Logbook

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Magnetic Levitating Cars and Electric Induction to Power Cities

TIMETABLE

Part 1

Objective

Attaining accurate car base dimensions to be able to make accurate calculations and scaling later.

Required results

- To have picked a car model of choice to use
- To get the car's mass (as accurate as possible)
- To acquire precise tire dimensions
- Acquire accurate car base dimensions

Part 2

Objective

To research Fleming's rules. To find the best coiling structure for the car to achieve maximum lift and minimum cost. Also, to find the best positioning to avoid magnetic cancellations.

Required results

- To find the best coiling structure for the car.
- To get the best positioning in the car's base.
- To be able to determine the area each coil occupies.

Part 3

Objective

Acquiring the total mass of the car of choice and added weight (maximum number of people it can carry, and things found in the boot or trunk). To have decided the distance the car will be lifted and to have calculated the force needed to lift the car and added weight.

Required results

- To have calculated the total mass of the car and added weight.
- To have calculated the force needed to lift the car by the chosen distance.

Part 4

Objective

Finding the magnetic flux density needed using the formula: $\frac{(B^2 \cdot A)}{2\mu_o}$

B is the magnetic force density which is the force acting per unit current per unit length on a wire placed at right angles to the magnetic field. Measured in Tesla or weber per meter square

A is the area of the material in meter square

μ₀ is the permeability of free space which is the amount of magnetization produced in a material in response to an applied magnetic field (4. π.10^-7)

Required results

- To find the accurate magnetic flux needed to lift the car.
- To be able to use the flux for further calculations

Part 5

Objective

Obtaining the voltage needed to power the main plate of the car and to set the magnetic ratio between the car and the road.

Required results

- Calculate the amount of electricity used to power the car's main plate.
- Divide by the number of coils to determine the approximate voltage for the main plate.

Part 6

Objective

Complete car model on paper. Detail all forces acting upon the car as it goes on the road.

Required results

- To have a detailed diagram of the car.
- To be able to perform calculations and build up on the diagram drawn.

Part 7

Objective

Make the final model and test it

Required results

- To have completely built and designed the model.
- To be able to manipulate the model.

MATERIALS

- Neodymium magnets ($57.00)
- Maisto car ($12.75)
- Wires ($5.75)
- Breadboard ($8.25)
- Copper wire ($11.75)
- Wood ($3.45)
- Motor ($16.80)

ENTRIES

Entry 1 15/10/2024

- Did some research on traffic collisions
- Started stating my problem
- I'm going to do research on electricity consumption and cost

Entry 2 17/10/2024

- Researched on electricity production
- Kept on stating my problem

Entry 3 20/10/2024

- Finished my problem
- Started a simulation on Algodoo
- Started my model on paper
- Must finish model on paper before the Algodoo simulation.

Entry 4 23/10/2024

- Started the model on paper.
- Drew car frame.
- Have to detail forces acting on the car.

Entry 5 24/10/2024

- Started typing up my method.
- I chose the car model I am going to use for my project (2025 Hyundai Elantra).
- I have to get the car's dimensions and mass for further calculations.
- I will input the dimensions and calculations into my model on paper.

Entry 6 26/10/2024

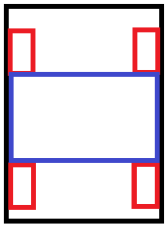
- Continued typing my method
- Decided on scale for my model (1:100)
- Have to make sure it makes sense for modelling
- I need to detail my model on paper.
- Changed the scale to 1:50 because it is better for modelling
- The car's dimensions are 4,710 mm L x 1,825 mm W x 1,415 mm H
- I got and scaled the tire dimensions (225/45R17)

Entry 7 27/10/2024

- Continued typing my method
- Got and scaled the car mass excluding a full tank and tires but including the maximum payload (Scaled: 33.4kg Original:1672.2kg).
- Calculated the force needed to lift the car off the ground using the formula: $F = m.a.d$.
  Where:
  - M= mass in kg
  - A= acceleration in m/s
  - D= distance in m
  - F=33.4 x9.807 x0.01= 3.275538N

Entry 8 28/10/2024

- Discovered a mistake within the calculations and corrected it
- The new mass is in grams, the acceleration in mm/s and the distance in mm
- The new force is 33.4 x9807 x10=3275538gmm/s or 0.003275538N



Entry 9 03/11/2024

- Calculated the magnetic flux density using the formula: $\sqrt{\frac{F2\mu_o}{A}} = B$
- This is derived from the formula: $F = \frac{B^2 A}{2\mu_o}$
- The flux density required to produce a force of 0.003275538N is $\sqrt{7.178831388 \times 10^{-6}}$

Entry 10 04/11/2024

- Kept on working on my method.
- Found the formula for electromotive force which is: $-N\left(\frac{\Delta\Phi}{\Delta t}\right)$
- Found the formula for magnetic flux $\Phi = \int B \,.\, da$

Entry 11 15/11/2024

- Started making a material list
- Have to read more on mag-lev trains and how they work

Entry 12 18/11/2024

- Read the "Magnetic Levitation: Maglev Technology and Applications" by Hyung-Suk Han and Dong-Sung Kim
- Have to calculate the voltage

Entry 13 19/11/2024

- Read the "Magnetic Levitation: Maglev Technology and Applications" by Hyung-Suk Han and Dong-Sung Kim
- Will calculate the area of the control plates

Entry 14 25/11/2024

- Bought a Mercedes AMG model by Maisto ($12.47)

Entry 15 29/11/2024

- Took out my Arduino Uno R3 to test it.
- My program set up didn't work I need to find the source of the problem.

Entry 16 30/11/2024

- I tried a direct connection to the board, and it worked
- I have to get a new breadboard.

Entry 17 01/12/2024

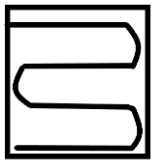
- Got copper wire, batteries and a metal sheet
- Measured the required dimensions and cut them.

Entry 18 02/12/2024

- I cut out the base plate.
- I need to calculate the magnetic flux density for the new model.

Entry 19 05/12/2024

- I started calculating the magnetic flux density
- I need to weigh the car to keep on calculating
- I have completely deviated from the 2025 Hyundai Elantra. I couldn't find any models
- I also have to test the wire placement.



Entry 20 06/12/2024

- I made models of the base plate and the road
- I need to get crocodile clips to test the magnetic structure.

Entry 21 13/12/2024

- Made a diagram representing the wire placement. The magnetic fields created will create tension within the system. I'll have to make a normal solenoid.

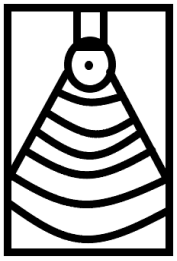
Entry 22 14/12/2024

- Tested a model solenoid with the 9V batteries
- Need to get stronger or more batteries
- I also need to recalculate the area of the solenoid

Entry 23 15/12/2024

- I calculated the solenoid area. It is 16286.01632mm^2 but it could be smaller.

Entry 24 20/12/2024

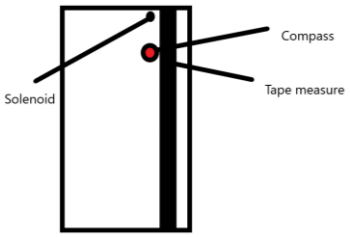
- I have devised a method to calculate the size of my solenoid's magnetic field.
- I will use this court  to determine how far the field extends.
- The solenoid will be taped to the black dot.

Entry 25 25/12/2024

- I received a compass, a breadboard, wires and 50 neodymium magnets.
- I will use the magnet to measure how far the solenoid's magnetic field increases for every 9V.
- The magnets will serve to be reinforcements.
- I marked and determined the different poles of the magnets and the field geometry.

Entry 26 26/12/2024

- Performed the experiment but with a different but similar structure.



- The results so far are tabulated below:

Voltage	Test1	Test2	Test 3	Average
9V	10cm	12cm	13cm	11.6cm
18V	17.9cm	18.5cm	19cm	18.46cm
27V				
36V				

45V				

- Couldn't continue because the batteries were swelling up and overheating quickly.
- Have to replace the 9V batteries with 1.5V batteries to avoid overexertion.
- Will continue tomorrow to plot the graph.

Entry 27 27/12/2024

- I tested the magnetic levitation theory regardless of its already existing applications.
- I made a 'car' and 'tracks' out of cardboard and neodymium magnets.
- Discovered that magnets don't 'repel' each other. They are merely trying to rotate to realign.

Entry 28 03/01/2025

- Made a model with 3 magnets and used a car frame.
- Model worked except airgaps were too big because I thought the magnets will not hold.

Entry 29 04/01/2025

- Tested the attractive method.
- It is too volatile so the repulsive method will be used.
- Will acquire the infrared codes tomorrow.
- Defined a propulsion method (it could change).

Entry 30 05/01/2025

- Tested the breadboards. They both worked. Didn't connect the first one properly.
- Uploaded the IR receiving code.
- Tested using signals from a phone
- Need to get a battery (CR2025)

Entry 31 06/01/2025

- Got the battery (1.31)
- Ran the program and acquired the codes.
- Need to keep on programming.

IR codes

On/Off	BA45FF00
Menu	B847FF00
Test	BB44FF00

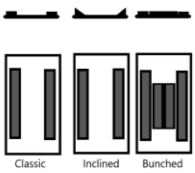
+	BF40FF00
	BC43FF00
	EA15FF00
	F807FF00
	F609FF00
0	E916FF00
-	E619FF00
C	F20DFF00
1	F30CFF00
2	E718FF00
3	A15EFF00
4	F708FF00
5	E31CFF00
6	A55AFF00
7	BD42FF00
8	AD52FF00
9	B54AFF00

Entry 32 15/01/2025

- Made the full track out of cardboard.
- It is approximately 90cm long.
- Was veery unstable, will make it out of a sturdier material: wood.

Entry 33 16/01/2025

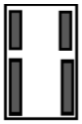
- Got wood and started making the track.
- Tested several car base models
- Will keep on testing and complete it.



- Have to determine the propulsion system.

Entry 34 17/01/2025

- Kept on testing the car base models.



- Found one that could work
- Have to get stronger tape
- Decided to work on the inducing system.
- Need to find a way to center the car the car and keep it balanced.

Entry 35 18/01/2025

- Defined a way to keep the car balanced
- Will push one side further in to keep the car from rotating too much.
- Started planning for the inducing system
- Also decided on a propulsion and sensing system

Entry 36 19/01/2025

- Completed the track
- Have started programming the propulsion system
- Need to get a motor driver
- Started testing the inducing system
- Will start building immediately

Entry 37 20/01/2025

- Measured where to screw the wood and marked it
- Will focus more on building the track
- Lay down some magnets to test

Entry 38 21/01/2025

- Cut out pieces of wood to hold the motor and rollers
- Drew the boundaries for the other rail and screwed the first one.
- Also lay down the other strip of magnets

Entry 39 22/01/2025

- Started programming the pulley system.
- Got the motor driver
- Made the necessary connections but it didn't work. Have to find out what is wrong.

Entry 40 23/01/2025

- Discovered the problem: the connection was not complete.
- Assembled the pulley system but it didn't work. The spool is too smooth
- Tested the pulley system need to get rougher rope

Entry 41 24/01/2025

- Tried adding gears to convert speed to force
- It worked, but the car wouldn't move. The motor's too weak.
- Need to get a stronger motor if possible

Entry 42 27/01/2025

- Used 12 volts with a plain rope
- Struggled to connect the motor driver

Entry 43 28/01/2025

- Finished the connection and tested the system
- Have to cut the metal beam to reduce the pull
- Also, might have to change the motor

Entry 44 30/01/2025

- The motor came and I attached it.
- It works but only backwards. The pulley is tilted so I'll glue it on.

Entry 45 31/01/2025

- The system works completely.
- Need to make sure the car stays straight throughout the whole trip

Entry 46 01/02/2025

- Nailed the bottom of the track to the top for support.
- Started planning for the trifold.

Entry 47 02/02/2025

- Finished the plan for the trifold
- Bought the trifold ($4.50)

Entry 48 05/02/2025

- Started writing on the trifold

Entry 49 08/02/2025

- Spray painted the whole system
- Need to fix the logo

Entry 50 09/02/2025

- Started cutting pieces for the train station.

Entry 51 13/02/2025

- Finished cutting out and gluing the pieces for my station

Entry 52 07/03/2025

- Started extending the radio antenna to ensure a better connection
- Built the antenna dish and beams and glued them to the station roof

Entry 53 11/03/2025

- Got 9V battery holders and installed them
- Fixed the antenna connection and tested it.
- It works except I have to find out why the car is struggling to move

CALCULATIONS

Force

Formula: $F = m.a.d$

To oppose the weight: 33.4g x 9807= 327553.8g.mm/s

To lift 10mm: 327553.8 x 10= 3275538g.mm/s

Base plate area

Formula: L x W

L= Wheelbase- tire diameter= 54.4- 12.7= 41.7 mm

W= 36.5- (4.5 x 2) = 36.5 - 9 = 27.5 mm

∴ Area = 41.7 x 27.5 = 1146.75 mm^2

Magnetic flux density

Formula: $F = \frac{B^2 A}{2\mu_o}$

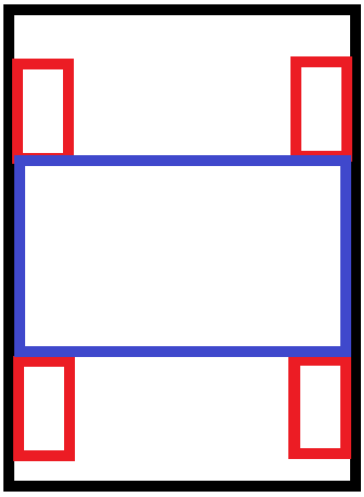
$$\rightarrow \frac{F}{A} = \frac{B^2}{2\mu_o}$$

$$\rightarrow \frac{F2\mu_o}{A} = B^2$$

$$\rightarrow \sqrt{\frac{F2\mu_o}{A}} = B$$

Becoming $\sqrt{\frac{0.003275538 \times 2(4\pi \times 10^{-7})}{0.00114675}}$

which simplifies to: $\sqrt{0.000007178831388}$ = 2.679334131x10^-3 T



Original arrangement

Actual Maglev Plan

Magnetic Levitating Cars and Electric Induction to Power Cities

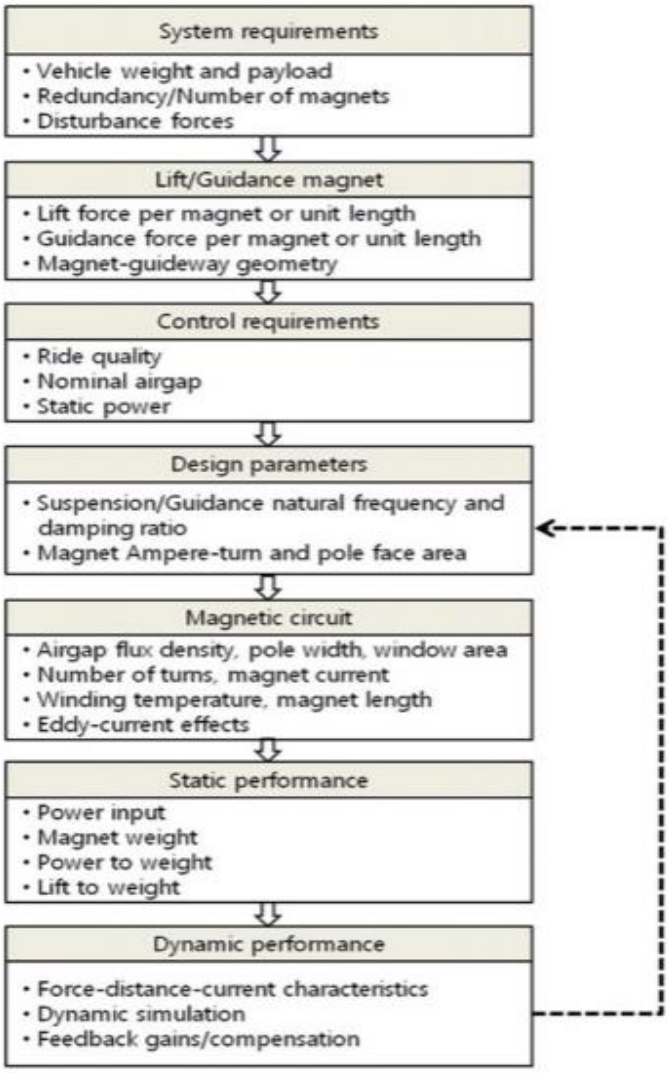


Fig. 5.12 Outline flow-chart for magnet design [1]