Surrounded by Science

Information, Resources, and Strategies for the Classroom

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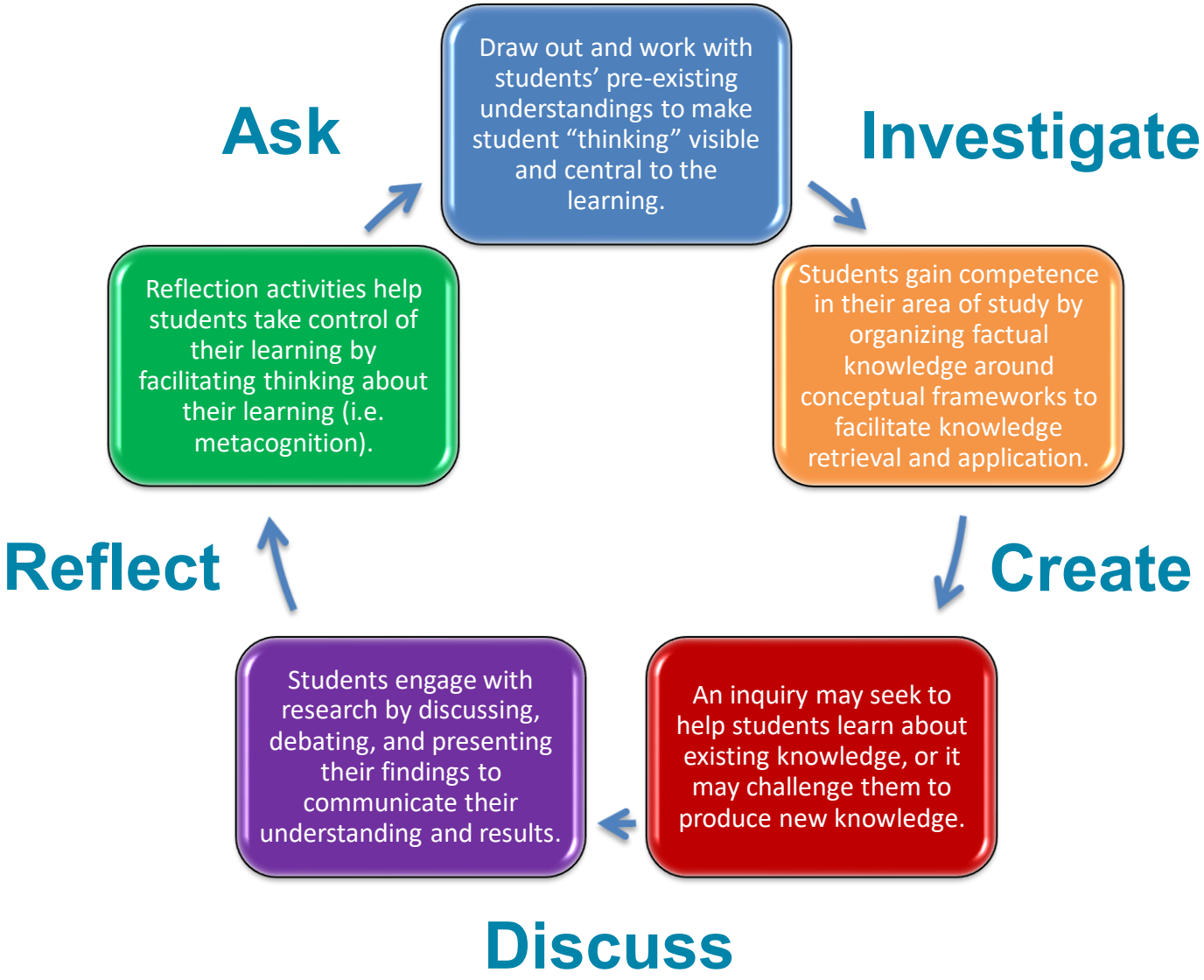
Overview of Science Themes and Example Content

		Science Example Content Topics		
		Life Science (40%)	**Physical Science (40%)**	**Earth & Space Science (20%)**
Focusing Themes	***Human Health and Living Systems***	• Human body and health • Organization of life • Molecular basis for heredity • Evolution	• Chemical properties and reactions related to human systems	• Interactions between Earth's systems and living things
	Energy and Related Systems	• Relationships between life functions and energy intake • Energy flows in ecologic networks (ecosystems)	• Conservation, transformation, and flow of energy • Work, motion, and forces	• Earth and its system components • Structure and organization of the cosmos

Circle of Inquiry

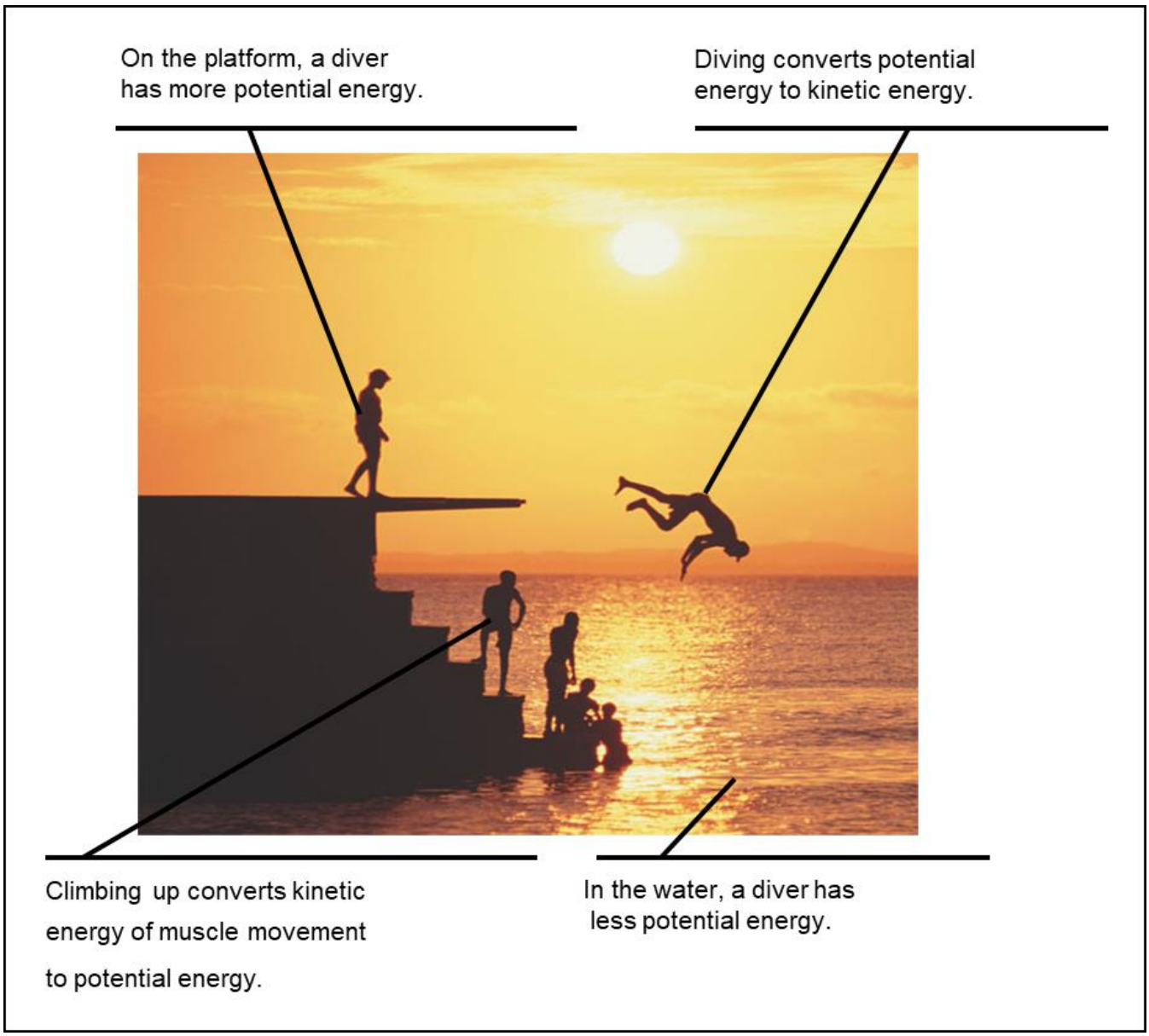


An Overview of the 5Es		
Phase	**Purpose**	**Role of Teacher**
Engage	Create interest and stimulate curiosity. Set learning within a meaningful context. Raise questions for inquiry. Reveal students' ideas and beliefs, compare students' ideas.	Activity or multi-modal text used to set context and establish topicality and relevance. Motivating/discrepant experience to create interest and raise questions. Open questions, individual student writing, drawing, acting out understandings, and discussion to reveal students' existing ideas and beliefs so that teachers are aware of current conceptions and can plan to extend and challenge as appropriate – a form of diagnostic assessment.
Explore	Provide experience of the phenomenon or concept. Explore and inquire into students' questions and test their ideas. Investigate and solve problems.	Open investigations to experience the phenomenon, collect evidence through observation and measurement, test ideas and try to answer questions. Investigation of text-based materials (e.g. newspaper articles, web-based articles) with consideration given to aspects of critical literacy, including making judgments about the reliability of the sources or the scientific claims made in the texts.
Explain	Introduce conceptual tools that can be used to interpret the evidence and construct explanations of the phenomenon. Construct multi-modal explanations and justify claims in terms of the evidence gathered. Compare explanations generated by different students/groups.	Student reading or teacher explanation to access concepts and terms that will be useful in interpreting evidence and explaining the phenomenon. Small group discussion to generate explanations, compare ideas and relate evidence to explanations. Individual writing, drawing and mapping to clarify ideas and explanations. Formative assessment to provide feedback to teacher and students about development of investigation skills and conceptual understandings. Small group writing/design to generate a communication product (e.g. poster, oral report, formal written report or PowerPoint presentation, cartoon strip, drama presentation, letter) with attention to form of argumentation, genre form/function and audience, and with integration of different modes for representing science ideas and findings.
Elaborate (extend)	Use and apply concepts and explanations in new contexts to test their general applicability. Reconstruct and extend explanations and understandings using and integrating different modes, such as written language, diagrammatic and graphic modes, and mathematics.	Further investigations, exercises, problems or design tasks to provide an opportunity to apply, clarify, extend and consolidate new conceptual understandings and skills. Further reading, individual and group writing may be used to introduce additional concepts and clarify meanings through writing. A communication product may be produced to re-represent ideas using and integrating diverse representational modes and genres consolidating and extending science understandings and literacy practices.
Evaluate	Provide an opportunity for students to review and reflect on their own learning and new understandings and skills. Provide evidence for changes to students' understandings, beliefs and skills.	Discussion of open questions or writing and diagrammatic responses to open questions – may use same/similar questions to those used in Engage phase to generate additional evidence of the extent to which the learning outcomes have been achieved. Reflections on changes to explanations generated in Engage and Evaluation phases to help students be more metacognitively aware of their learning.

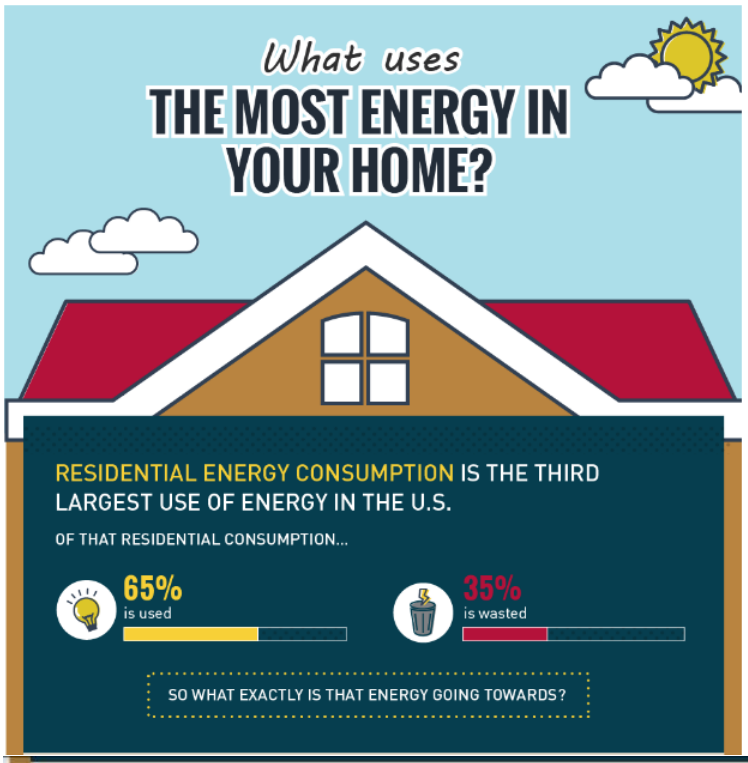
Noticings/Wonderings (Forget the Question)

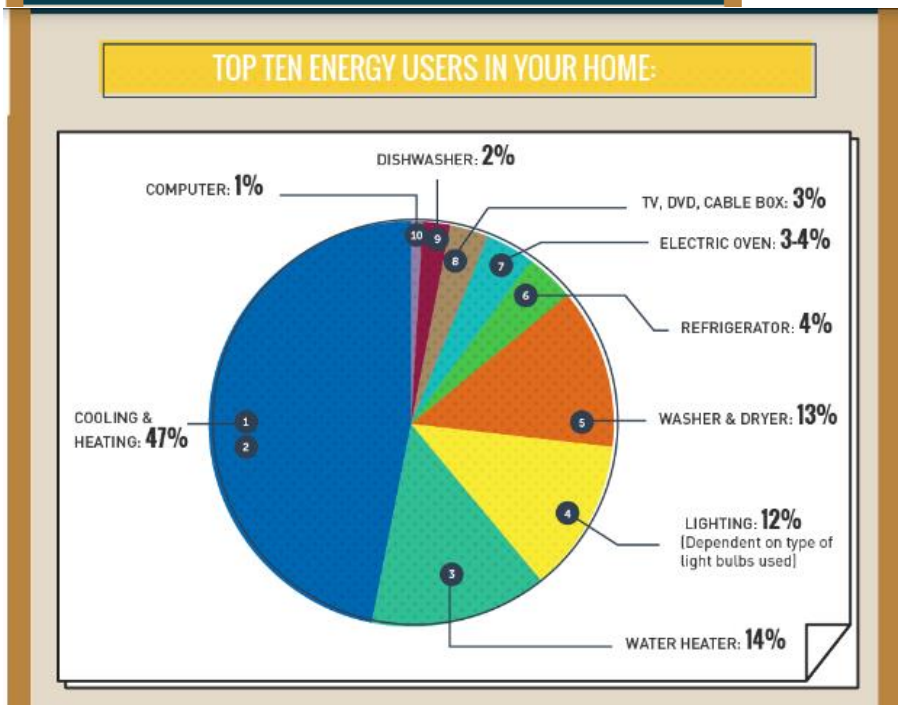
I notice . . .	I wonder . . .

Energy and Work



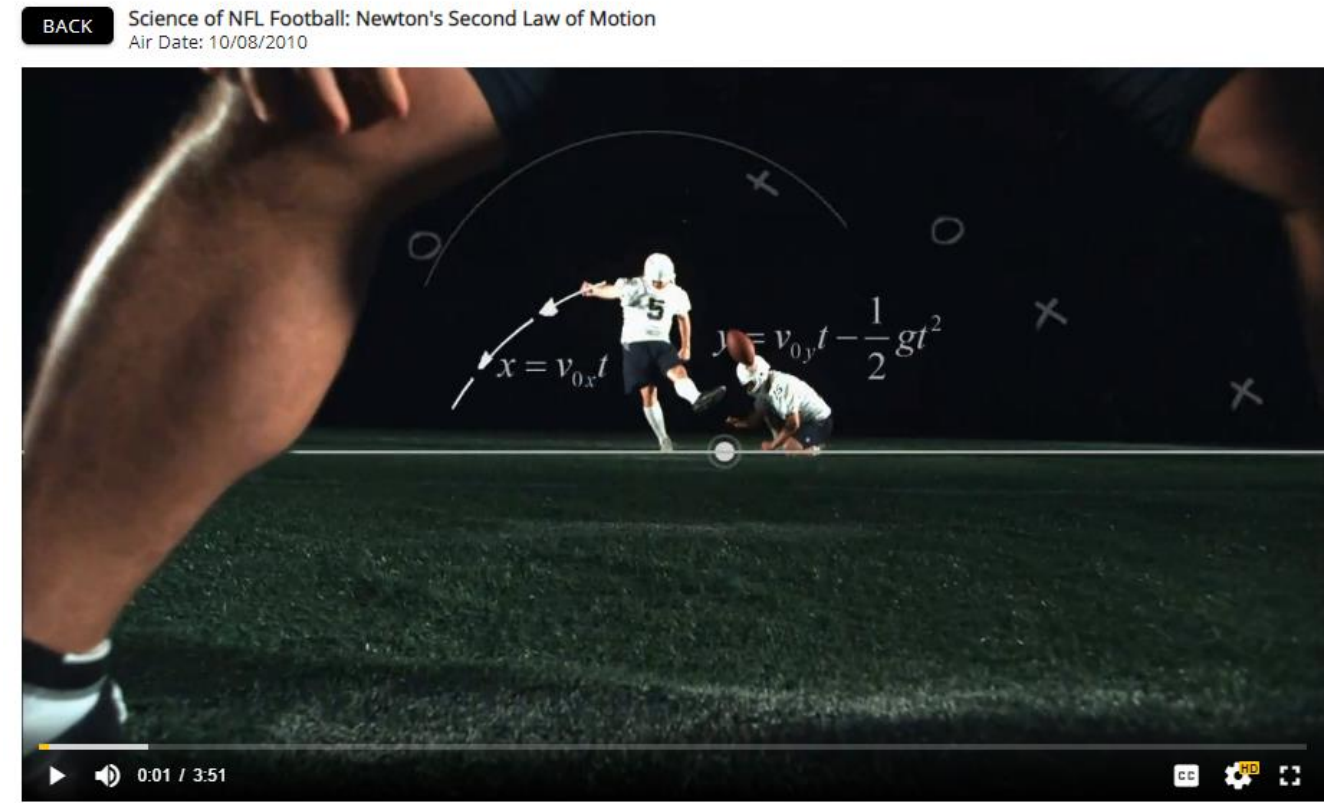
Visual Capitalist – Energy Usage at Home





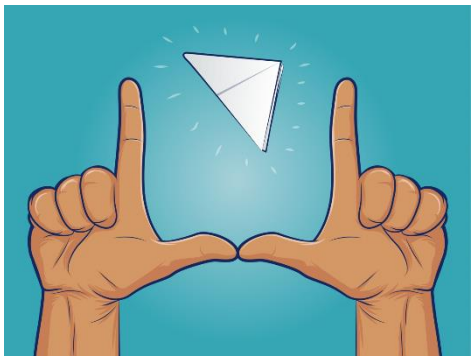
https://www.visualcapitalist.com/what-uses-the-most-energy-home/

Science of NFL Football



https://www.nsf.gov/news/special_reports/football/index.jsp

Paper Football



Make Your Football

1. Fold it in half lengthwise
2. Fold it in half lengthwise again
3. With the closed side of the paper facing you, fold the closed corner to the upper edge of the open edge
4. Repeat step 3 in alternating triangles
5. Tuck the last bit of paper into the triangle

Object and Rules of the Game

The object of the game is to get more points than your opponent.

Play is simple; you push the football from your side of the table to your opponent's side. If the football hangs over the edge of the table without falling off, you score a touchdown (6 points). If it doesn't hang off or drops off the table, it's you opponent's turn to try.

If you get a touchdown, you get to "kick" an extra point. Your opponent puts his index fingers up and points together his thumbs to make the goal posts, and then you kick it through the posts.

To attempt your field goal, stand the football on the table and hold it with one index finger. Then, flick it with the other hand. If you're successful, you get another point.

For a tutorial on playing paper football, click on the link below.

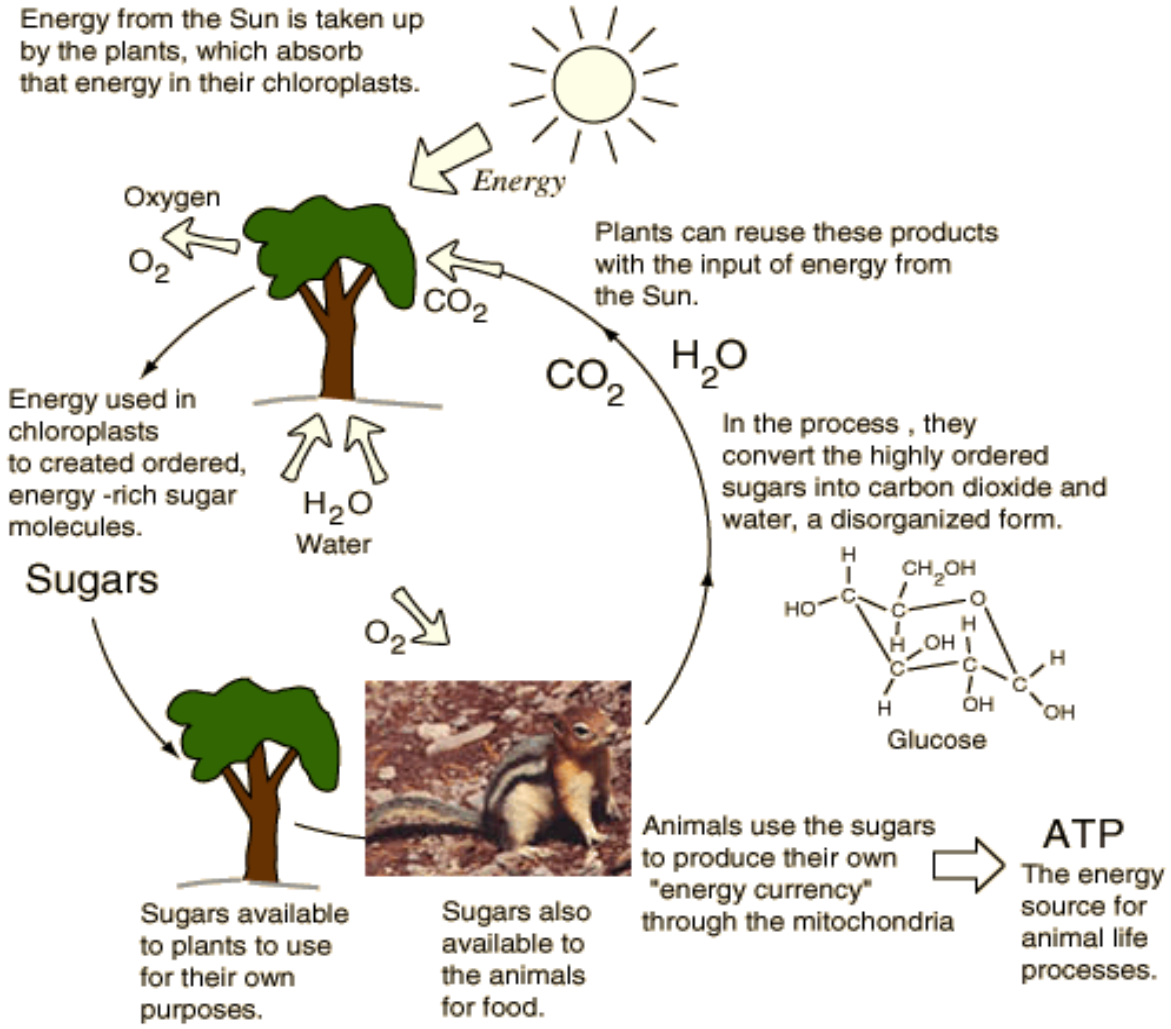
Best How To Play Paper Football Tutorial Ever!
http://www.youtube.com/watch?v=aIlVe3yrMM0&feature=related

Debrief the Activity

- So, how does this relate to learning more about energy?
- What types of energy does it take to play paper football?
- What other science concepts are involved?

Process Diagrams

Process diagrams are included on the GED Science test. Provide students with sample diagrams and have them discuss the steps in the process.



http://hyperphysics.phy-astr.gsu.edu/hbase/Biology/enercyc.html

Additional Resources for the Classroom

Thematic Plan: It's All About Energy!

Objectives

- Understand the relationship between life functions and energy in take
- Understand the interaction between Earth's systems and living things
- Understand chemical properties and reactions related to living systems

Engagement	Show students a video on energy or a current article or real-world example of energy in the world. Such as: https://florida.pbslearningmedia.org/asset/nvel_vid_defined/ Ask students: • What is energy? • What is something that doesn't involve energy? • What uses the most energy in your home? • What are different ways Earth supports life?
Exploration	Have students explore how energy is a part of physical, life, and earth and space science. Discuss different types of energy – potential and kinetic. Have students work together to explore a question on real-world energy. The purpose of this stage is for students to frame questions and ask questions regarding energy and its many facets. You may wish to have students explore a specific type of energy, such as work, states of matter, cellular respiration, ATP, photosynthesis, the energy cycle of living things, renewable vs. non-renewable resources, interaction of matter between living and non-living things.
Explain	Have students explain basic concepts of how energy is part of today's world by having them read non-fiction texts in order to build knowledge. The following are examples of activities that focus on photosynthesis and cellular respiration: *Life Science* Provide students with a reading on an identified area, such as photosynthesis and cellular respiration. Have each group identify similarities and differences between the two life processes. Have each group create a graphic to show what they have discovered (e.g., Venn Diagram). *Physical Science* Explain the different element symbols for photosynthesis and cellular respiration. Provide students with a graphic of the process of each, as well as the chemical equations. Share with students that in each equation, energy is required to start the reaction. Have students research how plants need

	animals and animals need plants. Have students report their findings to the class. *Earth and Space Science* Have students create a visual that shows the interaction of matter between living and non-living things. Have them discuss the importance of renewable vs. non-renewable resources regarding the sustainability of living things.
Extend (Elaborate)	Have students participate in different hands-on activities, such as an energy lab, an experiment, or a SIMS. Debrief by having students share how energy impacts the world.
Evaluate	Provide students with photographs representing types of energy. Have students determine the type of energy and its importance. Case studies, research projects, short answers, and real-world scenarios also provide systems of evaluation.

Resources

Nova Labs on Energy - https://florida.pbslearningmedia.org/collection/novalabs/?topic_id=1653#.WUh9bmjyuUl

Energy Classroom **- http://energyclassroom.com/**

Office of Energy Efficiency and Renewable Energy - **https://energy.gov/eere/education/education-homepage**
Ted Ed – A guide to the energy of the Earth - http://ed.ted.com/lessons/a-guide-to-the-energy-of-the-earth-joshua-m-sneideman

The Physics Classroom http://www.physicsclassroom.com/class/energy

Energy Cycle in Living Things
http://hyperphysics.phy-astr.gsu.edu/hbase/Biology/enercyc.html

ReadWorks - http://www.readworks.org/passages/everyday-energy

Newsela - https://newsela.com/text-sets/58/science--politics-science-energy

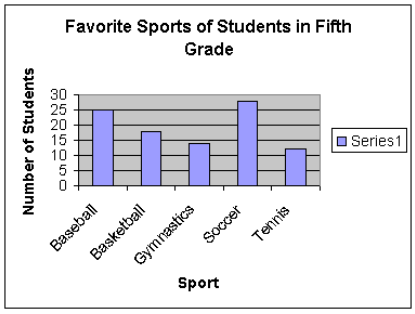
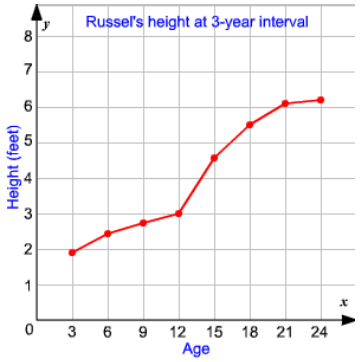
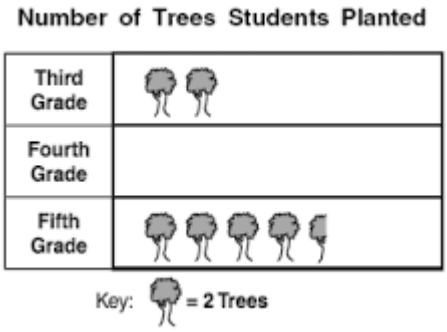
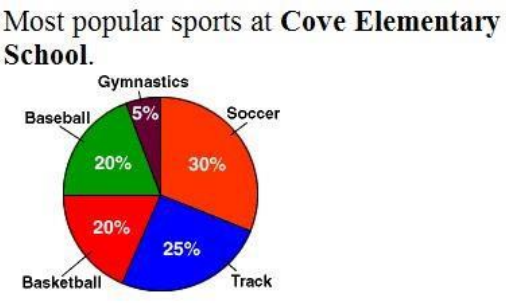
University of Colorado Boulder – PHET - https://phet.colorado.edu/en/simulations/category/new

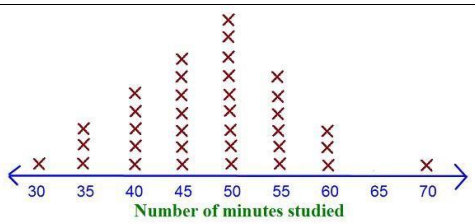
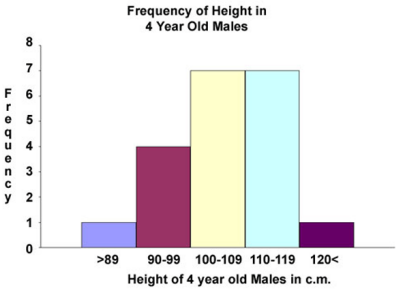
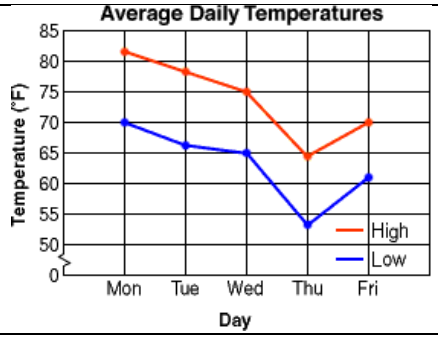
Science in Focus - https://www.learner.org/workshops/energy/workshop1/

High School Energy - http://highschoolenergy.acs.org/content/hsef/en.html

Explain That Stuff - http://www.explainthatstuff.com/energy.html

Types of Graphs

Type of Graph	Example	When do I want to use this kind of graph?
A bar graph presents data so that comparisons of different items can be made		• Used to compare the frequency of data • Use a bar graph when you want to compare 2 or more sets of data
A line graph presents data on one item so that changes and trends over time can be identified and comparisons can be made		• Use when you have continuous data • Use when you want to show changes over time
A pictograph presents data using pictures or symbols		• Each picture or symbol represents and assigned amount of data • The key tells the number that each picture or symbol represents • Use when you have large amounts of data that is too big for a bar graph • Use when you only have 2 to 6 categories
A circle graph shows how parts are related to the whole		• Use when you want to show how a total amount of data is divided into parts • Can be used to show percentages • Use when you have 3 to 7 categories

A line plot shows the frequency of data values. The range determines the number line. The x represents the data value.		• Useful when finding the range, mode, mean, and median of a set of data • Easy to identify outliers and clusters • An outlier is a piece of data that is set far apart from the rest of the data • A cluster is where data tends to group together • Best to use this graph when you have a small range
A histogram is a bar graph that shows the frequency of equal intervals of data		• Different than a bar graph because it uses intervals instead of individual numbers and the bars touch • The intervals must not overlap • Good to use with continuous data (ex: weight, height, time, etc.)
A stem and leaf plot is a special table where each data value is split into a "stem" and a "leaf"	Grades on a Science Test Stem | Leaf 7 | 2 2 4 5 6 9 8 | 1 4 5 7 7 9 9 | 0 1 3 5 8 10 | 0 0 Key: 7 / 2 means 72 percent	• The stem is the first digit(s) and the leaf is the last digit in a data value • Ex: In the number 72, the digit 7 is the stem and the digit 2 is the leaf • Useful when organizing numerical data
A double line graph is a line graph used to compare two sets of data		• Useful to compare how two things change over time • Each set of data is graphed separately but on the same grid • A key identifies the sets of data

Types of Graphs – Julie Rozier – Teachers Pay Teachers
https://www.teacherspayteachers.com/Product/Types-of-Graphs-Graphic-Organizer-2373146

Lesson Plan - SCIENCE OF NFL FOOTBALL: Newton's 2nd Law of Motion & Kicking (Grades 5-8)

Objective: Students will be able to understand and discuss Newton's 2nd Law, force, impulse, and momentum to understand how these concepts apply to sports such as football.

Introduction Notes:

SCIENCE OF NFL FOOTBALL
Newton's 2nd Law of Motion & Kicking (Grades 5-8)
STEM Lesson Plan
Lesson plans produced by Lessonopoly (lessonopoly.org)
Video produced by NBC Learn in partnership with the NFL and the National Science Foundation

SPECIFIC OBJECTIVES:

Students will be able to: Explain Newton's 2nd Law, both verbally and mathematically; Explain impulse and momentum; Explain a net force; Analyze forces on an object; Draw force diagrams representing forces on an object; Discuss whether forces on an object are balanced or unbalanced; Use Online Physics Simulation software (PhET); Build and play a game of paper football.

REQUIRED MATERIALS

Computer and internet connection, Scrap paper (for paper football game), Safety goggles

ANTICIPATORY SET (LEAD-IN)

Ask the students to discuss what a force is (a push or a pull). Ask for examples in everyday life. Ask for examples of force in football. Ask if the students have ever kicked a football (or some other type of ball).
What types of forces are pushing on the ball?

What can you do to make the ball go higher or farther?

Tell the students: "Today we will discuss how force affects kicking a football".

Watch the NBC Learn Science of NFL Football video: "Newton's Second Law of Motion."

LESSON PLAN PROCEDURE

Ask the students to discuss what a force is (a push or a pull). Ask for examples in everyday life. Ask for examples of force in football. Ask if the students have ever kicked a football (or some other type of ball). What types of forces are pushing on the ball? What can you do to make the ball go higher or farther?

Tell the students: "Today we will discuss how force affects kicking a football." Introduce the concept of Newton's 2nd Law. The students can be given the Reading Guide, or the teacher can lead the discussion.

Paper Football Activity

Obviously, forces have a lot to do with football. But students probably should not play football in the classroom.

A fun way to play football anywhere and anytime is paper football (or finger football). It is a timeless classic, just like the real game of football. Also, it involves forces, just like the real game.

If you are not familiar with paper football, there are many tutorials on YouTube.com. A great one is:

Best How To Play Paper Football Tutorial Ever!
http://www.youtube.com/watch?v=aIlVe3yrMM0&feature=related

Now tell the students they are going to play paper football. Ask for a show of hands for all students who have played this before. Students will get paper and make paper footballs. They will then spend 10-15 minutes playing at their tables.

Tips: For help playing the game see the video referenced above. Students should wear safety glasses while playing this game, as field goal kicks could easily hit someone's eye. The teacher may want to have several footballs premade in order to save time. The students could also be assigned to make footballs at home the night before.

Online Force Simulation Game

Next, the students will play a crude online version of paper football. The goal here is to think about the forces involved on the paper football.

Click on the link below. The site hosts a Newton's 2nd Law simulation, which can be useful for helping students learn about forces. After clicking on the link, click on the simulation image that appears on the screen.
http://phet.colorado.edu/en/simulation/forces-1d

The following link will take you to a video, which introduces a game (similar to paper football) that can be played using this site.
http://screencast.com/t/YmRjOTBk

Note: There are many other fun and useful simulations on the PhET website. Be sure to explore the other simulations available.

Quantitative Virtual Lab

Thus far, the discussion of Newton's 2nd Law has been qualitative (no numbers or measurements).

The next activity will allow students to do an online lab and take virtual measurements of force and acceleration. This activity can be considered optional or an extension, if necessary.

This activity is designed to be a fairly simple exploration of Newton's 2nd Law. The students will note that as they increase the force, the acceleration will increase proportionally. If the students are able to find the slope of the graph, they will note that it is 25 kg, which is the same as the mass of the dog. This is consistent with the relationship m = F/a.

There are many variations of this lab and the simulation is flexible enough to allow different types of exploration. In the chosen activity, the mass was kept constant and the force changed. Another option is to keep force constant and change the mass.

CLOSURE (REFLECT ANTICIPATORY SET)

Have the students reflect on how Newton's 2nd Law can be seen in the game of basketball or baseball. This can be verbal or written.

ADDITIONAL NOTES

Activities can all be done as a unit or individual pieces can be taken and tailored as desired. Also, the PhET Simulations site contains other teacher lesson plans that can be downloaded.

NEWTON'S LAWS OF MOTION: READING GUIDE

Isaac Newton, the great scientist, provided us with three laws about forces.

1. The first, actually observed by Galileo, was that without a net force present, objects tend to persist (remain) in the current motion (at rest or constant velocity).

2. When a net force is present on an object, there will be an acceleration in the same direction as the force. This acceleration is related to how hard it is pushed (force) and its mass (F=ma).

3. A force is an interaction between two objects. Two objects must touch one another mutually with the same amount of force. This is often stated as ‘equal and opposite forces’, but in reality there is only one force acting on both objects.

The 2nd Law and Impulse

The 2nd Law is often expressed mathematically as F=ma. This is stated as ‘the force on an object can be calculated by its mass times its acceleration’. It can also be stated as ‘the acceleration of an object will be determined by the force exerted on it, divided by the mass of the object’ (a=F/m).

It is also true that the longer you push on a shopping cart with a steady force, the more you will cause it to accelerate (or gain velocity). This idea is known as impulse and can be expressed mathematically as Impulse = Force x Time. An impulse will lead to a change of the carts momentum (mass x velocity). Therefore, impulse is also described as the cart’s change in velocity.

Units of Measure

Force is calculated by multiplying a mass value by an acceleration value. In physics mass is typically measured in kilograms (kg) and acceleration in meters per second per second (m/s^2). As a result, the units of force are $kg \cdot m/s^2$. This unit is abbreviated as a newton.

Acceleration

It should be noted that in physics when discussing acceleration, the term deceleration is not typically used. Rather, an object that is slowing down is said to have negative acceleration. This makes the discussion easier since objects speeding up or slowing down can both be said to have acceleration.

CONCEPTUAL QUESTIONS

1. What is a net force?

2. Describe what happens to an object when a net force acts upon it?

3. A football sits at rest on the ground. Explain whether the forces on the football are balanced or unbalanced.

4. A girl rides a bike down the street at a constant speed. Explain whether the forces on the bike are balanced or unbalanced.

5. Discuss the velocity of a football that has been punted high into the air. Is there any acceleration on the ball as it rises and falls to the ground?

6. Is there a net force on a ball that has been punted into the air? If so, what is providing the net force?

7. Using the idea of Impulse, explain why a field goal kicker should 'kick through the ball', meaning extend their foot as high up as possible at the end of the kick.

8. Does this idea of 'kicking through' or 'hitting through' or 'pushing through' apply to other parts of football or in other sports? Explain.

9. Describe what happens to an object's momentum if you push on it for twice as long.

10. Describe what happens to an object's momentum if you push on it twice as hard.

https://www.nbclearn.com/portal/site/learn/lesson/c2d4b20c18d01410VgnVCM10000075c1d240RCRD

Science Resources from the World Wide Web

ABC Science. News, video clips, games, and lots of activities for the science classroom from the American Broadcasting Company. http://www.abc.net.au/science/

Annenberg Foundation. Great science materials and courses from *The Habitable Planet* to *Force and Motion*. Courses, lesson plans, and interactives will keep students engage in science. http://www.learner.org/resources/discipline-science.html

BBC Science. From space to the human body to, this interactive site allows learners to discover many different facets of science. http://www.bbc.co.uk/sn/

Discovery Education. The website provides lesson plans on earth and space science. http://www.discoveryeducation.com/search/page/-/-/lesson-plan/earth%20science/index.cfm

DKFindout: This site covers a wide range of topics with high-quality information and graphics. A very interactive site. https://www.dkfindout.com/uk/human-body/keeping-healthy/whats-in-food

Earth Exploration Toolkit. Developed by teams of scientists and educators, the *Earth Exploration Toolbook* (EET) is a collection of online Earth system science activities. http://serc.carleton.edu/eet/index.html

Environmental Protection Agency. http://www.epa.gov/students/lesson-plans-teacher-guides-and-online-resources-educators

Exploratorium Online. The site contains over 15,000 articles and displays including interactivity regarding science. http://www.exploratorium.edu/

How Science Work. An app that provides lots of science information from the California Academy of Science. https://itunes.apple.com/us/course/how-science-works/id689052881

How Stuff Works. Ever wondered why a cd works? How about the ten myths about the brain? An interesting science site filled with real-world information. http://www.howstuffworks.com/

Interactive Websites for Teaching Science. Just click on one of the topics and explore the myriad of resources on the World Wide Web. http://interactivesites.weebly.com/science.html

Khan Academy. Lots of videos on graphics, as well as science content. https://www.khanacademy.org/

Science in Focus – Energy. Workshop focused on energy. Another excellent resource from the Annenberg Foundation: https://www.learner.org/workshops/energy/workshop1

National Science Teachers Association. Freebies for Teachers. All kinds of curriculum guides, lesson plans, experiments, and resources. http://www.nsta.org/publications/freebies.aspx

NEWSELA. This website is an innovative way to build reading comprehension with nonfiction through daily news articles. https://newsela.com/

Newton's Apple. NEWTON'S APPLE is a production of Twin Cities Public. The site is filled with free videos for use in many different areas. http://www.newtonsapple.tv/

Nova Labs. Great resources in different areas of science**.** http://www.pbs.org/wgbh/nova/labs/

PhET Simulations. University of Colorado. Dozens of simulations, as well as activities and lab experiences. https://phet.colorado.edu/

Science Net Links. Advancing Science Serving Society provides lessons and tools for K-12 that are usable in the adult education classroom as well. http://sciencenetlinks.com/

Science News for Student. The latest in science news, written for everyone. Shorter news pieces (typically 350 to 800 words), written at about 6.0 – 9.0. https://www.sciencenewsforstudents.org/

Science of NFL Football. Video series that includes lesson plans, related texts, and links to other resources. https://www.nbclearn.com/science-of-nfl-football

Share My Lesson. Lesson plans and resources in all different areas of science plus more. https://sharemylesson.com/

Steve Spangler. This site has lots of free experiments and videos for use in the classroom. http://www.stevespanglerscience.com/lab

Study Jams. Scientific Method. Short videos on such things as the scientific method and scientific theory, as well as content areas in science. http://studyjams.scholastic.com/studyjams/jams/science/scientific-inquiry/scientific-methods.htm

Surrounded by Science Infographic. Lots of materials to use in the classroom. https://www.neefusa.org/resource/surrounded-science-infographic

Teachers Try Science. This site provides free and engaging **lessons**, along with **teaching strategies and resources**. http://www.tryscience.org/

Ted Ed Lessons. This website has great videos and lesson plans in all areas of science**.** http://ed.ted.com/lessons

The Physics Classroom. Information and activities in different areas of physics. http://www.physicsclassroom.com/

Understanding Science. A fun, free resource that aims to accurately communicate what science is and how it really works. http://undsci.berkeley.edu/

Energy Matching Game

Kinetic Energy	Energy due to movement	Anything that moves, child swinging on a swing, waves, atoms, molecules
Potential Energy	Energy of an object's position	Skier at the top of a hill, gravitational energy
Sound (Sonic) Energy	Energy produced by vibrating objects	Radio, guitar string, voice
Electrical Energy	Energy produced by electrons or electromagnetic waves; the movement of electrical charges	X-rays, microwaves, tvs
Chemical Energy	Stored energy. Reactions between atoms or molecules, such as energy stored in food or gasoline	Batteries, (food and fuel – such as gas), respiration, striking a match

Heat (Thermal) Energy	Internal energy in substances – everything has this type of energy	Cup of hot coffee, living thing, candle burning, volcano
Mechanical Energy	Energy due to an object's motion or position	Moving car, people, rolling bicycle, writing answers on a text
Nuclear Energy	Energy stored in the nucleus of an atom	Power from a nuclear plant
Radiant (light) Energy	Energy created through electromagnetic waves or given off by luminous objects	Sunlight, lightbulbs, solar energy
Motion Energy	The movement of objects and substances from one place to another	Wind, moving an object