Programming and Projectiles

Total Number of Lessons: 3 lessons (2-4 class periods each)
Total Estimated Time for Module: 7-10 class periods

SECTION 1: MODULE OVERVIEW AND CURRICULAR CONNECTIONS – REQUIRED

- **Module goal**:
  At the end of this module, SWBAT utilize python (COLAB) to solve 2D projectile problems and use their solutions to launch a straw rocket and hit the intended target.

- **Connection to standards**:

NGSS:
-HS-PS2-1 Motion and Stability: Forces and Interactions
  Ties into Newton's 2nd Law by predicting changes in motion under the force of gravity
-SEP 3: Planning and Conducting Experiments
  Students must design a plan to collect reliable, repeatable data that will then be used in their model for rocket flight path
-SEP 5: Using Mathematics and Computational Thinking
  Students will use mathematical functions (including the quadratic formula and knowledge of basic trigonometry) to model the flight path for their rocket. They will also use a numerical solver they have developed in Google Colab to help perform calculations

- **RET materials/ideas to be leveraged**:

This module is leveraging the use of Python and basic computing to solve a real-world problem. Typically students do not have the math background to solve 2D projectile problems at an angle as this requires trigonometry and the quadratic formula. I will teach my students to use Python to solve these equations so they can explore 2D projectiles without needing to slog through math they haven't yet learned in their math class.

SECTION 2: OVERVIEW OF MODULE FRAMEWORK – REQUIRED

- **<u>Real-world context</u>**: Students will have the opportunity to explore projectile motion at an angle. Most objects that experience projectile motion are launched at an angle, rather than completely horizontally. Students will simulate projectile motion by launching a rocket. This real-world application will expose students to the motion and dynamics of a ball thrown in sports, an arrow shot by an archer, or even a cannonball or ballistic missile.
  - **Possible Lesson Ideas**:
    - Possibly lead off with selected scenes from October Sky that illustrate a real-world context for projectile motion

(https://www.youtube.com/watch?v=RJhUWcpLfoc&ab_channel=TheFightinAnalyst)

- Look at a case (or two) from the following website (https://physicsinfilmandtv.wordpress.com/2018/03/04/leaps-of-faith-in-film-and-tv-the-physics/) depending on what movies students are familiar with. These could illustrate how realistic the physics in movies/TV shows actually is. These could also be good practice problems for students to use once they know how to use Google Colab and break down the trigonometry in projectile problems.

- **Background STEM content**: This module will take place after students have already learned about free fall and horizontal projectile motion. They should be comfortable using the 5 basic kinematic equations and know how to divide a projectile problem up into the horizontal and vertical components. This module will also require students to use basic trigonometry.
    - **Possible Lesson Ideas**:
        - Teach free fall and horizontal projectile motion as normal under current scope and sequence
        - Brief lesson (1-2 days) on trig and applying Soh Cah Toa to right triangles.

- **Description of Main Activity/Project**:
    - **Possible Activity/Project Ideas**: The end goal of the project is for students to apply knowledge of projectile motion to a real-life scenario. Students will determine the correct initial conditions (initial velocity/launch velocity) of a projectile (straw rocket) in order to hit the intended target.
        - Activity 1: Programming Basics (2-3 days of basic programming in Google Colab that cover basic syntax, order of operations, writing code that can evaluate expressions)
        - Activity 2: Designing a way to measure the launch velocity of a rocket (Students will build a straw rocket and come up with a way to measure the velocity of the rocket during launch. Students will have a variety of tools at their disposal including Pitsco Straw Rocket Launchers, photogates, slow-motion video using cell phones, meter sticks, etc. They must be able to determine the Laucher settings that will yield a specific velocity)
        - Activity 3: Using Colab code to solve for launch parameters (students will use their knowledge of Colab to write a program that can take launch parameters such as launch angle and target distance to determine the

necessary initial velocity that will allow the rocket to hit the target. They will then launch their straw rocket and see if their model works correctly)

SECTION 3: MODULE SEQUENCING AND ASSESSMENT – REQUIRED

- **Brief description of sequenced learning objectives**:
  - (1) SWBAT write a sequence of code in Google Colab that can evaluate an algebraic function
  - (2) SWBAT plan and carry out an experiment that can measure the launch velocity of a straw rocket using a Pitsco Straw Launcher.
  - (3) SWBAT use their launch data and their knowledge of Google Colab to determine the plunger settings necessary to hit a specified target with their straw rocket.

There will be 3 separate learning objectives- one for each of the 3 steps of the module. Students will first be exposed to basic programming- specifically building up writing blocks of code in Google Colab that can evaluate algebraic functions. The next step will be to build a straw rocket and design an experimental method to collect launch velocities of the rocket using the Pitsco Straw Launcher. As the launcher has a plunger that can vary the launch speed, students will need to collect several data points and create a mathematical model or table of data that will be used later on. In the final part of the module, students will use Google Colab to evaluate the correct kinematic equations when given a target distance and launch angle. The output of their equation should yield a specific launch velocity that they will then use their experimental model/data to set the launcher to the correct settings. If done correctly, their rocket should hit the target.

- **Brief description of formative and summative assessment approaches**:
  During the coding portion of the module, I will have a variety of formative assessments (checking work along the way, small assignments, and a quiz) to ensure students are making progress.

  The summative assessment will be a lab report that is turned in at the end of the project. Students will upload the code they used in addition to the procedure and data table/model of their data. They will additionally receive credit for hitting the target. I will also plan on incorporating some coding into the unit test.

- **Recommendations for implementation**: The only safety precaution I foresee is requiring students to use safety glasses when launching the rockets and general safety practices when building the rockets (safety around scissors, Xacto blades, hot glue, etc)

SECTION 4: MODULE FILES – OPTIONAL

- **List of attached files**: [should include any lesson plans and handouts relevant to the Module, if you have them ready]

- [File name 1 and one line description]
- [File name 2 and one line description]
- [File name 3 and one line description]
- [File name 4 and one line description]
- [File name 5 and one line description]