Next Generation Science Standards (NGSS)

Goals and Objectives for Physics Classrooms

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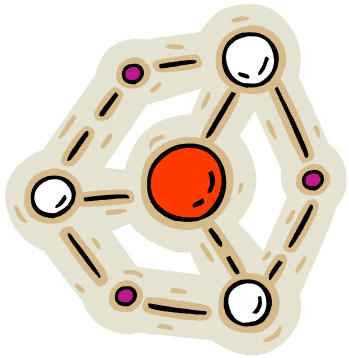
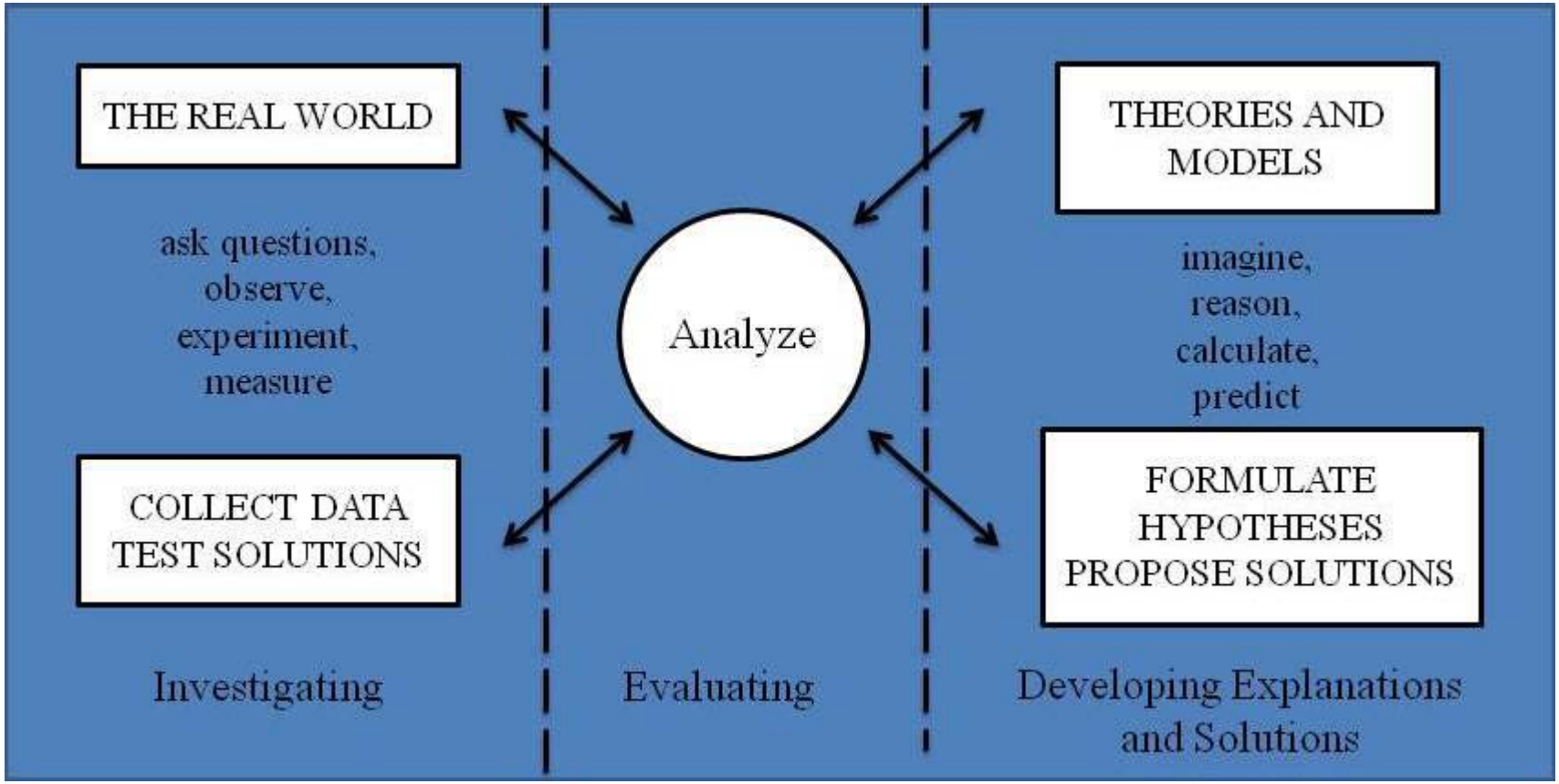


Next Generation Science Standards (NGSS) &Common Core Standards

- **The *Next Generation Science Standards (Practices, crosscutting concepts, and core ideas)* released summer 2013 by the National Academies Press. The NGSS are and the Common Core are based on the same framework.**
- **These new core standards (NGSS) are designed to strengthen the National Science Education Standards and gradually replace them. Free access at http://www.nextgenscience.org/next-generation-science-standards**
- **The *Common Core Standards* have been developed in English-Language Arts and Math to teach science across all subjects. http://www.corestandards.org/ and**
- **http://www.nap.edu/catalog.php?record_id=13165**

Three Spheres of Activity for Scientists and Engineers



NGSS Disciplinary Core Idea Areas

Physical Sciences (example only)

- **PS 1: Matter and its interactions**
- **PS 2: Motion and stability: Forces and interactions**
- **PS 3: Energy**
- **PS 4: Waves and their applications in technologies for information transfer**

Common Core Ideas in the Framework

PS1:Matter and its interactions

PS1A: Structure and properties of matter

PS1B:Chemical reactions

PS1C: Nuclear processes

PS2: Motion and stability: Forces and interactions

PS2A: Forces and motion

PS2B: Types of interaction

PS2C: Stability and instability in physical systems

PS3: Energy

PS3A: Definitions of energy

PS3B: Conservation of energy and energy transfer

PS3C: Relationship between energy and forces

PS3D: Energy in chemical processes and everyday life

PS4: Waves and their applications

PS4A: Wave properties

PS4B: Electromagnetic radiation

PS4C: Information technologies and instrumentation

NGSS Science and Engineering Practices
What scientists and engineers do?

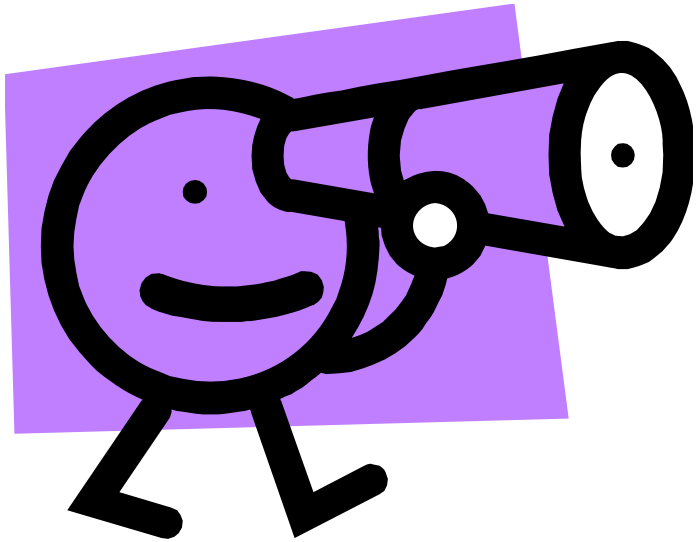
Practices include:

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and Interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating and communicating information

NGSS Crosscutting Concepts

1) Patterns
2) Cause and Effect
3) Scale, proportion, quantity
4) Systems and models
5) Energy and matter
6) Structure and function
7) Stability and change

What should I do now?

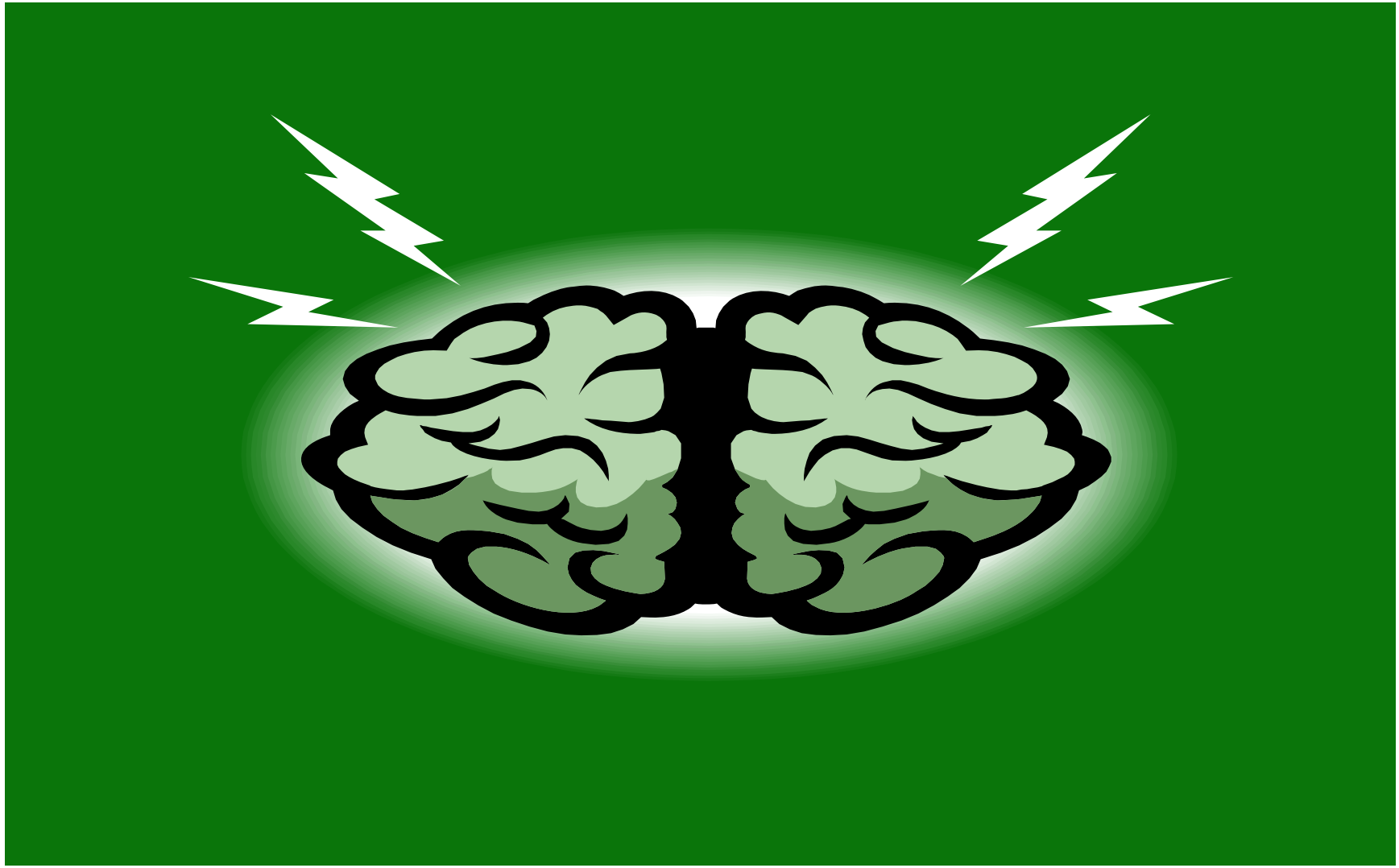


How do I plan my lessons around these requirements?

Ask these questions when planning your lessons:

1) What do my students need to know? (Discipline Content)
2) What do my students need to do? (Science Practices)
3) To what other sciences is this topic related (Cross-cutting)
4) Where do I get the materials that I need to teach this? (ASIM, AMSTI, or?)
5) How do I assess the content knowledge and the science skills they learned? (ACOS-S and NGSS Assessment)

Brain Storm Some Lesson Ideas on Forces and Interactions



PS2: Motion and Stability: Forces & Interactions

Example

PS2.A: Forces and Motion

Key Question

How can one predict an object's continued motion, changes in motion, or stability?

Key Concept

Interactions of an object with another object can be explained and predicted using the concept of forces, which can cause a change in motion of one or both of the interacting objects.

By the end of grade 8

- Any two interacting objects exert forces of equal magnitude on each other in opposite directions (Newton's third law). The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The heavier the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
- Forces on an object can also change its shape or orientation. In order to share information with others, all positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference system and arbitrarily chosen units of size.

By the end of grade 12

- Newton's second law accurately predicts changes in the motion of macroscopic objects, but it requires revision for subatomic scales or for speeds close to the speed of light. Momentum is a property of objects, defined for a particular frame of reference, that depends on their mass and speed. (Boundary: No details of quantum physics or relativity are included at this grade level. There is just the observation that, at the relevant scales, multiple phenomena necessitate revisions to Newton's laws and that these two theories developed to provide more adequate explanations.)
- In any system, total momentum is always conserved. If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in momentum of objects outside the system.

Each Core Idea is connected to

- 2) Crosscutting Concepts – These are concepts that have application across all domains of science. These include:
  - cause and effect,
  - systems,
  - stability and change,
  - scale and proportion,
  - energy and matter in systems
  - structure and function
  - patterns

Each Core Idea is Connected to

- 1) Science and Engineering Practices – What scientist and engineers do
- These include:
  - Asking questions and defining problems
  - Developing and using models
  - Planning and carrying out investigations
  - Analyzing and Interpreting data
  - Using mathematics and computational thinking
  - Constructing explanations and designing solutions
  - Engaging in argument from evidence
  - Obtaining, evaluating and communicating information

Internet Resources
Table of Contents

PS-21 WEEBLY
http://ps21pd.weebly.com/

1. Pathway: Physics Teaching Web Advisory

http://www.physicspathway.org/

2. Annenberg Free videos online

http://www.learner.org/resources/browse.html

***3.* Physical Sciences Resource Center**

http://www.compadre.org/psrc/

4. Physics classroom topics

www.physicsclassroom.com/Class

5. Physics Forums: help in teaching

http://physicsforums.com/

6. Physics related websites

7. Online simulations

http://phet.colorado.edu/index.php

8. Physical science classroom

PS–21 Resources: PS-21 Web Site

Website:PS-21 WEEBLY
http://ps21pd.weebly.com/

- Current activities and many resources
- Post your questions to be answered. Respond to other teachers questions
- Threaded discussions on physical science questions – e.g. light & color and other discussions.
- Request each teacher make a monthly posting to the discussion board on **http://ps21pd.weebly.com/**

Pathway: Physics Teaching Web Advisory

1. Pathway: Physics Teaching Web Advisory

- ***http://www.physicspathway.org/***
- ***Digital video library for physics teaching at secondary school level***
- ***Four expert physics teachers provide expert advice in short scenes through synthetic interviews - Roberta Lang, Paul Hewitt, Chuck Lang, & Leroy Salary***
- ***Related Videos are also available***

K-8 Physical Science

Physics First

Conceptual Physics

http://www.thephysicsfront.org/items/detail.cfm?ID=2493

Some Topics

Education Foundations
- Alternative Conceptions

Modern Physics
- General

Oscillations & Waves
- Wave Motion
= Interference and Diffraction
= Longitudinal Pulses and Waves
= Phase and Group Velocity
= Transfer of Energy in Waves
= Transverse Pulses and Waves

Quantum Physics
-Probability, Waves, and Interference

AAAS Project 2061 Science Assessment Website

- Here you will find free access to more than 600 items. The items:
- Are appropriate for middle and early high school students.
- Test student understanding in the earth, life, physical sciences, and the nature of science.
- Test for common misconceptions as well as correct ideas.

http://assessment.aaas.org/

- This website also includes:
- Data on how well U.S. students are doing
- My Item Bank," a feature that allows you to select, save, and print items
- A feature that allows you to create and take tests online using items from the item collection

PS–21 Resources: Physical Science Teaching Videos

2. Annenberg Free videos online

http://www.learner.org/resources/browse.html

- The Missing Link: Essential Concepts for Middle School Math Teachers

This video workshop for middle school math teachers covers essential topics missed in most U.S. math curricula.

- Physics for the 21st Century

A multimedia course for high school physics teachers, undergraduate students, and science enthusiasts; 11 half-hour programs, online text, facilitator's guide, and Web site.

- The Science of Teaching Science

This video workshop for new and veteran K-8 science teachers inspires them to explore new methods of teaching science.

- Teaching High School Science
- This video library for high school teachers shows the practice of effective inquiry teaching in the science classroom.

PS Resource Center URL

3. Physical Sciences Resource Center

- **http://www.compadre.org/psrc/**

Browse the PSRC by Subject:

- **- Astronomy**
- **- Education Practices**
- **- Electricity & Magnetism**
- **- General Physics**
- **- Modern Physics**
- **- Optics**
- **- Oscillations & Waves**
- **- Other Sciences**

The Physics Classroom Topics URL

4. Physics Topics

www.physicsclassroom.com/Class

- **The Physics Classroom Tutorial**
- **Multimedia Physics Studios**
- **Shockwave Physics Studios**
- **Minds on Physics Internet Modules**
- **Curriculum Corner**
- **The Laboratory**

- Physics Tutorials
  - 1-D Kinematics
  - Newton's Laws
  - Vectors - Motion and Forces in Two Dimensions
  - Momentum and Its Conservation
  - Work, Energy, and Power
  - Circular Motion and Satellite Motion

Physics Forums URL

5. Physics Forums: help in teaching science

- **http://physicsforums.com/**

- **Science Education**
- **Physics**
- **Astronomy & Cosmology**
- **Mathematics**
- **Engineering**
- **Chemistry**
- **Biology**
- **Other Sciences**

6. Physics-Related Websites

- American Association of Physics Teachers http://www.aapt.org.
- Alabama Section of AAPT http://bama.ua.edu/~alaapt/
- More links from AL/AAPT http://bama.ua.edu/~alaapt/links.htm
- Colorado http://phet.colorado.edu/index.php
- Campadre http://www.compadre.org/
- MERLOT http://www.merlot.org/merlot/index.htm
- American Physical Society educators' page http://www.aps.org/studentsandeducators/index.cfm
- Physics Central http://www.physicscentral.org/
- Particle physics http://particleadventure.org/
- Physics Teacher Education Coalition http://www.phystec.org/
- Live photo project http://livephoto.rit.edu/
- A good site for physics applets is: http://www.falstad.com/mathphysics.html

Interactive Science Simulations

7. Interactive, research based simulations of physical phenomena from the PhET project at the University of Colorado.

http://phet.colorado.edu/index.php

8. The Physical Science Classroom

- **Physical Science Activities** Teacher's Guides by Program Title

http://www.pbs.org/wgbh/nova/teachers/resources/title.html

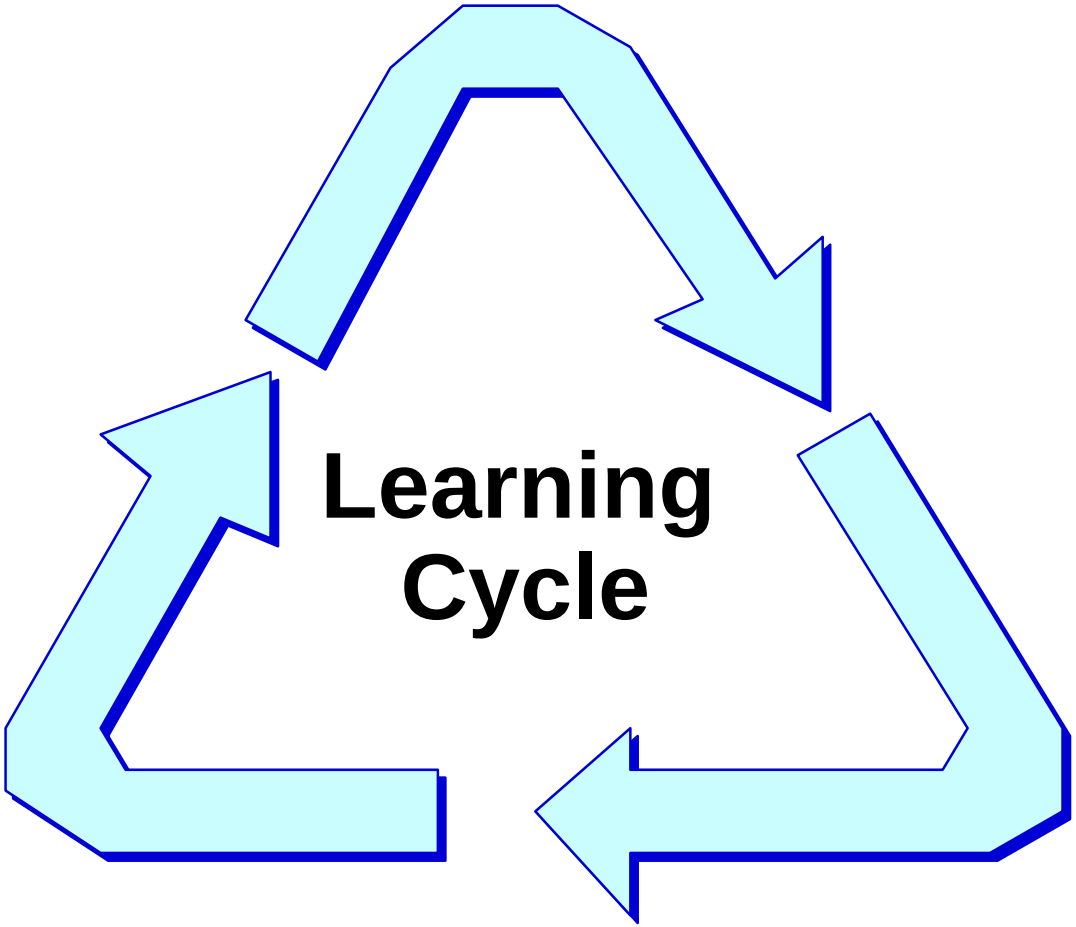
- **Chemistry Activities – Videos**

http://www.pbs.org/wgbh/nova/teachers/resources/subj_02_03.html

- **PBS-NOVA for Teachers**

http://www.pbs.org/wgbh/nova/teachers/

Inquiry Instruction Sequence



*Using the LEARNING CYCLE to Plan Inquiry Lessons**

- **EXPLORATION**
  - Confront existing knowledge - focus student's attention
  - Recall and relate previous knowledge in small groups
  - Try out prior knowledge in a new setting
- **INVENTION**
  - Reflect on and discuss the results of exploration
  - Use a variety of analogies
  - Provide examples and models
  - Provide closure
- **EXPANSION**
  - Provide additional student practice
  - Provide application and transfer skills
  - Provide summary

* See ALCOS - Science

Students Prior Knowledge

- Created from personal experiences
- Disagrees with scientific inquiry
- Partially valuable and useful in coping with everyday world
- Uses household meanings of scientific words
- Acquired from physical and social world
- Incorporated new facts with prior knowledge

Group Activity

Can you complete the task below?

Review the ideas and materials presented earlier for a Force, Motion, Energy, and Energy Transformation concept and **create / write** student activities that when sequenced form a **learning / teaching cycle** for the concept selected.

Work, Energy, and Energy Transformation Misconceptions

- **Energy is found only in living things**
  - For more information, go to *The Columbia Encyclopedia, Sixth edition, 2001, at http://www.bartleby.com/65/en/energy.html*
- **Electric current is a flow of energy**
  - For more information, go to *"Electricity" Misconceptions in K - 6 Textbooks, by William J. Beaty, at http://www.amasci.com/miscon/eleca.html#current*

Work, Energy, and Energy Transformation Misconceptions

- **The "electricity" that flows in wires is supplied by generators**
  - For more information, go to *"Electricity" Misconceptions in K - 6 Textbooks, by William J. Beaty, at http://www.amasci.com/miscon/eleca.html#current*
- **Energy is associated only with movement**
  - For more information, go to *The Columbia Encyclopedia, Sixth edition, 2001, at http://www.bartleby.com/65/en/energy.html*

Work, Energy, and Energy Transformation Misconceptions

- **Energy is created as the result of an activity**
  - For more information, go to:
    - • *The Columbia Encyclopedia, Sixth edition, 2001, at http://www.bartleby.com/65/en/energy.html*
    - • *Energy and Matter: The Laws of Thermodynamics, created by Michael J. Pidwirny, Ph.D., Department of Geography, Okanagan University College, at http://www.geog.ouc.bc.ca/physgeog/contents/6e.html*

Work, Energy, and Energy Transformation Misconceptions

- **Energy can be recycled through an ecosystem many times**
  - For more information, go to:
    - • *Energy and Matter: The Laws of Thermodynamics, created by Michael J. Pidwirny, Ph.D., Department of Geography, Okanagan University College, at http://www.geog.ouc.bc.ca/physgeog/contents/6e.html*
    - • *Energy Flow Through Ecosystems at the Marietta College Environmental Biology – Ecosystems Page http://www.marietta.edu/~biol/102/ecosystem.html#Energyflowthroughtheecosystem3*

Work, Energy, and Energy Transformation Misconceptions

- **Energy is a fuel**
  - For more information, go to *The Columbia Encyclopedia, Sixth edition, 2001, at http://www.bartleby.com/65/fu/fuel.html*
- **Photovoltaic cells convert light energy into electrical energy**
  - For more information, go to the U.S. Department of Energy Efficiency and Renewable Energy Web site http://www.eere.energy.gov/RE/solar_photovoltaics.html

Work, Energy, and Energy Transformation Misconceptions

- **Photosynthesis converts light energy into usable chemical energy**
  - For more information, go to:
    - • FT Exploring: Science and Technology Education at http://www.ftexploring.com/index.html
    - • Introduction to Photosynthesis and Its Applications [level: middle school and above] – This basic introduction to photosynthesis explains areas studied by researchers and highlights much of the work done at the Photosynthesis Center. http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookPS.html

Work, Energy, and Energy Transformation Misconceptions

- **Photovoltaic systems cause electricity to flow through conductors**
  - For more information, go to *"Electricity" Misconceptions in K - 6 Textbooks, by William J. Beaty, at http://www.amasci.com/miscon/eleca.html#exist*

Work, Energy, and Energy Transformation Misconceptions

- *Energy is truly lost in many energy transformations.*
- *There is no relationship between matter and energy.*
- *If energy is conserved, why are we running out of it?*
- *Energy can be changed completely from one form to another (no energy losses).*
- *Things "use up" energy.*

Work, Energy, and Energy Transformation Misconceptions

- *Energy is confined to some particular origin, such as what we get from food or what the electric company sells.*
- *An object at rest has no energy.*
- *The only type of potential energy is gravitational.*
- *Gravitational potential energy depends only on the height of an object.*
- *Doubling the speed of a moving object doubles the kinetic energy.*

Force, Energy, and Energy Transformation Misconceptions

- *Energy is a "thing." This is a fuzzy notion, probably because of the way we talk about newton-meters or joules. It is difficult to imagine an "amount" of an abstraction.*
- *The terms "energy" and "force" are interchangeable.*
- *From the non-scientific point of view, "work" is synonymous with "labor." It is hard to convince someone that more "work" is probably being done playing football for one hour than studying an hour for a quiz.*

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- National Research Council (2000). *Inquiry and the national standards.* Washington D. C: National Academy Press. ISBN 0-309-06476-7 pbk & pdf. Accessed free online at http://www.nap.edu/booksearch.php?term=Inquiry+and+the+National+standards&isbn=030906533X&Search+This+Book.x=17&Search+This+Book.y=15

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