

## How to Turn a Bolt in Space

On Earth, tightening a loose bolt is generally an easy task. However, in space, the conditions can make even the simplest of repairs a challenge. Without a handhold or other means of stabilizing themselves in a weightless environment, astronauts attempting to tighten bolts would be pushed in the opposite direction of their efforts. In other words, the astronauts would spin instead of the bolts! This is just as Newton's third law of motion predicts.

NASA's first attempts at sending astronauts outside their spacecrafts to "walk" and perform tasks quickly turned into an exercise in frustration and fear. In the aftermath of the failed space walks, NASA scientists set out to determine what was happening and, more importantly, how to help future astronauts overcome the effects of their own actions.

The problem NASA faced required an engineering solution. After lots of trial and error, engineers developed new strategies and equipment to provide some of the stability that gravity and friction provide here on Earth. Their solution: equip the spacecraft with footholds and handholds, which would allow astronauts to anchor themselves to the spacecraft. Thus, they



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would gain some control over the various forces they experience while doing work. In addition, scientists adopted new astronaut-training methods that included underwater activities. These helped astronauts learn to control their bodies more effectively while carrying out various tasks under conditions of weightlessness.

## Glossary

**friction:** a force that resists motion when two objects are in contact.

**weightless:** having little or no weight, or being free from the effects of gravity; in space, astronauts experience a sense of weightlessness because they and their spacecraft are in continuous free-fall as they orbit Earth.

## Writing Assignment

Using your notes from the lesson and updated activity chart, write a one- to two-page paper on one of the following topics:

1. When you hit a baseball with a bat, it may seem like the bat is applying all the force. However, Newton's third law of motion states that things are not so one-sided. The ball applies an equal amount of force back on the bat. Choose an example of an everyday activity and use it to explain Newton's action-reaction principle. Also, show how the action and reaction occur on different objects.
2. Choose an example of an everyday activity, such as brushing your teeth. Compare and contrast performing this task on Earth and in space. What challenges would you face if you had to do this activity in space? How could you meet those challenges?

If you would like more information about Newton's third law of motion to complete your paper, check out the following Web sites:

**HowStuffWorks: How Newton's Laws of Motion Work**

<http://science.howstuffworks.com/newton-law-of-motion4.htm>

**NASA Quest: Working in Space**

<http://quest.nasa.gov/space/teachers/suited/6work.html>