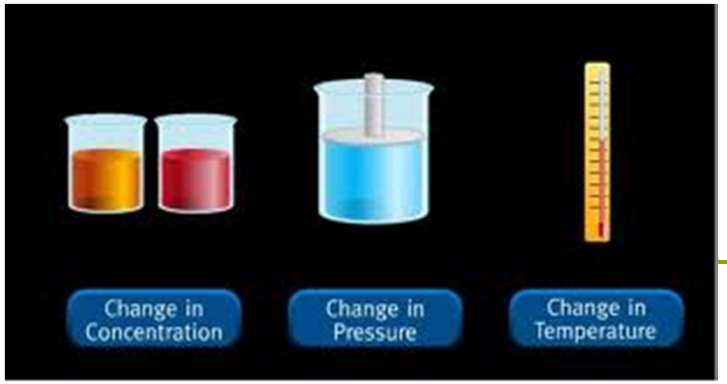
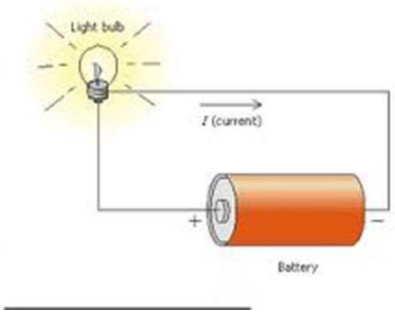
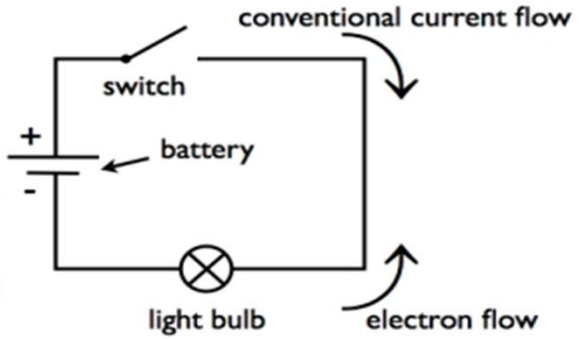






PS-21

Physical Science in the 21st Century

Second Spring Institute

February 28, 2014

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 Second Spring Institute Day 2013-2014:
Teaching Physical Science

Friday, February 28, 2014 `at the *University of Alabama, 3408 SEC, Tuscaloosa AL*

- ***8:00 am:*** **Registration, coffee, agenda, Institute surveys, PS-21 update, and concept pre-tests**
- ***8:30-10:20: Concept–1) Practical DC circuits, including light bulbs, LEDs, and light sensors*+ engaging students with hands-on strategies & sharing ideas**
- ***10:20 – 10:30:*** **Break**
- ***10:30-11:10: Concept–2) Inquiry lesson planning with currents and magnetism using the Common Core and NGSS* + developing lessons to motivate and engage students in learning ideas**
- ***11:10 – 12:10: Lunch***
- ***12:10-1:50: Concept–3) Equilibria in a chemical system* and Le Chatelier's Principle+ engaging students with hands-on strategies & sharing teaching/learning ideas**
- ***1:50– 2:00*** **Break**
- ***2:00– 2:50 Concept–4) Inquiry lesson planning with solutions and solubility using Common Core and NGSS* + developing lessons to motivate and engage students with hands-on strategies & sharing ideas**
- ***2:50– 3:20: Wrap up,* Institute surveys, feedback, post-test, & science topics for next year**

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.

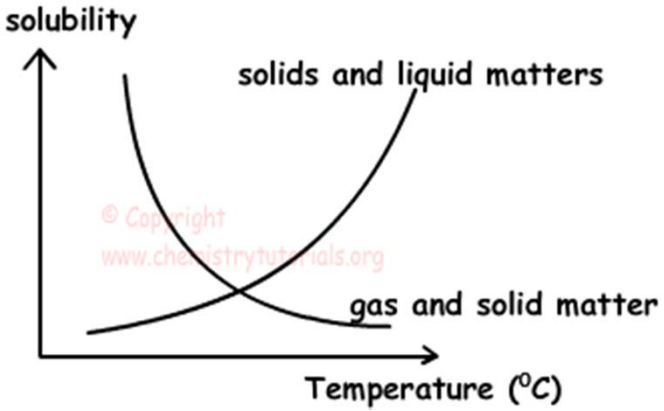
PS–21 Institute Objectives

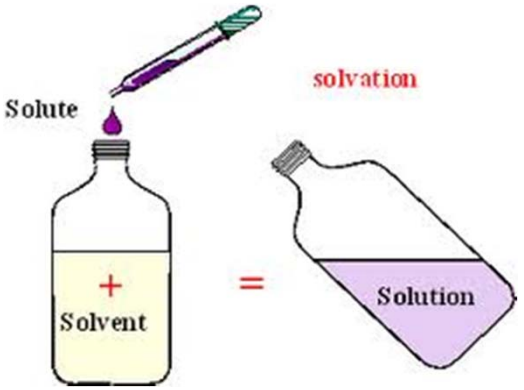
Experiencing, inquiring, using, and measuring to create meaningful learning of concepts in physical science through three questions:

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: Current Electricity

- **Khan Academy**

https://www.khanacademy.org/science/physics/electricity-and-magnetism/v/circuits--part-1

https://www.khanacademy.org/science/physics/electricity-and-magnetism/v/circuits--part-2

- **PhET**

http://phet.colorado.edu/en/simulation/circuit-construction-kit-ac

http://phet.colorado.edu/en/simulation/conductivity

http://phet.colorado.edu/en/simulation/semiconductor

http://phet.colorado.edu/en/simulation/signal-circuit

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

PS–21 Resources: Physical Science CCSS & NGSS

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

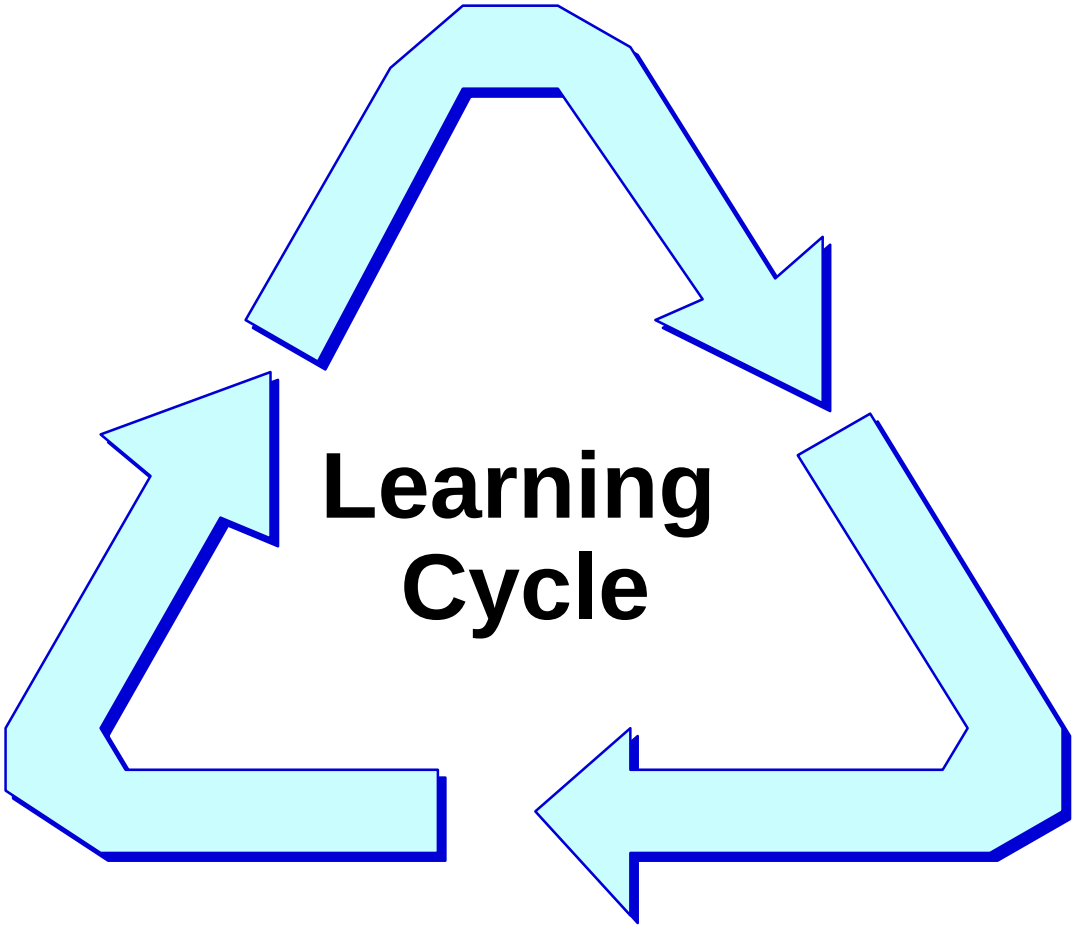
Common Core:

http://www.corestandards.org/

NGSS:

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

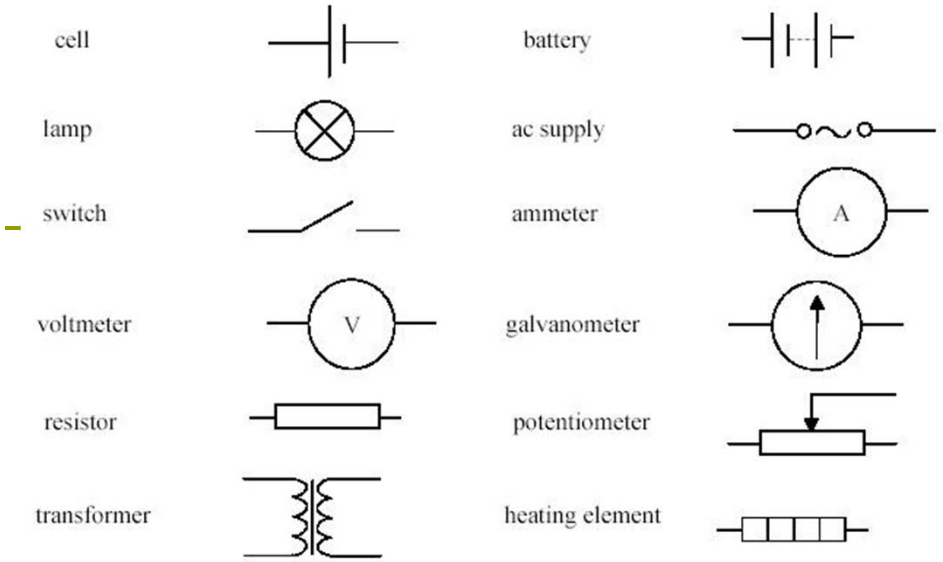
PS–21 Resources: Inquiry Instruction Sequence

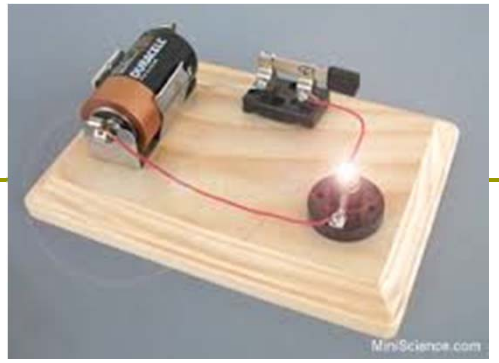


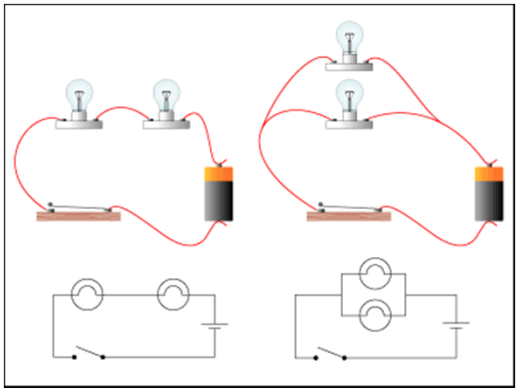
Students Prior Knowledge

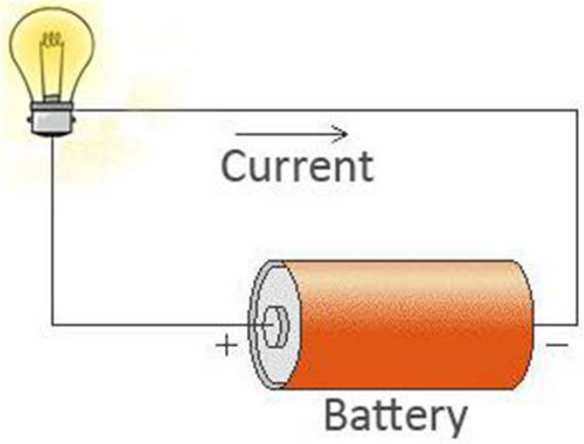
- Created from personal experiences
- Disagrees with scientific inquiry
- Partially valuable and useful in coping with everyday world
- Uses household meanings of scientific words
- Acquired from physical and social world
- Incorporated new facts with prior knowledge

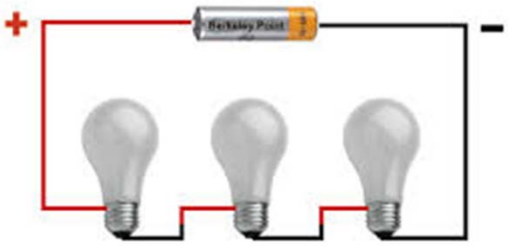
Electrical Circuit Symbols



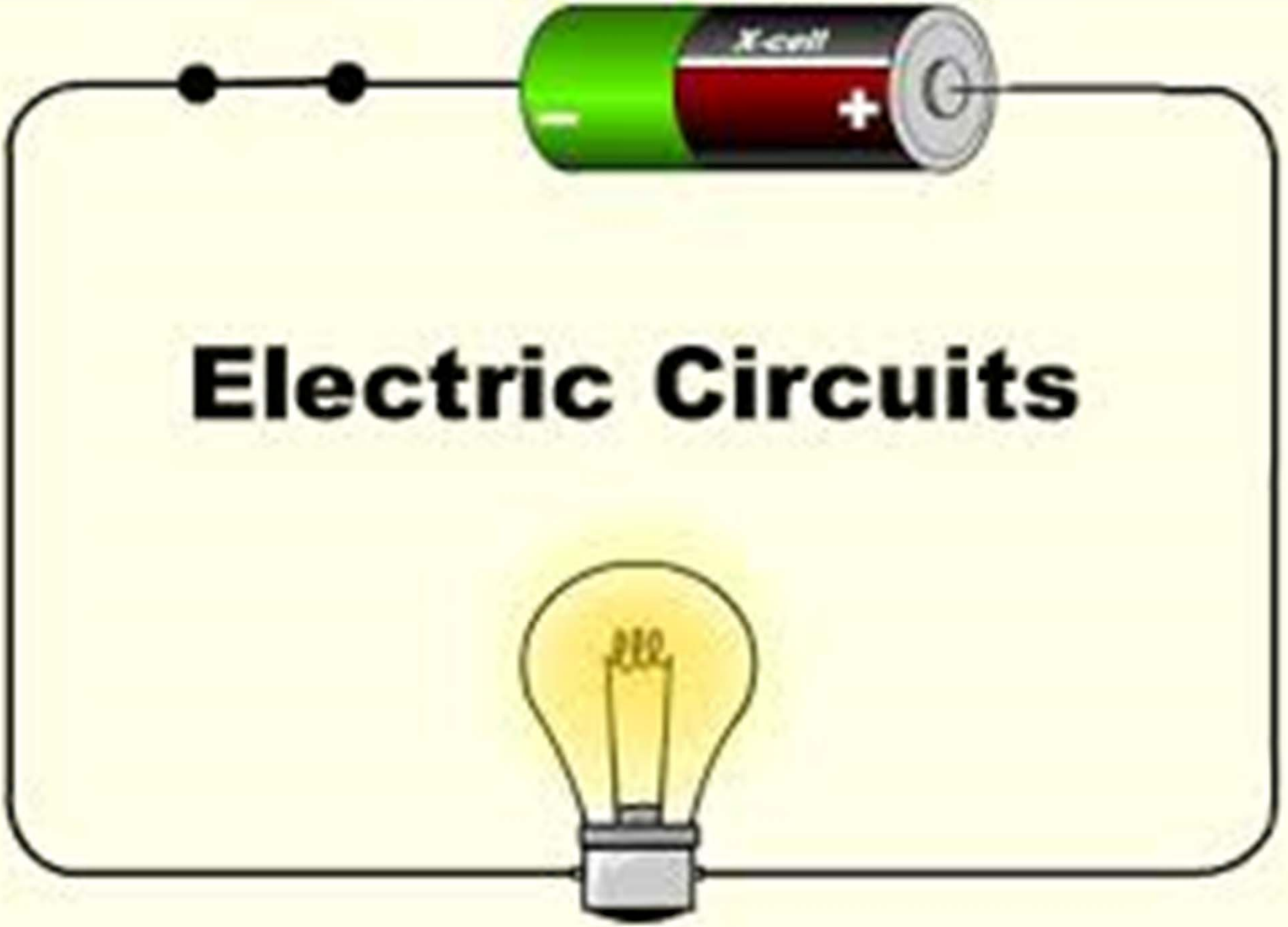








Electric Circuits



Current Electricity Misconceptions

- The concepts of current, energy and potential difference are not respected as different concepts and used interchangeably with each other.
- Current is consumed by circuit components.
- Current comes out from the (+) pole of the battery and enters to the bulb where it is consumed to light the bulb which is not affected by the second wire connected between the (-) pole and itself.

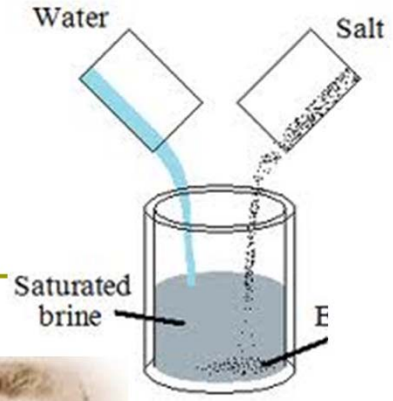
Current Electricity Misconceptions

- Current comes out from the both poles of the battery and clashes in the bulb to light it.
- Current is divided equally in each line of the parallel circuits.
- A change before the bulb affects the brightness of the bulb in circuit connected in series but the same bulb is not affect by change in anywhere of the circuit after the bulb.
- Batteries are constant current sources.

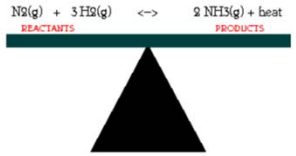
Henry Louis Le Châtelier

Le Chatelier's Principle

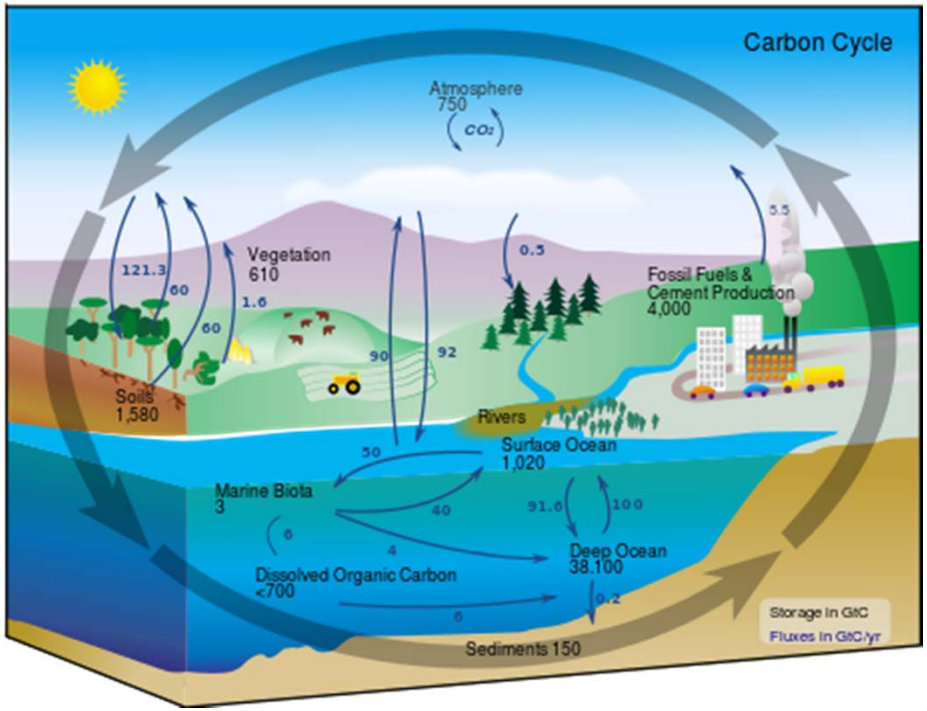
When a change is imposed on a system at equilibrium, the equilibrium will shift to counteract the change.

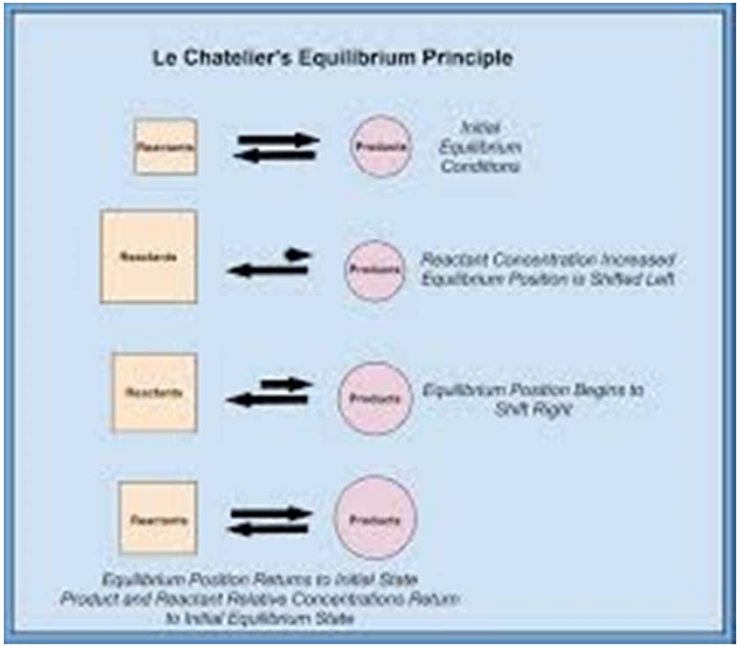


Le Chatelier's Principle
"Restoring Balance"



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.





Chemical Equilibria Misconceptions

- Equilibrium is the state where the rates of the forward and reverse reactions are equal, not when the rates reach zero. (Common misconception: Nothing is happening at equilibrium.)
- Equilibrium constants can change with temperature when the activation energies of forward and reverse reactions are different. (Common misconception: Equilibrium constants are constant under all conditions.)

Chemical Equilibria Misconceptions

- Le Chatelier's Rule. (Common misconception: Students sometimes have a hard time getting the idea that Le Chatelier's Rule is about perturbing an equilibrium state, driving the system to a new equilibrium state.)
- It doesn't matter how much of a solid is present when it is at equilibrium with a surrounding solution. The concentrations of the aqueous species will still end up being the same. (Common misconception: Students usually think that if you add more solid, the equilibrium concentrations of the aqueous species will go up. This is a misapplication of Le Chatelier's Rule.)

What are Effective Research Based Strategies in Teaching current electricity & chemical equilibria Models

- It is important to teach what a model is and that all models are limited in specific ways
- 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 electric current 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 electric circuits or 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

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

Group Activity

Can you complete the task below?

Review the ideas and materials presented earlier for a electric circuits or chemical equilibrium concepts and **create / write** 6 station activity **cards** that when sequenced form a learning/teaching cycle for the concept selected. First, name the concept.

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**

NGSS Overall Structure

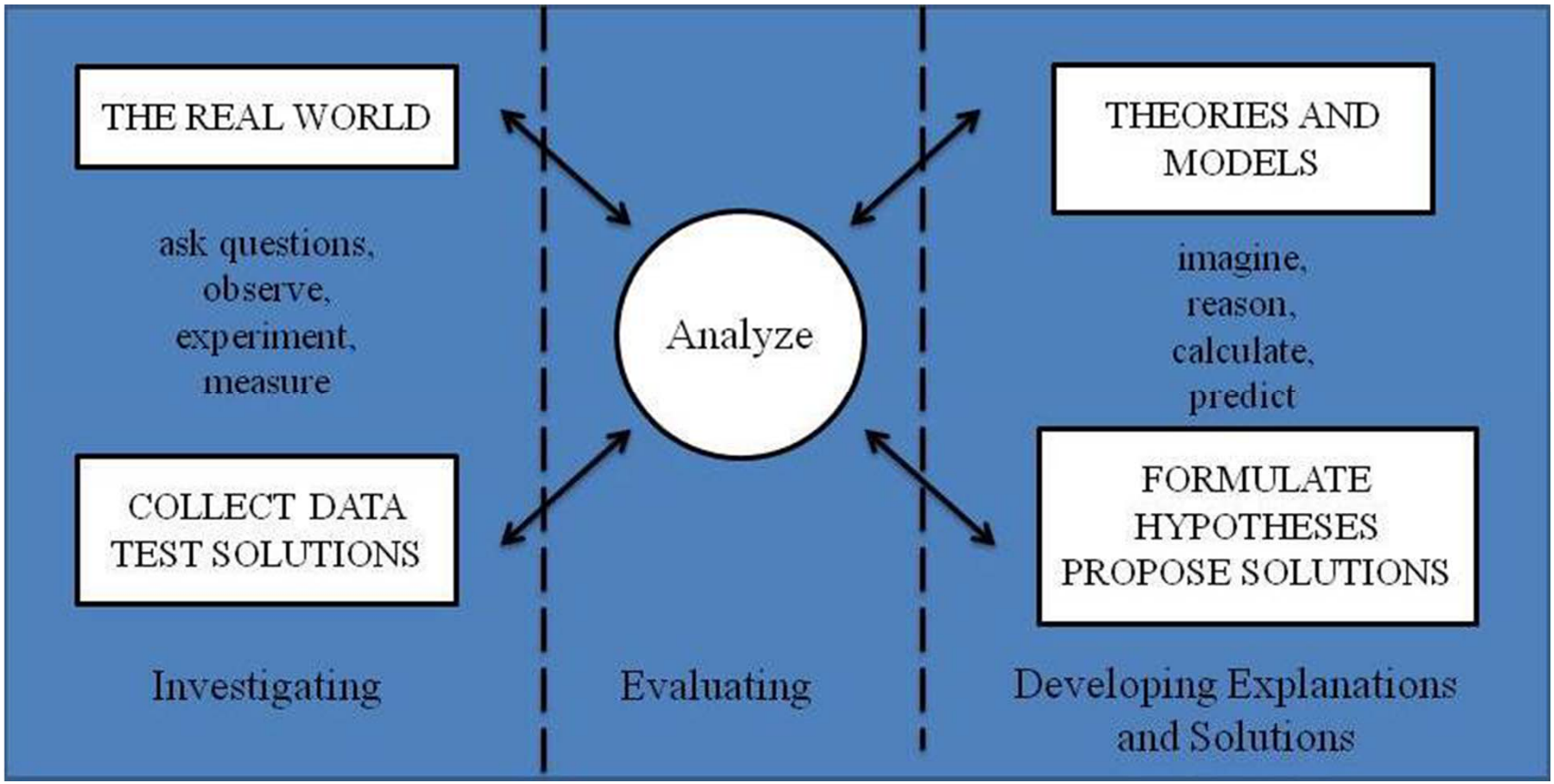
The committee recommends that science education in grades K-12 be built around three major dimensions. These dimensions are:

1. Scientific and engineering practices;
2. Crosscutting concepts that unify the study of science and engineering through their common application across fields; and
3. Core ideas in four disciplinary areas: physical sciences; life sciences; earth and space sciences; and engineering, technology, and the applications of science.

NGSS Overall Structure
1. Scientific and Engineering Practices

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

Three Spheres of Activity for Scientists and Engineers



NGSS Overall Structure
2. 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

NGSS Overall Structure
3. Disciplinary Common Core Idea Areas

- 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
- Earth and Space Sciences
  - ESS 1: Earth's place in the universe
  - ESS 2: Earth's systems
  - ESS 3: Earth and human activity

NGSS Overall Structure
3. Disciplinary Common Core Idea Areas

- Life Sciences
  - LS 1: From molecules to organisms: Structures and processes
  - LS 2: Ecosystems: Interactions, energy, & dynamics
  - LS 3: Heredity: Inheritance & variation of traits LS 4: Biological evolution: Unity and diversity
- Engineering, Technology, and the Applications of Science
  - ETS 1: Engineering design
  - ETS 2: Links among engineering, technology, science, and society

NGSS Overall Structure
3. Disciplinary Common Core Idea Areas

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**

NGSS Overall Structure

3. Disciplinary Core Ideas Physical Sciences

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

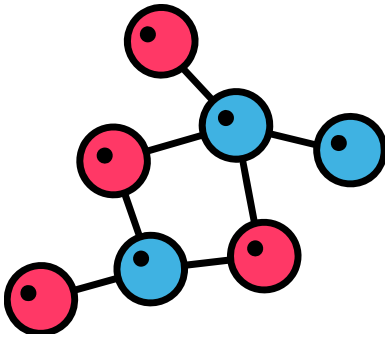
PS3D: Energy in chemical processes and everyday life

PS4: Waves and their applications

PS4A: Wave properties

PS4B: Electromagnetic radiation

PS4C: Information technologies and instrumentation



Chemical Reactions

PS1B Example

Chemical Reactions Misconceptions

- The atoms of the reactants of a chemical reaction are transformed into other atoms (Andersson, 1986).
- Substances can change their characteristic properties but maintain their identity (Pfundt, 1982).
- The products of a chemical reaction are the same substances as the reactants but with different properties (Solomonidou et al., 2000).

Chemical Reactions Misconceptions

- The products of a chemical reaction, though unseen, must have somehow existed from the start in another location, such as in the air or inside the reactants (Andersson, 1986; Solomonidou et al., 2000).
- After a chemical reaction, the product is a mixture in which the old substances persist, and is not a new substance (Johnson, 2000b; Solomonidou & Stavridou, 2000).
- The reactants and products of a chemical reaction are different and independent of each other. There is no recognition of a change of one sample to the other (Johnson, 2000b).

Chemical Reactions Misconceptions

- New atoms are created during chemical reactions (AAAS Project 2061, n.d.).
- Atoms can be destroyed during a chemical reaction (AAAS Project 2061, n.d.).
- The number of molecules is always conserved (Mitchell et al., 1984).
- The total number of atoms, not the number of each kind of atom, is always conserved (AAAS Project 2061, n.d.).
- The mass of a closed system will decrease if two substances combine to form one substance (AAAS Project 2061, n.d.).

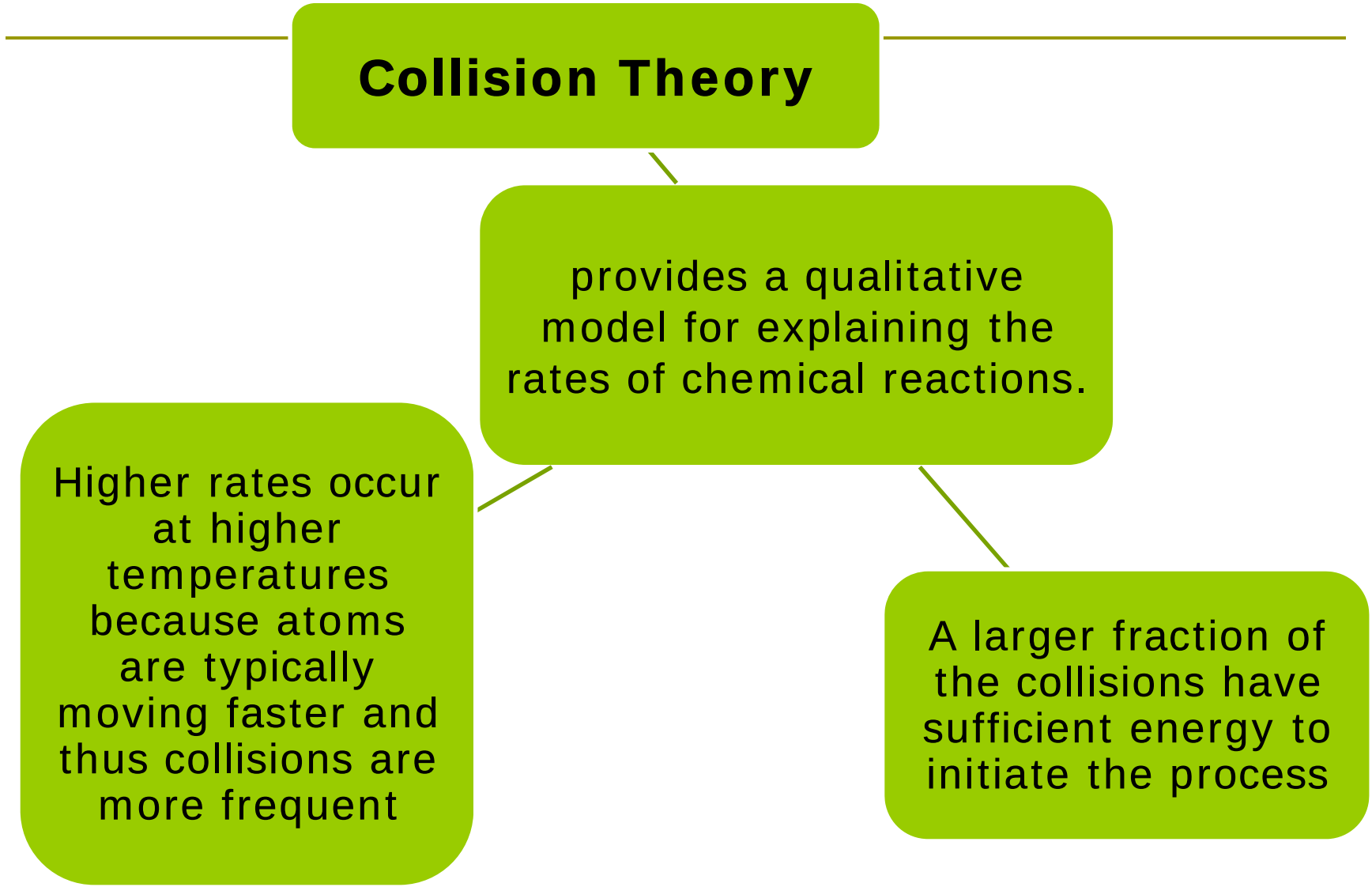
Chemical Reaction Concepts

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.

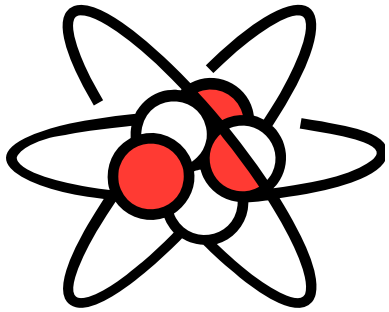
However, the total number of each type of atom is conserved (does not change) in any chemical process, mass does not change, either. The law of conservation can be used, along with knowledge of the chemical properties of particular elements, to describe and predict the outcomes of reactions.

Chemical Reaction Concepts



Chemical Reaction Concepts

Any chemical process involves a change in chemical bonds and the related bond energies and thus in the total chemical binding energy. This change is matched by a difference between the total kinetic energy of the set of reactant molecules before the collision and that of the set of product molecules after the collision (conservation of energy).



Some reactions release energy (e.g., burning fuel in the presence of oxygen) and others require energy input (e.g., synthesis of sugars from carbon dioxide and water).

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.

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.
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

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/

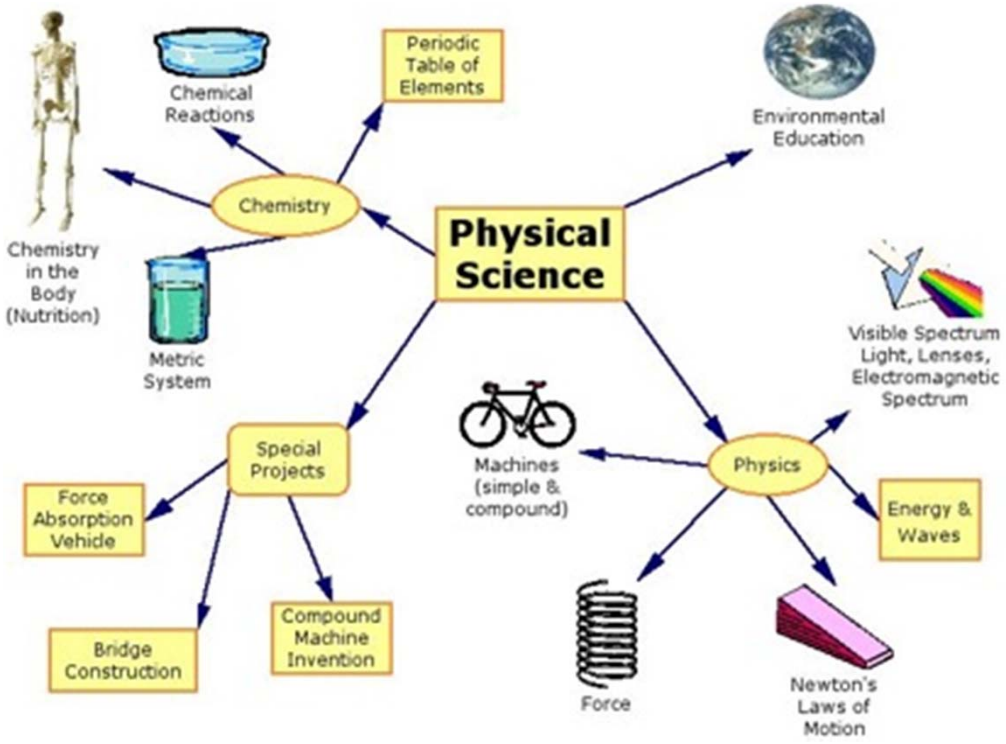
6. Physics related websites

7. Online simulations

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

8. Physical science classroom

PS-21 Internet Resources



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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/

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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?