

# *What Goes Up, Must Come Down-- But Why?*

## **A Debate About Gravity**

### **PURPOSE:**

To allow students to research and explore the revolutions in scientific thought about gravity.

### **OVERVIEW:**

In this activity, students will prepare for and deliver a historical debate over several days. They will research four key historic figures that shaped our understanding of gravity over time. As teams, they will prepare arguments and role play their historical figures during the debate. Students will then evaluate their teammates' arguments based upon a rubric given by the teacher.

### **OBJECTIVES:**

- Students will illustrate that our understanding of gravity continues to evolve.
- Students will research and synthesize historic theories of gravity.
- Students will analyze and debate the advances made in science and technology that relate to gravity.

### **INTENDED AUDIENCE:**

9<sup>th</sup>-12<sup>th</sup> grades

### **TIME REQUIRED:**

3 hours of class time with outside preparation time for students

Time should be broken into at least three sessions, but can be spread out into more sessions if necessary.

### **MATERIALS:**

- Stopwatch or other timing device
- Copies of debate rubric for each student (see sample rubric)
- Copies of the group work self-reflection for each student (included)

### **PREPARATION FOR SESSION 1 (MAY BE GIVEN AS HOMEWORK 1-2 WEEKS AHEAD OF TIME, OR AS IN-CLASS WORK SEVERAL DAYS BEFORE DEBATE):**

- Divide the class into 4 groups: Aristotle, Newton, Galileo and Einstein.
- Ask each group to prepare for a formal debate about gravity. You may want to provide a list of rules for formal debating so that the groups can follow the proper etiquette. For example, you may want to provide them with Robert's Rules of Order, <http://www.constitution.org/ror/ror--00.htm>. Clarify with students the time limits and procedures that you intend to follow.
- Ask the groups to prepare an opening statement containing the following information:
  - Who?- Biographical information about their scientist
  - When?- During what historic periods did their scientist live? What was going on around them and in other places in the world when their scientist did his work?

- Where? – What country did they live and work in? Was their work accepted by the government and people of that country?
- Why? – Why was this scientist able to make a new discovery? Was there new technology? Was there a new social climate?
- How? – How did the scientist arrive at a new theory of gravity? Was there a new tool, experiment?
- Ask each group to research and prepare short statements as to how their scientist would answer the following questions? (You may want to assign a pair of students to each question to ensure that all participate.) Suggested resources appear at the end of this lesson.
  - Why does a rock fall to Earth? (Communicate your ideas and understanding of gravity)
  - What evidence (experiments) can you use to convince others of your theory?
  - How do you “know” that you are correct? (What validates your work?)
  - What is new or different about your ideas compared with those that came before you?

**PREPARATION FOR SESSION 2 (SHOULD BE GIVEN IN BETWEEN SESSIONS):**

- Ask each group to prepare rebuttals to the statements of the other groups, using the information provided to the class during the first session.
- Distribute the rubric for the debate, so that students can prepare for session 2.

**PROCEDURE FOR SESSION 1:**

1. Have each group present its opening statement.
2. Opening statements should be limited to 15 minutes, or one-quarter of the available session time.
3. Instruct each group to take notes, since they will need this information to prepare rebuttals to the other groups in session two.

**PROCEDURE FOR SESSION 2:**

1. Review the rules that you intend to follow for the debate.
2. Instruct students to use the rubric to evaluate other groups during the debate.
3. Act as moderator for the debate.
4. Present the first question to the groups.
5. Depending on how much time you have available, allow each group to present their short answers to the question (approximately 2 minutes per group).
6. Once all groups have answered, allow time for rebuttal (approximately one minute per group).
7. Continue to debate the other 3 questions.

**PROCEDURE FOR SESSION 3:**

1. Complete any steps in the evaluation and closure sections that were not completed in Session 2.

**EVALUATION:**

- Have the students, who are not involved in the debate for each question use the rubric (sample included) to judge their classmates and determine the “winner” of the debate.



- Have the students complete the Group Work Evaluation Form (included). Teachers may choose to base a portion of the students' overall grade on the results of the evaluation. Let the students know how you plan to assign points based on the evaluation at the outset of this lesson and again just before the complete the Group Work Evaluation Form.
- Have the students write an essay addressing the following topic: Compare and contrast the theories of gravity presented in class and discuss how and why scientists choose to adopt new theories.

### **CLOSURE:**

Hold an informal discussion of the debate and modern concepts about gravity.

### **RESOURCES:**

This lesson is an adaptation of a play found in the following book. You may choose to give the play to your class as reference material, even though it is intended for grades 6-8. Gilbert, Harry and Diana Gilbert Smith. *Gravity, The Glue of the Universe: History and Activities*. Englewood, CO: Teacher Ideas Press, A Division of Libraries Unlimited, Inc., 1997 This book is sold at the following web address for \$26.00,

<http://www.lu.com/showbook.cfm?titleid=173&userid=46070072>

**This book is also available in the Check Out Kit.**

- Sections of the Gravity Background Material from the end of this document could be used as resources for students.
- <http://www.rit.edu/~flwstv/aristotle1.html>
- <http://www.ucmp.berkeley.edu/history/aristotle.html>
- <http://www.perseus.tufts.edu/GreekScience/Students/Tom/AristotleAstro.html>
- <http://csep10.phys.utk.edu/astr161/lect/history/newtongrav.html>
- <http://www.newton.cam.ac.uk/newtlife.html>
- <http://www.newton.org.uk/>
- <http://www.crs4.it/Ars/arshtml/arstoc.html>
- <http://www.jsc.nasa.gov/er/seh/galileobio.html>
- [http://galileoandinstein.physics.virginia.edu/lectures/gal\\_life.htm](http://galileoandinstein.physics.virginia.edu/lectures/gal_life.htm)
- <http://einstein.stanford.edu/> (background info available within lesson plans, good for teachers and students)
- <http://newton.dep.anl.gov/askasci/phy99/phy99x85.htm>
- <http://whyfiles.org/052einstein/>



# Class Debate: **Astronomy Connections**

Teacher name: \_\_\_\_\_

Student Name: \_\_\_\_\_

CATEGORY	Excellent	Good	Fair	Poor
<b>Respect for Other Team</b>	All statements, body language, and responses were respectful and were in appropriate language.	Statements and responses were respectful and used appropriate language, but once or twice body language was not	Most statements and responses were respectful and in appropriate language, but there was one sarcastic remark.	Statements, responses and/or body language were consistently not respectful.
<b>Information</b>	All information presented in the debate was clear, accurate and thorough.	Most information presented in the debate was clear, accurate and thorough.	Most information presented in the debate was clear and accurate, but was not usually thorough.	Information had several inaccuracies OR was usually not clear.
<b>Use of Facts/Statistics</b>	Every major point was well supported with several relevant facts, statistics and/or examples.	Every major point was adequately supported with relevant facts, statistics and/or examples.	Every major point was supported with facts, statistics and/or examples, but the relevance of some was questionable.	Every point was not supported.
<b>Rebuttal</b>	All counter-arguments were accurate, relevant and strong.	Most counter-arguments were accurate, relevant, and strong.	Most counter-arguments were accurate and relevant, but several were weak.	Counter-arguments were not accurate and/or relevant
<b>Presentation Style</b>	Team consistently used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Team usually used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Team sometimes used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	One or more members of the team had a presentation style that did not keep the attention of the audience.
<b>Organization</b>	All arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion.	Most arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion.	All arguments were clearly tied to an idea (premise) but the organization was sometimes not clear or logical.	Arguments were not clearly tied to an idea (premise).
<b>Understanding of Topic</b>	The team clearly understood the topic in-depth and presented their information forcefully and convincingly.	The team clearly understood the topic in-depth and presented their information with ease.	The team seemed to understand the main points of the topic and presented those with ease.	The team did not show an adequate understanding of the topic.

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## Group Work Evaluation Form<sup>1</sup>

1. Overall, how effectively did your group work together on this assignment? (Check the appropriate response)

Poorly

Adequately

Well

Extremely well

2. Rate each member of the group as to how actively he or she *participated* most of the time on a scale of 1-5 (1-no participation, 5-actively participated all of the time), and how fully he or she was *prepared* for group work on a scale of 1-5 (1-never prepared, 5-always very prepared).

**Name:**

**Participation Score:**

**Preparedness Score:**

3. Give one specific example of something you learned from the group that you probably wouldn't have learned working alone.

4. Give one specific example of something the other group members learned from you that they probably wouldn't have learned otherwise.

5. Give one specific change that the group could make to improve its performance.

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<sup>1</sup> This worksheet was modified from one found at <http://www.meredith.edu/epie/sourcebook/groupworkeval.htm>

