**Introduction:**

Clearly introduce topic in such a way that the need for the project is compelling. Larger question or concern is clearly articulated. Two or more key citations from primary literature are included to effectively embed the research topic in the body of knowledge.

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**Research Question:**

(1-2 Paragraphs): What is the main goal or question addressed by your research? How will it add to our existing body of knowledge?

The purpose of this investigation is to determine how sound waves affect the shape and formation of the gas cloud which is to be used as an electronic propellant for use in a spaceflight vehicle. Experiments done with lycopodium; a gas like particle used in physics have been done which produce a spherical vortex formation when under specific ranges of tones and frequency.

In this experiment, we will attempt to create formations similar to Hans Jenny’s experiment using noble gases which are commonly used in electronic propulsion devices. Creating a vortex formation in a cloud of propellant gas before applying an electronic ark to create a plasma will allow for experimentation in increased efficiency of electronic energy transfer while in space flight.

Research question or hypothesis is clearly articulated and effectively connected to the introduction. Authors clearly explain how their work adds to the existing body of knowledge.

**Methods:**

**Resonance Chamber Testing Gas vs Frequency**

We will begin testing our calibrated frequencies in our resonance chamber using gases which will allow us to attain proof of concept. sulfur hexafluoride. Sulfur hexafluoride is a very dense gas which has similar characteristics to xenon.

**Sulfur Hexafluoride & floating orbital Experiment**

Sulfur Hexafluoride vs Xenon Comparison

|  |  |  |
| --- | --- | --- |
| **QUALITY** | **XE** | **SF6** |
| DENSITY (STP) | 5.761 kg/m3 | 6.164 kg/m3 |
| MOLECULAR MASS | 131.29 g/mol | 146.055 g/mol |
| INERT | YES | YES |

(2-5 paragraphs): What methods will you use to conduct your research? Be as specific as possible and include details like your sample size, number of replicates, etc. Your plan may change, but do your best to outline a detailed method. A flow chart of other visual organizer might be a nice way to present part of this section.

Methods are written in enough detail that another scientist could replicate the experiment. Specifics such as sample size, number of replicates, etc. are included. References are cited appropriately.

**Equipment, Reagents, Supplies and Other Needs:**

(1-3 Paragraphs and/or table): This section of your proposal should include a detailed list of reagents and supplies you will need to complete your research. If you have specific needs, include the manufacturer, item number, and cost in your list. This section should also include any specific lab space or equipment your project will require. In addition, consider whether or not you will need additional expertise and/or scientific mentors. If so, who will you use? What do you need them for? How much time do you anticipate needing?

**A. Hard Copy of Main Reference Materials:**

|  |  |  |  |
| --- | --- | --- | --- |
| Cymatics Soundscapes: And Bringing Matter To Life With Sound... DVD | [Available on Amazon](https://www.amazon.com/dp/1888138106?tag=opr-mkt-opr-us-20&ascsubtag=1ba00-01000-ubp00-mac00-other-nomod-us000-pcomp-feature-scomp-wm-4-wl-sce0&ref=bit_scomp_sav0) | DVD Set with experimentation videos and data | $30 |
| Cymatics: A Study of Wave Phenomena & Vibration Hardcover – July 1, 2001 | [Available on Amazon](https://www.amazon.com/Cymatics-Study-Wave-Phenomena-Vibration/dp/1888138076/ref=pd_sbs_74_1?_encoding=UTF8&pd_rd_i=1888138076&pd_rd_r=T3RSFQ6EFH86SYZDMWM1&pd_rd_w=qGYyx&pd_rd_wg=gDqKj&psc=1&refRID=T3RSFQ6EFH86SYZDMWM1) | Full color reference material and instructions. | $58 |

**B. Hardware Required for Recording and Documenting Experiments:**

|  |  |  |  |
| --- | --- | --- | --- |
| DSLR Camera (x2) |  | Allows for multiple angle recording of substance shapes and wave path shape of laser. | $4000 for 2 and lenses |
| Quad Ruled Composition Notebooks (x4) |  | Allow for notes to be taken and graphing | $20 for 4 |
| Pro Tapes Measurement-Tape | [Available on Amazon](https://www.amazon.com/Pro-Tapes-Pro-Measurement-Ruler-Tape/dp/B003ZFGTWA) | paper tape with adhesive backing which can be used as a repositionable ruler. | $15 |
| Infrared Thermometer | [Available on Pasco](https://www.pasco.com/prodCatalog/SE/SE-9785_infrared-thermometer/index.cfm) & [Multiple Locations](https://www.google.com/search?q=Infrared+Thermometer+extech&client=opera&hs=BVf&source=univ&tbm=shop&tbo=u&sa=X&ved=0ahUKEwiZ1qKTsMvYAhVS3mMKHVNQAHgQsxgIKg&biw=1195&bih=663) | non-contact **infrared thermometer** measures up to 752°F (400°C) with built-in laser pointer to identify target area | $75 |
| Laser Switch | [Available on Pasco](https://www.pasco.com/prodCatalog/ME/ME-9259_laser-switch/index.cfm) | Laser timing sensor which will be used with the laser and rubber diaphragm experiment to calculate the period of oscillation using a single point in path of motion. | According to [Pasco](https://www.pasco.com/prodCatalog/ME/ME-9259_laser-switch/index.cfm) website, photogates used in NSC physics labs should work as laser switch. |
| Visible Laser Diode Mirror (x3) | Available at Edmund Opitcs | specially coated to attain maximum reflection of visible laser diodes. | $54 for 3 |
| Slow Motion Camera | Available at [Adorama](https://www.adorama.com/faftones.html?gclid=EAIaIQobChMImOnM3qvM2AIVj2V-Ch3N2AwyEAkYAiABEgKBqPD_BwE) | Will allow us to view the path of the laser using the rubber diaphragm and mirror.  Will allow us to look for vortex inconsistencies in later experiments | $10,000 |
| Wireless Pressure Sensor | [Available on Pasco](https://www.pasco.com/prodCatalog/PS/PS-3203_wireless-pressure-sensor/index.cfm) | Make accurate and consistent measurements of gas pressure, regardless of ambient conditions, and explore how chemical reactions affect gas pressure. | $69 |
| Sarasa Porous Pens | Available at Bookstore | Allow for Permanent and accurate journal entries. | $5 |
| Sharpies Markers | Available at Bookstore | Make Engineering Marks & Measurements on equipment | $10 |
| Digital Sound Level Meter | [Available at Pasco](https://www.pasco.com/prodCatalog/SE/SE-9761_digital-sound-level-meter/index.cfm) and [everywhere where else](https://www.google.com/search?client=opera&q=extech+digital+sound+level+meter&sourceid=opera&ie=UTF-8&oe=UTF-8) | provides greater accuracy and more sophisticated measuring capabilities than an analog meter. | $75 |
| Reagent Grade Lycopodium Powder, 500g | [Widely available](https://www.flinnsci.com/lycopodium-powder-reagent-500-g/l0034/) | Small, gas like particles Used in physics to visualize sound waves and electrostatic charge. | $100 |

**C. Materials Needed for Gas/Plasma Testing Chamber & Lycopodium Testing Chamber (MUST USE SEPARATE CHAMBERS TO AVOID DUST FIRE):**

|  |  |  |  |
| --- | --- | --- | --- |
| Function Generator | [Available NEW from Pasco](https://www.pasco.com/prodCatalog/PI/PI-8127_function-generator/index.cfm). Available USED, everywhere else. | Outputs sine, square, triangle, positive and negative ramps with a frequency range of 0.001 Hz to 150 kHz in addition to DC | $775  Available ON CAMPUS! For FREE |
| Reagent Grade Lycopodium Powder, 500g | [Widely available](https://www.flinnsci.com/lycopodium-powder-reagent-500-g/l0034/) | Small, gas like particles Used in physics to visualize sound waves and electrostatic charge. | $100 |
| Sulfur Hexafluoride SF6 |  |  |  |
| CO2 Gas / Dry Ice | Widely Available | Gas which is safe and visible |  |
| Mid-Range, Infinite Baffle, Marine Grade Speaker with Concave Structure (x2) | JL Audio has a good match | Can be used to create pressurized sound chamber for gas/plasma and lycopodium testing at midrange frequencies. | $580 for pair |
| Acrylic Cylinders & plates of various dimensions. |  |  | $900 |
| Valves, Piping and gas components |  |  | $150 |
| Paper Diaphragms of Varying Sizes (x2)  *Possibly Drumheads* |  | Will be used for replication of Hans Henny experimentation & Calibration. |  |
| Rubber Diaphragms (x2) |  | Will be used to record the sound and graph of physical sound wave. |  |
| Drum Mounting Equipment |  |  |  |
| 1 Pint of Weld-On 4 | [Widely Available](https://www.google.com/search?q=weld+on+4&client=opera&hs=wt3&source=lnms&tbm=shop&sa=X&ved=0ahUKEwixjdXN5cvYAhUPwmMKHWK4A2gQ_AUICigB&biw=1195&bih=663) | Used to Fuse Acrylic surfaces together (literally a chemical melting and hardening process) in order to maintain a vacuum. | $20 |
| Joint Sealing Compound (x5) | [Global Industrial](http://www.globalindustrial.com/p/hvac/chemicals-lubricants-cleaner/chemical/leak-lock-gold-one-and-one-third-oz?infoParam.campaignId=T9F&gclid=EAIaIQobChMIyZOL0ObL2AIVFdNkCh1E6Qa7EAQYASABEgLpBPD_BwE) | Use with pressures to 10,000 PSI to full vacuums. Safe with most chemicals and gas. | $30 for 5 packs |
| Shop and Machining Resources @ NSC |  | Will need to use certain cutting equipment, sanders and drill press for engineering of gas/plasma chamber and lycopodium testing chamber. |  |

Equipment and supply needs are effectively organized. List is complete. Additional needs (lab space, subject matter, expertise, etc.) are clearly articulate.

**Timeline:**

Provide a detailed, week-by-week timeline for your project. This timeline should include specific action items for each week. Note that you typically have two to four class hours available to you for research each week. Your timeline should indicate how you will use this time as well as the additional hours you spend outside of class.

|  |  |  |  |
| --- | --- | --- | --- |
| **Period** | **In Class** | **At Home** | **Goals** |
| ***Week 1*** |  |  |  |
| ***Week 2*** |  |  |  |
| ***Week 3*** | * Shopping for hardware required for assembly of experimentation equipment. * Overviewing Designs and methods * Work with Physics Instructors for relevant Eqautions * Work with Chemistry Instructors for relevant chemistry Equations * Work with Math instructors for measurement and calculation methods | * Shopping for hardware required for assembly of experimentation equipment. * Networking with campus faculty for assembly assistance. * Preparing home environment for at home assembly work. * Researching known frequency ranges and combinations of tuning methods. * Reading Hans Jenny Material and Videos * Working on Design Features * Consulting with audio professionals, Chemistry and physics faculty. * Start working on abstract * Write Abstract | 1. Aquire Equipment 2. Complete Measurements for chamber construction 3. Publish Proposal as new Plasma Vortex Theory 4. Home Lab Setup |
| ***Week 4*** | * building acrylic pressure chamber * Frequency Calibration * Recording Data and Video of Frequency Calibration.   **Abstract Writing Workshop**   * Edit Abstract | * Engineering Test Environment - Changes & Problems * Calculations related to Frequency Calibration * Organizing Video Sequences for Documentation. * Discussing Results with peers * Reading and Watching Similar Research Projects | * Start Testing with Wave Driver |
| ***Week 5*** | * Testing Noble Gas Ampoules / Micro Vortex Possible? * Finishing Chamber * Pressure Test Chamber * Lycopodium testing * Work on Abstract   **Optional Draft Abstract Due to instructors (in Canvas)** | * Work on Abstract * Promote Vortex Theory * Watch and Edit Recorded Video for Report * Work on Report Journal | * Atttain Vortex Formation with Laycopodium |
| ***Week 6*** | * Test Noble Gas and Sound in Completed Chamber | * Make Hardware Adjustments * Work on Abstract | * Finish Abstract |
| ***Week 7*** | * Work on Plasma creating Plasma in the lab * Conduct Laser Experiment   **Progress Report Session 1**  **UW Abstract Due 2/13** | * Research Electromagnetic Propulsion and Plasma Theories * Make Hardware Adjustments * Work on Abstract | * Edit and Compile Experimental Video Footage |
| ***Week 8*** | * Writing Results * Recording Video Documentation * Recording Promotional Video   **Progress Report Session 2** | * Start Micro Documentary * Create Scientific Pages & Groups |  |
| ***Week 9*** | * Recording Interviews of Scientists involved in Project * Introduce Scientific Journal for Publishing | * Work on PPT Presentation of experimental data * Work on Scientific Journal for Publishing   **Research Presentation PPT draft due to instructors (in Canvas)** | * Draft Results in Scientific Journal * Demonstrate Plasma Vortex for Scientific Review |
| ***Week 10*** | * Work on Scientific Journal | * Edit Video Footage For Micro Documentary For Presentation and Social Sharing for scientific review.   **Rehearsal of Presentation, Peer Review** | * Complete Scientific Journal for Publishing * Complete Micro Documentary |
| ***Week 11*** | **Final Presentations** |  |  |

Detailed weekly timeline is provided. All critical deadlines are noted on the timeline. Responsibility for key tasks is clearly delegated to specific team members when necessary.

**Conclusion:**

(~one short paragraph): What are the most significant challenges you see for your group’s research?

Conclusion restates overall goal and highlights any challenges or unmet needs the project faces.

**Other Considerations:**

Although the sections differ from a formal report or poster, your team should agree to write it with the same level of quality. Be sure to include tables and other figures to support your proposal. These figures should be numbered and have captions as usual. We are willing to read and critique drafts before the due date if your team would like feedback.

Writing is professional and proofread with a minimum number of typographical errors. Sentences and paragraphs are complete and transition smoothly from one to another. References are cited appropriately. Any figures are appropriately labeled and referenced clearly in the text. Use of first person is minimized.

**Bibliography**: