses (or best guesses).

Procedure:

1. Instruct your students to trace the outline of the nickel on the paper and cut it out.
2. Have them place the nickel outline on top of a quarter.
3. Tell them to hold the quarter horizontally (so that it is parallel with the floor) with their thumb and index finger.
4. When you say "Go", ask them to release the quarter and let it fall. What happens? They should observe that the nickel outline and the quarter both reach the floor at the same time. Why does this happen? Have them try it a few times to repeat the result and then ask them to let each object fall separately. The paper should take more time to fall to the floor than the quarter.

Wrap-up Questions:

What did you observe? Challenge your students to explain their observations with as much detail as possible.

Explanation:

Simple Explanation:

This experiment is a variation on Galileo's famous "feather and the brick" experiment that first lead to the explanation of how the force of friction affects the pull of gravity. All objects fall at the same rate MINUS air friction. The force of friction between the paper and the air causes the paper outline to fall slower than the quarter when the two objects are separated. However, when the paper is placed on top of the quarter, the paper's friction with the air is eliminated, allowing both to reach the floor at the same time. Friction is a force that we often have to take into consideration with moving objects, as it can significantly slow things down!

Extended Explanation:

Imagine a world in which every surface seemed coated with a fine layer of smooth, slippery ice. Not only the floor you walk across, buy even the shoes you are wearing. If you have ever tried to walk across ice with slick bottomed shoes, you have only an inkling of this imaginary world. Floors, streets, sidewalks, tires, the sides of buildings, etc… Imagine that the nail and the nail hole that you want to put the nail into are coated with ice. Every place that one surface comes in contact with another surface, this slippery surface exists. Walking, driving a car, or sitting in a chair, would be difficult if not impossible to do.

There are 3 basic kinds of friction. There is sliding friction, rolling friction, and fluid friction. The type of friction we are discussing in this experiment is fluid friction, because air is considered a fluid. Sliding friction occurs when two objects are trying to slide past one another. Rolling friction occurs when two objects are rolling. Rolling friction is usually less than sliding friction because of the amount of surface area that is touching. Fluid friction makes it difficult to walk through water and it is also what makes a parachute work.

Concept Emphasis by Age:

K-2:
- Friction is a force that can slow down movement.
- We can use different methods to overcome friction.

3-6:
- Objects at rest want to stay at rest.
- Friction is created when moving objects or surfaces rub together. This force can be overcome or reduced.

Experiment 5 - A Stack Of Coins

An amazing demonstration of inertia!

Time: 15 minutes

Materials: 1 strip of paper- 4 cm x 12 cm (2" x 5")
1 soft drink bottle
some coins (quarters, nickels, dimes, and pennies)

Vocabulary: Inertia
Force
Push
Pull
Motion

Notes: Do this experiment as a demonstration.

Safety Warnings: None

Introductory Questions:

? Do you think I can move this piece of paper without moving the coins? Does anyone have any suggestions or hypotheses about how I might do this?

Procedure:

1. Lay the strip of paper across the top of the soft drink bottle.
2. Stack some coins on top of the strip of paper. Place the largest coins on the bottom and stack them by increasing sizes.
3. Grab the strip of paper with your index finger and thumb. You can moisten your index finger so that it sticks to the paper and provides better contact.
4. Pull your hand down in a quick motion in order to remove the strip of paper.

Wrap-up Questions:

Do you think I can move this piece of paper without moving the coins? Does anyone have any suggestions or hypotheses about how I might do this?

Explanation:

Simple Explanation:

The coins remain on top of the soft drink bottle due to inertia. Inertia is the tendency of an object at rest to stay at rest, unless acted on by an outside force. The other force at work here is friction. The paper can be pulled away quickly because the force of friction (between the bottom coin and the paper) is too brief to overcome the inertia of the stack of coins. The coins are at rest, and they want to remain that way! The key to this experiment is to remove the paper strip very quickly. Several coins in the stack make it more stable and as a result, there is more inertia to overcome. This means the stack of coins is more likely to stay where it is.
Grade 3-6: Challenge your students to remove the strip of paper. Be sure to let your students know that they cannot touch the bottle or coins in their attempts. Having the coins topple off the bottle a couple of times beforehand makes the final demonstration really effective!

Extended Explanation:

Refer to "Objects in Motion" for more information on Newton's First Law of Motion and inertia.

Concept Emphasis by Age:

K-2:
- Objects at rest want to stay at rest.
- Pushing or pulling will move an object.

3-6:
- Objects at rest want to stay at rest.
- A force is needed to get an object moving.

Experiment 6 - Paper Power

How could paper be so strong?

Time: 15 minutes

Materials: corrugated cardboard
scissors
1 can
1 small cutting board
ruler

Vocabulary: Weight
Distribution of Weight

Notes: You may want to do this as a demonstration for your class but it can be a fun activity as well.

Safety Warnings: Tell your students to be careful when they step up onto the cardboard. Have some helpers nearby to make sure that they do not lose their balance!

Introductory Questions:

Do you think that a piece of cardboard can support your weight? Challenge their thinking by asking more questions such as; How can this little piece of cardboard support your weight?

Procedure:

1. Instruct your students to cut a strip of corrugated cardboard about 10 cm x 30 cm long (4"x12").
2. Have them wrap the strip around a can and secure it with masking tape. They can remove the can after a couple of minutes. You just want the cardboard to become curved like the can.
3. The next step is to place a small board on top of the cardboard circle (which should be on the floor) and carefully stand on it. What happens?

Wrap-up Questions:

Were you right or wrong in your hypothesis about the cardboard being able to support your weight? How is it possible that the cardboard could support your weight? Is there any other way that the cardboard would be able to support your weight?

Explanation:

Simple Explanation:

The corrugated cardboard is able to support a person's weight because of its shape. The corrugation, the folds within the cardboard, adds some additional support. Even though the surface area of the cardboard is small, the circular shape equally distributes the weight.
Grade 3-6: You can challenge older students to try different shapes (squares, triangles, rectangles, etc.) to see if they support weight as well as a circle does. Use books or another load to test these other shapes.

Extended Explanation:

Different shapes can support differing amounts of weight. For example, triangles are much stronger than squares and arches are generally stronger than triangles. If you look at many bridges that are built across large bodies of water, you will see many triangular shapes and not too many squares. Arches are also use to build bridges. Triangles and arches are stronger than other shapes because they distribute (spread out) the weight evenly which is placed on the structure.

Concept Emphasis by Age:

K-2:
- Some shapes are stronger than other shapes.
- A circle is a strong shape because it can distribute weight around its shape.

3-6:
- The shape of an object is important in determining how much weight it can support.
- Circles are known to be strong shapes because they distribute weight around the circle and not just at one point.

Experiment 7 - Swing Sets

This activity demonstrates what factors influence pendulum activity.

Time: 15 minutes

Materials: 1 pencil
25 cm piece of string (10")
1 paper clip
1 steel washer or large coin
tape

Vocabulary: Pendulum
Period
Estimate
Observation
Mass
Weight

Notes: This activity can be lengthened by including a step where the students change the length of the pendulum's string to see what effect this has on the swing of the pendulum.

Safety Warnings: None

Introductory Questions:

? Do not ask any questions to start this activity as it is more important for the class to first understand the activity and then pose the questions outlined in the procedure.

Procedure:

1. Students should tape a pencil to the top of a desk so that half of it sticks out over the edge of the desk.

2. Have them make a pendulum string about 25 cm long (10") with a loop at each end. A simple slipknot will accomplish this.

3. One loop of the pendulum should be put around the pencil, while the paper clip should be opened and attached to the other loop.

4. Students should attach the steel washer to the paper clip so that the pendulum string can swing freely.

5. Ask your students to estimate how many times that they think their pendulum can swing in a period of 20 seconds. They should be carefully to count only full periods, i.e. a full period is when the washer returns to the place where it was released (it goes forward and back for one complete swing). They should hold the washer straight out (at a 90 degree angle) and then release it.

6. Have the students record the number of periods that the pendulum completed in the 20 seconds. How close was their estimate?

7. Repeat steps 6 & 7 a few times to see if the same results are achieved. Try doing the same activity but adding some more washers to the paper clip. What happens? How does the weight of the pendulum bob (the paper clip + the washers) affect the number of periods that the pendulum can complete in 20 seconds?

Wrap-up Questions:

What did you observe?

Explanation

Simple Explanation:

A child's swing at a playground is actually a very good example of a pendulum. A pendulum is actually a falling object that is kept from falling to the ground by its string. The string allows the pendulum to travel in a curved path. Variables such as mass, angle of swing and the length of the string may all have an effect on how long it takes to complete one swing.
Grade 3-6: Have these older students determine through experimentation how the following three variables affect the speed of the pendulum's swing:
a) the weight of the pendulum bob
b)the length of the pendulum's string
c) the distance that you pull the pendulum back

Extended Explanation:

Pendulums are devices that consist of an object suspended from a fixed point that swings back and forth under the influence of gravity. Pendulums are used in several kinds of mechanical devices. For example, certain types of clocks use pendulums.
The most basic type of pendulum is the simple pendulum. In a simple pendulum (which swings back and forth in a one plane) all the mass of the device can be considered to reside entirely in the suspended object. The motion of pendulums (such as those in clocks) closely approximates the motion of a simple pendulum. Galileo discovered the principle of the pendulum. He established that the period (the back-and-forth oscillation of a pendulum) remains the same, no matter how large its swing is.

Concept Emphasis by Age:

K-2:
- A pendulum is a weight on the end of a string that travels in a curved path.
- The only thing that makes a pendulum speed up is making its string shorter.

3-6:
- There are three variables that you have to examine when discussing pendulums: the mass of the pendulum bob, the length of the string, and the distance that you pull the pendulum back to release it from.
- The only variable that affects the speed of the swing of the pendulum is the length of its string.

Experiment 8 - Fabulous Forces

Friction is a force that stops surfaces from sliding easily. Try this hands-on activity to get a feel for friction.

Time: 15 minutes

Materials: (Per Group)
2 rulers
1 meter stick
1 marble
a couple of large books
wax paper
sandpaper
1 small towel
aluminum foil
some markers.

Vocabulary:
Prediction
Observation
Friction
Force
Pendulum

Notes: This activity should be done on a floor or tabletop. The students will need some room to experiment.

Safety Warnings: None

Introductory Questions:

? Before asking any questions follow Step 1 and distribute the materials to each group. Then ask; Which material do you think will allow the marble to roll the furthest? Why do you think do? (Ensure that they can expalin their choices and predictions.)

Procedure:

1. Distribute all of the materials to each group and ask them to try and predict which of the materials would allow the marble to be rolled farthest over it.
2. Ask your students to create a ramp out of the two rulers and the books. Demonstrate the best method for younger students. The rulers should be close together so that a track is created for the marble to be rolled down onto the desk or floor.
3. Once they have assembled their ramp, instruct the groups to begin by placing the wax paper at the bottom of their track. Have them roll the marble down the track and across the wax paper. One member of the group should mark the point where the marble stopped, and measure this distance with the meter stick.
4. Repeat step 3 with the sandpaper, aluminum foil, and the towel. Remind the students that it is important that they are consistent with their procedure, i.e. they have to drop the marble from the same height or their results will not be accurate.
5. What happens? Challenge them to predict what is going to happen with each material before they try it.

Wrap-up Questions:

What did you observe? Challenge the students to hypothesize about why the marble rolled faster over certain materials.

Explanation

Simple Explanation:

Friction is a force that stops surfaces from sliding easily. The activity demonstrates that the distance that the marble was able to travel was dependent on the surface material over which it had to move. The more rough that the surface was, the less distance the marble traveled. Objects have to overcome the force of friction in order to keep traveling at the same rate. The pendulum with the bowling ball was eventually not able to overcome the force of friction of the rope wrapping around the pole, and it stopped the bowling ball from crashing to the ground. Friction is not always a bad force to have around!

Grade 3-6: Challenge older students to experiment with other materials than those listed here. Ask them to predict the outcome of their experiment before they perform it. How can this force of friction be overcome? Have them do some research to determine how we conquer this frictional force.

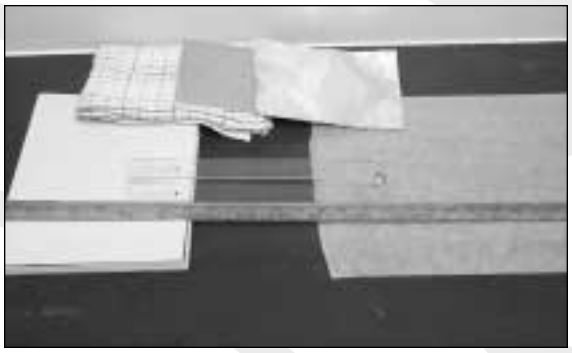
Extended Explanation:

Refer to the "Friction Fun" experiment for additional information on friction.

Concept Emphasis by Age:

K-2:
- Friction is a force that can slow down movement.
- We can use different methods to overcome friction.

3-6:
- Objects at rest want to stay at rest.
- Friction is created when moving objects or surfaces rub together. This force can be overcome or reduced.
- Different surfaces provide different amounts of friction for moving objects. The more texture that a surface has, the more friction it can create.



BACKGROUND INFORMATION

The effect of force on matter was described three centuries ago by Sir Isaac Newton in what are known today as Newton's Laws of Motion. He developed three laws which try to simplify the natural laws that govern motion. Newton's First Law states, "Every body continues in its state of rest or of uniform speed in a straight line unless it is compelled to change that state by forces acting on it." Here, Newton is talking about inertia, therefore, his first law is often referred to as the Law of Inertia. Inertia means that an object will remain at rest or in constant motion in a straight line until an outside force acts on it. My shoes are sitting on the floor in my closet. They are going to stay there and will not move until an outside force affects them. An example of an outside force acting on them may be when my dog goes to pick them up to bring them to me so we can go play. (I wish she would do this.) In addition, a bowling ball, once thrown down the lane, will continue to roll in a straight line and at the same speed until an outside force acts on it. When the ball strikes the pins and both the direction and the speed of the ball change, this is an example of an outside force acting upon the bowling ball.

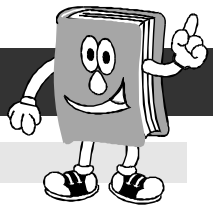
Newton's Second Law of Motion states: "The acceleration of an object is directly proportional to the net force acting on it and is inversely proportional to its mass. The direction of the acceleration is in the direction of the applied net forces." Basically, most of us know this simplified as F=ma, or Force equals mass times acceleration. Newton's Third Law states, "Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first. This can be simplified to mean that whenever two objects come in contact with each other, they both exert forces on the other in equal and opposite directions.

Centripetal ("center-seeking") force allows an object to continually keep moving in a circular path. This force is felt by an object that is moving in a circle as the inward pull towards the center. When a ball on a string is swung in a circle, the string supplies the centripetal force; if the string breaks, the ball will fly outward in a straight line from exactly where the string broke. In space, gravity supplies the centripetal force that keeps satellites and our moon in orbit around the Earth.

In physics we also witness what is called centrifugal force (center-fleeing). This is a fictitious force that is used to help understand the outward pull an object feels when it is moving in a circle. An example of centrifugal force can be felt when you are sitting in a car that is going around a curve. Your body feels like it is being pulled outward - this is the centrifugal force.

In conclusion, forces can make a sitting object move or a moving object stop. A force may change the direction an object is going. It may speed it up or slow it down. In general, forces can make something bend, stretch, squash, twist, turn, speed up, slow down, stop, etc. Forces are an integral part of our life.

Extension Ideas



Math

✓ Provide students with a variety of objects, such as paper, feathers, rocks and books. Challenge the students to drop two or more objects at once to determine which will land on the ground first. Record the findings in a chart.
✓ Using plastic cars, measure the distance that they can travel on a variety of surfaces, including rough, smooth and incline planes. Have the students chart or graph the results.
✓ Make shapes out of Jell-O® and distrubute them to the students. Ask the class to count how many times the shape moves when they shake it softly and when they move it quickly. You can compile the results in a graph or chart.
✓ Provide tops for the students and challenge them to spin the tops and count the number of rotations. Ask them to compile the results in a chart or graph.

Language Arts

✓ Ask the students to write poems about the forces they have learned about (for example, gravity, centrifugal forces, centripetal forces and inertia). They can even print their poems in interesting shapes and patterns to reflect the concept they are writing about.
✓ Have the students work on fictional or non-fictional stories about forces, like motion, friction, gravity and inertia. They could work individually, in pairs or as a class to publish a book to add to the classroom library.
✓ Have the students imagine that a being from another planet has landed on Earth. This creature has never lived with the pull or force of gravity before. Challenge the students to write a guidebook to help this creature adjust to the force of gravity here on Earth.
✓ Challenge the students to write a short newspaper article about the way in which forces are often forgotten but are part of our everyday lives. Examples include playing baseball, going to the amusement park and riding the roller coaster, going down a water slide or riding a skateboard.
✓ If you have studied the work of Sir Isaac Newton, ask the students to imagine that they are Sir Isaac Newton and are writing a letter to a friend about the amazing discoveries he made.

Social Studies

✓ Provide your students with books and resources about Newton, you might even want to review his discoveries with the class. Have your students write newspaper articles about Newton's discoveries. They can even draw accompanying illustrations.
✓ Challenge your students to conduct research projects on the history and development of the bicycle.
✓ Have the students do research about the laws of motion and how force and acceleration led to the formation of mountains, valleys, continents and other landforms. Ask the students to select a specific landform and have them report on how it was created.
✓ After studying forces and some of the main people involved in discoveries relating to forces, have the students write research reports and biographies on one of the following; Sir Isaac Newton, Aristotle, Copernicus, or any other scientist who studied forces.

Art

✓ Provide students with eyedroppers or pipettes and liquid pans. Have them drop paint from different levels and make a picture with it.
✓ Have the students create a flipbook. This is done by drawing a series of images of something falling in a specific setting. Then you flip through the book quickly by holding on to one corner with your thumb. As the pages turn, the images bled together and resemble an animated cartoon.
✓ Take a salad spinner and line it with paper so that the bottom and sides are covered. Ask the students to drop a few large globs of paint on the paper in the spinner, put the lid on and spin. The results will amaze you and your students.

Field Trip Suggestions

✓ Provide your students with
✓ Invite a physicist to visit the classroom.
✓ Go to the playground and challenge students to find as many examples of forces as possible.
✓ Visit an amusement park and challenge the students to find as many different examples of forces as possible.
✓ Invite Mad Science into the classroom to present a workshop all about forces. All workshops are age appropriate and curriculum relevant. Visit our website at www.madscience.org or call toll free 1-877-900-7300 to learn more.

Reference Books

Title: Horrible Science: Fatal Forces
Author: Nick Arnold
Publisher: Scholastic
ISBN#: 0439043638
Description: *Reference book with black and white illustrations that put a wacky spin on the fundamentals of forces, including gravity, speed, pressure, and friction.*

Title: Why Doesn't the Earth Fall Up?: And Other Not Such Dumb Questions About Motion
Author: Vicki Cobb
Publisher: Lodestar Books
ISBN#: 0325672532
Description: *This book addresses nine questions about motion, explains Newton's Laws of Motion, gravity, centrifugal force and other principles of motion. It is appropriate for children in Grades 1 to 3.*

Title: A Scholastic Kids' Encyclopedia of Science
Author: David Rubel
Publisher: Scholastic
ISBN#: 0590493671
Description: *This is a great reference book with color pictures and illustrations. It is an asset for all classrooms and is intended for children ages seven and older.*

Experiments and Activities

Title: Science Magic with Forces
Author: Chris Oxlade
Publisher: Barron's
ISBN#: 0812091914
Description: *Activities that explore the fundamentals of forces while providing an element of magic that will intrigue children in Grades 3 to 6.*

Title: Forces and Motion: Science Projects
Author: Simon De Pinna
Publisher: Raintree
ISBN#: 0817249621
Description: *This activity book explains the concepts of force and motion by including experiments that can be conducted with readily available materials. This book is appropriate for students in Grades 3 to 6.*

Title: Exploring Forces and Structures
Author: Keith Bardon
Publisher: Raintree Steck-Vaughn
ISBN#: 0811426025
Description: *This activity book includes colorful illustrations and photographs that accompany experiments and explanations related to the forces of friction, resistance, gravity and movement. This book is appropriate for students in Grades 1 to 3.*

Title: Gravity: Simple Experiments for Young Scientists
Author: Larry White
Publisher: Millbrook
ISBN#: 0761300899
Description: *The basic principles of gravity and the discoveries of Newton and Galileo are described in detail with accompanying experiments that help illustrate the complex concepts that relate to forces. This book is appropriate for students in Grades 1 to 3.*

Title: Lucky Science: Accidental Discoveries from Gravity to Velcro
Author: Royston Roberts
Publisher: John Wiley and Sons
ISBN#: 0471009547
Description: *This book outlines some incredible discoveries that were purely accidental. The topics covered include motion and gravity, along with other concepts and experiments to help reinforce the main ideas. Students in Grades 3 to 6 will enjoy this book that encourages young students to think for themselves and to ask why things work the way they do.*

Title: The Science Book of Gravity
Author: Neil Ardley
Publisher: Harcourt Brave
ISBN#: 0152006214
Description: *This book includes simple experiments that illustrate the concept of gravity for students in Grades 1 to 3.*

Title: The Spinning Blackboard and Other Dynamic Experiments on Force and Motion: Exploratorium Snackbook Series
Author: Paul Doherty, Don Rathjen and the Exploratorium Teacher Institute
Publisher: John Wiley and Sons
ISBN#: 0471115142
Description: *This fun and educational book includes 23 experiments that will enthrall children in Grades 3 to 6 while teaching them about the principles of motion.*

Storybooks

Title: The Magic School Bus Plays Ball: A Book About Forces
Author: Joanna Cole
Publisher: Scholastic
ISBN#: 0590922408
Description: *Another of the wild adventures in the Magic School Bus series. This time their investigative spirit has taken them into the wild world of forces. It is intended for students in Kindergarten to Grade 3.*

Title: Bowled Over: The Case of the Gravity Goof-Up
Author: Chuck Harwood
Publisher: McGraw-Hill
ISBN#: 0070070555
Description: *This book is another in the Kinetic City Super Crew series, which transports the characters back in time to the 17th century where they meet Galileo and have to help him with his gravity experiment. This fictional book is appropriate for students in Grades 4 to 6.*

National Science Education Standards Correlated to the Teacher Resource Manual for "Don't Try This At Home"

Mad Science Productions	Don't Try This At Home	Taking the World By Storm	
Science As Inquiry			
Abilities necessary to do scientific inquiry	●	●	
Understanding about scientific inquiry	●	●	
Physical Science			
Properties of objects & materials			
Position & motion of objects	●		
Life Science			
Characteristics of organisms			
Life cycles of organisms			
Organisms & environments			
Earth and Space Science			
Properties of earth materials			
Objects in the sky		●	
Changes in earth and sky		●	
Science and Technology			
Ability to distinguish between natural objects and objects made by humans			
Ability of technological design	●	●	
Understanding about science and technology	●		
Science in Personal & Social Perspectives			
Personal health			
Characteristics & changes in populations			
Types of resources			
Changes in environments		●	
Science and technology in local challenges			
History and Nature of Science			
Science as a human endeavour	●	●	

Mad Science Productions Correlations to the Common Framework of Science Learning Outcomes by the Council of Ministers of Education, Canada

Mad Science Productions shows and educational packages meet the following requirements outlined in the Common Framework of Science Learning Outcomes by the Council of Ministers of Education, Canada.

Kindergarten

Exploring the World with Our Senses
✓Don't Try This at Home
✓Taking the World by Storm

Grade 1

Life Science
Needs and Characteristics of Living Things – Students can observe similarities and differences and develop an understanding of the general characteristics of living things.

Materials and Our Senses – Our awareness of our environment – and the many materials found within it – are based on our sensory experiences. Through guided experiences that require careful and critical use of the senses, students can be encouraged to refine and become aware of their skills of observation.
✓Don't Try This at Home
✓Taking the World by Storm

Earth and Space Science
Daily and Seasonal Changes – In observing their environment, students become aware of things that change, including changes in physical factors, such as temperature, wind, or light, and changes in plants and animals found near their home.
✓Taking the World by Storm

Air and Water in the Environment – Air and water are all around us. Through investigations, students learn about changes and interactions of air and water when they are heated or cooled, and about their movement through the environment.
✓Don't Try This at Home
✓Taking the World by Storm

Grade 2

Life Science
Animal Growth and Changes – Students can observe that all animals grow and change from their earliest beginnings until they reach their full adult condition. The form and pattern of this growth distinguish one kind of animal from another and are sources of interest for children.

Physical Science
Liquids and Solids – Students examine materials in their environment and they become aware of a wide array of similarities and differences in their properties: the way they look, the way they feel, and the way they respond to environmental change. The categories of liquid and solid provide one way for students to organize their understanding of materials.
✓Don't Try This at Home
✓Taking the World by Storm

Relative Position and Motion – Through observation and the use of specific language, students develop the ability to describe where things are and how they are moving, and share their experience with others.
✓Don't Try This at Home

Earth and Space Science
Air and Water in the Environment – Through investigations, students learn about changes and interactions of air and water when they are heated or cooled, and about their movement through the environment. In the process, students will discover that water is important to us in many ways.
✓Taking the World by Storm

Grade 3

Physical Science
Materials and Structures – Students learn about the nature of materials, not just by observing them but, more importantly, by using them – sometimes in their original form and sometimes as things the students themselves construct. The focus for students is on building things, and on selecting and using materials to fit the task at hand.
✓Taking the World by Storm

Invisible Forces – Students learn that magnetic forces and electric forces both involve attraction and repulsion, but have different origins and involve different kinds of materials. Students discover a variety of ways these forces can be applied or can affect their daily life,

Grade 4

Physical Science
Light – Students become familiar with the properties of light by observing how light interacts with various objects in the environment.
✓Taking the World by Storm

Sound – Sound is a phenomenon that can be observed, measured, and controlled in various ways. Learning how sound is caused by vibrations is important as students explore both how sound travels and factors that affect the sounds that are produced.

They should be provided with opportunities to learn that rocks are used for many things within a community and that rock characteristics help determine their use.

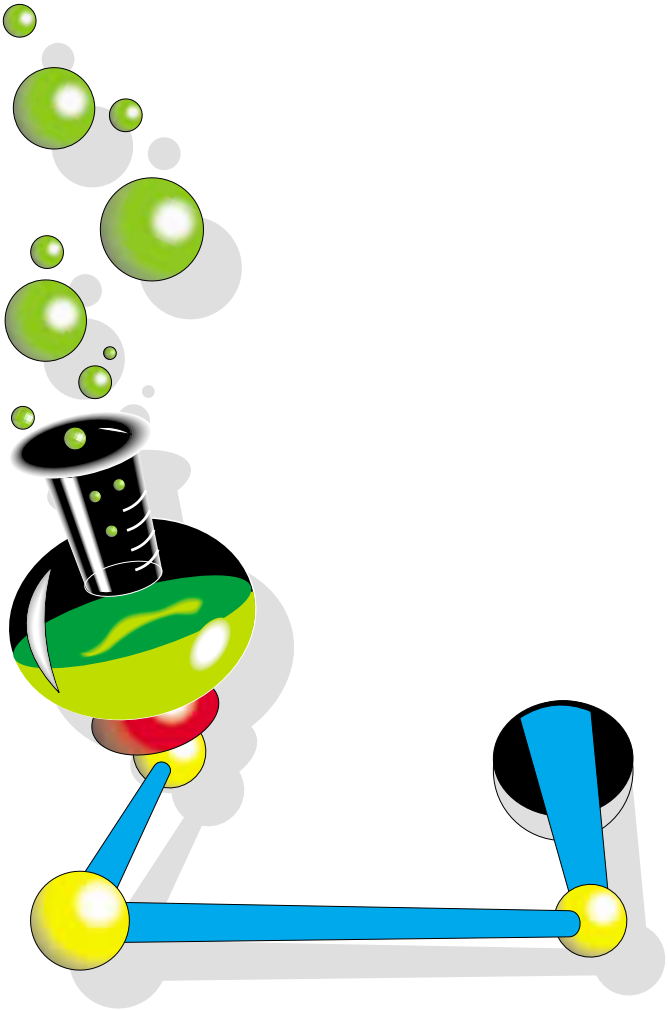
Earth and Space Science
Rocks, Minerals, and Erosion – In addition to exploring the living things around them, students should also become familiar with the earth materials that make up their world.

Grade 5

Physical Science
Properties and Changes in Materials – Students learn that the form a material takes, including its shape and structure, can be modified as required. They also learn that material substances themselves can be changed, and that some changes involve the production of new materials through reactions that are not reversible.

Forces and Simple Machines – The study of motion and the forces causing motion help students begin to build a more sophisticated understanding of forces. Students are able to move from qualitative to simple quantitative descriptions of forces acting on objects as they manipulate simple machines.

Earth and Space Science
Weather – Students should be provided with opportunities to realize that daily weather conditions are not the result of random occurrences, but rather are part of larger systems and patterns that can be predicted on both a short-term and seasonal basis.
✓Taking the World by Storm



Grade 6

Electricity – Students encounter electricity every day of their lives. A basic understanding of how electricity works can help students recognize the need for safe practices when around electricity, begin to realize that they have control over how much electricity they use in the home and at school, and begin to understand the impact energy consumption has on electricity as a resource.

Flight – Students learn to appreciate the science and technology involved as they investigate how things fly and develop and test a variety of prototype devices.
✓Don't Try This at Home

Earth and Space Science
Space – Space science involves learning about objects in the sky to discover their form, their movements, and their interactions. Students learn that manned and unmanned probes and earth-based devices are contributing to our knowledge of space, and that new capabilities are being developed for monitoring the Earth, for communications, and for the further exploration of space.

Welcome to the World of Mad Science

In March 1985 brothers Ariel and Ron Shlien, teenagers at the time, began launching rockets at birthday parties in their neighborhood. They quickly realized that their means of extra income was very appealing to educators, parents, after school programs and community centers. Fun, cool, hands-on science experiments were in demand. As a result, the first franchise was opened in 1994 and has grown to include over 120 franchises all over the world.

The franchise system, which continues to expand, is comprised of a network of thousands of Mad Scientists who work with schools, camps, community centers, and scout groups to spark imaginative learning in millions of elementary school children. All of the programs are inquiry based, age appropriate and are tested by both children and scientists prior to their integration into programs.

Mad Science sparks the imagination and curiosity of children everywhere. Our array of programming fosters confidence in children as potential scientists and engineers.

Workshops
This is a hassle-free and convenient way to bring hands-on science programs directly into your class. All workshops meet state and provincial curriculum requirements and offer teachers the flexibility to continue enriching their class with pre and post science activities. Children from kindergarten to grade 6 can learn about the intriguing world of light, sound, electricity, physical science, chemistry and so much more.

After School Programs
Mad Science sparks imaginative learning when school is out! We offer fun, hands-on science classes that will keep your students entertained and engaged. After-school programs are held during the lunch hour or after classes, and typically last from four to eight weeks. Parents pay a low, all-inclusive fee, with no cost to the school. Your students will create and take home their own model rockets, Mad Science Putty, periscopes and lots more!

Birthday Parties
Mad Science Birthday parties are exciting, high energy and interactive shows that make all children feel extra special on their birthday. Our edu-taining Mad Scientists come to your house or party room to animate the children with bubbling potions, laser lights, spectacular chemical magic, slippery slime and much more!

Special Events
Thrill and captivate your school assemblies with an extraordinary Mad Science Special Event. In large groups, children will participate in conjuring up foggy dry ice storms, taking a float on a Mad Science hovercraft, making magic mud and altering voice waves. Mad Science Events can be customized to suit any group size, any theme and any budget.

Pre-School
Mad Science pre-school workshops are developmentally appropriate and cover science that is relevant to preschoolers. Science is made fun with hands-on and minds-on programming such as colour, sound, sight, dinosaurs and much, much more! Children are further enthralled with imaginative projects they make and take home, and teachers can continue the learning process using the Mad Science Teacher's Resource Package.

Camps
Our summer camp programming relates science to life for children. With interactive and unique activities, children learn to discover the world around them with fascinating experiments such as testing the soil for "Martian" life, discovering pollution solutions by baking nachos with solar power and by teaming up with camper engineers to build bridges, domes and pyramids.

For more information about Mad Science in your area, please call 1-877-900-7300 or visit our website at www.madscience.org.

Acknowledgments

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