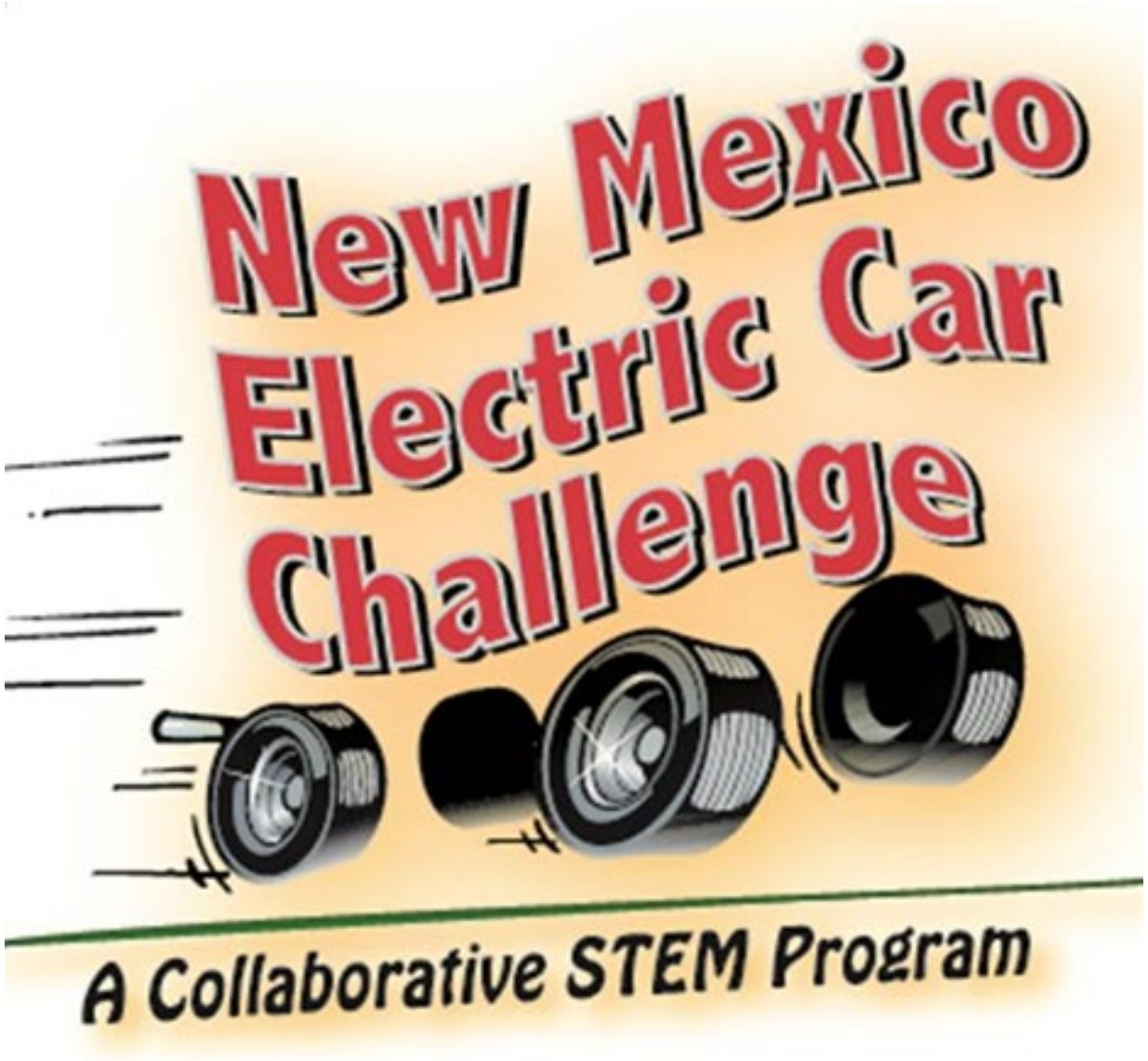
TEACHERS WORKSHOP 2022

Ford Davis
Debra Menke



Course Overview

- Goals and Description
- New Mexico Electric Car Challenge (NMECC) 2022 Guidelines
- Car Assembly
- Questions

Goals and Description

Primary Goals

- 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.

Challenge Basics

- Teams consist of 2-6 students.
- Students in grades 6th, 7th and 8th are eligible to participate.
- Students may elect to work on different challenges (construction, race, design, and research presentation) – all team members do not have to work on each challenge.
- A teacher or coach from the participating school must be present in race videos and/or at the in-person event.
- Each school may register a maximum of 3 teams – each team must have an adult coach.
- A maximum of 50 teams will be allowed to participate.
- Teams may participate in either the in-person or virtual event (held on different dates).
- Coaches must submit a signed participant release for all student participants.

Three Challenges

- **Race Challenge:** Challenge based on speed of electric car. In-person - maximum of 5 qualifying runs over a 10-meter course, fastest cars compete in a head-to-head race. Virtual – team submits 3 videotaped heats.
- **Design Challenge:** Challenge based on student demonstration and understanding of the design process. In-person and virtual – teams will participate in a scheduled 10-minute interview.
- **Research Challenge:** (formerly Orals) Challenge based on student research and presentation on an energy-related topic. In-person – teams make a 5–7-minute presentation. Virtual -team submits a 5–7-minute video.

Each Challenge is scored individually, and awards will be provided to the top three teams for each Challenge in both the In-Person and Virtual competitions. In addition, scores for all Challenges will be added to determine the top three overall winners. Participation in the Research Challenge earns points towards the Overall winners.

The virtual event will also feature a *Parade of Cars* that will feature a photo of each team and their car.

Car Specifications and Design Rules

- Each team is responsible for designing and building an AA alkaline battery powered model racecar.
- All vehicles must be safe for contestants and spectators (e.g., no sharp edges, projectiles, etc.)
- The dimensions of the car cannot exceed:
  - 20 cm in width (7.87 in.)
  - 40 cm in length (15.75 in.)
  - 20 cm in height (7.87 in.)
- The DC motor and AA Alkaline batteries must be used in the design – the battery holder and motor may not be modified in any way.

Car Specifications and Design Rules

- The switch on the battery module MUST be used and the module mounted so that the switch moves “side-to-side” or “up and down” when mounted. The switch may be engaged with the car flat on the track, but it is recommended the car be lifted at the back (assuming rear wheel drive) and the car released by dropping the rear while the motor is on and at full speed. The car CANNOT be pushed!
- The vehicle must be designed to carry a payload of 700g. The mass is up to the discretion of the team. The car will need to weigh at least 700g when raced.
- Each team provides the parts needed for the construction of the car – wheels, car body/chasses, axles, gears, etc. The motor and battery pack are required!
- All cars will be inspected. In-person – at registration. Virtual – during the design interview and in the race videos.
- The body may be decorated at the team’s discretion. The car must remain intact for the entire competition – including Design. No body parts can be removed or altered between the Design and Race Challenges.

New Mexico Electric Car Challenge (NMECC) 2022 Guidelines

Please read the 2022 Challenge Guidelines prior to construction

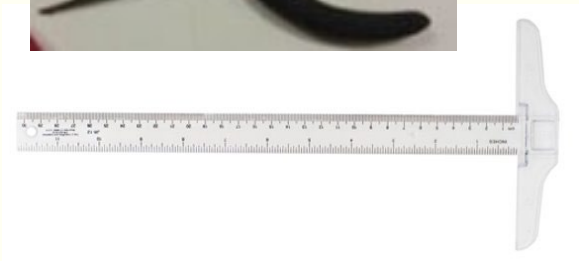
Supplied Materials

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)
- 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)

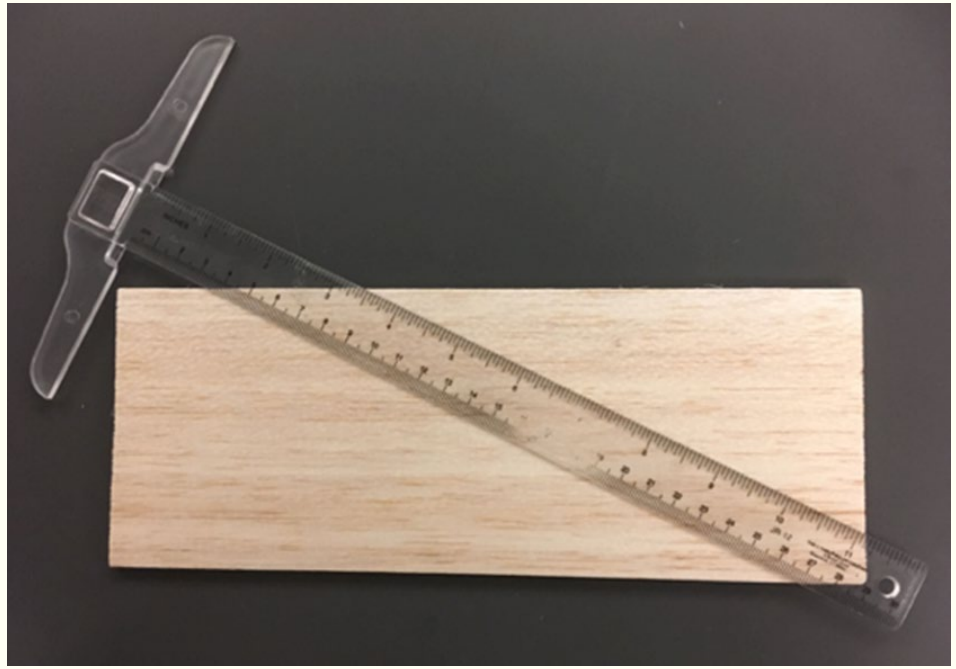
Tools Required

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.

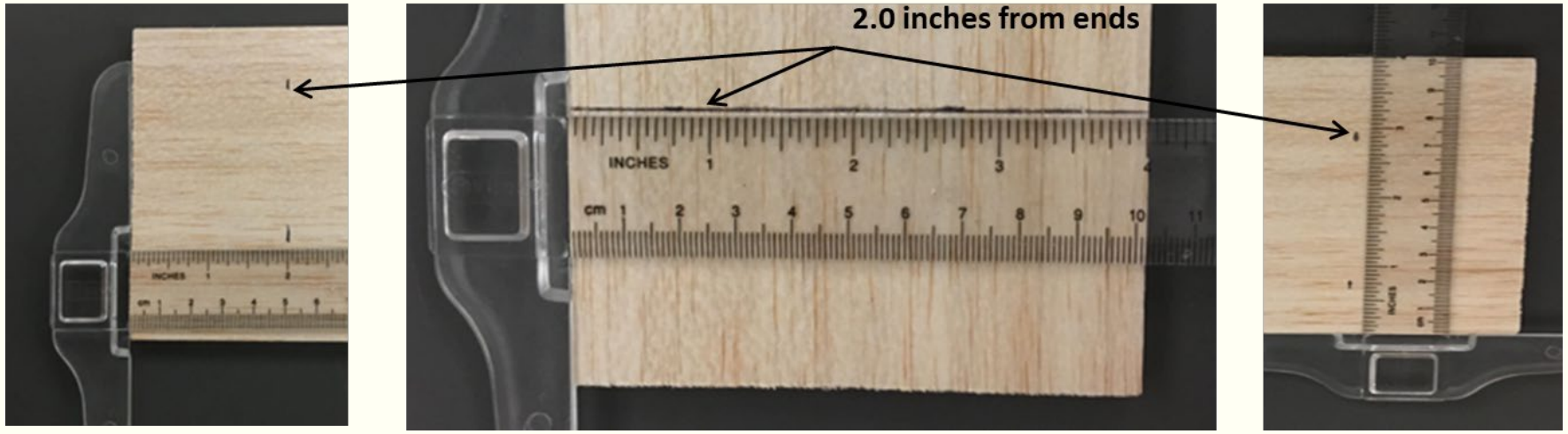


Making the Chassis

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.

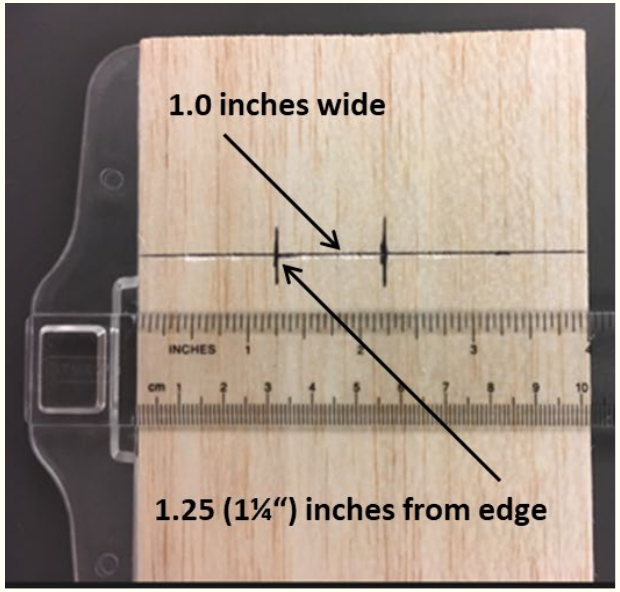
This are the locations for the front and rear axle and may vary with your design, but this is a good place to start for experimentation.

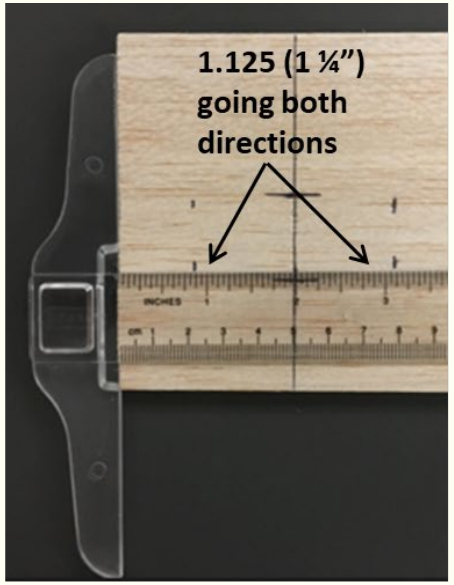


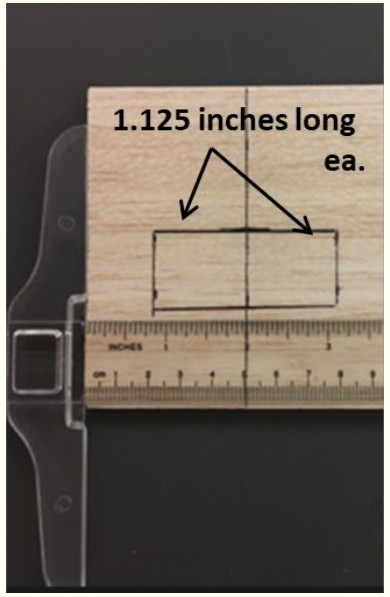
Making the Chassis

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

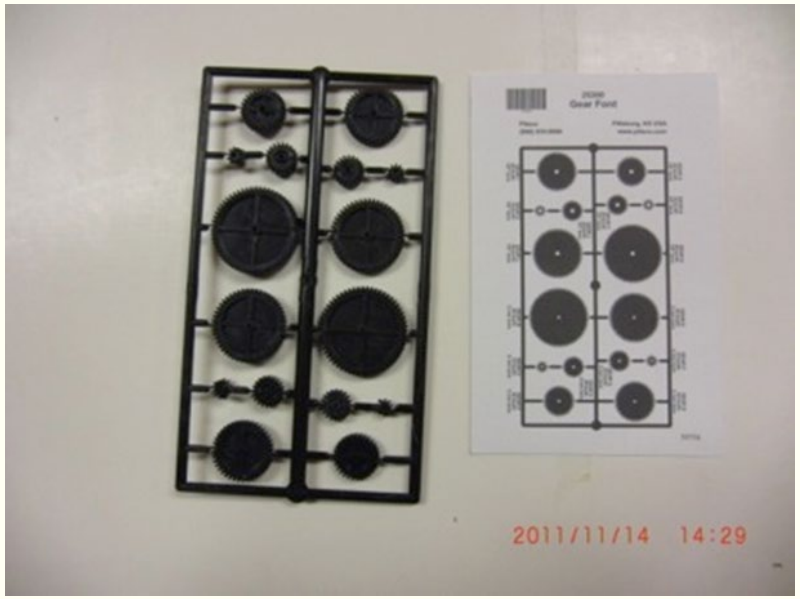
Step 3: Cutting the Gearbox Hole

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 Axels

Step 4: Rear Axle Assembly

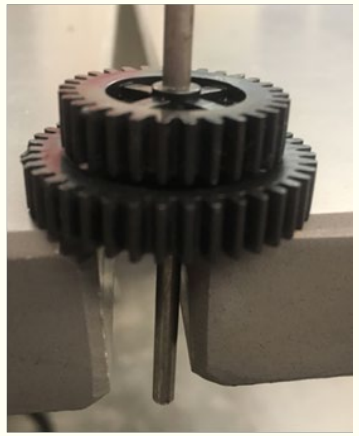
Locate the plastic gear font. Detach Gears D (60 tooth), L (50 tooth), I (40 tooth and L (30 tooth) (all with 1/8” bore for the axles) and inspect them and using a sharp knife, carefully remove any plastic flashing between the gear teeth. (Only detach and use D if you are using larger rear wheels than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

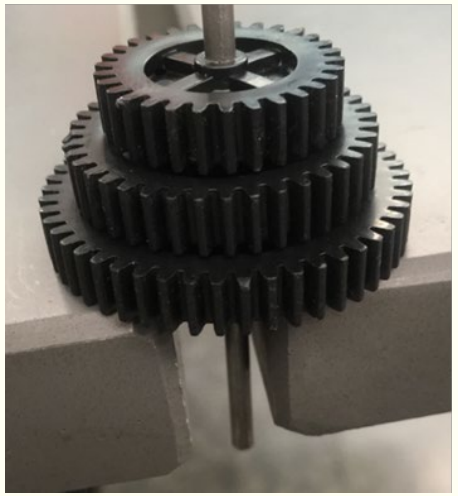


Wheels, Gears, and Axles

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.
- 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.

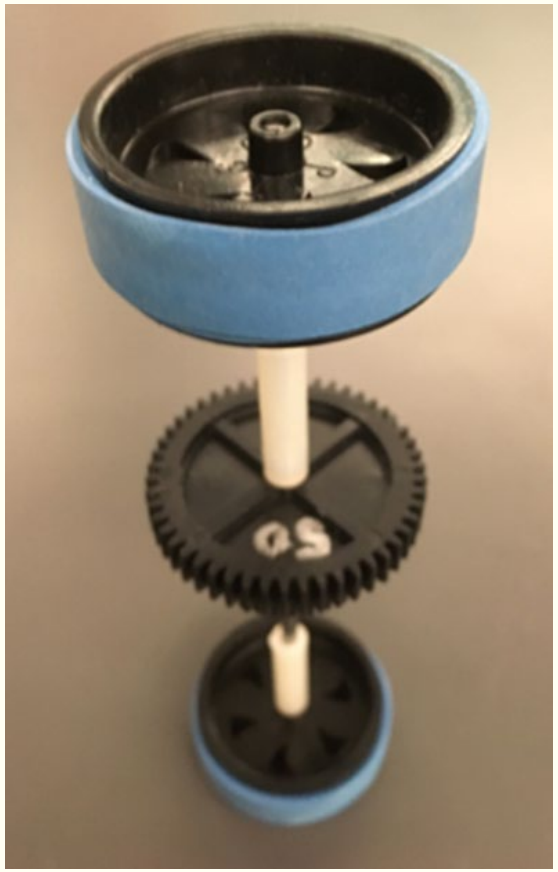




Wheels, Gears, and Axles

Step 6: Rear Axle Assembly

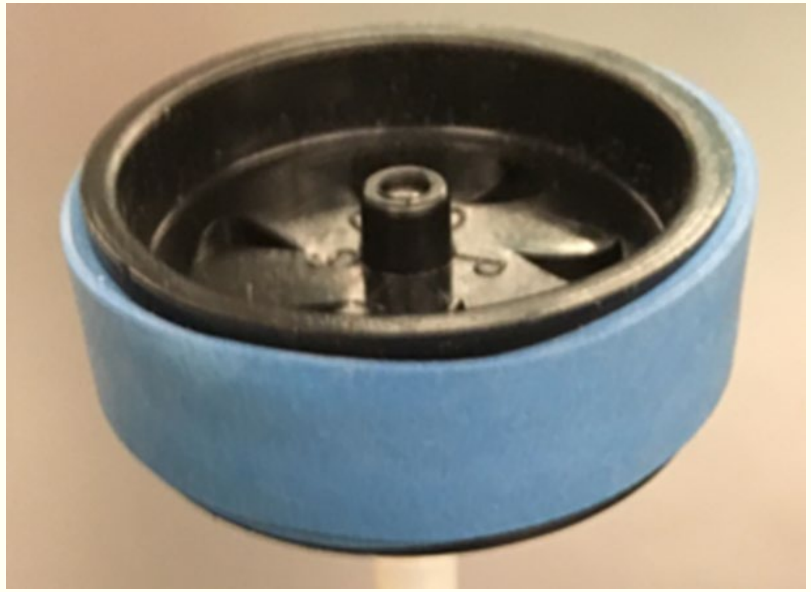
- Slide two nylon spacers onto both ends of the rear axle, one on each side of the gear set.
- Place one of the wide plastic wheels flat on a table, keeping the spacers in place, and again push the axle with a metal tool into the wheel hole until it is flush with the opposite side.
- Repeat on the other 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

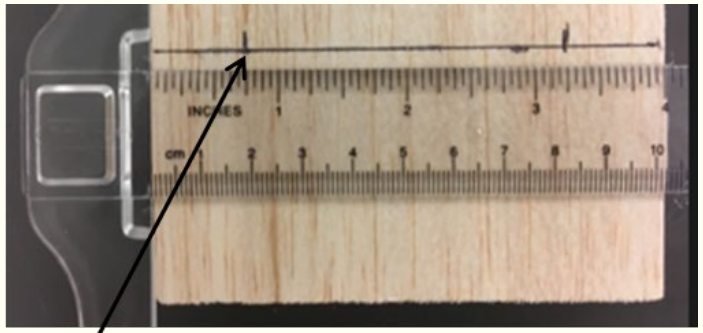
- Place one of the two thin wheels flat on the table and insert the second steel axle into the wheel and push with a metal tool until the end of the axle is flush with the opposite side of the wheel.
- Slide two nylon spacers onto the free end of the axle.
- While keeping the spacers on the axle, insert 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.

Attaching Axle Assemblies to Chassis

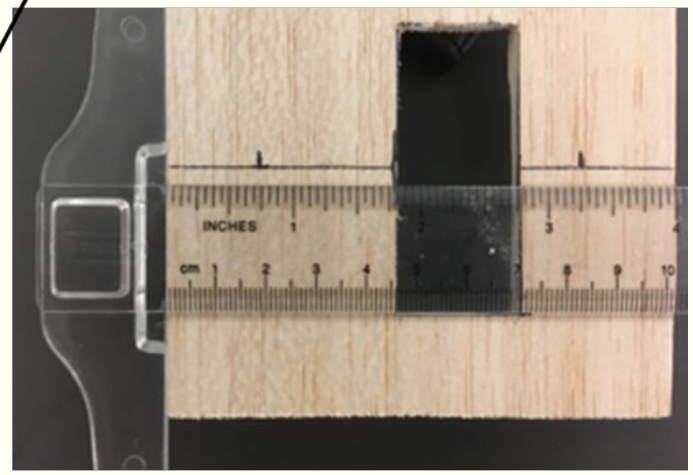
Step 9: Front/Rear Axle Measurement

- 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.

- 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



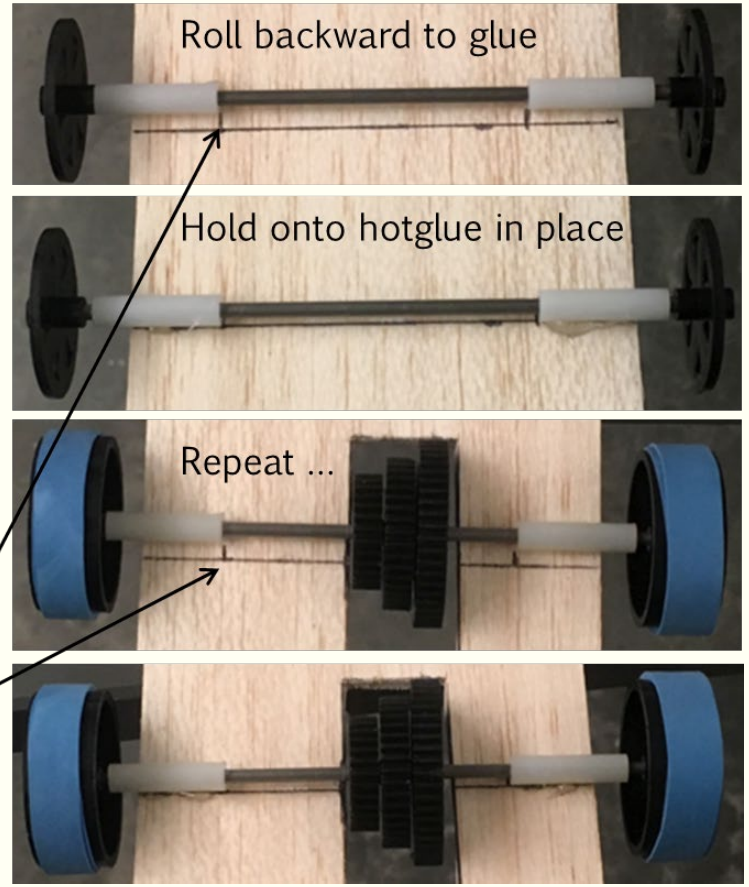
Rear End

.75 inches (¾”) from edge

Attaching Axle Assemblies to Chassis

Step 10: Front and Rear Axle Attachment

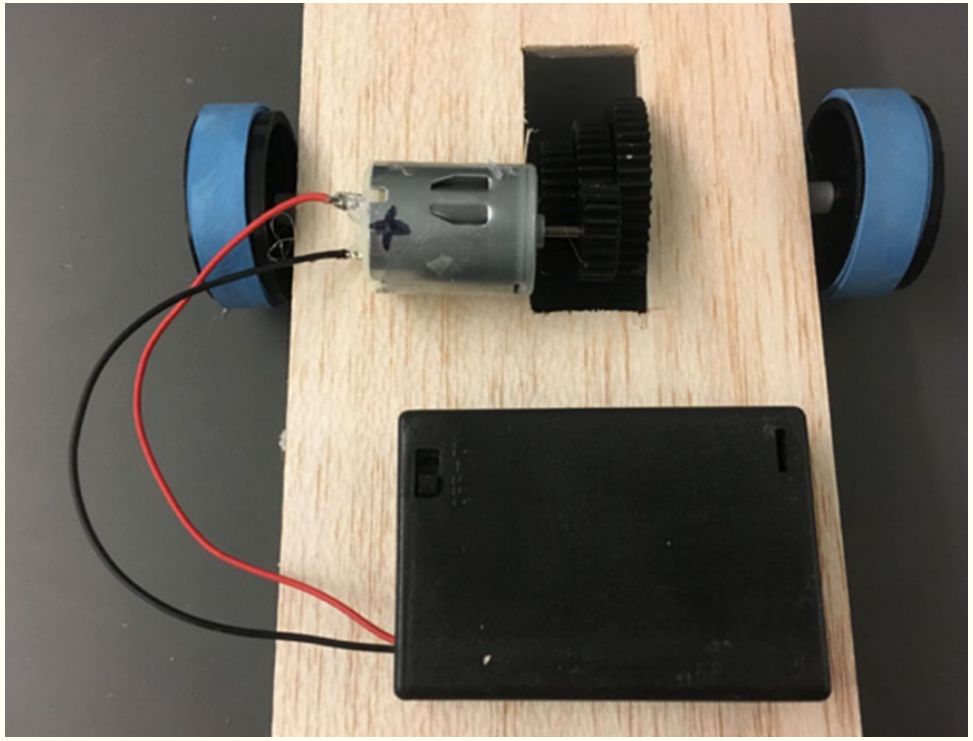
- Repeat this with the geared axle set. You will need to place it across two books or over the edge of a table to allow the gears and wheels to extend below the wood base while you tack the axle set in place.
- Make sure you hold the axle sets parallel to the lines when you tack them down and hold them in place.



.75 inches (¾”) from edge

Motor, Battery Pack and On/Off Switch

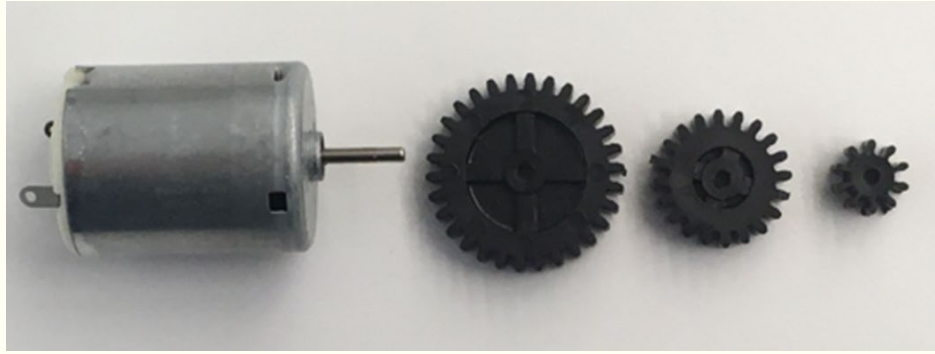
Adding – Wiring the Motor



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!.



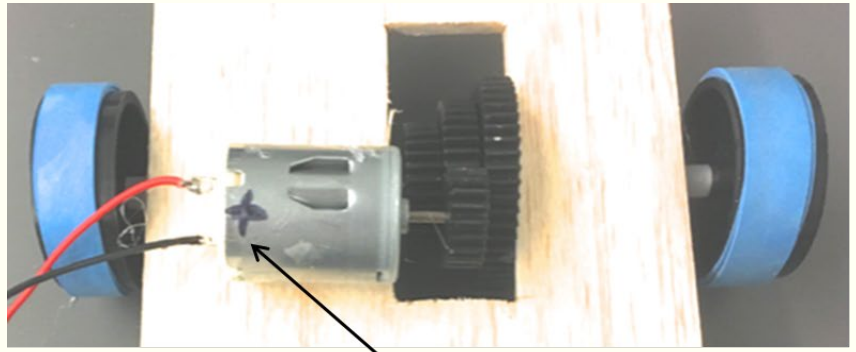
Experiment with different gears on the motor (10,20,30 tooth)

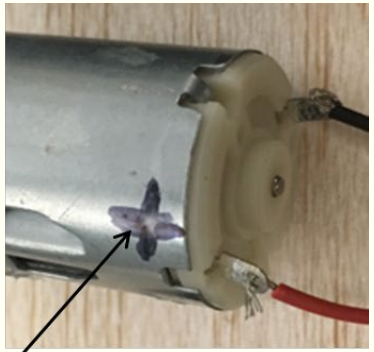
Battery Pack/On-Off Switch Attachment to the Motor

Step 13: Powering The Car

- 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.

- 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.



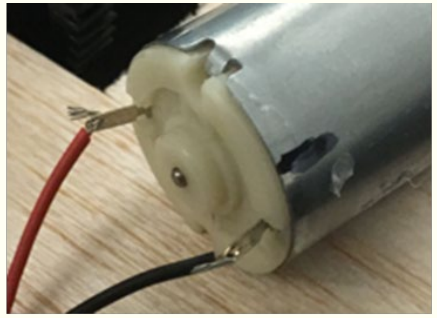


Mark the polarity on the motor, plus is red!

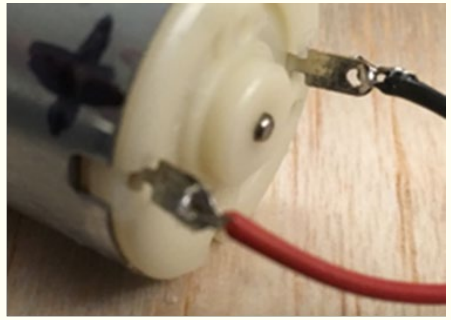
Battery Pack/On-Off Switch Attachment to the Motor

Step 14: Soldering the Wires

- Add the batteries and turn on the switch of the battery pack and find out if the car moves forward. If the direction is wrong, reverse the wires. Remove the batteries.
- Mark the red wire terminal when you get it right with a positive (+) sign, and the other one, the black wire negative (-).
- 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)
- 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

- 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.

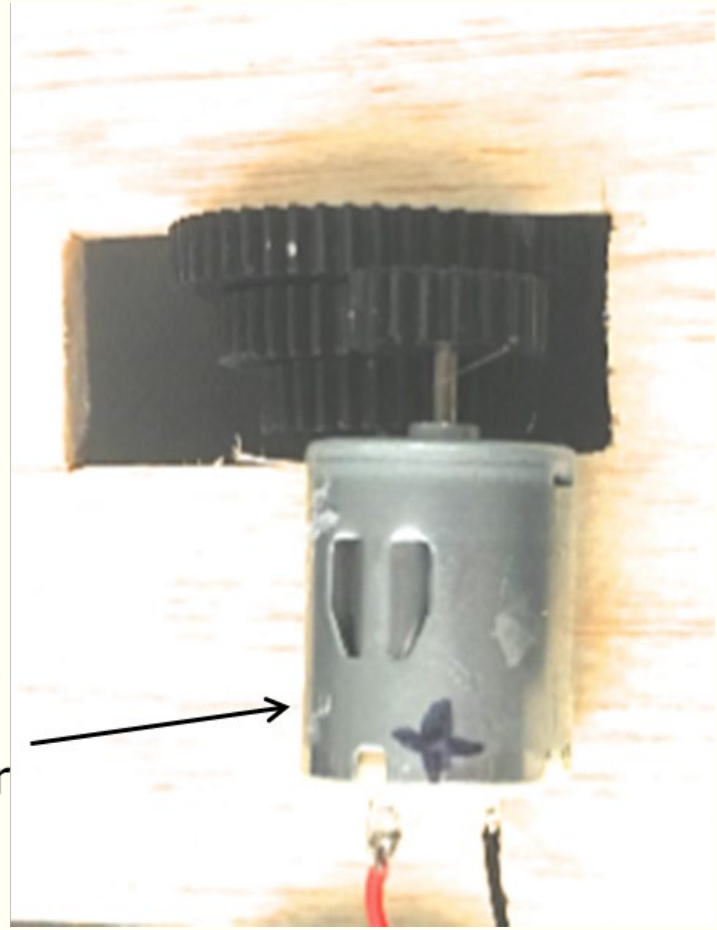
- Add the batteries back to the battery pack with the switch in the OFF position. Mount or place the pack where you can reach the switch but also change the batteries easily as needed.

Hot glue around the leads after soldering

Attaching Motor Assembly to Chassis

Step 16: Attaching the motor

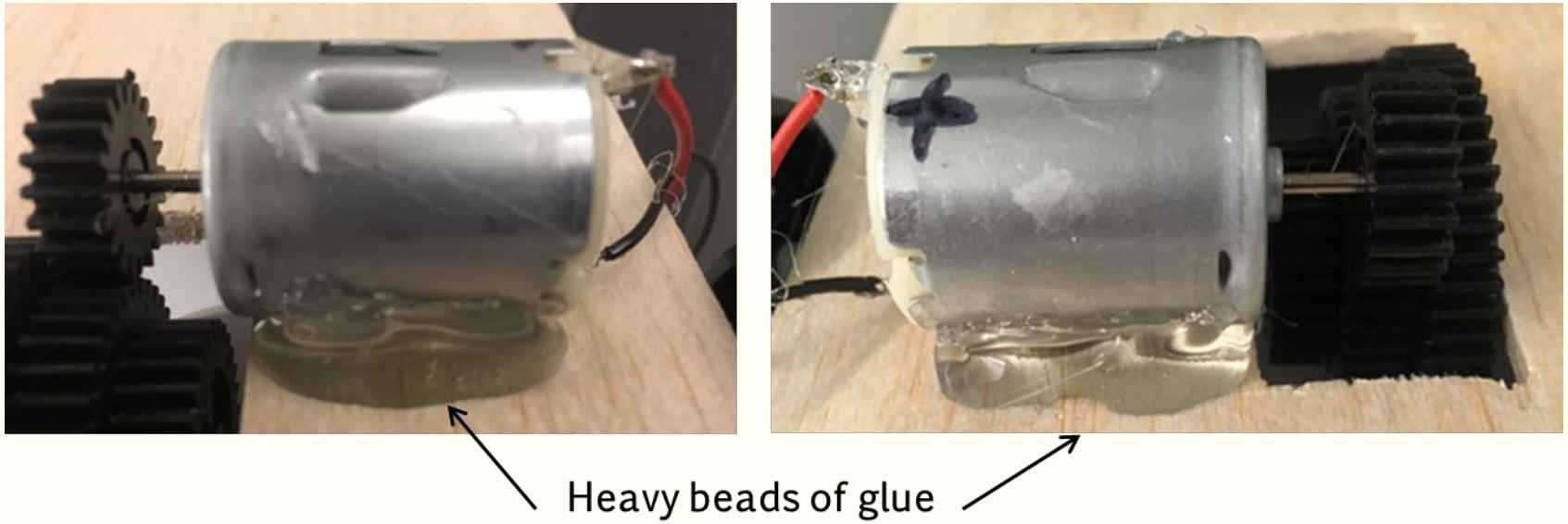
- Once you have verified that your car runs forward, you can experiment with different gear combinations and ratios. Make sure to place the motor on its side with vent holes up. The motor can easily be removed and re-tacked. Only use a single bead for tacking.
- When you have finalized the gear combinations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

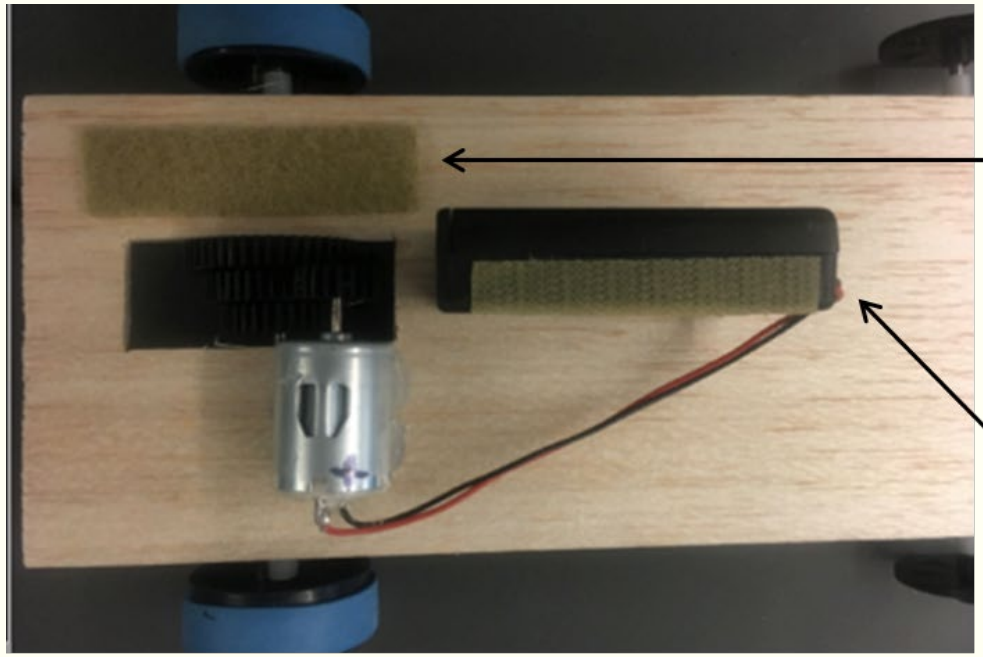
Step 17: Final Attachment of the motor (hard to remove, ready for competition!)

- 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!



Making the Chassis

Step 18: 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. 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 doing your virtual runs**, put in fresh batteries.

4. Remember, whatever design you use for the body, the vehicle MUST run at all times with it attached.

5. Have FUN!

Sample Race Day Schedule

7:30 AM - 8:30 AM	Team Registration & Judge Training
8:30 AM - 10:00 AM	Rotation 1
10:00 AM - 11:30 AM	Rotation 2
11:30 AM - 1:00 PM	Rotation 3
1:00 AM - 1:45 PM	Design Challenge & Research Challenge Finals Second Chance 8 team, single elimination “Head-to-Head” race contest
1:45 PM - 2:45 PM	8 team, single elimination “Head-to-Head” Race Final Rounds
2:45 PM -3:00 PM	Final calculations to determine Overall Winners in all categories
3:00 PM - 3:30 PM	Awards Ceremony

Timeline of Events – Virtual

ACTIVITY	DATE	TIME
Information to Schools	August 10	
Registration Deadline	August 31	
Mail Kits to Schools	September 12	
Teacher Workshop	September 24	9:00 AM – 12:00 PM
Project Work Time	September 26 – November 4	
Submit Parade of Cars photos, Research Challenge Video, Race Challenge Videos, and signed Release forms for participating students.	November 4	By 5:00 PM
Virtual Design Challenge Interviews – all teams	November 7	3:30 PM - 5:30 PM
Virtual Design Challenge Interviews – Finals	November 8	3:30 PM - 5:30 PM
Virtual Awards Ceremony – ZOOM Participation link will be provided	November 10	3:30 PM - 5:30 PM

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Teacher Workshop	September 24	9:00 AM – 12:00 PM
Project Work Time	September 26 – November 4	
Submit, Research Challenge presentation and signed Release forms for participating students.	November 4	By 5:00 PM
In-person Event	November 19	8:00 AM - 3:30 PM

Questions

Contacts

Debra Menke, MS

K-12 STEM Education Outreach Coordinator

Community Involvement SNL

Email: dmenke@sandia.gov

Mobile: 505.803.8098

Mónica Martínez-Archuleta, EdD

K-12 STEM Education Outreach Specialist

Community Partnerships Office LANL

Email: m.archuleta@lanl.gov

Mobile: 505.500.6076