Science Standards: All Teams

- Integrate information presented in different media or formats to develop a coherent understanding of a topic or issue
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- 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.

- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both objects have large mass—e.g., Earth and the sun.
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- Effectively work together with different individuals and groups, building on others' ideas and expressing one's own ideas clearly.
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- Velocity = Distance/Time

Earth Vs. Mars Facts: All Teams

- Earth Vs. Mars https://www.youtube.com/watch?v=RxD7iYQHdqo
- Mars = very little oxygen, low pressures, and extreme temperatures
  - 1 year: 365 days (Earth), 687 earth days (Mars)
  - Speed: 18.5 Mi/sec (Earth), 14.5 mi/sec (Mars)
  - Same amount of land mass due to Earth's oceans
  - Ave. Temperature: 57 degrees (Earth), -81 degrees (Mars)
  - Gravity: 9.807 m/s^2 (Earth), 3.711 m/s^2
    - You would weigh 63% less on Mars
  - Earth Atmosphere - 77% nitrogen, 21% oxygen, 1% Argon, 0.038% Carbon Dioxide
  - Mars Atmosphere - 96% Carbon Dioxide, 2% Argon, 2% Nitrogen, 0.15% Oxygen
  - Mars has 2 moons (Phobos and Deimos)
- Mars environment cards: https://marsed.mars.asu.edu/sites/default/files/stem_resources/mars-cards.pdf

Journey of the Inspiration Rover: All Teams

"Planes follow a specific process for taking off and landing to ensure success. They must get up to a certain speed and then they slowly increase their altitude until they're at the proper altitude to fly. When we go to the Challenger Learning Center, we will travel from one of Mars's moons, Phobos, to Mars. For this, we will be using a spacecraft; however, it is still important that it follows a specific take-off and landing procedure, just like airplanes.

“In this journey, we will be launching from Phobos, one of Mars’s moons, to the surface of Mars. You’ve seen spacecraft take off from Earth. What do you know about this process? How does the spacecraft launch and leave Earth?” [prompt students to talk about speed]

“In order to “leave” the Earth, a spacecraft has to escape from Earth’s atmosphere and gravity. To 'break free’ from something’s gravity, an object must go faster than the escape velocity. The **escape velocity is the speed it takes to escape the gravity of that body**. Everything has a different escape velocity: the escape velocity of **Earth is 25,000 mph, Mars is 11,000 mph, and Phobos’s is about 25 mph**. So, based on those numbers, do you think it’ll be easier to launch to and from Mars and Phobos or from Earth?

“When our rover has reached the escape velocity and is officially on its way to Mars, the next step is landing. This is challenging because the rover will be going very fast and must slow down quickly to land safely. Rovers must be planned and programmed ahead of time since no one is in the spacecraft. Also, because of the distance, when rovers have been launched from Earth, there is a radio delay in communication. By the time Mission Control gets word that the rover has entered the atmosphere, it will have already actually reached the ground. This means Mission Control waits anxiously to know whether the rover landing was a success.”

“The waiting period when Mission Control waits to hear from the rover is called the **‘seven minutes of terror.’** The seven minutes of terror refers to the time it takes the rover to go from full speed to a full stop. Because of the radio delay, Mission Control cannot monitor this process. They can only wait.

- https://www.youtube.com/watch?v=Ki_Af_o9Q9s Process of Descent

Extremophiles: BIO Team

- “Why extremophiles bode well for life beyond Earth”: https://www.youtube.com/watch?v=Bsp5JYNMAQE
  - Life on Earth requires three things: liquid water, a source of energy within a habitable range from the sun and organic carbon-based material. But life is surprisingly resilient, and organisms called extremophiles can be found in hostile living conditions (think extreme temperatures and little access to oxygen). Louisa Preston argues why extremophiles give astrobiologists hope for life in the universe.
- Extremophile cards: https://marsed.mars.asu.edu/sites/default/files/stem_resources/cards_0.pdf

- Why are scientists studying extremophiles?
  - "Extremophiles" are organisms with the ability to thrive in extreme environments such as hydrothermal vents. Since they live in “extreme environments” (under high pressure and temperature), they can tell us under which range of conditions life is possible.

Inspiration Rover: Nav, Bot, Rov, Weather Teams

Follow Curiosity's Descent to Mars
https://mars.nasa.gov/multimedia/interactives/edlcuriosity/index-2.html
(Builleted breakdown of descent process from video) - can skim through:

- **Cruise Stage Separation**
  - **Altitude 1,000 mi, Velocity 11,408mph**
  - 10 min. Before reaching the atmosphere, the cruise stage ejects and burns up.
- **Separation Cruise Balance Mass Devices**
  - **Altitude 900 mi, Velocity 11,448mph**
  - cruise stage ejects
- **Entry Interface**
  - **Altitude 80 mi, Velocity 13,199mph**
  - An instrument on the heat shield named MEDLI measures how hot the spacecraft gets
- **Peak Heating**
  - **Altitude 18 mi, velocity 11,183 mph**
  - Hotter than hot - Outside, the heat shield reaches 3,800 degrees Fahrenheit (2,100 degrees Celsius)
  - Inside Curiosity stays at about 50 degrees F (10 degrees C)
- **Peak Deceleration**
  - **Altitude 14 mi, velocity 9,400 mph**
  - Slamming on the breaks - Friction in the atmosphere slams on the "brakes". The spacecraft slows from 13,200 to 1,000 miles per hour
  - Getting lift - The capsule's shape and mass offset, keeps the air pressure lower on one side of the capsule, producing lift.
- **Parachute Deploy**
  - **Altitude 7 mi, velocity 900 mph**
  - Parachute pops out - Out pops the parachute, 7 miles from the ground slowing it to 9% of its original speed.
  - The view is similar to looking out of an airplane, except you are landing on Mars!
- **Heat Shield Separation**
  - **Altitude 5.5 mi, Velocity 300 mph**
  - About 5 miles above the surface of Mars, the heat shield pops off and drops away.
- **Radar Data Collection**
  - **Altitude 5 mi, Velocity 280 mph**
  - 5 seconds later, the radar system begins to calculate speed and altitude which determines when to start powered descent.
  - Start too early and the spacecraft will run out of fuel
  - Start too late and the spacecraft won't have enough time to stop
- **Backshell Separation**
  - **Altitude 1mi, Velocity 170mph**
  - Brief free fall. 80 seconds after heat shield separation, the backshell and parachute separate and fly off from the descent stage.

- **Retrorockets Fire**
  - **Altitude 4232 ft, Velocity 175mph**
  - All eight retrorockets fire, doing a divert maneuver to get away from the departing backshell and parachute so that they don't all crash together
- **Rover Separation**
  - **Altitude 66 ft, 1.7mph -** New landing system kicks into gear
  - Sky Crane maneuver: think of a large crane lowering a steel beam from a skyscraper to the ground.
  - As the rover separates, the engines slow descent
- **Sky Crane Maneuver: Mobility Deploy**
  - **Altitude 20 ft, 1.7mph**
  - Four of eight retrorockets shut off before three nylon ropes (the bridle)and an "umbilical cord" begins to spool out. About 25 feet long, they slowly lower the Curiosity rover.
  - Wheels down - Curiosity's wheels and suspension system, which doubles as the landing gear, pop into place. Just like a commercial plane
- **First Contact**
  - **Altitude 0 ft, Velocity 0 mph**
  - Touchdown! - The bridle cables are fully spooled as the rover descends "softly" and touches down.
  - When the weight on the cables reduces, the descent stage knows the rover has landed.
  - Sky Crane flies away - Pyros cut the bridle and "umbilical cord" connecting the descent stage to the rover's "brains". Now "unconscious," the descent stage flies out of the way - at least 492 ft from the rover.

- Upon a successful landing, Curiosity's computer would switch from entry, descent and landing mode to surface mode. The rover would begin her First Martian Day (sol) on the surface of Mars.

- "Curiosity Has Landed" video of NASA's Curiosity rover successfully landing on Mars Aug 5, 2011
  - https://www.youtube.com/watch?v=N9hXqzkH7YA

Geology of Mars: Geo Team

- NASA Now: Geology: Curiosity – Main Science Goals
  - NASA Now: Geology: Curiosity -- Main Science Goals (7 min)
  - Life Ingredients: Water, Carbon, Energy
- It is hypothesized that rocky planets like Earth and Mars formed from the debris of an exploded star that was once near the location of our current Sun. Over millions of years, the debris accumulated into many larger "clumps" of debris that formed some of the planets, moons, asteroids, and comets that now make up our solar system. According to this theory,

both planets should have similar features because Earth and Mars formed through similar processes.

- NASA is investigating plans to send the first humans to Mars within the next two decades. They will explore our planetary neighbor and the possibilities of creating a future habitat for explorers. If this timeline works, the first people who will go to Mars are probably in a middle school or junior high school classroom at this very moment. Could it be one of you?

Human Bodies on Mars: Medical/Life Support Teams

- On Mars (a lower gravity environment), everything weighs less than it would on Earth, just like how the Mars can weighs less than the Earth can. When things weigh less, astronauts' muscles don't have to work as hard to lift their bodies or equipment. Because their muscles are not working as hard, their muscles become smaller and weaker. To combat this, astronauts exercise almost two hours every day while they are in space, and even then, they still lose muscle mass.

- Blood and water are constantly circulating through the body. You don't feel it, but gravity is pulling your blood downward on Earth. When there is less gravity, like on Mars, fluids like blood and water float. They aren't being pushed downward, so they will move higher up in your body. This is why when astronauts first get to space the top half of their body will look bigger, their face will look puffy, and their legs and ankles will be smaller.

- Astronauts' bones become weak in space (a microgravity environment). Astronauts' muscles don't have to work as hard, and the muscles don't have to pull as hard on the bones to support the astronauts' bodies. Astronauts must exercise almost two hours daily and have a calcium-rich diet to keep their bones from weakening.

Living in Space: Medical/Life Support Teams

- Biggest issues for humans in Space, specifically Mars:
    - Low gravity, lack of oxygen, cold, needing to find water and make it safe for humans, no food, getting sick, psychological effects, the danger of launching/landing/travel, the unknown—who knows what's out there and what could happen?

    - Radiation is energy that travels in waves. Low levels of radiation are not dangerous, but high levels can be very harmful to humans. On Earth we have the ionosphere to protect us; however, Mars is not protected against this radiation from the Sun, this high energy radiation getting into bodies can change DNA and cause cancer.

- Explores living on ISS, sleeping quarters, bathroom, food, etc. (8:41) https://www.youtube.com/watch?v=tBVUTFPate0—