Spring into Action

Unit: Force and Motion

STEM Content Standards:

Science

Next Generation Science Standards:
PS2.A and PS2.B, The effect of unbalanced forces on an object results in a change of motion. Patterns of motion can be used to predict future motion. Some forces act through contact, some forces act even when the objects are not in contact. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

Technology and Engineering

Standards for Technological Literacy:
Standard 2, Students will develop an understanding of the core concepts of technology.

- B. Systems have parts or components that work together to accomplish a goal.

Standard 9, Students will develop an understanding of engineering design.

- A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.

Next Generation Science Standards:
ETS 1-1, 1-2, 1-3, Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost; 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; 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.

Math

Common Core State Standards:
Standard 2.MD.1, Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.
Standard 2.MD.10, Draw a picture graph and a bar graph (with single- unit scale) to represent a data set with up to four categories. Solve simple put- together, take- apart, and compare problems using information presented in a bar graph.

English Language Arts

Common Core State Curriculum Framework:
SL1 CCR Anchor Standard: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
SL4 CCR Anchor Standard: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

Economics

National Standards in Economics:
Standard 1, Scarcity: People make choices because they can't have everything they want.

Big Ideas:

Potential Energy	Conservation of Energy	Trajectory	Measurement
Mechanical Energy	Graphing	Angle	Altitude

Essential Question: How can you design a spring rocket that allows Wile E. Coyote to reach his target destination?

Scenario: Wile wants to try his super spring again. After all, he knows it can work! This time, he needs to make sure that he is ejected from the spring before the mechanical energy turns back into potential energy.

Challenge: Work as a member of an engineering design team to design a spring-powered launch system that can be controlled to accurately send Wile to his target destination. Your launch system should be tested for *accuracy* and *repeatability*. The launch system must *propel* Wile over a barrier to reach his destination. The launch device that proves to be the most accurate and repeatable during testing will be determined to be the winner.

Limitations: To complete this engineering design challenge successfully, teams must strictly adhere to the following design parameters:

1. Teams will be allowed one hour to: Brainstorm, conduct ideation, make sketches (using the engineering notebook), test theories, purchase tools/materials, and build a working prototype that solves the design challenge described above;
2. Teams will have a budget **(15 credits**) and may "*purchase*" materials (see Figures 1 and 2) needed to construct their launch device.
3. Your launching must be anchored to the given base.
4. After constructing a *prototype*, the engineering design team should experiment with the launch device until some measure of repeatability is achieved.
5. When your launch system is ready to be evaluated, bring it to the launch pad. You will have five attempts to officially test/evaluate your device.

Care must be taken to not pinch fingers when working with the springs.

Concepts to Explore:

Trajectory	Angle	Range	Altitude
Attitude	Distance	Accuracy	Direction
Elasticity	Tension	Compression	Potential Energy
Kinetic Energy	Measurement	Repeatability	

Additional Reading:
Wile E. Coyote: Experiments with Energy by Suzanne Slade
Using Springs by Wendy Sadler

Suggested Video Clip:
Best of Coyote and Roadrunner - https://www.youtube.com/watch?v=Jd_41tM6H2Y

How Springs Work:
In their most familiar form, springs are toughened coils of metal that help things return to a particular position, but they can also be used to absorb energy (car suspension) or store it for long periods of time (watches and clocks). You can find springs in everything from automatic doors to ballpoint pens. Let's take a closer look at how they work! A typical spring is a tightly wound coil or spiral of metal that stretches when you pull it (apply a force) and goes back to its original shape when you let it go again (remove the force). In other words, a spring is *elastic*. It gets longer when stress is applied but (providing you don't stretch it too much) returns exactly to its original length when that stress is removed. Depending on how a spring is made, it can work in the opposite way too: if you squeeze it, it compresses but returns to its original length when the pushing force is removed.

You can make a spring out of more or less anything—even paper or orange peel!—but the kinds of springs we use in machines work effectively only if they're stiff enough to *resist* a pulling force and *durable* enough to be stretched many times without breaking. Typically that means they have to be made from *metals* like *steel*. Some metals have a property called "shape-memory," which means they're naturally springy. Eyeglass frames are often made from nickel-titanium shape-memory metal called Nitinol.

There are several quite different kinds of springs. The most familiar ones are coil springs (like the ones in your pen). They are cylinders of wire wrapped around a circle of fixed *radius*. Spiral springs are similar, but the coil gets progressively smaller as you reach the center (paper spring). The delicate hairspring that helps to keep time in a watch is another example of a spring. Torsion springs work like the elastic in a rubber band twisted repeatedly between your fingers. Leaf springs are stacks of curved metal bars that support the wheels of a car or railroad truck and bend up and down to smooth out the bumps.

Open up a ballpoint pen (one of the ones with a button you click to retract the ball) and you'll find a spring inside. Look under a car and there are springs there too, helping the shock absorbers to smooth out the bumps in the road. There are springs in watches and clocks, as we've already seen. Once you've started spring spotting, you'll find you can see springs everywhere!

Figure 1 – Tools

Purchases/Rentals	Tools	Cost
	1 – Cutting tool	2 credits (rental fee)
	1 – Ruler	2 credit
	1 – Protractor	3 credits

*Tools may only be used for constructing your design and should not be used as part of your solution

Figure 2 – Materials

Purchases	Materials	Cost
	1 – coil compression spring	4 credits
	4 – plastic push pins	2 credits
	1 – 8” length woven string	3 credits
	1 – 8” length masking tape	1 credit
	1 – plastic tube (straw)	3 credits
	1 – piece of cardboard	4 credits
	1 – Candy stick	4 credits
	1 – Sticky tack	1 credits

** One Paper plate base, projectile, and target will be supplied to each team at no cost **

Ideas:
