PS-21

Physical Science in the 21st Century
Second Spring Institute 2013-14

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 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?
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/
Bring the following materials. We will use them with science concepts at PS-21 Institutes.

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

Bring your physical science textbook to compare curriculum sequences.
PS–21 Resources: Inquiry Instruction Sequence

Learning Cycle
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
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
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/](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](http://www.nap.edu/catalog.php?record_id=13165)
Three Spheres of Activity for Scientists and Engineers

- **THE REAL WORLD**: ask questions, observe, experiment, measure
- **COLLECT DATA TEST SOLUTIONS**: investigating
- **THEORIES AND MODELS**: imagine, reason, calculate, predict
- **FORMULATE HYPOTHESES PROPOSE SOLUTIONS**: developing explanations and solutions

Analyzing the relationships between these spheres involves:
- **THE REAL WORLD** to **THEORIES AND MODELS**
- **THEORIES AND MODELS** to **FORMULATE HYPOTHESES PROPOSE SOLUTIONS**
- **FORMULATE HYPOTHESES PROPOSE SOLUTIONS** back to **THE REAL WORLD**
Common Core 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
Disciplinary Common Core Idea Areas

PS-21 Institutes

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

## 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
### Example 1

**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.
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. Chemical processes and properties of materials underlie many important biological and geophysical phenomena.
**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.
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

- **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

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

http://www.thephysicsfront.org/items/detail.cfm?ID=2493
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/](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
5. Physics Forums: help in teaching science

http://physicsforums.com/
**PS–21 Resources:**

6. Physics-Related Websites

- 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

- Chemistry Activities – Videos
  [http://www.pbs.org/wgbh/nova/teachers/resources/subj_02_03.html](http://www.pbs.org/wgbh/nova/teachers/resources/subj_02_03.html)

- PBS-NOVA for Teachers
Bibliography

Bibliography


Bibliography


Bibliography

  http://www.nap.edu/catalog.php?record_id=4962#toc/


Bibliography


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?
- Chemistry and Physics 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
Second Spring Institute
2013-14

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