African Americans in Astronomy and Astrophysics

Principal Investigator Dr. George Carruthers (right) and Project Engineer William Conway with the Apollo 16 far ultraviolet camera/spectrograph instrument. Naval Research Laboratory (NRL), courtesy AIP Emilio Segré Visual Archives, Ronald E. Mickens Collection.

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

In-Class Time: (see below)
Prep Time: 10-15 min for each part

Part One: The Life of Benjamin Banneker (45-60 min)
Part Two: Dr. George Carruthers, Space Scientist (45-60 min)
Part Three: African American Astronomers and Astrophysicists (Work done at home, in-class presentations)

Materials
Part One: The Life of Benjamin Banneker
- Access to internet in order to provide groups of 3-4 copies of Benjamin Banneker’s 1793 almanac, found at the Temple University Libraries page: http://digital.library.temple.edu/cdm/ref/collection/p16002coll5/id/237.
- Copies of the Banneker’s Almanac Worksheet (see supplemental material)
The purpose of this lesson is for students to explore the history of astronomy in the United States and the African-American scientists that are associated with this discipline. This lesson introduces students to African Americans involved in astronomy and astrophysics from the 1700s when astronomy was used as a practical tool to the twentieth century space race. In the first part, students will learn about Benjamin Banneker — the eighteenth century African American astronomer. They will use his 1793 almanac and read a letter Banneker wrote to Thomas Jefferson regarding racial equality. In the second part, students will learn about George Carruthers, a contemporary African American astrophysicist whose inventions contributed to the study of space. Lastly, students will choose to study other African American astronomers and astrophysicists from the twentieth century.

Astronomy is a field of science that can trace its origins back to antiquity. People have based entire civilizations and technologies on the movement of the stars in the night sky. From the ancient Cushite empire in what is now Kenya to Benjamin Banneker to the African Americans who escaped slavery on the Underground Railroad by following the North Star to the African American astrophysicists and astronauts, people of African descent have long been connected to and contributed to the study of astronomy.

Benjamin Banneker was one of the earliest African American scientists. Banneker was born a free African American in Baltimore County, Maryland in 1731, more than 40 years before the United States would become an independent nation. Benjamin was one of about 200 free blacks in the area living among about 4,000 slaves and 13,000 whites. Though he had little formal education, Banneker was a dedicated scholar interested in science, surveying, and farming. He published a successful series of farmer’s almanacs – annual calendars that would include astronomical data, tide tables, and weather predictions to aid farmers. He also corresponded with Thomas Jefferson about race relations, chiding him and other writers of the Declaration of Independence for their hypocrisy in declaring all men created equal while maintaining a system of slavery which oppressed those of African descent.

More than 150 years after Banneker published his first almanac, African American astrophysicist George Carruthers invented the first moon-based observatory which was used in the Apollo 16 mission. Even though more than a century had passed since Banneker, Carruthers and other African Americans in the 1960s were still struggling for racial equality. During this time, schools and governmental agencies which were previously segregated began to open to African Americans. For example, the first black engineers to work at NASA joined in 1964. Carruthers was part of the first generation of African
Americans to have access to educational and employment opportunities in the sciences. Carruthers grew up in the South Side of Chicago. He received a bachelor’s degree in aeronautical engineering in 1961, a master’s degree in nuclear engineering in 1962, and a doctorate in aeronautical and astronautical engineering in 1964 from the University of Illinois. In 1964, Carruthers was hired by the U.S. Naval Research Laboratory in Washington, D.C. where his research focused on far ultraviolet astronomy. His is internationally recognized for his inventions and research which have contributed to the study of space science.

Often, the history of African Americans is told as a story of linear progress. We are told that as time has progressed, so has race relations in the United States. As this lesson illustrates, history is much more complex than that. In this lesson we will take a brief look at astronomy and astrophysics, their uses and the African American scientists associated with these fields from the 1700s to today. In particular we will explore the practical uses of astronomy in almanacs, the shift from earth to space science during and beyond the space race of the 1960s, and consider where astronomy has progressed (or digressed) to today.

### Instructions/Activities

**Part One: The Life of Benjamin Banneker**

In this part, students will learn about the life of Benjamin Banneker. They will examine a letter he wrote to Thomas Jefferson regarding racial equality and study one of his almanacs produced from his knowledge and study of astronomy.

1. Introduce students to Benjamin Banneker – where and when he was born and the historical context of the United States and the status of African Americans at the time. For resources on Benjamin Banneker, see the Required/Recommended Resources section.

2. Introduce students to what an almanac is. If you can get a copy of a modern almanac, show them what it looks like and give them some time to look through it. Have them identify the astronomical data found in almanacs such as the rising and setting of the sun and moon, eclipses, hours of full tide, and other data.


4. Give students copies of the Banneker Almanac Worksheet and have them answer the questions while reviewing Banneker’s almanac.

5. Discuss their answers.

6. Then, give students copies of Benjamin Banneker’s letter to Thomas Jefferson in 1791 (see supplemental material).

7. Have students read the letter and answer the discussion questions (see Discussion Questions section).

8. Discuss the letter together as a class.

**Part Two: Dr. George Carruthers, Space Scientist**

In this part, students will learn about Dr. George Carruthers, an African American physicist and space scientist who lived and worked during the “Space Age.” Students will learn about his experiences through excerpts of an oral history interview with Dr. Carruthers.
1. Introduce students to the “Space Age” and the civil rights movement. Give students historical context about the 1940s-1970s when Dr. Carruthers grew up, received his education, and worked at the U.S. Naval Research Laboratory. (See Required/Recommended Resources)

2. Divide the students into four or five groups. Assign each of the groups one of the excerpts (three) from George Carruthers Oral History Interview: Selected Excerpts (see supplemental material). They can answer questions from the Discussion Questions section.

3. Ask one of the remaining groups to research Dr. Carruthers general biography and the other to research general American history (1940s-1970s), particularly race relations and the “Space Age.”

4. Have each group share what they learned. Compare the experience of George Carruthers to Benjamin Banneker. See the Discussion Questions section for guiding questions.

Part Three: African Americans in Astronomy and Astrophysics

In this part, students can choose to research and give a presentation on an African American astronomer or astrophysicist. Students must use at least three or four credible sources for their research (see Required/Recommended Resources). The following is a potential list of physicists that they should choose from:

- Isaac Thomas Gillan, IV
- Joseph Granville Logan, Jr.
- Walter S. McAfee
- Ronald E. McNair
- Benjamin Peery, Jr.
- John B. Slaughter
- Neil deGrasse Tyson
- George Carruthers
- Carl Rouse
- Reva Williams
- Beth Brown
- Arthur B.C. Walker

Additional African-American astrophysicists or astronomers can be added to the list. Have students compose a short presentation on the African American scientist that they researched.

Required/Recommended Reading and Resources

Part One: The Life of Benjamin Banneker

Required Resources:
- Banneker’s Almanac Worksheet (see supplemental material)
- Letter to Thomas Jefferson from Benjamin Banneker, 1791 (see supplemental material)

Recommended Resources:

Part Two: Dr. George Carruthers, Space Scientist

- Selected passages from Interview of Dr. George R. Carruthers by David DeVorkin on August 18, 1992, Niels Bohr Library & Archives, American Institute of Physics,
Discussion Questions

Part One: The Life of Benjamin Banneker

1. How would a farmer use Banneker’s almanac? Why would it be important for them to know about eclipses, tides, and the other information provided in the almanac?
2. How did Benjamin Banneker collect data in order to predict the future weather?
3. Benjamin Banneker was also a surveyor. What was surveying? What kinds of tools were used in the process of surveying and what purpose did they serve in the project both from a surveyor’s perspective and from an astronomical perspective?
4. Why was Benjamin Banneker born free?
5. In his letter to Thomas Jefferson, why does Banneker claim that Jefferson and other writers of the Declaration of Independence are hypocrites?
6. Why does Banneker reference the American Revolution?

Part Two: George Carruthers, Space Scientist

Questions to be answered and discussed after reading the passage:

1. How did Carruthers become interested in science? What was his family history?
2. Why did Carruthers struggle when he went to the University of Illinois?
3. What event occurred in Carruthers freshman year that is relevant to his career path? Why was this a big deal at the time in which it happened?
4. Why do you think that astronomy and engineering were separated until around the time that Carruthers started becoming active in his career (Think back to the previous lesson)? If you think that the two disciplines weren’t truly separated as Carruthers said, explain your thought process.
5. Could Aeronautical Engineering be considered a form of the so-called “practical astronomy” today? If you think it is, explain why. If you think it is not, explain why as well as how it could come to be considered so in the future. Apart from rocketry, what other kinds of engineering can you think of that coincide nicely with astronomy. Likewise, what other kinds of astronomy can you think of that would not be where they are today without the aid of engineering?
6. What were some of Dr. Carruthers contributions to space science?
7. What does Dr. Carruthers think about the future of science education?
8. Compare the kind of work that Dr. Carruthers did as an astrophysicist to the kind of work that Benjamin Banneker did in the eighteenth century.
Part Three: African Americans in Astronomy and Astrophysics

1. Where was your scientist from and what was their family background?
2. What was life like for African Americans during this time?
3. Did your scientist attend a predominantly white institution or an HBCU?
4. What was your scientist’s field of study?
5. Where did they work and what was their contribution to the development of astronomy and astrophysics?

Further Reading and Additional Resources


Extensions

Paper Airplane Competition
To learn about aeronautical engineering, students can create, design and test their own model paper airplane and the class can have a paper airplane competition. Download and print paper airplane designs from http://www.funpaperairplanes.com/.

Related Resources from the AIP African Americans in Physics, Astronomy, and Related Disciplines Teacher's Guide:

- Lesson Plans:
  - Two Perspectives on African Americans in Physics in the 1960s
  - “The Real McCoy”: African American Inventors in History
  - “Follow the Drinking Gourd:” Astronomy and the Underground Railroad
  - “When Computers Wore Skirts:” Katherine Johnson, Christine Darden, and the “West Computers”
  - The Night Sky by another Name: Orion, Osiris, and African Mythologies
## Common Core Standards


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<thead>
<tr>
<th>History/Social Studies</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>CCSS.ELA-LITERACY.RH.9-10.1</strong></td>
<td>Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.</td>
</tr>
<tr>
<td><strong>CCSS.ELA-LITERACY.RH.9-10.2</strong></td>
<td>Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.</td>
</tr>
<tr>
<td><strong>CCSS.ELA-LITERACY.RH.9-10.4</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>CCSS.ELA-LITERACY.RH.9-10.5</strong></td>
<td>Analyze how a text uses structure to emphasize key points or advance an explanation or analysis.</td>
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<tr>
<td><strong>CCSS.ELA-LITERACY.RH.9-10.8</strong></td>
<td>Assess the extent to which the reasoning and evidence in a text support the author's claims.</td>
</tr>
<tr>
<td><strong>CCSS.ELA-LITERACY.RH.11-12.1</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>CCSS.ELA-LITERACY.RH.11-12.2</strong></td>
<td>Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.</td>
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<tr>
<td><strong>CCSS.ELA-LITERACY.RH.11-12.5</strong></td>
<td>Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.</td>
</tr>
<tr>
<td><strong>CCSS.ELA-LITERACY.RH.11-12.4</strong></td>
<td>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 <em>faction</em> in <em>Federalist</em> No. 10).</td>
</tr>
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<tr>
<td><strong>CCSS.ELA-LITERACY.RH.11-12.7</strong></td>
<td>Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.</td>
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## Next Generation Science Standards

N/A For more information on the Next Generation Science Standards, visit [http://www.nextgenscience.org/](http://www.nextgenscience.org/).