SASTA OLIPHANT SCIENCE AWARDS

Prize Winner

Science Investigation

Year 11 - 12

Zarif Hossain

Glenunga International High School

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Oliphant Science Awards Investigation

Effect of Temperature of Copper Ring on Levitation Height in Electrodynamic Levitation

Written by:

Zarif Hossain

Glenunga International High School - Year 11

2026 OSA Investigation: Electromagnetic Levitation

By Zarif Hossain

1.0 Introduction: Electromagnetic Levitation Technology

Electromagnetic levitation is the phenomenon where an object is suspended in the air due to the repulsion of magnetic forces opposing the force of gravity (Maglevboard.net, 2026). The technology has led to a subdivision of vehicles called Maglevs which are floating modes of transportation supported via electromagnetic attraction of repulsion, with Maglevs being conceptualised as early as the 1900s by Robert Goddard and Emile Bachelet and become commercially viable since 1984 (Boslaugh, 2014). The main principle which governs Maglevs is the fundamental nature of magnetism; like magnetic poles repel while opposite poles attract, which are used to help push, thrust and guide Maglevs over a specific track (Boslaugh, 2014).

Magnetic Levitation have primarily been seen in application through Maglev trains, with the most notable being in Japan where the vehicle is known as the Shinkansen, see *Figure 1* (JRailPass, 2017). This system is enabled through the series of connected carriages move through the repulsion and guidance of super conducting magnets residing along the track, facilitating the motion for the vehicle (JRailPass, 2017).

Figure 1: Image of Shinkansen (JRailPass, 2017)

The two main methods used to achieve magnetic levitation are electromagnetic suspension (EMS) and electrodynamic suspension (EDS), however both work off principles governing electromagnetism (Maglevboard.net, 2026). When the voltage of the system is switched on a current is supplied to the electric circuit (solenoid) which creates a time varying magnetic field around the solenoid (The Organic Chemistry Tutor, 2017). Resultingly, an electromagnetic force (EMF) is produced in accordance with Faradays Law, explained through *Figure 1*, around the copper ring (The Organic Chemistry Tutor, 2017). Due to EMFs, induced (eddy) currents within the copper ring produce its magnetic field, as showcased in *Figure 2* (The Organic Chemistry Tutor, 2017). However, because of Lenz's law the induced magnetic field is opposite the direction of the magnetic field produced by the solenoid, see *Figure 3*, thus, the copper ring is repelled upwards (The Organic Chemistry Tutor, 2017). However, since the system is supplied with an alternating current the magnetic field direction of both the solenoid and copper ring constantly reverse while remaining opposite of each other, therefore there is a sustained magnetic upwards force. Suspension within the air is possible through this when the sustained magnetic force is equal to the gravitational force (weight) of the ring.

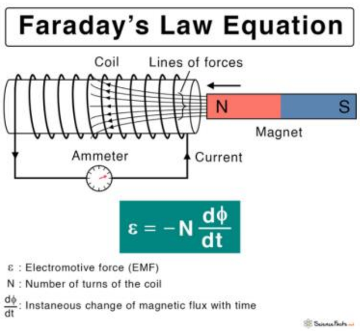

Figure 2: Faradays Law of Induction
Equation modelling Faradays law of induction paired with a supporting diagram (Bhuyan, 2020).

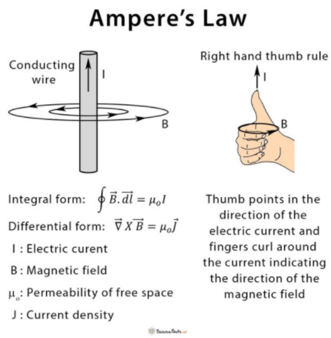

Figure 3: Amperes Law
Showcases the integral and differential forms for Amperes Law as well as a diagram of the right-hand rule (Bhuyan, 2021).

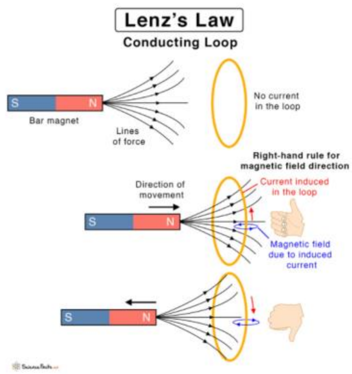

Figure 4: Lenz's Law
A diagram representing the reaction driven by Lenz's Law (Bhuyan, 2020).

2.0 Questioning and Predicting

2.1 Question

What is the effect of changing the temperature of the copper ring on its levitation height when levitated using electrodynamic and electromagnetic suspension?

2.2 Predicting – Hypothesis

If the temperature of the copper ring increases than the levitation height consequently decreases.

3.0 Planning & Conducting

3.1 Variables

3.11 Independent

The temperature of the copper ring levitated in the experiment (ºC).

3.12 Dependent Variable

The levitation height of the copper ring (cm).

3.13 Controlled Variables

What	*Method for Control*
Material of Magnet and Solenoid Coils	Use the same copper ring and solenoid (made from uniform material) for all trials.
Mass of Magnet	
Geometry of Magnet	
Number of Solenoid Coils/Size of Solenoid	
External Temperature	Conduct all trials at the same location and roughly the same time
Voltage Supplied	Use same electrical socket and magnetic levitation system

3.2 Methodology

3.21 Apparatus

- 1 x Magnetic Levitation Setup (Referred to as Lev System)
- 1 x Copper Ring (ensure ring's inner radius is slightly longer than the radius of the solenoid of the magnetic levitation setup)
- 1 x Laser thermometer gun (accurate to 2 decimal points)
- 1 x Eski
- 1 x Ice brick
- 1 x Ruler (Increments of 1mm clearly visible)
- 1 x Electrical Socket (240V)
- 1 x Laptop

3.22 Procedure

Set-up

1. Place Lev System in middle of table and plug into electrical socket, ensuring both Lev System and electrical socket are turned off and then turn on electrical socket
2. Slide copper ring through solenoid of Lev System and adjust from a bird's eye view such that copper ring is evenly distributed (not touching solenoid)
3. Move aluminium plate over the copper ring

Measuring

4. Turn on laser thermometer gun and record current temperature of the copper ring
5. Hold Ruler on resting plate on Lev system such that it is parallel to the solenoid, ensuring it is a fair distance apart such that it does not interfere with the motion of the copper ring
6. Turn on Lev System via switch and record the maximum and minimum height observed over a period of 5 seconds
7. Turn off Lev System, record final temperature and do not touch copper ring for 30 seconds
8. Place copper ring within the Eski over the ice brick at the base and check every 20 seconds until room temperature is reached

Repetition

9. Repeat steps 2-8 two more times
10. Repeat steps 2-9 with initial temps of roughly 17ºC, 20ºC, 26ºC, 30ºC. To achieve the higher temps required for the copper ring switch Lev System on and off, checking every 10 seconds for desired temperature.

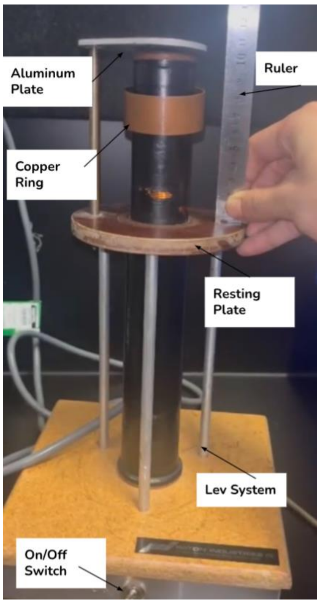

Figure 5: Annotated Lev System

Figure 5 showcases an annotated image of the Lev System to serve as visual aid for individuals conducting the experiment.

3.23 Risk Assessment:

What	*Justification + Management*
Burns	Due to use of electrical equipment (particularly solenoid and copper ring) heat is generated which can cause burns if hot enough. If burn does occur run area under cool water and cover loosely with cling wrap after 10 minutes, making sure someone switches of the power before so (Healthdirect.gov.au, 2026). If severe enough call for medical assistance and run burn under cool water during wait time (Healthdirect.gov.au, 2026).
Electrical Shock/Fires	Make sure the experiment is conducted on a dry surface with no water anywhere on the working station. Additionally keep fire extinguisher within vicinity if a fire were to occur and use if necessary. Moreover, ensure at least one other person is within the room when conducting the experiment to unplug electrical source, use a non-conductive material to break contact and call emergency services if a severe electrical shock occurs (Northern Territory Government, 2022).

3.24 Justification

The Lev System was used to observe the influence of a magnetic materials temperature on its levitation height through its simplicity in set up and use via fitting the copper ring through the solenoid and flipping a switch to allow for the flow of current.

4.0 Results

4.1 Raw Data

Table 1: Raw Data

Table 1 showcases the Raw Data collected from the experiment, which included the initial and final temperatures of the copper ring as well as the peak and trough, maximum and minimum heights respectively, achieved by the copper ring.

Temperature (ºC)		**Height of Equilibrium (cm)**	
Initial	*Final*	*Peak*	*Trough*
16.0	22.3	9.5	6.9
17.4	21.4	9.3	6.3
16.7	20.1	9.0	6.1
20.4	22.2	8.7	5.6
20.3	23.0	9.5	6.5
20.7	21.7	8.9	6.1

22.0	30.1	9.0	6.0
22.3	29.2	8.9	6.1
22.1	29.8	8.7	5.9
27.0	31.0	8.5	5.4
25.8	33.0	9.0	5.3
26.4	30.4	8.5	4.9
28.9	32.8	7.7	4.6
30.3	33.0	7.9	4.9
30.7	35.4	7.8	4.8

4.2 Processed Data

Equation 1: Average temperature

Equation 1 showcases how the average temperature of the copper ring during the trials was calculated for.

$$T_{Avg} = \frac{T_f + T_i}{2}$$

Where:

$$T_{Avg}\ is\ the\ Average\ Temperature$$
$$T_f\ is\ the\ final\ temperature$$
$$T_i\ is\ the\ inital\ temperature$$

Equation 2: Levitation Height

Equation 2 showcases how the average levitation height of the copper ring was calculated for, which involves dividing the sum of the peak (max height) and the trough (min height) by 2.

$$h_{Avg} = \frac{h_P + h_t}{2}$$

Where:

$$h_{Avg}\ is\ the\ Average\ Levitation\ Height$$
$$h_p\ is\ the\ peak$$
$$h_t\ is\ the\ trough$$

Table 2: Processed Data – Average Temperature and Height

Table 2 displays the average temperature and levitation height of the copper ring which was calculated from the raw data in *Table 1* using *Equation 1* and *Equation 2*.

Average Temperature (ºC)				**Average Levitation Height (cm)**			
Trial 1	*Trial 2*	*Trial 3*	*Average*	*Trial 1*	*Trial 2*	*Trial 3*	*Average*
19.15	19.40	18.40	18.98	8.20	7.80	7.55	7.85
21.30	21.65	21.20	21.93	7.15	8.00	7.50	7.55
26.05	25.75	25.95	25.92	7.50	7.50	7.30	7.43
29.0	29.40	28.40	28.93	6.95	7.15	6.70	6.93
30.85	31.65	33.05	31.85	6.15	6.40	6.30	6.28

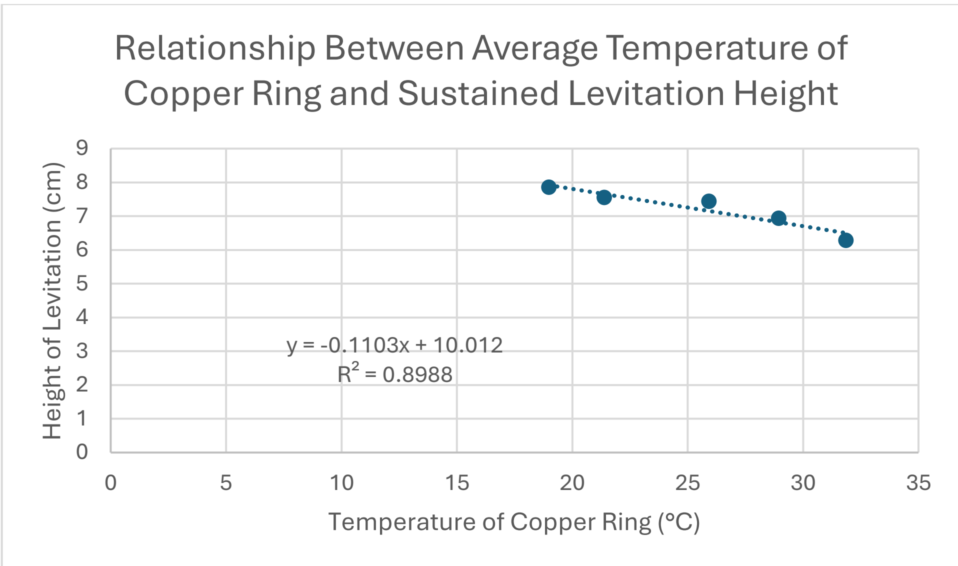

Figure 6: Graph of Relationship Between Temperature and Levitation Height

Figure 6 showcases a graph representing the processed results of the experiment which showcase data for the trend between the temperature of a copper ring and average levitation height to be observed. Additionally, the graph contains both the equation of the linear trendline used to model the trend between the data as well as the R^2 value of the trendline in relationship to the data points. It should be noted both mathematical relationships were generated by Excel.

5.0 Discussion

5.1 Analysis of Results

5.11 Key Analysis of Results

Figure 6 showcases the negative linear trendline between temperature of the copper ring and its levitation height, which possessed medium scatter. This trendline supports the hypothesis as it models a decrease in levitation height following an increase in temperature. The trend is supported by theory as the increase in temperature indicated particle of the mass, the copper ring, possess on average more kinetic energy, causing them to vibrate with larger magnitude and frequency. Resultingly, electrons flowing through the copper ring collide with the vibrating molecules, thus the resistance of the copper ring increases. Furthermore, according to Ohms Law, which states $V = IR$, resistance is inversely proportional to current when voltage is constant, thus, since this was the case in the experiment, as resistance increases current decreases. The reduction in current results in a reduction in the induced magnetic field, as modelled by Ampere's Law (The Organic Chemistry Tutor, 2017). Consequently, the reduction in magnitude results in less repulsion between the copper ring's magnetic field and the solenoids during the initial jump of the copper ring (The Organic Chemistry Tutor, 2017). Since the initial displacement is reduced the sustained levitation height is correspondingly reduced. Moreover, the increasing temperature of the copper ring over time is resultant of Joules Law of Heating, $Q = I^2Rt$, which involved the increase in the flow of heat within an electric circuit over time if there is a current and resistance (Admin, 2017). The increase in the flow of heat results in kinetic energy being transferred to particles of the substance, does increasing the temperature.

5.12 Additional Observations

Another notable observation was the increasing displacement of the aluminium plate at the top of the solenoid once the current was turned on. This can be attributed to the aluminium plate being a paramagnetic material, leaving it available to have an induced magnetic field due to the eddy currents in the solenoid due to Faradays, Amperes and Lenz's Law which results in repulsion from the solenoid (Aluminium Online, 2024) (The Organic Chemistry Tutor, 2017). Furthermore, the continuous oscillating nature of the copper ring is resultant of the necessity for the magnet to comply with Earnshaw's theorem that a stationary magnetic object cannot be stably levitated, thus the object oscillated vertically to create motion and consequently comply with the constraint. The rotational motion of the copper ring was another characteristic observed within the experiment, which likely initial because of slight tilts of the magnetic axes relative to their rotational axes and thus inducing rotation (Berkowitz, 2023).

5.2 Evaluation

5.21 Errors

The relatively mediocre R^2 value of the trendline, approximately 0.9, quantifies the medium amount of scatter within the data as well as indicates the presence of errors within the experiment.

Table 3: Errors

Table 3 illustrates major errors within the experiment, providing an explanation of the specifics, impact and possible improvements to ensure such flaws are not repeated in the future.

Type of Error	What - Explanation	Impact	Improvements
Random	Measurements regarding the minimum and maximum height were made at angles due to the constantly fluctuating height (parallax error).	Parallax errors result in the values recorded varying slightly from results, consequently decreasing the accuracy of results and influencing the trendline.	Use multiple cameras to capture video of the motion and cross check between footage to determine the maximum and minimum heights.
Systematic	During the initial repulsion, the ring always collided with the aluminium plate.	The copper ring loses energy from its initial burst due to the collision, thus lowering levitation height. Additionally, due to Newtons 3rd law of motion the ring gains additional downwards force. Consequently, there was an external force pushing the ring further downwards for all experiments, thus lowering levitation	Ensure solenoid is long enough to prevent collisions through preliminary trials of observing and adjusting length accordingly.

		height and reducing the accuracy of results.	
Random	Alignment of copper ring potentially varied throughout trials as uniform positioning was not done via using an apparatus to fix placement.	The non-uniform positioning of the copper ring results in unequal positioning of the induced magnetic field of the copper ring to that of the solenoid (The Organic Chemistry Tutor, 2017). Thus, the repulsion between the 2 magnetic fields is not directly pushing upwards, hence affecting the levitation height and resulting in a lack of precision in the data.	Use ruler to measure the distance from the copper ring to the solenoid from 4 evenly spaced-out points to ensure proper alignment.
Systematic	Variations 1-2 were done at a different (colder) room temperature than Variations 3-5.	The impact of this can be seen in the trend for the data points in *Figure 6* appearing to be more suited to have two separate trendlines, lining up with the two distinct room temperatures the set of variations were completed in.	Conduct all trials within a short time or simultaneously.

5.22 Limitations

Despite the investigation presenting strong evidence as to the relationship between temperature and levitation height of the magnet in levitation systems the experiment contained limitations for the practical to be carried out within a classroom environment. One limitation of the experiment is the means of achieving velocity, which is required for electrodynamic levitation for there to be a constantly changing magnetic flux with respect to time which drives EMFS within the system. Within the typical application of magnetic levitation systems, namely Maglev trains, this is achieved through the horizontal movement of the train along the magnetic train tracks whereas the experiment provided velocity through the oscillating movement of the copper ring. This poses as a significant limitation regarding the applicability of results due to the motion of the magnet differing to what is desired in real world application. Moreover, the necessity for the oscillating motion results in equilibrium levitation height never truly being achieved, thus the investigation recorded the behaviour of an unstable system which results in the diminishing value of the findings.

Another limitation was that an increase in temperature was not isolated to the copper ring but the magnetic levitation system itself. This is due to the solenoid being composed of a copper ring, which also abides by Joules Law of Heating, however this was not a variable which was controlled in the experiment due this being a natural phenomenon. Furthermore, the magnetic levitation system's positioning of the magnet relative to the solenoid significantly differs compared to its desired applications. The levitation system had the copper ring around the solenoid and levitate within its length whereas typically the magnet is positioned above the end of the solenoid, where magnetic field lines are most dense and thus optimising the sustaining force.

5.23 Use of Findings

The experiment provides valuable insight into how temperature changes within systems sustaining magnetic levitation through measuring the impact of changing temperature on levitation height. This is made evident through the slope of the trendline between temperature and levitation height, with the relatively large magnitude indicating the significant effect temperature has on electromagnetic levitation whereas the negative slope reveals the values are inversely proportional, supporting the hypothesis. Consequently, results can be taken into consideration for larger scale set-ups in designing systems that manage the temperature, thus optimising the height of levitation, or understanding the constraints of certain set-ups before efficiency plummets.

6.0 Conclusion

The investigation yielded a strong negative linear relationship between the temperature of the copper ring and its resultant levitation height, supporting the hypothesis. The trend in the data aligns with the expected theory through the increased resistance impacting the flow of current, thus limiting the magnetic fields strength and thus force withstanding the weight of the copper ring. However, errors and limitations regarding the systems set up as well as a lack of care taken into ensuring proper measurements impact the reliability of the data. However possible improvements involving an emphasis of pretrial testing to check and adjust equipment to ensure for the desired interaction of the magnet in the system, using technology to play back trials to make more accurate measurements and controlled variables using quantifiable methods should be considered for future investigations to allow for the improvement in the validity of results.

Word Count: 2192

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OSA Investigation Log Book

By Zarif Hossain **ID: 367-3193**

Mar 31, 2026:

Today I started thinking about some possible investigations I want to carry out - mainly want to focus on physics and potentially look into magnetism as a current area of interest such as how large (surface area of base) an object can be to sustain magnetic levitation.
Began creating a rough scaffold for the report such as titles for sections and controlled var + error tables
Began looking at tips on the website for science investigations

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Apr 6, 2026:

I began researching more into magnetic levitation and discovered a variety of ways in which it can be achieved, with the main one that interested me was how diamagnetic material levitates through a 'sandwich' method. I also began looking into some more possible Independent Variables such as Mass and shape + orientation of the magnet - will look more research to find which can be investigated the most
Will try to ask my Physics teacher to see what materials/Equipment are available at school

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Apr 9, 2026:

I was able to see the equipment at school - realised that I did not have my desired equipment for supporting diamagnetic levitation and would require some effort and material time testing. I did not have to continue with this area of levitation. Thus, I realised the equipment was able to facilitate electrodynamic suspension, another form of levitation, which I could potentially investigate. Through further research I realised the chance to change a variable which could be more easily manipulated, that being the current which would allow me to discuss more about the physics through its involvement in determining the magnetic strength which then correlates to the levitation height.

Also I am able to do this for my School Physics investigation and thus can more easily get feedback from physics teachers.

May 6, 2026:

Today I was able to procure the materials to try and create magnetic levitation with a copper ring and solenoid, however after setting it up properly it was unable to work. After viewing back on this experiment I deemed it to be due to the use of supplying the solenoid and consequently the copper ring with an DC current, which due to Earnshaw's Theorem creates a static magnetic field which does not allow for levitation. Instead, AC should have been used to comply with Earnshaw's theorem and thus allow for magnetic levitation. This also makes sense through the current of the system with an upwards current in the solenoid pulling the copper ring down whereas the inverse pushes the copper ring up. With these changes in direction occurring at a high enough frequency this results in the copper ring constantly being pulled and pushed which allows it to appear levitating in the air.

May 6, 2026:

Carried out the practical within class however magnetic levitation was not able to be achieved. I attribute this to the mass of the copper rings attempting to be levitated being much too great that the EMF produced by the selected solenoid could produce. However, I was able to feel some ‘strength’ when touching the copper ring as I increased current, which showed me there was an effect but the mass of the ring was too large for the EMF to levitate it.

May 7, 2026:

In this lesson I redid the method to include a lot more specification and reduce the amount of random errors as well as for consideration to the increase in risk the experiment had when using a more powerful solenoid, something I learnt from last lesson was how fast it heats up the larger the solenoid. Additionally, the material specifications of the method were designed to allow for a light enough ring for the EMF waves to allow for vertical motion, however my physics teachers mentioned some testing should be done to see whether it is possible with the specifications in mind.

May 12, 2026:

Today I got roughly all the necessary equipment required to test my practicality which included the wiring and power supply as well as a variety of solenoids to test. Additionally, a copper sheet with a wire cutter was made to make the ring light enough out of the sheet. Although, the idea of making the solenoid from scratch was also considered as a result of the solenoid having a sort of square at the ends which prevented a ring from sliding over, with the ones which didn't include this base being much too small for levitation to be achieved.

Jun 5, 2026:

I was able to take a large roll of copper wire home for the 4-day weekend, providing myself ample time to create the solenoid through wrapping the wire myself. However, despite my attempts I was unsuccessful primarily due to the copper wire not being able to maintain its tension and consequently springing back up.

Jun 11, 2026:

After re-evaluating the means I had for conducting the practical I had 2 potential ideas to use

- The first was to check with the lab technician if the school possessed a Variac; a device able to change the voltage supplied to an electrical load and consequently allow me to change the current as governed by Ohm's Law
- The second option was to attempt and create my own copper ring through cutting and bending a copper sheet around a pre-built solenoid such that it was close in contact to the solenoid but not directly touching

Therefore, I decided to email the lab technician to ask for their advice regarding whether the school had a Variac or if I could make the copper ring myself.

Jun 15, 2026:

The email I received from the lab tech revealed the school did not have a Variac as well as them saying they attempted to make a copper ring yet the results were not that good (which in hindsight I should have expected as I believe that due to the copper ring not being completely connected as the layers would be over each other the induced current could not properly flow uniformly throughout the ring, thus making the magnetic field unstable). However, they did suggest the idea of changing temperature, which I had realised from my previous practical was something which affected levitation height as leaving on the machine resulted in the copper ring gradually 'dropping'. Thus, I decided to shift my experiment from changing the current to changing temperature (both are related as temperature affects resistance and current and resistance are both variables in Ohm's law which are inversely proportional and measuring levitation height instead of amplitude of oscillations (roughly the same thing).

Jun 19, 2026:

Conducted the practical within this day during lunch time (variation 3-5) and after school (1-2) after finalising time period with lab tech and supervising (physics) teacher. Overall the set up and execution was very simple and easy to repeat, the main difficulty was the time it took for the copper ring to cool down, from the data I am quite happy with the results as when plotted indicate a clear trend which i expected. Although I did not get my desired variables to measure and change I was able to alter them to link it while maintaining the same (if not more) depth through doing so.

Screenshot of Raw Data

start temp (c)	final temp (c)	max height (cm)	min height (cm)
22	30.1	9	6
22.3	29.2	8.9	6.1
22.1	29.8	8.7	5.9
27	31	8.5	5.4
25.8	33	9	5.3
26.4	30.4	8.5	4.9
28.9	32.8	7.7	4.6
30.3	33	7.9	4.9
30.7	35.4	7.8	4.8
16	22.3	9.5	6.9
17.4	21.4	9.3	6.3
16.7	20.1	9	6.1
20.4	22.2	8.7	5.6
20.3	23	9.5	6.5
20.7	21.7	8.9	6.1

Jun 28, 2026:

I have essentially finished the entire investigation write up, it took some less time then I thought it would and I was able to reasonably fit in the word count to my surprise. Overall the process of my investigation has been more vigorous than I imagined when signing up. The initial phases of having a lot of potential ideas made it difficult to choose one to investigate, which combined with the difficulty of finding sources for my specific topic made it a long process. Additionally, a lot of shortcomings came when I was attempting to carry out my experiment, resulting in me having to make numerous alterations in order for the practical to even occur. Moreover, the time it took to do all of this made it clash with my school work, which resulted in even more time being needed as I had to frequently push back completing steps in the work. Some useful things which occurred throughout the process was the school already having a magnetic levitating system (allowed me to conduct the practical), learning about heat and electric circuits during physics while doing my investigation (proved my thinking and improved my knowledge) and doing this investigation as an assignment for physics earlier (combining school work with the extracurricular). Overall, this process has taught me a lot about the perseverance and work going into being a scientist, making me appreciate the field even more.

OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☐ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

STUDENT(S) NAME: Zarif Hossain
ID: 367-3191

SCHOOL: Glenunga International High School

Activity: Give a brief outline of what you are planning to do.

Create a vertical oscillating system that used both EMS and EDS concept that causes copper ring where a solenoid is inside the opening (not touching) to vertically oscillate through alternating current. The experiment will measure the amplitude of the oscillating copper ring and vary the current supplied to the solenoid.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control/manage the risk
Electrical Risks: Use of electrical equipment including a power supply, wires and a solenoid	Make sure the experiment is conducted on a dry surface with no water anywhere on the working station. When turning on and off make sure the voltage is slowly adjusted down to 0 and make sure the voltage knob is turned slowly when increasing the voltage. Additionally use relatively low currents (max of 2A) to reduce the risk of electrical fires. Furthermore, frequency of AC is kept to Australian Safety Guidelines of 50Hz.
Thermal Risks	Due to use of electrical equipment (particularly solenoid) heat is generated which can cause burns if hot enough. Making sure to frequently turn off the system and give it time to cool back down ensures the temperature never reaches an unsafe value.

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Zarif Hossain

SIGNATURE(S): Z Hossain

☑ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: STEPHANIE MAYES

SIGNATURE: [illegible] DATE: 07/05/2026