

Name 1: _____
Name 2: _____
Name 3: _____
Name 4: _____

Mr. Forrest & Mr. McChesney / AP Physics 22-23

Due date **12/16/22** @ 7:55 A. M.

Rebuild date: **01/13/23** @ 7:55 AM

Assigned: 11/18/22

Tiger Tanks Building Project

This was provided by Ryan Kabbes, who is an AP alumnus of Mr. Forrest (now working at Honda as an engineer – he helped design the new Honda Pilot). This project was assigned to him in his Introduction to Mechanical engineering class while he was a student at the University of Toledo. We will follow the design parameters exactly, with the exception that you will be allowed to rebuild to improve your grade.

(From Ryan Kabbes) Design Project:

Design and build a vehicle which will move on a hard surface a horizontal distance starting from rest and powered only by the falling motion of any number of full *unopened* {at least until after the testing day} 12oz. soft drink cans. In other words, the potential energy of the falling cans is converted to kinetic energy of the vehicle in the most efficient way possible. Specifically, the object is to maximize the value of Z , where $Z = [D - 6E] / W$. D is the distance traveled in feet, E is the lateral movement from the centerline, also measured in feet, and W is the total weight of the vehicle in pounds including the weight of the pop cans. The minimum distance to be traveled to be considered project completion (not an incomplete on the grade card) is eight feet. For example, if the vehicle travels 30 feet, has moved one foot from the centerline, and weighs 4 pounds, it has a Z value of:

$$[30 \text{ ft} - (6 \cdot 1 \text{ ft})] / 4 \text{ pounds} = 6.0 \text{ ft} / \text{lbs}$$

Restrictions are:

1. The cans must remain filled with the beverage, must not be opened, and must remain with the vehicle at all times. Any number may be used.
2. Materials used are limited to: any kind of wood, paper, plastic, wooden dowels, rubber bands (but not used to propel anything), twine, rope, fishing line, steel, aluminum, rubber, CD's, DVD's, LP records, common fasteners such as nails, tacks, screws, bolts, washers, pins, glue, tape, etc. and common lubricants. 3-D Printed material is allowed. No other materials can be used.
Specifically: no Cardboard or Styrofoam may be used.
3. The maximum dimensions of the vehicle {all parts} cannot exceed 50 inches long, 36 inches wide, and 96 inches high. Your project needs to be able to easily pass into and out of my room.
4. The weight of the vehicle plus pop cans may not exceed 18 pounds.
5. The vehicle is a ground vehicle, and is not to be airborne at any time in its motion.
6. The surface contact width of any wheel may not exceed 0.2 inches.
7. If the vehicle tips over during its run, **its Z-value will be decreased by 10 points.** (*This is another reason you must leave the cans unopened; after all it's dangerous to drink and drive - or as Mrs. Cores might say, "It's dangerous to drink and derive."*)
8. You may position or angle the vehicle at the starting line to decrease the final lateral displacement from the centerline.
9. You will be allowed 3 official test runs on test day. If you test before official day after school the week of December 16th you may count a run as an official test run provided McChesney is present and there is video evidence of the testing run.

PLEASE NOTE: Do not expect Mr. Kalash or Mr. Womack to help you. If you have taken their classes and know how to use equipment, they MAY choose to help, but you should not expect them to do so.

Ryan said, "Well, hope you like the idea. I thought it was a pretty good project; so feel free to add any of your own restrictions or rules. And, if you end up using it in class you had better let me know how it went. The top Z value for all sections of the class was a 39.3, which is a lot higher than those in the past, which usually range between .10 to 26." *FYI: the highest PHSN score ever was a 75 in 2017, although many years had a top score much lower (4.95, 5.6, 17.5, 17.0, etc.) with averages often less than 5.0*

PHSN / PHSC modifications and information:

1. Each group may only enter one Tiger Tank. Entries must be turned in to Mr. McChesney by 7:50 AM or before on the due date so he has time to inspect them prior to testing. Since this is an engineering event, failure to adhere to the specifications and rules will result in a zero, although you will be allowed to submit your project on rebuild day for up to 70% of the maximum score if you had Major Violations. All other projects will be eligible for a max score of 93% on the rebuilds. Groups must consist of 2-4 team members (NOT 5!). I have yet to see a 1-person group succeed, I strongly recommend you do not go it alone.
2. No design alterations to the Tiger Tank will be allowed after 7:50 AM on the day of testing.
3. The starting line of the race will be at the centerline of the main hallway by the door to my classroom. Your Tiger Tanks will be directed towards Mr. Ricker's room. This gives you a potential distance of about 130 feet. (Yes, I know nothing in this building is straight or level, so I strongly recommend that you test your device ahead of time on that particular stretch of floor, and calculate what score your vehicle will have if it has a perfect run ahead of the testing). I cannot stress strongly enough how important it is to calculate things beforehand and keep track of those items during the build process.
4. The lateral movement from the centerline will be measured where the center of the Tiger Tank ends up. If sidewalls get in the way of your Tiger Tank, the linear distance (D) and the lateral distance (E) will be measured where the Tiger Tank stops, not where it first strikes the obstruction.

Scoring: A minimum distance of 8 feet is needed to score the vehicle and a minimum Z of 4.0 is required for a passing grade, no matter what the maximum performance score is on the first testing day – this will likely be higher.

1. The overall scoring will be as follows:
 - Structural efficiency [Z value] (Up to 150 points)
 - Design characteristics and Individual documentation of involvement in project (Up to 50 points)

Since design characteristics and aesthetics are subjective (to an extent), it is advised to curry the judge's favor.

2. The Tiger Tanks will be ranked by their efficiencies. The top efficiency on first day of testing will receive a grade of 100% provided it is above 22. All other Tiger Tanks will be rated on this basis. If no team scores above a 22 then the efficiency grade will be based on a Z of 22 ft / lbs. So if the top score is a 20, then it earns $20/22 = 90.9\%$

For example: If the Tiger Tank with the maximum efficiency has an efficiency of 30.0, and your Tiger Tank has an efficiency of 10.0, your grade will be a 33.3 %, or 50/150 in the structural efficiency area. You may improve your grade by rebuilding your tank.

3. The Tiger Tank with the highest efficiency on the first day will receive a score of 110% with correct documentation if the Zee score is 22 or higher. If more than one car can achieve an efficiency score of 29.5 then they will score 110% on the project with correct documentation.
- * 4. Any qualifying Tiger Tank that attains a Z-value of 19.0 or greater on the first day will automatically score an 'A', provided you have the correct documentation. Any Tiger Tank with a Z-value of 35.0 or greater on the first day will earn an automatic 'A' for the entire 4th-nine weeks grading period as long as all your AP Physics C work for the 4th 9-weeks is fully completed at a high quality, with effort, on time, including active readings, HW, and HW corrections for tests – no excuses. In previous years the range of high scores has been 5.6 to 57.8 and up to 34.3 on the rebuilds. The AVERAGE score on the first try has been about a 4.0 – 5.0 (although it was a 19 in 2013, it was 10.7 in 2017, 18.1 in 2018, 12.03 in 2019).
5. Tiger Tank rebuilds may attain a maximum score of 93% with correct documentation. Only those Tiger Tanks that did not have a major violation and were turned in on time will be allowed to rebuild for a 93%. Tiger Tanks with a major violation on the first try will be allowed to rebuild to attain a maximum score of 70%. Major violations include excess weight, improper dimensions, or having the project turned in late (after 7:50 AM on testing day. Minor violations may include unpreparedness for testing (> 3 minutes to prepare for a trial) and minor material problems.
6. On rebuild day, the efficiency will be based on the best efficiency of the original day testing (in other words, it won't increase just because people build better the second time around) or a value set by Mr. McChesney. If your efficiency happens to be lower on rebuild day, your score will not be lowered.

7. Mr. McChesney will keep all Tiger Tanks (including the pop!) after testing until such time as he chooses to release them.

HINT FROM AWHILE BACK: PVC pipes that were long and skinny were NOT sturdy enough to fulfill this project with anywhere close to a passing grade.

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Mr. McChesney / AP Physics 22-23
Due date 12/16/22 Mod _____
Rebuild date: **01/13/23**

Tiger Tank Grading Rubric

Scoring:

1. The overall scoring will be as follows:

- Structural efficiency [Z value] (Up to 150 points)
- Design characteristics / Documentation (Up to 50 points)

The minimum distance to be traveled to be considered project completion (not an incomplete on the grade card) is 8 feet, and the minimum Z-value is a 4.0.

Documentation Score:

Design Score & Documentation = _____

Structural Efficiency Score (Z): $Z = \frac{[D - 6E]}{W}$

D is the distance traveled in feet.

E is the lateral movement from the centerline, also measured in feet.

W is the total weight of the vehicle in pounds including the weight of the pop cans.

D = _____ E = _____ W = _____

Z = _____ Efficiency Score = _____

The Tiger Tank with the highest efficiency on the first day will receive a score of 110% provided documentation is correct if the Z-score is greater than 25.

Any qualifying Tiger Tank that attains a Z-value of 20.0 or greater on the first testing will automatically score an 'A' with the correct documentation.

Tiger Tanks with no violations or minor violations that were turned in on time will be allowed to rebuild for a 93%. Tiger Tanks with a major violation on the first try will be allowed to rebuild to attain a maximum score of 70%. Major violations include excess weight, improper dimensions, or having the project turned in late (after 7:20 AM on testing day). Minor violations may include unpreparedness for testing (> 3 minutes to prepare for a trial) and minor material problems.

Overall Score:

Comments:

Individual documentation score information:

Part of your score on this project depends on documenting what you individually did, and what time you individually spent to contribute to the project. This score doesn't depend on how well your project performed, but an honest and verifiable documentation of what you did. For example, ways to document time at school are make a Google Doc and upload pictures every time you work on the project and write statements about what you did, take lots of pictures of yourself and others working with a parent or guardian on a certain date, taking a video of you working in the hall on your project and documenting the date and time, etc. Evidence of you working elsewhere would be pictures or videos taken and documented at a certain time, etc. Evidence of you contributing to the materials cost of the project would be receipts from places where you bought materials, or a picture showing you using materials from your home.

You are expected to make your documentation in a Google Doc that is shared with me at the start of the project and that is updated regularly and not just the day before the project is due. This is something where you can add photos, etc. as you work on the project. Think of this like a diary, where you add documentation each day you work on the project. Documentation should NOT be added more than two days after you work on the project, which is why I'm requesting this as a Google Doc since I can see when revisions are made. If you have videos, those can be uploaded to Youtube (set the video to public or unlisted) with a link pasted into your document, sent to my email directly or also shared.

The final documentation will be due on January 20th and you've completed the project, be that on the original testing day or by the rebuild date. Your final documentation should include the Google Doc and a post project breakdown video explaining the successes and failures you encountered along the way and how you overcame the hurdles. Also talk about what you would do differently if you had to repeat the project.

This document can be adjusted if loop holes are found or EYE just plain 4got one-things.....

Due dates for project:

Nov 22 – Blue prints with measurements, calculations, materials, and design specifications due

December 2 – Documentation check

December 9 – Proof of a working prototype

December 16 – Official Car turn in

January 5 – Plan for improving car

January 13 – Car rebuild

January 20 – Documentation due