TGR EDU:
EXPLORE

GRADES
6–12

To Our Solar System and Back

Discover the STEM Behind Sustainable Rocketry

DIGITAL EXPLORATION

EDUCATOR GUIDE

TGR FOUNDATION
A TIGER WOODS CHARITY

Discovery EDUCATION

DISCOVER THE STEM BEHIND SUSTAINABLE ROCKETRY

Using this Digital Exploration, students will act as planetary scientists who have been tasked with conducting a sample return mission. Students will be introduced to several celestial bodies that each offer a different type of sample for collection. Once students select a celestial body, they will investigate the future of reusable launch systems and the STEM behind both a successful launch and landing to obtain and return with their sample. Finally, students will examine the diverse range of careers in the aerospace industry.

TIME REQUIRED

25–30 minutes

TOPICS

- Forces and Motion
- Spectrometry
- Earth and the Solar System
- The Universe
- Careers in Science, Technology, Engineering and Mathematics

HARDWARE RECOMMENDATION

To Our Solar System and Back is accessible on any device. However, for optimal user experience, it is recommended that explorations are accessed via desktop or tablet. This exploration is functional for use on mobile devices (iOS and Android).

TECHNICAL SPECIFICATIONS

While the **To Our Solar System and Back** Digital Exploration will function in all browsers, including Internet Explorer, Safari, Chrome and Firefox, browser load speeds will vary. For best performance, it is recommended that the most current version of your browser of choice is used when accessing the modules. Please note, connection speeds may be impacted by factors such as highly trafficked shared Wi-Fi access, public Wi-Fi and accessing modules behind a firewall.

OVERVIEW

This Digital Exploration has four main sections:

INTRODUCTION

Why do we explore? Students will be introduced to reasons humans have an interest to venture into the universe and how space exploration benefits humans in unexpected ways.

INVESTIGATE

Students will explore space through the view of a telescope and learn how to identify characteristics of celestial objects. Students will use parallax to estimate the distances between Earth and celestial bodies, explore astronomical spectroscopy to classify unknown substances and practice sorting images by distance. Finally, students will scroll up into space to select a celestial body they would be interested in visiting to collect a sample.

ACT

The basics of forces and motion guide the design and flight of rockets. Students will explore four factors that affect flight: thrust, lift, weight and drag. They will then be given a task to launch and land a rocket by manipulating different variables to test their solution.

ANALYZE

To summarize, students will connect the principles of rocketry and force to real-life careers.

PROCEDURE

This exploration is designed to be flexible to meet the needs of many different learning environments.

ONE-TO-ONE ENVIRONMENT

Students using the exploration for independent, self-paced learning can simply move through the exploration at their own pace.

WORKING IN PAIRS OR AT CENTERS

Students can take turns answering the questions throughout the exploration or they can work together to answer the questions. As students may have different reading levels, you will want to guide them to provide each group member with an opportunity to read and comprehend the information before moving on.

CLASS ENVIRONMENT

If you are leading a group in a one-to-many environment, you can use a projector and screen or whiteboard to make the exploration the focus of instruction and discussion. Use the questions in this guide and a show of hands during each topic to gauge student comprehension.

CUSTOMIZED INSTRUCTION

You may also choose to use discrete elements from the exploration that fit your timeframe and curriculum.

PATH TO DISCOVERY

1. Explain that the purpose of this Digital Exploration is to examine the science, technology, engineering and math behind sustainable rocketry.
2. Read the discussion questions before starting the Digital Exploration.
3. Use a word wall (or other strategy) of key academic vocabulary to help students define important words and phrases encountered during the Digital Exploration.
4. Guide students to respond to the questions, in writing, using evidence from the Digital Exploration.
5. Explain that you will be available to support students as they work.
6. Review student responses to the discussion questions after they have completed the Digital Exploration.

DISCUSSION QUESTIONS

- How do telescopes add to human knowledge and understanding of the universe? Use evidence from the Digital Exploration in your response.
- Describe two examples of celestial objects that can be observed through spectroscopy and explain what data scientists can collect before visiting the object.
- Use the words weight, thrust, drag and lift to explain the different forces needed to launch a rocket.
- Rocket reusability can reduce the cost of access to space. What is one example you observed in the Digital Exploration that demonstrated how several trips to space can be helpful to learning more about our universe?
- Describe why it is important for different careers to collaborate. Use evidence from the Digital Exploration in your response.

NATIONAL STANDARDS

Next Generation Science Standards

MIDDLE SCHOOL

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Develop and use a model to describe phenomena.	**ESS1.B: Earth and the Solar System** The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2), (MSESS1-3)	**Systems and System Models** Models can be used to represent systems and their interactions.
Engaging in Argument from Evidence Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	**ETS1.B: Developing Possible Solutions** There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MSETS1-2), (MS-ETS1-3)	**Systems and System Models** Models can be used to represent systems and their interactions.
Planning and Carrying Out Investigations Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5)	**PS2.A: Forces and Motion** For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1) The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3),(MS-PS2-5)

	All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)	

HIGH SCHOOL

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing Explanations and Designing Solutions Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**ESS1.A : The Universe and Its Stars** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1- 2),(HS-ESS1-3) The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2)	**Energy and Matter** Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems.
Analyzing and Interpreting Data Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	**PS2.A: Forces and Motion** Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2) If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2), (HS-PS2-3)	**Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

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PS2.A: Forces and Motion

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