Mission to Mars Engineering Design Challenge
Drone Project
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Phase 1: Research and Planning

1. The Big Idea behind the drone project is to challenge students to consider the factors which are important in the design and implementation of a reliable drone design which will be used on Mars Exploration Missions. Students will be tasked with explaining the importance of considering how gravity and atmospheric conditions effect the design and implementation of a drone, which will be launched and landed near the main station (mission control HQ) or from a rover (piggy-back) base located on Mars. The goal of the project is for students to build/obtain a vacuum-chamber, as-well-as a basic drone model, which can be used to test the effects of changes in air density on the rotor blades of the drone, which generate lift, to fly drones in atmospheres which have limited air/gas density, similar to those on Mars.

2. This project addresses the following learning standards from the NGSS, or State of Missouri:

NGSS-HS-PS2-1.	**Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.**
NGSS-HS-PS2-2.	**Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.**
NGSS-HS-PS2-3.	**Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.**
NGSS-HS-PS2-4.	**Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.**
MLS-9-12.ESS1.C.2	**Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.**
MLS-9-12.ESS1.B.1	**Use Kepler's Law to predict the motion of orbiting objects in the solar system.**

3. Students will solve problems focused around how to design & construct a vacuum chamber to change the air-density/atmospheric conditions in which a drone must operate, which are similar to those on Earth versus Mars. Students will also construct a basic drone, which can be operated remotely inside the vacuum chamber. The final piece of the research and design challenge of this system is to find ways to measure and collect data on the operation and atmospheric conditions of the vacuum chamber and drone, in-situ. Students will solve problems which enforce the ideas of declarative knowledge by looking at the effects of gravity on an object in free-fall with air present (at STP) and how the mass of

various objects of different weights will fall at the same rate in a vacuum (or low air density environment), as opposed to falling through the oxygen-rich atmosphere, which is similar to that of Earth. This concept will lead students towards a better understanding of how lift actually occurs via the rotor blades on a drone. Students will apply procedural knowledge by developing a structure to adjust the amount of air present in the chamber, and determine which factors are important in re-designing the drone rotor blades to generate more lift, or change the rotation speed of the blades to generate more lift as the atmosphere in the vacuum chamber is changed.

4. The objective is for students to conclude which aspects of drone & rotor designs are important. Students will prioritize the project into categories which emphasize:
I. the design and construction of the vacuum chamber.
II. The design and construction of the drone power and drive system.
III. The software needed to control the drone remotely while inside the vacuum chamber.
IV. The design and construction of the rotor blades on the drone.
V. The design and construction of an apparatus and methodology which enables student to collect data which measures the lifting force generated by the drone as a result of:
    a) changing the rotor shape/design
    b) changing the rotational speed of the rotor blades

5. Students will choose which activity or team they would like to be a part of, in order to complete any or all of the steps I through V listed in part 4 (Above). Students will talk with the instructor to decide which part of the process they would like to work on, or be assigned to. Students will each utilize an engineering/design notebook for the project and will conclude the activity by giving a presentation of their findings, and how the project is relevant to an actual drone mission currently happening on Mars by NASA.

6. My school-system has a STEM- based technology lab available, which we will use to complete this activity. Students will collaborate with the instructor (ME), and the Tech-lab manager, to create a list of materials and supplies available, and those which will need to be obtained to complete the construction and testing of a drone in a vacuum chamber.