

■ Science in the Movies: Hidden Figures (2016) — Teacher Answer Key

Grade Level: 6–12 | Topics: Mathematics · Engineering · Physics · Equity in STEM
Includes sample responses and teaching notes.

■ A. Science Connections — Suggested Answers

1. **Mathematical Problem:** Katherine Johnson calculates the orbital re-entry trajectory for John Glenn's spacecraft — determining where and when it should re-enter Earth's atmosphere safely.
2. **Importance of Orbital Trajectory:** The correct angle ensures that the spacecraft doesn't bounce off the atmosphere or burn up upon re-entry.
3. **Engineering + Math Connection:** Engineers design and test spacecraft, but mathematicians provide the calculations that make flight possible.
4. **Teamwork + Expertise:** The scene highlights trust between scientists, engineers, and mathematicians — Glenn refuses to launch until Katherine verifies the data.

□ Teaching Notes: Emphasize how math is not abstract — it saves lives in applied contexts. Encourage students to see connections between classroom equations and real-world engineering.

■ B. Data & Analysis — Suggested Answers

1. **Distance Traveled:** $17,500 \text{ mph} \times (10 \div 60 \text{ hours}) = \approx 2,917 \text{ miles in 10 minutes.}$
2. **Angle of Re-entry:** If too shallow (4°), the spacecraft would skip off the atmosphere; if too steep (7°), it would burn up due to friction.
3. **Precision in Data:** Even a 1% miscalculation can cause failure in engineering — accuracy is vital in aerospace work.

□ Teaching Notes: Reinforce dimensional analysis and scientific notation. Use this section to review unit conversions and error tolerance in STEM calculations.

■ C. Real-World Connection — Suggested Answers

1. **Human Computers:** Groups of women (many African American) at NASA who performed complex calculations before electronic computers were common.
2. **Breaking Barriers:** Katherine Johnson (mathematician), Dorothy Vaughan (computer programming pioneer), and Mary Jackson (aerospace engineer) overcame segregation and bias through excellence and persistence.
3. **Modern-Day Example:** Students may mention scientists such as Dr. Mae Jemison, Dr. Kizzmekia Corbett, or Dr. Ayanna Howard.
4. **Equity in STEM:** The film shows how inclusion improves innovation and how talent

must be recognized regardless of gender or race.

□ Teaching Notes: This section integrates social studies and science. Encourage students to research current STEM equity initiatives or local organizations supporting girls and minorities in science.

■ D. Reflection — Example Responses

- Hidden Figures teaches that success in science requires collaboration, precision, and courage to challenge bias.
- Example Response: “Katherine Johnson proved that intelligence and persistence can break barriers and change history.”

□ Teaching Notes: Use reflection to discuss how perseverance, advocacy, and mentorship shape the scientific community. Encourage journaling or short essays on how diversity strengthens discovery.

■ Did You Know?

Katherine Johnson’s calculations ensured John Glenn’s safe return to Earth. This simplified equation models orbital re-entry:

$$R = v^2 / [g \times (1 - \cos \theta)]$$

- R = re-entry radius (distance to Earth’s center)
- v = velocity
- g = gravitational acceleration
- θ = re-entry angle

Johnson verified the results by hand, cross-checking early computer outputs — a remarkable feat of precision and trust.