Science Fair logbook - Divjot Batra 9B

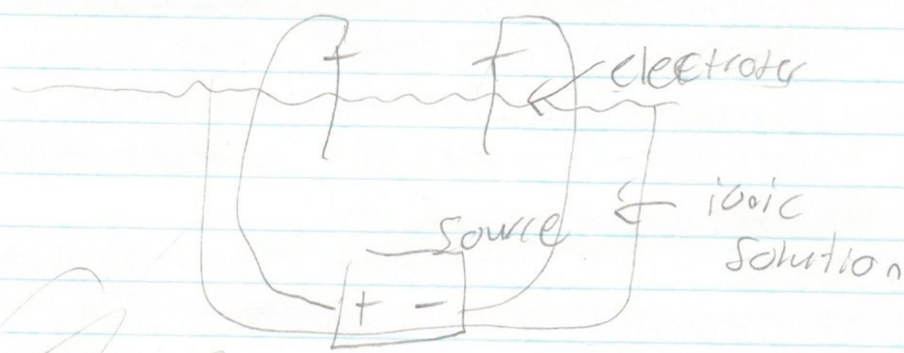
Oct 25th, 2025

list of topics of Intrest:

- topics related to energy - motion
- Rocketry = comparing propulsion systems
- ⓐ Something in electrolysis - comparing electrolytes/electrodes
- Robotics = arduino / coding
- = cell growth
- testing food adulteration

Oct 26th, 2025

= Research in electrolysis = how it works



= finalized topic

Comparing how different voltage inputs affect H_2 gas production in water electrolysis
3v, 6v, 9v

Oct 27, 2025 = topic submitted

↳ topic approved

Hilborg

30 ahead

NOV 20th 2025
Background research / prototypes for device

Electrolysis (youtube video - electrolysis)

process where electricity is used to drive a chemical change that wouldn't happen otherwise.

(textbook) Electrolysis is electrochemistry. Field of Science → relationship between chemical changes and electricity.

Electrolysis of water

↳ Separating H_2O into H_2 and O_2 (diatomic).

↳ Requires electricity passing through electrodes placed in an electrolytic solution.

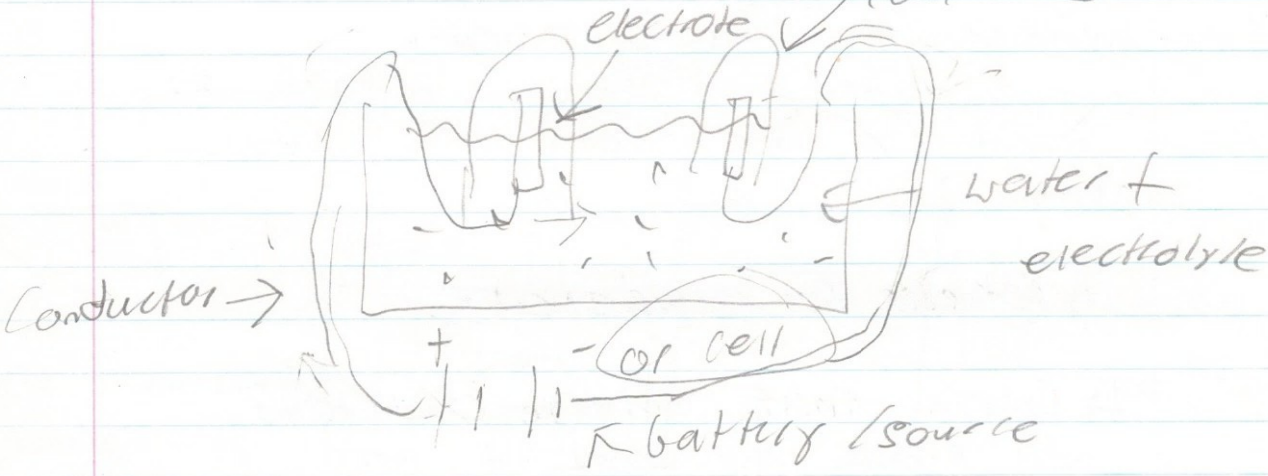
↳ electrodes are conductors that help electricity to flow through water. The gasses will form there.

↳ electrolyte mixed with water discharges ions which can be picked up by the electrodes. Ions are necessary to help electricity flow through water.

In electrolysis, electrons flow from the positive to negative terminals.
power gives voltage. The ability to push electrons

Research

O_2 produced ≠ H_2 produced



positive electrode = anode
negative electrode = cathode

In this electrolysis process, the electrons flow from the anode to the cathode.

pulled by anode – pushed by cathode

In electrolysis of water, the electrodes go through half reactions, Reduction and oxidation

Reduction of hydrogen and oxidation of oxygen

In electrolysis, electrons move from the anode to the cathode. When they travel, there is a loss of electrons at the anode. This is known as the oxidation process. When electricity passes through, oxygen would form at the anode.

coincidently, there would be a gain of electrons at the cathode or negative terminal. This is known as reduction of hydrogen. H_2 gas forms here.

Nov 23rd, 2025

Hypothesis for experiement.

↳ Believe that voltage of 9 volts will provide the most H_2 gas, 6v the second highest, and 3 volts the lowest amount of hydrogen gas. With a higher voltage, it would speed up the movement of the electrons. This would increase speed of the ions in the solution hence speeding up the attraction and eventual separation of the compound into hydrogen gas, and oxygen gas. Also, there would be a faster gain of electrons at the cathode, increasing the rate of the half reactions to take place.

variables,

controlled

- The device
- Distilled water = pure
- Amount of water
- electrolyte
- Time device is on for

Still update it

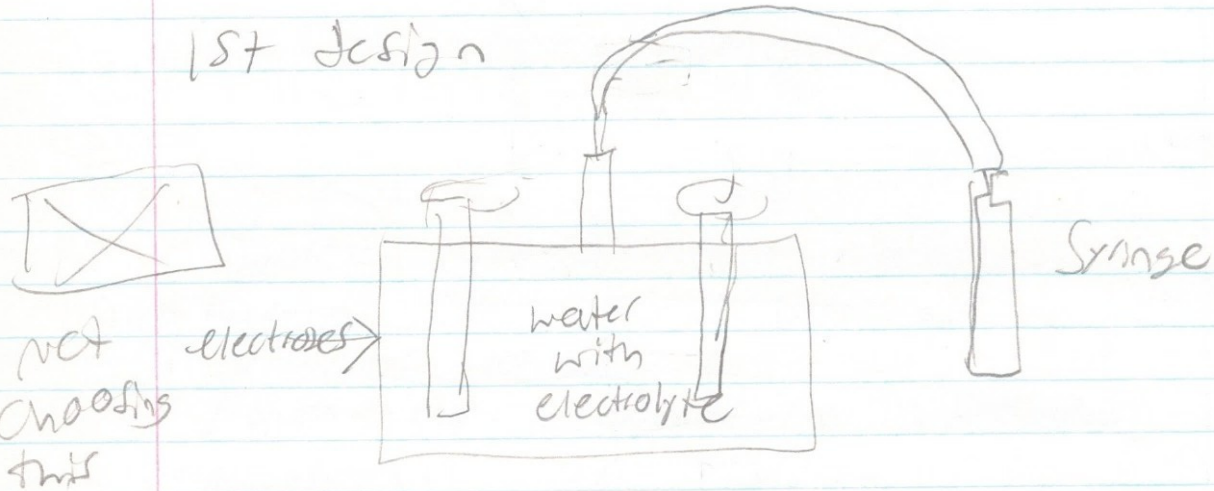
manipulated = different voltages

responding = amount of H_2 produced

NOV 27th, 2025

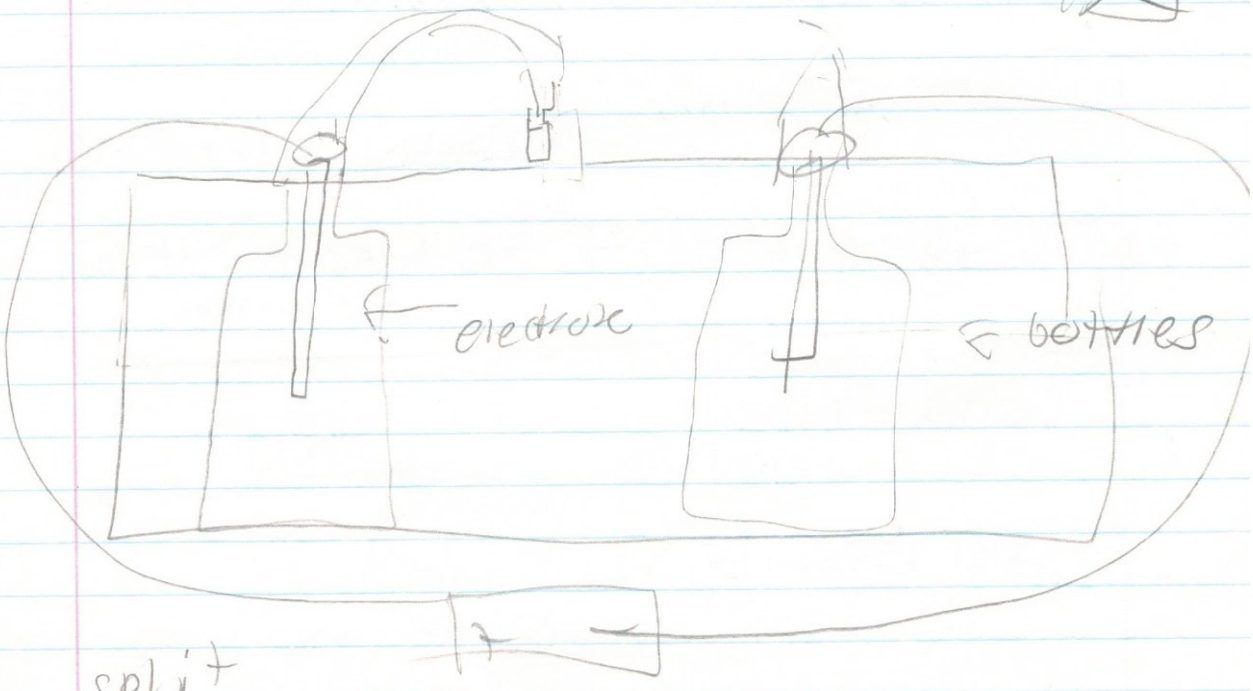
= designs to try and measure hydrogen gas. Different devices

1st design



Jar, syringe, nozzle, washers, screw, Pure water, baking soda, pipe, power

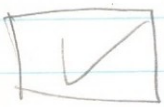
2nd proposition for device



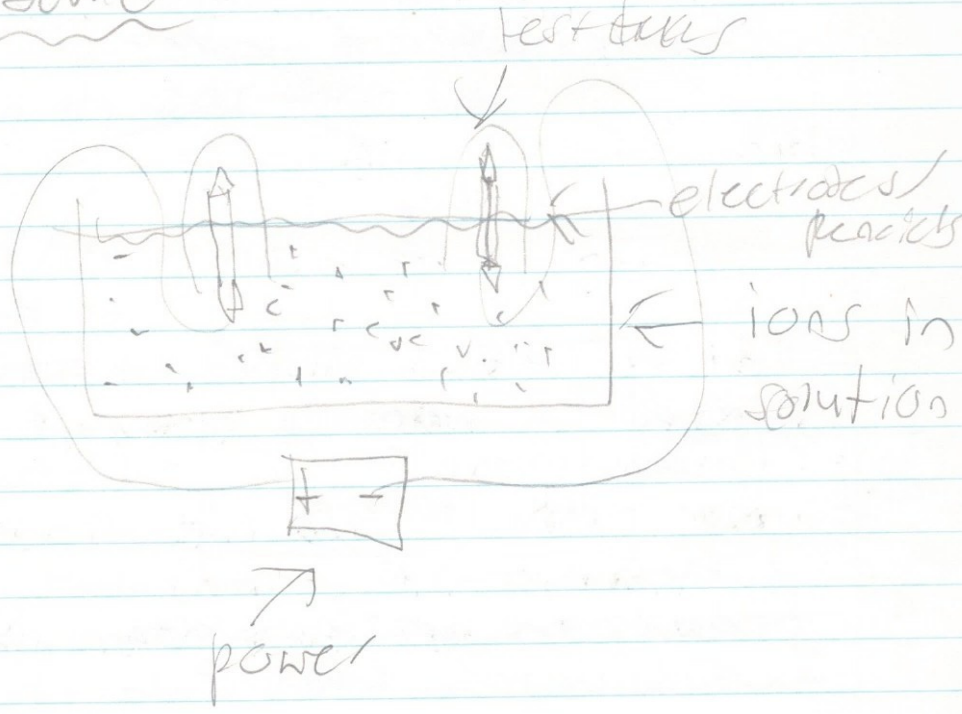
technic

Dec 5th

3rd device



approved



Collecting gas in test tubes and measuring it.

Dec 15th, 2025

= finalized design of device + variables, materials

variables in experiment

= controlled variables:

- Device used to collect hydrogen
- pureness of water = Distilled
- amount of water
- Amount of electrolyte in solution
- temperature of solution
- Amount of time device is on for (20min)

Manipulated variable

= The different voltages applied
-3v, 6v, and 9v

Responding variable

→ the amount of H_2 gas produced from separation

↳ Uncontrolled variables

The temperature/ humidity of surrounding environment.

materials needed for experiment

The materials needed for this project are in the following:

- clear plastic rectangular container that can hold 1500ml of water
- 6 1.5volts cells
- 9 volt battery
- battery clip
- two alligator clips
- Battery holder for 2cells and 4cells
- Baking soda → $NaHCO_3$
- Distilled water
- One spoon
- 1 ~~test tube~~ → graduated cylinder
- 1 test tube
- two pencils HB → Sharpened from both ends until 10cm in length
- logbook
- goggles
- camera
- Timer set to 20 min
- cardboard piece that can cover the area of the top of the container.

Dec 20th, 2025

= Procedure writing

1. procedure for creating the device is in the following:

↳ split electrolysis technique, to ensure only hydrogen gas is being collected

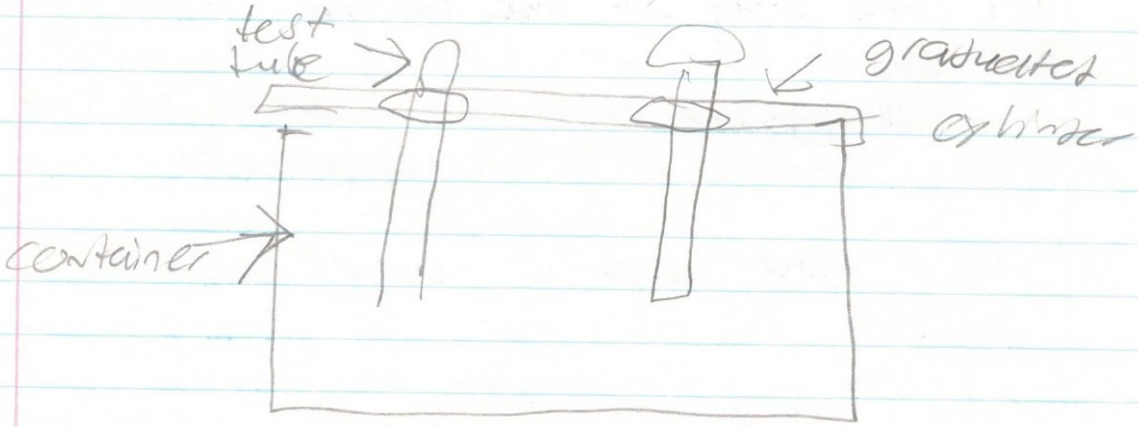
1. make holes of the same size in the cardboard that are equally spaced apart (in this case they are 1cm apart but still away from the edges.)

2. place the cardboard over the container

3. push the inverted graduated cylinder down one hole until it sticks in place

4. push the test tube the other hole until it sticks in place.

= Drawing of device



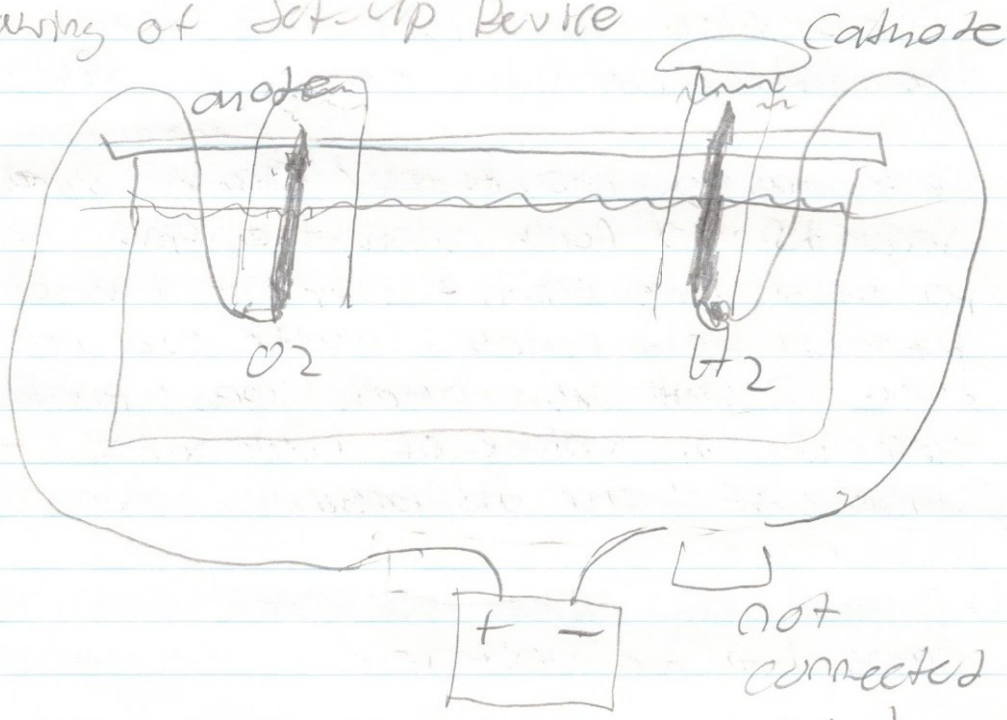
Hilroy

Procedure for Setting up the device

1. Fill the container with 4 L of Distilled water
2. Add 2 tablespoons of baking soda and dissolve it with the spoon
3. Connect the alligator clips to one end of the graphite pencils.
4. Fill the graduated cylinders and the test tube with the solution and place a finger on the end as you place it through the cardboard piece in the container. Make sure that the cylinder and test tube are filled with water and are submersed below the water line
5. Place the sharpened pencils (which are connected to the alligator clips) inside the cylinders (making sure that water does not come out of the cylinder. Also ensure the circuit is open. (To do this, just keep one alligator clip disconnected to the battery before doing the experiment.
6. Have your logbook, camera, and timer set to 30 min.

Note: One of the Graphite Pencils Should be connected to the negative alligator clip and be placed in the graduated cylinder. This ensures that we are measuring hydrogen gas at the cathode. The test tube is kept there to collect oxygen gas separately and help guarantee there is no mixin.

Drawing of Set-up Device



Procedure = How to conduct Experiment

1. Connect the alligator clip to the battery and simultaneously turn on the timer set to 20 min.

2. Record your observations over the duration of the timer

3. Immediately turn off the source after the timer comes to zero. (To do this, just unplug the alligator clip connected to the battery. Wait for around 5 to 10 seconds to fully allow the gas bubbles to fully rise to the top of the cylinder. Record how much water displacement there is and how much gas production there is. The volume of hydrogen = the volume of water displaced.

4. Repeat this step for each trial for each type of voltage.

5. For the different voltages, remove the alligator clips from the old battery and connect them to the new battery or battery holder. Also replace the water and add the baking soda to conduct a fresh experiment with different voltages.

Note: For this experiment, we are only going to look at the graduated cylinder since H_2 will be produced there

Dec 25th 2025 = Experiment Day

= I gathered all the materials and set up the device accordingly to the procedures. Here are the results and observations!

3volts = observations & Results + evidences

trial 1:

- Bubbling started in around 18 seconds
- H_2 bubbles slowly moved along walls
- Deposited at top creating gap

trial 2:

- Bubbling started in around 16 seconds
- rate of production was slow but continuous.
- Bubbles sizes were small

trial 3:

- Bubbling started after around 15 seconds
- Lots of small bubbles gathered at the top overtime
- created noticeable gas

	Trial 1	Trial 2	Trial 3
3 volts	1mL	1.4mL	1.3mL

Analysis

At the start of each trial with application of 3 volts to the device the formation of gas bubbles started very late around 15-20 seconds after the circuit was closed. The formulation started but while advancing at a low pace towards the top and along the walls of the cylinder. Since the potential difference was low, no possible source was produced but there was sufficient evidence of gas production. The amount of gas was produced in the end. The size of bubbles were small.

Trial 1

- Bubbling started in 16 s
- H_2 bubbles slowly moved along walls
- Deposited at top creating gap

trial 2

- Bubbling started in 16 s

- Rate of production was slow but continuous
- Bubbles sizes were small

trial3

- Bubbling started after 15 seconds
- Lots of small bubbles gathered at the top overtime
- Created noticeable gas

6 volts

	Trial1	Trial2	Trial3
6volts	2mL	2mL	2mL

- Analysis

With the experimentation of an input of 6vol I noticed quantitative and qualitative evidence across all three trials. With the addition of 6 volts this time, the start of the reaction was slow - creating bubbles in ~~60~~ seconds. When the bubbling started - it was at steady flow. In the end you could see and estimate that twice the amount of hydrogen was produced.

Trial 1

- Bubbling started in around 7 seconds
- H2 bubbles started to emerge immediately
- looked as if a mist was being produced

trial 2

- Bubbling started in around 5 seconds
- H2 bubbles rising along the walls
- molecules of moderate sizes

Trial 3

- Bubbling started in approximately 9 seconds
- carried steady flow
- some mist-like behavior visible.

9 volts

	Trial 1	Trial 2	Trial 3
9 volts	4mL	3.8mL	4.2mL

Analysis

- During all three trials at 9 volts, I observed that bubbles started to form immediately at the cathode. The bubbles were forming at a rapid and constant rate. A slight fizzing sound was heard indicating the production of hydrogen gas. In addition, bubbles formed along the walls of the cylinder and on the tips of the electrodes. The bubbles were of moderate sizes some being smaller than others.

The differences in the volume of gas production between the trials may have been due to the excessive or moderate rate of bubbling, electrode stationing inside the cylinder, or slight miscalculations in measurement.

Trial 4

- Fast start of bubbling - within 1-2 sizes
- Speed of collection is fast.

- Bubbles of big sizes
- fizzing sound produced

Trial 2

- mist with bubbles established in around 8 s
- Rate is steady and continuous
- Depasition of gas is quick
- slight sound is obtained

Trial 3

- H_2 gas formed immediately
- Gas bubbles sliding against walls along top
- Water being pushed down gradually
- Sound of bubbles being produced is noticeable.

Table

	Trial 1	Trial 2	Trial 3
3 volts	1 mL	1.4 mL	1.3 mL
6 volts	2 mL	2 mL	2.2 mL
9 volts	4 mL	3.8 mL	4.2 mL

Reminder
= Create chart on google Sheets

= Notes:

* Electrons

anode → cathode

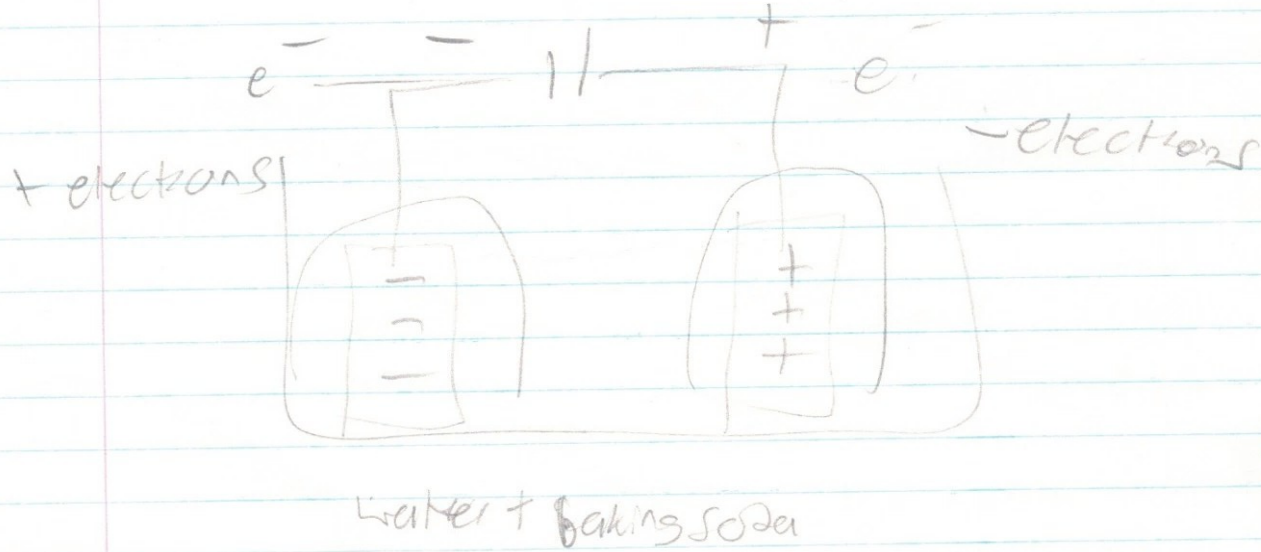
+ || −

= $NaHCO_3$ in water

↳ into Na^+, HCO_3^- ions (ions)
positive negative

gain of electrons at cathode

Loss of electrons at anode



Jan 2nd 2026

= Conclusion/application, extension + sources of error

= The purpose of this experiment was to investigate which potential difference would provide the most amount of hydrogen in the electrolysis of water. It was hypothesized that a potential difference of 9 volts would provide the most hydrogen. This was proved to be correct since with voltage of 9 volts, there was an average of 4mL of hydrogen exceeding the amounts in the other sets of trials. As we saw from all three trials, 9 volts demonstrated producing more gas than the trials from the other voltages. The starting time, rate of bubbling, and the size of the gas bubbles all contributed to upbring the potential. The completed circuit provided quantitative measurements that were recorded. Since the charge provided more voltage hence the electrons could move faster moving away from the anode and towards the cathode which sped up the reduction of hydrogen. The higher charge also caused the ions in the electrolytic solution to move towards their opposing electrode which completed the circuit allowing the half reactions to take place.

Applications

- Principles learned in this project can be used in many productions and Scenarios

- Electrolysis can be used to produce fuel cells which contain hydrogen

- The Hyundai Nexo and the Toyota Mirai are two cars that use hydrogen to power their motors

- Both hydrogen and oxygen are two main ingredients used in rocket fuel - Electrolysis can allow these gasses to be produced and later converted to liquid form to use in rocket propulsion systems

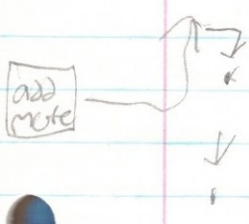
- Electrolysis can be used in electroplating or to disinfect water and to treat the water sources.

Sources of Errors

- Alligator clips slipped off the electrodes while submerged in water so it had to be replaced
- The S.A. in which the electrode reacts with the water could have changed the recordings
- The water started to get cloudy after certain period of time so it had to be replaced
- The electrode placement could have increased or decreased the actual readings.

Extension/next experiment

- Testing different electrodes such as brass, copper and steel and test how efficient and effective they're.
- Testing Different electrolytes for the solution such as table salt, and sulfuric acid to see which provides higher effectiveness
- I could experiment with different gas collection methods.



Jan 9th 2026

= submitted project for Formative evaluation

Jan 16th 2026

= received feedback

= fixed / added electrolyte section in Background research = Baking soda

↳ added distance between electrodes as one controlled variable

↳ labeled pictures and provided small descriptions

↳ wrote more about other voltages in conclusion

↳ added fuel cell descriptions.

more Research