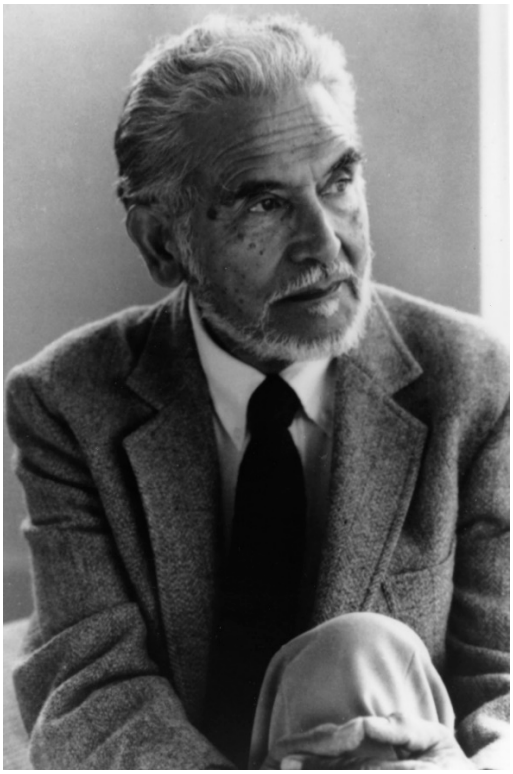
Lesson Plan
Curiosity, Creativity, Compassion: Albert V. Baez



Portrait of Albert Baez, circa 1993.
Photo courtesy of AIP Emilio Segre Visual Archives, gift of Albert Baez.

Grade Level(s): 9-12	**Subject(s): History, Physics**

In-Class Time: See below	**Prep Time: 15-25 minutes**

- Text-based sections: 35-50 minutes
- Experiment section: 25-40 minutes

Materials

- Audio/Video equipment to play video of musical performance
- Copies of Albert Baez's obituary from *Physics Today* (found in the Supplemental Materials)
- Copies of chapter from *A Year in Baghdad,* by Albert and Joan Baez (found in the Supplemental Materials)
- Copies of Discussion Questions (found in the Supplemental Materials, with corresponding Answer Key)
- For the Grazing Angle of Incidence activity (for each group):
    - Medium sized marble
    - Protractor

- String, laser point and chalk (optional)
- Modeling clay (roughly one pound)
- Play sand (roughly 1 liter)
- Slat of balsa wood, about 2 inches wide and at least 12 inches long

Objective

Students will learn about physicist Albert Baez, father of folk musician Joan Baez. They will read about his life and work, including his scientific contributions and his international science educational outreach. Readings include general biographical information as well as personal reflections by Baez about his year spent trying to establish science programs at the newly established University of Baghdad. Students will also explore optics, specifically properties of light and reflection, which Baez applied to develop X-Ray microscopy techniques.

Introduction

Albert Vinicio Baez was born November 15, 1912 in Puebla, Mexico, although he was primarily raised in New York after his family moved to Brooklyn when he was two years old. He studied mathematics in college, earning a bachelor's degree from Drew University in 1933 and a master's from Syracuse University in 1935. Baez taught mathematics at Wagner College during the early 1940s, before moving to Stanford University to teach mathematics and physics in 1944. He earned his Ph.D. in physics from Stanford in 1950 with research focused on X-ray optics and microscopy.

When the Cold War began after the end of World War II, funding opportunities abounded for physicists as the federal government awarded huge funds for defense industries and technological research. Baez briefly worked on one such classified US Navy project after graduating in 1950, but found the defense industry work conflicted with his burgeoning pacifistic ideals. He instead moved to Redlands University in California and continued his X-Ray optics research from 1950 to 1956. During this time, he took his family on a sabbatical to Iraq in 1951, as he worked to establish physical and biological science programs at Baghdad University under the auspices of United Nations Educational, Scientific and Cultural Organization, or UNESCO. During the late 1950s, Baez worked with the Massachusetts Institute of Technology to evaluate and reform how physics was taught in high schools, while also working at the Smithsonian Astrophysical Laboratory at Cambridge, Massachusetts. His passion for science education led him to head UNESCO's division of science teaching in Paris from 1961-1967, during which he also authored a physics textbook.[1]

Baez chaired the International Council of Scientific Unions' commission on scientific education, as well as the International Union on Conservation of Nature and Natural Resources' commission on education. However, his advocacy was not restricted to scientific education, as his pacifism led him to oppose the nuclear stockpiling of the 1950s and the Vietnam War. After retirement, he served as president of Vivamos Mejor (Let us Live Better) North America, which seeks to use science education and community projects to improve quality of life for Latin Americans. Baez passed his values to his students and his family. He was the father of three musically talented daughters: Paulina, Mimi, and Joan. Mimi and Joan, especially, used their talents promote pacifism and political activism from the 1960s into the present. To

[1] Albert V. Baez, *The New College Physics: A Spiral Approach* (San Francisco: W.H. Freeman, 1967).

his students, Albert Baez emphasized the importance of the "3 *C*s" in scientific research: curiosity, creativity, and compassion,[2] which accurately characterized his life and career.

Instructions/Activities

Engage: 5 Minutes

The teacher will play a video of Joan Baez singing for students (her renditions of "Blowin' in the Wind" or "Don't Think Twice It's Alright" are good options). After discussing who Joan Baez is, the teacher will introduce students to her physicist father, Albert Baez.	
What is the teacher doing? Play a video of Joan Baez singing (two options are found above). Ask students if they have ever heard of her. After accepting a few responses, explain that she is a folk singer and political activist. Go on to explain that her father, Albert Baez, was an optical physicist who held strong values of his own.	**What are the students doing?** Watch the video of Joan Baez singing. Listen to the teacher's introduction of her and her father, the physicist Albert Baez.

Explore: 20-30 Minutes

Students will read Albert Baez's obituary from *Physics Today* and a short chapter from his book, *A Year in Baghdad* (both found in Supplemental Materials). They will then answer Discussion Questions (found in the Supplemental Materials) about the readings.	
What is the teacher doing? Distribute copies of the Baez obituary, the chapter from *A Year in Baghdad*, and Discussion Questions to the students (all found in Supplemental Materials). Have students read the documents and answer the corresponding Discussion Questions.	**What are the students doing?** Read Albert Baez's obituary and selected chapter from his book, *A Year in Baghdad*, then answer the Discussion Questions based on the readings.

Explain: 10-15 Minutes

The teacher will review the answers to the Discussion Questions with the students (the Answer Key is found in the Supplemental Materials). The teacher will facilitate further class discussion related to the historical context of Baez's work. If desired, the teacher may choose to share Joan Baez's song "Gulf Winds" with students, in which she sings of her father's sacrifices. (Note: The relevant section of the song begins at the 6:00 mark and ends at the 6:45 mark.)	
What is the teacher doing? Review the Discussion Question answers with the students. If students remain unclear on certain points or issues, review them as a class. Be sure to highlight the final two questions about how Baez's ideals compared to his peers, and if they affected his career. Generate discussion among	**What are the students doing?** Review the answers to the Discussion Questions. Ask for clarification if necessary. Contribute to the discussion of Baez's peers and decisions. If the teacher plays/projects the song "Gulf Winds" listen to and contemplate it during the discussion.

[2] Introductory information attained from: Al Thompson and George Castro, "Albert Vinicio Baez," *Physics Today* 60 no. 11 (2007): 75-76, doi:10.1063/1.2812133.

students on these points. If desired, play the Joan Baez song "Gulf Winds" and project the lyrics for the students (link found here and in the Recommended Resources). Highlight the lyrics: "My father turned down many a job just to give us something real It's hard to be a scientist in the States when you've got ideals And mama kept the budget book, she kept the garden, too Bought fish from the man on Thursday, fed all of us and strangers, too" (6:00 to 6:45 in the song)	

Elaborate: 25-40 Minutes (This experiment could be conducted independently, or omitted entirely, based upon the needs of the class)

Baez and Kirkpatrick developed a system to reflect and focus x-rays, a challenge due to the rays' inherent tendency to penetrate and be absorbed by surfaces they contacted. In this section, students will explore the properties of the reflection of light using the Grazing-Incidence Angle Worksheet[3] (found in the Supplemental Materials). They will examine how changing reflective materials and the energy of photons will cause the light to reflect/be absorbed differently by different surfaces.	
What is the teacher doing? Split the students into small groups. Distribute copies of the Grazing-Incidence Angle Worksheet (found in the Supplemental Materials) to each student. Also distribute the materials for each group (listed in the Required Materials section of this lesson). Guide students through the worksheet. It will likely be necessary to help student establish the fixed point and angles of reference required to conduct the trials. To do this, have them create a perpendicular line from the wall at their fixed point, which is 0°. Measuring towards the wall with the protractor will provide the angles of incidence and reflection. If it hasn't already been discussed, explain the Law of Reflection to students. Emphasize that that on a flat mirror, the light's angle of incidence will equal its angle of reflection.	**What are the students doing?** Split into small groups. Receive the Grazing-Incidence Angle Worksheet and the associated materials. Complete the Grazing-Incidence Angle Worksheet, asking the teacher for assistance when necessary.

[3] This activity was adapted from the NASA-created lesson plan "Grazing Incidence Angle: Illustrating the Law of Reflection with a Twist," part of its' *Collaboration Across Cultures* website. This lesson plan and others like it can be found at http://globalastro.gsfc.nasa.gov/?page_id=427.

During the ramp portion of the activity, the marble should penetrate and roll over the ramp at all but the largest angles (those closest to parallel with the wall). Note: the answers to the questions in Part 4 of the worksheet are found on the Discussion Question Answer Key (found in the Supplemental Materials).	

Evaluate:

Opportunities for evaluation occurred during the Explain and Elaborate sections of this lesson. Teachers may elect to collect and evaluate student responses to the Discussion Questions, as well as the Grazing-Incidence Angle Worksheet.

Required/Recommended Reading and Resources

- Thompson, Al and Castro, George. "Albert Vinicio Baez." *Physics Today* 60 no. 11 (2007): 75-76. Doi: 10.1063/1.2812133. Found in the Supplemental Materials.
- Baez, Albert and Joan Sr. *A Year in Baghdad*. Santa Barbara: John Daniel and Company, 1988. Selected Chapters found in the Supplemental Materials.
- "Gulf Winds," Lyrics, accessed August 19, 2016. http://www.joanbaez.com/Lyrics/gulfwinds.html
- Preferred video of Joan Baez singing. Her renditions of the songs "Blowin' in the Wind" or "Don't Think Twice It's Alright" are good options. In the Explain section teachers may elect to show "Gulf Winds," as well. The songs have been hyperlinked in the Instructions sections, although several versions of each song can be found on YouTube and elsewhere.

Discussion Questions

Discussion Questions can be found as a Handout with a corresponding Answer Key in the Supplemental Materials to this lesson plan.

1. Where did Albert Baez earn his Ph.D.? What subject did he study?
2. Describe the theory/technique that Baez and his advisor Paul Kirkpatrick developed in 1948.
3. What did Baez work on from 1961-1967? From 1967-1974?
4. What did Baez do after retiring?
5. What was Baez's position and task in Baghdad?
6. Why do you think Baez was determined to establish a physics laboratory?
7. How do you think Baez's opinions about working on classified defense projects compared to those of the average 1950s physicist?
8. Do you think that his ideological and/or political views led to any difficulties in finding work opportunities?

Further Reading and Additional Resources

- Baez, Albert. *The New College Physics: A Spiral Approach*. San Francisco: W.H. Freeman, 1967.
- Newton, David E. *Latinos in Science, Math and Professions*. New York: Facts on File, 2007.

- Olesky, Walter G. *Hispanic-American Scientists*. New York: Facts on File, 1998.

Extensions

Related AIP Teacher's Guides on Women and Minorities in the Physical Sciences:

- Physicist Activist: Dr. Elmer Imes and the Civil Rights Case of Juliette Derricotte

Common Core Standards

For more information on Common Core Standards, visit http://www.corestandards.org/.

Reading: Informational Text	
CCSS.ELA-LITERACY.RI.9-10.1	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
CCSS.ELA-LITERACY.RI.9-10.3	Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.
CCSS.ELA-LITERACY.RI.9-10.6	Determine an author's point of view or purpose in a text and analyze how an author uses rhetoric to advance that point of view or purpose.
CCSS.ELA-LITERACY.RI.11-12.1	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
CCSS.ELA-LITERACY.RI.11-12.3	Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.
CCSS.ELA-LITERACY.RI.11-12.6	Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.
Speaking & Listening	
CCSS.ELA-LITERACY.SL.9-10.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY.SL.11-12.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
History/Social Studies	
CCSS.ELA-LITERACY.RH.9-10.1	Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.

CCSS.ELA-LITERACY.RH.9-10.3	Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.
CCSS.ELA-LITERACY.RH.9-10.4	Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.
CCSS.ELA-LITERACY.RH.9-10.6	Compare the point of view of two or more authors for how they treat the same or similar topics, including which details they include and emphasize in their respective accounts.
CCSS.ELA-LITERACY.RH.9-10.9	Compare and contrast treatments of the same topic in several primary and secondary sources.
CCSS.ELA-LITERACY.RH.11-12.1	Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.
CCSS.ELA-LITERACY.RH.11-12.4	Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines *faction* in *Federalist* No. 10).
CCSS.ELA-LITERACY.RH.11-12.6	Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.
CCSS.ELA-LITERACY.RH.11-12.9	Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.
Science & Technical Subjects	
CCSS.ELA-LITERACY.RST.9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
CCSS.ELA-LITERACY.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.
CCSS.ELA-LITERACY.RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
CCSS.ELA-LITERACY.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

Next Generation Science Standards

For more information on the Next Generation Science Standards, visit http://www.nextgenscience.org/.

Dimension One: 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
Dimension Two: Crosscutting Concepts	1. Patterns 2. Cause and effect 4. System and system models 5. Energy and matter 6. Structure and function 7. Stability and change
Dimension Three: Disciplinary Core Ideas	PS4.A Wave Properties PS4.B Electromagnetic Radiation PS4.C Information Technologies and Instrumentation