IB Summer Project Assignment Guide

Introduction:
- This is a practice IB IA, Internal Assessment. The real IA is worth of 20% of your IB exam grade.
- You may choose your own topic and a partner. You may also do the project on your own. Note that the IB IA is an individual project which requires you to design, carry out and analyse an investigation.
- It is my full intention that the project will be a fun exploration, intellectual application of the pre-IB physics, and will be completed in this summer.
- I do expect you to engage fully in this project as if it were the IB IA, and turn in the checkpoint product on REMIND on the following days:
  - 6/10/2019 Type of project and title of the project for approval.
  - 7/17/2019 Draft of the project product
  - 8/12/2019 Presentation in class
- Remember, this is supposed to be something that is fun and interesting to you, so don’t let it stress you out. Part of your grade on this assignment will be based purely on whether or not you turn in the assignments on time on 6/10, 7/17 and 8/12.
- Join the REMIND group “IB Physics 2019-2020” with the code @6a3a3d

Groups: You are allowed to choose your own groups, but each group cannot have more than two members. Choose a group member that you can work well with and who have similar interests. You will be receiving the same grade as them.

Expectations and Assessment: follow this link to a list of expectations for each option. Click at the bottom of the page, you will find tabs for each project choice. You will be scored on a 1 - 5 scale for each category on each rubric. 5 representing A-level work, 1 being F-level work.

A Note on Organization and Time Management: No matter which topic you choose, you will be creating a Google doc, shared with me and your group mates. This will be a place to keep all of your notes, research, messages, links, goals, and anything else that is relevant to your topic. I will also use this to gauge your progress. At the beginning of the project you will be asked to create a timeline for completion. Each day you will be asked to set goals for the next day and assess whether or not you met your goals for that day. This will be used to ensure you use your time effectively and complete the assignment in the given time.

*Note: If you have a project idea that doesn’t fit into any of the categories that I’ve outlined, come and talk to me. I am willing to be flexible if you are willing to work hard. :-)

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Projects

Teaching Video: The teaching video should relate to a unit that we learned this year or we will cover next year. As a model, consider the Veritasium videos and other “flipped classroom” videos. Your video should follow the criteria below:

- (6-8) minutes long
- Include at least 1 physics demonstration that is then analyzed to teach your concept.
- Include an application of a concept that goes slightly beyond what we discussed in class (or applies a concept we learned in class to a system that we did not study).
- Teach an amount of content that is appropriate in a six minute video
- Have professional production.

Links to Inspire:
- Circular Motion (Matthew, Derek & Hauk)
- Projectiles (Gloria, Sophia, SoMin)
- Electric Potential (Jeongmin)
- MinutePhysics
- BozemanScience
- Veritasium
- Smarter Every Day

Process:
1. Create a Google doc and share it with your group member and Mrs. Hwang. Put your names in the title.
2. Choose a unit from this year or next year.
3. Decide how many concepts and which concepts can be feasibly included in a six minute video. You won’t be able to fit everything in a unit into such a short time. For example “Waves” is too broad, but you could probably compose a video on standing waves and harmonics that would fit appropriately into the six minutes that you have.
4. Get your idea approved.
5. Create an outline/storyboard of your video detailing the sequence of scenes and how long each one will need to be.
6. Begin filming and editing process.

Products to Submit:
- A link to your video (It should be uploaded to the internet, but you can keep it private if you want). We will watch it in class.
**Literature Research with Presentation and Paper:** This option is designed to allow you an opportunity to research a topic of interest through library and internet resources. For this option you will be choosing a topic that takes a concept from this class and goes further. You are expected to write a paper and create a presentation on your topic.

Once you’ve chosen a topic, I expect you to research it thoroughly and create a 10 minute presentation aimed to educate your classmates about your topic. The presentation should go into appropriate depth for a presentation of this length. All group members are expected to contribute equally during the presentation and to writing the paper. The paper should contain the same information that was in the presentation, but should be in written form, giving detailed, written explanations of what was discussed in the presentation (min. 1000 words). The paper length may change depending on the number of students in your group → the required length should reflect productive work. If you find yourself finishing early, it means that you should be going into more depth. The paper and presentation must include proper citations (using the citation form of your choice).

Here are a couple of ideas:

- An industrial/engineering application. (Ex: What really needs to happen to create the space elevator or a hyperloop.)
- A detailed look at the history of this concept and experiments/thinking that allowed it to grow over time. (Ex: classical mechanics → quantum mechanics)
- A deeper study of the physics on a topic → moving towards a more thorough, university-level, understanding of something that we learned about already in class.
- A study into research that is currently being conducted that relates to this topic and where this topic could be going in the future. (Ex: What is dark matter? How are scientists working to find out? How are scientists searching for extraterrestrial life in the universe?)
- A study into the life and work of a physicist that you admire. (Ex: What was Einstein’s childhood like? What did he accomplish and what was his process of discovery?)

**Process:**
1. Create a Google doc and share it with your group members and me. Put your names and period in the title.
2. Select a topic of interest that connects to something we’ve studied this year.
3. Get your idea approved.
4. Begin doing web research and determine how much depth/what will be appropriate to include in your presentation.
5. Continue research with focus in the appropriate areas, save links and summaries of appropriate resources in your group’s Google doc.
6. Once research is complete, begin putting together the presentation and paper with your group members.

**Products to Submit:**
- Presentation (Approx 6-10 mins)
- Paper (Approx 1000 words not including properly formatted bibliography)

*The paper and the presentation should each serve as a stand-alone representation of your work, but the paper is likely to be a bit more detailed.*
**Experimental Research with Presentation:** This option allows you to extend an experiment that was conducted earlier in the year through investigating something experimentally and then sharing your results. Consider experiments we conducted throughout the year in which we found odd, or strange results, or one that could have been taken further with more time or different equipment. For instance, high-speed photography and video analysis software can be used in many motion experiments. This is a chance to go back and extend an experiment to investigate a phenomenon of your choice.

Here are a few example ideas:

- How does air resistance affect the behavior of a projectile? (Such as the water balloons)
- Modeling musical instruments as simple pipes → How does shape and structure of an instrument affect its fundamentals and overtone harmonic structure?
- The mass of an object is not supposed to affect the angle at which an object slides down an incline, but in reality it does. Why is this a factor and how does this factor affect the coefficient of static friction.
- How does netness affect the coefficient of friction between two surfaces?
- We know that tension in a rope affects the speed that a wave travels along the rope, but what is the quantitative relationship? How does tension of different materials affect the speed of wave propagation?
- In reality, no object follow Hooke's law \( F = -kx \) perfectly, but some do for only particular intervals. When does Hooke’s law work for certain objects and when does it not--what causes it to NOT work at certain displacements?
- Other ideas?

Here are some more examples of systems that would be worth investigating:

- **Bead Chain**
- **Spinning Disk with Hole**
- **Double Pendulum**

**Process:**

1. Create a Google doc and share it with your group members and me. Put your names and period in the title.
2. Discuss possible topics/ideas with your group, select one that seems appropriate for the given time. Think about systems that might be interesting to experiment with. The trickier, the better
3. Use your idea to phrase a question that will be testable with accessible materials.
4. Use your question to generate a hypothesis which you will be able to disprove or verify experimentally.
5. Design an experimental method
6. Set up your apparatus and perform your experiment.
7. Log and analyze your data.
8. Create a presentation that shows your process:
   a. Question
   b. Hypothesis
   c. Method (with images!)
   d. Data
   e. Data Analysis and Conclusions

**Products to Submit:**

- Raw data, methods, and notes in a lab notebook (can be rough & messy!)
- Short presentation (2-5 minutes)
**Engineering Design and Construction (With Prototype):** Have you ever wanted to build a trebuchet? What about a speaker? Are you interested in bridges, solar panels, or how cars work? This option allows you to research some type of engineered device and create your own version. For this assignment, you must clearly define the purpose of your device, research it’s design, and finally create a prototype that functions effectively.

Note: It’s okay to work in a simple medium like with Lego’s or popsicle sticks if you need to. We don’t have a ton of time, so it may be a good idea to think small!

**Links to Inspire:**
- Trebuchet
- Speaker Construction
- Signal generator and wave contraption
- LEGO Great Ball Contraption
- Home made Tennis Ball Launcher
- Arduino microprocessor projects (period of a pendulum, reaction time test, ultrasonic motion graphing, etc)

**Process:**
1. Create a Google doc and share it with your group members and me. Put your names and period in the title.
2. Determine the type of device and outline the main goal of your engineering project (Ex. We want a _____ that will do _____.)
3. Research other designs and specifications for this type of device. While summarizing the significant physics concepts (must include quantitative elements).
4. Draw up a design for a prototype of your device.
5. Re-evaluate the design and improve in any way possible (may need to alter it based on material availability.)
6. Acquire materials.
7. Build and test your prototype (it’s best if you can quantitatively test its effectiveness through a controlled experiment).
8. Create a presentation that:
   a. States the goal/purpose of your device.
   b. Describes important physical aspects of your device (including relevant physics and a summary of any important calculations).
   c. Outlines your development and construction process.
   d. Schematic diagrams showing the final design of your project including quantitative labels.
   e. Shows off your product (video or in real life!)

**Products to Submit:**
- Prototype
- Short presentation (3-5 minutes)
- Schematic diagrams and relevant calculations
Physics Modeling with Computer Programming (Must be Individual): This option is open to people with or without any programming experience. The goal of this assignment is to improve your coding skills and to learn to write some basic programs in order to model physical systems. There are a lot of options and if you have experience, you may have some idea of a starting point, but if you're starting fresh I would recommend using the python programming language. Here's a book that is all about computational physics using python. Visual Python is also a pretty neat tool because it lets you create visual, live animation models governed by your code. You can use glowscript the web-based interface that we used in class.

Note: I am not an expert, and not a programmer!! If you don’t use glowscript, I recommend working with open-source software to work with. Sourceforge is a good resource for finding it.

Here are a couple ideas:
- 1-D kinematics systems with constant acceleration
- 2-D kinematic projectile systems
- Gravitational interactions in a three-body system (or more!)
- Rotational dynamics

Process:
1. Create a Google doc and share it with me. Put your name and your period in the title. This is where you’ll outline your progress and will be my way of monitoring your progress.
2. Choose a language that you think you want to learn.
3. Download an appropriate text editor (or find a web-based interface).
4. Download all other software you will likely need to run your code (or use a web-based interface).
5. Find a programming tutorial for the code you have chosen to learn and code your first program and troubleshoot everything you need to make it run.
6. Run a few more practice programs.
7. Determine the system you want to model. Start with a simplified version and gradually add complexity.
8. Code it and modify it to become better and better.
9. Put together a presentation outlining your code and how it works to model the system you chose.

Products to Submit:
- Copy of your code
- Short presentation or video and demonstration (3-5 minutes)
Something else that are not IB IA alike:

Physics-Influenced Art Project: Your physics-influenced art project can be any medium: music, painting, drawing, creative fiction; it’s up to you. The idea behind this assignment is to create some art piece that is inspired by a physical concept and somehow embodies or represents the essence of that concept.

Links to Inspire:
- Particle Physics Based Animated Art
- Einstein’s Dreams Short Stories
- Jamming with the Cosmos
- Leonardo Da Vinci’s Drawing of Fluid Flow
- "Quantum Objects" by Julian Voss-Andreae

Process:
1. Create a Google doc and share it with your group members and me. Put your names and period in the title.
2. Pick a physics concept that you think is interesting or could inspire an interesting piece of artwork.
3. Perform some additional research on that concept and take notes to influence/further inspire your idea.
4. Begin to determine necessary materials and create concept sketches of your piece.
5. Begin work on your piece.
6. Create a 500 word minimum reflection that describes the entire process of this project including:
   a. What you learned during your initial research and how it influenced your thinking.
   b. Your creative process when making the piece.
7. Write a 100-200 word artist statement summarizing the main purpose/concepts involved in your art piece.
8. Prepare to explain the creation process of your piece and read your artist statement to the class.

Products to Submit:
1. Finished piece
2. Preliminary sketches/journaling/brainstorming
3. Written reflection (500 words)
4. Artist statement (100-200 words)
5. Short class presentation or video
**Physics-Based Art Project:** This is different than the physics-influenced project because a physics-based art project relies on physics concepts in order to function. This is similar to an engineering project, but it doesn’t need to have a utilitarian purpose, instead it just needs to exemplify a physics concept in its design. A great example of this project would be the pendulum sculpture created for the art show. Note that the project cannot simply be an exact copy of something else that exists, it needs to have some original component.

**Links to Inspire**
- Rubens Tube
- Harmonograph
- KIS Pendula Sculpture
- CYMATICS
- Wave pendulum
- Rock static equilibrium

**Process:**
1. Create a Google doc and share it with your group members and me. Put your names and period in the title.
2. Pick a physics concept that you think would serve as a good basis for constructing an art piece.
3. Perform some additional research on that concept and take notes to influence/further inspire your idea.
4. Begin to determine necessary materials and create concept sketches and schematic diagrams of your piece.
5. Begin work on your piece.
6. Write a reflection (500 word minimum) that describes the entire process of this project including:
   a. What you learned during your initial research and how it influenced your thinking.
   b. Your creative process when making the piece.
7. Write an artist statement (100-200 words) describing how your artwork exemplifies a physics concept.
8. Prepare to explain the creation process of your piece and read your artist statement to the class.

**Products to Submit:**
6. Finished artwork
7. Preliminary sketches/journaling/brainstorming
8. Written reflection (500 words)
9. Artist statement
10. Short class presentation or video