SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Prize Winner

Scientific Inquiry

Year 9-10

Caleb Van Wezel

Emmaus Christian College

ROWE SCIENTIFIC PTY. LTD. www.rowe.com.au

Australian Government
Department of Defence

Government of South Australia
Department for Education

SASTA South Australian Science Teachers Association

Length of a Light Bulb's Electrical Filament vs its Luminance

Caleb van wezel - February 2023
Teacher: Dr S

Abstract

This experiment determines the effect of the length of a light bulb's electrical filament on its luminance. A DIY lightbulb was constructed and different lengths of filament wire (nichrome wire) were used. Using a Lux (luminance) sensor, each length of wire was tested in the light bulb, and the average light reading over ten seconds was recorded. Everything was tested in a controlled environment. It was observed from the results obtained that as the length of the filament increased, the amount of light decreased. The relationship between the two is linear, as it decreases at a steady rate. The length of the filament and the light produced correlate negatively with each other. The results can be explained like this; resistance increases with length, reducing the current and power flowing through the filament, and thus decreasing the amount of light produced.

Aim

To determine the effect of the length of a light bulb's electrical filament on the luminance (Lux measure) of the light bulb.

Introduction

Energy is a precious resource, so it is important to use as little as possible. Making energy-consuming devices more efficient means that we can achieve this. Lightbulbs are an example of an energy-consuming device. They are used for illuminating rooms and help visibility at night.

Most incandescent light bulbs are around 10% efficient (Nisson & Wilson, 2008, p. 117). This means that 90% of the energy used to power the light is wasted as heat. So when making an incandescent light bulb, it is important to make it as efficient as possible. Various

factors affect the efficiency of a light bulb including, the type of electrical filament, the voltage it runs at and the thickness of the electrical filament.

This experiment investigates how the length of the electrical filament affects its brightness. Optimising the length of the electrical filament can increase the efficiency of the bulb and reduce the amount of wasted energy.

Hypothesis

The longer length of a light bulb's electrical filament, the more luminance it has. (A positive correlation between the length of a light bulb's electrical filament and its luminance).

Risk assessment

RISK ASSESSMENT **Emmaus Christian College Students**

The Length of a Light Bulbs Electrical Filament vs its Luminance

Written by: Caleb van Wezel **Commenced on:** 11 Feb 2023 **Expires:** 11 May 2024

Classes for which experiment is required

Teacher: Dr Skouroumounis **Year Group:** 9

Room	Period	Date
G.3	4-5	Wed 15/2/23

Items to be prepared by laboratory technician

1 x 10A Power Pack
1 x Nichrome wire

Procedure or reference, including variations

Powerpack powering a diy lightbulb

https://www.instructables.com/Homemade-Lightbulb/

Measuring using a lux/light sensor to see how the length of the nichrome wire (electrical filament) affects its luminance

Method:

- The light bulb was secured to a bench using tape, so that it didn't move.

- The power supply was plugged into a powerpoint, and its leads were connected to the bolts at the bottom of the diy light bulb.

- The Lux sensor (smartphone) was secured beside the jar in a phone stand that was taped down on the bench so it didn't move.

- The first length of Nichrome wire (10cm) was carefully attached between the tops of the bolts in the diy light bulb.

- Simultaneously, the light was turned on and the app started recording the lux for 10 seconds.

- The results were recorded.

- The 10cm length of nichrome wire was tested 2 more times, and the results were recorded

- Each other length of nichrome wire (16cm, 22cm and 28cm) was tested 3 times each in the same fashion. The results were recorded.

Equipment to be used

glass jar with lid

Potential hazards
Glass jar may break. Filling with hot liquids may cause cracking, due to differential expansion of glass inside and outside.

Standard handling procedures
Inspect and discard any chipped or cracked jars, no matter how small the damage. Sweep up broken glass with brush and dustpan; do not use fingers. If lid is rusty, particles of rust may contaminate contents of jar.

power supply

Potential hazards
Possibility of electrical shock; check cable, cable entry and plug before each use. Level of risk depends on output voltage.

Standard handling procedures
Leads should be well insulated at every point, so that it is impossible to touch live metal. Inspect regularly for signs of damage to cord, cord loose in plug, cord loose at entry to power supply, or any signs of corrosion or other damage. Should be tested and tagged regularly.

power supply leads

Standard handling procedures
Check for integrity of insulation at regular intervals.

Chemicals to be used

nichrome, wire **Ni (80% wt/wt), Cr (20% wt/wt)**

Class: nc PG: none Users: 7-12 Training: 1-5

GHS data: Not classified as a hazardous chemical.

Potential hazards
Repeated contact of skin with the surface of nichrome may cause skin irritation and sensitisation, e.g. with people allergic to nickel jewellery. Nickel and chromium oxide particles may be transferred to hands when touching nichrome.

Disposal
May be placed in the garbage.

Others
Lux/light sensor (on smartphone)
Potential Danger: Electricity, light, heat, glass shattering.

Knowledge
I/we have read and understood the potential hazards and standard handling procedures of all the equipment, chemicals and biological items, including living organisms.
I/we have read and understood the Safety Data Sheets for all hazardous chemicals used in the experiment.
I/we have copies of the Safety Data Sheets of all the hazardous chemicals available in or near the laboratory.

Agreement by student(s)

I/we, Caleb van Wezel, agree to conduct this experiment safely in accordance with school rules and teacher instructions.

Risk assessment

I/we have considered the risks of:

fire or explosion	injuries from equipment	biohazards	waste disposal
chemicals in eyes	rotating equipment	injuries from animals	improper labelling/storage
inhalation of gas/dust	electrical shock	environmental impact	inappropriate behaviour
chemicals on skin	vibration or noise	intense light/lasers	communication issues
ingestion of chemicals	sharp objects	UV, IR, nuclear radiation	allergies
runaway reaction	falling or flying objects	pressure inside equipment	special needs
heat or cold	contamination of area	heavy lifting	ethical issues
breakage of equipment	exposure to pathogens	slipping, tripping, falling	other risks

For outdoor activities, consider also wind, temperature, rain/hail/snow, UV, air quality, fire danger, pollen, bites/stings etc

Assessment by Student(s)

I/we have assessed the risks associated with performing this experiment in the classroom on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018.

I/we consider the inherent level of risk (risk level without control measures) to be:

Low risk **Medium risk** High risk Extreme risk

Control measures:

Electrical gloves - To insulate from electricity
Additional measures: gloves

With the specified control measures in place, I/we have found that all the risks are "low risk". Risks will therefore be managed by routine procedures in the classroom, in combination with the specified control measures.

Certification by Teacher

I have assessed the risks associated with performing this experiment in the classroom on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018. I confirm that the risk level and control measures entered by student(s) above are correct and appropriate.

Name: ..... **Signature:** ..... **Date:** .....

Certification by Laboratory Technician

I have assessed the risks associated with preparing the equipment, chemicals and and biological items, including living organisms, for this experiment and subsequently cleaning up after the experiment and disposing of wastes, on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018.

I consider the inherent level of risk (risk level without control measures) to be:

☐ Low risk ☐ Medium risk ☐ High risk ☐ Extreme risk

Where the risk level is "medium risk", "high risk" or "extreme risk", the following control measures will be employed:

Control measures (attach further pages as required):

☐ safety glasses ☐ gloves ☐ lab coat ☐ apron ☐ fume cupboard

With the specified control measures in place, I have found that all the risks are "low risk". Risks will therefore be managed by routine procedures in the laboratory, in combination with the specified control measures.

Name: ..... **Signature:** ..... **Date:** .....

Monitoring and review

This risk assessment will be monitored using electronic review notes or hand-written notes on a printout. It will be reviewed within 15 months as part of the regular review process.

Variables

Independent variable:	Length of the electrical filament (nichrome wire) inside the light globe. (Lengths of: 10cm, 16cm, 22cm and 28cm).
Dependent variable:	The luminance of the light globe (in Lux).
Controlled variables:	The brightness of the background light, the voltage powering the globe, the design of the light globe, the type of wire, the wire thickness, the type of light sensor, the position of the Lux sensor, the position of the light globe.

Materials

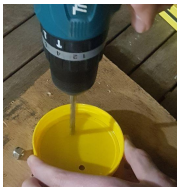
- DIY lightbulb
- - (*Nichrome wire, Glass jar, 2 Bolts,* 6 Nuts)
- Tape
- Cardboard box
- Power supply
- Power supply wires
- Alligator Clips
- Smartphone Lux sensor
- Tweezers
- Scissors
- 30cm Ruler

Method

1. Electrical gloves were put on

DIY lightbulb:

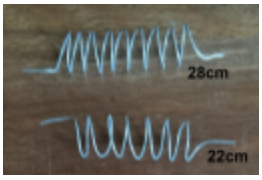
2. Two ¼-inch holes were drilled into the plastic lid of a 560g vegemite jar 4 cm apart.

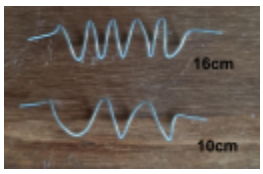


3. A ¼-inch bolt was screwed into one of the holes, and a ¼-inch nut was screwed down the other side of the lid, to hold it on. This was repeated on the other side

4. Two nuts were screwed onto the top of each bolt (This meant that the nichrome wire could be clamped in between the 2 nuts later in the experiment).
5. A stand was made for the light bulb holding it 5cm off the ground. This meant that the bottom of the bolts were accessible for Alligator Clips later in the experiment.

6. The glass bottom of the jar was screwed on top of the lid.
7. Nichrome wire (Ni 80%, Cr 20%) that was 0.315mm in diameter was collected.
8. Each length of Nichrome wire (electrical filament lengths: 10cm, 16cm, 22cm and 28cm) was measured using a ruler and cut using scissors.
9. Then the wire was wound over the same pencil with a diameter of 8mm. It was then stretched out to 5cm.

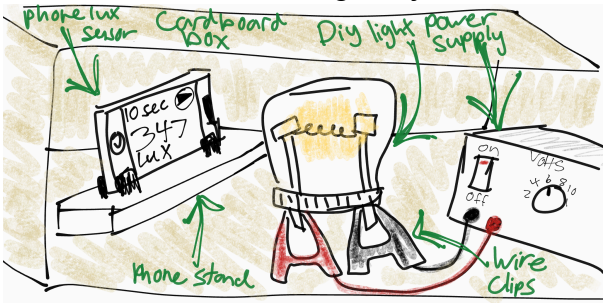




Setup:

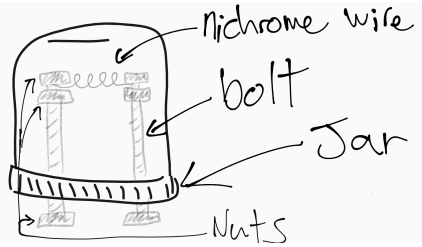
10. A cardboard box, with one side open, was placed onto a bench.
11. The DIY light bulb was secured to the bottom of the cardboard box using tape so that it didn't move.

12. A 2-12V power supply was plugged into a PowerPoint and set to 6 volts.
13. The power supply leads/wire were inserted into the power supply and the other end was clipped onto the ends of the bolts at the bottom of the DIY light bulb.
14. The smartphone Lux sensor was placed into a phone stand that was taped down to the cardboard box facing the jar.



Experimental Method:

15. A length of Nichrome wire was carefully clamped between the tops of the bolts in the DIY light bulb.

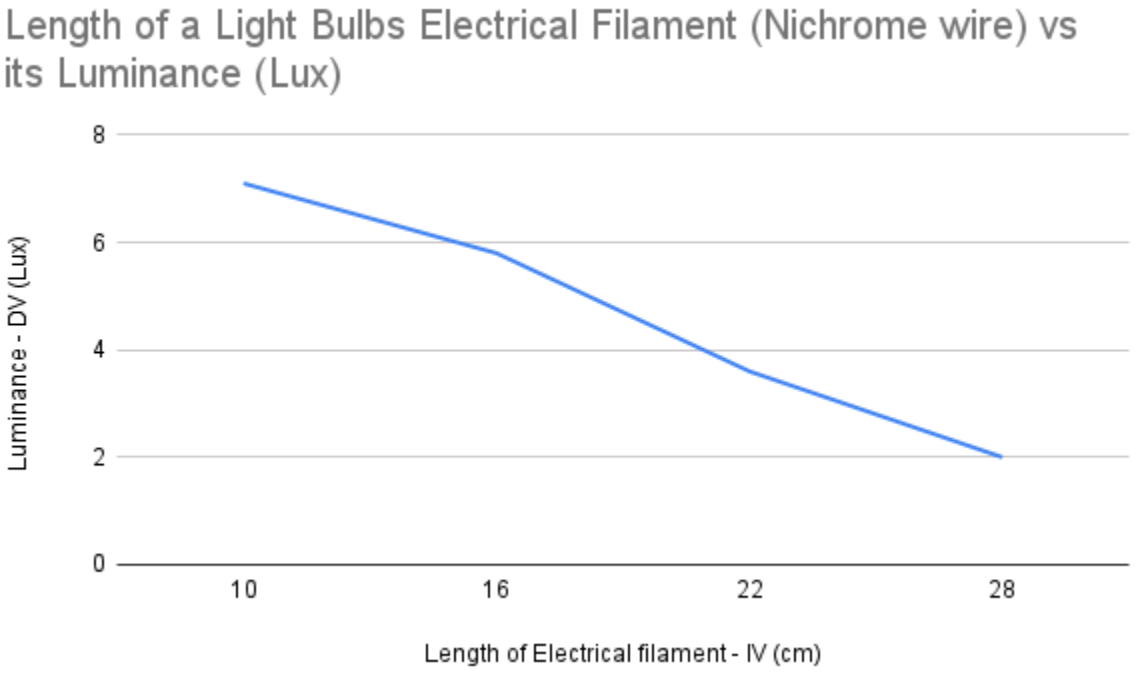


16. The power supply was turned on, which subsequently turned on the light bulb
17. The 'Light Meter - Lux Meter' app started recording the luminance for 10 seconds.

18. The average Lux was recorded.
19. The Nichrome wire was taken out with tweezers
20. Steps 15 to 19 were completed 4 times for each length of nichrome wire, 10cm, 16cm, 22cm and 28cm.

Results

Length of a Light Bulb's Electrical Filament (Nichrome wire) vs its Luminance (Lux):					
Length of Nichrome Wire (cm)	**1st trial** *(Average Lux measure over an average of 10 seconds)*	**2nd trial** *(Average Lux measure over an average of 10 seconds)*	**3rd trial** *(Average Lux measure over an average of 10 seconds)*	**4th trial** *(Average Lux measure over an average of 10 seconds)*	**Average trial (Lux) (Rounded to one decimal place)**
Control (Light turned off)	**1.8**	**1.5**	**1.6**	**1.5**	**1.6**
10	**7.3**	**7.0**	**7.1**	**7.1**	**7.1**
16	**5.9**	**5.6**	**5.7**	**6.0**	**5.8**
22	**3.6**	**3.5**	**3.5**	**3.8**	**3.6**
28	**2.1**	**1.9**	**1.8**	**2.0**	**2.0**



Discussion

Trends and Background Research:

This experiment aimed to determine the effect of the length of a light bulb's electrical filament on the luminance (Lux measure) of the light bulb.

The amount of light emitted by the lightbulb was measured using a Lux sensor. The results show that the longer the length of the electrical filament in the lightbulb, causes the lightbulb to emit less light (a lower lux level). The relationship between the length of the filament and the light produced is a negative correlation. There is a direct relationship between the two variables. The results are relatively linear, in a constant declining slope.

The hypothesis that was posed at the start of the experiment is not supported by these findings.

The results from this experiment are supported by Ohm's Law and the equation for electrical power.

The light in an incandescent lightbulb is produced through the resistance of a wire filament. This is because, while a 'resistance wire' resists the flow of electrons, it uses some of that electricity to make heat and light as a byproduct (the electrical energy is converted into heat and light energy).

Resistance is proportional to length, so the longer the wire is, the more resistance it has. Ohm's law states that Current = Volts / Resistance. Knowing that the volts are a constant variable (always stays at 6v), as the resistance goes up the current goes down. So, the more resistance the wire has, the less current flows through it. (Fluke, 2022)

The equation for electrical power is Power = Volts * Current. As the volts are constant, when the current goes down so does the power. As the power is decreased (due to the wire being longer), it results in less light being produced. (Phet, 2023)

Errors:

This experiment used a phone Lux sensor. If the sensor was not calibrated properly when it was used, then it might not show the true lux measure. The consequence of this would be that all of the results would be slightly wrong, but all by the same amount (systematic error). This would affect the data, but not the trend. This would be a minor error. To reduce the error, if the experiment is repeated, the Lux sensor must be professional grade, and fully calibrated.

This experiment was conducted inside a cardboard box in a classroom environment. Due to the classroom environment, the light levels are not controlled, so any light that makes its way into the cardboard box through holes could cause random error. The consequence of this is that it could make the data less precise. This would be a medium error. To reduce this error, should the experiment be repeated, the test should be conducted in a different room, where all outside light is blocked out.

During this experiment, the Lux sensor and the Light Globe were taped down. Due to the temporary solution to hold it down, there could have been slight movement between the light globe and the Lux sensor. Causing random error and making the data less precise. This would be a minor error. To reduce this error, if the experiment is repeated, the Light bulb and Lux sensor should be secured down using a more permanent solution (eg. nailed to a wooden baseplate).

This experiment used different lengths of Nichrome wire. To obtain the different lengths, they were measured beside a ruler and cut using scissors. Due to a curve in the wire, they might have been measured and cut slightly incorrectly. This would be a random error and would make the data less precise. This would be a minor error. To reduce this error, should the experiment be repeated, the wire should be fully straightened between two clamps, before measuring and cutting.

Evaluation

This experiment investigates how the length of a lightbulb’s electrical filament affects its luminance, it is the first step to measuring a light bulb's efficiency.

This means the investigation is useful because the experiment could be used to optimise the length of the electrical filament and increase the efficiency of the bulb to reduce the amount of wasted energy.

A related investigation that could be investigated is completely the same, but the voltage could be regulated to keep the same power output the same for all lengths of filaments. This would actually measure the efficiency of the light bulb. Unfortunately, this is too complicated to do at school with the tools provided, as it would need professional equipment.

Conclusion

This experiment was conducted to determine the effect of the length of a light bulb's electrical filament on its luminance. This aim was achieved, as the relationship between the two was clearly identified. The experiment found that the longer the length of a light bulb's electrical filament, the less luminance it has. This is a negative correlation between the length of a light bulb's electrical filament and its luminance. These findings are opposed to and do not support the hypothesis that was proposed.

References / Bibliography

Fluke, U. (2022, April 29). What is Ohm's law? Retrieved March 10, 2023, from https://www.fluke.com/en-us/learn/blog/electrical/what-is-ohms-law

Nisson, N., & Wilson, A. (2008). The Virginia Energy Savers Handbook. Retrieved March 1, 2023, from http://large.stanford.edu/courses/2014/ph240/dikeou2/docs/va-handbook.pdf

Science, K. F. (Director). (2017, March 14). *How to make a light bulb Experiment (homemade light bulb)* [Video file]. In *YouTube*. Retrieved February 2, 2023, from https://www.youtube.com/watch?v=c7NaDyTDm3c&t=308s

Staff, M. U. (2022, October 18). Science: Lab report. Retrieved February 1, 2023, from https://www.monash.edu/learnhq/write-like-a-pro/annotated-assessment-samples/science/science-lab-report

Staff, W. (2023, January 26). 55 best science experiments for High School Labs and science fairs. Retrieved February 2, 2023, from https://www.weareteachers.com/science-experiments-for-high-school

Team, M. (2022, March 15). How to write a scientific report: Step-by-step guide. Retrieved February 1, 2023, from https://www.matrix.edu.au/how-to-write-a-scientific-report/

Tech, A. (Director). (2018, December 19). *How to make light bulb , Amazing idea* [Video file]. In *YouTube*. Retrieved February 2, 2023, from https://www.youtube.com/watch?v=eUNugWKBfJY

Tulip, S., Morgante, K., & Starczak, L. (2022). Analysis of Data, Critical evaluation. In *Chemistry: Workbook, SACE 1 third edition* (pp. 300-306). Adelaide, South Australia: Adelaide Tuition Centre.

Unknown, U. (2023). Phet Ohm's Law. Retrieved March 10, 2023, from https://phet.colorado.edu/en/simulations/ohms-law

Unknown, U. (n.d). How to Write a Practical/Laboratory Report. Retrieved March 11, 2023,

from https://www.adelaide.edu.au/writingcentre/ua/media/46/learningguide-practicalreportinscience.pdf

Whyte, D. (2022, September 17). Compare electrolytes in sports drinks and Orange Juice: Science Project. Retrieved January 23, 2023, from https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p053/chemistry/electrolyte-challenge-orange-juice-vs-sports-drink

RISK ASSESSMENT **Emmaus Christian College Students**

Length of a Light Bulbs Electrical Filament vs its Luminance

Written by: Caleb van Wezel **Commenced on:** 9 Feb 2023 **Expires:** 9 May 2024

Classes for which experiment is required

Teacher: Dr Skouroumounis **Year Group:** 9

Room	Period	Date
2.1B	2	Tue 14/2/23
G3	4-5	Wed 15/2/23

Items to be prepared by laboratory technician

1 x 10A Power Pack
1 x Light sensor
1 x Nichrome wire

Procedure or reference, including variations

Powerpack powering diy lightbulb

https://www.instructables.com/Homemade-Lightbulb/

Measuring using a lux/light sensor to see how the length of the nichrome wire (electrical filament) affects its luminance

Equipment to be used

light sensor

power supply

Potential hazards
Possibility of electrical shock; check cable, cable entry and plug before each use. Level of risk depends on output voltage.

Standard handling procedures
Leads should be well insulated at every point, so that it is impossible to touch live metal. Inspect regularly for signs of damage to cord, cord loose in plug, cord loose at entry to power supply, or any signs of corrosion or other damage. Should be tested and tagged regularly.

power supply leads

Standard handling procedures
Check for integrity of insulation at regular intervals.

Chemicals to be used

nichrome, wire **Ni (80% wt/wt), Cr (20% wt/wt)**

Class: nc PG: none Users: 7-12 Training: 1-5

GHS data: Not classified as a hazardous chemical.

Potential hazards
Repeated contact of skin with the surface of nichrome may cause skin irritation and sensitisation, e.g. with people allergic to nickel jewellery. Nickel and chromium oxide particles may be transferred to hands when touching nichrome.

Disposal
May be placed in the garbage.

Others

Electricity, light and heat from nichrome wire

Knowledge

I/we have read and understood the potential hazards and standard handling procedures of all the equipment, chemicals and biological items, including living organisms.
I/we have read and understood the Safety Data Sheets for all hazardous chemicals used in the experiment.
I/we have copies of the Safety Data Sheets of all the hazardous chemicals available in or near the laboratory.

Agreement by student(s)

I/we, Caleb van Wezel, agree to conduct this experiment safely in accordance with school rules and teacher instructions.

Risk assessment

I/we have considered the risks of:

fire or explosion	injuries from equipment	biohazards	waste disposal
chemicals in eyes	rotating equipment	injuries from animals	improper labelling/storage

inhalation of gas/dust	electrical shock	environmental impact	inappropriate behaviour
chemicals on skin	vibration or noise	intense light/lasers	communication issues
ingestion of chemicals	sharp objects	UV, IR, nuclear radiation	allergies
runaway reaction	falling or flying objects	pressure inside equipment	special needs
heat or cold	contamination of area	heavy lifting	ethical issues
breakage of equipment	exposure to pathogens	slipping, tripping, falling	other risks

For outdoor activities, consider also wind, temperature, rain/hail/snow, UV, air quality, fire danger, pollen, bites/stings etc

Assessment by Student(s)

I/we have assessed the risks associated with performing this experiment in the classroom on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018.

I/we consider the inherent level of risk (risk level without control measures) to be:

Low risk **Medium risk** High risk Extreme risk

Control measures:

- Insulated gloves to eliminate the possibility of being affected by accidentally touching electrical supply from power-pack
Additional measures: safety glasses, gloves, apron

With the specified control measures in place, I/we have found that all the risks are "low risk". Risks will therefore be managed by routine procedures in the classroom, in combination with the specified control measures.

Certification by Teacher

I have assessed the risks associated with performing this experiment in the classroom on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018. I confirm that the risk level and control measures entered by student(s) above are correct and appropriate.

Electronic Signature: George Skouroumounis **Date:** 21 Jun 2023

You have provided an electronic signature which is the equivalent of signing your name with a pen and as such will constitute a legally binding agreement between the relevant parties. We can give no warranty in respect to fraud or security breach resulting from the use of an electronic signature.

Certification by Laboratory Technician

I have assessed the risks associated with preparing the equipment, chemicals and and biological items, including living organisms, for this experiment and subsequently cleaning up after the experiment and disposing of wastes, on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018.

I consider the inherent level of risk (risk level without control measures) to be:

Low risk **Medium risk** High risk Extreme risk

Control measures:

Additional measures: safety glasses, gloves, apron

With the specified control measures in place, I have found that all the risks are "low risk". Risks will therefore be managed by routine procedures in the laboratory, in combination with the specified control measures.

Electronic Signature: Jenelle Reeves **Date:** 21 Jun 2023

You have provided an electronic signature which is the equivalent of signing your name with a pen and as such will constitute a legally binding agreement between the relevant parties. We can give no warranty in respect to fraud or security breach resulting from the use of an electronic signature.

Monitoring and review

This risk assessment will be monitored using electronic review notes or hand-written notes on a printout. It will be reviewed within 15 months as part of the regular review process.

Science Project Online Journal: The 31st of January 2023 (week 1)

1.

In science today, I found out about the research project that we will be doing over the coming weeks. I can't think of any ideas yet, but I know that I would like to do something in the field of physics (it's my area of interest)

2.

I have just done some research online and found an interesting idea. It measures the electrolytes in a liquid. It works by putting two copper wires into the liquid and letting the liquid bridge the gap between them. It has a battery at one end and a multimeter to measure the voltage. The more electrolytes the liquid has, the better it will bridge the gap between the wires and the higher the voltage the multimeter will measure (as *'An electrolyte is a substance that will dissociate into ions in a solution. The ions in the solution give it the capacity to conduct electricity'*) (https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p053/chemistry/electrolyte-challenge-orange-juice-vs-sports-drink).

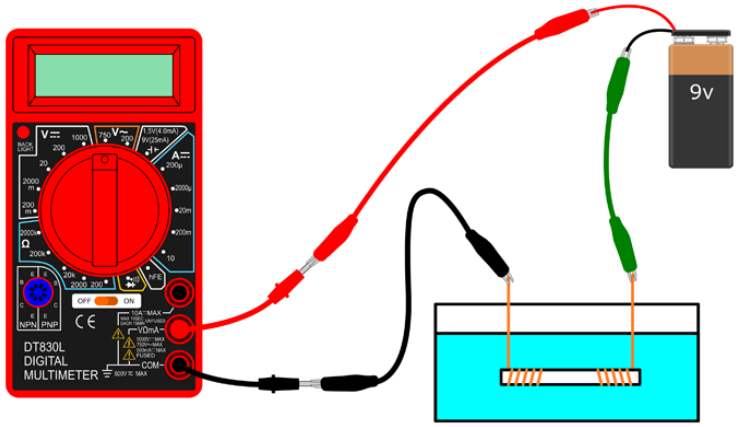
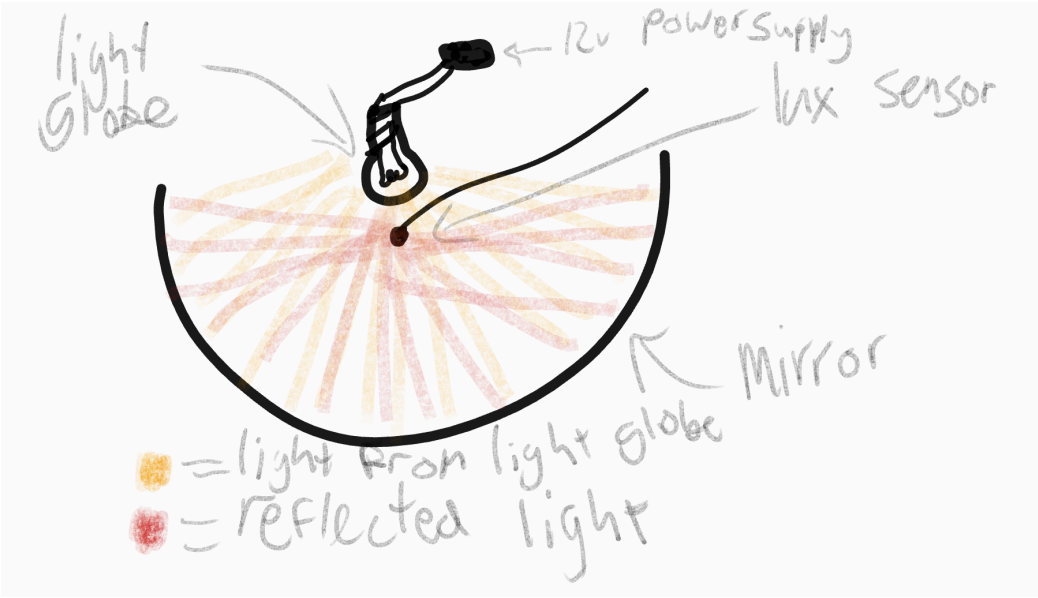


Diagram of the electrolyte measuring experiment (https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p053/chemistry/electrolyte-challenge-orange-juice-vs-sports-drink)

I think the idea of measuring electrolytes in liquids is interesting, but I don't want to do it for two main reasons. Firstly, I think that it is too simple and secondly, it has been done before.

3.

I just came up with the idea of measuring the efficiency of different lights (comparing the efficiency between different brands of lightbulbs)
To compare the efficiency of a light bulb, you would need to run different light bulbs at the same voltage and test how much light it produces. The brighter it is, the less energy is wasted as heat. This experiment works by using a concave mirror to concentrate all of the light from the light globe down to one point, where the lux sensor is, which measures all of the light created by the light globe.



A diagram I drew of the setup for comparing the efficiency of different lights

I like the idea of comparing the efficiency of different lights more than the electrolyte idea. I like it better because it is my idea, and I am interested in the area of efficiency. But I still don't want to do it because I think that it would be a hard experiment to do, due to needing to buy lots of lights, and find a concave mirror. I also don't really want to do an experiment comparing different products (boring!).

Science Project Online Journal: The 2nd of February 2023 (week 1)

1.

I don't like any of the ideas that I have come up with so far, so I am still thinking of a better one.

2.

I just had a conversation with my Mum about general experiment ideas. She gave me an insight into the area of exercise physiology. Exercise physiology is a field about how exercise affects the human body. A couple of example experiments for exercise physiology are: ' How does exercising indoors vs outdoors affect heart rate' or 'How does listening to music while exercising affect heart rate'. It would be an interesting topic to do, but it is not one of my main interests.

3.

I just came up with the idea of testing how the length of an incandescent light bulb's electrical coil filament vs its luminance.
It would be completed by making a diy light bulb, changing the length of the electrical filament wire and measuring the luminance with a lux sensor.
IV: Length of the light bulb's electrical filament
DV: Luminance/Lux measure
CVs: Voltage, brightness of room, position on the lux sensor, electrical filament thickness

The idea was inspired by a video (https://www.youtube.com/watch?v=c7NaDyTDm3c&t=308) that had a project of making a DIY light bulb. After finding this, I had the Idea of changing the length of the filament to affect the brightness.
I found another video of a DIY light bulb (https://www.youtube.com/watch?v=eUNugWKBfJY). This video used nichrome wire, I think I will also use it.

I really like the idea and I think that I am going to do it for my experiment. It ticks all my boxes.

4.

I just had a conversation with my Mum about this science journal. She told me about how when she worked at CSIRO, they had 'lab books' . She told me about how they were used to jot down any ideas and thoughts about various things. This Highlighted the importance and use of them to me.

Science Project Online Journal: The 7th of February 2023 (week 2)

1.

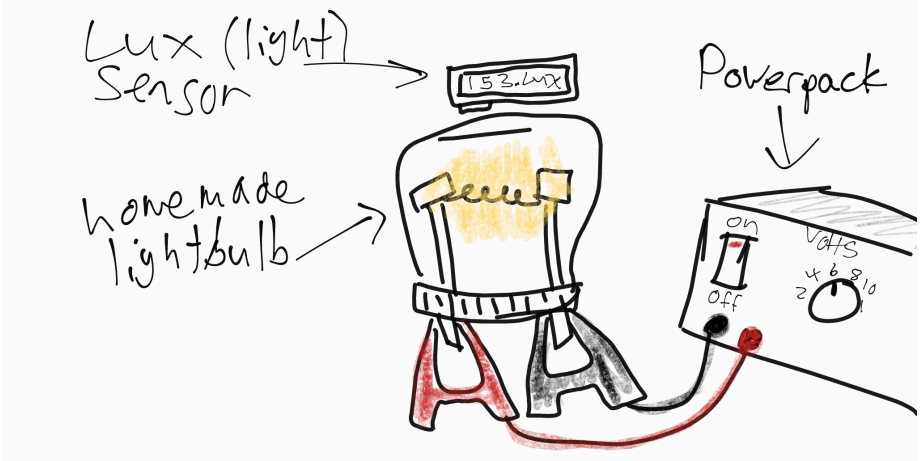
Week by week plan:

Week 2: Complete the details of the experiment. Write the Aim, Introduction, Hypothesis, Risk assessment, Variables, Materials, and Method. Start building the diy light globe.
Week 3: Complete the light globe, complete the Lux sensor stand and conduct the experiment.
Week 4: Reflect on how the experiment went to write the results, discussion and evaluation.
Week 5: Write the discussion, conclusion and start on the abstract.
Week 6: Finish the abstract and edit the whole report, to be handed up.

Science Project Online Journal: The 8th of February 2023 (week 2)

1.

I just drew an outline diagram of the experiment, to match the idea in my head.



The original diagram of the experimental setup for: 'Length of a Light Bulbs Electrical Filament vs its Luminance'

2.

This lesson, I just finished writing out a draft of the title, aim, hypothesis, variables, materials and equipment.

WORK:

Title: Length of a Light Bulb Electrical Filament vs its Luminance

Aim: To determine the effect of the length of a light bulb's electrical filament on the luminance (lux measure) of the light bulb.

Hypothesis: The longer the length of a light bulbs electrical filament, the more luminance it has.

Variables:

Independent variable:	Length of the electrical filament (nichrome wire) (3cm, 5cm and 7cm)
Dependent variable:	The luminance in Lux
Controlled variables:	

Materials:

- Diy lightbulb
- Nichrome wire

- Glass jar
- Copper wire

Equipment:

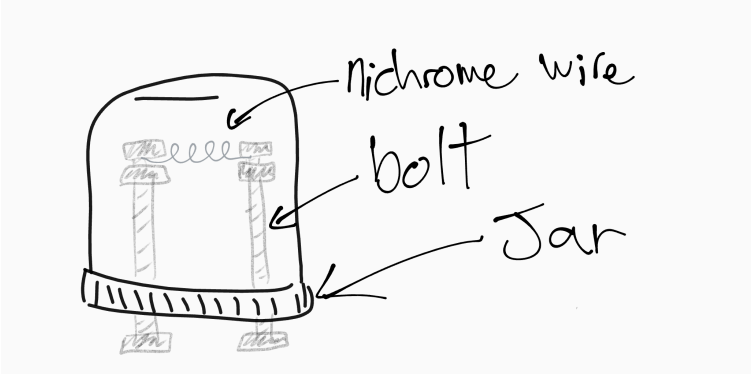
- 10A 6V Power Pack
- Lux sensor

3.

This lesson, I checked in with Mr S, and he said that my idea was feasible and interesting.

4.

- I just drew A diagram of what I think the DIY light bulb will look like



A diagram I drew of the DIY lightbulb I am going to make

Science Project Online Journal: The 9th of February 2023 (week 2)

1.

I just wrote the first draft of the method, which also allowed me to send an email to Mr S, outlining my experiment. I just filled out my risk assessment at riskassess.com.au, and sent it to Mr S.

Science Project Online Journal: The 9th of February 2023 (week 2)

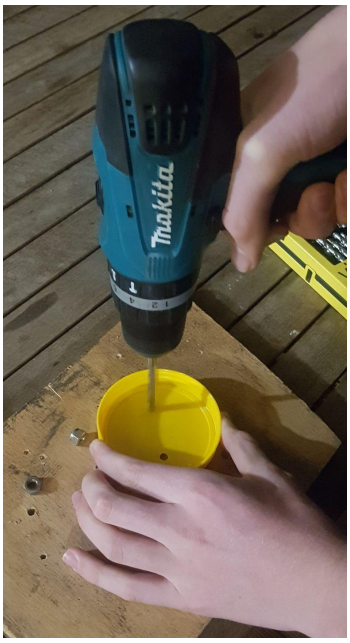
1.

I just decided that it would be easier to use a smartphone as the lux sensor, rather than a sensor specifically for it. I chose this because it means that I can put it in a phone stand to keep it in the same spot each time (most smartphones have lux sensors built in).

2.

I just started making the lightbulb to be ready in time for the experiment on wednesday next week. It is based on the diagram I drew on Wednesday, and it uses a vegemite jar.

-



Drilling holes in the lid of a jar.

Bolts clamped onto the lid with nuts.

Stand (made out of corrugated polypropylene) holding the jar lid.

3.

I just realised that I would have to do the whole experiment inside a box, to keep the brightness from the room from contaminating and ruining the results (the room brightness needs to be controlled as it is a constant variable).

Science Project Online Journal: The 13th of February 2023 (week 3)

1.

Today I found a suitable light sensor app to measure the lux in my experiment. It has a mode where you can set a timer and it will record the average lux over that amount of time.

The App I am going to use in the experiment to measure Lux

2.

I just updated the method and variables to add the new ideas I had, and to make it more accurate.

WORK:

Variables:

Independent variable:	Length of the electrical filament inside the light globe (nichrome wire) (10cm, 16cm, 22cm and 28cm)
Dependent variable:	The luminance of the light globe (in Lux)
Controlled variables:	The sun/room light, the angle of the lux sensor, the voltage powering the globe, the amperage powering the globe, the design of the globe, the type of wire, the wire thickness, the type of light sensor.

Method:

1. The Light Bulb was made using nichrome wire, a glass jar and 2 bolts.
2. The light bulb was secured to a bench using tape, so that it didn't move.
3. The power supply was plugged into a powerpoint, and its leads were connected to the bolts at the bottom of the diy light bulb.

4. The Lux sensor (smartphone) was secured beside the jar in a phone stand that was taped down on the bench so it didn't move.
5. The first length of Nichrome wire (10cm) was carefully attached between the tops of the bolts in the diy light bulb.
6. The light was turned on and the app started recording the luminance for 10 seconds.
7. The average, min and max results over the 10 seconds were recorded.
8. The 10cm length of nichrome wire was tested 2 more times, and the results were recorded
9. Each other length of nichrome wire (16cm, 22cm and 28cm) was tested 3 times each in the same fashion. The results were recorded.

3.

Today I conducted a test experiment. It's point was to test the precision of my experimental setup for my main experiment.

Practice Experiment

Aim: To test the experiment setup and lux sensor app for my experiment (Length of a lightbulbs electrical filament vs its lumenance) by testing the luminance of a bike light with 2 brightness settings in the same set

Materials and Equipment:

- Cardboard box
- Phone stand
- Phone lux sensor
- Bike light

Method:

1. The cardboard box was placed on a bench, with one side open (to block out and control most of the light)
2. The phone was put inside the phone stand, and stuck to the bottom of the cardboard box
3. The bike light was taped down
4. The phone light sensor app was opened
5. The light was turned on
6. The app started recording the lux, over of 10 seconds
7. The results were copied from the app and recorded down
8. Steps 5, 6 and 7 were completed 3 times on the dim setting and 3 times on the bright setting

Results:

	1st recording (Average lux over 10 seconds)	2nd recording (Average lux over 10 seconds)	3rd recording (Average lux over 10 seconds)	Data Range	Average recording
Bike light (dim setting)	2871 Lux	2876 Lux	2873 Lux	5 Lux	2873.33 Lux

Bike light (bright Setting)	696 Lux	689 Lux	701 Lux	11 Lux	695.33 Lux

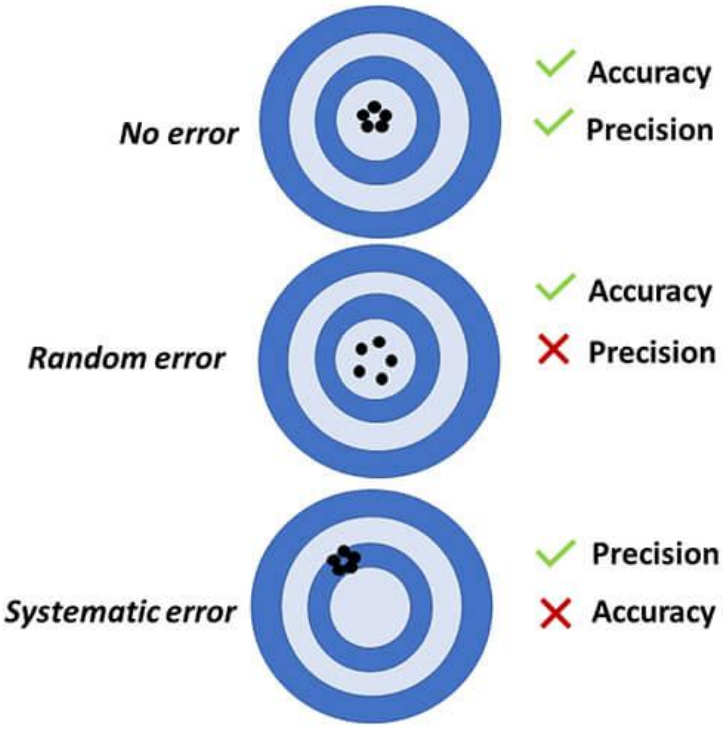
The results show that using this setup, there is a very precise result because while the average lux was up in the thousands, the range between each data point was in the tens.

Science Project Online Journal: The 14th of February 2023 (week 3)

1.

Today I did some research about random and systematic errors, I found out that:

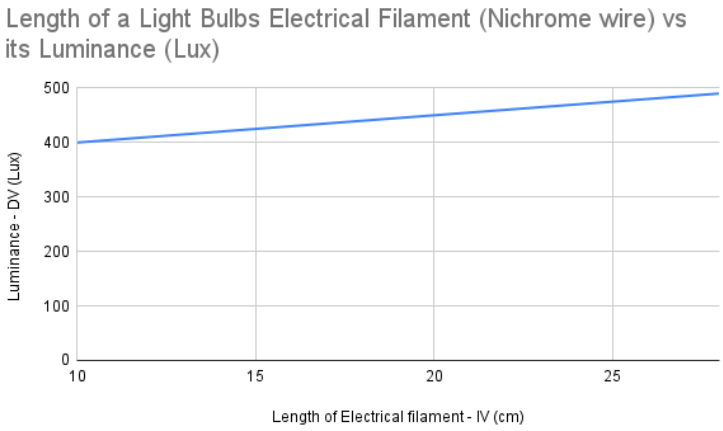
- Systematic error: an error that affects all of you results by the same amount in the same direction (precise, but not accurate)
- Random error: an error that affects as little or as many results as little or as much. (mostly accurate, but not precise)



A really good diagram to explain it (https://www.bachelorprint.eu/methodology/random-vs-systematic-errors/)

2.

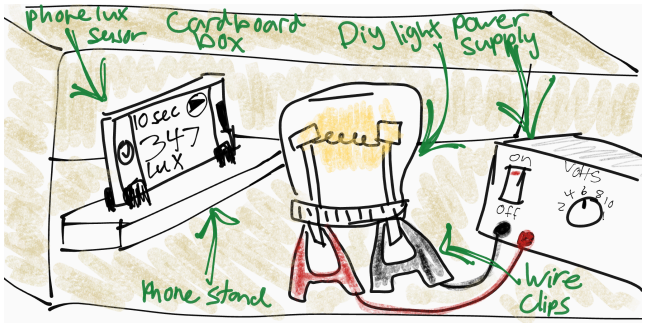
I just made a graph of my predicted results.



A graph of my predicted results

3.

I drew an updated diagram of my experimental setup.



An updated diagram of the experimental setup that I drew.
(Updates: Cardboard box around the whole lot and a phone for the lux sensor)

4.

I edited my method, made a table to put my results in when I get them and dot pointed down ideas for my introduction

WORK:

Introduction:

- Most incandescent light bulbs are around 2% efficient. This means that 98% of the energy put into running the light is wasted as heat. So, when making an incandescent light bulb, it is important to make it as efficient as possible.
- When making a lightbulb, it is important to get the amount of electrical filament that emits the most light, so that you can make it more efficient
- To determine the effect of the length of a light bulb's electrical filament on the luminance (Lux measure) of the light bulb.

Results table:

Length of a Light Bulbs Electrical Filament (Nichrome wire) vs its Luminance (Lux): ***(Lux measure over an average of 10 seconds)***				
Length of Nichrome Wire (cm)	**1st trial (Lux)**	**2nd trial (Lux)**	**3rd trial (Lux)**	**Average trial (Lux)**
10				
16				
22				
28				

Method:

1. Electrical gloves were put on

DIY lightbulb:

2. Two ¼ inch holes were drilled into the plastic lid of a 560g vegemite jar 4 cm apart.
3. A ¼ inch bolt was screwed into one of the holes, and a ¼ inch nut was screwed down the other side of the lid, to hold it on.
4. Step 3 was repeated to the other hole.
5. Two nuts were screwed onto the top of each bolt (This meant that the nichrome wire could be clamped in between the 2 nuts later in the experiment).
6. A stand was made for the light bulb holding it 5cm off the ground. This meant that the bottom of the bolts were accessible for Alligator Clips later in the experiment.
7. The glass bottom of the jar was screwed on top
8. Each length of Nichrome wire (electrical filament lengths: 10cm, 16cm, 22cm and 28cm) was wound over the same pencil with a diameter of 8mm. Then it was stretched out to 5cm.

Setup:

9. A cardboard box, that was enclosed apart from one side, was placed onto a bench
10. The DIY light bulb was secured to the bottom of the cardboard box using tape, so that it didn't move.
11. A 2-12V power supply was plugged into a powerpoint and set to 6 volts.
12. The power supply leads/wire were inserted into the power supply and the other end was clipped onto the ends of the bolts at the bottom of the DIY light bulb.
13. The smartphone Lux sensor was placed into a phone stand that was taped down to the cardboard box facing the jar.

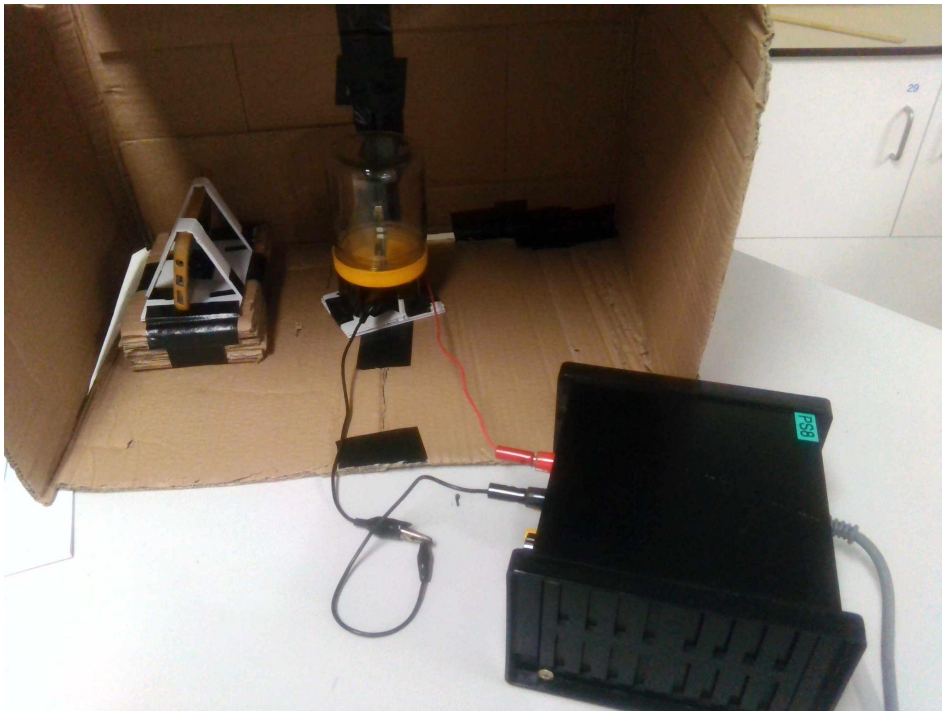
Experimental Method:

14. A length of Nichrome wire was carefully clamped between the tops of the bolts in the DIY light bulb.
15. The power supply was turned on, which on the light bulb
16. The Light Meter - Lux Meter app started recording the luminance for 10 seconds.
17. The 10 second average Lux was recorded.
18. Steps 13 to 16 were completed 3 times for each length of nichrome wire, 10cm, 16cm, 22cm and 28cm.

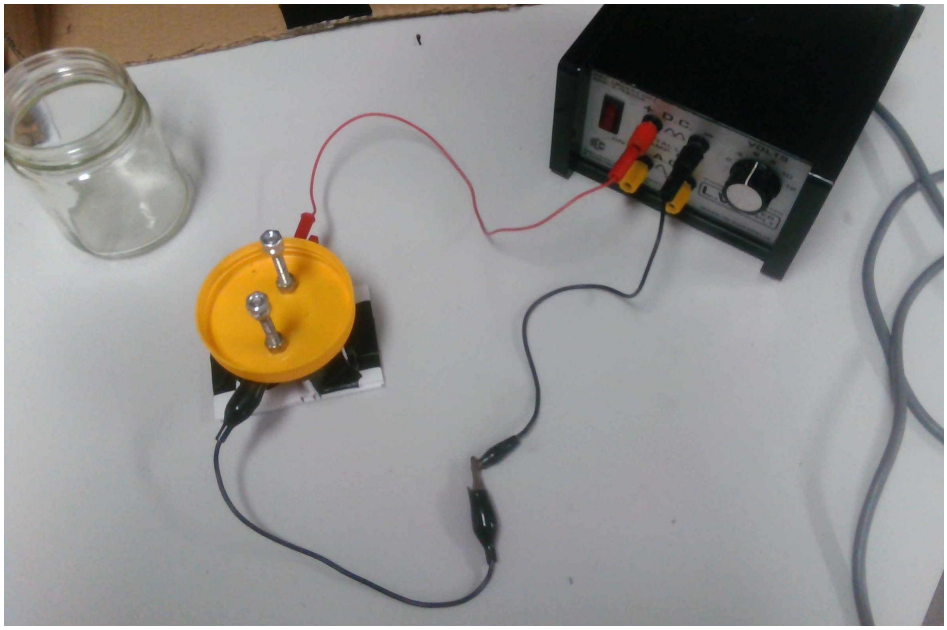
Science Project Online Journal: The 15th of February 2023 (week 3)

1.

Today I tried to conduct my experiment during the double lesson in the lab. I set up everything as I had planned before.



A picture of the whole experimental setup.
Note: Cardboard box blocking out light



A picture of how the lightbulb is connected to the power supply

I collected the nichrome wire and created each length of coil. I had tested my setup at home, but it was my first time using the DIY light bulb and the nichrome wire. After testing my DIY lightbulb, I found out that it would turn on a 6v.

-

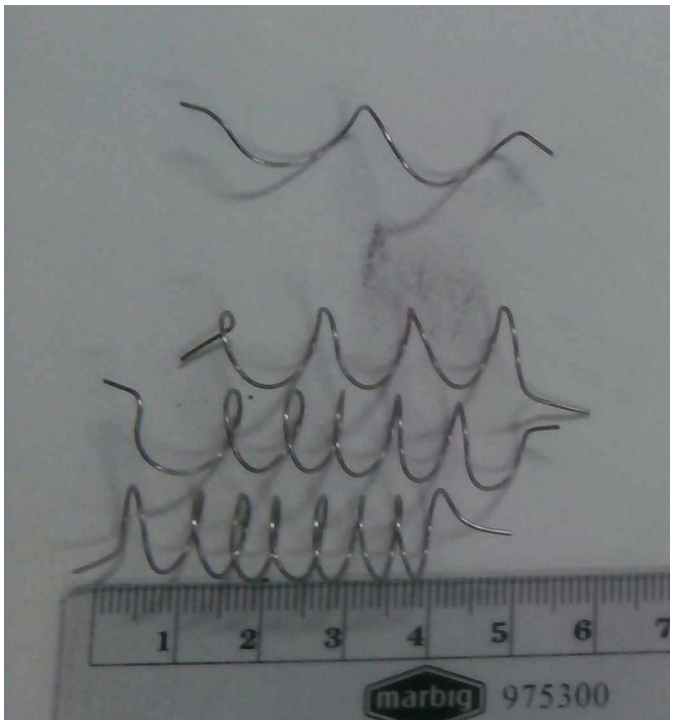
The lengths of wire cut

-

A picture of the first length of nichrome wire wound around the *pacer pencil.*

Each length of wound nichrome wire side by side

-

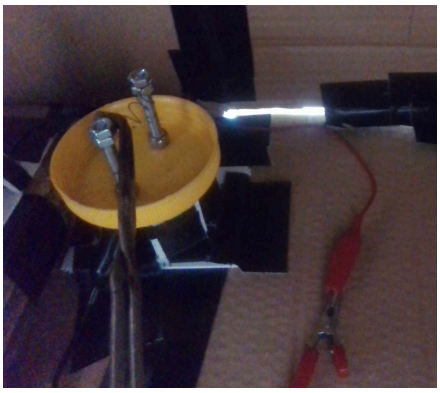


Each length of wound nichrome wire side by side all stretched out to the same length.

Note: To control the room light, I had to face the box away from the room light, to shadow the experimental setup.

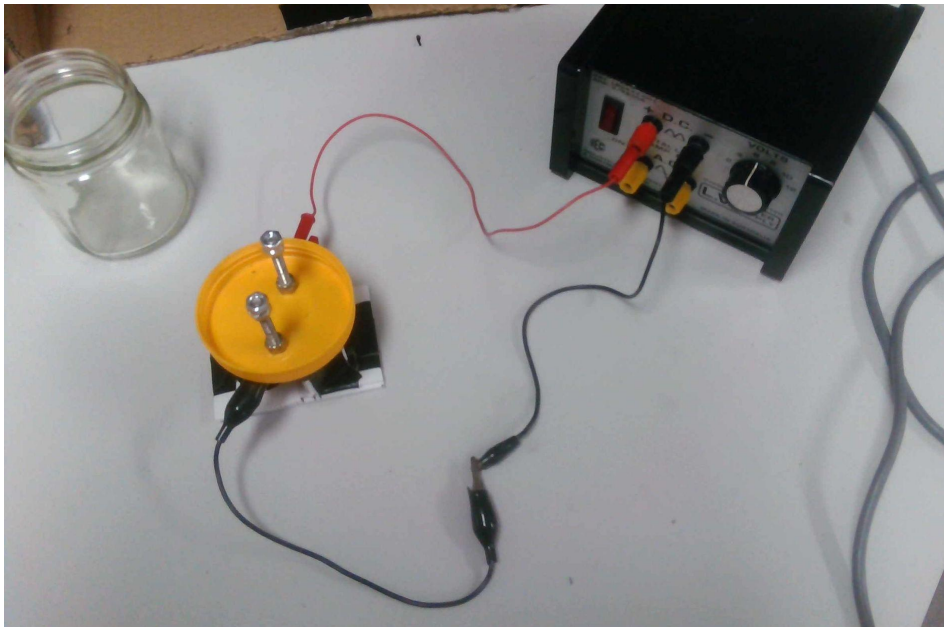
I started the experiment with the 10cm (shortest) piece of wire. When I turned on the power supply, the light began to glow. But after ~4 seconds I could hear the power supply switch itself off, and the lightbulb stopped glowing. I was quite confused. I thought that maybe the light was pulling too much current.

A picture of the DIY Lightbulb inside the cardboard box
Note: darkness inside cardboard box



A different angle of the same thing

-



A picture of how the lightbulb is connected to the power supply

I thought maybe if I used a resistor, it would limit the current pulled by the light, and allow it to work. The lab manager gave me a rheostat (a variable resistor) and I tried using it to limit the current. But the power supply continued to cut out.

An example of a rheostat, similar to the one used (https://www.amazon.com.au/Aexit-Scientific-Resistor-Laboratory-20ry678qf347/dp/B07DW2KFSM)

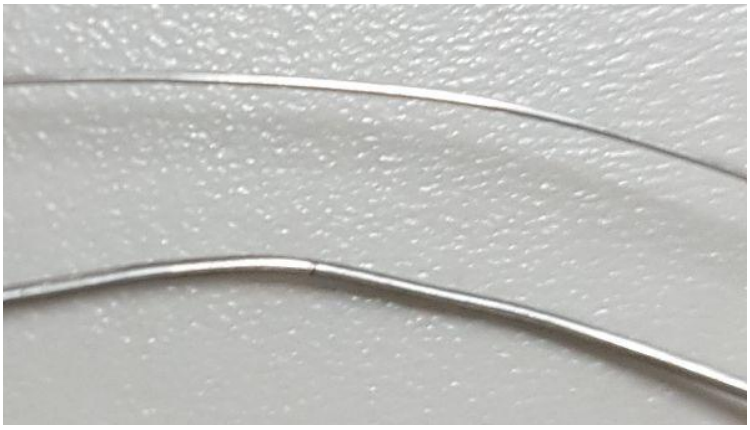
2.

When I got home from school, I had a conversation with my dad about how I would solve the problem of the power supply cutting out. He said that a resistor wouldn't have helped, and that simply turning the voltage down would have helped. The wire that I used is 0.51mm thick, it is 0.053 Ohms/cm. The shortest wire in my experiment is 10cm long. That means that its resistance is 0.53 Ohms. Using Ohm's Law, we can work out the maximum voltage we can use in the experiment. Ohm's law is 'Voltage = Current x Resistance'. The current of the power supply I used was 5 Amps. This means that the equation is 'Voltage = 5 Amps x 0.53 Ohms' This means that the maximum voltage I could have used was 2.65 Volts.
During the experiment I was running it at 6 volts, much higher than the max voltage it should have been at, so it was no wonder that the power supply was tripping.

Science Project Online Journal: The 22nd of February 2023 (week 4)

1.

Today I tried to conduct my experiment during the double lesson in the lab again. Everything was set up the same as last time, but the thinner filament wire was used. Last time, I used wire that was 0.51mm thick, but this time I used 0.315mm thick wire. The resistance of this wire is 0.1377 Ohms/cm. Using the maths from the last journal entry, we can figure out that the maximum voltage I could use was 6.89 Volts. So this time, I used 6 volts for the experiment. The experiment worked this time!



Different thicknesses of the Nichrome wire (top: *0.315mm* bottom: *0.510mm)*

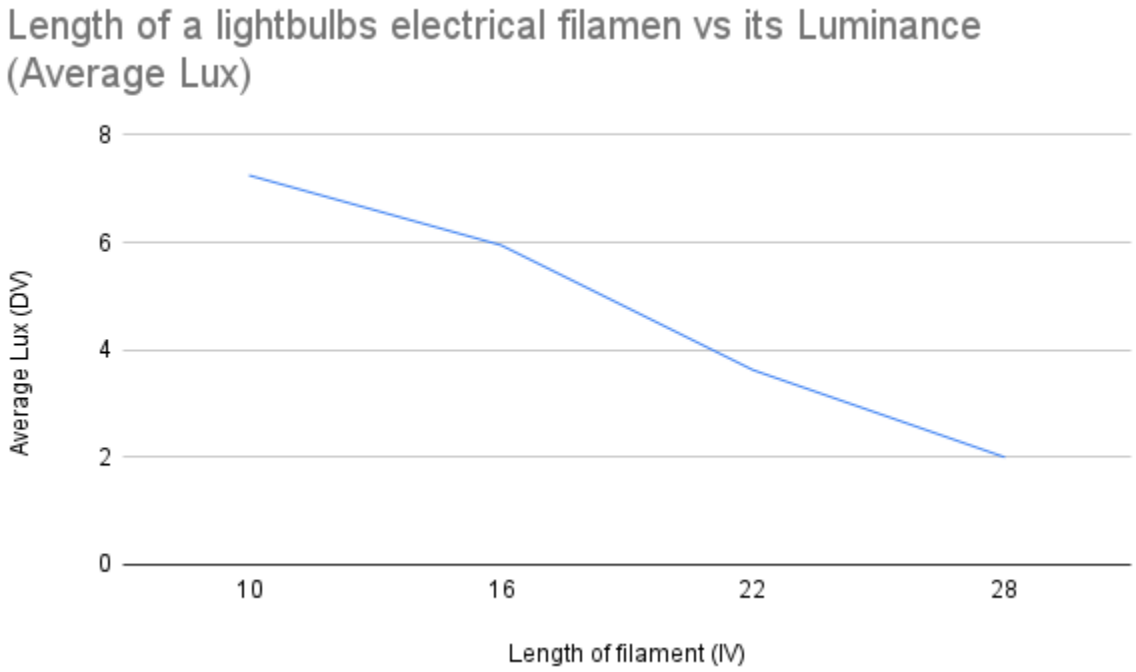
2.

I wrote down the results in my table and made a graph.

WORK:

Length of a Light Bulbs Electrical Filament (Nichrome wire) vs its Luminance (Lux): ***(Lux measure over an average of 10 seconds)***					
Length of Nichrome Wire (cm)	**1st trial (Lux)**	**2nd trial (Lux)**	**3rd trial (Lux)**	**4th trial (Lux)**	**Average trial (Lux)**
0	**1.8**	**1.5**	**1.6**	**1.5**	**1.75**
10	**7.3**	**7.0**	**7.1**	**7.1**	**7.25**
16	**5.9**	**6.1**	**6.0**	**5.8**	**5.95**
22	**3.8**	**3.5**	**3.6**	**3.6**	**3.625**

28	**2.1**	**2.0**	**1.9**	**2.0**	**2.0**



Science Project Online Journal: The 1st of March 2023 (week 5)

1.

Today I mainly worked on my discussion. But I also worked on editing my introduction and other sections of the report.

WORK:

Introduction:

Energy is a precious resource, so it is important to use as little as possible. Making energy consuming devices more efficient means that we can achieve this. Lightbulbs are an example of an energy consuming device. They are used for illuminating rooms, and help visibility at night.

Most incandescent light bulbs are around 10% efficient (Nisson & Wilson, 2008, p. 117). This means that 90% of the energy used to power the light is wasted as heat. So~~,~~ when making an incandescent light bulb, it is important to make it as efficient as possible. Various factors affect the efficiency of a light bulb including, the type of electrical filament, the voltage it runs at and the Thickness of the electrical filament.

This experiment investigates how the length of the electrical filament affects its brightness. By optimising the length of the electrical filament, it can increase the efficiency of the bulb and reduce the amount of wasted energy.

Science Project Online Journal: The 2nd of March 2023 (week 5)

1.

Today I set out a plan for my discussion, evaluation and conclusion. I dot-pointed out the different sections in each of them.

These two websites were very useful:

https://www.monash.edu/learnhq/excel-at-writing/annotated-assessment-samples/science/science-lab-report

https://www.matrix.edu.au/how-to-write-a-scientific-report/

The Research Project Information Booklet (task sheet) was also quite helpful.

Science Project Online Journal: The 8th of March 2023 (week 6)

1.

Today I Edited most of my report

WORK:

Discussion:

The amount of light being emitted by the lightbulb was measured by a Lux sensor.
The results show that, the shorter the length of electrical filament in the lightbulb causes it to emit more light, measured by having a higher lux.

The light in an incandescent lightbulb is produced through resistance

- Discuss results, trends/patterns, relationship between IV and DV
- Discuss what findings mean in relation to Aim, Hypothesis, questions
- Discuss error

Evaluation:

- Limitations of the study: This experiment investigates how the length of a lightbulb's electrical filament affects its luminance. This is the first step to measuring a light bulbs efficiency, a more complicated experiment which could be done is the same exact, except, the voltage could be regulated to keep the same power output the same for all lengths of filaments. But this is too complicated to do with the tools provided.
- How experiment can be improved
- Usefulness of findings
- Related questions that could be investigated

Conclusion:

- Restate purpose of experiment
- Restate essential finding is relation to aim
- Summarise the experiment

Science Project Online Journal: The 10th of March 2023 (week 6)

1.

Today I finished a good draft of my conclusion and came up with different possible errors, to discuss in my discussion.

WORK:

Conclusion:

This experiment was conducted to determine the effect of the length of a light bulb's electrical filament on its luminance. This aim was achieved, as the relationship between the two was clearly identified. The experiment found that the longer the length of a light bulb's electrical filament, the less luminance it has. This is a negative correlation between the length of a light bulb's electrical filament and its luminance. These findings are opposed to and do not support the hypothesis that was proposed.

Possible errors for discussion:

The calibration of the Phone Lux Sensor could have caused a systematic error. This would have impacted all of the results the same amount, which would have affected the actual numbers, but not the trend. It would be a minor error. This error could have been reduced by using more professional grade lux measuring gear.

The background light not being the same for each measure could have caused a random error. This would have impacted all of the results in different amounts, but only by a small amount. It would be a medium error. This error could have been reduced by conducting the experiment in a different room where the outside light was blocked out.

Slight movement between the light globe and Lux sensor could have caused a random error. This would have impacted all of the results in different amounts, but only by a very small amount. It would be a minor error. This error could have been reduced by using a more permanent solution to hold it down, rather than tape.

Slight error when cutting filament wire to length could have caused a random error. This would have impacted all of the results in different amounts, but only by a very small amount. It would be a minor error. This error could have been reduced by fully straightening the wire between two clamps before measuring and cutting.

The accuracy of the voltage of the Power pack could have caused a systematic error. This would have impacted all of the results the same amount, which would have affected the actual numbers, but not the trend. It would be a minor error. This error could have been reduced by using a more professional grade power pack.

The smoothness of the glass jar could have caused a random error. This would have

impacted all of the results in different amounts, but only by a very small amount. It would be a minor error. This error could have been reduced by not using a glass jar around the light.

2.

Today I researched Ohm's law (Current = Volts / Resistance).
https://www.fluke.com/en-us/learn/blog/electrical/what-is-ohms-law
https://phet.colorado.edu/en/simulations/ohms-law
In my experiment, the volts are constant (it always stays at 6 volts), so as the resistance goes up, the current goes down. When the current goes down, less light is produced. So, the longer the wire, the more resistance, which means less current, so less light.
I wrote this down more specifically in my discussion.

WORK:

Part of discussion:

The light in an incandescent lightbulb is produced through the resistance of a wire filament.
This is because, as a resistance wire resists the flow of electrons, it uses some of that electricity to make heat and light as a byproduct (the electrical energy is converted into heat and light energy).

Resistance is proportional to length, so the longer the wire is, the more resistance it has. Ohm's law states that Current = Volts / Resistance. Knowing that the volts are a constant variable (always stays at 6v), as the resistance goes up, the current goes down. So, the more resistance the wire has, the less current flows through it.

The equation for electrical power is Power = Volts * Current. As the volts are constant, when the current goes down, so does the power. As the power is decreased (due to the wire being longer), it results in less light being produced.

Science Project Online Journal: The 11th of March 2023

1.

Today I fully referenced all of my sources in APA style and wrote part of my discussion.
WORK:

References:

How to make a light bulb Experiment (homemade light bulb) (2017) YouTube. YouTube. Available at: https://www.youtube.com/watch?v=c7NaDyTDm3c&t=308s (Accessed: February 2, 2023).

Science, K. F. (Director). (2017, March 14). *How to make a light bulb Experiment (homemade light bulb)* [Video file]. In *YouTube*. Retrieved February 2, 2023, from https://www.youtube.com/watch?v=c7NaDyTDm3c&t=308s

Staff, M. U. (2022, October 18). Science: Lab report. Retrieved February 1, 2023, from https://www.monash.edu/learnhq/write-like-a-pro/annotated-assessment-samples/science/science-lab-report

Staff, W. (2023, January 26). 55 best science experiments for High School Labs and science fairs. Retrieved February 2, 2023, from https://www.weareteachers.com/science-experiments-for-high-school

Team, M. (2022, March 15). How to write a scientific report: Step-by-step guide. Retrieved February 1, 2023, from https://www.matrix.edu.au/how-to-write-a-scientific-report/

Tech, A. (Director). (2018, December 19). *How to make light bulb , Amazing idea* [Video file]. In *YouTube*. Retrieved February 2, 2023, from https://www.youtube.com/watch?v=eUNugWKBfJY

Unknown, U. (n.d). How to Write a Practical/Laboratory Report. Retrieved March 11, 2023, from https://www.adelaide.edu.au/writingcentre/ua/media/46/learningguide-practicalreportinscience.pdf

Whyte, D. (2022, September 17). Compare electrolytes in sports drinks and Orange Juice: Science Project. Retrieved January 23, 2023, from https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p053/chemistry/electrolyte-challenge-orange-juice-vs-sports-drink

Discussion:

The amount of light being emitted by the lightbulb was measured using a Lux sensor. The results show that the longer the length of electrical filament in the lightbulb, causes the lightbulb to emit less light (a lower lux level). The relationship between the length of the filament and the light produced, is a negative correlation. There is a direct relationship between the two variables. The results are relatively linear, in a constantly falling slope.

The light in an incandescent lightbulb is produced through the resistance of a wire filament. This is because, as a resistance wire resists the flow of electrons, it uses some of that electricity to make heat and light as a byproduct (the electrical energy is converted into heat and light energy).

Resistance is proportional to length, so the longer the wire is, the more resistance it has. Ohm's law states that Current = Volts / Resistance. Knowing that the volts are a constant variable (always stays at 6v), as the resistance goes up, the current goes down. So, the more resistance the wire has, the less current flows through it.

The equation for electrical power is Power = Volts * Current. As the volts are constant, when the current goes down, so does the power. As the power is decreased (due to the wire being longer), it results in less light being produced.

Science Project Online Journal: The 13th of March 2023

1.
Today I finished my draft report:
WORK:

Draft report:

Length of a Light Bulb's Electrical Filament vs its Luminance

Caleb van wezel - February 2023
Teacher: Dr S

Abstract

This experiment was conducted to determine the effect of the length of a light bulb's electrical filament on its luminance. A DIY lightbulb was constructed and different lengths of filament wire (nichrome wire) were used. Using a LUX (luminance) sensor, each length of wire was tested in the light bulb, and the average light reading over ten seconds was recorded four times each. Everything was tested in a controlled environment. It was observed from the results obtained that as the length of filament increased, the amount of light decreased. The relationship between the two is linear, as it decreases at a steady rate. The length of the filament and the light produced correlate negatively to each other. It can be explained like this; as resistance increases with length, it reduces the current and power flowing through the filament, and less light is produced.

Aim

To determine the effect of the length of a light bulb's electrical filament on the luminance (Lux measure) of the light bulb.

Introduction

Energy is a precious resource, so it is important to use as little as possible. Making energy consuming devices more efficient means that we can achieve this. Lightbulbs are an example of an energy consuming device. They are used for illuminating rooms, and help visibility at night.

Most incandescent light bulbs are around 10% efficient. This means that 90% of the energy used to power the light is wasted as heat. So when making an incandescent light bulb, it is important to make it as efficient as possible. Various factors affect the efficiency of a light bulb including, the type of electrical filament, the voltage it runs at and the thickness of the electrical filament.

This experiment investigates how the length of the electrical filament affects its brightness. By optimising the length of the electrical filament, it can increase the efficiency of the bulb and reduce the amount of wasted energy.

Hypothesis

The longer the length of a light bulb's electrical filament, the more luminance it has. (A positive correlation between the length of a light bulb's electrical filament and its luminance).

Risk assessment

RISK ASSESSMENT **Emmaus Christian College Students**

The Length of a Light Bulbs Electrical Filament vs its Luminance

Written by: Caleb van Wezel **Commenced on:** 11 Feb 2023 **Expires:** 11 May 2024

Classes for which experiment is required

Teacher: Dr Skouroumounis **Year Group:** 9

Room	Period	Date
G.3	4-5	Wed 15/2/23

Items to be prepared by laboratory technician

1 x 10A Power Pack
1 x Nichrome wire

Procedure or reference, including variations

Powerpack powering a diy lightbulb

https://www.instructables.com/Homemade-Lightbulb/

Measuring using a lux/light sensor to see how the length of the nichrome wire (electrical filament) affects its luminance

Method:

- The light bulb was secured to a bench using tape, so that it didn't move.

- The power supply was plugged into a powerpoint, and its leads were connected to the bolts at the bottom of the diy light bulb.

- The Lux sensor (smartphone) was secured beside the jar in a phone stand that was taped down on the bench so it didn't move.

- The first length of Nichrome wire (10cm) was carefully attached between the tops of the bolts in the diy light bulb.

- Simultaneously, the light was turned on and the app started recording the lux for 10 seconds.

- The results were recorded.

- The 10cm length of nichrome wire was tested 2 more times, and the results were recorded

- Each other length of nichrome wire (16cm, 22cm and 28cm) was tested 3 times each in the same fashion. The results were recorded.

Equipment to be used

glass jar with lid

Potential hazards
Glass jar may break. Filling with hot liquids may cause cracking, due to differential expansion of glass inside and outside.

Standard handling procedures
Inspect and discard any chipped or cracked jars, no matter how small the damage. Sweep up broken glass with brush and dustpan; do not use fingers. If lid is rusty, particles of rust may contaminate contents of jar.

power supply

Potential hazards
Possibility of electrical shock; check cable, cable entry and plug before each use. Level of risk depends on output voltage.

Standard handling procedures
Leads should be well insulated at every point, so that it is impossible to touch live metal. Inspect regularly for signs of damage to cord, cord loose in plug, cord loose at entry to power supply, or any signs of corrosion or other damage. Should be tested and tagged regularly.

power supply leads

Standard handling procedures
Check for integrity of insulation at regular intervals.

Chemicals to be used

nichrome, wire **Ni (80% wt/wt), Cr (20% wt/wt)**

Class: nc PG: none Users: 7-12 Training: 1-5

GHS data: Not classified as a hazardous chemical.

Potential hazards
Repeated contact of skin with the surface of nichrome may cause skin irritation and sensitisation, e.g. with people allergic to nickel jewellery. Nickel and chromium oxide particles may be transferred to hands when touching nichrome.

Disposal
May be placed in the garbage.

Others

Lux/light sensor (on smartphone)
Potential Danger: Electricity, light, heat, glass shattering.

Knowledge

I/we have read and understood the potential hazards and standard handling procedures of all the equipment, chemicals and biological items, including living organisms.
I/we have read and understood the Safety Data Sheets for all hazardous chemicals used in the experiment.
I/we have copies of the Safety Data Sheets of all the hazardous chemicals available in or near the laboratory.

Agreement by student(s)

I/we, Caleb van Wezel, agree to conduct this experiment safely in accordance with school rules and teacher instructions.

Risk assessment

I/we have considered the risks of:

fire or explosion	injuries from equipment	biohazards	waste disposal
chemicals in eyes	rotating equipment	injuries from animals	improper labelling/storage
inhalation of gas/dust	electrical shock	environmental impact	inappropriate behaviour
chemicals on skin	vibration or noise	intense light/lasers	communication issues
ingestion of chemicals	sharp objects	UV, IR, nuclear radiation	allergies
runaway reaction	falling or flying objects	pressure inside equipment	special needs
heat or cold	contamination of area	heavy lifting	ethical issues
breakage of equipment	exposure to pathogens	slipping, tripping, falling	other risks

For outdoor activities, consider also wind, temperature, rain/hail/snow, UV, air quality, fire danger, pollen, bites/stings etc

Assessment by Student(s)

I/we have assessed the risks associated with performing this experiment in the classroom on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018.

I/we consider the inherent level of risk (risk level without control measures) to be:

Low risk **Medium risk** High risk Extreme risk

Control measures:

Electrical gloves - To insulate from electricity
Additional measures: gloves

With the specified control measures in place, I/we have found that all the risks are "low risk". Risks will therefore be managed by routine procedures in the classroom, in combination with the specified control measures.

Certification by Teacher

I have assessed the risks associated with performing this experiment in the classroom on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018. I confirm that the risk level and control measures entered by student(s) above are correct and appropriate.

Name: ..... **Signature:** ..... **Date:** .....

Certification by Laboratory Technician

I have assessed the risks associated with preparing the equipment, chemicals and and biological items, including living organisms, for this experiment and subsequently cleaning up after the experiment and disposing of wastes, on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018.

I consider the inherent level of risk (risk level without control measures) to be:

☐ Low risk ☐ Medium risk ☐ High risk ☐ Extreme risk

Where the risk level is "medium risk", "high risk" or "extreme risk", the following control measures will be employed:

Control measures (attach further pages as required):

☐ safety glasses ☐ gloves ☐ lab coat ☐ apron ☐ fume cupboard

With the specified control measures in place, I have found that all the risks are "low risk". Risks will therefore be managed by routine procedures in the laboratory, in combination with the specified control measures.

Name: ..... **Signature:** ..... **Date:** .....

Monitoring and review

This risk assessment will be monitored using electronic review notes or hand-written notes on a printout. It will be reviewed within 15 months as part of the regular review process.

Variables

Independent variable:	Length of the electrical filament inside the light globe (nichrome wire) (10cm, 16cm, 22cm and 28cm)
Dependent variable:	The luminance of the light globe (in Lux)
Controlled variables:	The brightness of the room, the angle of the Lux sensor, the voltage powering the globe, the design of the globe, the type of wire, the wire thickness, the type of light sensor.

Materials

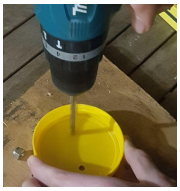
- DIY lightbulb
- - (*Nichrome wire, Glass jar, 2 Bolts,* 6 Nuts)
- Tape
- Cardboard box
- Power supply
- Power supply wires
- Smartphone Lux sensor
- Tweezers
- Scissors
- 30cm Ruler

Method

1. Electrical gloves were put on

DIY lightbulb:

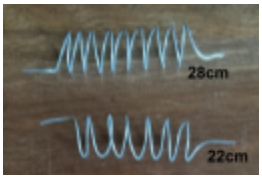
2. Two ¼ inch holes were drilled into the plastic lid of a 560g vegemite jar 4 cm apart.

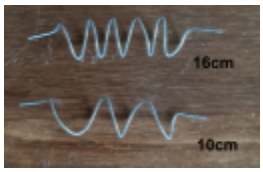


3. A ¼ inch bolt was screwed into one of the holes, and a ¼ inch nut was screwed down the other side of the lid, to hold it on.
4. Step 3 was repeated to the other hole.

5. Two nuts were screwed onto the top of each bolt (This meant that the nichrome wire could be clamped in between the 2 nuts later in the experiment).
6. A stand was made for the light bulb holding it 5cm off the ground. This meant that the bottom of the bolts were accessible for Alligator Clips later in the experiment.

7. The glass bottom of the jar was screwed on top
8. Nichrome wire (Ni 80%, Cr 20%) that was 0.315mm in diameter was collected.
9. Each length of Nichrome wire (electrical filament lengths: 10cm, 16cm, 22cm and 28cm) was measured using a ruler and cut using scissors.
10. Then the wire was wound over the same pencil with a diameter of 8mm. Then it was stretched out to 5cm.

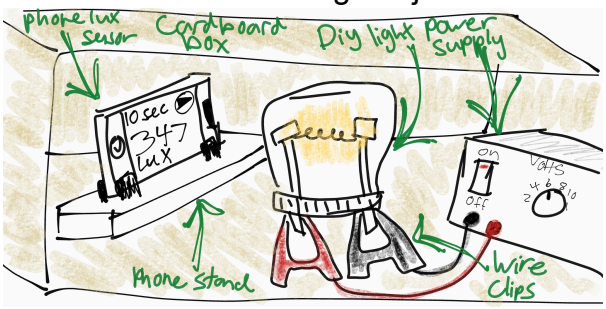




Setup:

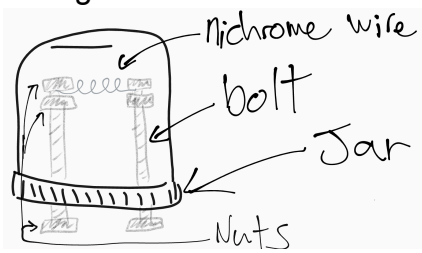
11. A cardboard box, that was enclosed apart from one side, was placed onto a bench
12. The DIY light bulb was secured to the bottom of the cardboard box using tape, so that it didn't move.

13. A 2-12V power supply was plugged into a powerpoint and set to 6 volts.
14. The power supply leads/wire were inserted into the power supply and the other end was clipped onto the ends of the bolts at the bottom of the DIY light bulb.
15. The smartphone Lux sensor was placed into a phone stand that was taped down to the cardboard box facing the jar.

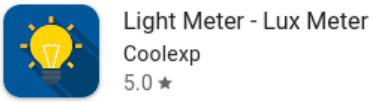


Experimental Method:

16. A length of Nichrome wire was carefully clamped between the tops of the bolts in the DIY light bulb.



17. The power supply was turned on, which on the light bulb
18. The Light Meter - Lux Meter app started recording the luminance for 10 seconds.

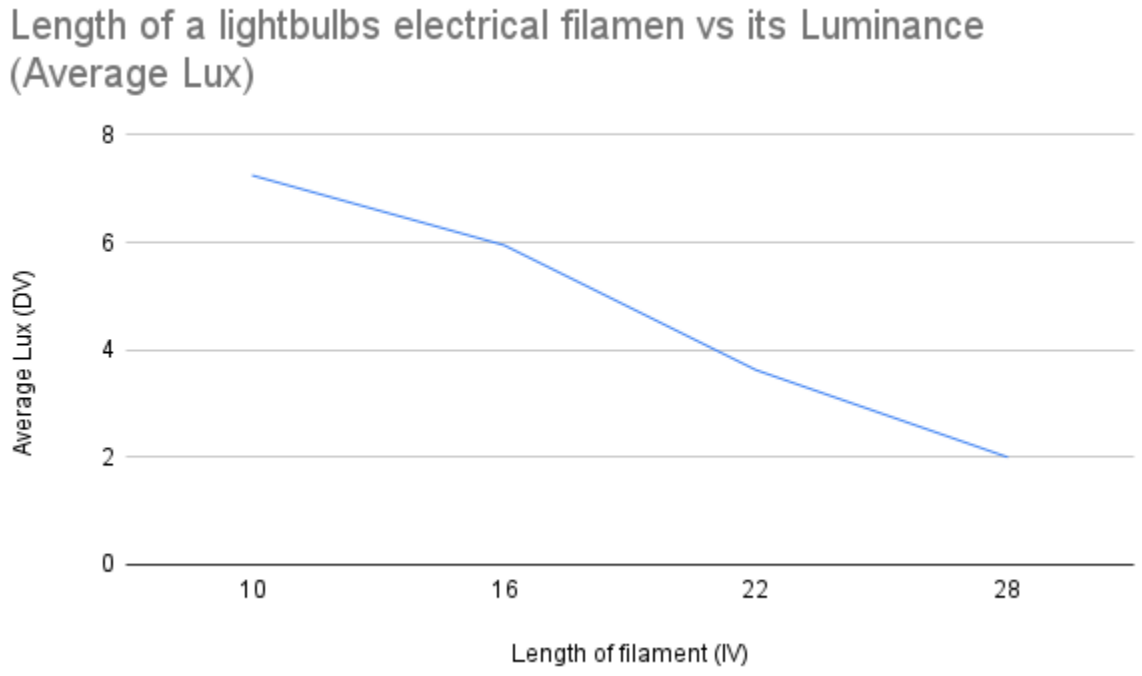


19. The 10 second average Lux was recorded.
20. The Nichrome wire was taken out with tweezers
21. Steps 13 to 16 were completed 3 times for each length of nichrome wire, 10cm, 16cm, 22cm and 28cm.

Results

Length of a Light Bulb's Electrical Filament (Nichrome wire) vs its

Luminance (Lux): *(Lux measure over an average of 10 seconds)*					
Length of Nichrome Wire (cm)	**1st trial (Lux)**	**2nd trial (Lux)**	**3rd trial (Lux)**	**4th trial (Lux)**	**Average trial (Lux) (Rounded to one decimal place)**
Control (Light turned off)	**1.8**	**1.5**	**1.6**	**1.5**	**1.6**
10	**7.3**	**7.0**	**7.1**	**7.1**	**7.1**
16	**5.9**	**5.6**	**5.7**	**6.0**	**5.8**
22	**3.6**	**3.5**	**3.5**	**3.8**	**3.6**
28	**2.1**	**1.9**	**1.8**	**2.0**	**2.0**



Discussion

Trends and Background Research:

The aim of this experiment was, ‘To determine the effect of the length of a light bulb's electrical filament on the luminance (Lux measure) of the light bulb.’ And the hypothesis was, ‘The longer the length of a light bulb's electrical filament, the more luminance it has. (A positive correlation between the length of a light bulb's electrical filament and its luminance).’

The amount of light being emitted by the lightbulb was measured using a Lux sensor. The results show that the longer the length of electrical filament in the lightbulb, causes the lightbulb to emit less light (a lower lux level). The relationship between the length of the filament and the light produced, is a negative correlation. There is a direct relationship between the two variables. The results are relatively linear, in a constantly falling slope.

These findings do not support the hypothesis that was proposed at the start of the experiment.

The results from this experiment are supported by Ohm’s Law and the equation for electrical power.

The light in an incandescent lightbulb is produced through the resistance of a wire filament. This is because, as a resistance wire resists the flow of electrons, it uses some of that electricity to make heat and light as a byproduct (the electrical energy is converted into heat and light energy).

Resistance is proportional to length, so the longer the wire is, the more resistance it has. Ohm’s law states that Current = Volts / Resistance. Knowing that the volts are a constant variable (always stays at 6v), as the resistance goes up, the current goes down. So, the more resistance the wire has, the less current flows through it.

The equation for electrical power is Power = Volts * Current. As the volts are constant, when the current goes down, so does the power. As the power is decreased (due to the wire being longer), it results in less light being produced.

Errors:

The calibration of the Phone Lux Sensor could have caused a systematic error. This would have impacted all of the results the same amount, which would have affected the actual numbers, but not the trend. It would be a minor error. This error could have been reduced by using more professional grade lux measuring gear.

The background light not being the same for each measure could have caused a random error. This would have impacted all of the results in different amounts, but only by a small amount. It would be a medium error. This error could have been reduced by conducting the

experiment in a different room where the outside light was blocked out.

Slight movement between the light globe and Lux sensor could have caused a random error. This would have impacted all of the results in different amounts, but only by a very small amount. It would be a minor error. This error could have been reduced by using a more permanent solution to hold it down, rather than tape.

Slight error when cutting filament wire to length could have caused a random error. This would have impacted all of the results in different amounts, but only by a very small amount. It would be a minor error. This error could have been reduced by fully straightening the wire between two clamps before measuring and cutting.

The accuracy of the voltage of the Power pack could have caused a systematic error. This would have impacted all of the results the same amount, which would have affected the actual numbers, but not the trend. It would be a minor error. This error could have been reduced by using a more professional grade power pack.

The smoothness of the glass jar could have caused a random error. This would have impacted all of the results in different amounts, but only by a very small amount. It would be a minor error. This error could have been reduced by not using a glass jar around the light.

Conclusion

This experiment was conducted to determine the effect of the length of a light bulb's electrical filament on its luminance. This aim was achieved, as the relationship between the two was clearly identified. The experiment found that the longer the length of a light bulb's electrical filament, the less luminance it has. This is a negative correlation between the length of a light bulb's electrical filament and its luminance. These findings are opposed to and do not support the hypothesis that was proposed.

References / Bibliography

Fluke, U. (2022, April 29). What is Ohm's law? Retrieved March 10, 2023, from https://www.fluke.com/en-us/learn/blog/electrical/what-is-ohms-law

Nisson, N., & Wilson, A. (2008). The Virginia Energy Savers Handbook. Retrieved March 1, 2023, from http://large.stanford.edu/courses/2014/ph240/dikeou2/docs/va-handbook.pdf

Science, K. F. (Director). (2017, March 14). *How to make a light bulb Experiment (homemade light bulb)* [Video file]. In *YouTube*. Retrieved February 2, 2023, from

https://www.youtube.com/watch?v=c7NaDyTDm3c&t=308s

Staff, M. U. (2022, October 18). Science: Lab report. Retrieved February 1, 2023, from https://www.monash.edu/learnhq/write-like-a-pro/annotated-assessment-samples/science/science-lab-report

Staff, W. (2023, January 26). 55 best science experiments for High School Labs and science fairs. Retrieved February 2, 2023, from https://www.weareteachers.com/science-experiments-for-high-school

Team, M. (2022, March 15). How to write a scientific report: Step-by-step guide. Retrieved February 1, 2023, from https://www.matrix.edu.au/how-to-write-a-scientific-report/

Tech, A. (Director). (2018, December 19). *How to make light bulb , Amazing idea* [Video file]. In *YouTube*. Retrieved February 2, 2023, from https://www.youtube.com/watch?v=eUNugWKBfJY

Tulip, S., Morgante, K., & Starczak, L. (2022). Analysis of Data, Critical evaluation. In *Chemistry: Workbook, SACE 1 third edition* (pp. 300-306). Adelaide, South Australia: Adelaide Tuition Centre.

Unknown, U. (2023). Phet Ohm's Law. Retrieved March 10, 2023, from https://phet.colorado.edu/en/simulations/ohms-law

Unknown, U. (n.d). How to Write a Practical/Laboratory Report. Retrieved March 11, 2023, from https://www.adelaide.edu.au/writingcentre/ua/media/46/learningguide-practicalreportinscience.pdf

Whyte, D. (2022, September 17). Compare electrolytes in sports drinks and Orange Juice: Science Project. Retrieved January 23, 2023, from https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p053/chemistry/electrolyte-challenge-orange-juice-vs-sports-drink

2.

I just handed up my report.