Galvanicar

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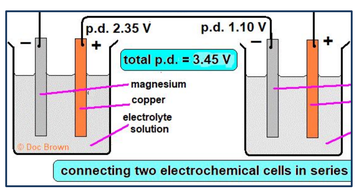
Introduction

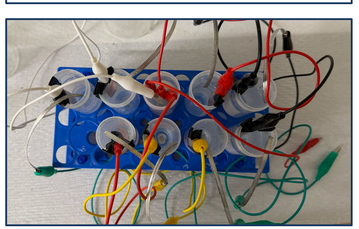
- Our Chem-E-Car is powered by a magnesium-copper galvanic battery system
- Electricity is generated through spontaneous redox reaction in a saltwater electrolyte
- Magnesium acts as the anode and is oxidized, while copper serves as the cathode
- Multiple electrochemical cells are connected in series to generate ~12 V
- The system is designed for controlled, consistent voltage output and safe operation
- The stopping mechanism uses an iodine clock reaction with optical detection

Team	Capital Cost
Chassis	$102
Electronics	$79
Propulsion	$140.58
Stopping	$1.80
Total	**$314**

Car Design

PROPULSION

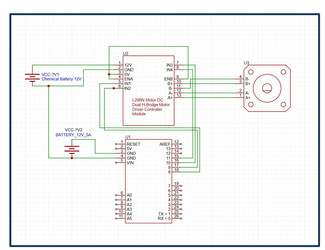




- Magnesium ribbon is used as the anode and copper as the cathode in a saltwater electrolyte solution
- The electrolyte facilitates ion transport
- The battery generates electricity through spontaneous redox reactions
- Cells sealed with caps containing controlled openings to allow for wire passage
- Each galvanic cell produces approximately 1.5 V, and multiple cells are connected in series to increase total voltage output. A system of 8 cells generates ~12 V, which powers the car's motor
- Anode (Oxidation): $Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$
- Cathode (Reduction)

CHASSIS & ELECTRONICS

- The body of the vehicle is comprised of a polycarbonate enclosure
- 4 holes were drilled into the sides for the axles
- 3-6V DC gearbox motor – attached to center base of enclosure
- The enclosure eliminated all pinch points, exposed wiring, and served as a double containment layer
- All Chassis and Electrical components are contained
- Propulsion components are secured in a inner wooden box with a removable lid, attached with velcro
- Stopping reactions secured to box lid
- The galvanic cell batteries are connected to an intermediate Arduino, detecting the completion of the stopping reaction using voltage measurement over a photoresistor.

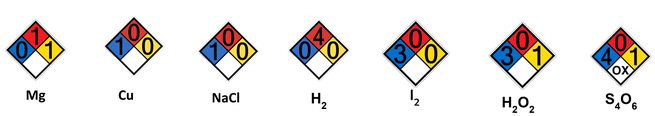


Safety

DESIGN SAFETY & CHEMICAL SAFETY

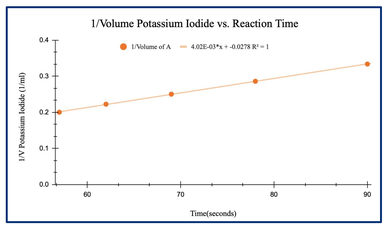
- PPE (gloves, goggles, lab coats) worn whilst conducting experiments and handling chemicals
- Hazardous chemicals are double-contained and sealed
- All wiring insulated and secured with electrical tape and hot glue
- Hydrogen gas (flammable) generation mitigated via appropriate ventilation
- Iodine species are irritants
- Acetic acid is corrosive
- Oxidizers such as H_2O_2 are kept away from flammable materials
- Byproducts are neutralized with base then disposed as needed

NFPA FIRE DIAMONDS



STOPPING

- Iodine Clock Reaction that involves several chemical solutions
  - Mixture A (starch, potassium iodide (KI))
  - Mixture B (3% hydrogen peroxide (H_2O_2))
  - Mixture C (sodium thiosulfate ($Na_2S_2O_3$))
  - Mixture D (5% acetic acid (CH_3COOH))
- Once thiosulfate is deleted → sudden blue color (starch-iodine complex if formed)



DETECTION

- LED + photoresistor measure light change
  - Arduino detects change → motor shut off

TIME CONTROL

1. Calculate time needed using car's avg. velocity, given the desired distance
2. Find the volume of Potassium Iodide corresponding to desired time (see graph)

Reactions

- ***Equation I (Slow Reaction)***
  - $2I^-(aq) + H_2O_2(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)$
- ***Equation II (Fast Reaction)***
  - $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$
- ***Equation III (Rate Law)***
  - Rate (gmol/(L*s)) = $k[H_2O_2][KI]$
  - $k \approx 0.027 \pm 0.003$

CAR & CONFERENCE OVERVIEW

Acknowledgements

- JHU Department of Chemical & Biomolecular Engineering
- JHU AIChE Student Chapter
- Professor Sourojeet Chakraborty (Faculty Advisor)
- Kai Lewis (Teaching Assistant)