GRAVITY OF THE SITUATION

TEACHER GUIDE

LAUNCH

PLANNING

Here's a suggested schedule for this kit! The activities should be completed in order, but you can choose when the lessons take place over time.

ACTIVITY INFORMATION	SECTION(S)	TIME REQUIRED	DAY/ LESSON
ACTIVITY 1: SPACE SLINGSHOT Does gravity change as you move through the Solar System? **Time required: 30 min**	☐ Voyager Out	30 minutes	Day 1
ACTIVITY 2: ALL FALL AROUND Learn how objects get into orbit around the Earth. **Time required: 2 h 30 min**	☐ Curved Shot	60 minutes	Day 2
	☐ Newton's Thoughts	90 minutes	Day 3
ACTIVITY 3: HANGING AROUND Explore how mass and distance effect the orbit and velocity of planets. **Time required: 3 h**	☐ Newton's Return	90 minutes	Day 4
	☐ A System of Laws ☐ Show What You Know	90 minutes	Day 5
ACTIVITY 4: ATOMIC ATTRACTION Learn about the fundamental forces th describe the behavior of all ma universe.			

Cover image courtesy of NASA

activity 2

ALL FALL AROUND

Your student read about the force of gravity on a satellite as it passed by objects in the solar system. Now, they will learn about how it escaped the gravity of other planets and the Sun.

LEARNING GOALS:

- I can use a model to explain how the amount of potential energy in a system depends on the arrangement of interacting objects.
- I can use evidence to argue that gravitational forces are attractive and that they depend on the masses of objects and the distances between them.

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CURVED SHOT

• In this activity, the student will experiment with the escape velocity of different size objects. The modeling dough will be used to increase the mass of the object, making it easier to launch off of the fishing line.
• Be sure that your student chooses a space with plenty of room for this experiment. Make sure to look around and move any delicate objects that could be in the radius of their launch.
• The fishing line is used as a model of the pull of gravity. The force pulling between the modeling dough and the student's hand is tension in the line, modeling gravity. The force launching the dough ball off the line is from the student accelerating the ball with enough force to overcome the friction on the line.
  - In addition to the modeled forces, this experiment actually represents centripetal force, or the force as an object follows a curved path. This force is continually moving at a right angle, while the string – modeling gravity – is keeping it in orbit. This creates a circular or elliptical path.
  - Inertia is also represented in this model, as the objects remain in motion until a force overcomes its steady path. The increased velocity overcomes the inertia, and the object flies off.
• Your student will read more about how this relates to calculations of force (F = ma) in the next section.
  - This model does not acknowledge drag (air resistance) that objects need to overcome for escape velocity.

THINK ABOUT IT!

Question 1: Describe what you observed as you increase the spin rate for each of the balls.
Answer: The faster the fishing line spins, the more likely the ball would reach escape velocity.
How to Help:
- *Direct your student to their data table.*
- *If their results did not match this answer, have them repeat the experiment.*

Atomic Models

• The student will review several atomic models and learn about the components of an atom.
• The vocabulary terms electron, neutron, and proton are defined.
• The theoretical structure of the atom has drastically changed over the previous 200 years. In 1803, John Dalton used the outdated term atom from the Greek root of atomos, or "indivisible" because it was assumed that it was smallest unit of all matter.
- Electrons and other subatomic particles were discovered around the turn of the 20th century, and the model grew over several years.
- In 1926, scientists like Erwin Schrödinger and Werner Heisenberg determined that motion and position of electrons cannot be determined. Their models describe the motion of electrons in a "cloud of probability" that predicts the likelihood of finding electrons.

MULTIPLE AGES AND ABILITIES:

The concept of electron cloud can be difficult. While it is not essential to understand the behavior of electrons, it can be helpful to visualize it in another way. Use the illustration of an electric fan. When the blades of the fan are moving, it is difficult to tell how many there are and track their speed exactly. If you were to take a snapshot of this fan, you may get a single frame position of the blades, but not measure its speed. In the same way, physicists are able to predict probably locations of electrons and some motion, but it is impossible to quantify all of that information.

• For more in-depth look at atomic structure and the behavior at the subatomic level, check out the Science Unlocked Launch level kit called Atoms and Angles.
• The scale of the Solar System increases from units of gigameters (a billion meters) of the diameter of the Sun, to petameters (a quadrillion meters) to measure the diameter of the Solar System.
• The scaled radius of an atom is 10,000 times the radius of the nucleus alone. An atom is measured in angstroms (one ten-billionth of a meter) while the nucleus is measured in femtometers (one quadrillionth of a meter).

REFLECT

Question 1: Describe two limitations of the gravity well activity in explaining the structure of an atom.
Answer: Answers will vary. The mass of the balls and the distances between them cannot be made at the correct scale. These objects only model the motion of the subatomic particles, but don't represent positive or negative charges.
How to Help: *Have your student review the previous reading section for additional limitations of the atomic model.*

Question 2: What are some questions you still have about the structure of atoms?
Answer: Answers will vary.
How to Help:
• These questions might relate to the structure of an atom, the motion of subatomic particles, other subatomic particles that they have heard about.
• Encourage your student to save these questions for a future activity to research more about their questions.

LAUNCH

SCIENCE UNLOCKED

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Kit	SU-GRAVST
Instructions	IN-GRAVSTT
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