

Teacher's Guide: Newton's Third Law: Action-Reaction

Recommended Grade Level: 7-8

(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:

- Newton's third law of motion states that for every action, there is an equal and opposite reaction
- Engineers consider how forces act as they use the design process to solve problems

Vocabulary

- gravity
- astronaut
- zero gravity
- reaction force
- counteract

Key Literacy Strategies

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

- Determining important information (screens 4, 9, and 10)
- Understanding problem/solution (screens 8 and 10, writing assignment 2)
- Establishing cause and effect (screens 2, 5, 6, 7, and 8, writing assignment 1)
- Comparing and contrasting ideas (writing assignment 2)

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

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

Overview

Newton's Third Law: Action-Reaction 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 explore why the conditions of space make doing even the easiest of work a challenge.
- Screen 2: Students read about gravity and how its effects differ on Earth and in space.
- 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 watch a video about the first astronauts to perform spacewalks and about Gene Cernan’s attempt to do work. Students then write down the reasons Cernan failed in his efforts.
- Screen 5: Students read about Isaac Newton and are introduced to his third law of motion.
- Screen 6: Students read another explanation of the third law. The terms “action” and “reaction,” and “equal” and “opposite,” are clearly defined.
- Screen 7: Students read more details about Newton’s third law, including some real-world examples of the law in action. They also think of other examples to write down.
- Screen 8: Students watch a second video that explains what NASA learned from Cernan’s failed spacewalk and the steps they took to ensure other astronauts would not share this experience. Students also answer quiz questions to show comprehension of what they’ve learned so far.
- Screen 9: Students use an interactive activity to highlight text that answers two questions about how Newton’s third law operates on Earth and in space.
- Screen 10: Students read a passage on how NASA scientists and engineers developed solutions to overcome the challenges of working in space. Students then take notes to describe how NASA scientists and engineers developed their solution.
- Screen 11: Students complete a vocabulary activity, and then choose two words from the vocabulary list and write a new sentence for each word. This demonstrates their understanding of the words’ meaning.

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).
- ❑ Determine what students already know about gravity, space, or even what they know about action-reaction and Newton’s laws of motion, in particular the third law. Record their ideas on a chart. This will give you a sense of students’ possible misconceptions and the background knowledge they 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’re progressing through the lesson.

- **Notes** - Students take notes on screens 4, 7, and 10. If time allows, review their notes before students begin their writing assignment.
- **Multiple-choice quiz** - Students complete the quiz on screen 8. Walk around to make sure students answer all three questions in the quiz before they move on. If students click to go to the next page before they finish, their work on the quiz will not be saved.
- **Match It!** - Students complete a vocabulary activity on screen 11. They begin by placing 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, and the words should be used specifically in the context of the challenges or conditions of working in space. (An example of an insufficient response is “Gene Cernan was an astronaut.”)

- **Highlight It!** - Students complete the comprehension activity Highlight It! on screen 9. 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.

Following are some of the statements students may highlight to answer each question:

Question 1: What are examples of the third law of motion on Earth and in space?

Highlighted information to answer question 1 should include that if we lean against a wall on Earth, the wall pushes back with a force equal and opposite to our lean. Answers should also include that in space, astronauts trying to move an object in one direction will be forced in the opposite direction.

Question 2: How are conditions on Earth different from conditions in space?

Highlighted information to answer question 2 should include that on Earth, the force of gravity helps us counteract many of the forces we meet doing our daily tasks. Answers should also include that in space, astronauts must struggle against conditions created by their spaceship moving in circles around Earth. This “free-fall” motion creates the feeling of weightlessness.

- **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 6 to assess the writing assignments.

Lesson Aids and Extensions

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

- **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 was the role of the engineering design process in making working in space easier for astronauts?
 - o What went wrong during Gene Cernan’s spacewalk?
 - o What did NASA scientists and engineers learn through failure, and what changes did they make in response?
 - o Where do you think our space program would be today without having made these changes?
- **Reading the Passage** - Before they read the passage on screen 10, tell students to think about Gene Cernan’s experience working in space. Ask them to suggest some things they would have changed to make this experience easier for Cernan and other astronauts. Record these suggestions on a chart or on the board.

- **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 signup 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. Convene students as a whole class or in small groups to discuss the following questions.
 - 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?

Final Assignment Rubric Newton’s Third Law: Action-Reaction

- When you hit a baseball with a bat, it may seem like only the bat is producing a force. However, Newton’s third law of motion states that things are not so one-sided. The ball produces an equal amount of force back on the bat. Think of an example of another common activity and use it to explain action-reaction. Be sure to describe how the action and reaction occur on the objects in your example.
- Choose an example of a common activity, such as brushing your teeth. Describe how doing this task on Earth would be different from doing it in space. Be sure to explain the challenges you would face if you had to do this activity in space. Also explain how you might change the equipment or technology you use—or the way that you use it—to help you meet those challenges.

4	3	2	1
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.	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.	Provides a generally accurate response, with one supporting detail from the reading passage, video, and other materials in the lesson.	Provides an inaccurate response to the question or fails to address the question. May include misinterpretations. Understanding of the topic is not apparent.
Uses at least three vocabulary words (or a form of the vocabulary words) from the lesson, and uses them all correctly.	Uses two vocabulary words (or a form of the vocabulary words) from the lesson, and uses them both correctly.	Uses one vocabulary word (or a form of the vocabulary word) from the lesson, and uses it correctly.	Does not use any vocabulary words, or uses vocabulary words incorrectly.

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).