INDEPENDENT RESEARCH PROJECTS:
Physical Science PREVIEW

Overview:

This resource includes everything you need to administer semester-long or yearlong independent research projects in your physical science class. It is a perfect way to differentiate your instruction by providing more advanced students with this project-based challenge. Teachers can assign students a topic from the list of suggested driving questions, let students pick from the list, or let write their own question. This resource has all of the support documents you need to bring structure to using a PBL-style assessment over the course of a semester or yearlong class – plus editable versions of all student handouts!

Project Based Learning:

I have always LOVED so many of the characteristics of PBL (Project Based Learning). I especially love the emphasis on student voice and choice, student autonomy, and the value of the investigative process to create products that communicate an answer to the original essential/driving question. However, this resource isn't 100% true to PBL in that the focus is more on the long-term nature of investigating the topic independently rather than working collaboratively with peers to learn about a unit through the completion of a project. You will see throughout the pages in the resource where I have pulled in my favorite components from PBL to create my vision for these independent research projects, but know that this resource wasn't designed to be 100% PBL. However, I've included helpful hints to make it more fully PBL on **p.14**.

Why you should use:

I love so many things about projects and specifically PBL, but especially that PBL is student-led, multidisciplinary, and relevant. I love how PBL incorporates student choice, community relevance, and communicating findings of the learning process through multiple products. Why? Because this type of learning engages students and gives them essential practice with critical skills they will use their entire lives, including: researching, synthesizing ideas, asking questions, collaborating, revising, managing time, project planning, making community and cross-curricular connections, varying communication formats, and reflecting. **If you've been looking for a different way to summatively assess your students at the end of the year, or a way to challenge students to see the relevance and interconnectedness of every topic covered in physical science all year long, this resource is for you.**

When to use:

These projects are designed to get students to spend the entire time they are in your course making connections between what they are learning in class and what they are researching for their project at home. The projects require a significant amount of student time and research to fully complete them. Because of this, I would introduce the project at the beginning of the year, do regular check ins with students throughout the year, and culminate the year with student presentations of their products. See my suggested pacing guidelines on **p.9-10** for how to implement these projects over the course of a semester or a full school year in order to best meet you and your students' needs.

How to use:

This is best used as a semester or yearlong independent research project, but can be adapted to be done entirely in class, as a partner or small group project, or as a PBL-style final assessment for your course.

The process:

The traditional PBL process is as follows:

1. Establish or select a driving question.
2. Design a plan for the project*.
3. Set a schedule for executing the plan.
4. Work through the plan and monitor progress.
5. Assess the product(s)*.
6. Evaluate and reflect upon the experience.

*In PBL, the **project** is defined as the entire learning process to get to the end result, whereas the **product** is defined as the outcome that students actually create to represent their learning. Since this resource is designed to be used over the length of an entire physical science course, the project covers the entire year (or semester) the course runs, while the products are what will be submitted at the end for assessment.

Implementation options:

I believe this resource is best implemented over the entire length of the course – whether you are on a semester block schedule or a yearlong schedule. See the mock pacing schedules on **p.9-10**.

Project components:

Since the project is the process in PBL, the following components will be part of the assessment for the project:

- **Planning** = establishing/selecting a driving question, designing the plan for the project, and setting a schedule for executing the plan.
- **Check ins** = students will complete check in forms on their process ~biweekly, at the end of each unit, and at the halfway point *(end of the first semester if following the yearlong pacing, or end of the first quarter if following the semester long pacing)*
- **Peer Revision** = both in the middle and at the end of the project students will receive peer feedback and be expected to reflect and respond to the feedback.
- **Products** = the culmination of the project will be three products that demonstrate their understanding and ability to answer the initial driving question → a visual product, written product, and oral product.
- **Reflection** = students will complete a final reflection evaluating the overall experience.

Assessment:

You can assess this however is best for YOU and your students. I use a simple two category grading system of minor *(formative)* and major *(summative)* grades. I weight by points within each category. Based on my grading policy, I would grade each component as the following:

- **Planning** = 50 pt minor grade for completing all planning sheets on **p.7-11** in the student handouts
- **Check ins** = 10 pt minor grade per check in
  - See sample paper check ins on **p.12-13** of the student handouts, and a link to the Google Form version on **p.11** of this document.
- **Peer Revision** = 30 pt minor grade per revision/reflection
- **Products** = 100 pt major grade for the written product, 100 pt major grade for the visual and oral products (assessed together)
- **Final Reflection** = 50 pt major grade for the final reflection.

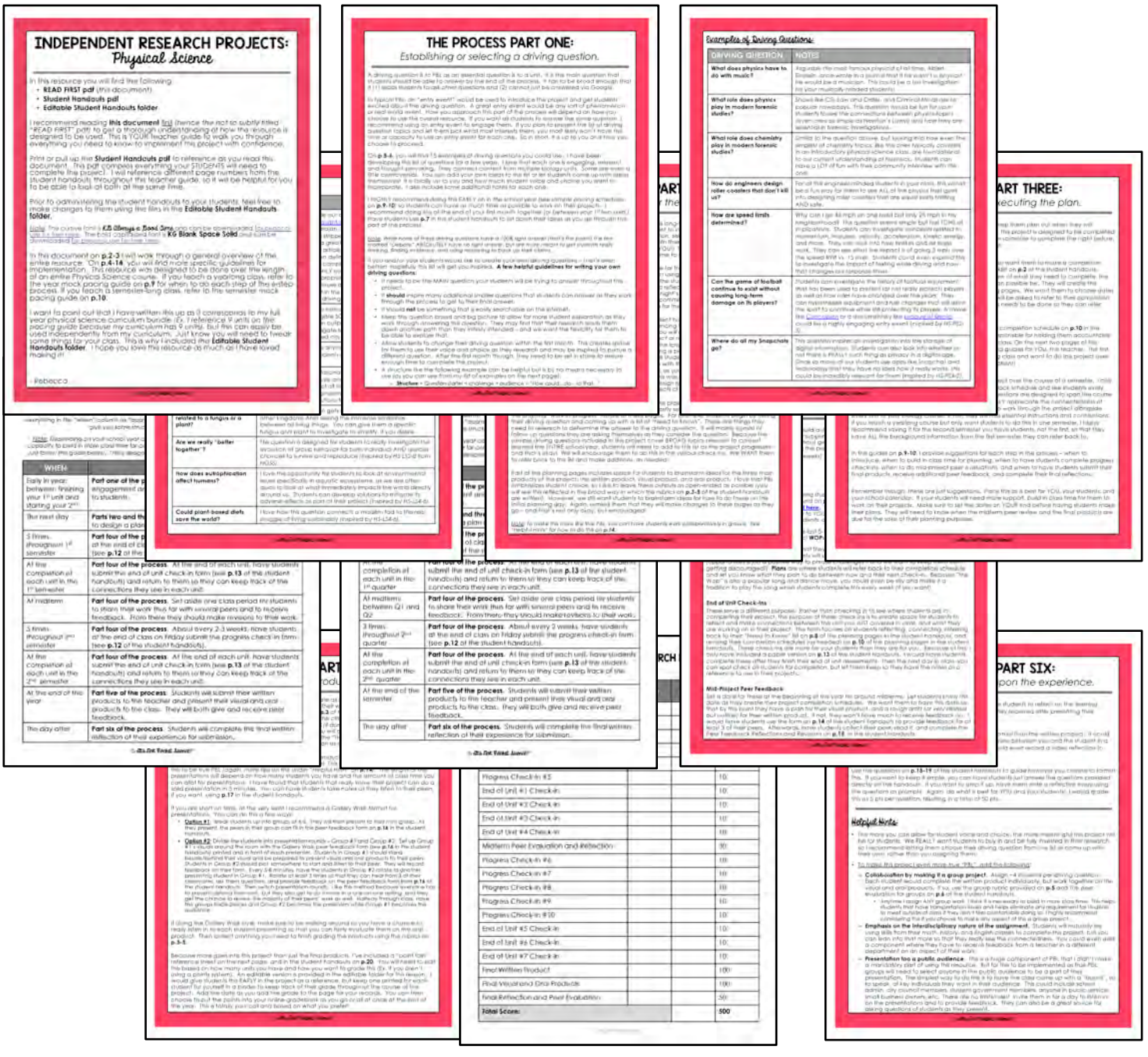
See an example of a point tally for this project on p.13 of this document.

Materials:

There are no required materials other than the student handouts included in this resource. If you choose to provide your students with additional materials, that is totally up to you!

PREVIEW

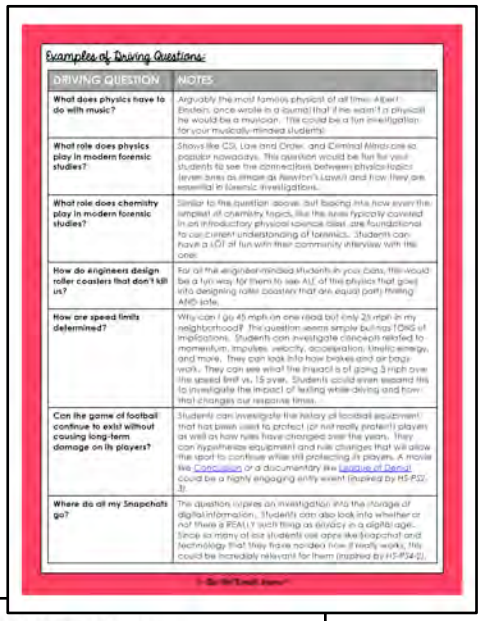
12 additional pages of teacher implementation notes



PREVIEW

including

15 sample driving questions for potential research

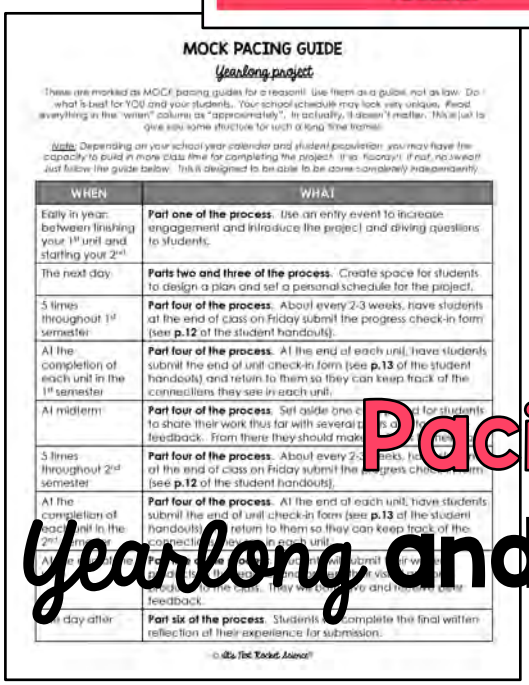


Examples of Driving Questions:

DRIVING QUESTION	NOTES
What does physics have to do with music?	Arguably the most famous physicist of all time, Albert Einstein, once wrote in a journal that if he wasn't a physicist he would be a musician. This could be a fun investigation for your musically-minded students.
What role does physics play in modern forensic studies?	Shows like CSI, Law and Order, and Criminal Minds are so popular nowadays. This question would be fun for your students to see the connections between physics topics (even ones as simple as Newton's Laws!) and how they are essential in forensic investigations.
What role does chemistry play in modern forensic studies?	Similar to the question above, but taking into how even the simplest of chemistry topics, like the ones typically covered in an introductory physical science class, are foundational to our current understanding of forensics. Students can have a LOT of fun with their community interview with this one!
How do engineers design roller coasters that don't kill us?	For all the engineer-minded students in your class, this would be a fun way for them to see ALL of the physics that goes into designing roller coasters that are equal parts thrilling AND safe.
How are speed limits determined?	Why can I go 45 mph on one road but only 25 mph in my neighborhood? The question seems simple but has TONS of implications. Students can investigate concepts related to momentum, impulses, velocity, acceleration, kinetic energy, and more. They can look into how brakes and air bags work. They can see what the impact is of going 3 mph over the speed limit vs. 15 over. Students could even research this to investigate the impact of texting while driving and how that changes our response times.
Can the game of football continue to exist without causing long-term damage on its players?	Students can investigate the history of football equipment that has been used to protect (or not really protect!) players as well as how rules have changed over the years. They can hypothesize equipment and rule changes that will allow the sport to continue while still protecting its players. A movie like Concussion or a documentary like Hardest of Hearts could be a highly engaging entry event (inspired by HS-PS2-3).
Where do all my Snapchats go?	This question inspires an investigation into the storage of digital information. Students can also look into whether or not there is REALLY such thing as privacy in a digital age. Since so many of our students use apps like Snapchat and technology that they have no idea how it really works, this could be incredibly relevant for them (inspired by HS-PS4-2).

Examples of Driving Questions:

DRIVING QUESTION	NOTES
Is it safe to sleep with your phone by your pillow every night?	This question could lead to an investigation of all the different ways that waves are transmitted in our everyday society and if they impact us from a medical standpoint. So many students sleep with their phones on and under their pillows, so the question is relevant to them. A similar question could be – Are X-ray machines in airports safe for pregnant women? (inspired by HS-PS4-2)
Can a solar-powered cell phone charger be designed?	As I mentioned above, our students love their phones. This hands-on investigation could give students the opportunity to apply what they are learning in class and researching to build a device they could actually use (inspired by HS-PS3-3).
Could understanding the physics of golf allow you to always make a hole-in-one?	This connection between physics and sports is so fun! I love the relevance and hands-on nature of this question. Alternatively, students could even look into the physics of a free throw – what you need to know to always make that extra point! A fun and engaging entry event could be taking students down to the gym to shoot free throws!
How do bioengineers create artificial devices, like prosthetics, to enable people to walk?	I love this opportunity for students interested in physics AND medicine to investigate what it means to be a bioengineer and the science behind what they really do.
Does lightning REALLY never strike the same place twice?	I love giving students an opportunity to investigate common myths...if you will, like this one. It expands not only into an investigation of electricity but also weather!
Will Chernobyl ever be inhabitable again?	Students can investigate the long-term impact of nuclear explosions – the historic event, immediate impact, long-term impact, and potential future recovery of the town where it all happened.
What are the implications of biochemical warfare?	Shows like Jack Ryan and 24 have hypothesized about biochemical warfare for years. But what does it really mean? How does it work? What would be the implications of this type of warfare? Students could even investigate a comparison of biochemical weapons to nuclear weapons.
Do "clean" cleaning supplies really work?	I always enjoy a chance for students to investigate everyday phenomena - like cleaning. We all have to do it, but are our cleaning supplies REALLY cleaning? This could open an investigation into the history of cleaning supplies and sanitation, the chemistry behind how cleaning supplies are designed, and an opportunity to experiment with "clean" cleaning supplies to see if they can really get the job done.



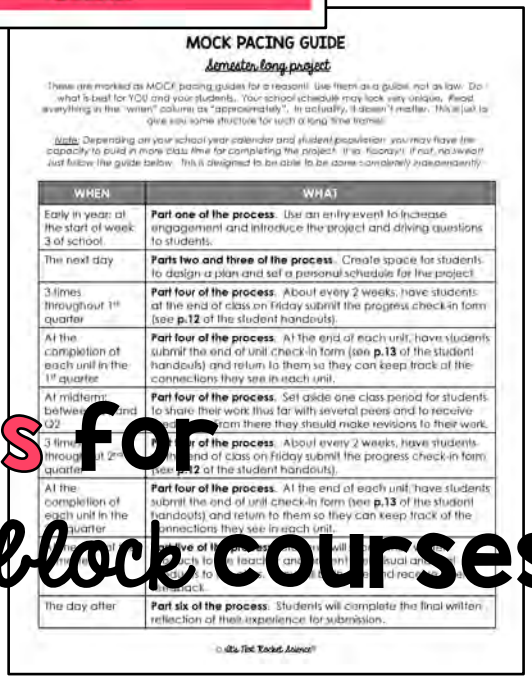
MOCK PACING GUIDE

Yearlong project

These are marked as MOCK pacing guides for a reason!! Use them as a guide, not as law. Do what is best for YOU and your students. Your school schedule may look very unique. Read everything in the "when" column as "approximately". In actuality, it doesn't matter. This is just to give you some structure for such a long time frame!

Note: Depending on your school year calendar and student population, you may have the capacity to build in more class time for completing the project. If so, hooray!! If not, no sweat! Just follow the guide below. This is designed to be able to be done completely independently.

WHEN	WHAT
Early in year: between finishing your 1st unit and starting your 2nd	**Part one of the process**. Use an entry event to increase engagement and introduce the project and driving questions to students.
The next day	**Parts two and three of the process**. Create space for students to design a plan and set a personal schedule for the project.
3 times throughout 1st semester	**Part four of the process**. About every 2-3 weeks, have students at the end of class on Friday submit the progress check-in form (see p.12 of the student handouts).
At the completion of each unit in the 1st semester	**Part four of the process**. At the end of each unit, have students submit the end of unit check-in form (see p.13 of the student handouts) and return to them so they can keep track of the connections they see in each unit.
At midterm	**Part four of the process**. Set aside one c[illegible] for students to share their work thus far with several p[illegible] s o[illegible] feedback. From there they should mak[illegible]
3 times throughout 2nd semester	**Part four of the process**. About every 2-[illegible] weeks, h[illegible] at the end of class on Friday submit the progress check-in form (see p.12 of the student handouts).
At the completion of each unit in the 2nd semester	**Part four of the process**. At the end of each unit, have students submit the end of unit check-in form (see p.13 of the student handouts) and return to them so they can keep track of the connections they see in each unit.
[illegible]	**Part five of the process**. [illegible]
The day after	**Part six of the process**. Students will complete the final written reflection of their experience for submission.



MOCK PACING GUIDE

Semester-long project

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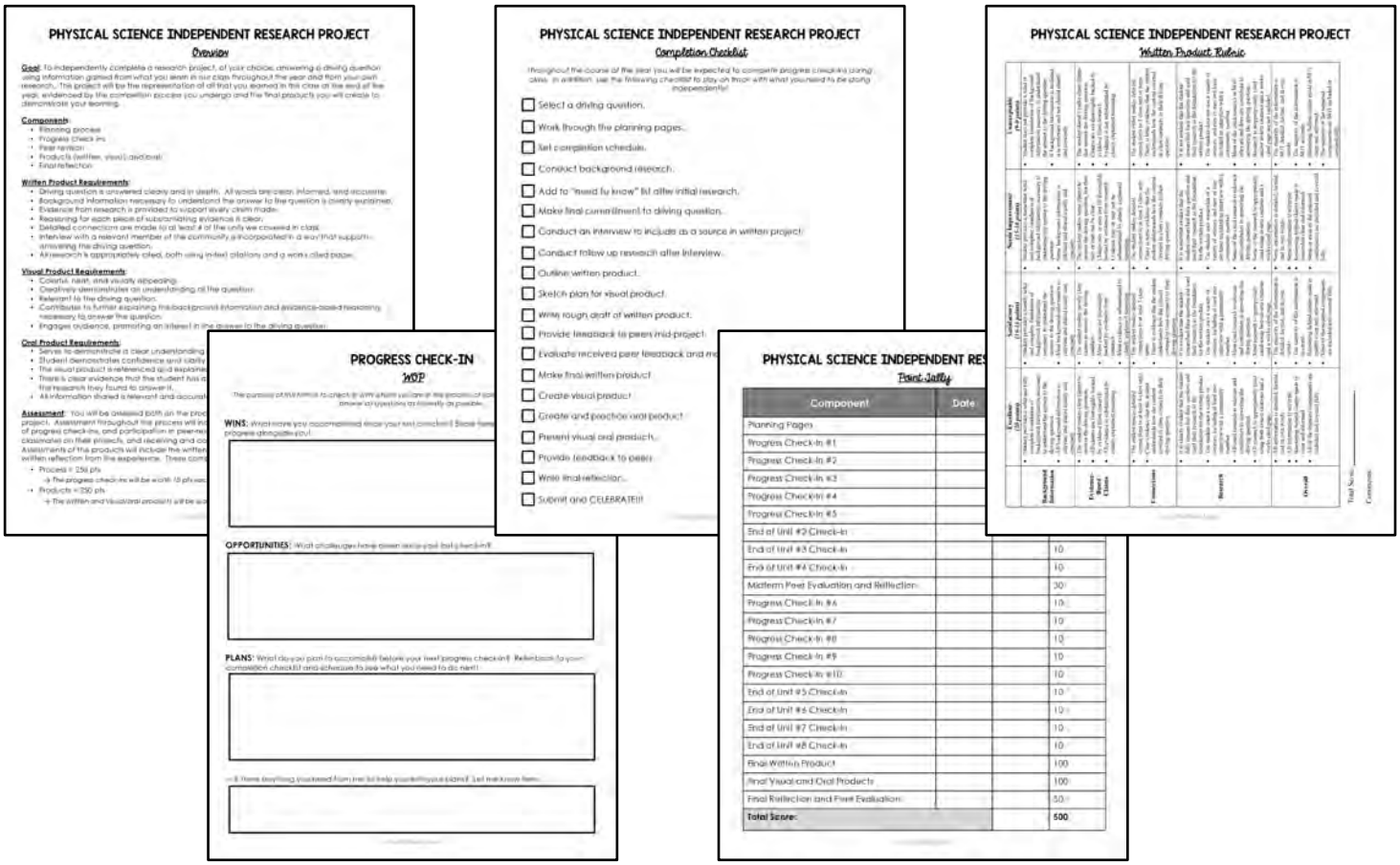
Note: Depending on your school year calendar and student population, you may have the capacity to build in more class time for completing the project. If so, hooray!! If not, no sweat! Just follow the guide below. This is designed to be able to be done completely independently.

WHEN	WHAT
Early in year: at the start of week 3 of school	**Part one of the process**. Use an entry event to increase engagement and introduce the project and driving questions to students.
The next day	**Parts two and three of the process**. Create space for students to design a plan and set a personal schedule for the project.
3 times throughout 1st quarter	**Part four of the process**. About every 2 weeks, have students at the end of class on Friday submit the progress check-in form (see p.12 of the student handouts).
At the completion of each unit in the 1st quarter	**Part four of the process**. At the end of each unit, have students submit the end of unit check-in form (see p.13 of the student handouts) and return to them so they can keep track of the connections they see in each unit.
At midterm	**Part four of the process**. Set aside one class period for students to share their work thus far with several peers and to receive [illegible] from there they should make revisions to their work.
3 times throughout 2nd quarter	**Part four of the process**. About every 2 weeks, have students at the end of class on Friday submit the progress check-in form (see p.12 of the student handouts).
At the completion of each unit in the 2nd quarter	**Part four of the process**. At the end of each unit, have students submit the end of unit check-in form (see p.13 of the student handouts) and return to them so they can keep track of the connections they see in each unit.
[illegible]	**Part five of the process**. [illegible]
The day after	**Part six of the process**. Students will complete the final written reflection of their experience for submission.

Pacing guides for yearlong and semester block courses

PREVIEW

20 student handouts *including* rubrics, checklists, planning pages, and MORE!



PLUS

All student handouts are EDITABLE to customize for your classes!

THANK YOU!

I hope you find this resource to be useful to you in your classroom and that your students enjoy it as well!

WANT TO SHARE YOUR THOUGHTS?

If you enjoy this resource, PLEASE leave feedback for me! I'd love to hear specifically what you enjoyed and how you used this in your classroom so that I can continue to create resources that are beneficial to you and your students. Your encouragement and feedback mean so much to me!

If you have negative feedback, I would love for you to email me first (itsnotrocketsciencestore@gmail.com) so that I can serve you best on an individual basis to guarantee your satisfaction with my products. I will consider any changes you suggest for the product or product description.

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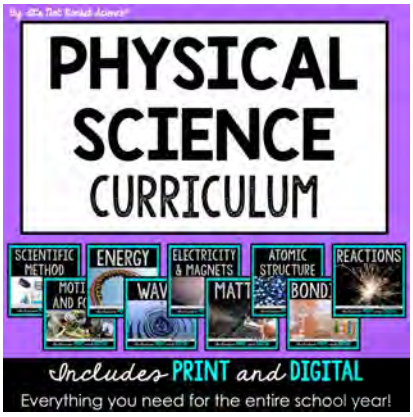

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