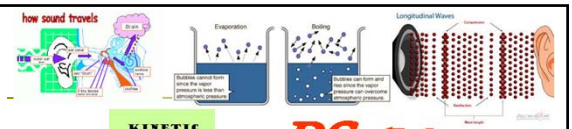


KINETIC THEORY OF MATTER

PS-21

Physical Science in the 21st Century

Second Fall Institute

November 8, 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 Second Fall Institute Day 2013- 2014:
Teaching Physical Science

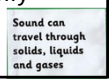
Friday, Novemver 8, 2013 at the *University of Alabama, 3408 SEC, Tuscaloosa AL*

- ***8:30 am:*** **Registration, coffee, agenda, Institute surveys, PS-21 update, and concept pre-tests**
- ***9:00-10:50: Concept–1) Principles of sound and waves* + engaging students with hands-on strategies & sharing ideas**
- ***10:50 – 11:00:* Break**
- ***11:00-11:40: Concept–2) Inquiry lesson planning of lessons with sound using the Common Core and NGSS* + developing lessons to motivate and engage students in learning ideas**
- ***11:40 – 12:40: Lunch***
- ***12:40-2:30: Concept–3*) Using kinetic theory to explain states of matter, phase changes, solubility, and chemical reactions+ engaging students with hands-on strategies & sharing teaching/learning ideas**
- ***2:30– 2:40* Break**
- ***2:40– 3:25 Concept–4) Inquiry lesson planning with the Common Core and NGSS* + developing lessons to motivate and engage students with hands-on strategies & sharing ideas**
- ***3:25– 3:45: Wrap up,* Institute surveys, Feedback, post-test, & science topics– graduate credit assignments**

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. We have lap top (netbooks) spares here if you need one.

KINETIC THEORY OF MATTER

Websites to Accompany PS-21 Institute Activities

Concept 1: Properties of Sound

- **The Physics Classroom**

http://www.physicsclassroom.com/class/sound/

- **Physics.org**

http://www.dosits.org/science/sound/whatissound/

http://www.stevespanglerscience.com/lab/experiments/halloween-screaming-cup

- **PhET**

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

http://phet.colorado.edu/en/simulation/wave-on-a-string

http://phet.colorado.edu/en/simulation/radio-waves

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

http://phet.colorado.edu/en/simulation/wave-interference

Websites to Accompany PS-21 Institute Activities

Concept 2:Kinetic Theory in States of Matter

- **ThinkQuest**

http://library.thinkquest.org/C0110228/molecules/kinetic.htm

- **WiseGeek**

http://www.wisegeek.com/what-is-kinetic-theory.htm

- **PhET**

http://phet.colorado.edu/en/contributions/view/2816

http://phet.colorado.edu/en/simulation/states-of-matter-basics

http://phet.colorado.edu/en/simulation/reactions-and-rates

http://phet.colorado.edu/en/simulation/states-of-matter

PS–21 Resources: Physical Science CCSS & NGSS

Concept:

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

Common Core:

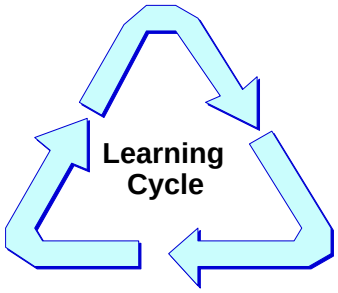
http://www.corestandards.org/

http://www.nap.edu/catalog.php?record_id=13165

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

Sound & Kinetic Theory Misconceptions

- Solid, liquid and gas are three types of same substance. One disappears as the other appears.
- Solid, liquid and gas are different substances. One disappears as the other appears.
- Bubbles from boiling water consist of oxygen and hydrogen gas.
- Freezing and boiling are examples of chemical reactions; a phase change is a kind of chemical reaction.

Sound & Kinetic Theory Misconceptions

- When reversibility of a chemical reaction is observed, it can be explained as phase changes which occur as the temperature fluctuates.
- Melting and dissolving are the same thing.
- Chemical reactions are reactions which produce irreversible change.
- The original substance vanishes "completely and forever" in a chemical reaction.

Sound & Kinetic Theory Misconceptions

- Sounds can be produced without using any material objects.
- Hitting an object harder changes the pitch of the sound produced.
- Human voice sounds are produced by a large number of vocal cords that all produce different sounds.
- Loudness and pitch of sounds are the same things.
- You can see and hear a distinct event at the same moment.

Sound & Kinetic Theory Misconceptions

- Sounds can travel through empty space (a vacuum).
- Sounds cannot travel through liquids and solids.
- Sounds made by vehicles (like the whistle of a train) change as the vehicles move past the listener because something (like the train engineer) purposely changes the pitch of the sound.

Sound & Kinetic Theory Misconceptions

- In wind instruments, the instrument itself vibrates (not the internal air column).
- Music is strictly an art form; it has nothing to do with science.
- Sound waves are transverse waves (like water and light waves).

What are Research Based Strategies in Teaching Sound & Kinetic Theory Models

- It is important to teach what a model is and that all models are limited in specific ways (waves, propagation of waves, particle motion, particle collision, 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 determining the effects sound or particle motion 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 sound waves and particle motion effects on matter.

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

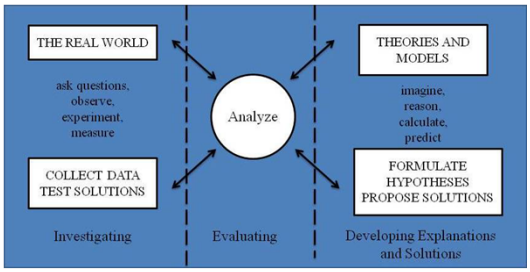
Planning Physical Science Lessons

- 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

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

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

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

PS1:Matter and Its Interactions
Example 1

- **PS4.A: Wave Properties**

Key Question

- *What are the characteristic properties and behaviors of waves?*

Key Concept

Whether a wave in water, a sound wave, or a light wave, all waves have some features in common. A simple wave has a repeating pattern of specific wavelength, frequency, and amplitude. The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which, for each type of wave, depends on the medium in which the wave is travelling.

By the end of grade 8

A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. A sound wave needs a medium through which it is transmitted. Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.

By the end of grade 12

The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

The reflection, refraction, and transmission of waves at an interface between two media can be modeled on the basis of these properties. Combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information.

Resonance is a phenomenon in which waves add up in phase in a structure, growing in amplitude due to some energy input. Structures have particular frequencies at which they resonate. This phenomenon (e.g., waves in a stretched string, vibrating air in a pipe) is used in speech and in the design of all musical instruments.

PS1:Matter and Its Interactions
Example 2

PS1.A: Structure and Properties of Matter

Key Question

- *How do particles combine to form the variety of substances one observes?*

Key Concept

Within matter, atoms and their constituents are constantly in motion. The arrangement and motion of atoms vary in characteristic ways, depending on the substance and its current state (e.g., solid, liquid). Chemical composition, temperature, and pressure affect such arrangements and motions of atoms, as well as the ways in which they interact.

By the end of grade 8

Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.

In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide.

In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).

The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

By the end of grade 12

The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.

Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy, by an amount known as the binding energy, than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

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

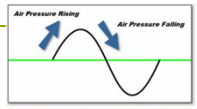
How do I plan my lessons around these requirements?

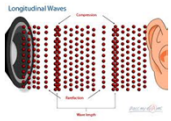
Ask these questions when planning your lessons:

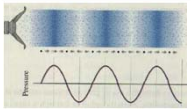
1) What do my students need to know? (Content)
2) What do my students need to do? (Practices)
3) To what other sciences is this topic related (Cross-cutting)
4) Where do I get the materials that I need to teach this? (ASIM, AMSTI, UA)
5) How do I assess the content knowledge and the science skills they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

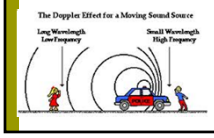
Sound and Waves

in Physical Science

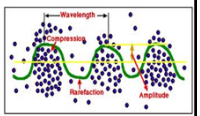








Sound can travel through solids, liquids and gases



Next Generation Science Standards
Wave properties (PS4.A)

Grade	Learning Progression
K-2	-Sound can make *matter vibrate*, and vibrating matter can make sound.
3-5	-Waves are *regular patterns of motion*, which can be made in water by disturbing the surface.
	-Waves of the same type can differ in *loudness and pitch*.
	-Waves can make *objects move*.
6-8	-A *simple wave* model has a repeating pattern with a specific *wavelength*, *frequency*, and *amplitude*.
	-*Mechanical waves* need a *medium* through which they are transmitted. This model can explain many phenomena including sound and light.
	-Waves can *transmit energy*.
9-12	-The wavelength and frequency of a wave are related to one another by the *speed of the wave*, which depends on the type of wave and the medium through which it is passing.
	-Waves can be used to *transmit information and energy*.

Wave Properties (PS4.A)
By the end of grade 12

- The *wavelength* and *frequency* of a wave are related to one another by the *speed* of travel of the wave, which depends on the type of wave and the medium through which it is passing.
- The *reflection, refraction, and transmission* of waves at an interface between two media can be modeled on the basis of a waves properties. For example, combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information.
- Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of waves), but they emerge unaffected by each other. (*interference*)
- *Resonance* is a phenomenon in which waves add up in phase in a structure, growing in amplitude due to some energy input. Structures have particular frequencies at which they resonate. This phenomenon (e.g., waves in a stretched string, vibrating air in a pipe) is used in speech and in the design of all musical instruments.

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

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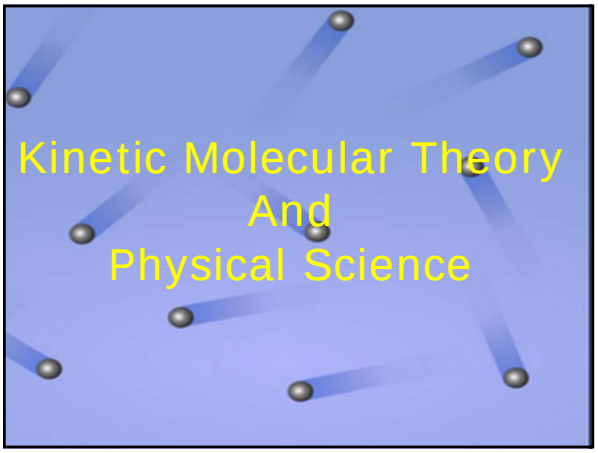
- Have students present and defend their ideas
- Introduce scientific perspective
- Change context
- Have students apply and defend their new understanding
- Have students reflect on their learning

Resonance Activities

- 1.
- 2.
- 3.
- 4.

Resonance Lesson Plan

- Objectives:
- Exploration:
- Invention:
- Expansion:



Kinetic Theory Assumptions

- A gas consists of a collection of small particles traveling in straight-line motion and obeying Newton's Laws.
- The molecules in a gas occupy no volume (that is, they are points).
- Collisions between molecules are perfectly elastic (that is, no energy is gained or lost during the collision).
- There are no attractive or repulsive forces between the molecules.
- The average kinetic energy of a molecule is $3kT/2$. (T is the absolute temperature and k is the Boltzmann constant.)
- These assumptions are not 100% true but close enough for us to use to explain phenomena.

Middle School: Kinetic Theory Core Idea - PS-1-4

- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)
- In a liquid, the molecules are constantly in contact with others; in a gas, they collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)
- Solids may be formed from molecules, or they may be extended structures with repeating sub-units (e.g., crystals)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)

What topics will I cover in Physical Science (MS) that are part of the Kinetic Theory of Matter?

Topics:

- Gas Laws
  - Boyle's Law
  - Charles' Law
  - Combined Gas Law
  - Avogadro's Law
- Changes in State
  - Heating and Cooling Curves – solid ↔ liquid ↔ gas
  - Sublimation – solid → gas or Deposition - gas→ solid
- Diffusion
  - Rate

High School: Kinetic Theory Core Idea– Chemical Reactions HS-PS-1.B and Energy HS- PS3-2

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of collisions of molecules and the rearrangements of atoms into new molecules, and with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS-1.B)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). (HS-PS3-2)

What topics will I cover in Physical Science (HS) that are part of the Kinetic Theory of Matter?

- Activation Energy and Chemical Reactions
- Exothermic and Endothermic Reactions
- Diffusion
- States of matter/Changes in State
- Gas Laws
  - Boyles
  - Charles'
  - Combined
  - Ideal
  - Avogadro's

How do I plan a lesson for these topics today?

1. Brainstorm Activities
2. Develop Lesson Plans using a Learning Cycle Approach.
   - Exploration
   - Invention
   - Expansion

Directions:

Topics on Kinetic Theory

1. Divide into groups of 2.
2. You will be assigned a topic. Three groups will have activation energy, three will have reactions, etc.
3. Brainstorm as many activities as you can for each topic that will help students understand the concept.
4. We will combine topic groups in 5 minutes.
5. Topic groups make a rough outline of a lesson plan using the learning cycle.
6. Turn in lesson plan and we will post.

1. Activation Energy
2. Endothermic and Exothermic Reactions
3. Diffusion
4. States of Matter/Changes in State
5. Gas Laws (We won't address these today, but they are part of KMT)

Activation Energy Activities

- 1.
- 2.
- 3.
- 4.

Activation Energy Lesson Plan

- Objectives:
- Exploration:
- Invention:
- Expansion:

Using the LEARNING CYCLE to Plan Lessons*

- **EXPLORATION**
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PS–21 Resources

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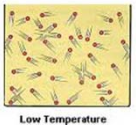
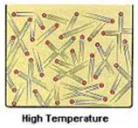

Low Temperature


High Temperature

PS-21 Internet Resources Table of Contents

1. **PS-21 WEEBLY** http://ps21pd.weebly.com/
2. ***Pathway: Physics Teaching Web Advisory*** http://www.physicspathway.org/
3. ***Physics Front*** http://www.thephysicsfront.org/items/detail.cfm?ID=2493
4. ***AAAS Assessment Website*** http://assessment.aaas.org/
5. **Annenberg Free videos online** http://www.learner.org/resources/browse.html
6. **Physical Sciences Resource Center** http://www.compadre.org/psrc/

7. Physics classroom topics
www.physicsclassroom.com/Class

8. Physics Forums: help in teaching
http://physicsforums.com/

9. Physics related websites
Multiple URLs

10. Online simulations
http://phet.colorado.edu/index.php

11. Physical science websites
Multiple URLs

12. Mozart – Misconceptions Assessments
http://www.cfa.harvard.edu/smgphp/mosart/aboutmosart_2.html

PS–21 Resources: PS-21 Web Site

1. 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: PATHWAY

2. 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***

The Physics Front
Physics and Physical Science Teaching Resources

3. 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

PS–21 Resources: **4. 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

5. 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

6. 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

7. 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

8. Physics Forums: help in teaching science

http://physicsforums.com/

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

PS–21 Resources: Physics-Related Websites

9. 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

10. 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: Physical Science URLs

11. Physical Science URLs

- **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/

PS–21 Resources: Mozart

12. Mozart – Self-Service Site

Misconceptions Assessments

Misconceptions-Oriented Standards-Based Assessment Resources for Teachers

http://www.cfa.harvard.edu/smgphp/mosart/aboutmosart_2.html

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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

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Second Fall Institute
November 8, 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