**Exotrex 2 Lesson 2.2: Planetary Explorations**
**Objectives**:
-Complete explorations related to Titan, Mercury and Venus
-Evaluate planets (and a moon) for viability of human settlement

**Materials and Preparation:** *These materials are designed for students who are playing the narrative version of Exotrex2. If students are playing mini-games chosen from the "Missions" option on the main screen they will have access to each of the games referenced in this lesson but the game-play will be different. You should have experience playing both versions to see which one will best fit your teaching goals and time constraints. There are four additional handouts with this lesson and each one will be used to accompany the exploration of each planet (and moon) as well as an emergency situation.*

*Once students have chosen a planet or moon to explore from the solar system map, hand them a corresponding handout. Each planet, or moon, is a mission that consists of a serious of games and students use the corresponding handouts to record their thoughts, observations and reflections while completing each game. The chart below lists the mini-games associated with each mission.*

| 2.2a Mercury Mission | 2.2b Venus Mission | 2.2c Titan Mission | 2.2d Electrical Emergency! |
|---|---|---|---|
| - Probe Lander Mercury<br>- Mercury Rover<br>- Particle Analysis | -Venus Atmospheric Probe<br>-Particle Analysis Venus | - Probe Lander Titan<br>- Titan Rover<br>- Methane Cycle Puzzle | -Energy Game |

**Mercury Mission Overview:** Mercury is a solid terrestrial planet and students' first task is to land a probe on its surface. The **Probe Lander** game will test their ability to navigate the probe to the surface using speed, velocity and acceleration to respond to Mercury's unique gravitational pull. Once the probe has landed, students will then play the **Rover** game to remotely pilot a rover to hover over the surface of Mercury to collect samples and make observations of the planet's surface conditions. Once all samples and observations are successfully collected, students will then play the **Particle Analysis** game to analyze the chemical composition of the collected substances. Once these three games have been played in succession, students will then have the opportunity to share their findings with Dr. Estella Burke via video chat. Encourage students to take notes on handout **2.2a Mercury Mission** to be fully prepared to report their findings.

**Mercury Mission Addressed Standards:**
*Next Generation Science Standards*
**MS-PS-1.1** Develop models to describe the atomic composition of simple molecules and extended structures.
**MS-PS-2.1** - Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
**MS-PS-2.4** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

*Common Core State Standards*

**Venus Mission Overview:** Venus is a solid terrestrial planet but the atmosphere is extremely thick and needs to be studied. Dr. Burke will ask students to fly an atmospheric probe through the upper layers of Venus' atmosphere to collect samples in the **Venus Atmospheric Probe** game. Students will then be tasked with analyzing the collected samples while playing the **Particle Analysis** game before reporting back to Dr. Burke with their findings via video chat. Encourage students to take notes on handout **2.2b Venus Mission** to be fully prepared to report their findings.

**Venus Mission Addressed Standards:**
*Next Generation Science Standards*
**MS-PS-1.1** Develop models to describe the atomic composition of simple molecules and extended structures.

*Common Core State Standards*
**CCSS.ELA-LITERACY.RST.6-8.1**
Cite specific textual evidence to support analysis of science and technical texts.

**Titan Mission Overview:** Titan is a solid terrestrial moon of Saturn and students' first task is to land a probe on its surface. The **Probe Lander** game will test their ability to navigate the probe to the surface using speed, velocity and acceleration to respond to Titan's unique gravitational pull. Once the probe has landed, students will then play the **Rover** game to remotely pilot a rover to hover over the surface of Titan to collect samples and make observations of the moon's surface conditions. Titan has an abundance of cryovolcanoes on its surface that not only challenge students while collecting samples but also allow for an up-close study of a methane cycle in action. Unfortunately, as the samples from Titan are brought back onto the space ship they are jumbled and students must reorganize the data while playing the **Methane Cycle Puzzle.** Once these three games have been played in succession, students will then have the opportunity to share their findings with Dr. Estella Burke via video chat. Encourage students to take notes on handout **2.2c Titan Mission** to be fully prepared to report their findings.

**Titan Mission Addressed Standards:**
*Next Generation Science Standards*
**MS-ESS - 2.4** Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

*Common Core State Standards*
**CCSS.ELA-LITERACY.RST.6-8.1**
Cite specific textual evidence to support analysis of science and technical texts.

**Electrical Emergency!** At some point during gameplay an emergency will occur in which the central electrical systems of the space ship fail. It will be a race against time to successfully fix and restart the system by playing the **Energy Game**. This game challenges students to harness enough steam power

generating enough power to sustain life on the ship. This fun game reviews thermal, kinetic and electrical energy.

**Electrical Emergency Addressed Standards:**
*Next Generation Science Standards*
**MS-PS-3.4** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

**What should I expect during the video chat with Dr. Estella Burke (*i.e. Branching Dialogue Quizzes*)?**
After all the games associated with a mission for a planet or moon have been completed, students will have the opportunity to report their findings to Dr. Estella Burke. This video chat does not happen automatically and students can either complete a video chat after each mission or report all findings at one time. It is generally better to report to Dr. Burke immediately after a mission has been completed but not necessary.

The video chats with Dr. Burke are conversations in which students are sharing what they learned. These talks are essentially quizzes but they are not structured like a traditional quiz. The prompts are conversational in nature and if a student is not performing well, Dr. Burke finishes the conversation early and encourages students to play the games again and to pay closer attention before reporting back.

Keep in mind, students are exploring planets and a moon that are pretty well known at this point. Dr. Burke is not looking to students for new findings, he is evaluating whether students can independently come to the scientific community's agreed upon understandings of each of these locations.

Students will experience these conversations as a pass fail state. If they do well they can move on, whereas if they do not do well they will need to play the games and report to Dr. Burke again. There will not be a score presented to students but teachers will get a clear sense of how students have done while reviewing the xAPI data associated with each time it is played.