

Teacher's Guide: Forces of Gravity and Air Resistance

Recommended Grade Level: 5-8

(also applicable to grades 9-12 for students requiring significant support in learning)

Suggested Time: About 50-60 minutes spread over one or more class periods, plus additional time to complete a writing assignment

Goals

Following are the big ideas that students should take away after completing this lesson:

- Things on or near Earth are pulled toward it by gravity.
- A force can cause changes in the speed or direction of an object.
- When more than one force acts on an object, the effect on the object's motion depends on the direction of these forces.

Vocabulary

(See definitions on page 6.)

- acceleration
- balanced
- counteract
- force
- gravity
- resistance

Key Literacy Strategies

Following are the primary literacy strategies students will use to complete this activity:

- Determining important information (screens 5, 8, and 9; writing assignment 1)
- Constructing summaries (screen 5; writing assignment 1)
- Using text features (screens 5 and 7)
- Comparing and contrasting ideas (screen 11)
- Making inferences (writing assignment 2)

Note: In addition to the key literacy strategies listed above, students will also use each of these strategies to complete this lesson:

- Monitoring comprehension
- Synthesizing
- Making predictions
- Developing vocabulary
- Developing a topic in writing
- Identifying and using text features (photographs, captions, diagrams, and/or maps)

Overview

Forces of Gravity and Air Resistance is a student-directed learning experience. However, while students are expected to work through the lesson on their own, teachers should be available to keep the lesson on track, organize groupings, facilitate discussions, answer questions, and ensure that all learning goals are met.

The following is a summary of the lesson screens:

- Screen 1: Students learn that they will be studying gravity and the reason why some objects fall more slowly than others.
- Screen 2: Students read about the force of gravity. They learn that gravity makes an object gain speed as the object falls and that gravity is not the only force that affects falling objects on Earth. They learn that they will explore gravity and how other forces affect moving objects.
- Screen 3: Students learn what the goals are for the lesson, which strategies they will be using to complete the lesson, and the important vocabulary words they will use during the lesson.
- Screen 4: Students read that the force of gravity pulls everything toward the center of Earth. Students then watch a video about how gravity would affect the motion of a person falling through an imaginary tunnel that passes through the center of Earth.
- Screen 5: Students read about how the force of gravity on Earth causes a falling object to accelerate toward the center of Earth. Students then write two to four sentences describing how gravity affects the speed of a man falling through an imaginary tunnel that passes through the planet.
- Screen 6: Students read about Galileo's studies on the motion of falling objects. They then watch a video that shows one of Galileo's experiments being conducted on the Moon. After watching the video, students write two to three sentences about how the demonstration in the video supports Galileo's findings.
- Screen 7: Students read about the force of air resistance and how it affects the motion of an object. Students then read about how the experiment seen in the video would not have the same result if done on Earth because of air resistance.
- Screen 8: Students learn that when there is more than one force acting on an object, the effect on the object depends on the combination of the forces. Students then read a PDF text about how the forces of gravity and air resistance counteract each other and affect the falling rates of a hammer and a feather. Students then write two to three sentences describing how air resistance affects how fast a feather falls.
- Screen 9: Students answer three multiple-choice questions to show their comprehension of how gravity and air resistance affect the motion of a falling object.
- Screen 10: Students complete an interactive vocabulary activity, and then choose two words from the vocabulary list and write a new sentence for each word. These tasks demonstrate their understanding of the meanings of the words.
- Screen 11: Students complete an interactive activity by comparing statements about the forces of gravity and air resistance.
- Final
Assignment: Students select and complete a writing assignment about the lesson topic.

Before the Lesson

- ❑ Go through each screen of the lesson, including all the interactive activities, so that you can experience ahead of time what students will be doing. As you go through each screen, jot down your own expectations for students' responses.
- ❑ Determine if students will be working individually or in pairs on the lesson. Some students may be able to work independently with little or no support. Students who are less familiar with the subject area or who struggle with literacy skills may benefit from working with another student. An effective way to do this is to pair a stronger student with a less able reader. You can also have students work individually on certain tasks and in pairs on others, depending on their experience and needs. If students will be working in pairs on any portion of the lesson, let them know if they will be expected to type in their notes individually or together.
- ❑ Provide instruction on key vocabulary (vocabulary words are defined in the lesson on screen 3, and on page 6 of this guide).
- ❑ Determine what students already know about the forces of gravity and air resistance. You may want to use specific questions to start the discussion, such as: What is gravity? How does gravity affect a moving object? What is air resistance? How do you think it affects a moving object? Record their ideas on a chart. This will give you a sense of the background knowledge and possible misconceptions that students have before beginning this lesson. If time allows, return to the chart after students have completed the lesson to add new learning and correct misconceptions. Note: You may want to record their new learning in a different-colored ink so they can see how much they've learned.
- ❑ Arrange computers with Internet access so students can work individually or in pairs.
- ❑ Before students begin, suggest a timeline for completing the lesson, mention the different types of media they will encounter, and let them know how you expect them to submit their work. You may want to provide an outline of this information on a chart, chalkboard, or whiteboard, or as a handout.

Lesson Assessments

The following are descriptions of the lesson features that will be part of the packet of materials that students will submit. Students will use the packet for reference when writing their final assignment. It also serves as a formative assessment tool to monitor students' work as they are progressing through the lesson.

- **Notes** - Students write their ideas in response to a prompt on screens 5, 6, and 8. If time allows, review their notes before students begin their writing assignment.
- **Multiple-choice questions** - Students complete the three questions on screen 9. Walk around to make sure students answer all three questions before they continue. If students click to go to the next page before they finish, their work will not be saved.
- **Match It!** - Students complete an interactive vocabulary activity on screen 10. They begin

by dragging the vocabulary terms into the correct sentences. After they finish and save their work, they will be able to check their answers against an answer key. When they are done, they will be asked to choose two vocabulary words and write a new sentence for each word. Sentences should demonstrate a clear understanding of the meaning of each word. An inappropriate response would be “A rock can accelerate.” An appropriate response would be “A push or pull can cause a rock to accelerate, which means it speeds up, slows down, or changes direction.”

- **Compare It!** - Students complete the information sorting activity Compare It! on screen 11. Students will read several statements and then drag each one under the correct heading: Gravity or Air Resistance. Students will not be able to check their answers online, so you will need to provide them with correct answers when they are finished with the lesson. You can choose to review the answers as a class or return the corrected packet of materials to students before they begin the final assignment. The statements and the column headings under which they belong are as follows:

Gravity

- Causes a falling object to accelerate toward the ground
- Acts in the same direction as the movement of a falling object
- Is a force that pulls two objects toward each other
- Counteracts air resistance
- Acts on all objects equally

Air Resistance

- Slows the downward acceleration of a falling object
 - Acts in the opposite direction as the movement of a falling object
 - Is a force caused by air particles
 - Counteracts gravity
 - Depends on the size, shape, and speed of an object
- **Final Assignment** - Students complete one final writing assignment. You can choose to let students make their own selection or assign one according to your goals for the lesson. Use the rubric on page 7 to assess the writing assignments.

Lesson Aids and Extensions

Use the following suggestions to help students if they are stuck on a particular screen, to prepare students for completing their writing assignments, or as follow-up discussions to reinforce learning.

- **Watching Videos** - Encourage students to watch the videos more than once. After the initial viewing, provide students with a specific content focus to frame their next viewing(s) of the video. This will help them draw connections between the main topic and the information that the videos have to offer.

- **Participating in Discussions** - Organize class discussions or encourage students to talk about their questions in pairs. You may want to use the following discussion starters:
 - o What are examples of forces that affect the motion of an object?
 - o What happens when you push an object?
 - o How does gravity affect your everyday life?
 - o When would someone want to decrease air resistance? When would someone want to increase air resistance?
 - o Why do you think planes usually fly higher up in the atmosphere rather than lower to the ground?
 - o Why do you think the Moon is a good place to perform Galileo's experiment about gravity and the falling motions of different objects?
- **Reading the PDF Text** - Before they read the PDF text on screen 8, ask students what they think the result of the hammer and feather drop experiment would be if it were conducted on Earth.
- **Sharing Student Work** - It may be motivational, and a further learning opportunity, for students to post their final essays so that their classmates, peers, and/or parents can see them. This may also provide an opportunity for students to comment on and discuss each other's essays.

If you do not already have access to an online writing community, Teaching Matters™ provides TeXT, free classroom publishing tools that allow teachers and students to create and publish their own online eZine. More information and a free sign up are available at Teaching Matters: TeXT (<http://text.teachingmatters.org>).
- **Reflection and Self-Assessment** - After students have turned in their writing assignments, you can choose to have them assess their learning. Bring students together as a whole class or in small groups to discuss the questions below. You may want to return to the chart of their ideas developed before the lesson and record their new learning. You may also have students respond individually to the questions and then convene the class to discuss the chart.
 - o What did you learn?
 - o What was surprising?
 - o What questions do you still have?
 - o What was the easiest for you to understand and do?
 - o What was the most difficult?

Vocabulary Definitions

acceleration

The rate of change of the speed and/or direction of an object.

balanced

When talking about forces, two forces are balanced when they act with equal strength and from opposite directions on an object.

counteract

To reduce the effect of something, such as a force; to act against something.

force

A push or pull that can make an object speed up, slow down, or change direction.

gravity

A force of nature that pulls any two objects toward each other. At or near the surface of a large body, such as Earth, the force of gravity pulls smaller objects toward the center of the large body.

resistance

When talking about forces, resistance is a force that acts in the direction opposite to the movement of an object.

Final Assignment Rubric Forces of Gravity and Air Resistance

1. Describe how the forces of gravity and air resistance affect how fast an object falls. Use specific examples to support your ideas.
2. Describe the forces that act on a skydiver after he or she has jumped out of a plane. Explain how different body positions would affect how the skydiver falls, and why a parachute is important.

4	3	2	1
<p>Provides a clear and accurate response to the question. Ideas are elaborated, with three or more relevant supporting details from the reading passage, video, and other materials in the lesson.</p>	<p>Provides an adequate response to the question. Topic and ideas are generally well organized, with two relevant supporting details from the reading passage, video, and other materials in the lesson.</p>	<p>Provides a generally accurate response, with one supporting detail from the reading passage, video, and other materials in the lesson.</p>	<p>Provides an inaccurate response to the question or fails to address the question. May include misinterpretations. Understanding of the topic is not apparent.</p>
<p>Uses at least three vocabulary words (or a form of the vocabulary words) from the lesson, and uses them all correctly.</p>	<p>Uses two vocabulary words (or a form of the vocabulary words) from the lesson, and uses them both correctly.</p>	<p>Uses one vocabulary word (or a form of the vocabulary word) from the lesson, and uses it correctly.</p>	<p>Does not use any vocabulary words, or uses vocabulary words incorrectly.</p>

Scoring the Rubric

Here are two suggestions for scoring the final assignment rubric. Select the option that best meets your needs or develop your own grading system.

Option 1: This option provides one score for each submitted assignment.

Assign a score of 4 or below for the written response (first row of the rubric) and a score of 4 or below for the use of vocabulary (second row of the rubric), for a total maximum score of 8. The interpretation of scores is as follows:

Score	Grade	Narrative Interpretation
7-8	A	Excellent
5-6	B	Good
4	C	Adequate (Fair)
3 or below	D	Minimal

Option 2: This option provides two scores for each submitted assignment: one for written content and one for the use of key vocabulary. An advantage of separate scores is that you can weight students' comprehension and composition differently than you do their knowledge of vocabulary. It can also help you identify specific needs for future instruction.

Assign a score of 4 or below for the written response (first row of the rubric) and a score of 4 or below for the use of vocabulary (second row of the rubric) and then score them separately. The interpretation of scores is as follows:

Score	Grade	Narrative Interpretation
4	A	Excellent
3	B	Good
2	C	Adequate (Fair)
1	D	Minimal

The final grade may look like this: A/B (A for content and B for vocabulary use).