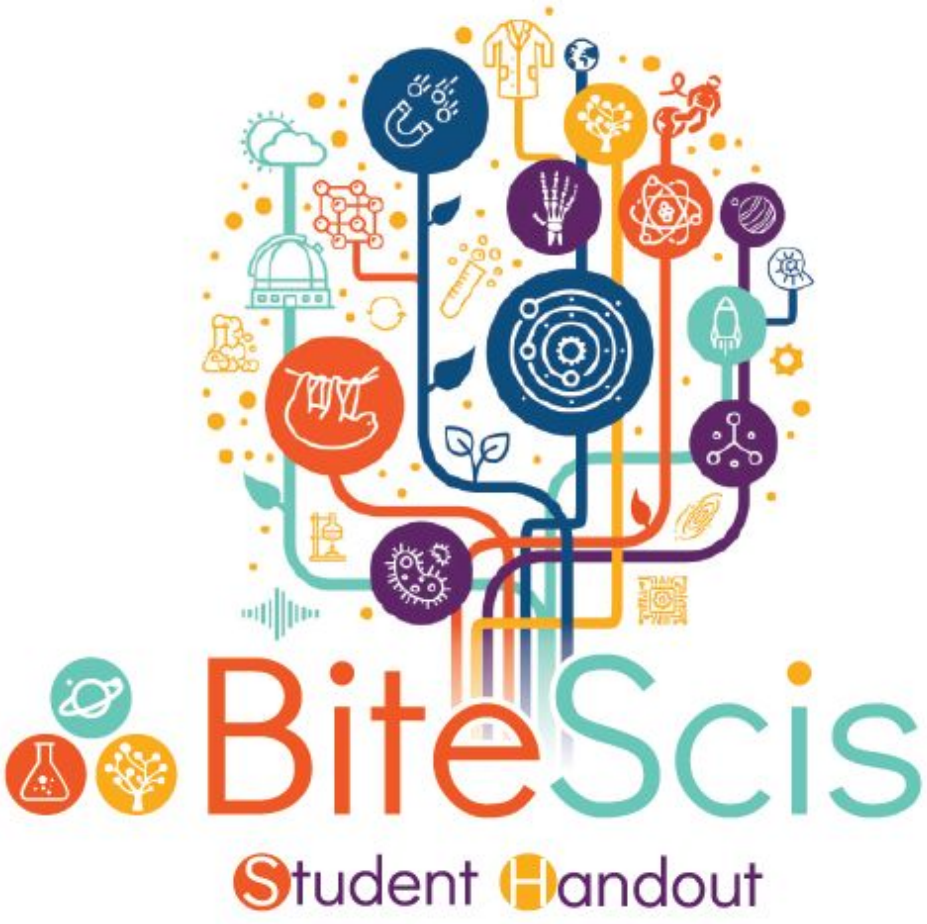


# Newton's Second Law and Acceleration: Finding Planets Using Physics

BiteScis

Student Handout

# Newton's Second Law and Acceleration: Finding Planets Using Physics

## Introduction

What do you think of when you hear the word **acceleration**? Probably a car speeding up or slowing down, or maybe a rocket being launched into space. But acceleration isn't just changing speed in one direction—it's any change in velocity. **Velocity** is how fast an object is going *and* what direction it's moving. The planets in our system are constantly accelerating simply because they're constantly changing direction as they move around the sun. But they are accelerating because of something else, too. Gravitational interactions among all the objects in our solar system—planets, the sun, and smaller objects like asteroids—can alter the objects' **orbits** (their near circular paths around the sun). When the distance between objects in space changes due to an alteration in the orbit, the gravitational force between the objects changes. This change in the gravitational force causes a change in acceleration, as given by Newton's 2$^{nd}$ Law ($F=ma$). In this lesson, you'll explore how scientists are using Newton's 2$^{nd}$ Law to develop a greater understanding of our solar system by examining the orbits of objects in the solar system.

## What To Do

Answer the analysis questions below, reading the Bite when instructed.

## Analysis Questions

**1.** Speed only describes how fast something is going. How is that different from velocity?

**2.** A person is pushing a box on a frictionless table.

**a.** If the force on the box increases, what happens to its acceleration? Explain your answer.

**b.** What happens to the acceleration if the person decreases the force on the box? Explain your answer.

**c.** If the force stays constant, is the box still accelerating? Explain your answer.

The person stops pushing the box.

**d.** What happens to the box's acceleration? Explain your answer.

**e.** What happens to the box's velocity? Explain your answer.

**3.** You and your friend are watching a documentary about our solar system. Your friend is watching the planets move along their orbits and says that there is no way that the planets are accelerating—it looks like they're all moving at the same speed around the Sun during its whole orbit! Do you agree with their claim that the planets are not accelerating? Explain why or why not.

STOP & read Science Bite:

**A Mysterious New Planet in the Solar System**

**4.** Where are Kuiper Belt Objects in our solar system and what are they made of?

**5.** Why do scientists think that there is a "Planet 9"? What evidence do they have? Cite specific evidence from the text.

**6.** What can cause an object's orbit to change?

**7.** Are the KBOs affected by “Planet 9” accelerating? Why or why not?

**8.** Gravity is a force that pulls two objects together, based on their size and distance from each other. If the objects are closer, the force is stronger. As a KBO gets close to a planet the force of gravity between the two objects increases.

**a.** What would this change in force do to the acceleration of the KBO?

**b.** Is the force exerted on the planet by the KBO the same as the force exerted by the KBO on the planet? Why or why not?

**c.** Would the acceleration of the KBO be more noticeable than the acceleration of the planet? Explain your reasoning. *Hint: Think about F=ma. What terms are different for the planet and the KBO? Which would be the same?*

**9.** **Connect to the Big Question**. Some other scientists claimed that Planet 9 actually doesn’t exist. Their research showed that the observations of the “clustered” KBOs might be biased—that is, we observe only the clustered KBOs because they’re easier for our telescopes to detect, but there may be more KBOs out there we just can’t see yet. Are you convinced Planet 9 is out there? Why or why not? If not, would extra observations change your mind?