Center-Level Portfolio: Johns Hopkins University

The following table, proposed implementation plans by participating teachers, and when available other examples are intended to provide an overall narrative about how and in what ways program participation has influenced teachers in using QuarkNet content and materials in their classrooms (and in-after class events). The value of these qualitative reviews is to expand on the instructional practices measured quantitatively via Teacher Survey responses to specific sets of questions/self-reported by teachers providing narrative examples of implemented or planned instructional practices in teachers' classrooms and in schools. This evaluation approach is consistent with the use of *authentic assessment* to evaluate performance, "teaching for under-standing and application rather than for rote recall" (Darling-Hammond & Snyder, 2000, p. 523).

In keeping with Darling-Hammond, Hyler and Gardner (2017), we do not naively expect a single workshop (or event) to have a measurable impact on teachers' knowledge and subsequent classroom implementation. A characteristic of effective professional development is a program of sustained duration, providing "multiple opportunities for teachers to engage in learning around a single set of concepts or practices; that is rigorous and cumulative" (Darling-Hammond, et al., 2017, p. 15). As such, the table summarizes responses by teachers over the course of several program years and likely several QuarkNet programs and/or events.

These responses come from the Teacher Survey (either the full or update version) where each row represents the responses to open-ended questions from the same teacher over time. Also, each row starts with the original responses to the first time a teacher completes his/her full teacher. If a particular box in the table is blank, it likely means that that teacher did not participate in an event for that program year (or, the center may not have had a major event that year). The table provides the essence of these responses; a given response, as presented, may be a direct quote, a paraphrase, or lightly edited; the intent is to convey the overall idea or its essence from that particular teacher.

Because these are responses to open-ended questions, teachers are free (and encouraged) to provide information that he or she thinks most relevant. Each highlighted response is intentionally anonymous to respect the principles of collecting evaluation data (*Guiding Principles for Evaluators*, American Evaluation Association) and to help encourage teachers to respond frankly to these questions. If a reader is familiar with a given center, it may be possible to "reverse engineer" the identify of a particular teacher. We encourage readers to respect this anonymity. At various times, we may have identified a given teacher by name and/or school; when this happens the written approval of that teacher has been obtained. It is also important to note that the full breath of a response by a given teacher may not be fully articulated in this table. For example, responses related to how QuarkNet may have advanced the knowledge of a given teacher or bolstered a collegial network among participants are likely discussed elsewhere in subsequent evaluation reports.

The table is followed by examples of implementation plans, and at times teacher presentations and student presentations when available. The intent of providing these examples is to deepen the narrative as to what and how teachers have planned (and have used) QuarkNet content and materials in their classrooms and in-after class events (e.g., Physics Club). Examples from Annual Center annual reports may be highlighted as well.

Table 1
Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years **Johns Hopkins University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Johns Hopkins University	2019	2020	2021	2022	2023
	Rolling with Rutherford. It's the most approachable, with a small amount of prep for students.	I am going to consider new physics principles, such as pulsars and microwave telescopes. Example: Rolling with Rutherford	I will use some of the new cosmology lessons with my Astronomy class. I teach them about the Big Bang, black body radiation and the HR diagram. I will use DAP activities as well as conservation tools. Examples: Signal and noise 1, signal and noise 2, and histograms. Rolling with Rutherford		Rolling with Rutherford is great - we gather data together as a class and analyze the results. QuarkNet has been a wonderful experience and a source of many high-quality lessons and activities. They have benefited my students greatly over the years.
	Top Quark mass	I plan to teach a unit on particle physics using activities from the data portfolio and the cosmic ray detector in my classroom. Examples: Top quark mass, mean lifetime, shuffling the particle deck	I teach particle physics and astrophysics/ cosmology in my Physics course. I will use many of the activities we worked on this week including from the Data Portfolio and new activities developed at JHU. Examples: Top Quark Mass, Hidden Neutrino, Particle Transformations	I teach a unit on quantum physics including particle physics. This includes the standard model and activities from the data activities portfolio. Examples: Top quark mass, Hidden Neutrino, Quark workbench.	Top quark mass, Rolling with Rutherford, Histograms These activities allow students to explore particle physics concepts using physics they are learning in introductory courses.
	Rolling with Rutherford, calculating energy and momentum, quark puzzle activity	Conservation laws, the standard model. Examples: Rolling with Rutherford, conservation of energy and momentum, quark model	I plan to use the blackbody radiation activity and the Hubble's law activity as culminating activities for my introductory physics class. Examples: Cosmic microwaves, Hubble's law	Rolling with Rutherford, calculating energy and momentum, quark puzzle activity	

Table 1 (con't.)

Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years **Johns Hopkins University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Johns Hopkins University	2019	2020	2021	2022	2023	2024
	I think Rolling for Rutherford is an easy way for them to understand the experiment through experience and inquiry. I would adapt it to more than just rolling a marble at dice. I would also have them roll a marble at a mystery shape underneath a piece of cardboard and predict what the shape was.	This year, we did more related to online learning because of the circumstances related the pandemic. Having content that can be used virtually, like the QuarkNet e-Labs, will be super useful. Examples: Rolling with Rutherford; The one where you use the detector information.	Next year I will be teaching astronomy in addition to physics, so the cosmology topics and activities that we just happen to focus on this year will be particularly helpful. The new ones I will incorporate are: Mapping the Poles and Particle Transformation.	I was doing Coding Camp 1. The obvious thing from this experience is that I would incorporate is the coding in Python. I will have some introductory coding activities, but ultimately I envision it as a tool that they will be using to help them with labs, homework or projects. I would love to do the muon decays or the leptonic mass coding activities if we get that deep into particle physics.		(1.) Rolling for Rutherford (2.) Dice, Histograms, and Probability (3.) Histogram: The Basics (4.) All the coding notebooks. I would recommend the Data Activities Portfolio and Quarknet to everyone because it is free, and it has changed my content and pedagogical knowledge better than any other PD.
	I have not had the opportunity to really share with other teachers and, unfortunately, in today's test happy society, it is difficult to fit these topics into class and to convince others to fit them into class.		I plan on using the spectral analysis activities we were working on this past week into my ninth-grade physics course. Examples: Mass of the pennies; What Heisenberg knew; CMS masterclass.	When teaching forces, I have a unit on the fundamental forces of nature where I present and the students explore the standard model and the reason why we have Fermilab and the LHC. The first lab is based on the Millikan experiment using histograms and searching for patterns.	Millikan experiment developing histograms. The projects based leaning with an inquiry approach drives my classroom instruction.	Great resources. I always refer to my inquiry approach as "guided inquiry."
	The I2U2 site examples, specifically modern physics puzzle	1. Use of the materials in classroom is great: The subparticle puzzle to start modern physics 2. Masterclass involvement and implementation 3. Standard model discussions, etc. Examples: 1. Quark puzzle/map involving learning color charge, bosons, etc. 2. Penny/coin activity	I have used a significant number of resources involving the QuarkNet workbench, some investigations and more. Overall, my last 10+ years at QuarkNet have really increased my knowledge of certain areas. Examples: The quark workbench, masterclass, J psi (occasionally)	I intend to use my QuarkNet experiences in my own modern physics unit with all physics classes as well as having my Science National Honor Society students to listen to some of the speakers who come to our high school. Examples: The Quark Puzzle, Z mass activities, missing momentum, etc.	Quark puzzle workbench and the mass of the top quark	Workbench. It (DAP) has some really good things for students and teachers

Table 1 (con't.)

Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years **Johns Hopkins University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
	2020	2021	2022	2023	2024
Johns Hopkins University	Indicated use of DAP activities but no examples provided.	We have discussed the standard model and uncertainty while describing atomic theory. Examples: Mass of Pennies, Dice, Histograms, and Probability and Signal and Noise.			
	I love the dice rolling activities. I always use the dice rolling as an intro to the course because it gives them an intro to data but also problem solving. I plan to use all the lessons we looked at and the race discussions we talked about. Everything was extremely useful this year. I really enjoyed it. Examples: Dice rolling, Rutherford, Cosmic ray muons	I use the data activities portfolio activities pretty often. I also use the coding activities. Examples: Histograms, coin toss, quark workbench.			I use a lot of the coding activities
	Z Boson - It serves as a great conservation of momentum 2-D lab. I can also have students research particle physics before or after.		I have used coding activities to introduce experimental design, resistive forces, and worked with LHC data to show the conservation laws. I will attend World Wide Data Day with my classes and offer Masterclass to my students. I have muon detectors to extend students access to particle physics. Examples: 1. I used my implementation plan for the "Mass of Z boson" and my work at data and coding camp to have students complete the activity in Google Colab. 2. I use "quark workbench" to introduce science practices or the E & M unit.		

Table 1 (con't.)
Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years **Johns Hopkins University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
	2021	2022	2023
Johns Hopkins University	I have used the top quark mass activity the most often, not only as an approachable way to teach detector physics but also as an example of 2D momentum conservation. I use the quark workbench fairly often with my AP class as an introduction to particle physics. With my new conceptual class, I plan to use the rolling with Rutherford activity to show the students how we develop a model for the atom. If I can get kids interested this year, I'd like to use several of the muon activities in there (except for signal and noise #1 because it's terrible, which I am allowed to say because I wrote parts of it and am not happy with it)	QuarkNet shows up pretty much anywhere you want to put it. The top quark activity is a nice fit for not only vectors but also conservation of energy and momentum. Muon detectors are a cool way to test a constant velocity model and get a very surprising value for its speed. The use of histograms can help a 9th grade biology or physical science class understand that pennies have discreet mass. Examples: Top Quark, Pennies, Rolling with Rutherford, Dice Histograms Signal and Noise (once I fix that awful one I wrote). We are all partly-finished sculptures. I hope that QuarkNet continues to shape me into what a good science teacher looks like. .	Top quark - use it for 2D momemtum conservation in AP physics; penny histogram - use it in intro biology courses for data representation; rolling with rutherford - use it with low level physical science courses for atomic theory and also showed it to the chem teachers; quark workbench - use it sporadically as a low pressure introduction to the rules of the standard model

Note: Each row presents responses from the same individual teacher from a given center. Empty table cells indicate that the teacher did not participate in QuarkNet in that subsequent program year(s). Or, less likely did not complete the Update Survey; or did not answer specific questions about the use of DAP activities in their classrooms.

Table 2

Johns Hopkins University Summer Workshop July 23-28, 2023 Implementation Plans/Coding Projects

<table>
<tr><th>Plan #</th><th>Title</th><th>Brief Description</th><th>Implementation Plan</th></tr>
<tr>
<td>1</td>
<td>Spring Mass</td>
<td>Understand how masses behave on (vertical) springs as well as how to create and apply code to express this behavior.

Brief Summary: This is a modified Mass on a Spring JupyterLite notebook. The use of the Lite notebook is for educators whose students are not able to access normal Jupyter notebooks due to security/IT issues.

The Mass on a Spring has been modified for use in an AP Physics 1 and AP Physics C mechanics class. This will serve not as an introduction to the topic but instead is more of a culminating set of activities to incorporate coding with physics</td>
<td>Mass On A Spring with JupyterLite

<table>
<tr><th>Topic</th><th>Comments</th></tr>
<tr><td>Intro to Physics, Kinematics and Projectile Motion</td><td>Possible use of the Graphing notebooks and/or the Falcon9 notebook to introduce coding with physics</td></tr>
<tr><td>All Basic Forces, Pulleys, Ramps</td><td>Possible use of Pulley notebook adjusted with ramp activities</td></tr>
<tr><td>Energy</td><td></td></tr>
<tr><td>Momentum</td><td>Use of QuarkNet workbench activities (Top Quark)</td></tr>
<tr><td>Rotation and Angular</td><td></td></tr>
<tr><td>Simple Harmonic Motion</td><td>Use of Spring code notebook as presented here</td></tr>
</table>

Spring Notebook Background:
This collaboration Spring notebook is serving as a summary experience for students that takes place near the end of the Simple Harmonic Motion topic. It is taking place as a mini coding activity for students to demonstrate competence of spring motion and the relationships governing the position of a spring mass. Furthermore, the coding aspects of the activity serve to help the student navigate the difficult parts of spring motion analysis.

The students will have access to a separate document they will use to answer the questions and paste their code analysis and results. I leave it to the reader to decide whether to have this as an individual project or a pair collaboration project.

Students are expected to be able to determine the spring constant of a basic vertical spring with mass on it through the analysis of a graph based on student created data. In addition, students will be able to graph the position of a mass on a spring as a function of several different variables, and be able to justify how changing a variable affects the positions outcome over time.

Spring Notebook Application:

Students will be introduced to the Spring notebook with at least 45 minutes in the period. A class wide conversation will introduce this notebook and the goals behind it, along with the importance of being able to represent the physics ideas involved through a coding approach. From there, students will be introduced to the actual task. From there, students have a number of built-in checks for students to come to the instructor that will serve as a way to judge student progress.</td>
</tr>
</table>

Table 2 (con't.)

Johns Hopkins University Summer Workshop July 23-28, 2023 Implementation Plans/Coding Projects

Plan #	Title	Brief Description	Implementation Plan
2	Position Time Graphs	JuptyerLite Notebook Section 1 - Position Time Graphs: Modeling In this activity, you'll use the *position function* to model different types of motion. Section 2 - Position Time Graphs: Data Table In this activity, you'll use a csv file and pull in data to create your position-time graph. First you'll have a data set to use, then you can create your own Part 2A: Plot data that you collect Part 2B: Import data that you collect (*OPTIONAL*) In this example, we have measured the position of a ball rolling off a table (Video Link) The data is stored in a separate csv file.	Implementation Plan for Using Code in Physics Beginning of year • Use the Intro to Code notebook to get students familiar with the code and the process of using JupyterLite. • Use the Probability notebook to show students histograms and how coding can graph data. Kinematics Unit • Use the Position v time graph notebook to graph student data from inquiry-based activity of constant velocity cars. This is the one I modified to add to my graphing motion lesson. Force Unit • Adapt/Create a notebook to graph F = ma. Maybe have students create one, using the Position v time as a model. Put in data for F and A then scatterplot with line of best fit to get value for m. Scaffold according to Energy Unit • Adapt the Mass of Spring notebook. I use a hands-on lab and a phet simulation. Instead of simulation, I want to give the option of using the code. Or • Adapt the Pendulum notebook. Momentum Unit • Use the Mass of Z QuarkNet lesson for conservation of momentum. Going forward after using/modifying notebooks, offer to students to use their coding skills to graph/analyze their data from other labs for the rest of the units. If time permits and we get to E &M, discuss particle accelerators and how Electric and magnetic fields are used and then use Muon Mass notebook or Plotting CMS data for more advanced data analysis.

Table 2 (con't.)

Johns Hopkins University Summer Workshop July 23-28, 2023 Implementation Plans/Coding Projects

<table>
<tr><th>Plan #</th><th>Title</th><th>Brief Description</th><th>Implementation Plan</th></tr>
<tr><td>3</td><td>Periodic Trends (using the periodic tool to predict major trends)</td><td>Sequence:
Coding basics:
(Introduction to Coding Notebook)
Half-life Coin Flip Lab:
(Probability Notebook)
Periodic Table:
(Elements and the Periodic Table Notebook)</td><td>
<u>Lesson Plan: Periodic Trends</u>
Rationale:
Students can use the periodic table as a tool to predict major trends, allowing for students to predict elemental placement based on elemental properties.

Objectives:
When you have completed this activity, students can:
1. Construct a model using trend data.
2. Use a model to describe the trends in several physical properties of the elements.
3. Use code to help represent trend data in graphs.
4. Relate these trends to the electron configuration of the elements, and its position on the periodic table.

Sequence:
<table>
<tr><th>Unit</th><th>Timeframe</th><th>Topic</th><th>Notebook</th></tr>
<tr><td>Introduction</td><td>30 mins in the 1st week</td><td>Coding basics</td><td><u>Introduction to Coding</u></td></tr>
<tr><td>Nuclear</td><td>1 class period</td><td>Half life: Coin flip lab</td><td><u>Probability</u></td></tr>
<tr><td>Nuclear</td><td>1 class period</td><td>Periodic Trends</td><td><u>Elements and the periodic table</u></td></tr>
</table>

Engagement:
1. Quick review of groups vs periods, electron configuration, and valence electron understanding.
2. Show video demoing reaction rates based on location on periodic table. https://youtu.be/K7ZdajBz4ak.
Exploration:
1. Periodic Trends Straw Lab https://docs.google.com/document/d/1K5MgCFzG0m3ROouFdO7V8n3ZRaHg6hP/edit?usp=sharing&ouid=103024363023706119199&rtpof=true&sd=true
2. Build straw model of atomic radius, ionization energy, and electronegativity.
3. Analyze model based on straw length with electron configuration.
Explanation:
1. Have the students go into the Elements and the periodic table notebook and work through the code.
2. Students will be focusing on the relationship of 3 trends (atomic radius, electronegativity, and ionization energy).
3. They will code so that they can graph the data of the elements that they had made the models for (Hydrogen to Argon). They will then also import those graphs into the lab report for support.
Elaborate:
1. Have the students watch this video to take another look at periods and rose of the periodic table. https://youtu.be/Regufd-yibQ
2. Have the students code to see all of the elements and have them explain what they are observing in the transitional metal section.
Evaluation:
1. Students should be comfortable to complete this worksheet only using position on the periodic table and explain why they are placing them in that order and relationship. https://drive.google.com/drive/folders/0B0aTluJykUXBfmVJWUtFd2JqdDZPNERVV01sZHVTeFg4TGJJc1N1WXpmeWc4eDZNMnA2aEk?resourcekey=0-EydH0bkazJas-qrqOFP6vA
</td></tr>
</table>

Table 2 (con't.)

Johns Hopkins University Summer Workshop July 23-28, 2023 Implementation Plans/Coding Projects

Plan #	Title	Brief Description	Implementation Plan
4	Constant Velocity and Coding (Developed by two teachers)	Graphing motion of an Object Moving at a Constant Velocity Unit This unit is designed for classes that are 80 minutes in length.	**Day 1:** • Objectives - o Understand and demonstrate knowledge of using a graph to determine an object's velocity o Calculate slope to find velocity of a non-accelerating object • Activities - o Lecture on constant velocity. o Have students practice finding velocity for an object moving with constant velocity. o Discuss graphing position vs. time o Phet Moving Man Activity • Assessments – o The Phet Moving Man Activity will be collected and graded as an assessment for the class. **Day 2:** • Objectives - o Understand and demonstrate knowledge of using a graph to determine an object's velocity o Collect data that will be useful for determining the velocity of an object • Activities - o Discuss Moving Man Activity from previous day o Introduce Physics 500 Lab o Give students time to collect data for toy car, marble, person walking backwards • Students will record data in a data table o Ask students how they think we can determine the average velocity of our moving objects from today's measurements. Guide students to previous day's discussion on graphing position vs. time. o Collect student data for tomorrow's activity. • Assessments – o Use end of class discussion as a formative assessment of student understanding. **Day 3:** • Objectives - o Understand the basics of coding o Graph data using coding to determine the velocity of a moving object • Activities - o Intro to Coding Activity ▪ Students use this as an introduction to coding o Physics 500 Graphing Activity ▪ Students work in pairs as driver and navigator to input data from previous day's data table and create a line of best fit for each of the three objects in the lab o Discuss velocities that students find. Ask them if they seem reasonable. • Assessments – o As students find their velocities, check student results as a formative assessment of their progress. **Day 4:** • Objectives - o Students will demonstrate their understanding of finding velocity from a position vs. time graph • Activities - o Conclude Physics 500 Activity ▪ Give students time to finish lab reports ▪ Discuss student results from lab reports. ▪ Ask students which objects traveled the fastest in the lab ▪ Ask students how they know which objects travel the fastest o Graphing/velocity assessment • Assessments – o The graphing/velocity assessment will be a summative assessment of what they learned from the lab activity.

Table 2 (con't.)

Johns Hopkins University Summer Workshop July 23-28, 2023 Implementation Plans/Coding Projects

Plan #	Title	Brief Description	Implementation Plan

5	Balancing Chemical Reactions	Implement this activity for sophomore Chemistry students who have already been introduced to balancing chemical reactions in class. Student have already been introduced to the underlying concepts behind why we balance chemical reactions (law of conservation of matter, counting particles using "moles." Notebook after students had with a Phet simulation.	Balancing Chemical Equations… with Python!
			
			Overview
			This notebook is designed for students with little to no coding experience. The primary focus of the activity is to introduce best practices and conventions with coding in Python (focus: writing descriptive comments). There is no intended age group that this notebook was written for. The only prerequisite is that students should have some exposure to Chemistry before using this notebook.
			
			Rationale
			I plan to implement this activity for sophomore Chemistry students who have already been introduced to balancing chemical reactions in class. Students have already been introduced to the underlying concepts behind why we balance chemical reactions (law of conservation of matter, counting particles using "moles").
			
			Objectives
			1. By the end of this lesson, students will be able to balance chemical equations by developing their own strategy to solve a balancing problem.
			2. By the end of this lesson, students will recognize and implement best practices and conventions of coding in Python, with a primary focus on writing descriptive comments.
			3. By the end of this lesson, students will be able to analyze, edit and use Python code to solve a problem.
			
			Sequence
			The notebook will be used after students have already worked with a Phet simulation (Balancing Chemical Equations), during which they will recognize patterns while balancing reactions. Students will determine their own strategies for balancing chemical reactions, whether it is keeping track of the count of each element/ion in their head or writing the counts down, and students will be asked to complete a problem set for balancing chemical reactions.
			
			Lesson Plan - Balancing Chemical Equations (80 min period)
			1. 40 mins - Phet Simulation (Balancing Chemical Equations)
			    1. Students may work in groups or individually.
			    2. Students will complete a packet that guides them through the activity
			2. 20 mins - Problem Set
			    1. Students will work individually on the problem set
			    2. If students get stuck on a problem, they are encouraged to mark that problem and return to it later
			3. **20 mins - Python Notebook** (Balancing Chemical Equations… with Python!)
			    1. Students may work in groups or individually when they have completed both the Phet simulation and the problem set
			    2. Students are encouraged to use the Python notebook as a way to check their work from the problem set

Table 2 (con't.)

Johns Hopkins University Summer Workshop July 23-28, 2023 Implementation Plans/Coding Projects

<table>
<tr><th>Plan #</th><th>Title</th><th>Implementation Plan</th></tr>
<tr><td>6</td><td>Kinematics Unit (adding coding notebooks to several lessons throughout the year)</td><td>
Implementation Plan Overview

I plan on adding coding notebooks to several lessons throughout the year instead of having a specific coding unit.

Rationale -

Coding notebooks are a cross platform tool that can be used to teach students about data analysis and coding
Coding notebooks have applications in a wide range of fields, not just physics
Coding notebooks are accessible as long as there is internet access. Absent or remote learners have full access to the content.
Allows students to work together to solve problems using code.
Allows students to interact with real-world data sets.

<table>
<tr><th>Unit</th><th>Timeframe</th><th>Coding Notebook Implementation</th></tr>
<tr><td>Beginning of School Year (before Kinematics)</td><td>First or second day of school</td><td>Intro notebook activity - get students acquainted with coding notebooks</td></tr>
<tr><td>Kinematics</td><td>September - October</td><td>After students have conducted lab investigations involving the creation and analysis of graphs from objects moving with constant velocity, constant acceleration, and free fall, a coding notebook lab will be used as a review and extension activity.</td></tr>
</table>

Specific Implementation - Kinematics Unit

Lesson Objective: Students will be able to use evidence to justify a claim about a rocket's motion.

NSTA Position Statement:
PreK–12 teachers of science, school and district leaders, and other key stakeholders should embrace the following key points:

PreK–12 teachers of science should recognize the compelling and inherent opportunities of aerospace to strengthen and support the teaching of science and mathematics education, and where possible, integrate aerospace into the curriculum.

Engagement: Think/Pair/Share

If a ball is thrown straight upwards from Earth's surface, what would the P vs T and V vs. T graphs look like for its motion? Explain your reasoning.
If a drone takes off from the surface of Earth and accelerates upwards, what would the P vs. T and V vs. T graphs look like for its motion? Explain your reasoning.

Exploration: Coding Notebook Activity

Students work through these notebooks (position graphs, velocity graphs, and Falcon 9 Rocket stuff), recording their responses, evidence, and reasoning on this Google Doc.
This notebook combines parts of the following notebooks:

Matching Position Graphs
Matching Velocity Graphs
Falcon 9 Rocket Data

Explanation/Evaluation:

Students individually make claims about why the Velocity vs. Time and Acceleration vs. Time graphs for the Falcon 9 rocket look the way they do. Specifically, what is happening around 160 seconds?
Each student shares their claim, evidence, and reasoning with their small group. Each group then discusses their collective claims and produces a brief presentation (one slide of a Jamboard used by the whole class).
Several groups share their findings with the class.

</td></tr>
</table>

Table 2 (con't.)

Johns Hopkins University Summer Workshop July 23-28, 2023 Implementation Plans/Coding Projects

Plan #	Title	Implementation Plan
6 (con't.)	Kinematics Unit (adding coding notebooks to several lessons throughout the year)