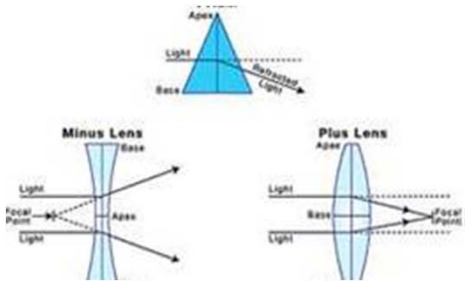
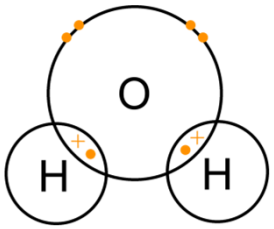
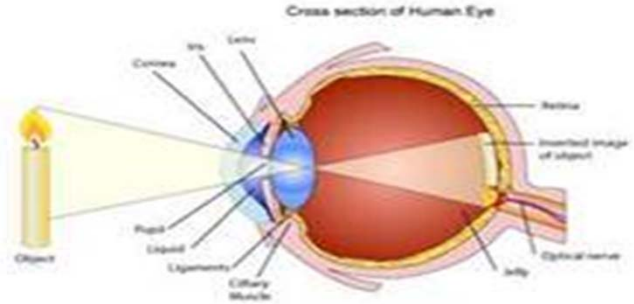
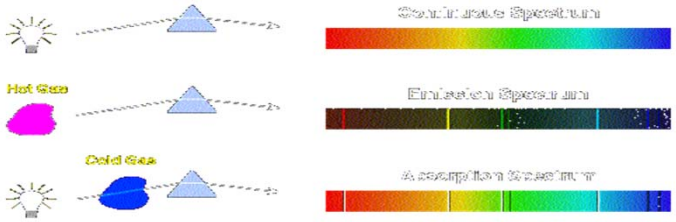








PS-21

Physical Science in the 21st Century

Second Spring Institute

March 13, 2015

University of Alabama, Tuscaloosa AL

J. W. Harrell, John Vincent, Rainer Schad, Dennis Sunal, Cynthia Sunal,
Donna Turner, Marilyn Stephens, Penni Wallace, Tara Ray

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 2014- 2015:
Teaching Physical Science

Friday, March 13, 2015 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**
- ***9:00-10:50: Concept 1)*** **Light - Image formation and spectra**
- **Including activities to engage students.**
- ***10:50– 11:00*** **Break**
- ***11:00– 12:30 Concept 2)*** **Using Technology in teaching physical science including activities to engage students.**
- ***12:30 – 1:30: Lunch*** **& Video on Student Prior Knowledge**
- ***1:30– 3:10 Concept 3)*** **Chemical Reactions and Chemical Bonding– materials, safety, and activities to engage students.**
- ***3:10-3:30: Concept 4) ACOS - NGSS & PS-21 Physical Science Teachers Online as a Virtual Learning Community at*** **http://ps21.ua.edu**
- ***3:30– 3:45: Wrap up,*** **Institute surveys, Feedback, Concept post-test + graduate credit assignments**

Bring laptop computers to use applications and data sensors and Pasco Digital Adapter with USB cord connector.

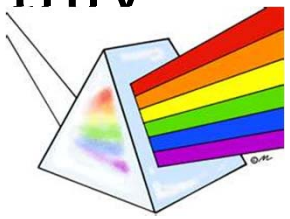
PS–21 Resources: PS-21 Web Site

Website:PS-21

URL: http://ps21.ua.edu

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 at **http://ps21.ua.edu**



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.

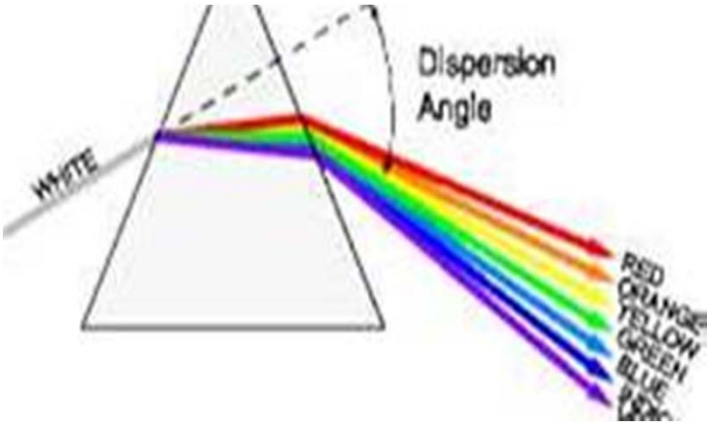
PS–21 Institute Objectives

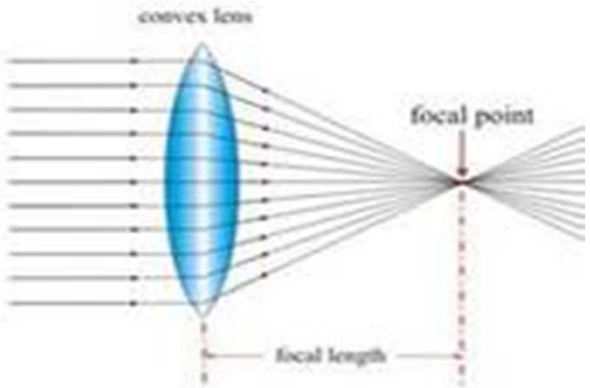
Experiencing, inquiring, using, and measuring to create meaningful learning of concepts in physical science through three questions:

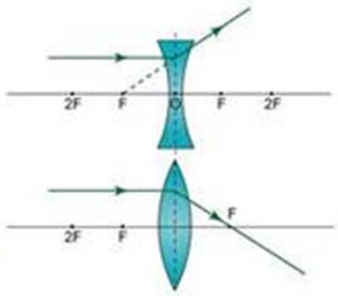
1. **What misconceptions do your students bring to physical science and what should you do about them?**
2. **What engaging explanations and activities can be used in teaching the concepts?**
3. **What applications can be used with the concepts to assist application and transfer to the real world?**

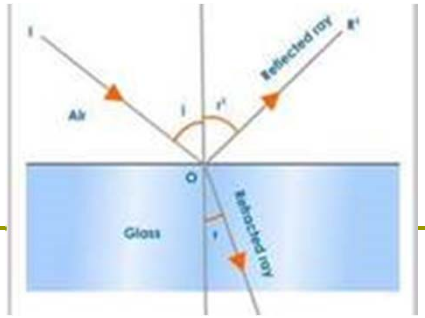
Bring the following materials. We will use them with science concepts at this PS-21 Institute.

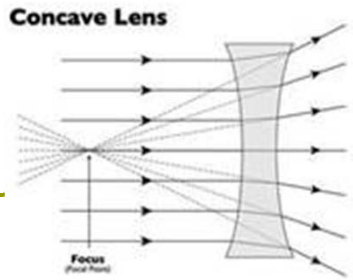
Bring lap top computer and/or a flash drive if you have one, you can bookmark URLs of useful sites on it. <u>We have lap top (netbooks) spares here if you need one.</u>

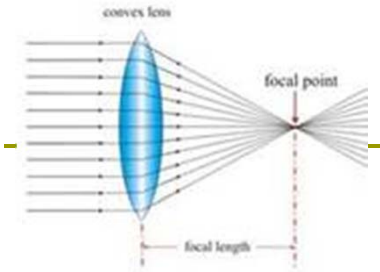


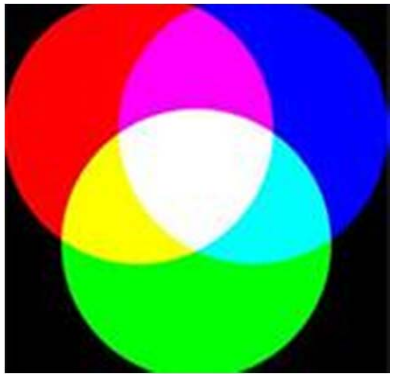


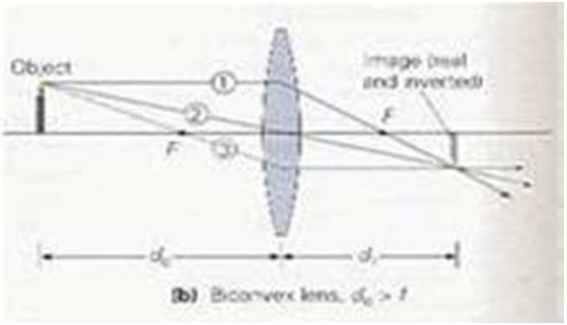

2F
F
O
F
2F
2F
F
F

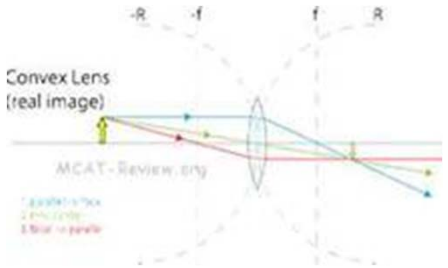

i
Air
i
r'
Reflected ray
R'
O
Glass
r
Refracted ray

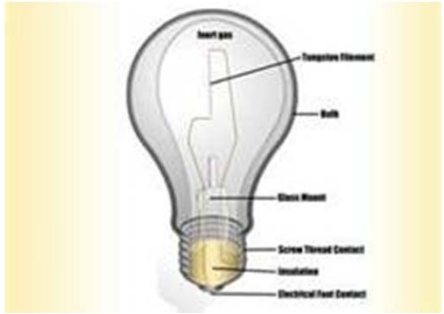

Concave Lens
Focus


convex lens
focal point
focal length

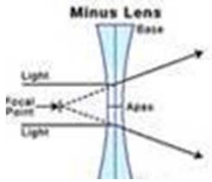


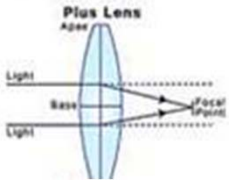

Object
image (real and inverted)
F
F
(b) Biconvex lens, $d_o > f$

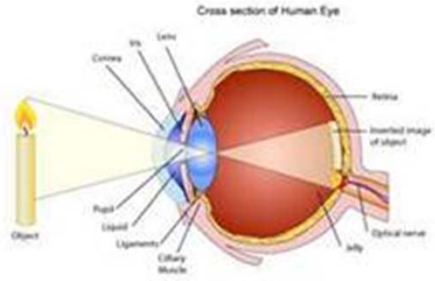

-R
-f
f
R
Convex Lens
(real image)
MCAT-Review.org

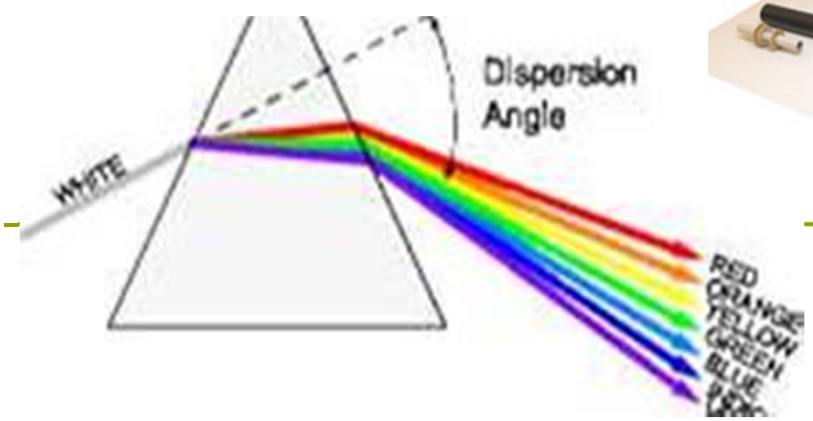

Inert gas
Tungsten Filament
Bulb
Glass Mount
Screw Thread Contact
Insulation
Electrical Foot Contact

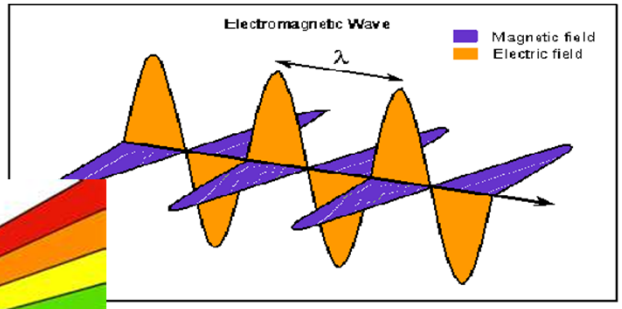

Apex
Light
Base
Refracted Light

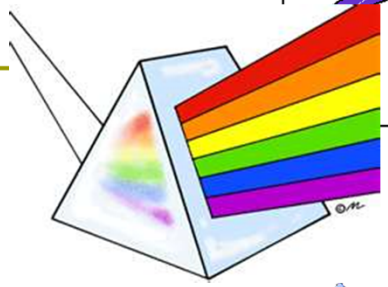

Minus Lens
Base
Light
Focal Point
Apex
Light

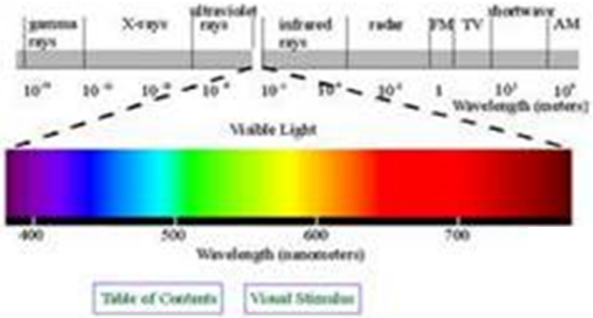

Plus Lens
Apex
Light
Base
Focal Point
Light

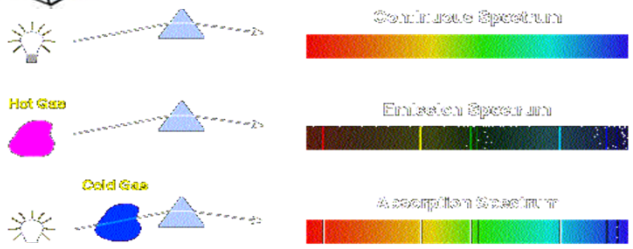

Cross section of Human Eye
Cornea
Iris
Lens
Retina
Inverted image of object
Pupil
Liquid
Ligaments
Ciliary Muscle
Jelly
Optical nerve
Object

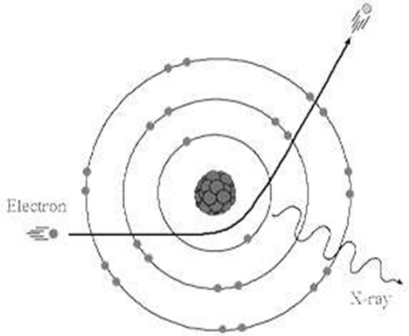

Dispersion
Angle
WHITE
RED
ORANGE
YELLOW
GREEN
BLUE

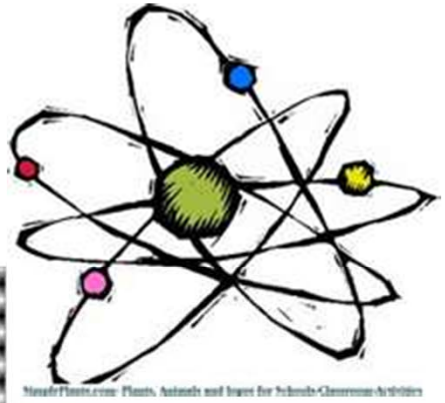

Electromagnetic Wave
Magnetic field
Electric field
λ

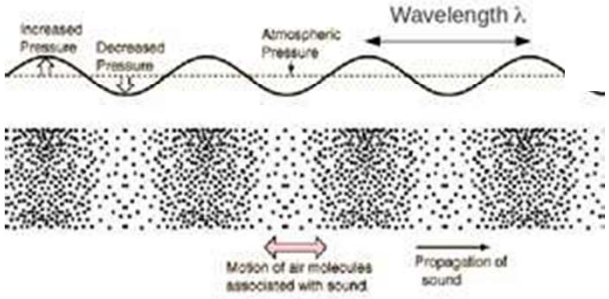


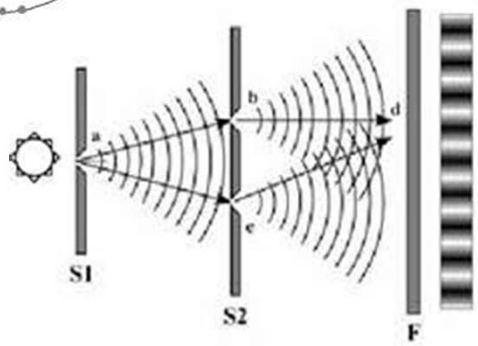

gamma rays
X-rays
ultraviolet rays
infrared rays
radar
FM
TV
shortwave
AM
Wavelength (meters)
Visible Light
400
500
600
700
Wavelength (nanometers)
Table of Contents
Visual Stimulus

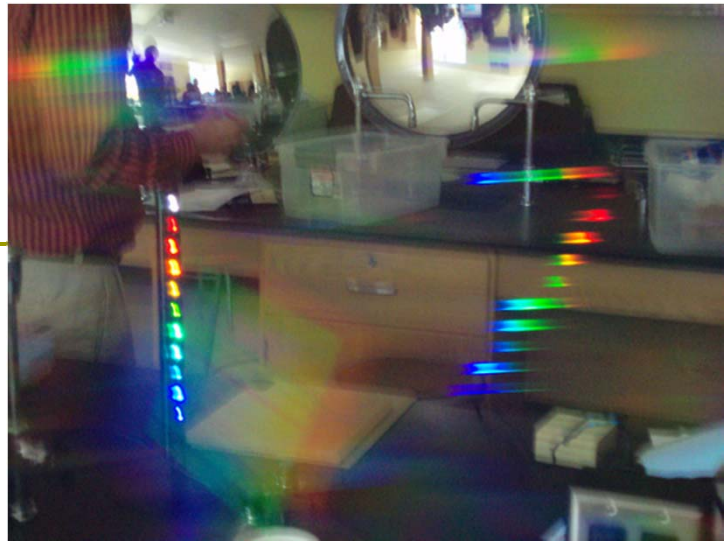

Hot Gas
Cold Gas


Electron
X-ray




Wavelength λ
Increased Pressure
Decreased Pressure
Atmospheric Pressure
Motion of air molecules associated with sound
Propagation of sound


S1
S2
F



Websites to Accompany PS-21 Institute Activities

Concept 1:*Light:Optics*

- **Optics For Kids - Optical Society of America:** Web site is devoted to everything optics! Optical Society of America (OSA)

www.optics4kids.org

- **Physics Front and PhET Simulations:**

Multiple examples

http://www.compadre.org/precollege/static/unit.cfm?sb=13&course=2

- **Hands-On Optics**
- Many websites

http://www.hands-on-optics.org/resources/links.aspx

- **Fun Science Gallery**

Optics Projects
http://www.funsci.com/texts/eno.htm

- **PhET Simulations**

http://phet.colorado.edu/en/simulations/category/physics/light-and-radiation

Properties, Reflection, Refraction, & Dispersion of Light

The Science Spot

http://sciencespot.net/Pages/kdzphysics4.html

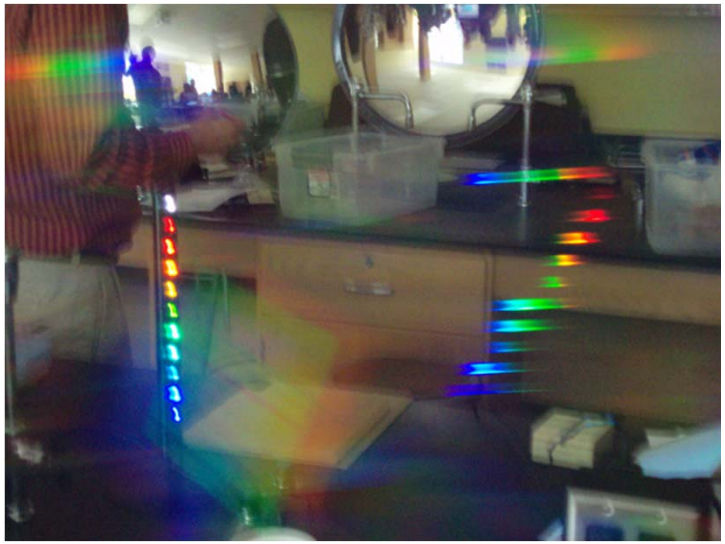
- **The Science of Light**
- **Physics of Light**
- **Shockwave Physics**
- **Sandlot Science**
- **Optics for Kids**
- **See The Light**
- **Color Matters**
- **OMSI Color Mix**
- **Colors - Stroop Effect**
- **Carmine Chameleon:**
- **Color Theory**
- **Color Cube Activities**
- **Exploratorium - Mix & Match**
- **NOVA - The Light Stuff**
- **iknowthat.com**

Operation Optics

- **iknowthat.com - Optics Workbench**
- **http://micro.magnet.fsu.edu/primer/lightandcolor/java.html**

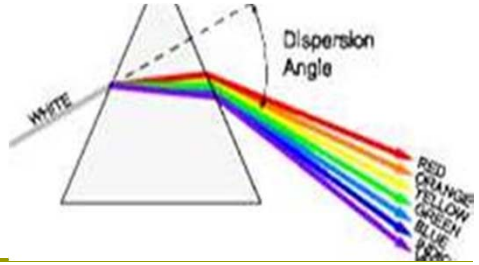
Lenses & Mirrors

- http://micro.magnet.fsu.edu/primer/lightandcolor/java.html



- Basic Properties of Mirrors
- Refraction of Light
- Lenses and Geometrical Optics
- Diffraction of Light

Websites to Accompany PS-21 Institute Activities



Light: Color

- **PhET Simulations**

http://phet.colorado.edu/en/simulations/category/physics/light-and-radiation

- **Physics Front and PhET Simulations:**

Multiple examples

http://www.compadre.org/precollege/items/detail.cfm?ID=4592

- **Lesson Plan Library**

http://www.discoveryeducation.com/teachers/free-lesson-plans/sight-and-light.cfm

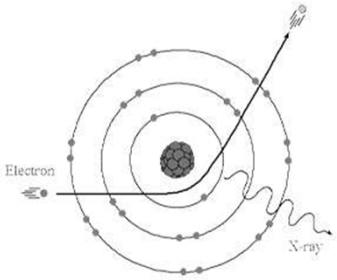
- **Middle school color and light activities**

http://www.delta-education.com/downloads/samples_dsm/ColorLightLink1.pdf

- Bill Nye: Light and Color #16

http://www.tv.com/shows/bill-nye-the-science-guy/light-and-color-241864/

Websites to Accompany PS-21 Institute Activities



Atom / electron Structure through Spectroscopy

- **Atomic spectra and the Bohr model**

http://www.learnnc.org/lp/pages/3563

- **Bill Nye Atoms 1**

http://teachertube.com/viewVideo.php?video_id=105573

- **Atoms and Light Energy**

http://imagine.gsfc.nasa.gov/docs/teachers/lessons/xray_spectra/background-atoms.html

- **Middle school color and light activities**

http://www.discoveryeducation.com/teachers/free-lesson-plans/the-color-spectrum-how-does-it-work.cfm

http://www.discoveryeducation.com/teachers/free-lesson-plans/the-electromagnetic-spectrum-waves-of-energy.cfm

- **Concord Consortium: High school activities with the atom**

http://concord.org/activities/atomic-structure

PS–21 Resources: Physical Science Teaching Videos

Annenberg Free videos online

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

Minds of our own -- 1. Can we believe our eyes? – Mirrors

http://www.learner.org/resources/series26.html Problem and explanation 5:30-9:50

Private Universe Project in Science: Workshop 5 Can we believe our eyes? – Mirror interviews and explanation 4:50-9:00-11:30

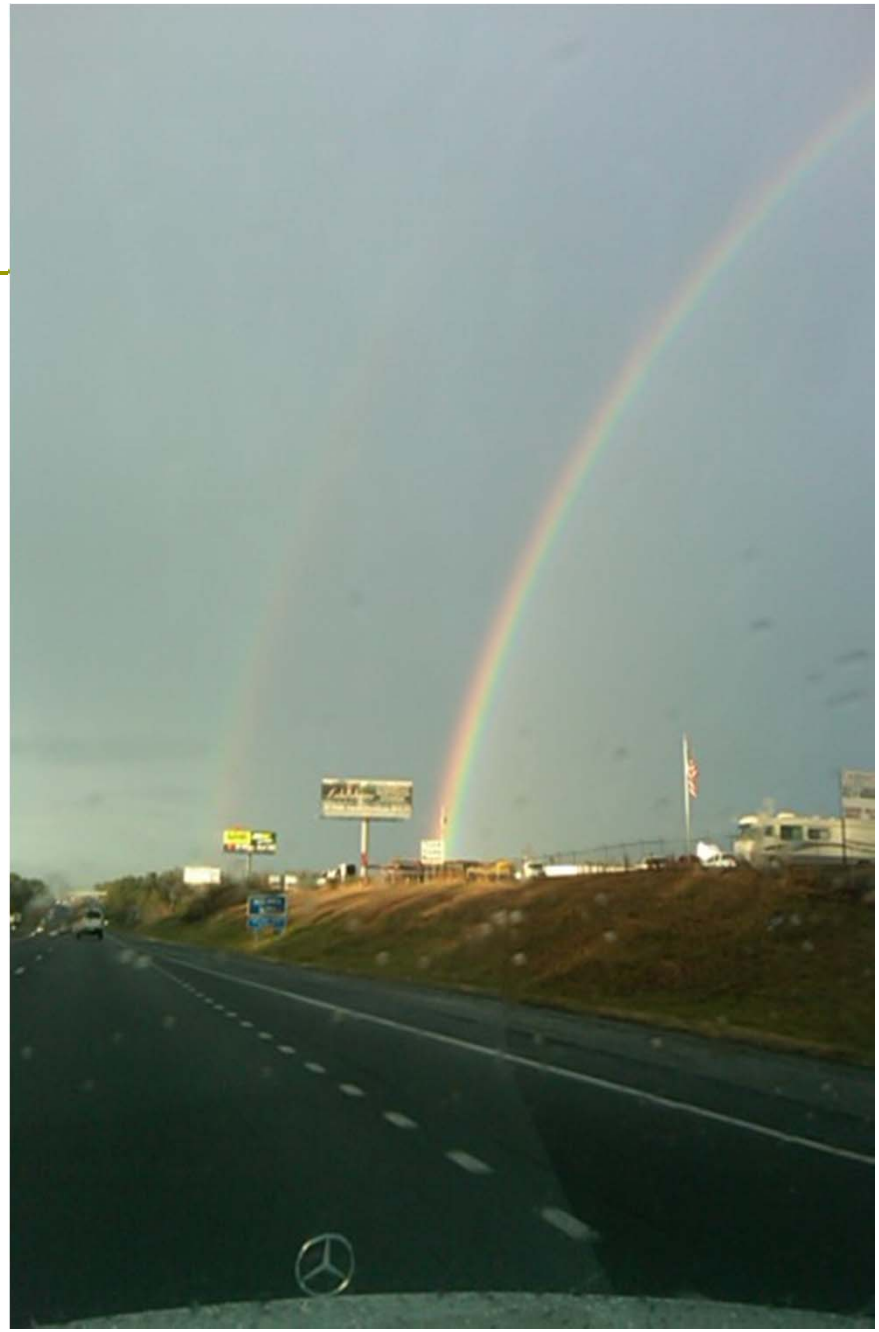
http://www.learner.org/resources/series29.html

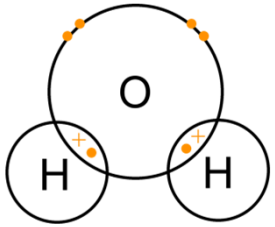
Interference and Diffraction of Light

- http://micro.magnet.fsu.edu/primer/java/diffraction/basicdiffraction/index.html

Polarization and Color

- http://www.nasa.gov/pdf/350535main_Optics_Polarization_of_Light.pdf





Websites to Accompany PS-21 Institute Activities

Concept 2: Chemical Bonding

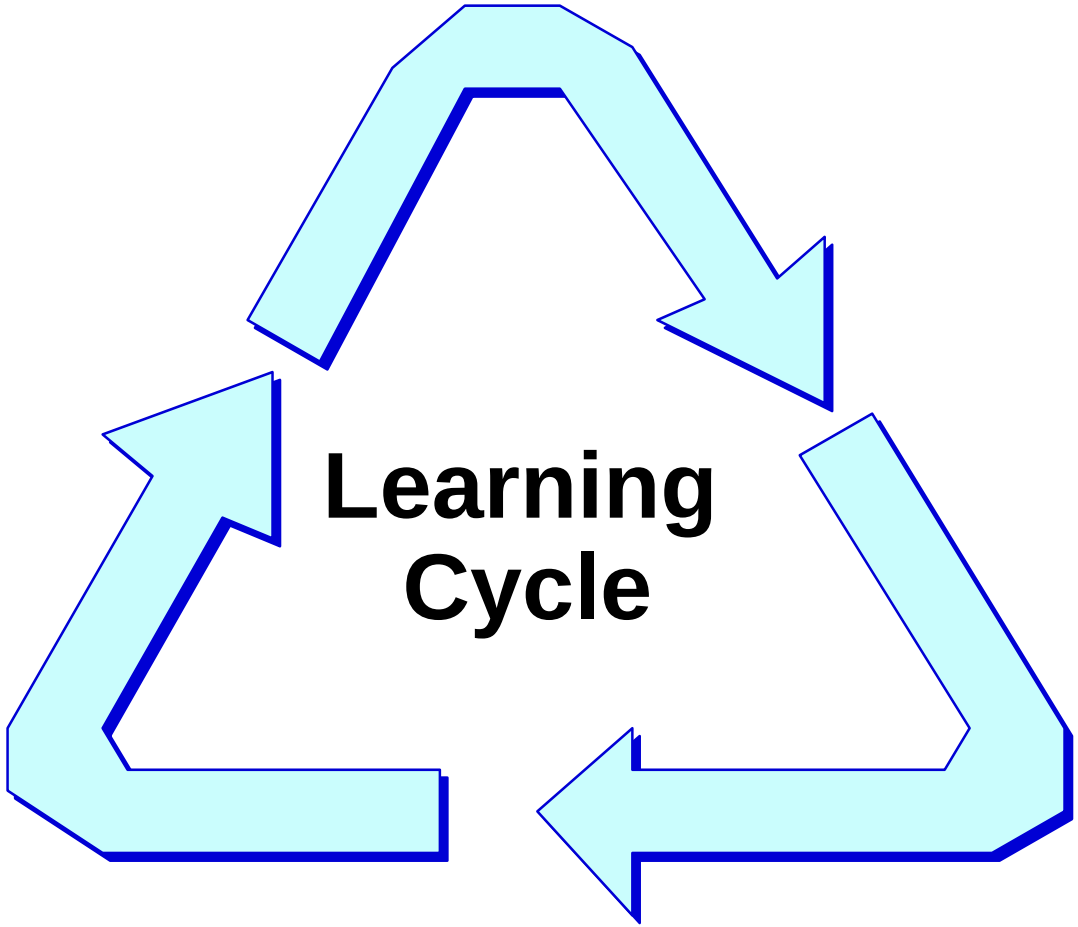
- Chemistry PhETs
- Purdue Chemistry
- Khan Academy
- Definitions and Primer
- Energy Education
- Kids Web
- Movies and Animations
- Explanation

Websites to Accompany PS-21 Institute Activities

Concept: *Inquiry Lesson Planning with the Common Core and NGSS ideas*

- Common Core
- NGSS
- Inquiry Lessons from Office of Science Outreach
- Community Resources for Inquiry Teaching
- Exploratorium Institute for Inquiry
- Science Treasure Trove of Websites

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

Common Student Ideas About Light and Vision

Students explanations and mental models of what is light and how light works.

- Reflected light is shine or glare not something associated with seeing objects.
- Light can only do some of the following: be absorbed, blocked, reflected, or refracted by an object.
- Light is not reflected in a predictable manner & angle.
- Light is not refracted in a predictable manner & angle.
- The reflection of an object is located on the surface of the mirror. The reflection is often thought of as a picture on a flat or curved surface.

- To be seen in a mirror, the object must be directly in front of the mirror or within the line-of-sight from the observer to the mirror.
- Light always passes straight through transparent material (without changing direction).
- When an object is viewed through a transparent material, the object is seen exactly where it is located.
- Light only reflects from mirrors and shiny objects.
- If students are asked what helps you see? Most will answer glasses, seeing-eye dogs, binoculars, hand lenses, or microscopes, not light.

- White light is pure and colorless light.
- Color is a property of something other than a property of light.
- Sunlight is red, yellow, or orange
- Light travels from our eyes so we can see.
- Light eminates from the object being looked at (not a property of what light is reflected or absorbed).
- A prism or colored filter (piece of gel or plastic) puts color into light when it passes through it.
- Bright light travels further than dim.
- Light travels further at night.

- Light only travels a short way.
- Light stops.
- Bats and owls can see in complete darkness.
- Humans can see in complete darkness after the eye adjusts. Students can persist with this belief by simply extending the time minutes, hours, days, years...
- Rainbows are sunlight reflected from rain
- Water has color in it and when it hits the light you see it.

Light and Color Misconceptions

- Visible light is the only type of light
- All radiation is harmful.
- The primary colors of light are identical to the primary colors of pigments.
- Red objects in space are hot; blue objects are cool.
- Filters change the color of light.

http://amazing-space.stsci.edu/resources/myths/light.php

- **Misconceptions: Color and vision**

http://www.cyberphysics.co.uk/PGCE/Misconceptions/colour.htm

- **NASA From Questions to Discoveries PDF**

http://www.nasa.gov/pdf/274682main_Light_and_Color_Educator.pdf

Light and Color Misconceptions

- The pupil of the eye is a black object or spot on the surface of the eye.
- The eye receives upright images.
- The lens is the only part of the eye responsible for focusing light.
- The lens forms and image (picture) on the retina. The brain then "looks" at this image and that is how we see.
- The eye is the only organ for sight; the brain is only for thinking.
- A white light source, such as an incandescent or fluorescent bulb, produces light made up of only one color.
- Sunlight is different from other sources of light because it contains no color.
- When white light passes through a prism, color is added to the light.

Summary List of Student Misconceptions of Light to Plan Lessons Around

- Nature of light rarely taught before middle school, only definition - Light is a form of energy (Watts, 1984).
- By 13-14 understand light is a source (bulb), an effect (spot of light), or a state (bright) but may not recognize light as a *physical entity* (Guesne, 1985).
- Students need to construct understanding while exploring properties in secondary science.

- By 13-15 year old students do not think of light as
  - traveling at all from place to place (Guesne, 1985).
  - traveling out from source very far before it stops.
  - not traveling in the daytime
  - traveling further at night (Stead and Osborne, 1980)
- Lenses not necessary to form images
- Whole lens needed to form an image

- Light bounces off mirrors but not other objects
- Light scattering off objects not understood (Anderson & Smith, 1983)
- Moving back from a mirror enables you to see more (Goldberg & McDermott, 1986)
- White light is an entity not a mixture of colors
- Red light from a projector not understood as transmission of some frequencies of light
- Color an innate property of an object, light just helps us see the color

What are Effective Research Based Strategies in Teaching Light and Vision?

- Important to teach what a model is and that all models are limited in specific ways (light, frequency, wave length, transmission, etc.)
- Need to present students with cognitive conflict challenging their existing models.
- Then need to offer 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 sound in in various contexts order to challenge prior ideas.
- Then, ask students to explain what and why these light phenomena occur.
- Introduce light with a focus on energy as well as properties
- Important to ask students to develop a generalized theory of light and light transmission, and light waves

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.

Periodic Table and General Chemistry Misconceptions

Unit Plan for Periodic Table

http://www.umanitoba.ca/outreach/crystal/Grade%209/Cluster%202/S1-2%20-%20Chemistry%20and%20Periodic%20Table%20Unit%20Plan.doc

Misconceptions that are addressed:

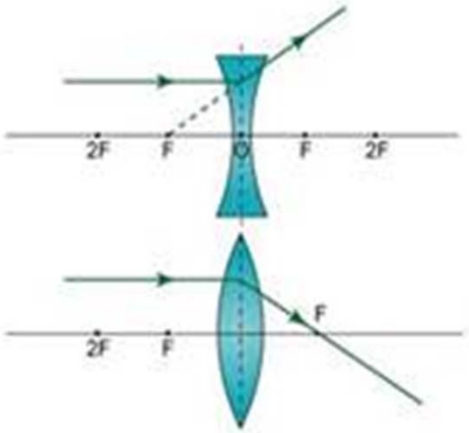
1. The Periodic Table in its present form is the way the elements have always been categorized
2. There is only one way to categorize the elements, consensus was easily achieved
3. Science and its methods provide absolute truth rather than being tentative and evolving
4. All that is to be known is known regarding atoms and elements
5. Science is procedural more than creative

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

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

In your assignment groups complete one of these assigned the tasks.

1) Light – review the activities at the stations and develop a science learning /teaching cycle **using** some or all of the **cards** at the 6 stations

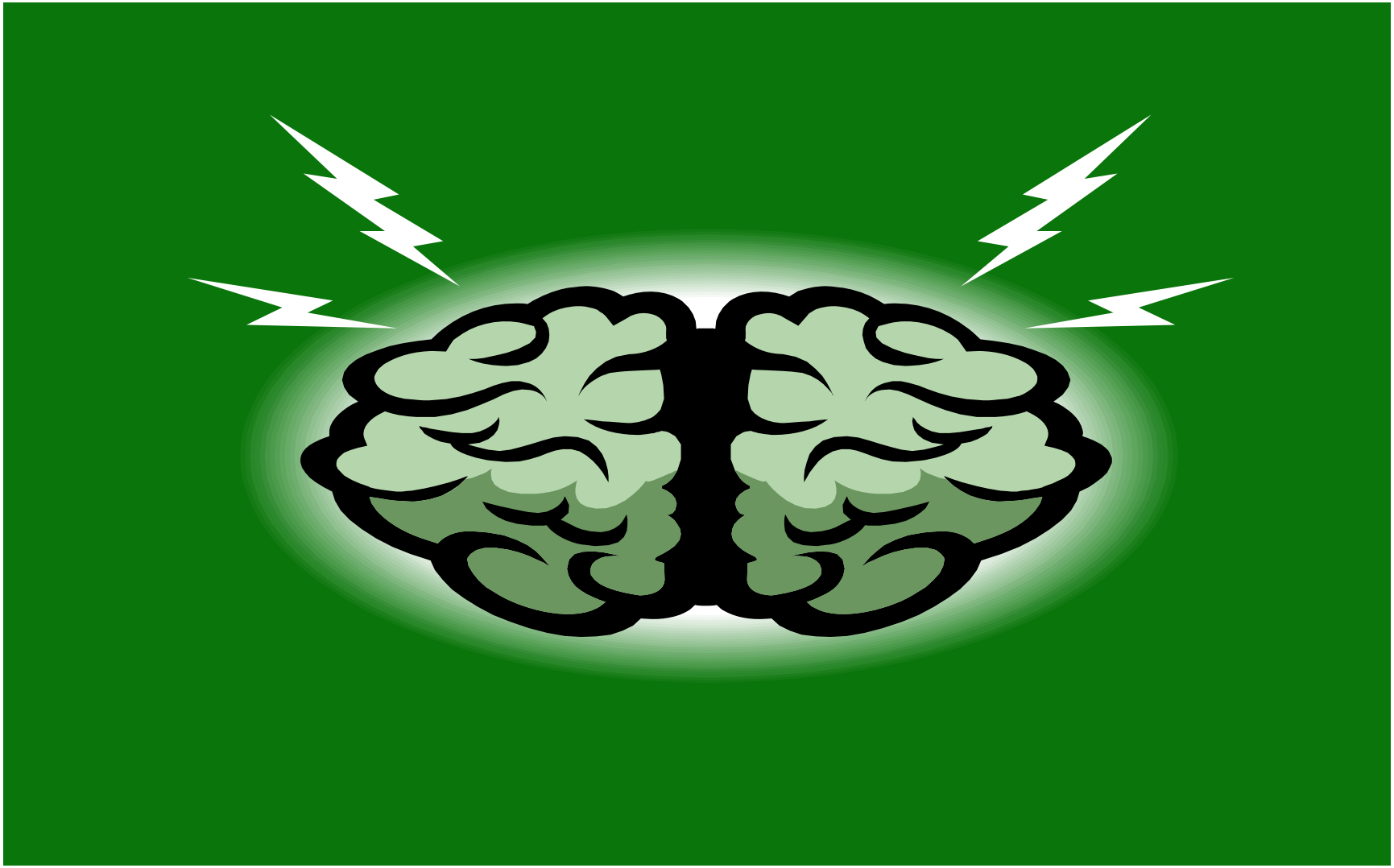
2) Lenses– review the materials in the box and **create/write** 6 station activity **cards** that when sequenced form a learning/teaching cycle. Use all of the cards.

What are Effective Research Based Strategies in Teaching Electricity?

- Important to teach what a model is and that all models are limited in specific ways.
- Need to present students with cognitive conflict challenging their existing models.
- Then need to offer 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.

- Introduce voltage first as a property of the battery
- A great amount of experience is needed with predicting and measuring current and voltage in circuits in order to challenge the voltage equals current idea.
- At first teach voltage and not PD or EMF
- Introduce electricity with a focus on energy as well as current
- Important to teach series and parallel circuits separately and separated

Brain Storm Some Lesson Ideas on One of the Workshop Concepts



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)

PS-21 Internet General Resources

Table of Contents

PS–21 Resources:
1. 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:
2. Pathway

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

PS–21 Resources:
3. Physics Front

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 2061 Science Assessment

- 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:
5. Physical Science Teaching Videos

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:

Physical Science Teaching Videos

Annenberg Free videos online for physical science – Electricity

1) Minds of Our Own -- Can We Believe Our Eyes?
http://www.learner.org/resources/series26.html

2) Private Universe Project in Science
Workshop 3. Physics: Hands-On / Minds-On Learning (90 min.)
http://www.learner.org/resources/series29.html

Others available at this resource site

PS–21 Resources:
6. PS Resource Center URL

Physical Science 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:
7. The Physics Classroom Topics URL

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:
8. Physics Forums URL

Physics Forums: help in teaching science

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

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

PS–21 Resources:
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:
10. Interactive Science Simulations

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:
11. 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

Chemistry Activities – Videos

- **PBS-NOVA for Teachers**

PBS-NOVA for Teachers

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

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- 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

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Use of Analogies in Teaching Electricity

- 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 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 found that students do not see value in the water analogy 33% and only 6% used it correctly.
- Research has shown some value in mechanical analogies – rigid bicycle chain, workers pushing a train around a track
- Students using circuit diagrams find it hard to recognize circuits in the practical situation of real equipment

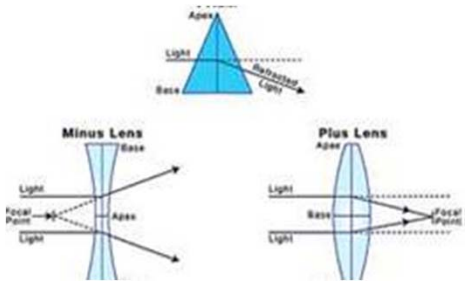
- Students spatial abilities affect their use of circuits – rotation, angle etc. topological arrangement difficulties
- Resistance is seen only as a hindrance, a barrier to the flow of charge and only affecting parts of the circuit down stream..

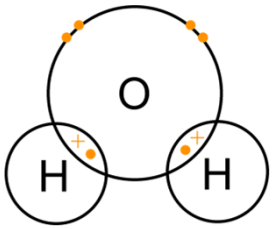
Teaching Strategy for Science Analogies

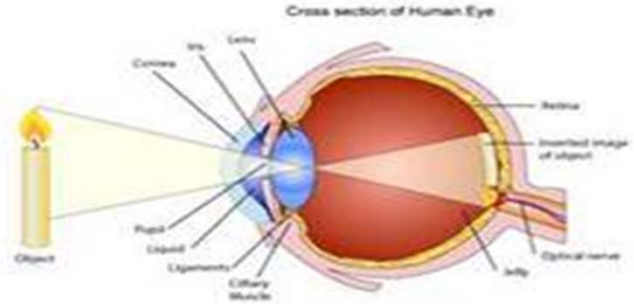
- Step 1--Introduce the concept to be learned
- Step 2--Review with the students' the analogous situation.
- Step 3--Identify the relevant features of the analog model.
- Step 4--Map out the similarities between the analog model and the concept.
- Step 5--Indicate where the analogy breaks down.
- Step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

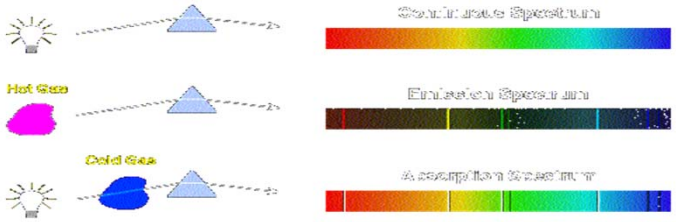
Feedback

- 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

Second Spring Institute

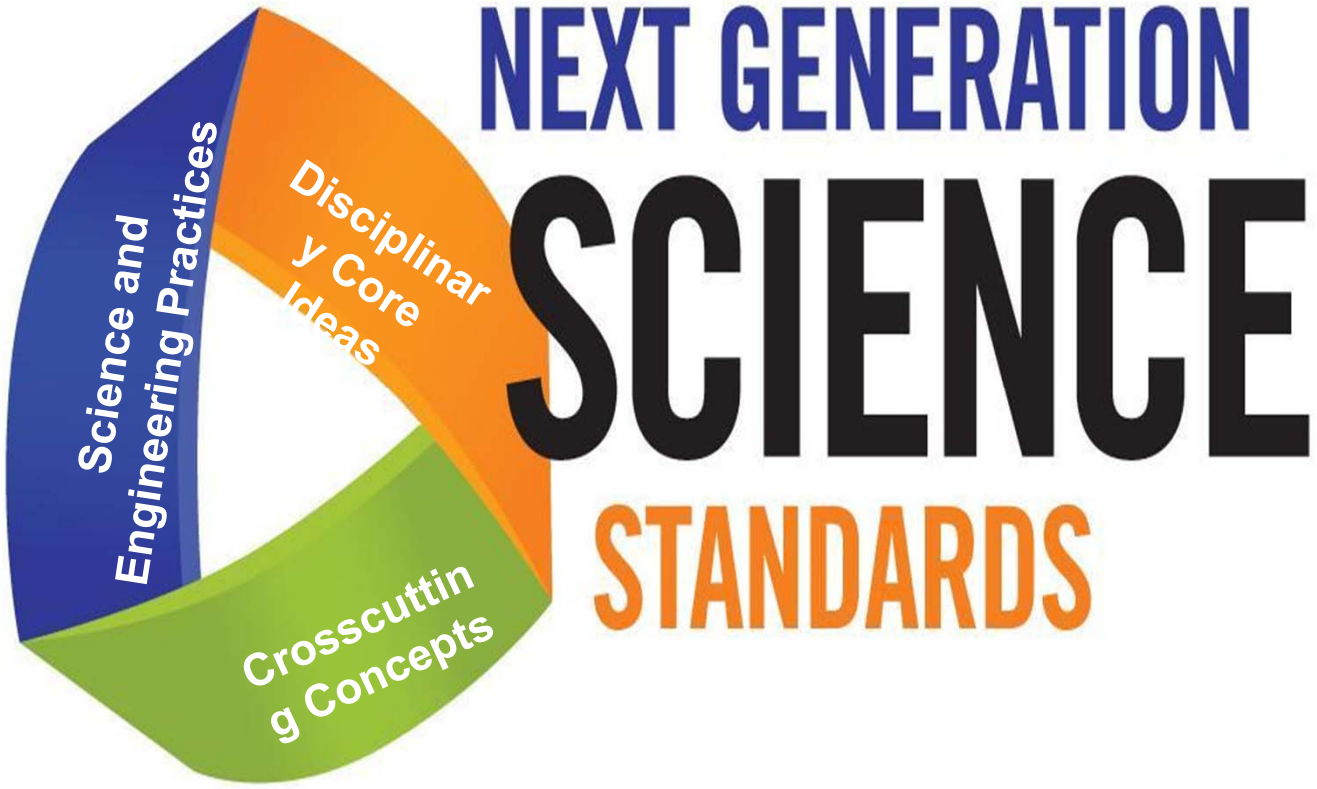
March 13, 2015

University of Alabama, Tuscaloosa AL

J. W. Harrell, John Vincent, Rainer Schad, Dennis Sunal, Cynthia Sunal,
Donna Turner, Marilyn Stephens, Penni Wallace, Tara Ray

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


Science and Engineering Practices
Disciplinary Core Ideas
Crosscutting Concepts
NEXT GENERATION
SCIENCE
STANDARDS

Why were these standards developed?

- NGSS Video

Developing the Standards

Groups Involved in the Writing of NGSS

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Achieve

NSTA National Science Teachers Association

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

Need for NGSS

- Current Standards are out of date
  - Advances in science & technology
  - Advances in understanding of learning
- College & Career Readiness
  - Lagging achievement of U.S. students
  - Demands of the Job Market
  - Global Competitiveness

The NGSS reflects a national need. What do you think the need is for new science standards for the students in <u>your school and community</u>?

Conceptual Shifts in NGSS

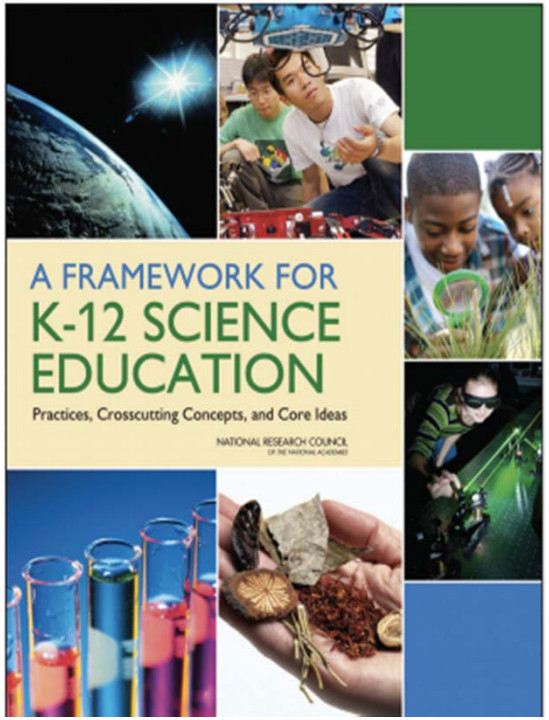
1. K-12 Science Education Should Reflect the Interconnected Nature of Science as it is Practiced and Experienced in the Real World.
2. The Next Generation Science Standards are student performance expectations – NOT curriculum.
3. The science concepts in the NGSS build coherently from K-12.
4. The NGSS Focus on Deeper Understanding of Content as well as Application of Content.

Science and Engineering are Integrated in the NGSS from K–12.

5. The NGSS are designed to prepare students for college, career, and citizenship.

6. The NGSS and Common Core State Standards (Mathematics and English Language Arts) are Aligned.

A Framework for K-12 Science Education



Three-Dimensions:

- **Scientific and Engineering Practices**
- **Crosscutting Concepts**
- **Disciplinary Core Ideas**

What Does NGSS Look Like?
Boxes with Information

Performance Expectations

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Cross-cutting Concepts

Foundation Boxes

Performance Expectations

MS-PS1 Matter and Its Interactions
Students who demonstrate understanding can: **MS-PS1-d. Develop molecular models of reactants and products to support the explanation that atoms, and therefore mass, are conserved in a chemical reaction.** [Clarification Statement: Models can include physical models and drawings that represent atoms rather than symbols. The focus is on law of conservation of matter.] [Assessment Boundary: The use of atomic masses is not required. Balancing symbolic equations (e.g. N2 + H2 -> NH3) is not required.]

- Students are required to operate at the **intersection of practice, content, and connection.**
- Integrates the 3 dimensions
- Provides Specificity
- Sets tone for instruction – Coherent, Rigorous, Application of content, Problem Solving and Scientific Reasoning (NGSS page 4)

Performance Expectations, cont.

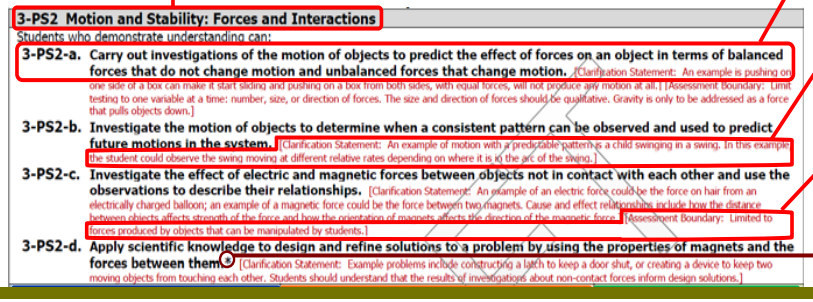
Inside the NGSS Box

What is Assessed

A collection of several performance expectations describing what students should be able to do to master this standard.

Title and Code

The titles of standard pages are not necessarily unique and may be reused at several different grade levels. The code, however, is a unique identifier for each set based on the grade level, content area, and topic it addresses.



Performance Expectations

A statement that combines practices, core ideas, and crosscutting concepts together to describe how students can show what they have learned.

Clarification Statement

A statement that supplies examples or additional clarification to the performance expectation.

Assessment Boundary

A statement that provides guidance about the scope of the performance expectation at a particular grade level.

Engineering Connection (*)

An asterisk indicates an engineering connection

- Performance Expectations …
  - Are presented in collections to represent the standard
  - Include “clarification statements” of examples and further detail
  - Include “assessment boundaries” that define the scope for the grade level

Scientific and Engineering (Student) Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

DCI – Disciplinary Core Ideas

A core idea for K-12 science instruction is a scientific idea that:

- Has broad importance across multiple science or engineering disciplines or is a key organizing concept of a single discipline
- Provides a key tool for understanding or investigating more complex ideas and solving problems
- Relates to the interests and life experiences of students or can be connected to societal or personal concerns that require scientific or technical knowledge
- Is teachable and learnable over multiple grades at increasing levels of depth and sophistication

CCC – Cross Cutting Concepts

Crosscutting Concepts In NGSS

Crosscutting concepts bridge boundaries across the various sub-disciplines of science and engineering.

The crosscutting concepts provide students with an organizational framework for making sense of and connecting knowledge across the various science disciplines.

Cross Cutting Concepts

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

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

PS2A: Forces and motion

Example 1

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.

PS1:Matter and Its Interactions

Example 2

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

Key Question

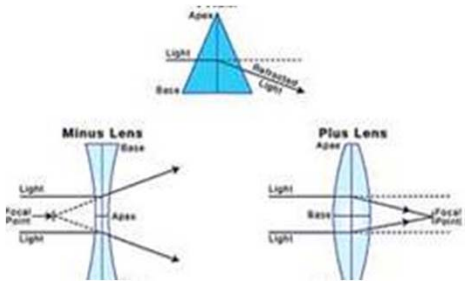
Why are some physical systems more stable than others?

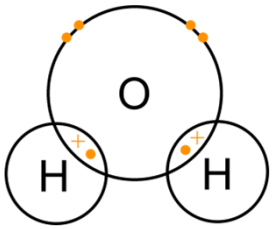
Key Concept

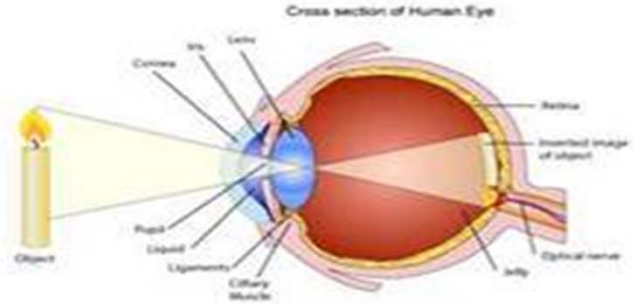
Many substances react chemically with other substances to form new substances with different properties. This change in properties results from the ways in which atoms from the original substances are combined and rearranged in the new substances. However, the total number of each type of atom is conserved.

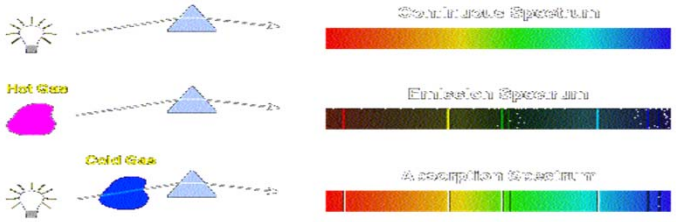
PS–21 Resources: Next Generation Science Standards (NGSS) & Common Core Standards

- **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**









PS-21

Physical Science in the 21st Century

Second Spring Institute

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University of Alabama, Tuscaloosa AL

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