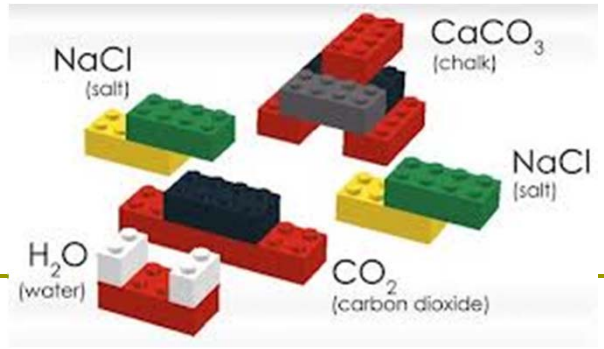
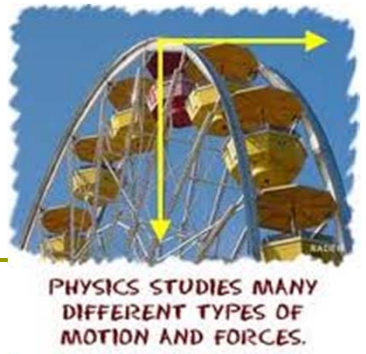
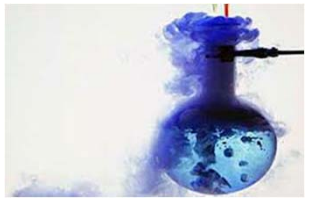




PS-21

Physical Science in the 21st Century
First Fall Institute
October 4, 2013



University of Alabama, Tuscaloosa AL

J. W. Harrell, John Vincent, Stan Jones, Dennis Sunal, Cynthia Sunal, Donna Turner

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

PS-21 Partners: Alabama Commission on Higher Education (ACHE), UA College of Arts and Sciences – Physics Department, Chemistry Department; UA College of Education, C&I Dept. – Science Education; AMSTI, Office of Research in the Disciplines; and Alabama City and County Schools

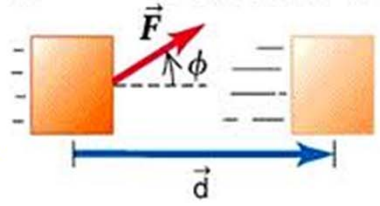
PS–21 First Fall Institute Day 2013- 2014:
Teaching Physical Science

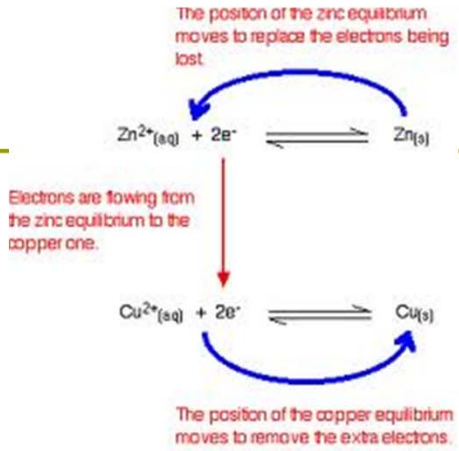
Friday, October 4, 2013 at the *University of Alabama, 3408 SEC, Tuscaloosa AL*

- ***8:30 am:*** **Registration, Coffee, Agenda, Institute surveys, and PS-21 update and Concept Pre-test**
- ***9:00-10:15: Concept–1) Force & Motion*** **+ engaging students with hands-on strategies & sharing teaching/learning ideas**
- ***10:15 – 10:25:*** **Break**
- ***10:25-11:30: Concept–2) Work & Energy Activities*** **+engaging students with hands-on activities & sharing teaching/learning ideas**
- ***11:30 – 12:30: Lunch***
- ***12:30-2:15: Concept–3) Chemical Chemiluminescence and Conservation of Energy Activities in Physical Science*** **+ engaging students with hands-on strategies & sharing teaching/learning ideas**
- ***2:15– 2:30*** **Break**
- ***2:30– 3:30 Concept–4) Inquiry Lesson Planning with the Common Core and NGSS*** **+ developing physical science lessons to motivate and engage students with hands-on strategies & sharing teaching/learning ideas**
- ***3:30– 3:45: Wrap up,*** **Institute surveys, Feedback, post-test, &**

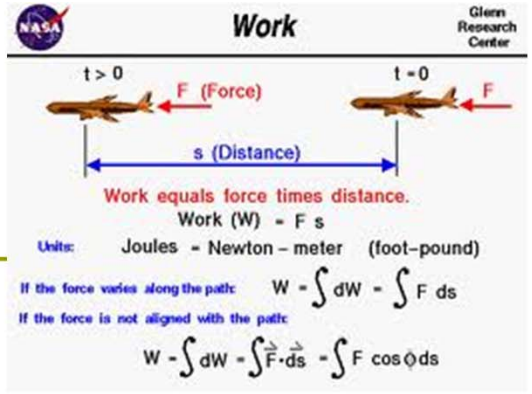
Work

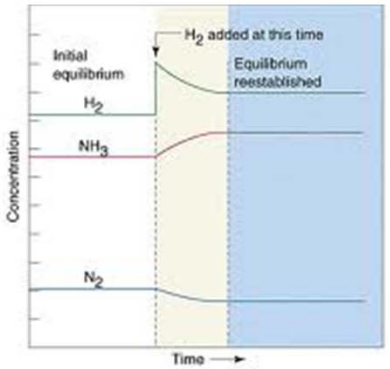
$$W = Fd\cos\theta$$



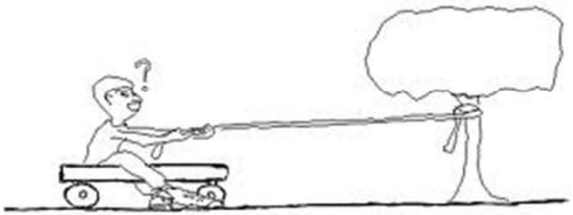


A weightlifter applies a force to cause a barbell to be displaced. The barbell then possesses mechanical energy - all in the form of potential energy.

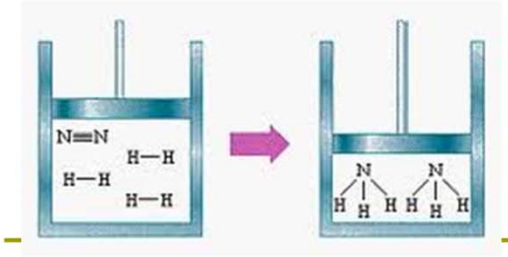


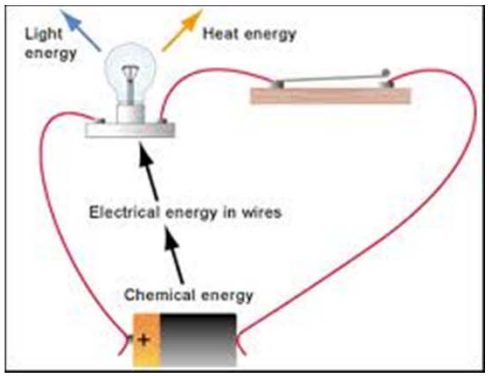


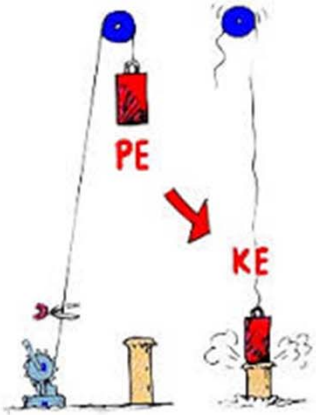
When he pulls on the tree, does the tree pull back? Does the tree do any work?

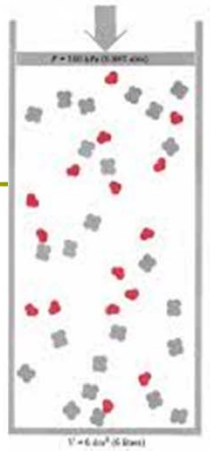


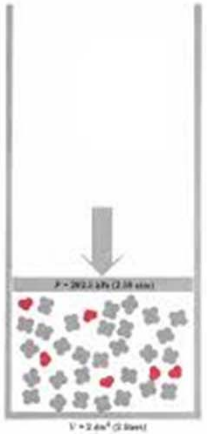
If he stands still, does he do any work?

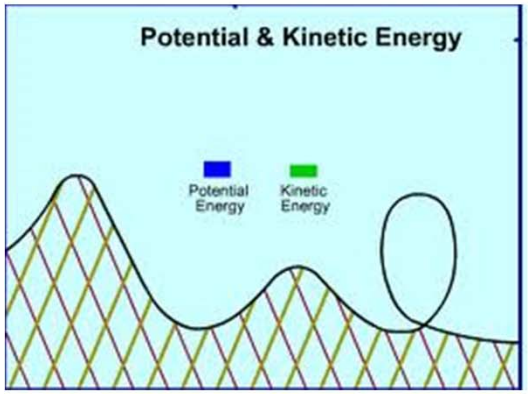




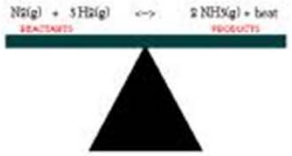




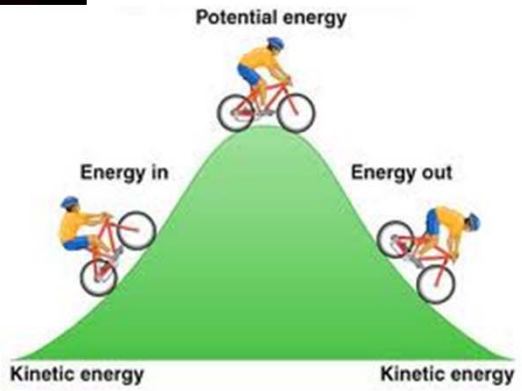




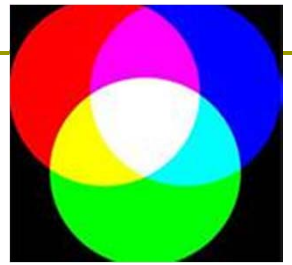
Le Chatelier's Principle
"Restoring Balance"



If you add more to the left side (*Reactants*), the lever will tip to the left. In order to restore balance, the system responds by making more of what is on the right (*Products*) and vice versa.

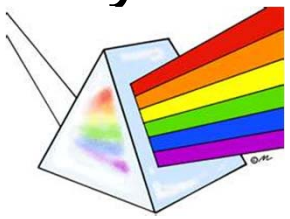


PS–21 Resources: PS-21 Web Site



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/**



PS-21 Year long objectives

- Acquire and demonstrate greater and deeper 21st century content knowledge on key physics concept themes in the physical sciences found in the national and state standards,
- Acquire and implement in science classrooms effective teaching techniques aimed at facilitating students' meaningful understanding of physical science content [Science pedagogical content knowledge (PCK)]
- Use student inquiry labs and interactive approaches to model conceptual themes in the physical sciences
- Engage in professional development with both science content and pedagogy during the school year through varied venues as a means of maintaining and enhancing practice as highly qualified science teachers.

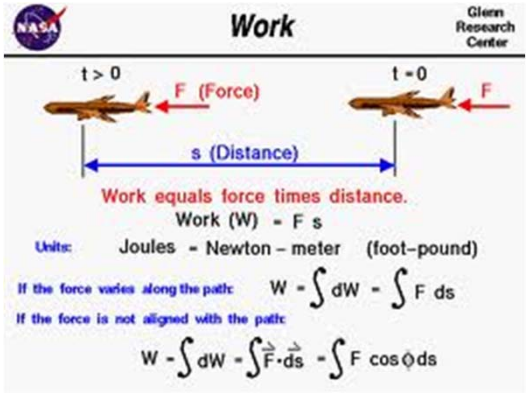
PS–21 Institute Objectives

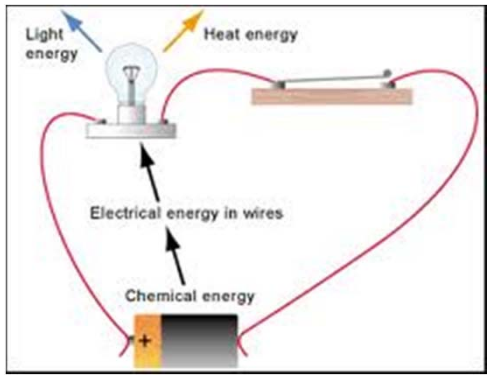
Experiencing, inquiring, using, and measuring to create meaningful learning of concepts in physical science through three questions:

1. **What misconceptions do your students bring to physical science and what should you do about them?**
2. **What engaging explanations and activities can be used in teaching the concepts?**
3. **What applications can be used with the concepts to assist application and transfer to the real world?**

Bring the following materials. We will use them with science concepts at this PS-21 Institute.

Bring lap top computer and/or a flash drive if you have one, you can bookmark URLs of useful sites on it. <u>We have lap top (netbooks) spares here if you need one.</u>





Websites to Accompany PS-21 Institute Activities

Concept 1: Work and Energy in Physical Systems

- **The Physics Classroom**

http://www.physicsclassroom.com/Class/energy/

http://www.physicsclassroom.com/curriculum/energy/

http://www.physicsclassroom.com/lab/

- **PhET**

http://phet.colorado.edu/en/search?q=work

http://phet.colorado.edu/en/search?q=energy

- **Energy Kids**

http://www.eia.gov/kids/energy.cfm?page=1

- **ThinkQuest**

http://library.thinkquest.org/20331/

Physics.org:

- **Laws of energy:**

http://www.physics.org/explorelink.asp?id=5643

- **Energy Hotlist:**

http://www.physics.org/explorelink.asp?id=627

- **Energy 4 Me:**

http://www.physics.org/explorelink.asp?id=4869

- **Energy Story:**

http://www.physics.org/explorelink.asp?id=4682

- **Energy Interactive:**

http://www.physics.org/explorelink.asp?id=1135

- **Hyper Physics:**

http://www.physics.org/explorelink.asp?id=4143

- **Energy Conversions:**

http://www.physics.org/explorelink.asp?id=3665

- **Energy Resources:**

http://www.physics.org/explorelink.asp?id=1940

Websites to Accompany PS-21 Institute Activities

Concept 2: Le Châtelier's Principle

- **Chem Guide**

http://www.chemguide.co.uk/physical/equilibria/lechatelier.html

- **Purdue Chemistry**

http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch16/lechat.html

- **Khan Academy**

http://www.youtube.com/watch?v=4-fEvpVNTlE

- **ChemWiki**

http://chemwiki.ucdavis.edu/Physical_Chemistry/Chemical_Equilibrium/Le_Chatelier's_Principle

- **Practice**

http://www.sciencegeek.net/Chemistry/taters/LeChatelier.htm

Websites to Accompany PS-21 Institute Activities

Concept 3: Transferring Chemical Energy to Light Energy

- **Energy Education:**

http://www.energyeducation.tx.gov/energy/section_1/topics/energy_transformations/index.html

- **Definitions and Primer:**

http://www.shsu.edu/chm_tgc/chemilumdir/Define.html

- **Kids Web:**

http://kisdwebs.katyisd.org/campuses/WCJH/teacherweb/kmelody/Teacher%20Documents/2nd%20six%20weeks/Energy%20Reading.pdf

- **Movies and Animations:**

http://www.shsu.edu/~chm_tgc/chemilumdir/chemiluminescence2.html

- **Explanation:**

http://www.chemistryexplained.com/Ce-Co/Chemiluminescence.html

PS–21 Resources: Physical Science CCSS & NGSS

Concept:

Relevance of Common Core State Standards and Next Generation Science Standards:

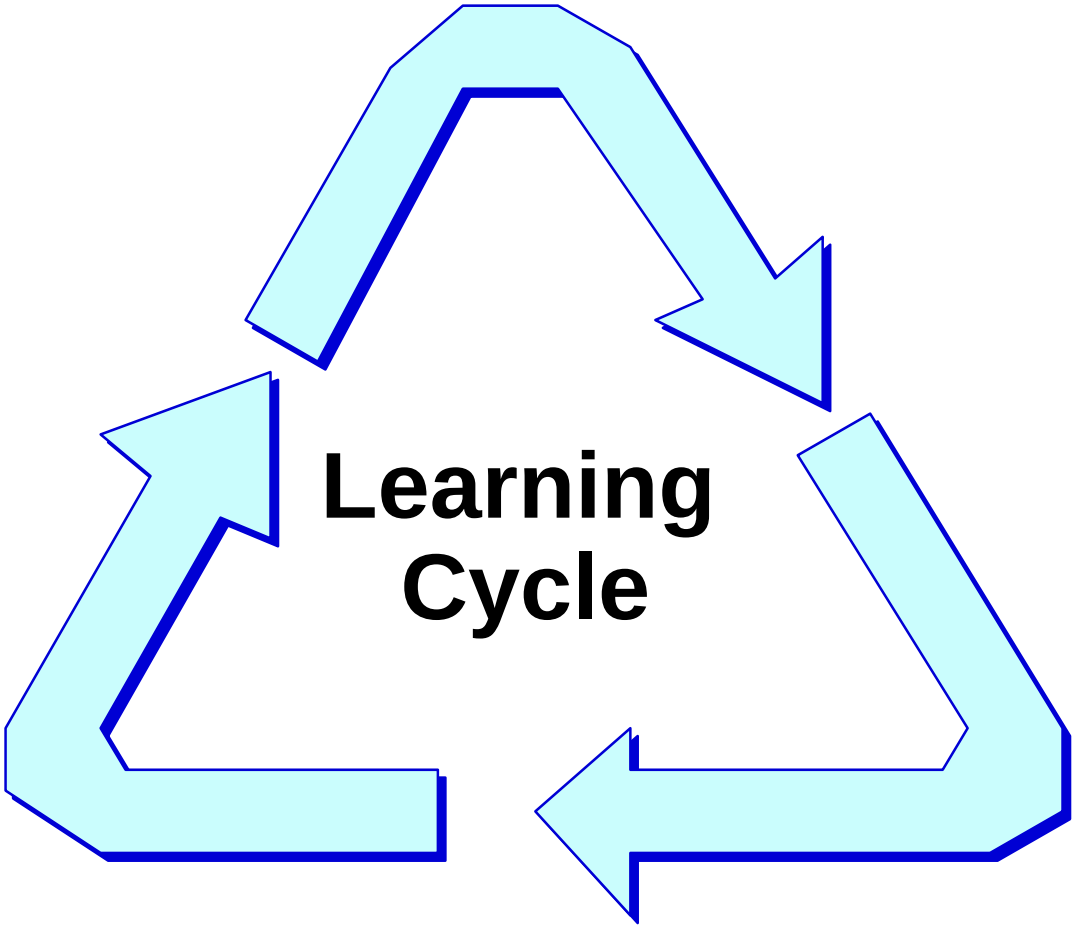
Common Core:

http://www.corestandards.org/

NGSS:

http://www.nextgenscience.org/next-generation-science-standards

PS–21 Resources: Inquiry Instruction Sequence



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

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.*

What are Research Based Strategies in Teaching Force, Energy, and Energy Transformation Models

- It is important to teach what a model is and that all models are limited in specific ways (force, distance, transformation, concentration, etc.)
- Teaching should present students with cognitive conflict challenging their existing models.
- Then students should be offered a new “better” model that must be practiced.
- Next, the new model must impress the students by working when applied in new settings

- The new models must be simple ones that clearly relate to students prior knowledge.
- A great amount of experience is needed with predicting and measuring work or equilibrium in various contexts order to challenge prior ideas.
- Then, ask students to explain what and why these phenomena occur.
- Important to ask students to develop a generalized theory of energy transformation and chemical equilibrium.

Using the LEARNING CYCLE to Plan 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

Group Activity

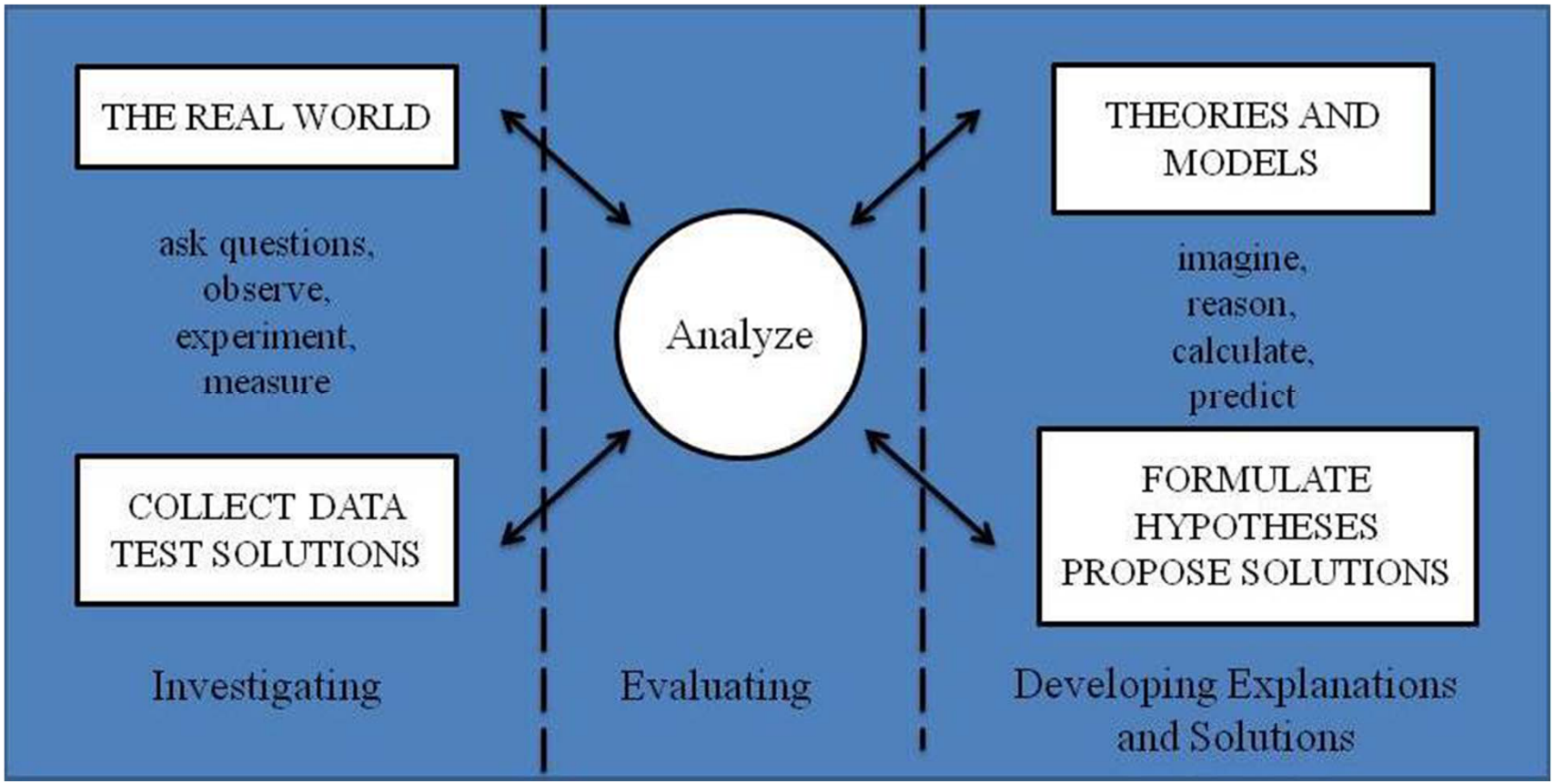
Can you complete the task below?

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.

PS–21 Resources: Next Generation Science Standards (NGSS) & Common Core Standards

- **The *Next Generation Science Standards (Practices, crosscutting concepts, and core ideas)* were released summer 2013 by the National Academies Press. The NGSS are based on the Common Core 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/**
- **The Common Core Standards have already been developed in English-Language Arts and Math to teach science across all subjects. http://www.nap.edu/catalog.php?record_id=13165**

Three Spheres of Activity for Scientists and Engineers



Crosscutting Concepts
PS-21 Institute #2

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

Disciplinary Common Core Idea Areas
PS-21 Institute #2

Physical Sciences

- **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: Physical Sciences - PS-21 Institute #2

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

PS1:Matter and Its Interactions

Example 1

- ***PS1.B: Chemical Reactions***

Key Question

Why are some physical systems more stable than others?

Key Concept

Many substances react chemically with other substances to form new substances with different properties. This change in properties results from the ways in which atoms from the original substances are combined and rearranged in the new substances. However, the total number of each type of atom is conserved.

By the end of grade 8

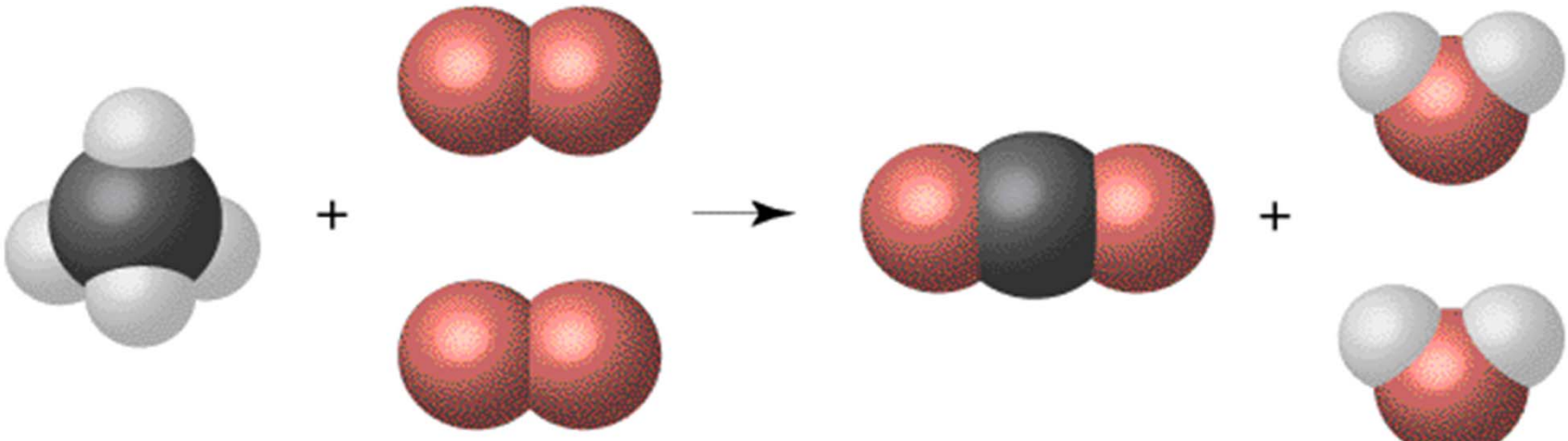
- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change. Some chemical reactions release energy, others capture or store energy.

This means that they need to know:

- Matter is conserved when a chemical reaction takes place.
- Compounds have different properties than the elements that make up the compound.
- Some chemical reactions release energy (exothermic) and other chemical reactions take in or absorb energy (endothermic).

These are called Performance Expectations in the ***Next Generation Science Standards***

Law of Conservation of Mass



One methane molecule + Two oxygen molecules → One carbon dioxide molecule + Two water molecules

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

$\begin{pmatrix} 1\,C \\ 4\,H \end{pmatrix}$ (4 O) $\begin{pmatrix} 1\,C \\ 2\,O \end{pmatrix}$ $\begin{pmatrix} 2\,O \\ 4\,H \end{pmatrix}$

By the end of grade 12

- Chemical processes, their rates, and whether or not energy is absorbed or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.

That statement means that they need to understand:

- The basic assumptions of the kinetic molecular theory. Kinetic Theory Animation
- Basic kinetics of a reaction (rates of reaction)

High School Performance Objectives

Law of Conservation of Energy

- Basic thermodynamics related to conservation of energy and related to bond energies (Basic Law of Conservation of Energy but related to bond energy)

- Basic knowledge of equilibrium –

Le Châtelier's Principle Dynamic Equilibrium

High School Performance Objectives

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

Each Core Idea is connected to

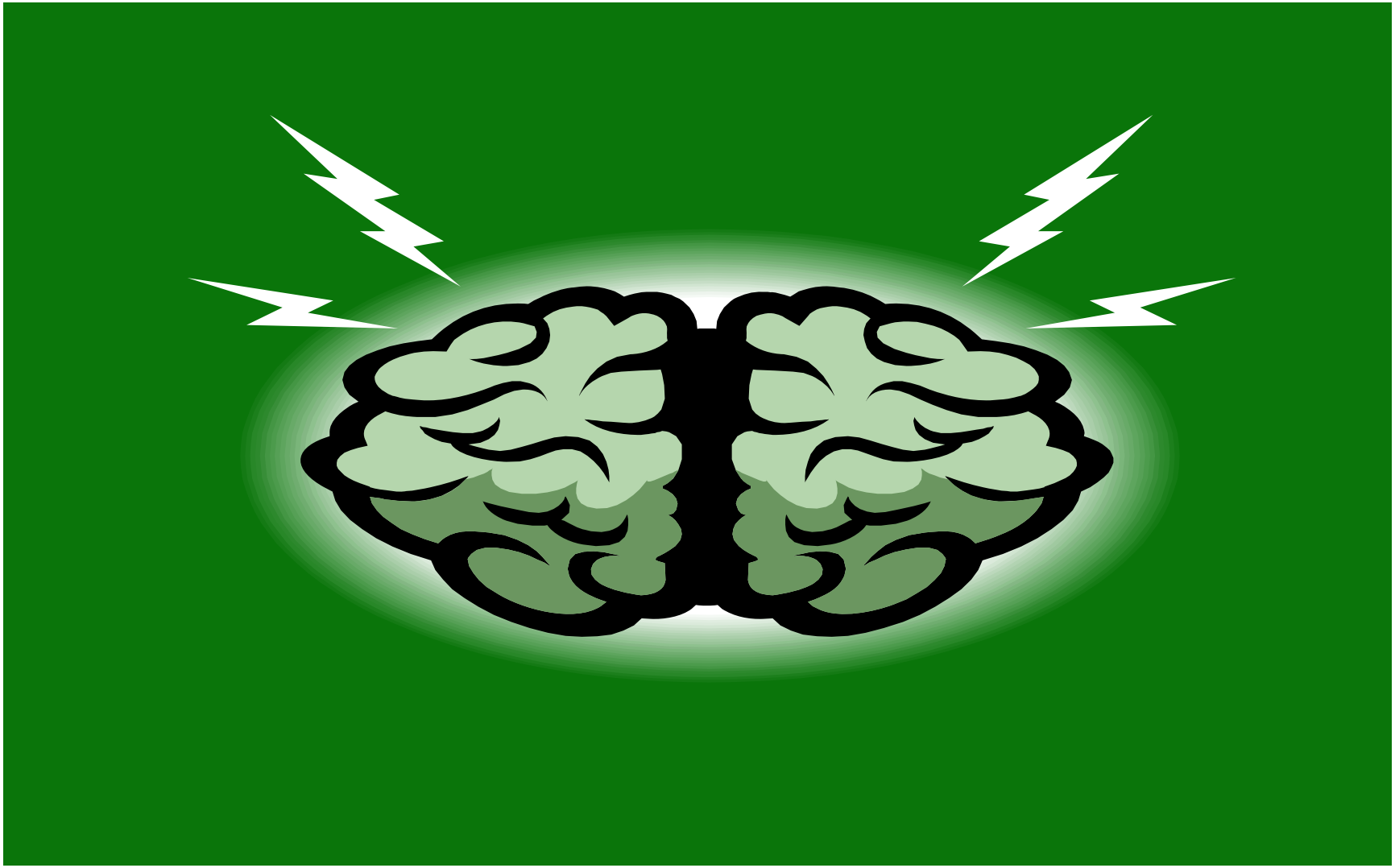
- 2) Crosscutting Concepts – These are concepts that have application across all domains of science. These include:
  - cause and effect,
  - systems,
  - stability and change,
  - scale and proportion,
  - energy and matter in systems
  - structure and function
  - patterns

How do I plan my lessons around these requirements?

Ask these questions when planning your lessons:

1) What do my students need to know? (Content)
2) What do my students need to do? (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, UA)
5) How do I assess the content knowledge and the science skills they learned? (Assessment)

Brain Storm Some Lesson Ideas on Chemical Reactions



PS2: Motion and Stability: Forces & Interactions

Example 2

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.

PS-21 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/**

PS–21 Resources:

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–21 Resources: 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**

PS–21 Resources: 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

PS–21 Resources: Physics Forums URL

5. Physics Forums: help in teaching science

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

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

PS–21 Resources:
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

PS–21 Resources: 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

PS–21 Resources:
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/

Bibliography

- Alabama State Department of Education. (2001). *Alabama Course of Study: Science*. Montgomery, AL: Alabama State Department of Education - http://alex.state.al.us/browseSC.php
- American Association for the Advancement of Science. (1993). *Benchmarks for scientific literacy*. New York: Oxford University Press. http://project2061.aaas.org/tools/benchol/bolframe.html
- American Association for the Advancement of Science (1990). *Science for all Americans.* New York: Oxford University Press. **http://www.project2061.org/tools/sfaaol/sfaatoc.htm**
- American Association for the Advancement of Science. (2001). *Atlas of scientific literacy*. Volume 1, New York: Oxford University Press. **http://www.project2061.org/tools/atlas/default.htm** **http://www.project2061.org/publications/atlas/sample/toc.htm** Table of Contents Vol 1 & 2 at **http://www.project2061.org/publications/atlas/media/combinedTOC.pdf**

Bibliography

- American Association for the Advancement of Science. (2001). *Atlas of scientific literacy*. Volume 2, New York: Oxford University Press. Accessed free online at http://www.project2061.org/publications/atlas/sample/toc2.htm
- Beisenherz, P. & Dantonio, M. (1996). *Using the learning cycle to teach physical science*, Portsmouth, NH: Heinemann Publishers.
- Driver, Squires, Rushworth, Wood-Robinson, (1994). *Making Sense of Secondary Science*, New York: Routledge.
- Driver, R. (1983). *The pupil as scientist*, Philadelphia: Open University Press,

Bibliography

- National Research Council (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (NGSS),* Committee on Conceptual Framework for the New K-12 Science Education Standards. Washington D. C: National Academy Press. Accessed free online at **http://www.nap.edu/catalog.php?record_id=13165**
- National Research Council (2013). Next generation science standards (NGSS) Washington D. C: National Academy Press. **http://www.nextgenscience.org/**
- 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**

Bibliography

- National Research Council, (1996). *National science education standards*, Washington, DC: National Research Council. Accessed free online at http://www.nap.edu/readingroom/books/nses/html http://www.nap.edu/catalog.php?record_id=4962#toc/
- Sunal, D. & Wright E. (2011). (Series Eds.) *Research in Science Education:* DeBoer, G. (Ed. Vol. 5), *The role of public policy in K-12 science education*. Charlotte, NC: Information Age Publishing.
- Sunal, D., Sunal, C., & Wright, E. (Eds.). (2010). *Teaching Science with Hispanic ELLs in K-16 Classrooms.* Charlotte, NC: Information Age Publishing.
- Sunal, D., Wright, E., & Sundberg, C. (Eds.) (2008). *The impact of the laboratory and technology on learning and teaching science K-16.* Greenwich, CT: Information Age Publishing.

Bibliography

- Sunal, D. & Wright, E. (Eds.) (2006). *The impact of state and national standards on K-12 science teaching*, Greenwich, CT: Information Age Publishing.
- Sunal, C., Karr, C., & Sunal, D., (2003). Fuzzy logic, neural networks, genetic algorithms: Views of three artificial intelligence concepts used in modeling scientific systems, *School Science and Mathematics*, *103*(2), 81-91.
- Wright, E. and Govindarajan, G. (1992). *Teaching with scientific conceptual discrepancies*, Manhattan, KS: Kansas State University. (C/O Emmett Wright, College of Education, Bluemont Hall, Kansas State University, Manhattan, KS 1-913-532-7838)

Use of Analogies in Teaching Light Concepts

- Analogies have both value and problems. You must judge the cost vs benefit.
- Students naturally use their own experience and generate analogies
- Biological, hydrodynamic, thermal, and mechanical analogies have been used. There are many traps and false conclusions with analogies.
- As with all analogies you must review or teach the analogy first – understand and experience it, then make specific connections.

- Important to use multiple analogies citing limitations in each.
- Research has shown some value in mechanical analogies – v waves from a row of swimming ducks
- Students applying ideas find it hard to recognize the concepts of waves and sound in the practical situations.

Teaching Strategy for Science Analogies

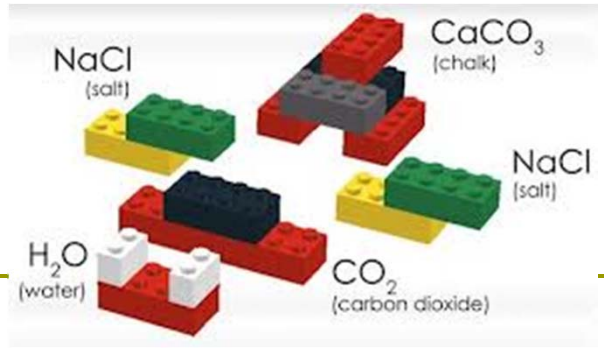
- Step 1--Introduce the concept to be learned
- Step 2--Review with the students' the analogous situation.
- Step 3--Identify the relevant features of the analog model.
- Step 4--Map out the similarities between the analog model and the concept.
- Step 5--Indicate where the analogy breaks down.
- Step 6--Draw conclusions about the concept.

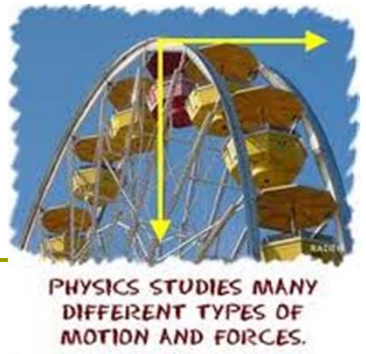
Planning Physical Science Lessons

- Elicit student ideas
- Provide data to link student ideas to science concepts
- Have students present and defend their ideas
- Introduce scientific perspective
- Change context
- Have students apply and defend their new understanding
- Have students reflect on their learning

Feedback

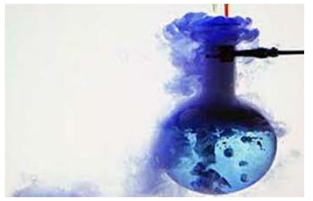
- Status: How are you doing? What are you doing? What is coming up next in your planning?
- Planning: What are you now planning that relates to this workshop? How far are you along? Do you need any help?
- Light and Color Concepts: Do you see difficult physical science concepts coming up that we could discuss with you?
- Technical: What comments on problems do you have with using technology/internet materials or other technical questions?





PS-21

Physical Science in the 21st Century
First Fall Institute
October 4, 2013



University of Alabama, Tuscaloosa AL

J. W. Harrell, John Vincent, Stan Jones, Dennis Sunal, Cynthia Sunal, Donna Turner

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

PS-21 Partners: Alabama Commission on Higher Education (ACHE), UA College of Arts and Sciences – Physics Department, Chemistry Department; UA College of Education, C&I Dept. – Science Education; AMSTI, Office of Research in the Disciplines; and Alabama City and County Schools