Teacher Workshop 2019

2018 NM Middle School Electric Car Challenge

Introduction

- As part of the sponsors' education outreach, middle school students will design, build and race lithium-ion battery-powered model cars as part of an engineering design competition.
- The New Mexico Electric Car Challenge is a classroom-based, hands-on educational program for 6th, 7th, and 8th grade students.
- Student teams apply math, engineering, science, and creativity to construct and race a model electric-powered car.
- The car competition challenges students to use scientific know-how, creative thinking, experimentation, and teamwork to design and build high-performance model electric vehicles.

New Mexico Electric Car Challenge
A Collaborative STEM Program

Goals and Description

The primary goals of the programs are to:

- Generate enthusiasm for science and engineering at a crucial stage in the educational development of young people,
- Improve students' understanding of scientific concepts and renewable energy technologies, and
- Encourage young people to consider and prepare for technical careers at an early age.

Program description:

- Students use mathematics and science principles together with their creativity in a fun, hands-on educational program.
- Using engineering principles, students get excited about generating ideas in a group and then building and modifying models based on these ideas.
- Students can see for themselves how changes in design are reflected in car performance.
- Students work together on teams to apply problem solving and project management skills.

PLEASE!!

Please read through ALL directions before beginning construction!

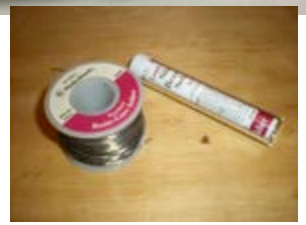
Supplied Materials

You will need the following items from the teacher kit:

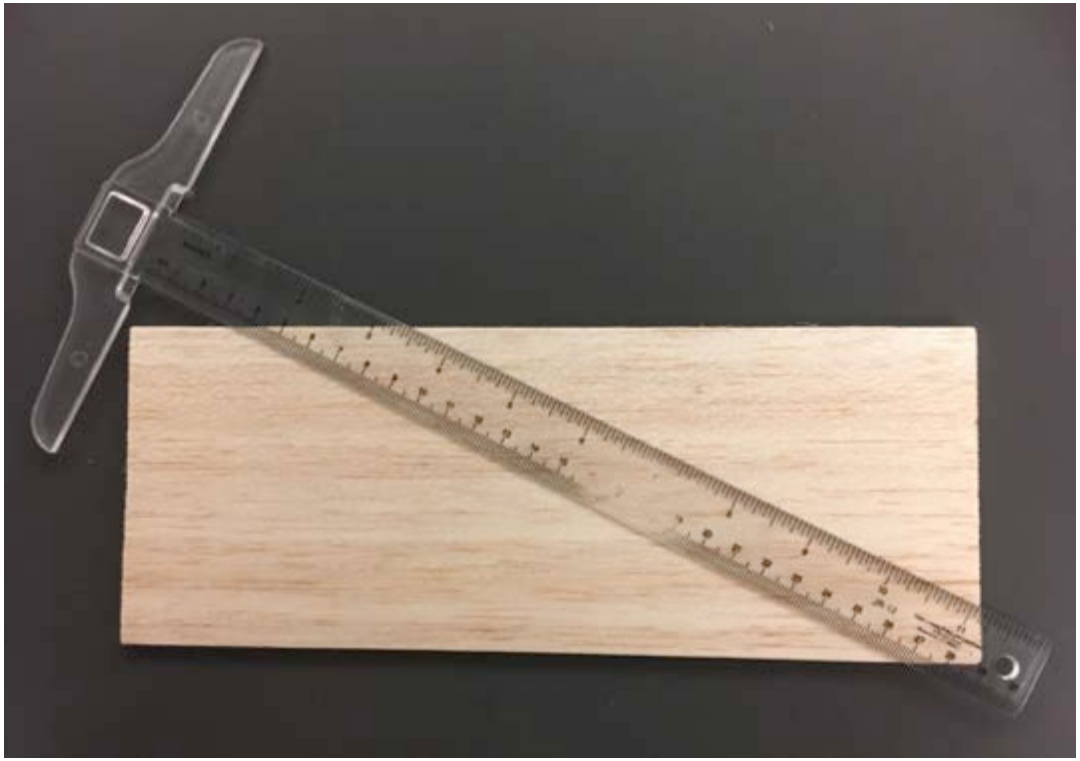
- 2 balsa wood sheets (10 ½” x 4” x 3/16”)
- 2 Pitsco GT-F wheels
- 2 Pitsco GT-R wheels
- 4 wide blue rubber bands (two for each of two rear wheels)
- 2 spiral wire guides
- 4 nylon spacers (axle bearings)
- 2 steel axles
- 1 black plastic gear font
- 1 No. 280 motor (required)
- 1 AA Battery Pack with Switch (required)
- 1 Velcro strips (for battery pack, salt, etc.)
- 1 T-Square clear plastic ruler

Tools Required (not in kit, except ruler)

1. Soldering Iron and Rosin Core Solder
2. Craft Knife / Box Cutter
3. Hot Glue gun
4. Needle-nose pliers
5. T-Square Ruler (supplied)



Making the Chassis



The chassis may be constructed with the balsa wood sheet provided. Other light stiff materials are optional, but the T-Square ruler should be used to carefully mark the mounting/cutting lines to keep them parallel.

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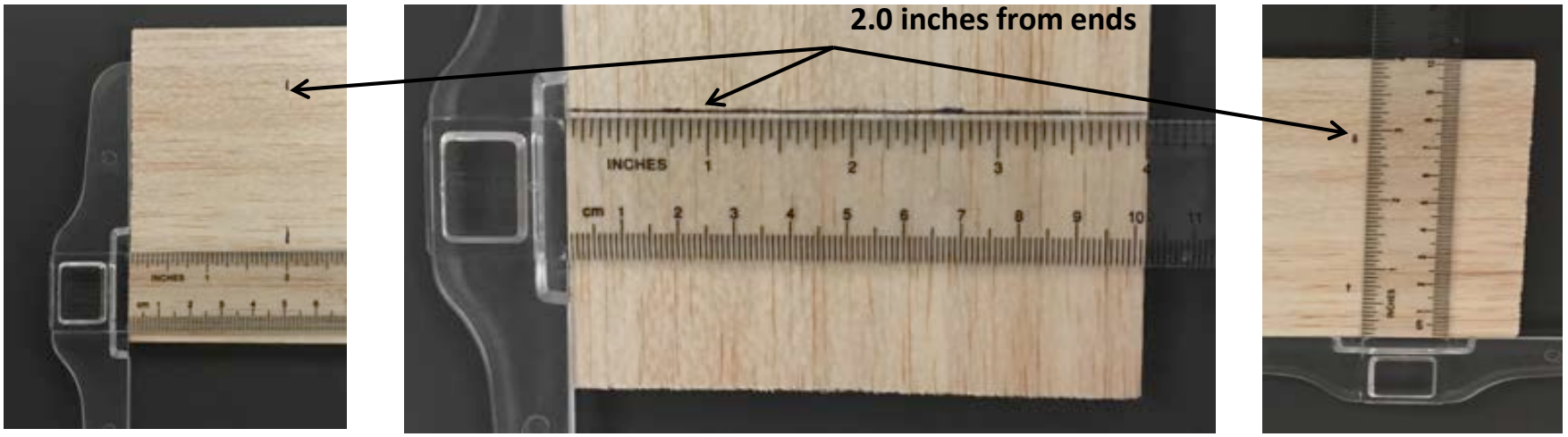
Making the Chassis



Step 1: Axle Lines At both ends of the balsa sheet, draw a line 2 inches from the ends. Use the T-square to make sure it is square with the edges. This is critical to make sure the axles are parallel so the car drives straight.

This are the locations for the front and rear axle and may vary with your design, but this is a good place to start for experimentation.

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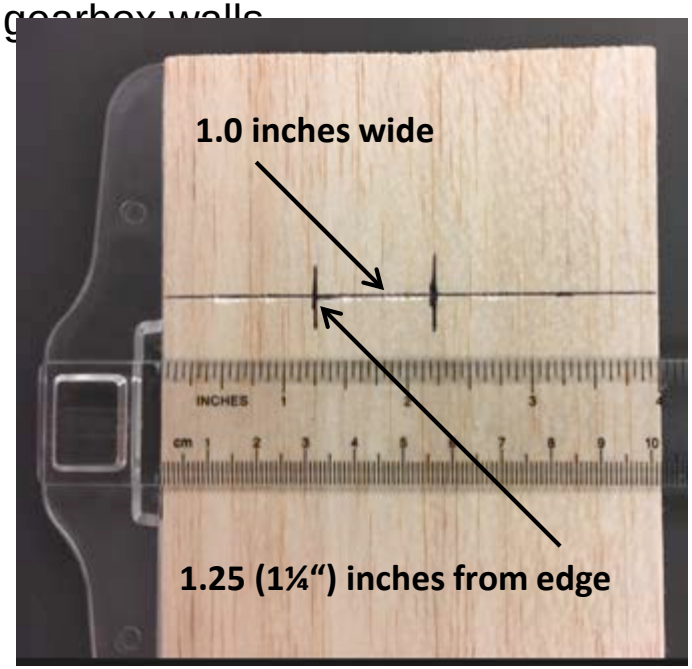
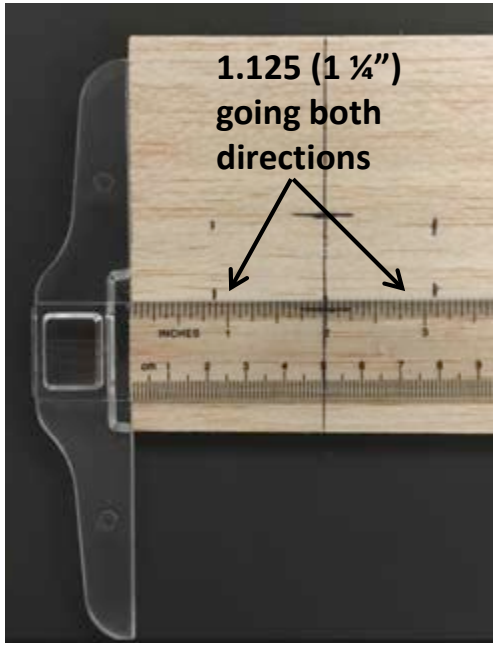
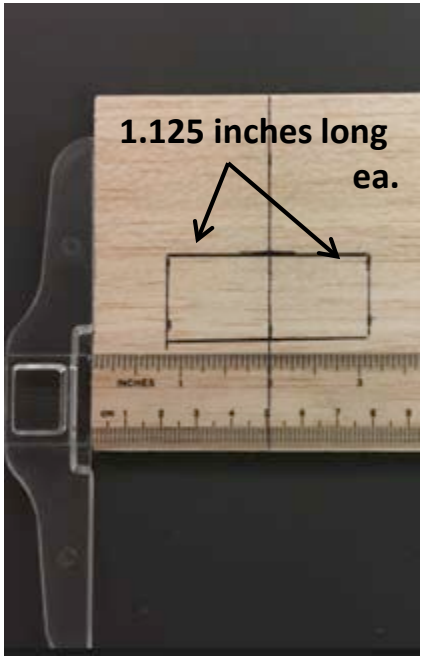
Making the Chassis

Step 2: Marking the Chassis Draw the gear box as 1.0” by 2.25” (2¼“) inches and it is located 1.25” (1¼“) from the left outer edge as shown below. The box should be centered as shown with the gearbox hole 1.125” on either side of the axle line, 1.0” wide. The rear axle with the gears mounted will be mounted at this end. The spacing is important to allow the nylon bearings to be well attached and to keep the gears from rubbing the gearbox walls.







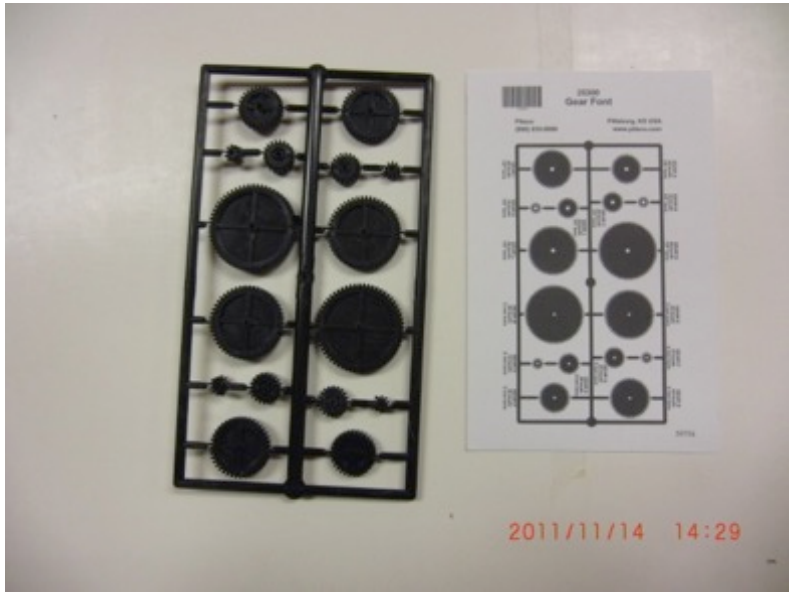
Making the Chassis

Step 3: Cutting the Gearbox Hole Cut the gearbox opening with the craft knife. Guide students to learn to cut safely and on some kind of cutting surface. The lines being cut can also be suspended over the edge of the table or between two books, but cutting the short sides (across the grain) will take patience and care to be done properly. Repeated light cuts across the grain are the best approach.

Wheels, Gears, and Axles

Step 4: Rear Axle Assembly Locate the plastic gear font. Detach Gears D (60 tooth), L (50 tooth), I (40 tooth and L (30 tooth) (all with 1/8" bore for the axles) and inspect them and using a sharp knife, carefully remove any plastic flashing between the gear teeth. (Only detach and use D if you are using larger rear wheels than provided in the teacher kit. The rear wheels must be larger than the largest gear used.).

Plastic Gear
Font and Guide



Wheels, Gears, and Axles

Step 5: Rear Axle Gear-Set

Place the A gear, 30 tooth, (or smallest you picked) on a table between two books spaced slightly apart. Insert one of the steel axles into the A gear and with a metal tool put pressure directly down to force the axle through the gear bore hole and in between the books. (Hammers can damage the axle when wheels are added later.) Just push down until it goes through an inch or two. Now with the same axle end, push the axle through the I gear until it is flush with the A gear. Do again a third time with the L gear. Now press the axle through all 3 gears until 2.0 inches come out of the largest gear. (Do I-L-D instead if your rear wheels are larger than the D gear.) You may need to push the axle further or back the other way until 2.0" comes out of the largest gear, last installed.

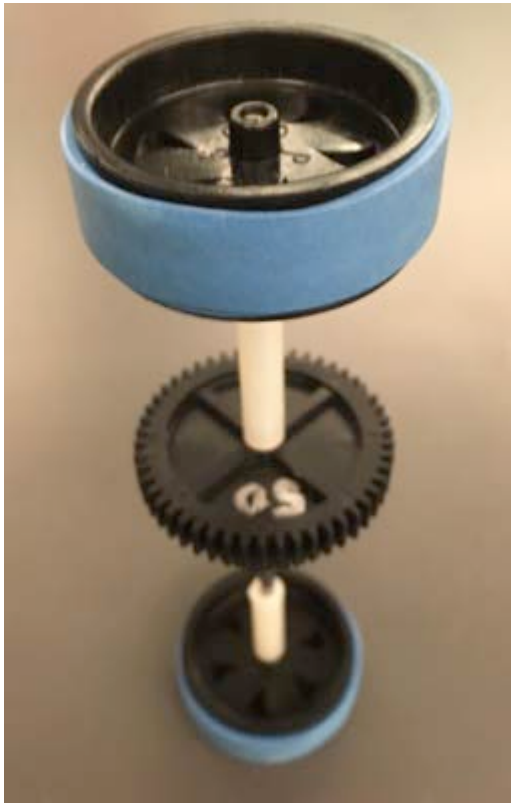
Wheels, Gears, and Axles

Step 6: Rear Axle Assembly

A. Slide two nylon spacers onto both ends of the rear axle, one on each side of the gear set.

B. Place one of the wide plastic wheels flat on a table, keeping the spacers in place, and again push the axle with a metal tool into the wheel hole until it is flush with the opposite side.

C. Repeat on the other end with the other wheel.



Wheels, Gears, and Axles

Step 7: Rear Wheel Rubber Bands

If you haven't already, stretch two wide blue rubber bands around each of the rear wheels, one at a time. These act as tires and provide greater traction for your vehicle. The two rubber bands on each wheel also make the rear wheels bigger than the 50 tooth gear! Failure to add the rubber bands will make the gear drag below the car on the floor and poor traction.

Wheels, Gears, and Axles

Step 8: The Front Axle Assembly

A. Place one of the two thin wheels flat on the table and insert the second steel axle into the wheel and push with a metal tool until the end of the axle is flush with the opposite side of the wheel.

B. Slide two nylon spacers onto the free end of the axle.

C. While keeping the spacers on the axle, insert the remaining end into the wheel and push with a metal tool until the end of the axle is flush with the opposite side of the wheel. Now both axles are ready to be mounted.

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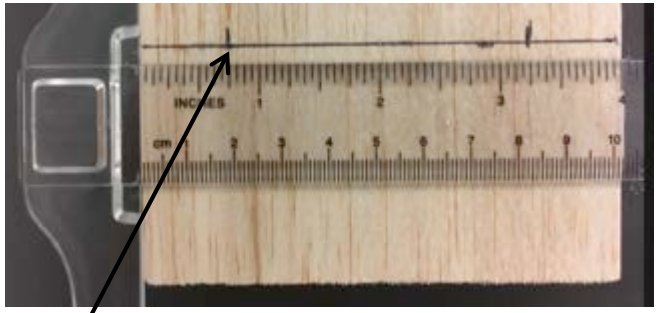
Attaching Axle Assemblies to Chassis

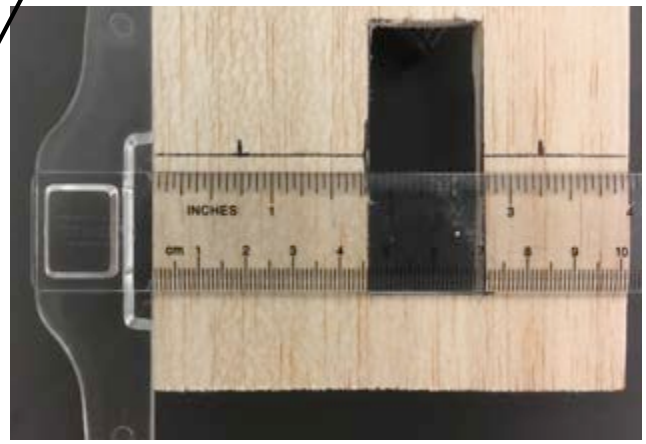
Step 9: Front/Rear Axle Measurement

A. Mark both axle lines .75 inches (¾“) from the edges on both sides as shown. This is to allows the glued bearings to extend past the edge of the chassis .25 inches (¼“) to keep the wheels from rubbing on the chassis and keeps the 3 gears centered.

B. Position the front axle/wheel set on the single line so you can see the line parallel to the axle below and the bearings in the right position. Roll them forward about ¼“ and put a small bead of hot glue on the line or just next to it on both sides on the balsa base where the bearings will be positioned. Quickly roll it back into position making sure the axle is exactly parallel to the line and hold it for 10-25 seconds. Look at the line on the chassis. This tacks the axle and bearings in the right place.



Front End



Rear End

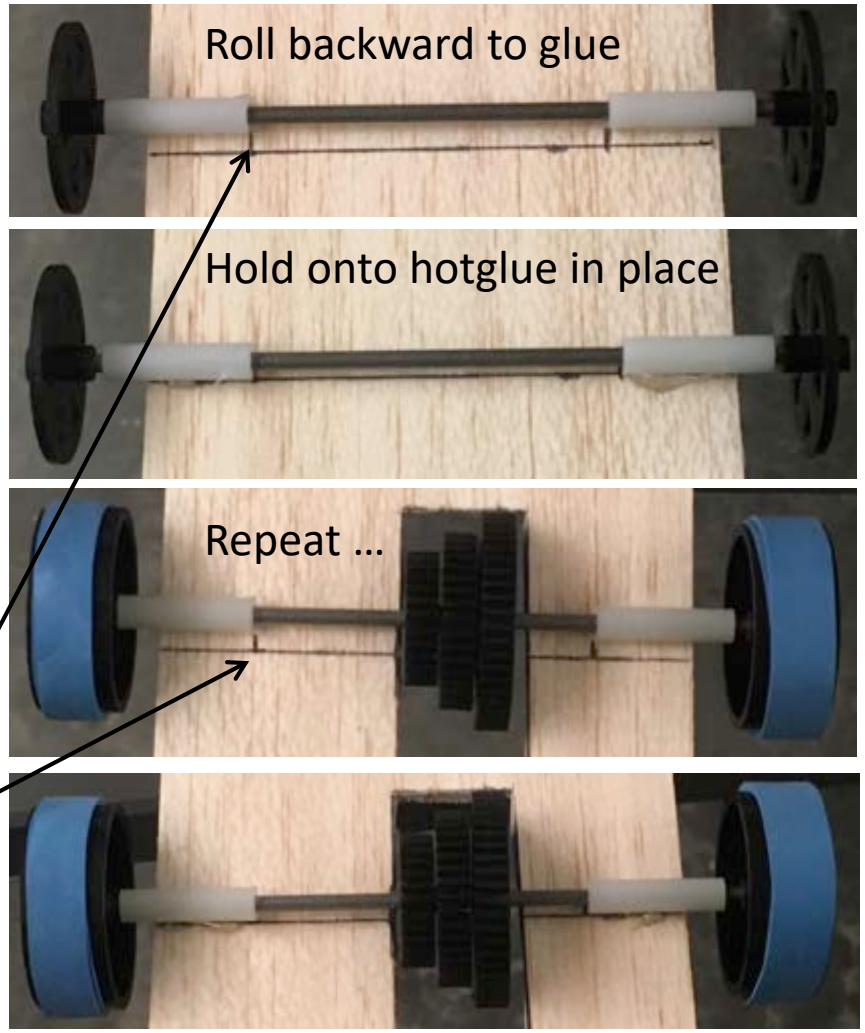
.75 inches (¾”) from edge

Attaching Axle Assemblies to Chassis

Step 10: Front and Rear Axle Attachment

Repeat this with the geared axle set. You will need to place it across two books or over the edge of a table to allow the gears and wheels to extend below the wood base while you tack the axle set in place.

Make sure you hold the axle sets parallel to the lines when you tack them down and hold them in place.



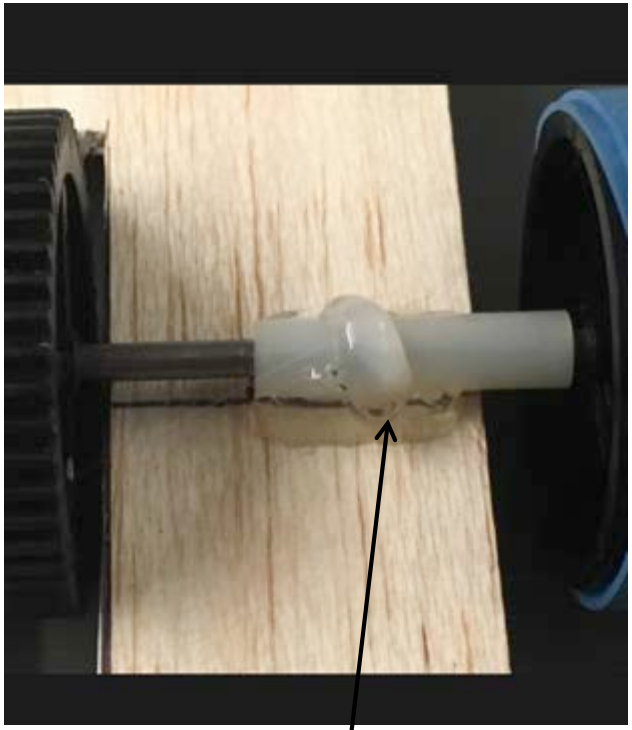
Attaching Axle Assemblies to Chassis

Step 11: Testing the Alignment

A. With both axles tacked on, push the car across the floor and see if it steers straight ahead when you let go. Adjust if needed. An aligned car will run much faster than one that must be steered constantly due to poor alignment.

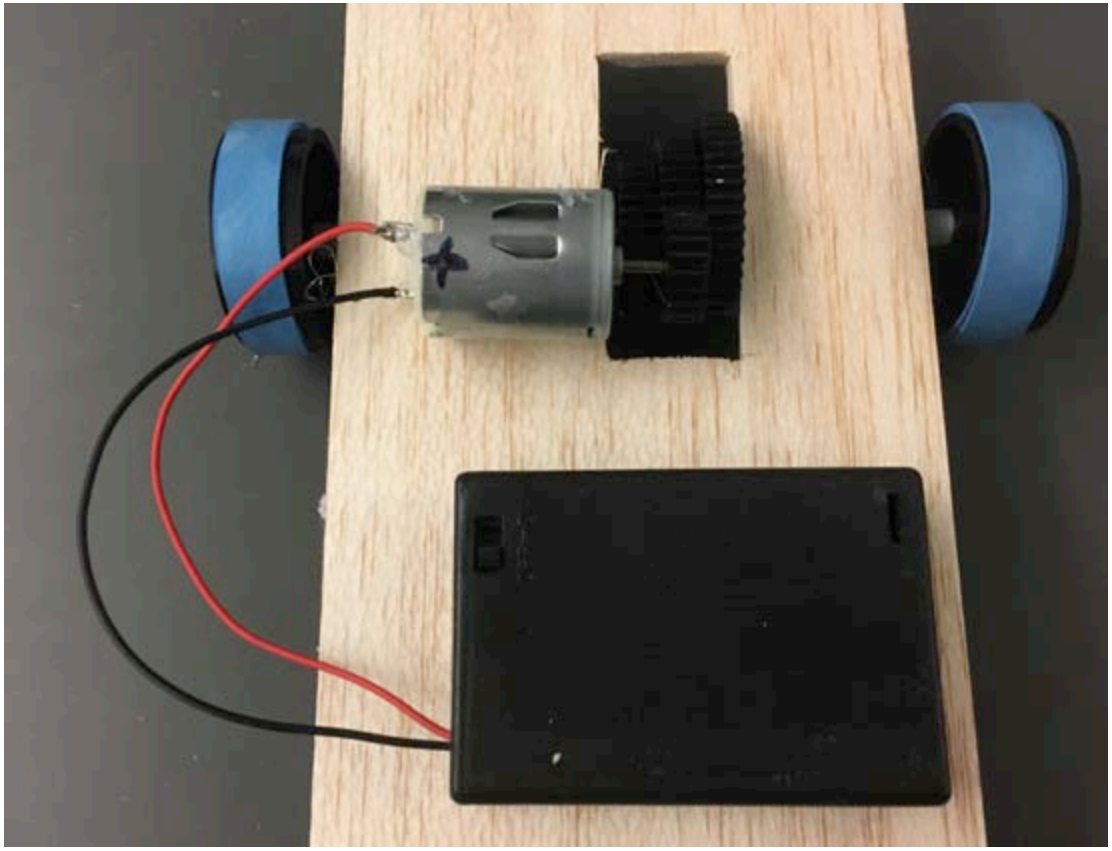
B. Picking the car up in the air, the wheels should turn effortlessly and spin when turned. Reposition if they stop immediately and or you hear them rub and drag.

C. When it runs straight and coasts well, add glue filets on both sides of the nylon bearings to make the bearing attachments permanent. Take a bead of glue over the bearing to connect both filets for strength. Make sure to not get glue into the bearing/axles, but if you do, they should peel out easily using needle nose pliers or even your nail and fingers. Clean away all glue strands left on the car or axles.



Hot Glue fillet both sides and over

Motor, Battery Pack and On/Off Switch

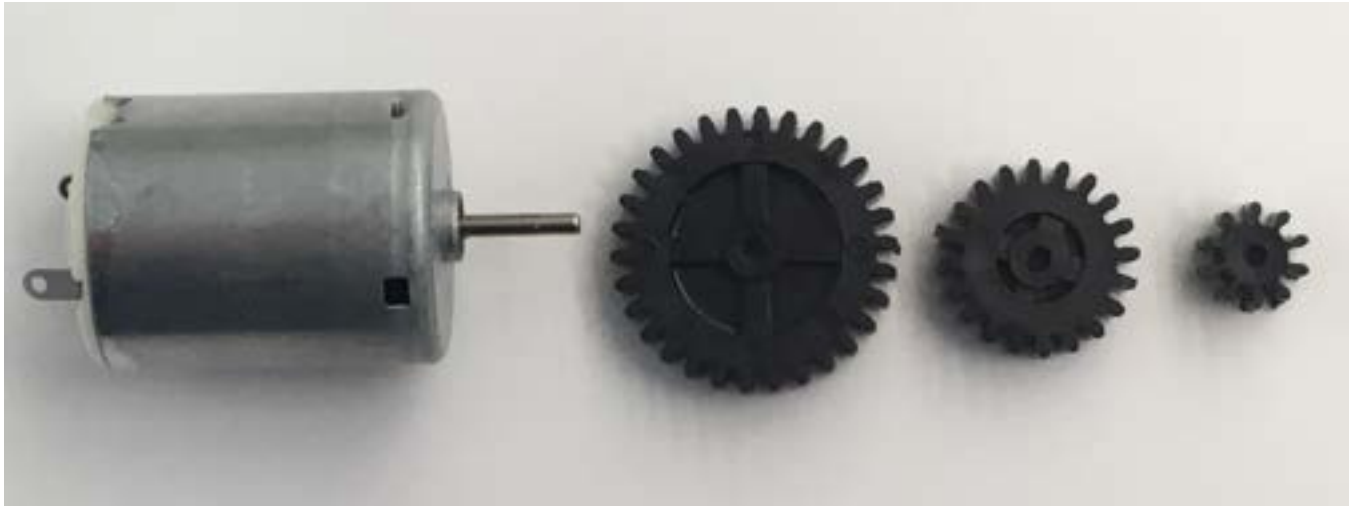


Adding and Wiring the Motor

Motor Gears

Step 12: Motor Setup and Gears

Take out the motor and the P (30 tooth), N (20 tooth), F (10 tooth) gears (all 2mm bore) from the font and clean them like the bigger gears. The gear you use, and the axle gear you match it to on the car will have different results. Learn about gear ratios and decide which of the three to try first. Experiment before you choose the "best" for your team and vehicle. Tack the motor on and run some trials. It can be removed and re-glued and different gear combinations tried. You will tack the motor on until you are sure. Make sure a salt container is used in your trials and that you run the full ten meters!.



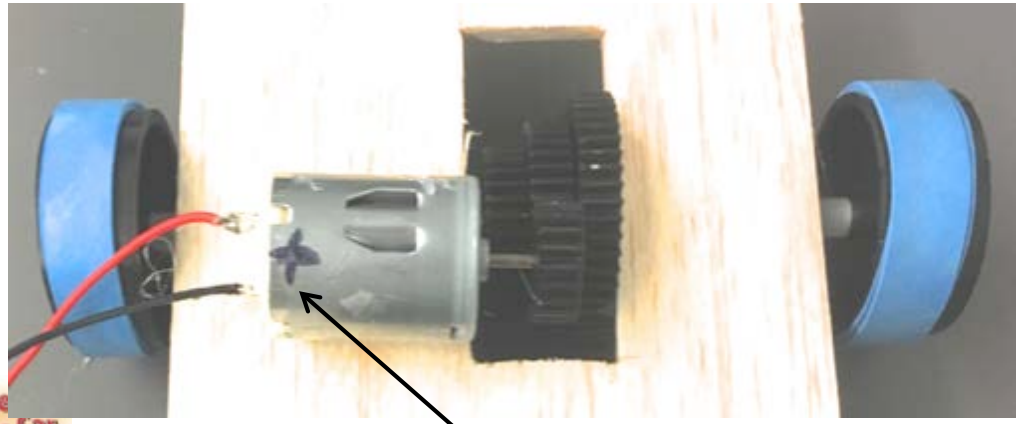
Experiment with different gears on the motor (10,20,30 tooth)

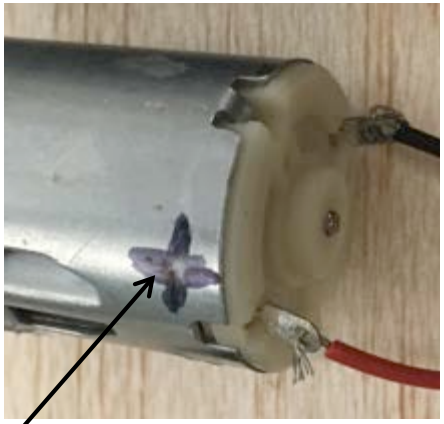
Battery Pack/On-Off Switch attachment to the motor.

Step 13: Powering The Car

A. Make sure the batteries are NOT in the battery pack. Tack the motor on with a single bead of glue, matching a motor-mounted gear to one of the three on the axle and hold. Always put the glue on the wood first. The metal of the motor will cool it too fast. The motor can be mounted either side of the chassis. Putting the motor on the axle side makes it more accessible, but the wires from the battery pack will have to penetrate the chassis.

B. Strip and twist the wire onto the motor leads (temporary), this is just to test the direction of the turn of the motor and to mark the motor polarity.





Mark the polarity on the motor, plus is red!

Battery Pack/On-Off Switch attachment to the motor.

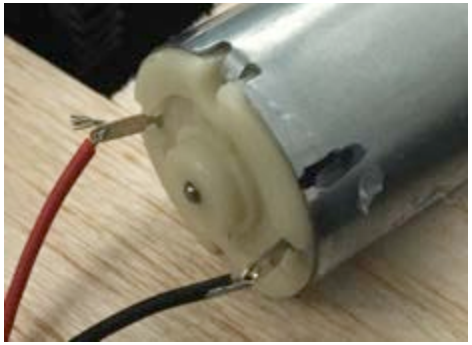
Step 14: Soldering the Wires

A. Add the batteries and turn on the switch of the battery pack and find out if the the car moves forward. If the direction is wrong, reverse the wires. Remove the batteries.

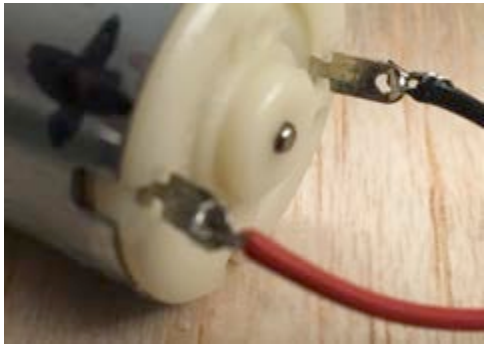
B. Mark the red wire terminal when you get it right with a positive (+) sign, and the other one, the black wire negative (-).

C. Push a freshly stripped red wire through the hole on the + terminal, bend it over, and solder it. Strip the black wire the same and do the same on the other terminal. (nail clippers CAN be good wire strippers if you are careful)

D. Only a very small amount of solder is necessary … actually less is better! For tips on how to solder try: https://learn.sparkfun.com/tutorials/how-to-solder-through-hole-soldering



Bend the wires first



Solder each lead

Battery Pack/On-Off Switch attachment to the motor.

Step 15: Protecting the Motor Leads and the Battery Pack

A. It is STRONGLY recommended that you put a bead of hot glue all around both of the motor leads AFTER soldering to protect these leads. A small amount of hot glue goes a long way.

B. Add the batteries back to the battery pack with the switch in the OFF position. Mount or place the pack where you can reach the switch but also change the batteries easily as needed.

Hot glue around the leads after soldering

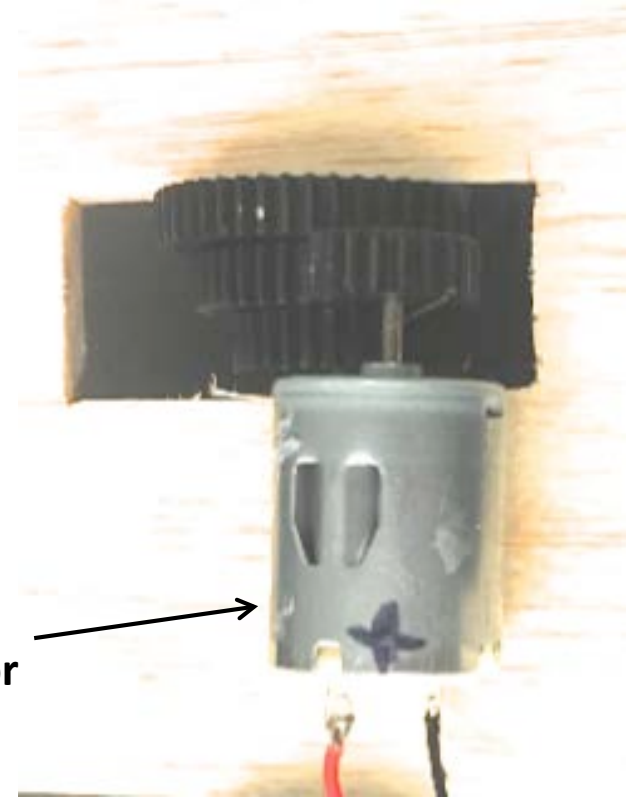
Attaching Motor Assembly to Chassis

Step 16: Attaching the motor

A. Once you have verified that your car runs forward, you can experiment with different gear combinations and ratios. Make sure to place the motor on its side with vent holes up. The motor can easily be removed and re-tacked. Only use a single bead for tacking.

B. When you have finalized the gear combinations and choose one, the motor can be attached more completely.

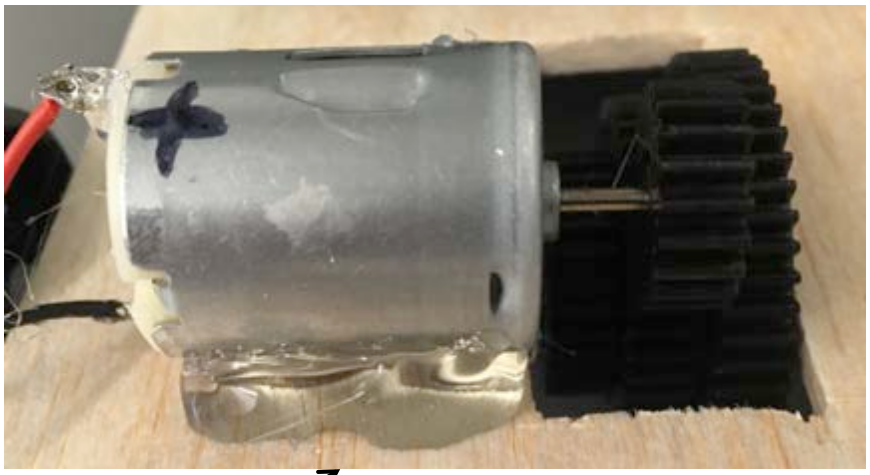
C. Holding the car in the air, make sure the motor, rear axle and gears run free and coast after the motor is turned off



Attaching Motor Assembly to Chassis

Step 17: Final Attachment of the motor (hard to remove, ready for competition!)

Apply a heavy bead of glue BEHIND AND IN FRONT of the motor. This will keep the motor in place if the vehicle comes to a sudden stop or crashes. The glue can go up the motor sides a bit if you want. Don't cover the vents!



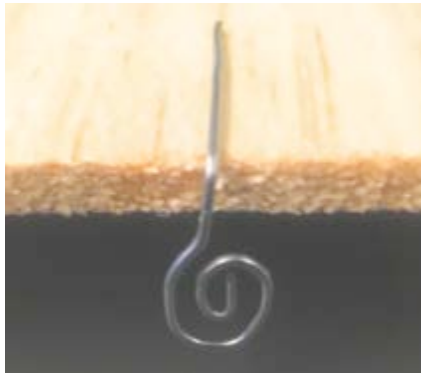
heavy beads of glue

Attaching a Wire Guide

Step 18: The Wire Guide

A. You will be running your car on a guide wire made of fishing line. Use ONE of the included spiral guides to keep the front of your car on the fishing line. You can make more with large paper clips and needle nose pliers.

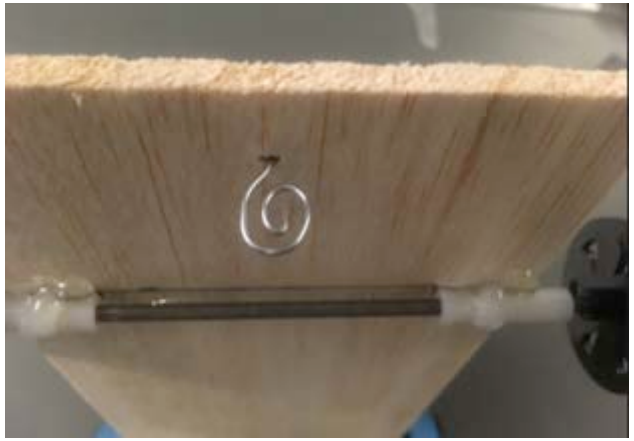
B. Bend the wire at a right angle that will allow the spiral to extend below the car and NOT touch the floor. The center of the spiral should be 1.0 cm from the floor. It will poke through the chassis and be hot glued in place as shown.

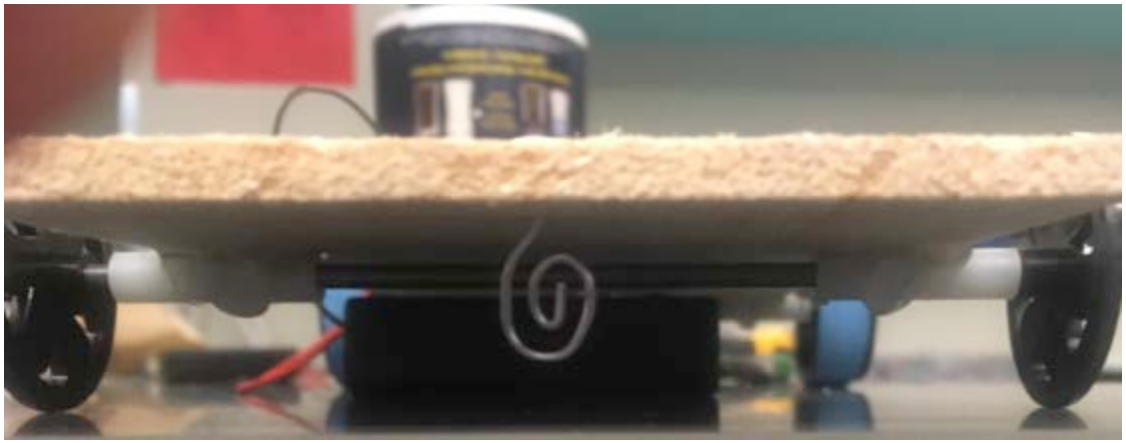


Locating the Wire Guide

C. The bent wire MUST go through the chassis and be glued above! Let it cool 5 minutes.

D. Attaching to the guide wire is simple: Put the car down next to the guide wire. Lift and drop the wire into the spiral. Lift it slightly and follow the spiral until it rests in the center hook. Taking it off is just lifting the wire and reversing the process.





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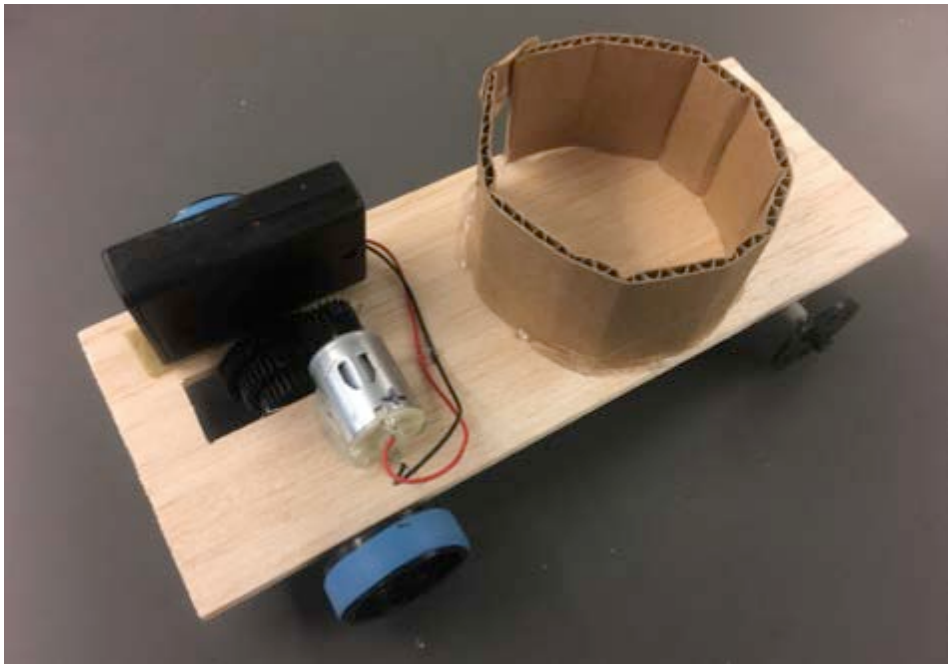
Making the Chassis

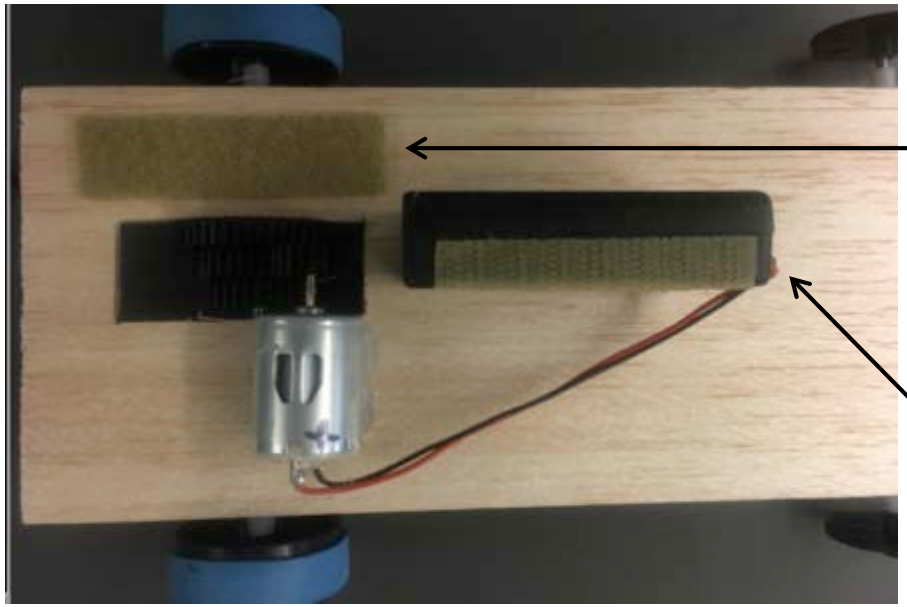
Step 19: Mounting the Salt Container The salt container can be attached any way you want, but remember, a “regulation” salt container MUST be used in competition. Make sure ANY salt container can be added and removed without adhesives or velcro. Your body design MUST incorporate the container provided at the competition.

A cardboard wall can be added to hold the salt container. A piece 2.0 inches by 12 inches long can work well. Hot glue it to the chassis allowing for a snug fit! The salt container cannot fall off during the race. If it falls off the car, it will result in a “Did Not Finish (DNF)



Making the Chassis

Step 20: Attaching the Battery Pack: The Battery Pack needs to be secured for testing and in competition. The included velcro strips can work well.



Possible location for velcro felt for testing

Add velcro hooks to base, don't cover the removable door

Final Notes

1. These instructions are only a starting point, especially for beginning teams. They can construct a working car and learn a lot about gearing and motors.
2. Students are encouraged to design differently, use other wheels, gears, anything, save changing the motor or the battery pack. The motor and battery pack are the two things must be used to qualify. Use the kit as a test bed, a place to try ideas and materials. Test your modifications to see how and if they improve the speed of your car!
3. Remember when mounting the battery pack, it must be removable and the back opened. The batteries will need to be changed often. After practice, before qualification runs, put in fresh batteries. Keep the old ones for practice. All final eliminations will be given fresh battery sets by the competition so everyone has the same chance to win.
4. Remember, whatever design you use for the body, the vehicle MUST run at all times with it attached. Salt container, battery mounting and replacement all must be considered!

Questions?

Please contact

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Design Challenge Scoring Rubric

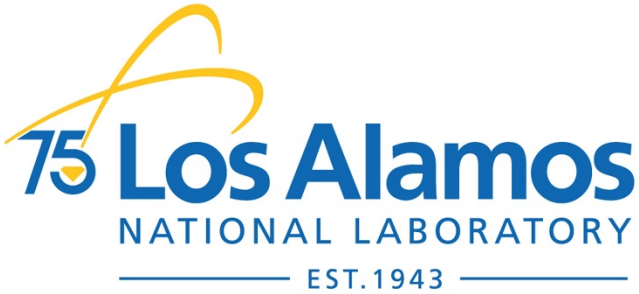
	Basic 1	2	Intermediate 3	4	Advanced 5
Chassis	Incorporates basic design components of chassis		Incorporates moderate level of sophistication into chassis design		Incorporates high level of sophistication into chassis design and mounting of equipment
Body	Very little in body design and creativity		Incorporates moderate level of sophistication & functionality in body design & application; draws a second look		Incorporates high level of sophistication and functionality, aerodynamics into body design
Creativity / Aesthetics	Very little in body creativity (basic paint & attachment)		Some creativity used in the design (unique painting, more interesting than basic design)		Very creative design that also enhance the performance of the vehicle (great aesthetic value; attracts attention)
Drive Train, Transmission, & Gear Application	Uses transmission & gears supplied in kit with basic wheels & tires		Uses kit transmission & gears with modifications; better wheels & tires		Enhanced modifications to transmission & gears to increase torque & speed; enhance wheels & tires
Construction Quality	Basic construction & materials used; little more than basic kit		Moderate attempt to improve overall construction quality with adherence to detail		Very high quality & detail in construction; well thought out & applied
Overall Design	Very little modification to basic kit; simple & effective overall design		More advanced design concept with some modifications; creative; good overall design		Extensive modifications demonstrating an understanding of engineering & physics in the design
Response Skills	Missing some ideas of the project development & application; lacks eye contact; hesitating in response		Has the main idea and effective in sharing the concept; good eye contact; speaks clearly with confidence		Thorough in concept of the project & able to express it very well; good eye contact; speaks very confidently

Oral Presentation Challenge Scoring Rubric

	Basic 1	2	Intermediate 3	4	Advanced 5
Informative	Missing some main ideas, inaccurate information		Captures main ideas, mostly accurate		Captures main ideas, thorough, accurate, provides good examples, and insightful
Professional Attitude	Often slouches, sways, turns back on audience frequently, fidgets frequently, hard to hear rare eye contact		Sometimes slouches, sways, sometimes turns back on audience, fidgets, volume too low at times, some eye contact		Stands straight, faces audience, words pronounced and heard clearly, good eye contact
Organization	Information not presented in a logical, interesting sequence; the audience could not follow		Information was interesting but not presented in a logical order; audience had difficulty following		Information presented in a logical, interesting sequence which the audience could follow
Visual Aids	Utilized less than two different types of media; information not relevant to outcome/content; messy; minimal artistic effort		Utilized two different types of media, information relevant to outcomes/content; messy; adequate artistic effort		Utilized more than two different types of media; information relevant to outcomes/content; very neat; excellent artistic effort
Time / Flow	Used significantly less or more than allotted time; time punctuated with many pauses and “bridges”		Used less or more than allotted time; time punctuated with some pauses and “bridges”		Used allotted time efficiently; utilized very few pauses and “bridging”

Topic: "Hybrid vehicles use a gasoline engine and electric motor to power the vehicle. What are the advantages and disadvantages of hybrid cars compared to electric cars?”

THANK YOU SPONSORS!



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