Space Racing Around Mars

Objectives:

- To create a Sphero-powered chariot using K'Nex pieces
- Identify how Sphero can power a land-based vehicle constructed with inexpensive materials
- Drive Sphero around a defined course with a chariot attached.
- Analyze the effectiveness of your work with supporting facts
- Collect and analyze data concerning speed and time of each run completed
- Apply the Engineering Design Process to create a chariot

Materials:

1 Sphero per group	Paper	Tape
K'Nex building sets	CD's	Digital balance
1 Clear plastic cup per group	Cardstock	Large space for races

Standards:

Social Studies

9.1) Describe developments in Italy and Northern Europe during the Renaissance period with respect to humanism, arts and literature, intellectual development, increased trade, and advances in technology.

7.9) Apply principles of money management to the preparation of a personal budget that addresses housing, transportation, food, clothing, medical expenses, insurance, checking and savings accounts, loans, investments, credit, and comparison shopping.

Science (Physics)

9-12.1) Investigate and analyze, based on evidence obtained through observation or experimental design, the motion of an object using both graphical and mathematical models (e.g., creating or interpreting graphs of position, velocity, and acceleration versus time graphs for one- and two-dimensional motion; solving problems using kinematic equations for the case of constant acceleration) that may include descriptors such as position, distance traveled, displacement, speed, velocity, and acceleration.

9-12.4) Identify and analyze forces responsible for changes in rotational motion and develop an understanding of the effect of rotational inertia on the motion of a rotating object (e.g., merry-go-round, spinning toy, spinning figure skater, stellar collapse [supernova], rapidly spinning pulsar).

9-12.5) Construct models that illustrate how energy is related to work performed on or by an object and explain how different forms of energy are transformed from one form to another (e.g., distinguishing between kinetic, potential, and other forms of energy such as thermal and sound; applying both the work-energy theorem and the law of conservation of energy to systems such as roller coasters, falling objects, and spring-mass systems; discussing the effect of frictional forces on energy conservation and how it affects the motion of an object)

Science (Physical Science)

9-12.8) Apply Newton's laws to predict the resulting motion of a system by constructing force diagrams that identify the external forces acting on the system, including friction (e.g., a book on a table, an object being pushed across a floor, an accelerating car).

9-12.9) Use mathematical equations (e.g., $(m_1v_1 + m_2v_2)_{before} = (m_1v_1 + m_2v_2)_{after}$) and diagrams to explain that the total momentum of a system of objects is conserved when there is no net external force on the system.

a. Use the laws of conservation of mechanical energy and momentum to predict the result of one-dimensional elastic collisions.

Next Generation Science Standards (NGSS)

3-5-ETS1-1
Grades 6, 7, 8
Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
Science

3-5-ETS1-2
Grades 6, 7, 8
Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
Science

3-5-ETS1-3
Grades 6, 7, 8
Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
Science

MS-ETS1-1
Grades 6, 7, 8
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
Science

MS-ETS1-2
Grades 6, 7, 8
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
Science

MS-ETS1-3
Grades 6, 7, 8
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Mathematics (Pre-calculus)

39) Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. (*Focus on increasing rigor using standard deviation*). [S-ID2] (Alabama)

40) Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). (*Identify uniform, skewed, and normal distributions in a set of data. Determine the quartiles and interquartile range for a set of data.*) [S-ID3] (Alabama)

41) Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. [S-ID4]

Mathematics (Algebra I)

41) Represent data with plots on the real number line (dot plots, histograms, and box plots). [S-ID1]

42) Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. [S-ID2]

43) Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). [S-ID3]

Background: The Engineering Design Process is used throughout every grade level and is apparent in every invention ever created. Students will use the EDP to create a Sphero-driven chariot to race around a track in your classroom. Students can then gather data to analyze speeds and weights of the various designs. Students can also analyze the differences in speed if the same chariot is used on various terrains (smooth flat tile, carpet, the parking lot, a grassy area, etc.) and how Newton's Laws play a role in these differences.

Introduction: We have made it to Mars and now we can officially let the games begin! We only had enough room to bring Spheros and K'Nex with us on our journey to Mars. Your job is to develop a chariot-type racer that can complete a race in the fastest time using only the supplies given to you to kick start the first official Mars Space Race!

Procedure:

1. Group students based off of how many Spheros are available. Groups of 4 are ideal.
2. Optional: K'Nex pieces can be set at standard prices per piece, or type of piece, and students can be given a limit of how much "Martian Money" they are allowed to spend.
3. Teams will plan, design, and create a working Sphero-powered chariot. Students will be given 2 days to build, test, and redesign their chariots.
4. Optional: If a 3-D Printer is available, teams can be given parameters concerning size and can be allowed to print ONE originally created piece to add to their chariot. A fee can also be established to use the printer (Martian Money).
5. Students can be assigned to use the Blocks or Draw canvas to create a program which will allow their Spheros to drive autonomously. This can also be up to the students' preference if you do not wish to specifically assign an app to use.
6. Allow students to practice and make adjustments during the two days of designing.
7. Be sure to ask: which build has seemed to work best and why? What can be done to better utilize the money you are able to spend? If block coding, is there a way to run it with fewer lines? If a 3-D piece was created, what advantage did it create, if any, that an offered piece did not have? Would making your prototype have less mass create a faster machine?
8. On Day 3, hold a "First Annual Space Race on Mars" event in your classroom. Allow teams to compete with one another to find out who has the fastest Sphero-driven chariot. All students will need to collect data from every team's run.
9. Data can then be constructed into graphs (dot plots, box and whisker plots) and analyzed.
10. Students can recreate the track on other terrains using the same dimensions. Data can then be collected and analyzed to see the effects on time, completion, etc.

Assessment:

Teacher observation.
Graphs can be collected/graded.