2021

AP® CollegeBoard

AP® Research Academic Paper

Sample Student Responses and Scoring Commentary

Inside:

Sample F

☑ Scoring Guideline

☑ Student Samples

☑ Scoring Commentary

The Response…				
Score of 1 **Report on Existing Knowledge**	**Score of 2** **Report on Existing Knowledge with Simplistic Use of a Research Method**	**Score of 3** **Ineffectual Argument for a New Understanding**	**Score of 4** **Well-Supported, Articulate Argument Conveying a New Understanding**	**Score of 5** **Rich Analysis of a New Understanding Addressing a Gap in the Research Base**
Presents an overly broad topic of inquiry.	Presents a topic of inquiry with narrowing scope or focus, that is NOT carried through either in the method or in the overall line of reasoning.	Carries the focus or scope of a topic of inquiry through the method **AND** overall line of reasoning, even though the focus or scope might still be narrowing.	Focuses a topic of inquiry with clear and narrow parameters, which are addressed through the method and the conclusion.	Focuses a topic of inquiry with clear and narrow parameters, which are addressed through the method and the conclusion.
Situates a topic of inquiry within a single perspective derived from scholarly works **OR** through a variety of perspectives derived from mostly non-scholarly works.	Situates a topic of inquiry within a single perspective derived from scholarly works **OR** through a variety of perspectives derived from mostly non-scholarly works.	Situates a topic of inquiry within relevant scholarly works of varying perspectives, although connections to some works may be unclear.	Explicitly connects a topic of inquiry to relevant scholarly works of varying perspectives **AND** logically explains how the topic of inquiry addresses a gap.	Explicitly connects a topic of inquiry to relevant scholarly works of varying perspectives **AND** logically explains how the topic of inquiry addresses a gap.
Describes a search and report process.	Describes a nonreplicable research method **OR** provides an oversimplified description of a method, with questionable alignment to the purpose of the inquiry.	Describes a reasonably replicable research method, with questionable alignment to the purpose of the inquiry.	Logically defends the alignment of a detailed, replicable research method to the purpose of the inquiry.	Logically defends the alignment of a detailed, replicable research method to the purpose of the inquiry.
Summarizes or reports existing knowledge in the field of understanding pertaining to the topic of inquiry.	Summarizes or reports existing knowledge in the field of understanding pertaining to the topic of inquiry.	Conveys a new understanding or conclusion, with an underdeveloped line of reasoning **OR** insufficient evidence.	Supports a new understanding or conclusion through a logically organized line of reasoning **AND** sufficient evidence. The limitations and/or implications, if present, of the new understanding or conclusion are oversimplified.	Justifies a new understanding or conclusion through a logical progression of inquiry choices, sufficient evidence, explanation of the limitations of the conclusion, and an explanation of the implications to the community of practice.
Generally communicates the student's ideas, although errors in grammar, discipline-specific style, and organization distract or confuse the reader.	Generally communicates the student's ideas, although errors in grammar, discipline-specific style, and organization distract or confuse the reader.	Competently communicates the student's ideas, although there may be some errors in grammar, discipline-specific style, and organization.	Competently communicates the student's ideas, although there may be some errors in grammar, discipline-specific style, and organization.	Enhances the communication of the student's ideas through organization, use of design elements, conventions of grammar, style, mechanics, and word precision, with few to no errors.
Cites **AND/OR** attributes sources (in bibliography/ works cited and/or in-text), with multiple errors and/or an inconsistent use of a discipline-specific style.	Cites **AND/OR** attributes sources (in bibliography/ works cited and/or in-text), with multiple errors and/or an inconsistent use of a discipline-specific style.	Cites **AND** attributes sources, using a discipline-specific style (in both bibliography/works cited **AND** in-text), with few errors or inconsistencies.	Cites **AND** attributes sources, with a consistent use of an appropriate discipline-specific style (in both bibliography/works cited **AND** in-text), with few to no errors.	Cites **AND** attributes sources, with a consistent use of an appropriate discipline-specific style (in both bibliography/works cited **AND** in-text), with few to no errors.

Academic Paper

Overview

This performance task was intended to assess students' ability to conduct scholarly and responsible research and articulate an evidence-based argument that clearly communicates the conclusion, solution, or answer to their stated research question. More specifically, this performance task was intended to assess students' ability to:

- Generate a focused research question that is situated within or connected to a larger scholarly context or community;

- Explore relationships between and among multiple works representing multiple perspectives within the scholarly literature related to the topic of inquiry;
  Articulate what approach, method, or process they have chosen to use to address their research question, why they have chosen that approach to answering their question, and how they employed it;

- Develop and present their own argument, conclusion, or new understanding while acknowledging its limitations and discussing implications;

- Support their conclusion through the compilation, use, and synthesis of relevant and significant evidence generated by their research;

- Use organizational and design elements to effectively convey the paper's message;

- Consistently and accurately cite, attribute, and integrate the knowledge and work of others, while distinguishing between the student's voice and that of others;

- Generate a paper in which word choice and syntax enhance communication by adhering to established conventions of grammar, usage, and mechanics.

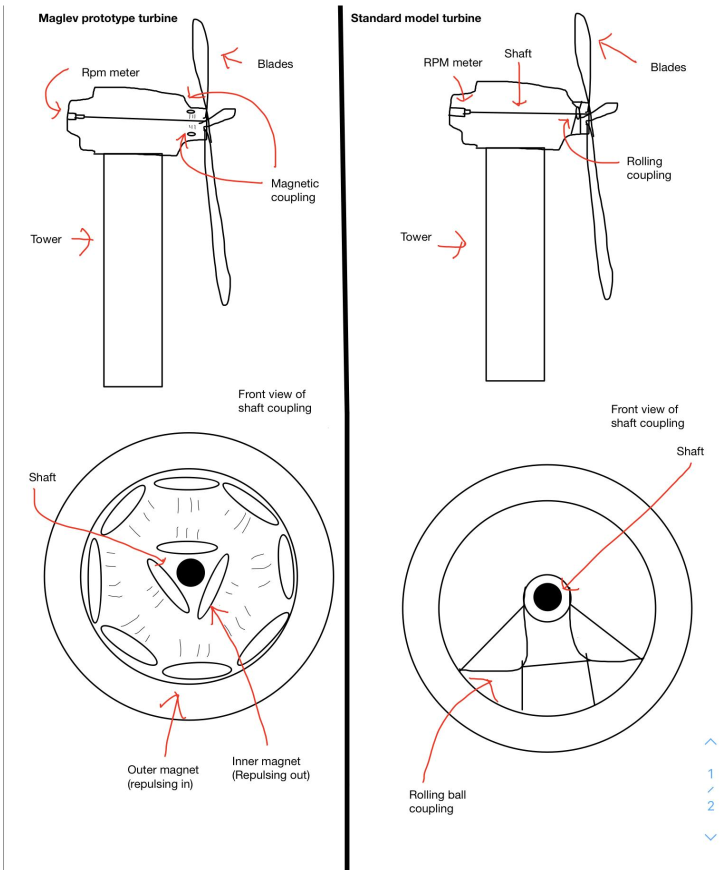
How Does a Prototype Magnetic Levitation Wind Turbine Model Compare to a Modern Horizontal Wind Turbine Model?

Word count: 4554

Abstract: This project is an experiment meant to compare the efficiencies of a model of a modern horizontal wind turbine and a model of a prototype horizontal magnetic levitation wind turbine. These turbines are identical except for how the shaft interacts with the main coupling. The modern wind turbine will have a miniature rolling coupling in place while the MAGLEV wind turbine will have the prototype magnetic coupling I have built.

Introduction: The modern world is run by electricity ;and in order to get that electricity we need energy resources. Some energy resources pollute the atmosphere and others do not and they are called clean or renewable energy resources. These energy sources consist but are not limited to solar, wind, geothermal, hydro, and nuclear. Currently the most widely used clean energy resources and most well known are solar and wind energy. The focus for this experiment is wind energy and wind turbines. Wind turbines, specifically horizontal turbines, are very tall towers that have a room that basically contains the shaft, gearbox, and generator of the turbine. On the front end of that room is the hub and the turbine blades which spin from the push of the wind to spin the shaft, generating electricity. This is the current design of the wind turbines and the most widely used model. There is another type of wind turbine however called a vertical wind turbine where instead of the shaft sitting in a horizontal plane the shaft is positioned vertically. These vertical wind turbines have been under much research lately due to the discovery of how compatible they are with Magnetic levitation technology, or magnetic levitation. Magnetic levitation is when two magnets that oppose each other are pointed at each other , normally in a vertical direction, causing the magnet above to float or levitate. This technology is currently being used to create faster transportation in trains and to make more efficient generators. Recently however there has been talk about how vertical magnetic levitation turbines are "Configured to capture winds from any direction, the Maglev converts wind to energy at very high efficiencies"(Guevara 6). This shows how vertical magnetic levitation wind turbines compare to modern horizontal wind turbines and how regular turbines may be improved upon. That is the purpose of my experiment is to test to see how current horizontal wind turbines may be improved upon using magnetic levitation technology. Based on the information from Guevara's article, I can hypothesize from that information that a horizontal magnetic levitation or MAGLEV wind turbine would outperform a regular model horizontal wind turbine when it comes to speed efficiency or rotations per minute.

Literature review: What this experiment will be testing is a prototype horizontal magnetic levitation wind turbine, not a vertical magnetic levitation turbine. MAGLEV or magnetic levitation is when 2 magnets vertically oppose each other. In the paper *'magnetic levitation'* by David E Newton, he states that "Magnetic suspension or magnetic levitation is the phenomenon in which two magnetic objects are repelled from each other in a vertical direction"(Newton, 1). Vertical turbines have been proven to work with magnetic levitation technology but there have been minimal studies produced. I have found in all of my research about the possibility of a magnetic levitation horizontal wind turbine. The results of the vertical magnetic levitation wind turbine have been very successful proving it is more efficient than its regular counterpart and the horizontal turbine.



The 2 turbines that are being used in this test are, from an outside perspective, the same. In order to cancel out any unwanted variables they have been made so that the only difference between them is the design of the shaft bearing. The main part of the test is to see if magnetic levitation technology can be integrated into horizontal turbines to reduce friction wherever possible, mainly in the shaft bearing. Most modern turbines

Figure 1

currently use some pathing similar to a rolling ball bearing to keep the shaft in place while maximizing the spin.

As shown in figure 1, the shaft is the center 'pipe' or 'pole' holding the blades onto the turbine allowing for them to spin. In the magnetic levitation wind turbine the central shaft will have a triangle of magnets to repel the ones making up the external part of the shaft bearing. On the regular turbine model there will instead be metal plates holding the shaft in place. A bearing is what keeps the shaft in place and allows it to spin. The shaft bearing design for the regular horizontal turbine is relatively simple with the metal plates on either side of the memory stops in order to keep the shaft in place. The magnetic levitation shaft bearing on the other hand is more complicated. Around the circular pipe, there are 8 magnets repealing inward toward the shaft. On the shaft there is a square of magnets repelling outward. This pushing from all sides should hold the shaft in place where it needs to be. According to a study published by Richard F. Post and Dmitri D. Ryutov called *The Inductrack: A Simpler Approach to Magnetic Levitation,* they talk about a stable design for a super speed magnetic levitation train system. In this they state that "The system is passively stable: Only motion is required for levitation"(Post 1). This proves that as long as you maintain motion the magnets will hold in place and maintain levitation. This is the case for all horizontal turbines anyways where they have to maintain movement to generate power. This is discussed in a book called *Aerodynamics of wind turbines* by Martin Hanson, where he goes over the basics of wind turbines and states that "One problem is that wind energy can only be produced when nature supplies sufficient wind"(Hanson 12). This is one of the largest drawbacks to wind turbines, where if they lack wind they can't move, then they aren't generating electricity. In order for the magnets to stay stable Posts paper says that they must maintain movement, which brings up some issues for the design. If the magnets require movement to stay stable and the turbines have intermediate movement based on wind that could make them unstable and therefore problematic. With the octogonal design of the coupling, that should cancel out the instability making these work great for upgraded turbines.

The biggest issue with this experiment is the gap. There is little to no research on magnetic levitation technology being integrated into horizontal wind turbines. This leaves a lot of unknowns in the open meaning that this is an almost untouched region of study. The lack of data makes it very difficult to formulate a good argument for the functionality of the project, but that is the purpose of this experiment. This is meant to fill that gap and allow future research to be conducted with this as the base experiment.

Materials:

Quantity two: 2 foot tall by 4 inch diameter pvc pipe

Quantity two: concentric reducer that goes from 6 inches to 4 inches

Quantity two: 4 inch diameter Tee fitter pvc pipes

Quantity two: 1 foot long, ⅜ diameter threaded rods

Quantity four: 8-10 inch long, 1/16 diameter threaded rod

Quantity twelve: neodymium disk magnets

Quantity three: thin metal sheets

Quantity sixteen: 1/16 inch nuts

Quantity eight: ⅜ inch nuts

Quantity four: ⅜ inch washers

Quantity two to four: wooden mounts for the blades (doesn't have to specifically be wooden)

Quantity sixteen: 1 foot long by 3 inch wide balsa wood sheets

Quantity sixteen: 1 foot long balsa wood cube dowels

One roll of duct tape

Glue gun

Powerful glue such as gorilla glue

A timer

A notepad or iPad for noting data

A tachometer rotations per minute (RPM) laser tracker

Source of wind (leaf blower with nozzle removed)

Experiment Model Design: For this experiment I am using 2 turbines, one to model a state-of-the-art horizontal wind turbine and the other to model what my experimental prototype will look like. This experiment is to determine if the prototype functions better than the regular turbine. I used basic PVC pipe parts for the tower and the exterior of the head for both turbines. The biggest thing is to make them identical except for the change in the coupling. For the blades, they need to be made of an easily manipulated material that is sturdy enough to withstand the high rotational speeds, and the wind blowing at it. Balsa wood sheets with balsa wood sticks behind them are the best material I found for the blades. The turbines are to be at the same height which may differ based on the pipe that is used. For this project, I used a 2 foot long pipe with a 4 inch diameter interior. Plus the rough height of the head it turns out to be almost 3 feet or 85 centimeters.

For the turbine tower, the design is very simple. All that is needed is a base wider than the top, and a 2 foot pipe. I used a concentric reducer that goes from 6 inches to 4 inches in diameter for the base. The bottom is to be weighed down so that the turbine is not top heavy.

The head has 2 different designs for the 2 different turbines. Both have the same external design but a slightly different interior head design which is meant to function as the independent variable in this experiment.

The head for the regular horizontal turbine model is very simple. To build it, you start off with the Tee fitting and mount it to the 2 foot pipe. This 2 foot pipe will act as the tower for the turbine. Inside the tee fitting,(the Tee fitting will also be referred to as the head of the turbine) 2 metal sheets will be placed on both sides of the interior of the head and stop at the memory stop. Different pipe companies will have different sized memory stops so the sheets need to be able to account for the difference in size which is why there is no specific size mentioned in the materials list. These metal sheets will need three holes drilled in them; one hole about 1 inch in from the edge of the metal sheet that is about 1/16 inch in diameter and one hole in the center a bit larger than ⅜ inch in diameter. The two smaller holes on each plate will be to hold the two plates to the internal memory stops of the head. The small threaded rod will be put through the holes on the inside then double nutted to keep the threaded rod and the metal sheets in place. This will be done twice in each head so four times in total. The middle, larger hole will be for the shaft of the turbine that connects from the back to the blades of the turbine. On the magnetic turbine, instead of a metal sheet on the front, a plastic one may be necessary so that the magnets do not make it difficult to connect them. Also, on the magnetic turbine the plastic sheet used to keep the inside of the head together must have a larger center hole than the other turbine so that friction can be reduced. The plastic sheet on the from is only meant to act as a stabilizer for the shaft.

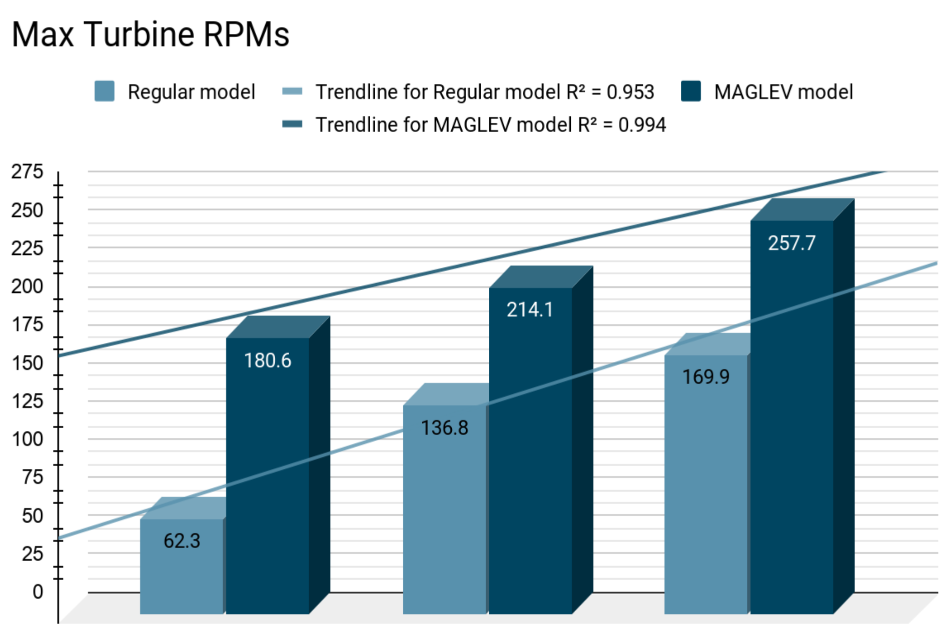
The shaft of each turbine will be connected differently. For the regular model wind turbine, the shaft will have the nuts on the outside of the metal sheets for simplicity purposes. First the one foot long threaded rod must be put through the metal sheet's center holes so that it goes all the way through the front and the back. Then, washers are to be placed on both ends of the threaded rod up against the metal sheets. The nuts will be placed on the outside of the washes and be double nutted so there is no movement from them. Make sure to not tighten the nuts too tight that the turbine shaft cannot spin but tight enough that it does not move back and forth. On the magnetic levitation wind turbine however, the design of the turbine shaft will be slightly different. The magnetic levitation wind turbine shaft will have the nuts on the back side of the back metal sheet like the regular turbine but due to the magnets the double nuts will be placed on the inside of the back metal sheet so that there is no interference from the magnets. This is to act as a stabilizer so that the magnetic bearing does not move forward and backward. The plastic sheet in the front stops the magnetic coupling from moving up and down. Once the washers are placed on the inside and outside of the back metal sheet, the nuts can be placed to restrict the movement of the shaft. Do not tighten it too much so that it can still be loose enough to not influence the friction of the turbine blades too much.

The design for the turbine blades are the same for both wind turbines but the mounting for the blades is different for each turbine. The blades are simply made using just glue, tape, balsa wood sheets, and balsa wood dowels. The twelve inch sheets of balsa wood are to be taped together to create a 24 inch sheet. The same will need to be done for the wooden dowels. Then the dowels are to be put down the center of the balsa wood sheets but leaving about two to three inches of dowel sticking out from the bottom of the sheets so that it can be mounted. For design and appeal purposes, it is a good idea to paint them or round the tops of the sheets so that it looks more like a wind turbine, but that is all for added design and will not matter much in the physical experiment. There will need to be at least eight blades made, four for each turbine, for this experiment. The blade mounting will have to either be round or square with four holes all on each side or equidistant from one another so that the four blades can be mounted on each turbine. The difference between the turbine blade mountings is that the magnetic levitation wind turbine model will have magnets put on the shaft near where the blades are mounted. For my purposes, I had used the same round blade mounting parts to mount the magnets but that is not necessary. The magnets on the blades must only line up with the coupling in the head, that is the only requirement. Four magnets will have to be placed on the shaft to optimise space and how much repelling power is being produced from the magnets.

Once both the blades and the blade mounting are completed the blades all need to be attached. The blades all need to be angled at about a 45 degree angle and pointed in the same direction to allow it to spin correctly. If the blades are angled too much forward or sideways then the wind will catch wrong and the turbine will spin incorrectly. To eliminate unwanted variables, the angle of every blade must be as close as possible to one another. After the construction of the experimental part of the turbines is the design portion which is all up to the experimenter on how it is painted or if weights are needed due to different material usage. After all that is completed, all that is left is to run the experiments.

Methodology: This experiment will have one main testing section. The test will be looking for the max sustained rpms within 30 seconds, which will be looking for quantitative data, and durability, which will be looking at qualitative information. These tests will be conducted using a leaf blower to simulate the wind and the fan will be placed at a safe of roughly four meters distance from the turbine blades and blow at the same height as the blades at roughly 85cm. The turbine's total height is roughly 89-90 cm. The un-nozzled leaf blower (simulates wind) must be placed roughly 13 feet away or 4 meters away from the wind turbine being tested. All the measurements will be constant throughout the testing.

The main set of experiments will be looking at the max rpm of the turbines after 30 seconds and the structural stability of the turbines while reaching the max rpms. Using the Tachometer RPM tracking laser, the max rpms of the turbines will be measured during the 30 seconds that wind is being blown at the turbine. After those 30 second, take the max rotations per minute displayed on the tachometer laser that were recorded in the 30 seconds the wind was blowing and mark it down. This is to be done at low, medium, and high speeds on the multi speed leaf blower with the nozzle remved. The other portion of the testing is qualitative. This is all observation based. For example, if the turbine is shaking or vibrating oddly then that would be added to the qualitative analysis section. If parts break or are functioning strangely then that is also to be noted. If it is a design flaw then it does not need to be noted only if it is caused by the testing. If the turbine is damaged beyond immediate



repair then mark that down and the highest rpms the turbine achieved before damage occurred.

Results: The simulated wind was blown at each turbine for 30 seconds then shut off to see the max rotations per minute each turbine could achieve at the 3 different speeds. This added up to tests total for the whole experiment.

In the graph shown below, there are 3 sections of columns. Each column section represents the different testing speeds going from slowest to fastest. The vertical axis is how many rpms were achieved by each turbine in all the tests. The light blue is the regular turbine model and the dark blue is the magnetic levitation wind turbine model. A bar graph is the best representation for this data because it can easily display comparative data sets.

Data Analysis: In the data there are a couple of varying numbers displayed on the graph for the two turbines in order to represent their performance. They both had a steady increase as the wind speed increased, as expected. The regular model turbine started out with a relatively low number of 62.3 rotations per minute. In comparison, the Magnetic levitation model turbine had a much higher starting speed of 180.6 rotations per minute. That is nearly three times faster than the regular model turbine's max rotations per minute on the low speed. On the medium speed, the regular model hit a max rotations per minute of 136.8 in the 30 seconds it was allowed to speed up. On the other hand, the magnetic levitation wind turbine model got up to 214.1 rotations per minute. Though the magnetic levitation wind turbine was still rotating much faster than the regular model, the regular model gained significantly more speed between the tests. The regular model increased by about 74 rotations per minute while the magnetic levitation wind turbine model only increased by about 34 rotations per minute. While the magnetic levitation wind turbine is faster overall, the regular model seems to increase in rotations between wind speeds. For the final wind speed, the regular model turbine reached a max rotations per minute of 169.9. The magnetic levitation model turbine reached a maximum rotation per minute of 257.7. The magnetic levitation wind turbine still ended up being a little more than 1.5 times the speed of the regular model turbine in the final speed test. Although, there was an odd change in the speed increases for this test. The regular turbine only increased by about 33 rotations per minute. This is significantly lower than the previous increase of 74 rotations per minute. For the other turbine however, it increased by 43 rotations per minute from the medium speed test to the high speed test. The regular turbine seems to already be approaching its max speeds due to the numbers level of decreasing. While the magnetic levitation wind turbine seems to be increasing or at least decreasing in speed gradually but much more gradually than the regular turbine. As displayed on the graph, there are two trend lines that are meant to display the rates of change from start to finish in the experiment. The magnetic levitation wind turbine's trend line shows that it has significantly higher trending numbers but the line does not increase as much as the regular turbine's line. The regular turbine's trend line shows the opposite as the magnetic levitation wind turbine's trend line. It has lower trending numbers but increases at a higher rate. The rates are displayed this way due to the difference in the increases of rotations per minute between tests. Because the regular model turbine had higher jumps in rotations per minute, the line is going to be increasing more than the magnetic levitation wind turbine. On the other hand, due to the magnetic levitation wind turbine's higher rotations per minute from the tests, it's line is situated much higher on the vertical axis of the graph. Although the rate of change was higher for the regular model turbine, the higher max rotations per minute for the magnetic levitation turbine made its performance greater. This means that overall the magnetic levitation wind turbine performed significantly better than the regular model wind turbine when it came to rotations per minute, but the qualitative structure performance data tells a different story.

The other part of the test was using visual data to determine how the turbines reacted at the higher speeds. For example, if the turbines began to shake, fall apart or rotate unexpectedly; this would be then noted under the qualitative visual performance data. In this part of the testing, the regular model actually did better than the magnetic levitation wind turbine. In the earlier speed tests there was little to no change between the turbines when it came to visual abnormalities. When the highest speed was hit however, the magnetic levitation wind turbine model began to vibrate and rotate to the left, while the regular model wind turbine showed no such activity. This could be due to the higher speed or the positioning of simulated wind device used in my experiment. If the wind turbine had been mounted to the ground, it may not have rotated at the higher speeds. For experimental purposes though, I decided against mounting it to the ground in order to have better qualitative visual data.

Conclusion: In conclusion, my hypothesis was correct, for the most part. In my data analysis I discussed the significance of the data I produced and compared it. The horizontal magnetic levitation model wind turbine reached much higher rotations per minute than the regular model wind turbine. This makes my hypothesis that magnetic levitation technology integration into horizontal wind turbines would increase the rotations per minute and therefore increase the speed efficiency. The one part of my hypothesis that I did not account for was the qualitative data section. I did not predict that the magnetic levitation turbine would end up spinning on the base and vibrating, making my hypothesis slightly incorrect because in the two categories I was measuring, the magnetic levitation wind turbine out performed the regular wind turbine while in the second test the regular wind turbine beat the magnetic levitation wind turbine. Further testing would need to be done maybe with a control to compare to or more trials to put the turbines through. All in all, the magnetic levitation wind turbine model did outperform the regular wind turbine model, therefore making it have better rotational efficiency than the regular wind turbine model.

<u>Limitations:</u> There were multiple limitations influencing the results of this project. The biggest of which being time and inexperience. When it comes to time, I had about 7 months to ideate, blueprint and build this project all the while maintaining the other parts of the class and writing the paper. Due to the Covid-19 virus spreading rampantly there were part delivery delays and my experiment being inaccessible due to the school being closed. As the deadline approached for the project to be complete, I had gone through many revisions to the design of the turbine heads ranging from using clay as the bottom of the head structure and wooden rotating parts on the inside, to using almost all metal parts for the heads. The final revision wasn't selected until about two weeks from the results completion deadline. This meant I needed more time to write the results and to complete the testing leading up to a multitude of timing and scheduling issues. The other big limitation was my inexperience with the research process. I had focused most of my research on finding better sources to base my paper off of but because there is an apparent lack of research on magnetic levitation integration into horizontal wind turbines, I had no such examples or sources to pick from and instead focused all my research time into finding papers on magnets, magnetic levitation technologies in other systems, and horizontal wind turbine designs. I resorted to a trial and error process figuring out which kinds of shafts and head mounting

designs worked and which did not. This process ended up being inefficient and I had to consult a professional on the interior design for the interior of the turbine heads. This design used multiple metal rods, plates, and nuts to keep the shaft in place, which I had not thought about due to my lack of tools, resources ,and experience. If I were to do this project again, I would have researched more and stated earlier to have more time to write and plan my experiment. I would also make a control turbine or purchase one. I would also add further testing to improve the data I collected both in the quantitative and qualitative sections of data.

Significance and Future Applications: For my research, I intentionally touched on a specific area of study that had not been researched much. Both magnetic levitation and experimental wind turbines have been researched but have been very rarely combined. There have been papers on experimental vertical magnetic levitation wind turbines but not any horizontal magnetic levitation wind turbines. I wanted to shed some light on that gap of research and present my own experiment and hypothesis on the subject. My hypothesis I presented turned out correct and my experiment a success, but there is much more to do. This experiment only used two wind turbines that were barely a meter tall. To further this research the turbines would have to become larger and have more changed variables or possibly more turbines to have recurring data to confirm its effectiveness. Due to my lack of resources and time I was not able to pursue a more advanced experiment but I hope to do so in the future and I hope others will see this as a good reason to invest in experimental energy production.

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Academic Paper

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Sample: F
Score: 3

This paper earned a score of 3. The paper introduces a clear and focused topic and purpose of inquiry on page 2, stating, "the purpose of my experiment is to test to see how current horizontal wind turbines may be improved upon using magnetic levitation technology." A gap is stated on page 4: "There is little to no research on magnetic levitation technology being integrated into horizontal wind turbines." However, the stated gap is not logically defended. The paper situates the topic in multiple perspectives on pages 3-4; however, many of these sources are not scholarly. The method is presented starting on page 5. The methods are reasonably replicable but are not always explicitly clear. There is a new understanding on page 12, stating, "The magnetic levitation wind turbine still ended up being a little more than 1.5 times the speed of the regular model turbine in the final speed test."

The paper did not earn a 4 because there is not sufficient evidence to support the conclusion with limited trials. The paper also did not earn a 4 as the method is not logically defended, even though it is replicable. The paper did not earn a 2 because there is a narrow topic and a replicable method present. The paper also did not earn a 2 as the method generates a new understanding.