1. Good Morning fellow presenters and judges. My name is Dev Lochan. I am in 10th grade and I go to Cumberland Valley High School. This year

   I decided to "Take a Step" towards solving the foot crisis by Reducing Joint Impact with Magnetic Levitation.

2. There's a need for this project because it provides a new alternative for the current foam technology. This project will provide **greater** cushioning in **less** space. My mom was recently diagnosed with Plantar Fasciitis so it's my goal to give my mom, and people like her, a new opportunity to combat joint pain.

   My constraints, which ensured that the shoe would be affordable and wearable, included a limit of $20, 435.5 g of total weight, and access to commonly available tools.

3. So after all of this, my goal was to create a cheap, soft, and flexible shoe sole using magnetic levitation with little extra weight to provide greater compression.

   I achieved this by implementing a simple magnetic levitation system into the sole of the shoe. This system allows for **more** compression in **less** area, **lowering** joint pain.

4. I used magnetic laws to power my project, which states that opposite poles attract and similar poles repel.

   This technology was used because foam, which is currently being used in almost every shoe on the planet, wears out quickly, doesn't allow much room for innovation, and can only provide so much support.

   It was my aim to combat the problems of foam, as well as the 4 biggest foam supplements in the market: springs, gel inserts, custom orthotics, and memory foam.

5. In addition to that, an orthopedic doctor was consulted to understand the possible effects of magnets on the human body and the safety of the concept, and I found that **magnets** had **no observed effect** on the human body.

6. Here are the Tools and Instruments I used, which were kindly provided by my school

   These are the materials that were used and they came to a total of $17.

7. I needed to create a timeline to make sure I stayed on track. I spent the first week understanding the nature of the magnets and their repulsion, which is critical for magnetic levitation. I spent the next 4 weeks making the prototype and changing it as needed. In my design, I chose to use Nike Free Runs, which are the most popular running shoes in the US.

8. Over the course of this project, 3 different prototypes were made and 2 were tested.

   The first one was Prototype X which was made of 2 ring magnets with thick washers in between to provide separation, along with a straw to keep the magnets from flipping.

9. I found that the straw wasn't strong enough to keep the magnets from flipping. To fix this, the magnets were placed directly into the shoe in Prototype Y, where a hole was created to snugly fit a magnet into the heel of the shoe, along with a magnet on the insole to create repulsion.

10. For this prototype, compression testing was done using various weights, and as you can see, the new and modified shoe provided greater compression compared to the unmodified shoe.

11. In redesigning Prototype Y, it was found that the super glue was not strong enough so 3M Double Sided Foam Tape was used to form a **stronger** bond between the sole and the midsole. Also, magnets were added throughout the foot in Prototype Z using Pedobarography which measures pressures across the foot to find points where the magnets were needed the most.

12. To create Prototype Z, a process similar to Prototype Y was employed where small areas were chiseled out to create little pockets for the magnets. Once these pockets were chiseled out and the magnet was installed, the double sided tape surrounded each of these magnets to join the midsole and sole together and the corresponding magnets were glued onto the midsole in the exact location as the corresponding magnet with the polarities matching for repulsion.

13. The testing was improved to test deceleration with an Arduino Accelerometer. This involved dropping 8 kilograms from a high of 2 inches onto a piece of plywood that was cut out to fit the shoe to distribute the force and test the complete hoe and not just the heel.

    This is the code that was used to program the Arduino.

    And here are the results. The new and **modified** shoe had the lowest average change in deceleration, making it the best option of the 3 shoes tested. Memory Foam was tested due to its recent popularity so it was used as a secondary frame of reference. Here is the graph of the 3 trials for each of the shoes.

14. The data shows that this project was a complete success, as the average change in deceleration was 7.63 m/s^2, which was lower than that of the old, nonmodified shoe and the memory foam, as well as the compression testing which produced the same outcome. In addition to that, the shoe stayed under the constraints as it spent $17, was 425.2 g, and was built using common workshop tools.

    The outcome of the project was a truly practical and comfortable shoe that used magnetic levitation to reduce joint impact to hopefully give new hope to those living in pain, as well as people in general.

15. In the future, it'd be cool to explore a new way to connect the sole and midsole, use electromagnetic levitation, or apply this technology to other areas.

    Magnetic levitation truly is a very interesting field. This technology is being used by trains in China and Japan that can travel at over 501 kilometers per hour as a result. So, in conclusion, the benefits of the modified shoe really come down to one main point: It's a more effective foam alternative which is simpler and has more opportunity.

16. So, thank you for your time and are you ready to take a step towards solving the foot crisis?