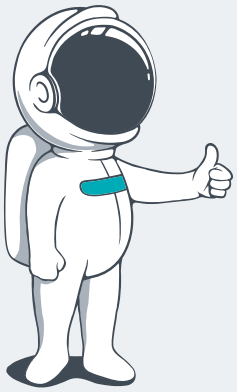
Welcome to STARBASE

During your visits...

Our **GOAL** -
is to create a positive STEM-based experience for your students.

Our **FOCUS** -
is to provide hands-on activities where all students feel welcomed and a part of our team.

Our **Belief** -
is to inspire curiosity by creating unforgettable memories.



In this guidebook, you will find...

- Tips
- Daily Schedule
- Career Tours Information
- Battle Creek Air National Guard Base Fun Facts
- Lesson Objectives, Standards, & Vocabulary
- Lesson Reviews, & Printable Extension Activities

Note:

STARBASE has 2 classrooms; however, both classes cover the same material.

The list of activities in this resource book are subject to change as needed.

TIPS for an exceptional STARBASE experience

FEEL FREE TO...

- √ JUMP IN when we are teaching and make connections for your students to what they have learned, are learning, or will learn in your classroom!
- √ ROAM about the classroom, supporting students who need assistance with activities or behavior.
- √ MAKE the decision to leave a student at school if you feel they are not ready for STARBASE.
- √ TAKE as many pictures as you like and post them to school-related sites. Sometimes having students bring their phones and cameras is a distraction. You "championing" this task and sharing it with students is a splendid option! We also have a STARBASE Battle Creek Facebook group where we post pictures.
- √ CONTACT the Director if concerns arise. Please don't wait! We can often solve problems if you reach out early, which allows us to ensure your class has an exceptional experience.

PLAN ON HELPING WITH...

- √ ACTIVITIES: Most of what we conduct needs extra hands to facilitate. Since we do not know your students like you do, your presence is essential for success.
- √ MONITORING bathroom breaks, free time, and lunch.

REMIND YOUR CHAPERONES TO...

- √ BE RESPECTFUL: They should restrict phone calls, texting, and conversations amongst themselves to the hallway, away from students. Loud conversations in the classroom are disruptive for students and the STARBASE instructors trying to provide your students a rewarding experience.

REMIND STUDENTS TO...

- √ BRING THEIR LUNCH before they board the bus. While we try to make some food available for students who forget their lunches, we are not equipped or funded to provide food regularly.
- √ PARTICIPATE: Please encourage student participation: answering questions, sharing ideas, etc. The STARBASE experience grows exponentially with increased student involvement! We all learn from each other!

BE MINDFUL OF...

- √ STUDENTS EXHIBITING ANY SIGNS OF ILLNESS: If students arrive at STARBASE and staff deems they are too ill to participate, we will require a call to their parents. Parents will need to pick up sick children at the front contractor gate. While we do not want any student to miss an exciting day with us, we see different classes each day providing an opportunity for pathogens to spread quickly.

Battle Creek
DoD STARBASE
A Department of Defense Youth Program

The STARBASE Battle Creek Team:

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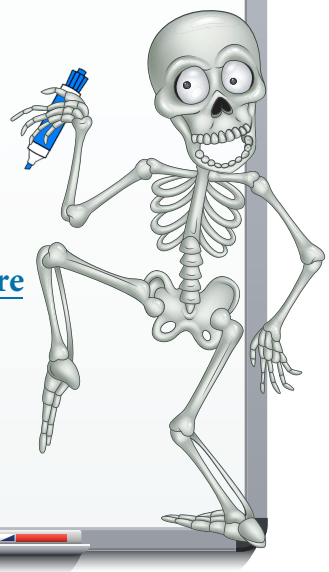
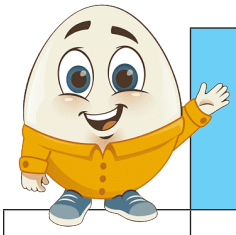
Dave Carl, Teacher Assistant - dcarl@starbasebattlecreek.org
Robin Goodwin, Teacher Assistant

Daily Schedule

- ✓ Welcome
- ✓ Overview of Agenda
- ✓ Activities
- ✓ Whole Group Snack & Bathroom /Brain Break
- ✓ Activities
- ✓ Lunch/Movie/DVDs - **You choose the DVD!**
  Bugs Life, Finding Nemo, Monsters, Inc, & More
- ✓ Cleanup and Bathroom Break
- ✓ Activities
- ✓ Dismissal





	Instructor: Amy Markos Instructor Assistant: Dave Carl or Robin Goodwin	Instructor: Mary Clark Instructor Assistant: Dave Carl or Robin Goodwin
Day 1	Teamwork CAD Intro - Scavenger Hunt Spheros Pop Goes the Fizz	Teamwork CAD Intro - Scavenger Hunt Spheros Pop Goes the Fizz
Day 2	Newton's Law Intro Straw Rockets Energy Explorations Eggbert and the EDP	Robotics Guest Speaker Chromatography CAD - Gyrosphere Assembly
Day 3	Newton's Law Intro Straw Rockets Energy Explorations Eggbert and the EDP	Robotics Guest Speaker Chromatography CAD - Gyrosphere Assembly
Day 4	Rocketry - Newton's Laws review Rocket Construction Aviation Explorations Western College of Aviation Tour Rocket Launch	Rocketry - Newton's Laws review Rocket Construction Aviation Explorations Western College of Aviation Tour Rocket Launch
Day 5	Buoyancy Happy Atoms Molecular Models Exploration CAD - STARBASE Keychain sketch	Buoyancy Happy Atoms Molecular Models Exploration CAD - STARBASE Keychain sketch

- ❖ ***Classes will be referred to as either the Yankee group or the Zulu group.***
- ❖ ***Classes will alternate teachers each week and the schedule may change based on need.***

WESTERN MICHIGAN UNIVERSITY
College of Aviation

Career Tours & Guest Speakers

"A field trip within a field trip"

Western Michigan College of Aviation

Overview:

Your students will take a field trip to Western Michigan College of Aviation just a few miles from STARBASE. Upon arrival, a student ambassador from the college will lead students through several aviation-themed activities. Please separate your class into 2 groups based on the following colored groupings:

Yankee: A *Purple* group and a *Yellow* group

Zulu: A *Red* group and a *White* group

Students will have the opportunity to tour the facility while rotating through stations that allow students to be up close and personal with an aircraft, walk on the flight line, learn how to create circuits (the epi-center of an air craft) and tour a control tower. Students will also play an informative game of Aviation Jeopardy. Jeopardy educates students on aviation vocabulary, important people in aviation history as well as tools and equipment used in flight. We look forward to inspiring students to achieve a career in STEM.

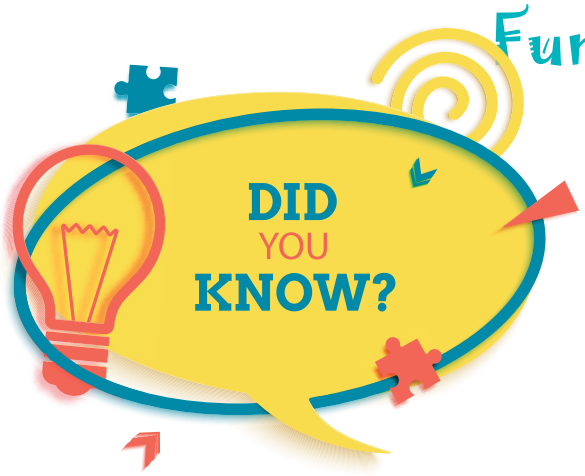
Fun Facts:

- One of the most advanced training fleets and equipment available in collegiate aviation
- Second ranked aviation college in the United States
- 92% flight and tech ops post-graduation success.
- Scholarships available
- With over 1,150 resident undergraduate students it is one of the largest aviation programs in the U.S/Largest in the Mid-West.
- Is home to a fleet of 28 Cirrus SR20's

*****Besides touring Western, students will also learn about the mission on the base, how remotely piloted aircrafts work as well as how STEM relates to many career fields through the briefings of different guest speakers who belong to the 110th ANG Base team.**

Battle Creek Air National Guard Base

Fun Facts



STARBASE is a DoD (Department of Defense) funded program located at Battle Creek Air National Guard Base.

1. Battle Creek Air National Guard Base is home station for nearly 1,000 diverse men and women – Airmen, federal, state, and civilian employees – who have together established a proud heritage of service in southwest Michigan dating back to 1947.

2. The 110th Wing traces its lineage back to WWII with the 361st Fighter Group, 375th Fighter Squadron.

3. Battle Creek ANGB is a former fighter base that operated the A-10 Thunderbolt aircraft until 2009 and C-21 Lear jets until 2013. Most facilities and infrastructure required to support a flying operation remain in place in Battle Creek.

4. The 110th Operations Group flies the MQ-9 "Reaper" remotely piloted aircraft (RPA) in support of overseas contingency operations 24/7, 365 days a year.

5. In 2015, the 110th Airlift Wing was re-designated the 110th Attack Wing. Its MQ-9 Reaper operations facility was fully activated in February 2017. In January 2018, the 272D Cyber Operations Squadron was activated, completing the 110th Attack Wing's transition to a multi-mission capability set.

6. Significant deployments included:
   - 88 members deployed with 110th Operations Group at home station conducting MQ-9 operations abroad
   - 23 members deployed in support of Air Expeditionary Force deployments (AEF) worldwide
   - Over 100 members supported COVID-19 missions in the state of Michigan

7. In participation with Talons Out Honor Flight, the 110th Wing Honor Guard participated in a tribute to the nation's oldest living veteran at Oakland International Airport, Waterford, Michigan.

8. The 110th Operations Group is researching the possibility of supporting an MQ-9 Launch and Recovery Element (LRE); or gaining the capability through partnerships to launch and recover MQ-9 aircraft from inside Michigan to be able to capitalize on what Michigan has to offer

This information is provided by the 127th Wing website. For more information go to https://www.127wg.ang.af.mil

This information is provided by the 110th Wing website. For more information go to https://www.110wg.ang.af.mil

Onshape for Students

RESOURCES FOR GETTING STARTED

Onshape
A PTC Business

Onshape requires zero software installation, can be deployed within minutes, and can be accessed from any device, anywhere, anytime.

1 CREATE AN ACCOUNT

Onshape is entirely online – there's nothing to install.
Create your free account here and get up and running in minutes.

2 GET ORIENTED

I'm new to CAD:
New CAD users should start with the Introduction to CAD learning pathway.

I've used CAD before:
Get familiar with basic features & capabilities with the Onshape Fundamentals learning pathway.

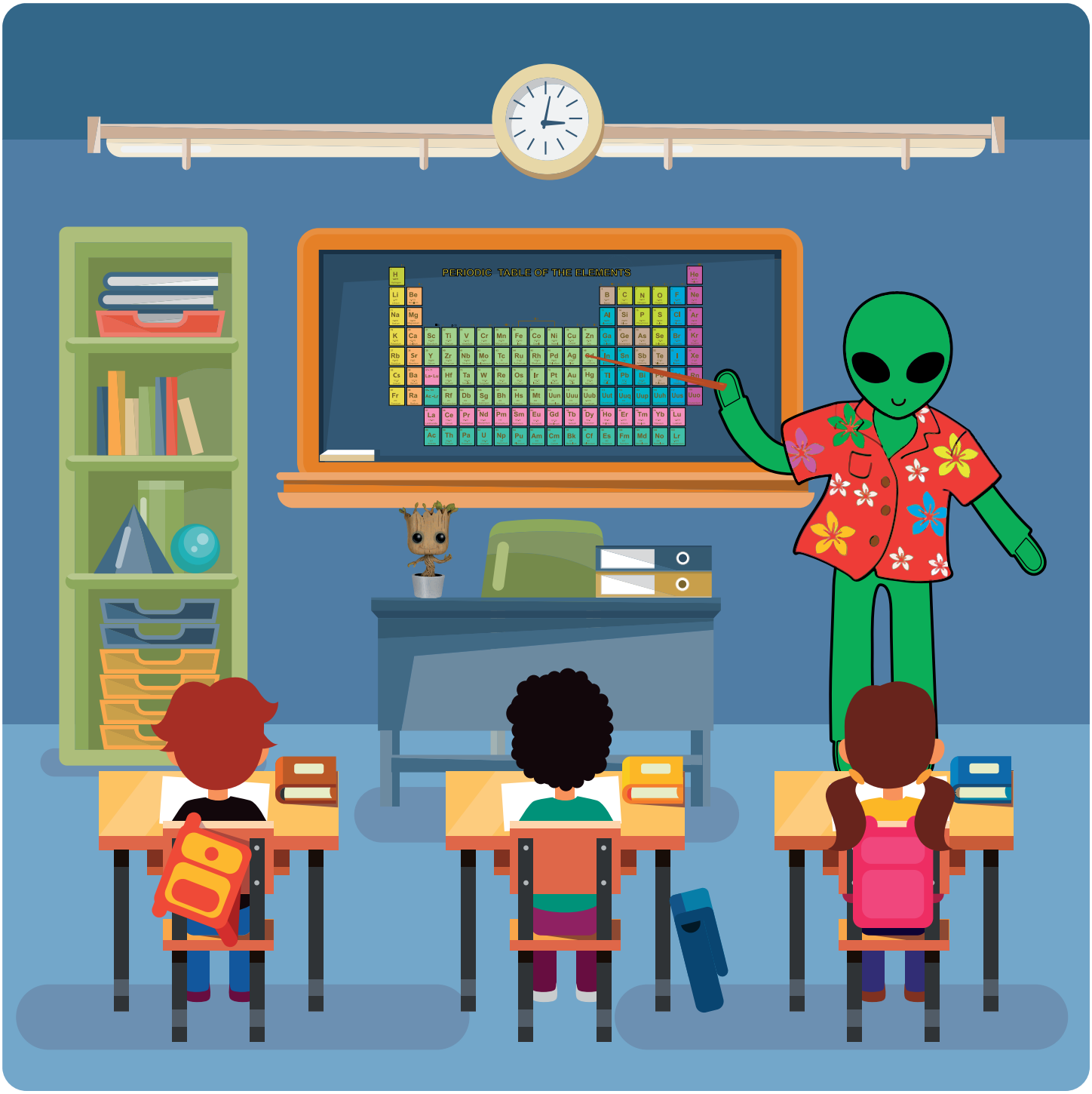
3 EXPLORE ADDITIONAL RESOURCES

- Onshape Essentials Webinar
- Onshape Primer
- Onshape Instructor Community
- Onshape Learning Center
- Onshape Forum
- Onshape Help Center

For additional information or questions about Onshape for Education contact us at
academicsuccess@ptc.com

Lesson

Objectives, Standards, & Vocabulary



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TEACHER: Guide

Mathematics: Number Relationships
Atmospheric Ratios

Lesson Objective

Students will...

- Solve problems using ratios expressed as a fraction, a decimal, or a percent.

Standards

4-NBT-3	Use place value understanding to round multi-digit whole numbers to any place.
4-NF-6	Use decimal notation for fractions with denominators 10 or 100. For example, rewrite 0.62 as 62/100, describe a length as 0.62 meters, locate 0.62 on a number line diagram.
5-NBT-1	Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left
5-PS1-1	Develop a model to describe that matter is made of particles too small to be seen.

Vocabulary

Atmosphere → The envelope of gases surrounding the earth or another planet.

Decimal → A linear array of digits that represent a real number, every decimal place indicating a multiple of a negative power of ten. For example, the decimal .1 equals 1⁄10, 0.12 equals 12⁄100, 0.003 equals 3⁄1000; also called decimal fraction.

Elements → Substances made of only one type of atom. Example: Oxygen, O_2

Fraction → An expression that indicates the quotient of two quantities, such as 1⁄3.

Percent → One part in a hundred. For example, 62 percent (also written 62%) means 62 parts out of 100.

Ratio → The quantitative relation between two amounts showing the number of times a value contains or is contained within the other.

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TEACHER: Guide

Science: Characteristic Properties
Buoyancy

Lesson Objective

Students will...

- Understand the definition of a fluid, any substance that flows and has no fixed shape.
- Understand that both liquids and gasses are fluids.
- Understand that there are two forces acting on an object in a fluid, buoyant force and gravitational force.
- Predict and witness what occurs when the two forces are equal and not equal.
- Use modeling clay to create boats and to comprehend the principle of buoyancy.

Standards

5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Vocabulary

Buoyancy → The property of a fluid to exert an upward force on a body that is wholly or partly submerged in it.

Density → The amount of mass per unit volume. Something that is more tightly packed is denser than something that has more spaces between the molecules.

Float → To be suspended in or move through space as if supported by a liquid.

Fluid → A substance (either a liquid or a gas) that is capable of flowing and has no fixed shape.

Gravity → The natural attraction between physical bodies, especially when one of the bodies is a celestial body, such as the earth.

Mass → The amount of matter in an object, independent of gravity. Mass is different from weight of an object. Weight is the gravitational effect on mass.

Sink → To go below the surface of water or another fluid.

Surface Area → The measure of how much exposed area an object has, expressed in square units.

Volume → Amount of space an object occupies expressed in cubic units.

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TEACHER: Guide

Engineering: Engineering Design Process (EDP)
Eggbert

Lesson Objective

Students will...

- Be inspired by engineering design as both a profession and a necessary activity in exploring problems and solutions in day-to-day life.
- Learn and discuss the steps of the Engineering Design Process (EDP) and Newton's 1st Law* as well as expand on their meaning through examples.
- Employ the EDP and teamwork to solve a design challenge.

***Newton's 1st Law (Inertia)**
An object at rest will remain at rest unless acted upon by an outside force. An object in motion will remain in motion unless acted upon by an outside force.

Vocabulary

Acceleration → The rate of change of the velocity of a moving body. An increase in the magnitude of the velocity of a moving body (an increase in speed) is called a positive acceleration; a decrease in speed is called a negative acceleration.

Force → A push or a pull that gives energy to an object, sometimes causing a change in the motion of the object.

Inertia → The tendency of an object to resist a change in motion. An object at rest, will remain at rest unless a force acts on it. An object in motion will continue in the same direction at the same speed unless an outside force acts on it. Newton's First Law of Motion addresses inertia.

Momentum → The product of an object's mass and velocity, which determines how difficult it is to stop the object's motion.

Kinetic Energy → Energy in motion.

Potential Energy → Energy that is stored within an object, not in motion but capable of becoming active.

Standards

5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

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TEACHER: Guide

Science: Science Fundamentals

Energy Exploration

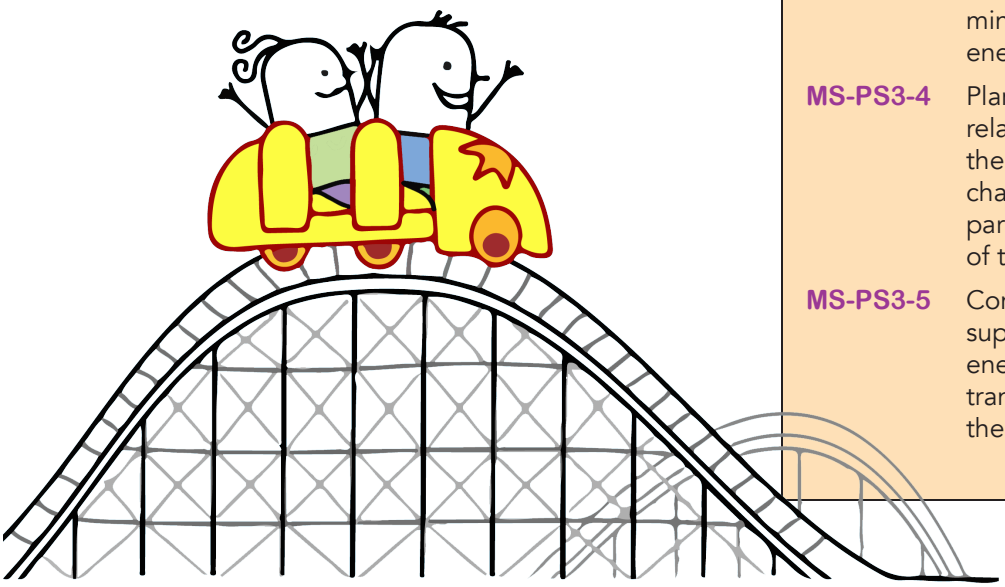
Lesson Objective

Students will...

- Understand that energy transfers in many ways, such as heat, light, electricity, mechanical motion, sound and the nature of a chemical.
- Understand all energy can be classified as potential energy or kinetic energy.
- Be introduced to and understand some of the different types of potential and kinetic energy.
- Understand the Law of Conservation of Energy, energy cannot be created or destroyed in a closed system.

Standards

4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.
4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
4-PS3-3	Ask questions and predict outcomes about the changes in energy that occur when objects collide.
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
MS-PS3-2	Develop a model to describe that when the arrangements of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
MS-PS3-4	Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.



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A Department of Defense Youth Program

TEACHER: Guide

Science: Science Fundamentals

Energy Exploration

Vocabulary

Atom → The smallest particle of an element that retains all the properties of that element.

Chemical Energy → That part of the energy in a substance that can be released by a chemical reaction.

Elastic Energy → Energy stored in objects that are stretched.

Electrical Energy → Energy made available by the flow of electric charge through a conductor.

Energy → A measure of the capacity to do work, expressed as the work that it does, measured in joules.

Gravitational Energy → Energy stored in an object when it is above the Earth's surface.

Kinetic Energy → Energy of movement. Energy comes from moving.

Law of Conservation of Energy → States that energy cannot be created or destroyed in a closed system.

Light (Radiant) Energy → Energy in a form that can radiate or travel in waves, generally electromagnetic energy such as energy from the sun.

Magnetic Energy → Energy causing a push or a pull.

Mechanical Energy → The sum of potential energy and kinetic energy; the energy associated with the motion and position of an object.

Nuclear Energy → Energy released by a nuclear reaction (either through nuclear fission or nuclear fusion) and used as a power source.

Potential Energy → Energy that is stored within an object, not in motion but capable of becoming active. A raised weight, coiled spring, or charged battery has potential energy.

Sound Energy → Energy present in a sound wave.

State of Matter → Distinct forms in which material can exist: solid, liquid, gas, and plasma.

System → A group of interacting, interrelated, or interdependent elements forming a complex whole.

Thermal Energy → Internal energy present in a system due to its temperature.

Work → Work is done upon an object when a force causes it to be moved or changed.

DoD STARBASE Battle Creek
A Department of Defense Youth Program

TEACHER: Guide

Technology: Applying Technology
Robotics - Lego Spikes

Lesson Objective

Students will...

- Learn what coding is.
- Practice coding a robot using Lightbot app on iPads.
- Employ current and emerging technologies to solve a simulated or real-world problem.
- Use multiple processes and diverse perspectives to explore alternative solutions.
- Be exposed to a symbol-based programming language.

Vocabulary

Algorithm → A sequence of steps designed for programming a computer to solve a specific problem.

Bug → A defect in the code or routine of a program.

Code → A system of symbols and rules that serve as instructions for a computer.

Debugging → To search for and eliminate malfunctioning elements or errors in a computer program.

Program → To provide a machine with a set of coded working instructions.

Standards

1B-AP-08	Compare and refine multiple algorithms for the same task and determine which is the most appropriate.
1B-AP-09	Create programs that use variables to store and modify data.
1B-AP-10	Create programs that include sequences, events, loops, and conditionals.
1B-AP-16	Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair test in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MITECS 1.c	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety or ways.
MITECS 1.d	Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use, and troubleshoot current technologies, and are able to transfer their knowledge to explore emerging technologies.
MITECS 4.b	Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

DoD STARBASE Battle Creek
A Department of Defense Youth Program

TEACHER: Guide

Science: Science Fundamentals
Physical & Chemical Changes

Lesson Objective

Students will...

- Understand that energy transfers in many ways, such as heat, light, electricity, mechanical motion, and sound.
- Differentiate between a physical change in which matter changes state or form and a chemical change in which one or more substances are formed.
- Conduct a hands-on experiment featuring a chemical reaction, illustrating an endothermic reaction, where several compounds are combined.
- Observe an additional experiment, also featuring a chemical reaction demonstrated by a STARBASE instructor, illustrating an energy transfer that generates heat (an exothermic reaction).

Standards

5-PS1-4	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
MS-PS1-2	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
MS-PS1-6	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Vocabulary

Atom → The smallest particle of an element that retains all the properties of that element.

Beaker → A cylindrical, flat-bottomed container used in laboratories, usually made of glass and having a pouring lip.

Catalyst → A substance that increases the rate of a chemical reaction without itself undergoing any permanent change.

Chemical Energy → That part of the energy in a substance that can be released by a chemical reaction.

Chemical Formula → A model that gives information about the atoms that make up a particular chemical compound. They are used in chemical equations to represent how atoms are rearranged in a chemical reaction.

Compounds → Substances made of two or more types of atoms. Example: water, H_2O.

Elements → Substances made of only one type of atom. Example: oxygen, O_2.

Endothermic Reaction → A chemical reaction accompanied by the absorption of heat.

Exothermic Reaction → A chemical reaction in which energy is released in the form of heat.

Gas → A state of matter that involves molecules moving very vigorously without a defined shape.

Graduated Cylinder → A cylindrical instrument used to measure the volume of liquids per markings on the side of the container.

Liquids → A state of matter that involves molecules moving and sliding past each other without a defined shape.

Molecule → The smallest particle of a substance that retains the chemical and physical properties of the substance and is composed of two or more atoms.

Solids → A state of matter that involves molecules in a fixed position with a defined shape.

Temperature → A measure of the average kinetic energy of the particles in a sample of matter, expressed in terms of units or degrees designated on a standard scale.

DoD STARBASE Battle Creek
A Department of Defense Youth Program

TEACHER: Guide

Science: Science Fundamentals
Molecular Models

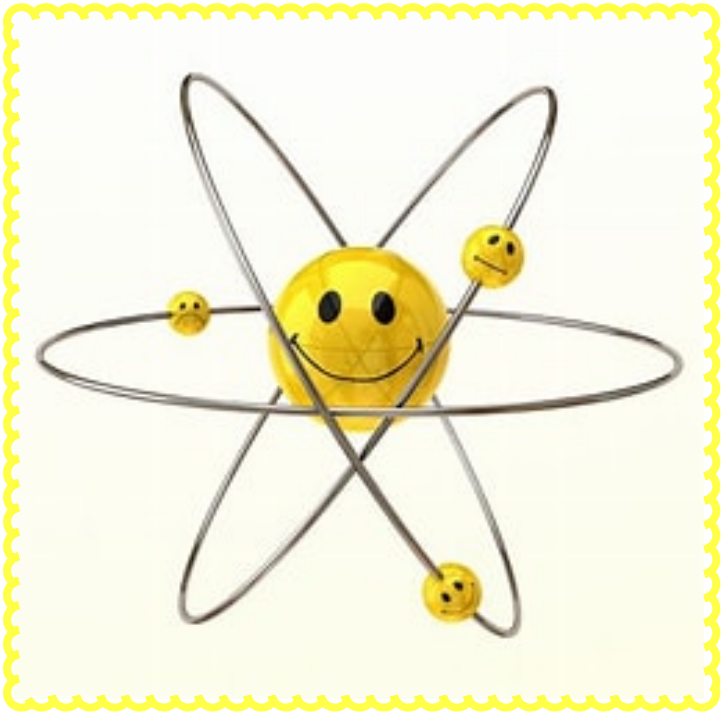
Lesson Objective

Students will...

- Review matter (living and nonliving), atoms, elements, the periodic table, compounds, and molecular structures.
- Discover that atoms combine to form molecules, and that molecules formed from different types of atoms combine to form compounds.
- Learn molecular nomenclature and build molecular models using kits.

Standards

5-PS1-1	Develop a model to describe that matter is made of particles too small to be seen.
MS-PS1-1	Develop models to describe the atomic composition of simple molecules and extended structures.



Vocabulary

Atom → The smallest particle of an element that retains all the properties of that element.

Chemical Formula → A model that gives information about the atoms that makes up a particular chemical compound. They are used in chemical equations to represent how atoms are rearranged in a chemical reaction.

Compounds → Substances made of two or more types of atoms. Example: Water (H_2O).

Electrons → Negatively charged particles that exist in a cloud surrounding the nucleus.

Elements → Substances made of only one type of atom. Example: Oxygen, O_2.

Molecule → The smallest particle of an element or compound that retains the chemical and physical properties of the substance, composed of two or more atoms chemically bonded.

Neutron → A subatomic particle with roughly the mass of a proton and no electric charge.

Nucleus → The center or core of an atom. It is made up of protons and neutrons.

Periodic Table of Elements → A list of elements ordered in rows according to atomic number (number of protons in the nucleus of an atom of the element). The rows are arranged so that elements with similar chemical properties occur in the same column.

Protons → Subatomic particles with a positive electric charge found in the nucleus of an atom.

Single and Double Bonds → A single bond is a chemical bond in which one pair of electrons is shared by two atoms in a molecule. A double bond is a chemical bond in which two pairs of electrons are shared by two atoms in a molecule.

DoD STARBASE Battle Creek
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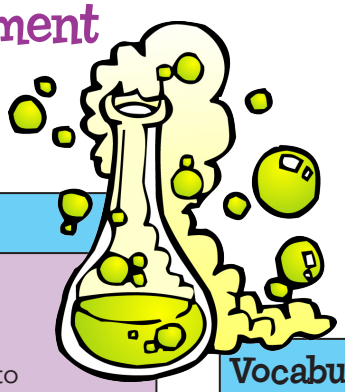
TEACHER: Guide

Mathematics: Measurement
Pop Goes the Fizz



Lesson Objective

Students will...

- Use a real-world scenario to apply appropriate standard units and tools to measure length, liquid volume, and mass.
- Be given a directive to determine the least amount of "fuel" (Alka Seltzer) needed to launch a "rocket" (film canister) to a desired height of 140 cm.
- Utilize teamwork as they test four different amounts of Alka Seltzer in their rockets.
- Analyze their data and report their results.

Vocabulary

Effervescence → The bubbling of a solution due to the escape of gas. The gas may form by a chemical reaction or by coming out of solution after having been under pressure, such as a carbonated drink.

Mass → The amount of matter in an object.

Mean → The average value of a set of numbers.

Metric System → Universal system of measurement used by scientists all over the world; based on 10 and powers of 10.

Volume → The amount of space an object occupies.

Standards

5-PS1-4	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
3-5-ETS1-1	Define a simple design problem reflecting a need or want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
5.NBT	Perform operations with multi-digit whole numbers and with decimals to the hundredths.
5.NF	Use equivalent fractions to add and subtract fractions.
5.MD	Represent and interpret data.
6.EE	Represent and analyze quantitative relationships between dependent and independent variables.

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Motion & Forces
Rocketry- Water Rockets

Lesson Objective

- **Students will examine Newton's Three Laws of Motion**
- **Students will understand how a rocket launch demonstrates an object at rest being at rest until being acted upon by an outside force (concept of inertia)**
- **Students will understand how a rocket launch demonstrates an action with an equal and opposite reaction**

Standards

5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-ETS1-2	Evaluate competing design solution using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Vocabulary

Acceleration→the rate of change of the velocity of a moving body. An increase in the magnitude of the velocity of a moving body (an increase in speed) is called a positive acceleration; a decrease in speed is called a negative acceleration.

Constant→ parts of the trial that remain the same each time the trial is repeated.

Force→ a push or a pull that gives energy to an object, sometimes causing a change in the motion of the object.

Gram →standard metric unit used to measure the mass of an object.

Hodometer→ a device for measuring the length of a path, consisting of a wheel of known circumference attached to a rod held in the hand, and pushed along a surface, which is usually the ground or a floor.

Inertia→ the tendency of an object to resist a change in motion. An object at rest will remain at rest unless an outside force acts on it. An object in motion will continue in the same direction at the same speed, unless an outside force acts on it. Newton's First Law of Motion pertains to inertia.

Kinetic Energy→ energy of motion.

Magnitude→ the greatness of size or amount.

Potential Energy→ energy that is stored within an object, not in motion but capable of becoming active.

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Motion & Forces

Rocketry- Water Rockets

Vocabulary

Scientific Law → a law generalizes a body of observations. At the time it is made, no exceptions have been found to a law. Scientific laws explain things, but they do not describe them. Also, a phenomenon of nature that has been proven to invariably occur whenever certain conditions exist or are met.

Velocity → the rate of motion in a particular direction.

Weight → measure of the pull of gravity on an object or substance. It is proportional to the mass. The greater the mass, the greater the weight.

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Math Curriculum Component
Fingerprint Analysis

Lesson Objectives

- Students will recognize that all fingerprints are unique to an individual.
- Students will understand fingerprints will remain unchanged during a person's lifetime, and have distinct patterns that can be classified and used for comparison.
- Students will collect data based on their fingerprint type and compare their findings to the class and national averages.
- Students will use fractions, decimals and percentages to represent their findings.

Standards

Geometry 5.G

-Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate place, and interpret coordinate values of points in the context of the situation.

-Classify two-dimensional figures in a hierarchy based on properties.

Operations & Algebraic Thinking 5.0 A

Generate two numerical patterns using two given rules. Identify apparent Relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns and graph the ordered pairs on the coordinate plane.

Vocabulary

Automated Fingerprint Identification System (AFIS) → A computer system that scans fingerprints from crime scenes and compares them with millions of others around the world.

Biometric → The measurement of physical characteristics, such as of individuals.

Fingerprint → An impression of the markings of the inner surface of the finger.

Forensic Science → The application of science to criminal and civil laws, mainly-on the criminal side-during criminal investigation, as governed by the legal standards of admissible evidence and criminal procedure. [Fingerprint Analysis]

Ridgeology → An evaluative method of friction ridge identification that have been established and verified through years of research.

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TEACHER: Guide

Engineering: 3-D Computer Aided Design
PTC OnShape

Lesson Objective

Students will...

- Complete a scavenger hunt that will expose students to various Onshape tools
- Use tools such as extrude, chamfer, dimension, and more to sketch a 3D printed STARBASE key chain.
- Start with a base piece, add parts, and customize an assembly of their own Gyrosphere

Standards

4-G-1	Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.
MITECS 1.c	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
MITECS 1.d	Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use, and troubleshoot current technologies, and are able to transfer their knowledge to explore emerging technologies.
MITECS 3.c	Curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections of conclusions.
MITECS 4.a:	Know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems.
MITECS 4.b	Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
MITECS 4.c	Develop, test, and refine prototypes as part of a cyclical design process.
MITECS 4.d	Exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.

Vocabulary

CAD → Computer Aided Design.

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TEACHER: Guide

Science: Motion & Force
Straw Rockets

Vocabulary

Acceleration → The rate of change of the velocity of a moving body. An increase in the magnitude of the velocity of a moving body (an increase in speed) is called a positive acceleration; a decrease in speed is called a negative acceleration.

Constant → Parts of the trial that remain the same each time the trial is repeated.

Force → A push or a pull that gives energy to an object, sometimes causing a change in the motion of the object.

Gram → Standard metric unit used to measure the mass of an object.

Hodometer (Measuring Wheel) → A device for measuring the length of a path, consisting of a wheel of known circumference attached to a rod held in the hand, and pushed along a surface, which is usually the ground or a floor.

Inertia → The tendency of an object to resist a change in motion. An object at rest will remain at rest unless an outside force acts on it. An object in motion will continue in the same direction at the same speed, unless an outside force acts on it. Newton's First Law of Motion pertains to inertia.

Kinetic Energy → Energy of motion.

Magnitude → The greatness of size or amount.

Mass → The amount of matter in an object, independent of gravity. Mass is different from weight of an object. Weight is the gravitational effect on mass.

Potential Energy → Energy that is stored within an object, not in motion but capable of becoming active.

Scientific Law → A law generalizes a body of observations. At the time it is made, no exceptions have been found to a law. Scientific laws explain things, but they do not describe them. Also, a phenomenon of nature that has been proven to invariably occur whenever certain conditions exist or are met.

Velocity → The rate of motion in a particular direction.

Weight → Measure of the pull of gravity on an object or substance. It is proportional to the mass. The greater the mass, the greater the weight.

Lesson Objective

Students will...

- Recognize examples of motion and force in the physical world.
- Be introduced to and will demonstrate that an object in motion will stay in motion or an object at rest will stay at rest unless acted upon by an outside force. (Newton's First Law, Inertia)
- Be introduced to and will demonstrate that the force of an object is equal to the object's mass multiplied by the object's acceleration (F=ma, Newton's Second Law)
- Be introduced to and will conclude that every action is followed by an equal and opposite reaction. (Newton's Third Law)

Standards

3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
5.NBT	Perform operations with multi-digit whole numbers and with decimals to the hundredths.
5.MD	Represent and interpret data.
6.EE	Represent and analyze quantitative relationships between dependent and independent variables.

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TEACHER: Guide

SEM - Science: Characteristic Properties
Chromatography

Lesson Objective

Students will...

- Review the difference between compounds (chemically combined substances) and mixtures (easily separated substances).
- Discover that a solution is a specific type of mixture in which one substance (a solute) is dissolved into another substance (a solvent).
- Recognize that one of the characteristics of a substance is solubility.
- Be introduced to chromatography as a process used to separate mixtures.

Vocabulary

Analytical Chemistry → A branch of chemistry that deals with the development and use of techniques for chemical measurement. These techniques are used in analyzing the chemical composition of substances.

Chromatogram → The pattern of separated substances obtained by chromatography.

Chromatography → Any of various processes of chemical analysis in which the constituents of a mixture are separated into distinct bands or spots on an absorbent material.

Compound → When two or more substances are chemically combined.

Medium → Intervening substance through which something else is transmitted or carried on.

Mixture → When two or more substances are mixed together, but not chemically combined; can be separated.

Solubility → The ability of a substance to dissolve; the quantity of a substance that may be dissolved in a given amount of solvent.

Solute → A substance dissolved in a solution; for solutions of fluids, the solvent is present in greater amounts than the solute.

Solution → A homogeneous mixture of two or more substances that can exist in any phase. An example of a solid solution is brass. An example of a liquid solution is aqueous hydrochloric acid. An example of a gas solution is air.

Solvent → The component of a solution that is present in the greatest amount; the substance in which the solute is dissolved.

Standards

5-PS1-4	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

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TEACHER: Guide

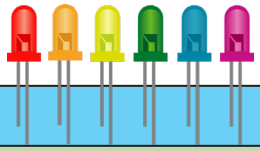
SEM - Science: Science Eploration

littleBits of Energy

Lesson Objective

Students will...

- Investigate current and/or emerging technological innovations.
- Identify current and /or potential real-world applications of technological innovations.



Vocabulary

Atom → An atom is the smallest particle of an element that retains all the properties of that element.

Closed Circuit → An electrical circuit providing an uninterrupted, endless path for the flow of current.

Conductor → A material or an object that conducts heat, electricity, light, or sound.

Dynamic Electricity → A flow of electrical charge.

Electrical Current → A flow of electricity through a conductor.

Electricity → The physical phenomena arising from the behavior of electrons and protons that is caused by the attraction of particles with opposite charges and the repulsion of particles with the same charge.

Electrons → Negatively charged particles that exist in a cloud surrounding the nucleus.

Open Circuit → An electrical circuit through which current cannot flow because the path is broken or interrupted by an opening.

Protons → Subatomic particles with a positive electric charge found in the nucleus of an atom.

Static Electricity → Electrical charge that accumulates on an object rather than flowing through it as a current.

Standards

4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MITECS 1.a	Articulate and set personal learning goals, develop strategies leveraging technology to achieve them, and reflect on the learning process itself to improve learning outcomes.
MITECS 1.c	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
MITECS 1.d	Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use, and troubleshoot current technologies, and are able to transfer their knowledge to explore emerging technologies.
MITECS 4.b	Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
MITECS 4.c	Develop, test, and refine prototypes as part of a cyclical design process.
MITECS 4.d	Exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.
MITECS 6.b	Create original works or responsibly repurpose or remix digital resources into new creations.

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TEACHER: Guide

SEM - Mathematics: Geometry
Sphero

Lesson Objective

Students will....

- Recognize geometric properties and relationships and apply them to other disciplines and simulated real-world problems.
- Be introduced to and utilize a block-based programming language, using an iPad app, to manipulate a robotic sphere to complete a challenge.
- Be introduced to and utilize a protractor to complete a challenge.
- Use spatial reasoning, geometric modeling, and many aspects of the Engineering Design Process in their efforts to complete a challenge.

Vocabulary

Angle → A figure formed by two rays having a common endpoint (vertex).

Geometry → The mathematics of the properties, measurement, and relationships of points, lines, angles, surfaces, and solids.

Orientation → Position or positioning with relation to the points of the compass or other specific directions.

Program → To provide a machine with a set of coded working instructions.

Protractor → A semicircular instrument for measuring and constructing angles, usually a flat semicircular transparent plastic sheet graduated in degrees.

Robot → A machine that is programmed to do work on its own, automatically.

Standards

Science

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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TEACHER: Guide

SEM - Mathematics: Geometry

Sphero

Standards

Math

4.MD.5 Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.

4.MD.6 Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.

Computer Science

1B-DA-07 Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea.

1B-AP-08 Compare and refine multiple algorithms for the same task and determine which is the most appropriate.

1B-AP-11 Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process.

1B-AP-15 Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended.

1B-AP-16 Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development.

Michigan Integrated Technology Competencies for Students

MITECS 1: Empowered Learner - Students leverage technology to take an active role in choosing, achieving, and demonstrating competency in their learning goals, informed by the learning sciences.

- **MITECS 1.a** Articulate and set personal learning goals, develop strategies leveraging technology to achieve them, and reflect on the learning process itself to improve learning outcomes.
- **MITECS 1.c** Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
- **MITECS 1.d** Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use, and troubleshoot current technologies, and are able to transfer their knowledge to explore emerging technologies.

MITECS 4: Innovative Designer - Students use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.

- **MITECS 4.b** Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
- **MITECS 4.c** Develop, test, and refine prototypes as part of a cyclical design process.
- **MITECS 4.d** Exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.

MITECS 5: Computational Thinker - Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

- **MITECS 5.c** Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Lesson Reviews and Printable Extension Activities

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Buoyancy

Fluids

1. What are the two characteristics that make something a fluid?

2. Which two states of matter are fluids?

Our Earth's Atmosphere

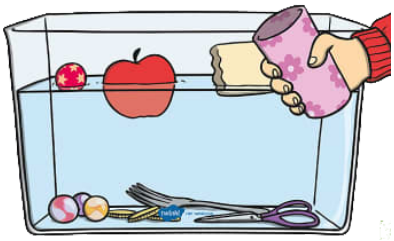
1. On average, what percentage of our earth's atmosphere is made up of each of these?

Nitrogen:_____ **Oxygen:**_____ **Water vapor & other gasses:**_____

Density

1. What is the density of fresh water?
2. Would these objects float or sink in fresh water?
   - Jelly bean (density = 1.45 g/cm^3): ☐ **Float** ☐ **Sink**
   - Apple (density = 0.96 g/cm^3): ☐ **Float** ☐ **Sink**
   - Wooden pencil (density = 0.68 g/cm^3): ☐ **Float** ☐ **Sink**

Float or Sink?



Clay Challenge

1. Were you able to get your clay to float when you redesigned it? ☐ **Yes** ☐ **No**
   - If yes, how much added mass did it hold?

2. What features of your design do you think helped make it float?

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Chromatography

Solubility

1. How are mixtures and compounds different?

2. In a solution, what do you call the substance that gets dissolved? (circle one)

   Solute **Solvent** **Solution**

3. In a solution, what do you call the substance that does the dissolving? (circle one)

   Solute **Solvent** **Solution**

Chromatography

1. What did you dissolve in your chromatography experiment?

2. Why did the chromatograms made from the suspects' black markers look different?

3. Who was guilty in the end?

4. How can chromatography be useful in forensics?

Stem Careers

1. **What are some jobs you could have in the future that involve chromatography?**

2. **What other industries use chromatography?**

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Energy Exploration

Energy

1. What are the two types of energy?

2a. Can energy be created?
☐ Yes ☐ No

2b. Can energy be destroyed?
☐ Yes ☐ No

3a. Can energy be transferred?
☐ Yes ☐ No

3b. Can energy be transformed?
☐ Yes ☐ No

Energy Around Us

Give an example of each of these forms of energy -think of something around your house or an activity you might do after school:

Thermal: _____ **Mechanical:** _____

Light: _____ **Sound:** _____

Gravitational: _____ **Chemical:** _____

Electrical: _____ **Elastic:** _____

Electricity

1. **What type of circuit allows electricity to flow: open or closed?**

2. **When a light is turned on, is that an example of a closed or open circuit?**

3. **Is metal commonly a good example of a conductor or an insulator?**

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Engineering Design Process (EDP) - Eggbert

The Engineering Design Process (EDP) is the eight step process engineers use when designing. Listed below are the eight steps. Can you put them in order? Draw a line from the number to the correct step.

1	**Define the problem**
2	**Redesign**
3	**Communicate with your team about the results**
4	**Choose the best solution**
5	**Brainstorm possible solutions**
6	**Build a prototype**
7	**Test and evaluate**
8	**Research the problem**

1. Draw a diagram of the safety restraint system you and your team designed for Eggbert.

2. Did Eggbert survive his ride on the zip line?

☐ **Yes** 

☐ **No** 

A. If no, what would you change about your design now that you saw the results of your prototype test ?

B. If yes, would you change anything about your design? If so, what?

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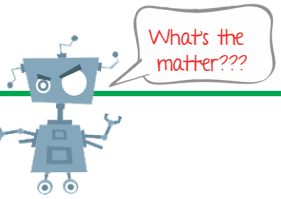
Molecular Models



Matter

1. What is matter?

2. What makes up matter?

3. What do we call the 118 different types of atoms discovered so far?

Elements

Can you identify the missing information from the periodic table?

Name: _____ **Atomic Number:** 10 **Atomic Symbol:** _____

Name: Hydrogen **Atomic Number:** _____ **Atomic Symbol:** _____

Name: _____ **Atomic Number:** _____ **Atomic Symbol:** Au

Name: _____ **Atomic Number:** _____ **Atomic Symbol:** Na

Name: Copper **Atomic Number:** _____ **Atomic Symbol:** _____

Compounds

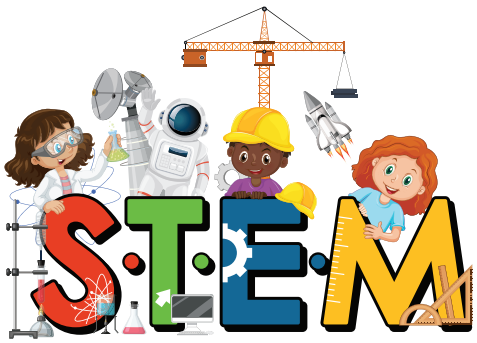
1. What is the difference between an element and a compound?

2. Below are 5 molecules. Circle the molecules that are compounds.

H_2O, NA, CH_4, CO_2, O_2,

3. Give one example of a physical change.

4. Give one example of a chemical change.



WORD SEARCH

G Y X N W E G T U C P O E A C
N R S M V A R S O R C L T F O
I T R S R B H D O B E M O M M
G E O D A L Y T I C O L E V P
G M T Q Y M O J T S J R I Z O
U O C D A N W R P D V F W T U
B E U I S V O H W I A A Y L N
E G D W G N E Z F O Z C G Z D
D Q N Y S R Y T I S N E D P S
A U O A E Y O R B I T L G E B
B T C F G S O L U B I L I T Y
R R O R W V F G U D E W P Y K
S U E M T S Y L A T A C L X J
K N K I N E T I C Q X F L H M
E Y H P A R G O T A M O R H C

atmosphere
atom
CAD
catalyst
chromatography
compounds
conductor
debugging
density
drag
electrons
energy
geometry
kinetic
mass
orbit
protons
robot
solubility
velocity