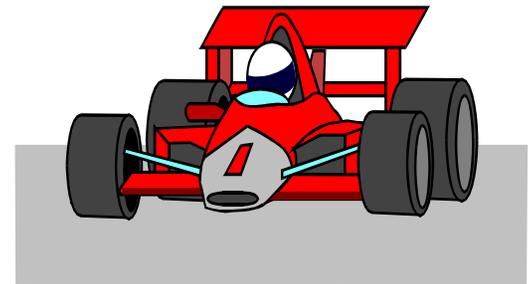


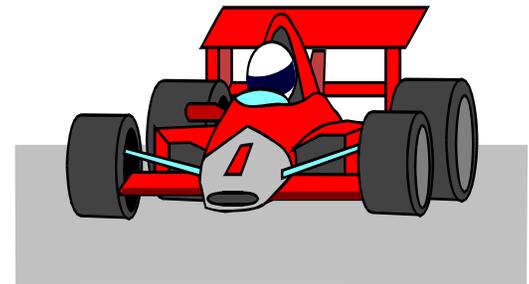
# Future of Transportation

In the coming decades, transportation in the U.S. is expected to change radically in response to environmental constraints, fluctuating oil availability and economic factors.



# Future Decision-Makers

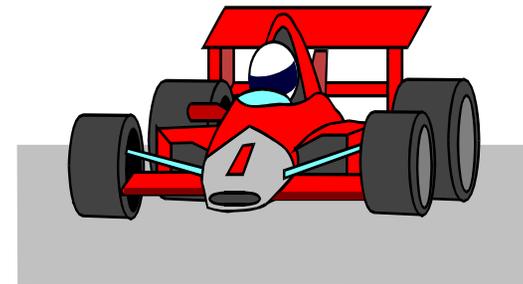
The transportation systems that emerge in the 21<sup>st</sup> century will be defined largely by the choices, skills and imaginations of today's youth.



# Future Workforce

As scientists and engineers, they will develop new vehicle and fuel technologies.

As citizens, they will make decisions balancing mobility, environmental, and economic needs.



# Social Implications

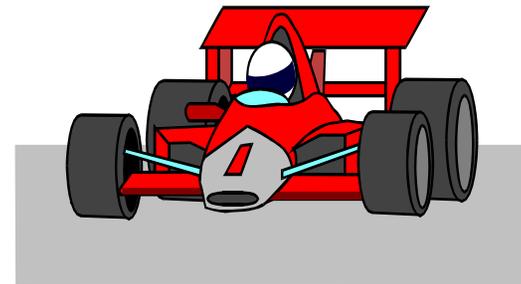
Students are encouraged to consider the influence of transportation on social and economic patterns, energy use and the environment.

JSS is an excellent opportunity to combine the teaching of scientific and social principles in an atmosphere of fun and excitement.



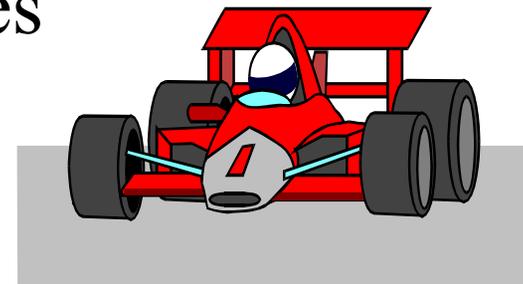
# Junior Solar Sprint Goals

- 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 technical careers at an early age.



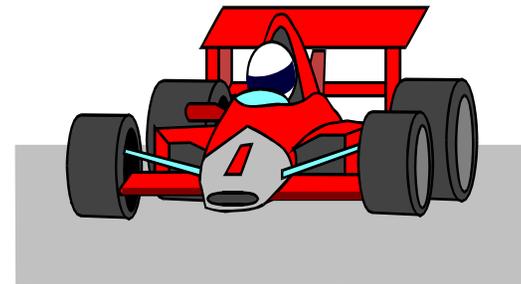
# Program Description

- 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



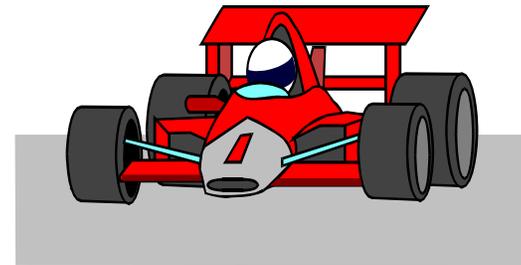
# Junior Solar Sprint Strategy

JSS challenges students to use scientific know-how, creative thinking, experimentation, and teamwork to design and build high-performance model solar vehicles.



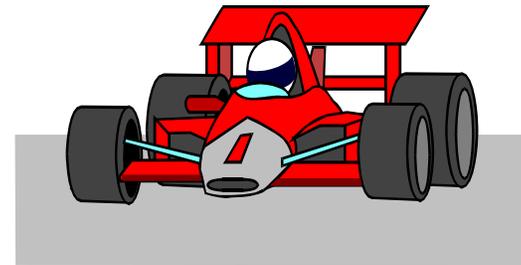
# Concepts Taught By The Junior Solar Sprint

- Alternative energy sources
- Teamwork
- How design effects function
- Aerodynamics
- Force
- Motion
- Problem solving



# What Teachers Like Best

- Challenges and excites students
- Students become highly motivated because of the competition
- Teaches students to think on their feet and react quickly
- It's do-able
- Active participation in a competitive situation



# Colorado Science Standards

- Standard 1: Students understand the processes of scientific investigation: design, communication, and evaluation of such investigations.
- Standard 2: Physical Science: Student know and understand common properties, forms and changes in matter and energy (Focus: Physics and Chemistry)
- Standard 5: Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
- Standard 6: Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
- Standard 7: Students use appropriate technologies to facilitate understanding of scientific concepts, communicate scientific information and conduct scientific inquiry.

# Vehicle Specifications

1. The vehicle must be safe to contestants and spectators, e.g., no sharp edges, projectiles, etc.
2. The vehicle must fit the following dimensions: 30 cm. by 60 cm. by 30 cm.
3. Decals of the sponsor organizations (provided by JSS) must be visible from the side on the body of the car. A 3 cm. by 3 cm. space must be left for the assigned car number.
4. The sun's light is the only energy source that may be used to power the vehicle. No other batteries or energy storage devices are permitted.

## Vehicle Specifications (cont.)

5. Any energy-enhancing devices, like mirrors, must be firmly attached to the vehicle.
6. The vehicle must be steered by the guide wire using one or more eyelets affixed to the front of the vehicle. The vehicle must be easily removable from the guide wire, without disconnecting the guide wire.
7. The body of the **car must be three dimensional**. Teams will **NOT** be allowed to bolt the axles and wheels to the solar cell. The solar cell cannot be used as the body of the car.

# Track Specifications

1. The length of the race course is 20 meters over flat terrain.
2. Race lanes are at least 60 cm. wide.
3. The guide wire will be located in the center of the track and will not be more than 1.5 cm. above the track surface.
4. The track is a hard, flat, smooth surface such as a tennis court or running track. A large sheet of rolled material, i.e., plastic, heavy paper, or roll roofing (half-lap), or hardwood taped or bolted together may be used to cover an unsuitable surface.

# Conduct of the Race

1. At race time, the vehicle will be placed behind the starting line with all its wheels in contact with the ground and an opaque sheet covering (NREL will provide at the regional competition), but not touching the solar panel. The opaque sheet will be removed at the start of the race, allowing the vehicle to collect solar power and start driving. No more than two team members will be allowed in the start area.
2. An early or push start may result in disqualification or a re-run of the heat. The determination will be left to the race judges.

## Conduct of the Race (cont.)

3. All vehicles will be started when the official signal is given. The winner of the heat will be the first vehicle to cross the finish line or the farthest car down the lane when the race is called.
4. During the initial heats, the judges may declare multiple wins or losses.
5. One team member must wait at the finish line to catch the vehicle.
6. Team members may not accompany or touch the vehicle on the track. Vehicles stalled on the track may be retrieved after the end of the race has been declared by the Lead Judge.

## Conduct of the Race (cont.)

7. Lane changing or crossing will result in disqualification.
8. Challenges must be made before the race judges begin the next heat. All challenges must come from the team members who are actively competing and directed to the lead judges. The decisions of the race judges are final.
9. The vehicle and team member must remain at the finish line until the order of the race has been established.
10. Judges **will** inspect cars prior to the final heat or at anytime during/after heats.

# Junior Solar Sprint Instructions

## **Kit Materials:**

- 1 Pitsco Ray Catcher Solar Panel (2.76V, 1, 100 mA)
- 1 White Sheet of Plastic Coated Paper
- 2 Balsa Sheets (10-1/2"x4"x3/16")
- 2 Alligator Clips
- 2 Pitsco GTF Wheels
- 2 Pitsco GTR Wheels
- 1 Straw
- 1 No. 280 Motor
- 4 Nylon Spacers
- 2 Plastic Delrin Axles
- 1 Plastic Gear Font
- 4 Rubberbands (2 No. 14 Rubber Bands and 2 Wide Rubber Bands)
- Junior Solar Sprint Rules and Regulations

# Materials and Tools Needed

- Soldering Iron
- Sharp Utility Knife or Coping Saw
- Cool-Melt Glue Gun
- Needle-Nose Pliers
- 1/8" Drill Bit or Electric Drill with Bit
- 2 C-Clamps
- Rulers
- Pencils
- Wire Strippers and Wire Cutters

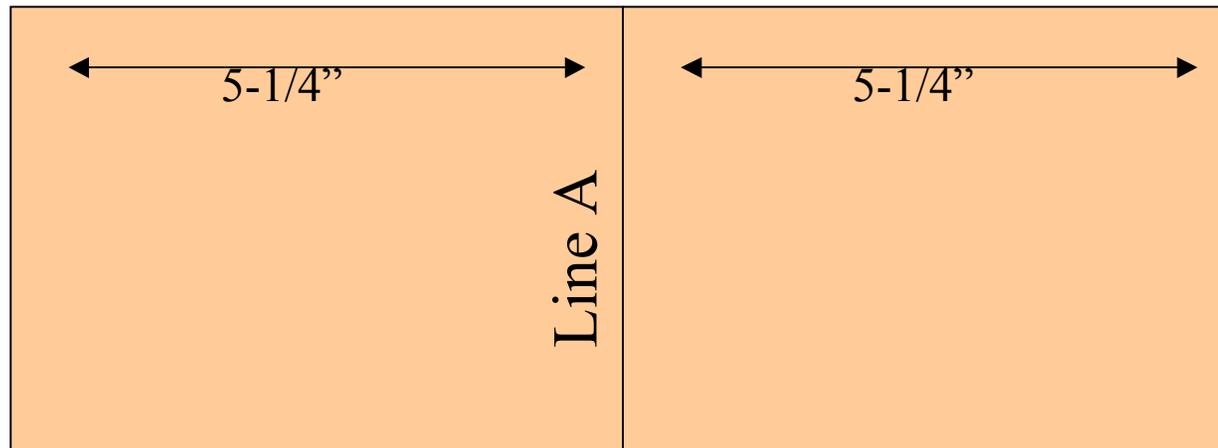
# Safety Precautions

- Instruct students in the proper use and care of sharp utility knives and coping saws. If there are safety concerns, use coping saws, not utility knives.
- Cover safety precautions for the use of electrical equipment such as glue guns and soldering irons.
- Caution students not to touch the metal top of the cool-melt glue gun and to keep the glue off their skin.
- The voltage produced by the solar panel and batteries are entirely SAFE for student use.
- Properly dispose of batteries.
- Before inserting wheels and gears onto axles, students need to insert a 1/8” drill bit through the holes of the wheels and gears for easy assembly. They should not “drill” the wheels and gear, but merely ream the hole slightly. If the fit is still too tight, either ream the hole again or use sandpaper to bring the diameter of the axle shaft to a good firm fit.
- Never force the wheels and gears onto the axles.

# Making the Chassis

## Step 1

- Using a No. 2 pencil, draw **Line A** down the center of a balsa sheet.



# Making the Chassis

## Step 2

- Turn over the balsa sheet and draw **Line B**  $\frac{3}{4}$ " from one end of the sheet.



# Making the Chassis

## Step 3

- Draw a  $5/8$ " x  $1-1/2$ " notch 1" from the top of the sheet.



# Making the Chassis

## Step 4

- Draw **Line C** 2-1/2" from the other end of the same sheet of balsa.



# Making the Chassis

## Step 5

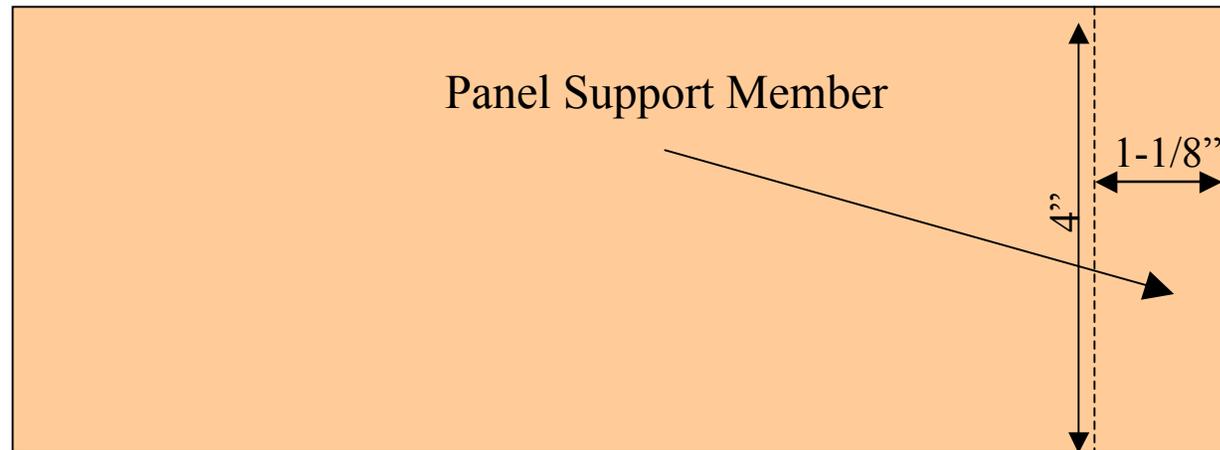
- Using a sharp utility knife or a coping saw, cut out the notch drawn in Step 3. **Save the cut out piece of balsa for a later step.**



# Making the Chassis

## Step 6

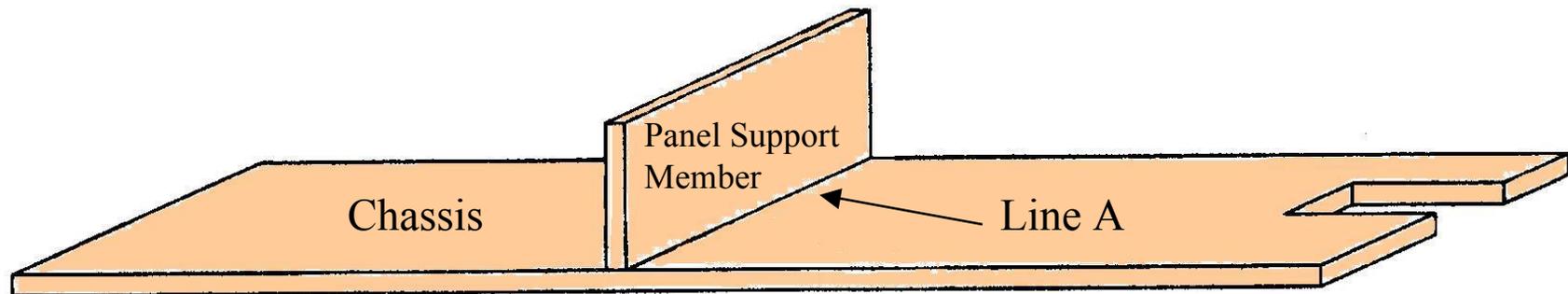
- Locate the other sheet of balsa and draw a line 1-1/8" from one of the narrow ends. Cut along the line to produce a 1-1/8"x4" **panel support member**.



# Making the Chassis

## Step 7

- Using a cool-melt glue gun, run a small bead of glue along one of the 4” edges of the panel support member and attach firmly at **Line A**. After it is in place, run an additional bead of glue on each side of the joint between the chassis and the support member.



# Wheels, Gears, and Axles

## **Note:**

Installing wheels and gears on axles can be difficult. Be careful not to bend the Delrin axle.

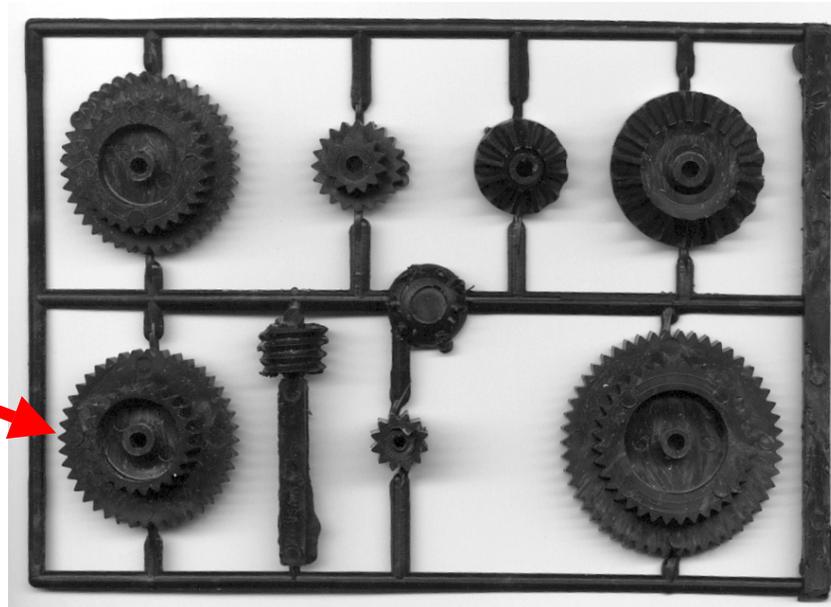
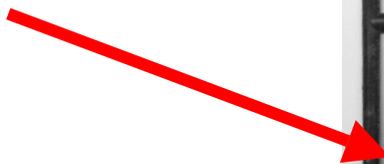
To ease the process, insert a 1/8" drill bit through the holes. The gears and wheels should fit snugly to the axle and provide power to the wheels.

# Rear Axle Assembly

## Step 1

- Locate the plastic gear font and detach **Gear D** from the font. (A letter can be found on the back of each gear)

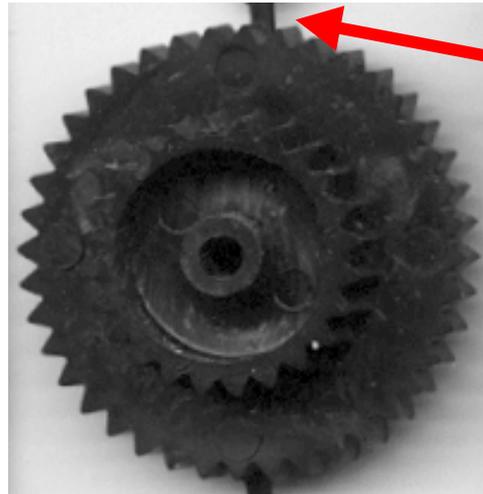
Gear D



# Rear Axle Assembly

## Step 2

- Inspect the gear and, using a sharp knife, carefully remove any plastic flashing between the gear teeth.

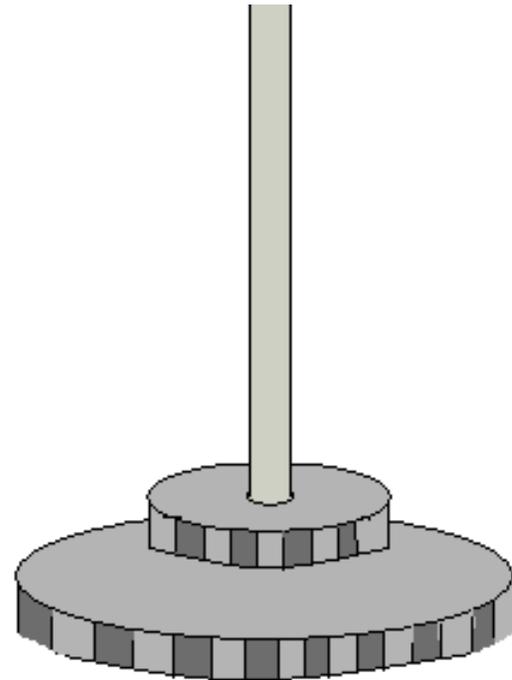


Plastic Flashing

# Rear Axle Assembly

## Step 3

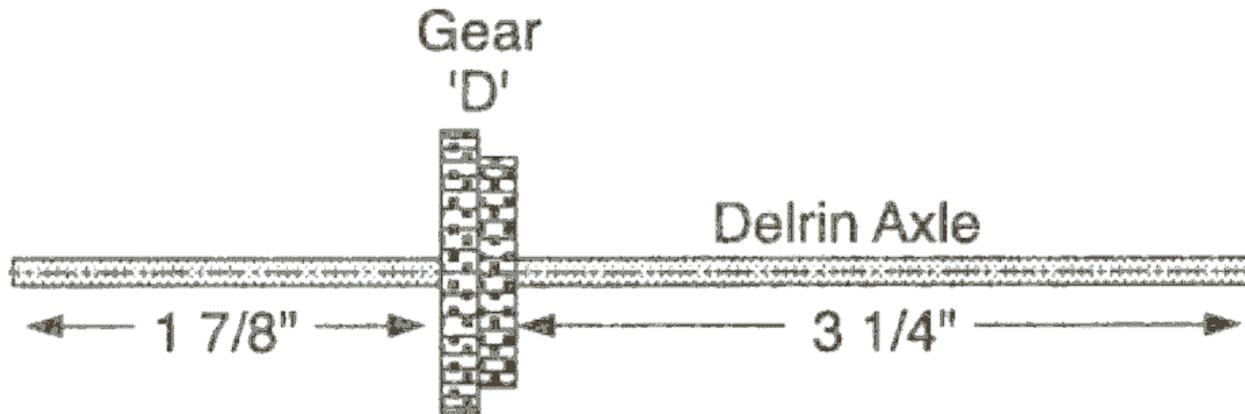
- Place the gear on a table with the smaller gear face up and insert one of the Delrin axles into the gear.



# Rear Axle Assembly

## Step 4

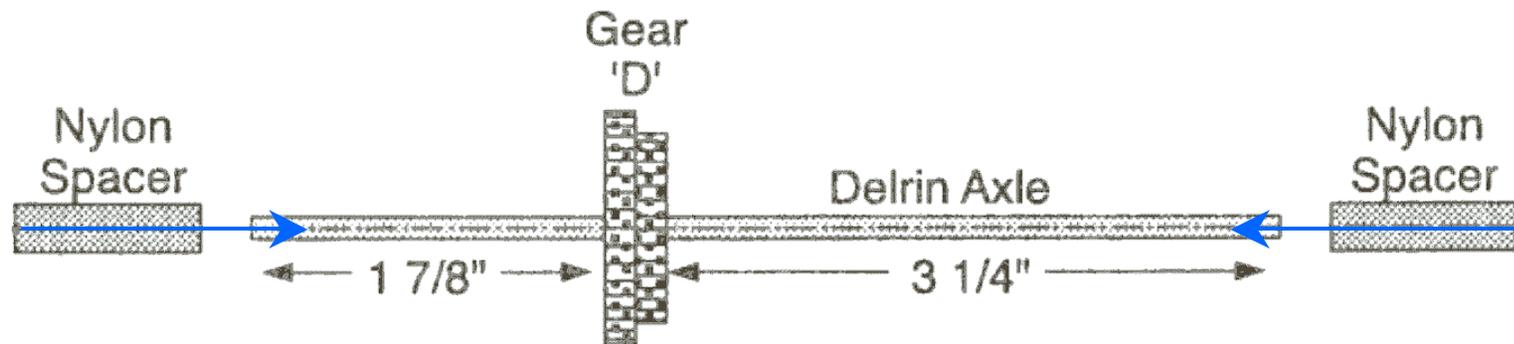
- Carefully slide the gear 1-7/8" from one end of the axle. It should be 3-1/4" from the other end of the axle.



# Rear Axle Assembly

## Step 5

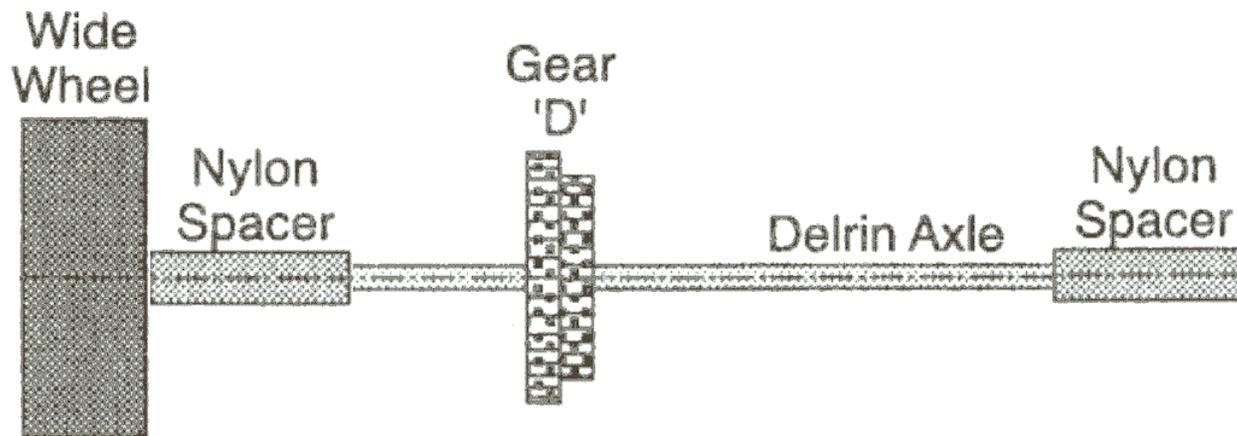
- Slide two nylon spacers onto the axle, one on each side of the gear.



# Rear Axle Assembly

## Step 6

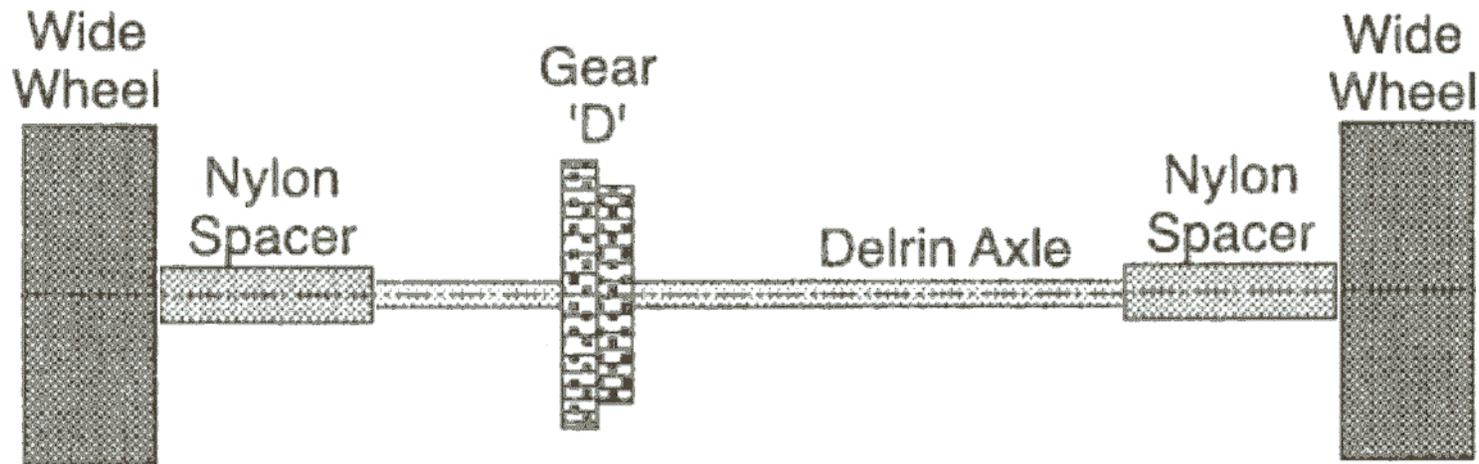
- Place one of the wide plastic wheels flat on a table. Keeping the spacers in place, insert one end of the axle into the wheel. Slide the axle into the wheel until it is flush with the opposite side of the wheel.



# Rear Axle Assembly

## Step 7

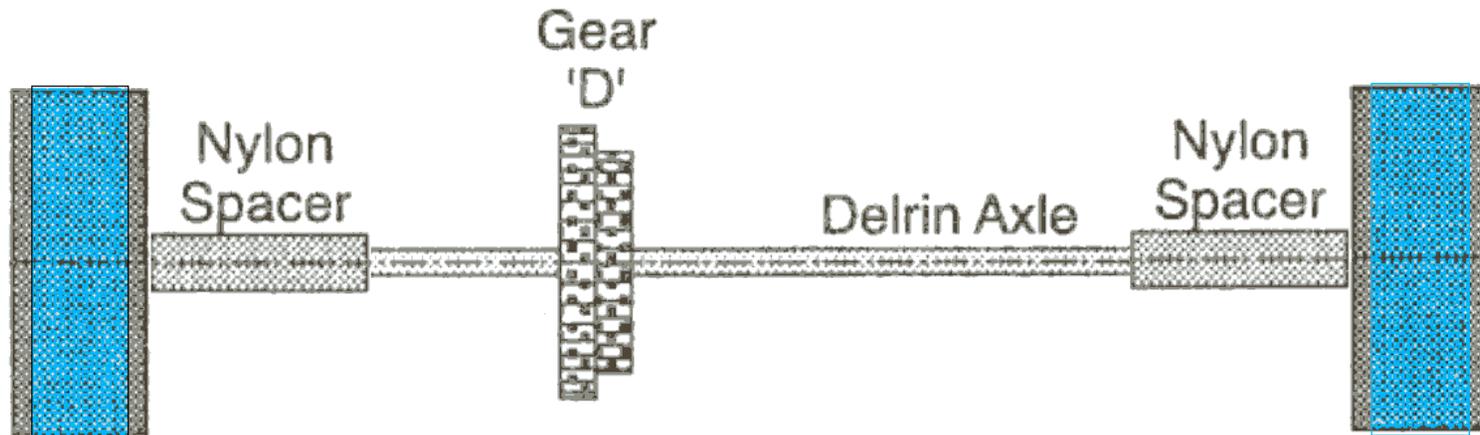
- Lay the other wide plastic wheel flat on the table. With spacers still in place, slide the free end of the axle into the wheel until it, too, is flush with the opposite side of the wheel.



# Rear Axle Assembly

## Step 8

- Stretch a wide rubber band around each of the wide wheels. These act as tires and provide traction for your vehicle.



# Front Axle Assembly

## Step 1

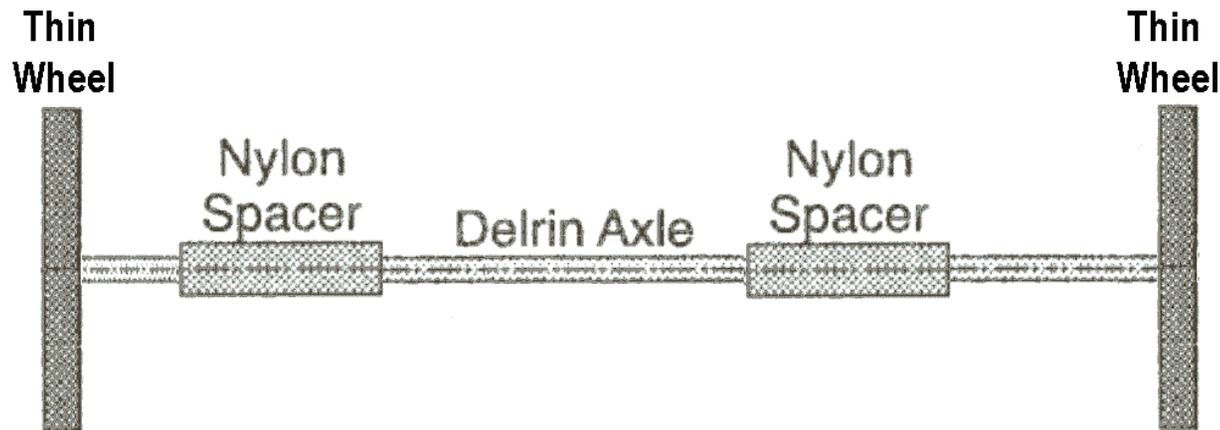
- Place one of the two thin wheels flat on the table. Insert one end of the remaining Delrin axle into the wheel until the end of the axle is flush with the opposite side of the wheel.



# Front Axle Assembly

## Steps 2 & 3

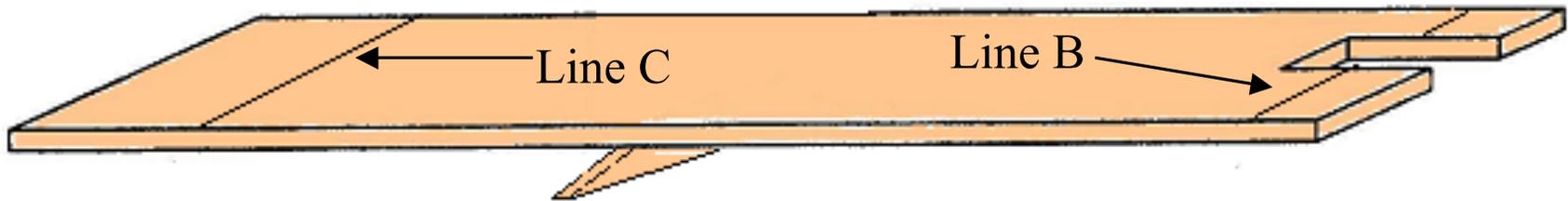
- Slide two nylon spacers onto the free end of the axle. While keeping the spacers on the axle shaft, slide the free end of the axle into the other thin wheel until the end of the axle is flush with the opposite side of the wheel.



# Attaching Axle Assemblies to Chassis

## Step 1

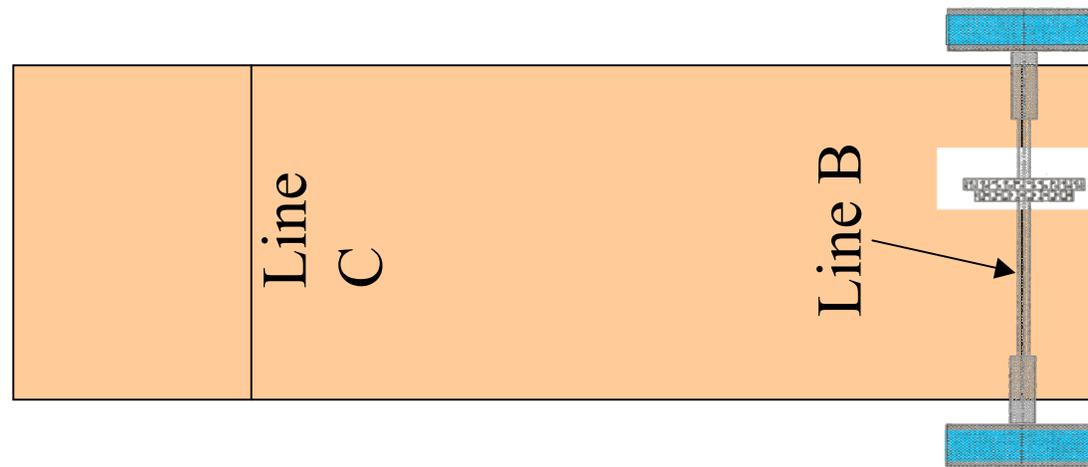
- Position the notched chassis on the table so that the notched end of the balsa is hanging over the table edge, and **Lines B and C** are shown.



# Attaching Axle Assemblies to Chassis

## Step 2

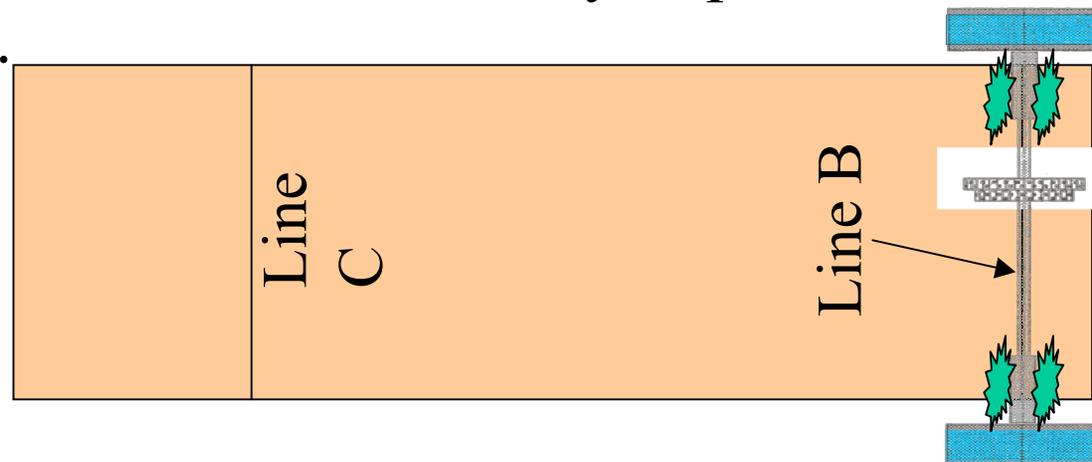
- Carefully position the rear axle assembly so that:
  - **Gear D** is centered in the notched area of the chassis.
  - The axle is positioned along **Line B** between the line and the end of the chassis.
  - The nylon spacers are positioned within 1/16” of each wheel.



# Attaching Axle Assemblies to Chassis

## Step 3, 4 & 5

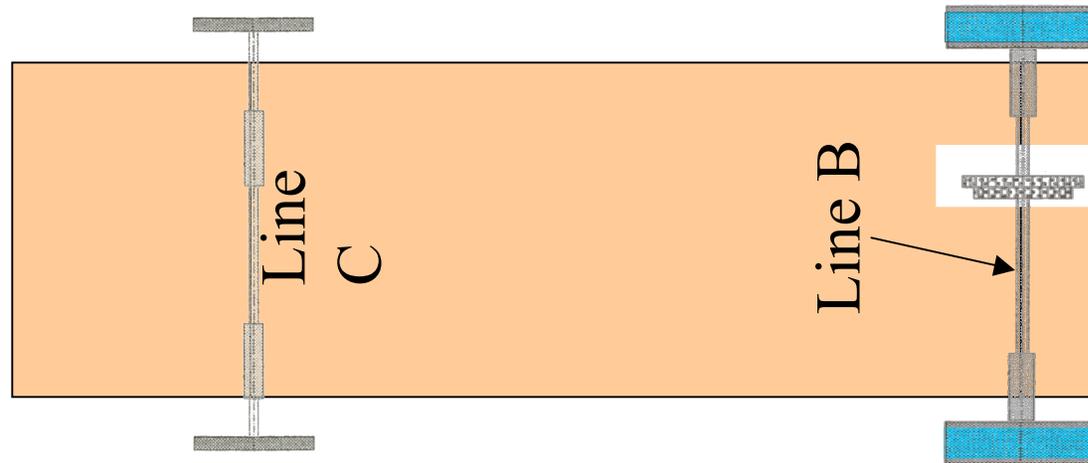
- When the rear axle is positioned as described in Step 2, use small C-clamps or ask a friend to hold the rear axle assembly in the correct position.
- While the rear axle is in the correct position, gently apply a bead of cool-melt glue along the sides of the nylon spacers where they contact the chassis.
- Hold the rear axle assembly in place until the glue cools.



# Attaching Axle Assemblies to Chassis

## Steps 6 & 7

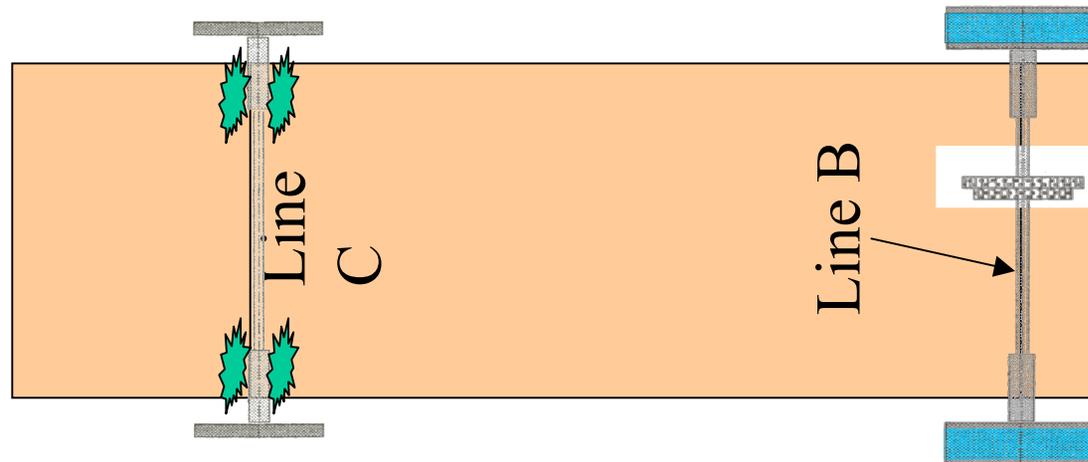
- Place the front axle assembly along **Line C** between the line and the rear axle assembly.
- Position the axle so that the wheels are equidistant from the chassis.



# Attaching Axle Assemblies to Chassis

## Steps 8, 9 & 10

- Slide the spacers to within 1/16" of each wheel.
- Hold the assembly in place and gently apply a bead of cool-melt glue along the sides of the nylon spacers where they contact the chassis.
- Hold the front axle assembly until the glue dries.

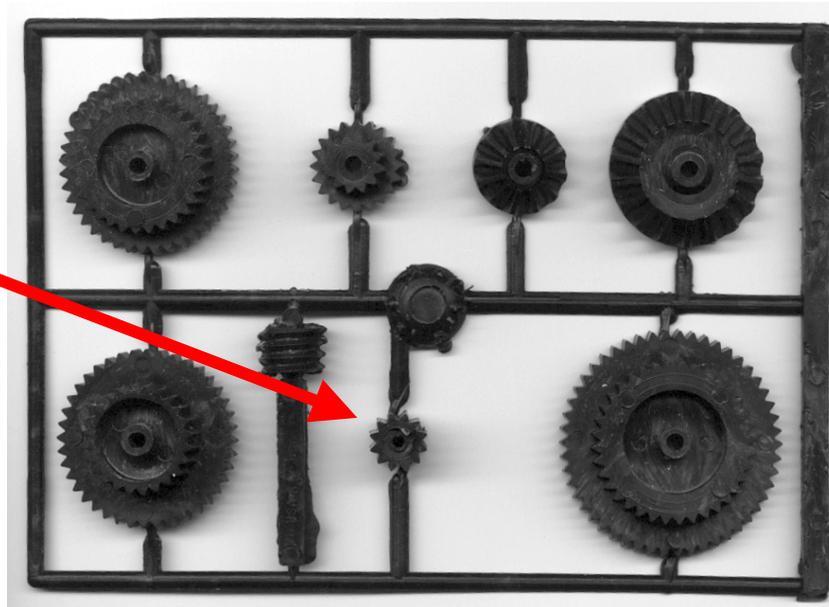


# Attaching Motor Assembly to Chassis

## Steps 1 & 2

- Find the spur gear (**Gear A**) on the plastic gear font.
- Remove Gear A from the font and cut off any excess plastic between the teeth of the gear.

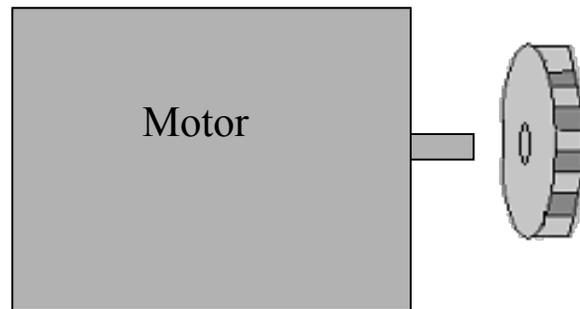
Gear A



# Attaching Motor Assembly to Chassis

## Step 3

- Insert the shaft of the motor into **Gear A** to within 1/8" of the body of the motor.

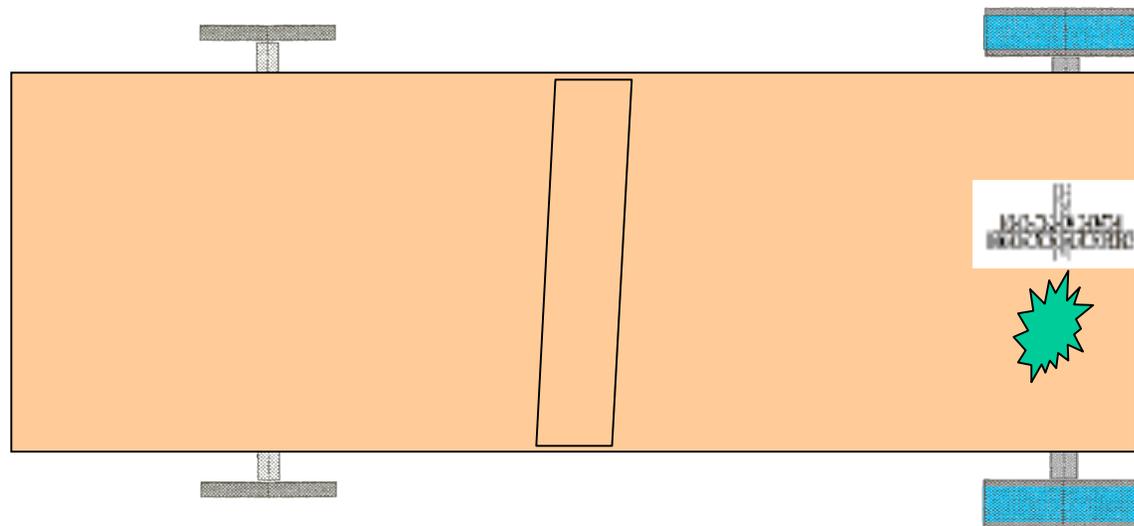




# Attaching Motor Assembly to Chassis

## Step 5

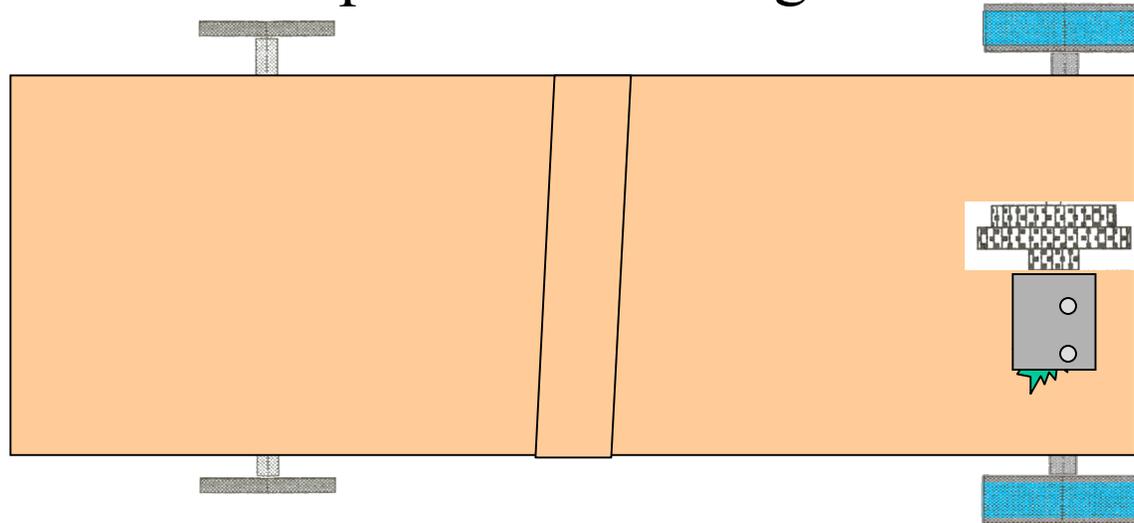
- Using a cool-melt glue gun, create a  $\frac{1}{2}$ "x 1" rectangle of glue about  $\frac{1}{8}$ " deep in the larger area to the side of the notch.



# Attaching Motor Assembly to Chassis

## Steps 6 & 7

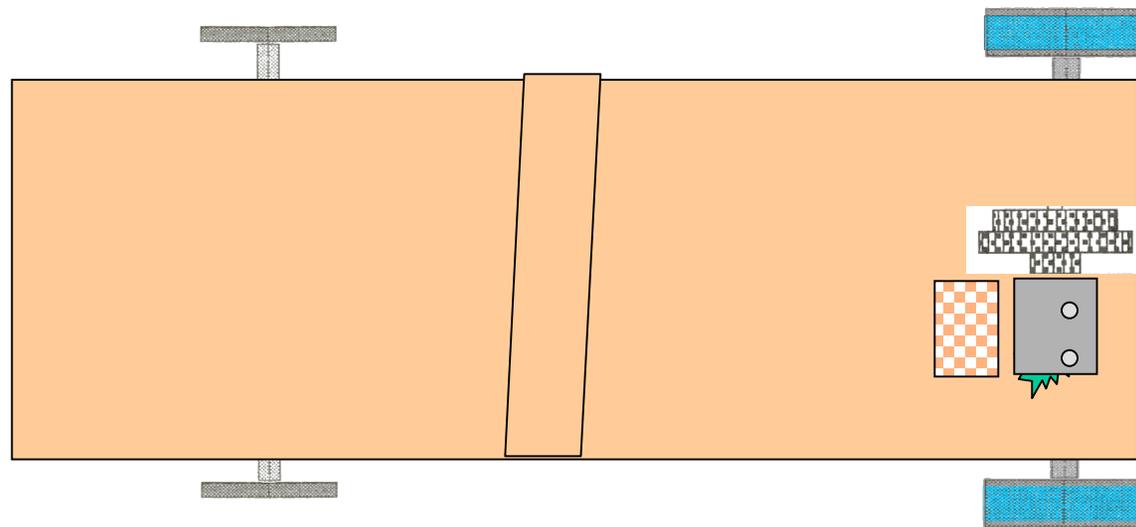
- While the glue is still liquid, place the motor on its side (with vent holes up) on the glue so that **Gear A** sits directly on top of and engages **Gear D**. Be sure not to obstruct or fill the vent holes with glue.
- Hold the motor in place while the glue cools.



# Attaching Motor Assembly to Chassis

## Step 8

- Locate the small piece of balsa you saved when you cut out the notch from the chassis. Apply cool-melt glue to one side of the balsa piece. Press it into place on the chassis directly in front of the motor. This will keep the motor in place if the vehicle comes to a sudden stop (crashes).



# Attaching Motor Assembly to Chassis

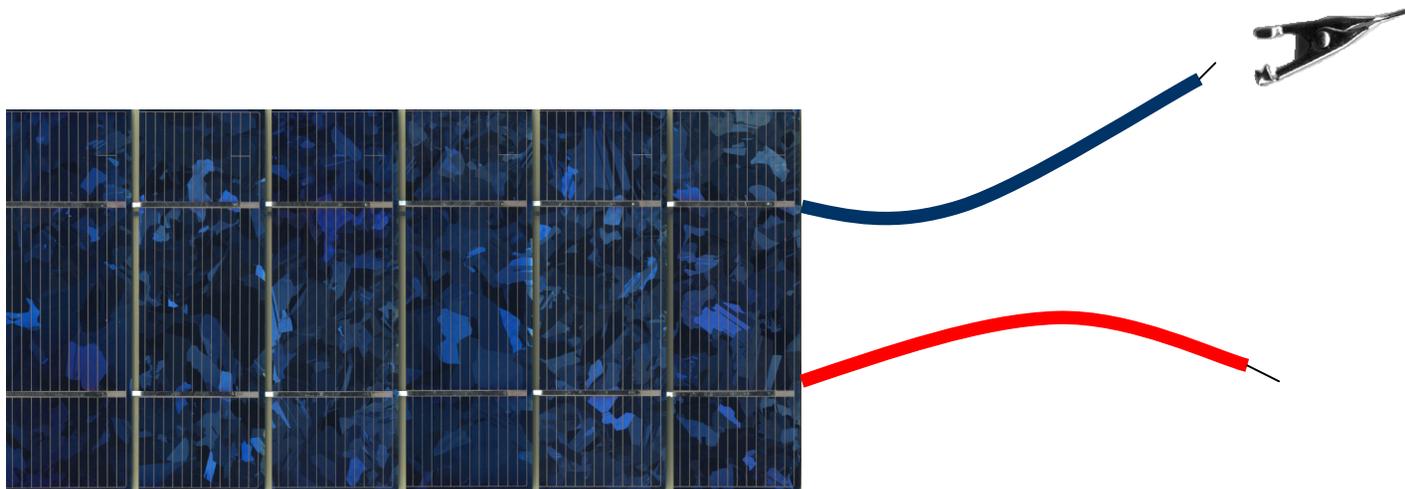
## Step 9

- If the motor dislodges, use the tip of the glue gun to soften the glue on the chassis where the motor was. Add a small amount of glue and reattach the motor as you did before.

# Solar Panel Assembly

## Step 1

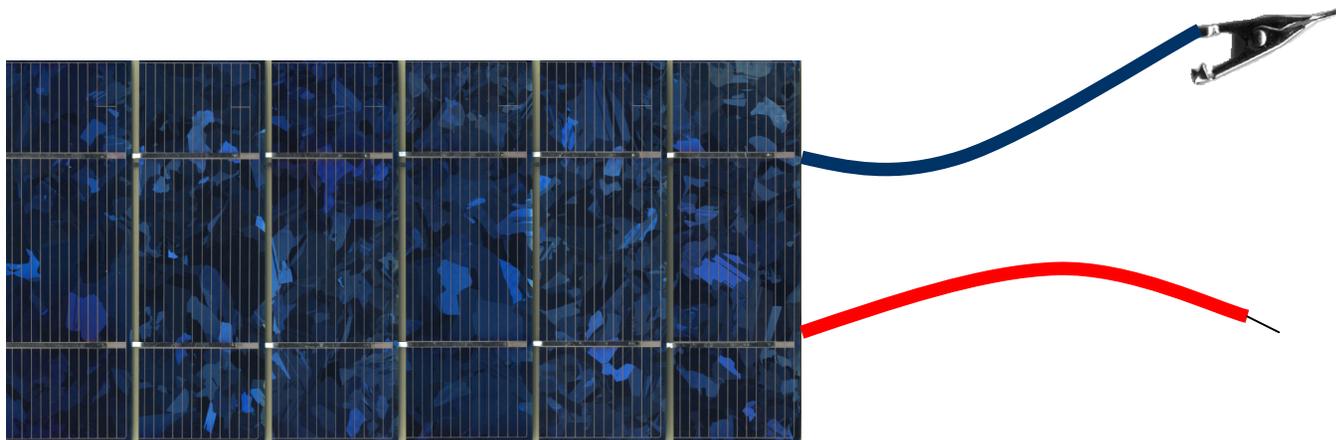
- Connect the alligator clips to the leads on the solar panel.
  - A. Insert one of the two leads through the small hole in an alligator clip.



# Solar Panel Assembly

## Step 1 (continued)

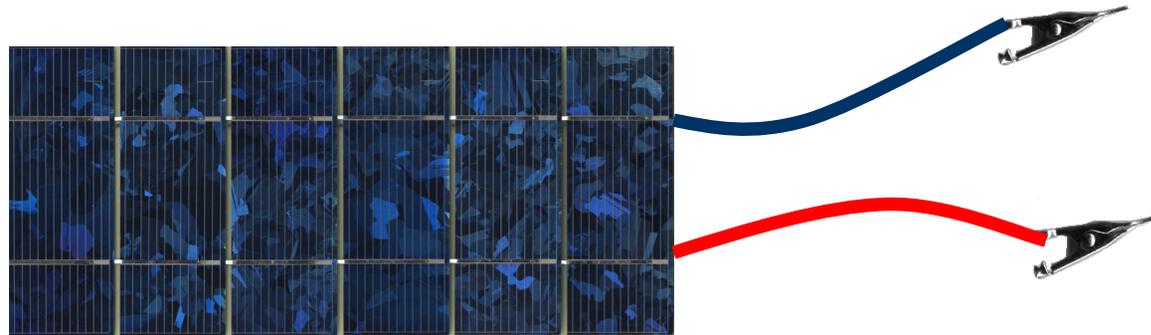
- Connect the alligator clips to the leads on the solar panel.
  - B.** Using a pair of pliers, bend the tabs on the alligator clip over the lead.



# Solar Panel Assembly

## Step 1 (continued)

- Connect the alligator clips to the leads on the solar panel.
  - A. Strip the insulation from the leads.
  - B. Solder the lead to the alligator clip. Be sure to heat the metal around the lead thoroughly so solder flows freely and attaches to the clip.
  - C. Solder the lead to the alligator clip. Be sure to heat the metal around the lead thoroughly so solder flows freely and attaches to the clip.



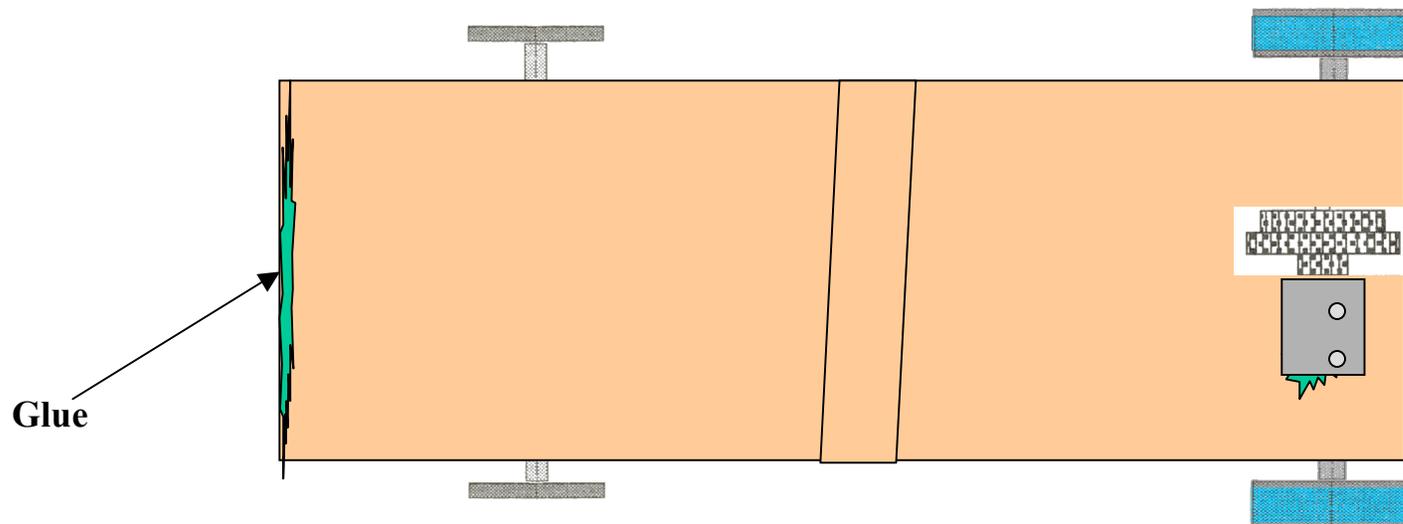
## Step 2

- Repeat step one for the second lead of the panel

# Final Assembly

## Step 1

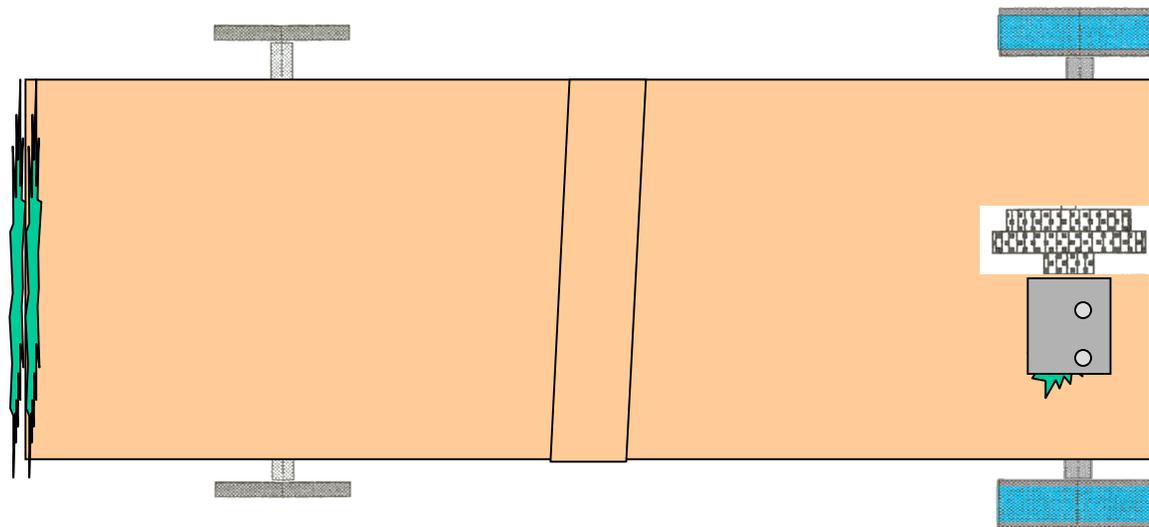
- Using a cool-melt glue gun, run a small bead of glue on the top, extreme front of the chassis. Allow the glue to cool. This will provide a ledge for the solar panel or solar panel blank to rest.



# Final Assembly

## Step 2

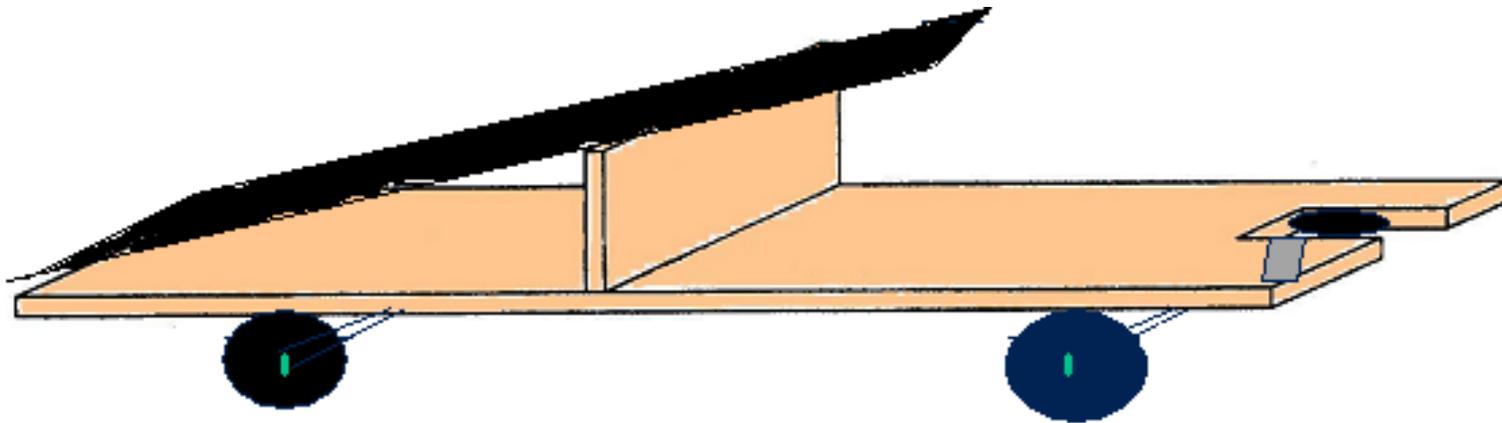
- Run another bead of glue along the front edge of the chassis to provide a bumper for your vehicle.



# Final Assembly

## Step 3

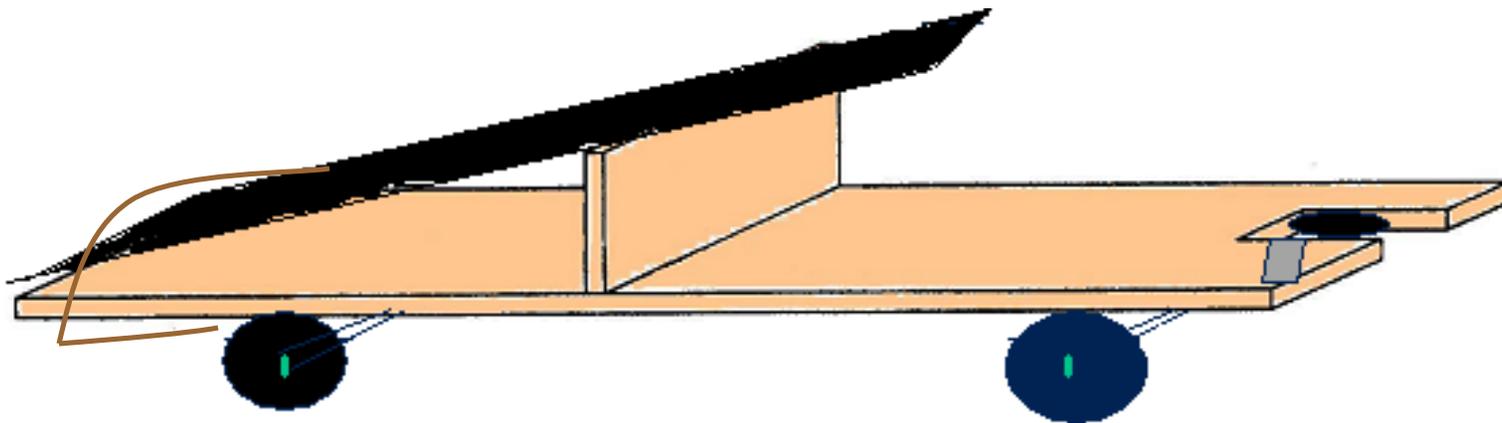
- Position the solar panel blank on the chassis so that it rests at the front of the vehicle and on the panel support member. The blank is used to show the position and effect of the solar panel on the vehicle while you test your vehicle with the battery pack. When you are ready to test or race, use the solar panel your teacher provides and replace the blank with the solar panel.



# Final Assembly

## Step 4

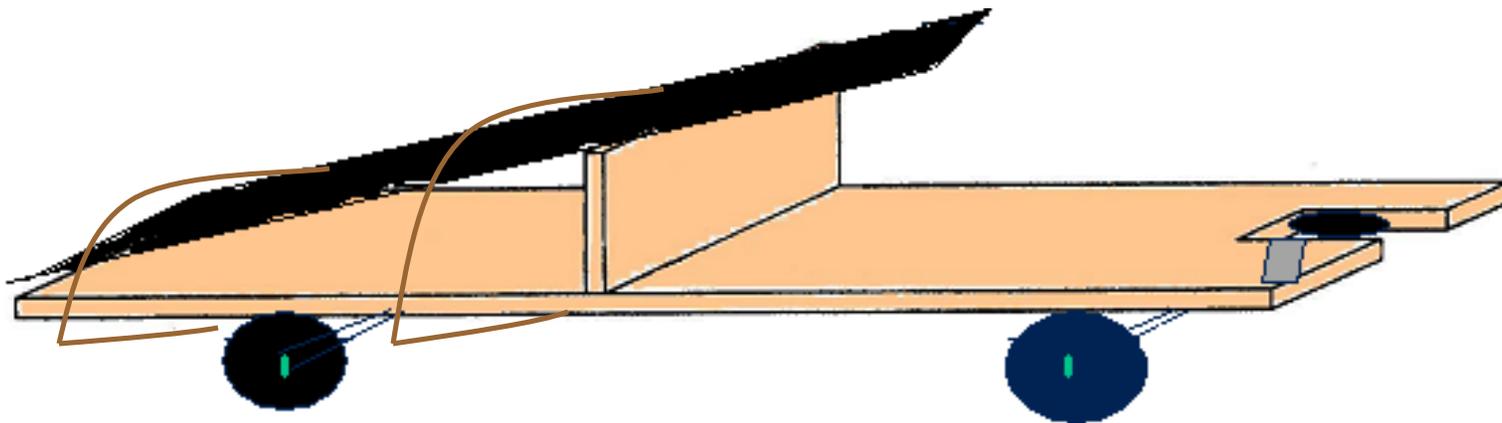
- Stretch one of the No. 14 rubber bands around the front of the chassis and the solar panel blank.



# Final Assembly

## Step 5

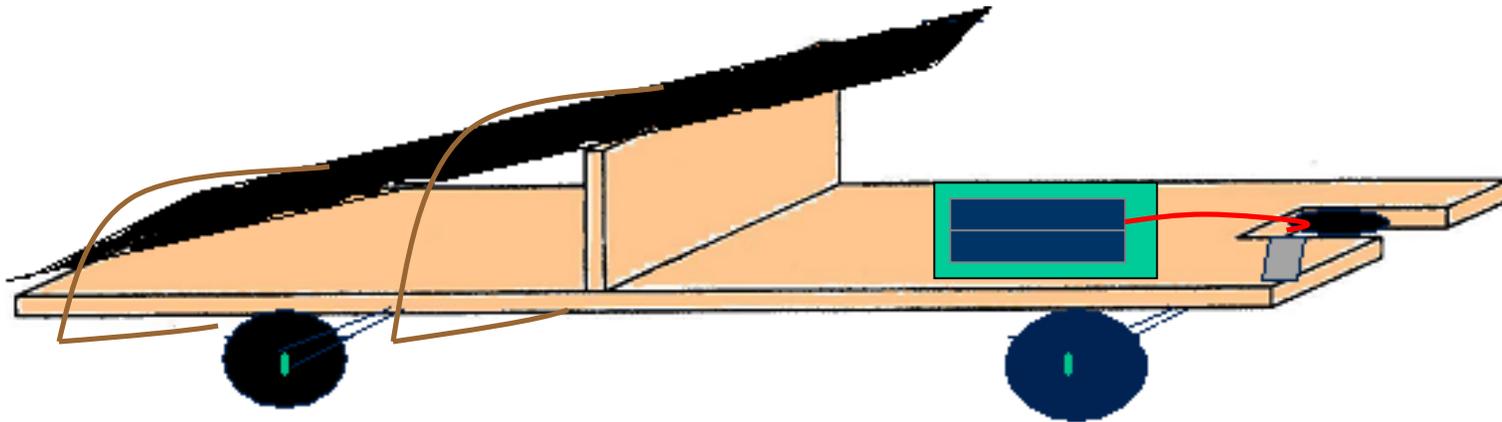
- Stretch the other No. 14 rubber band around the chassis and panel blank and position it at about the center of the panel blank.



# Final Assembly

## Step 6

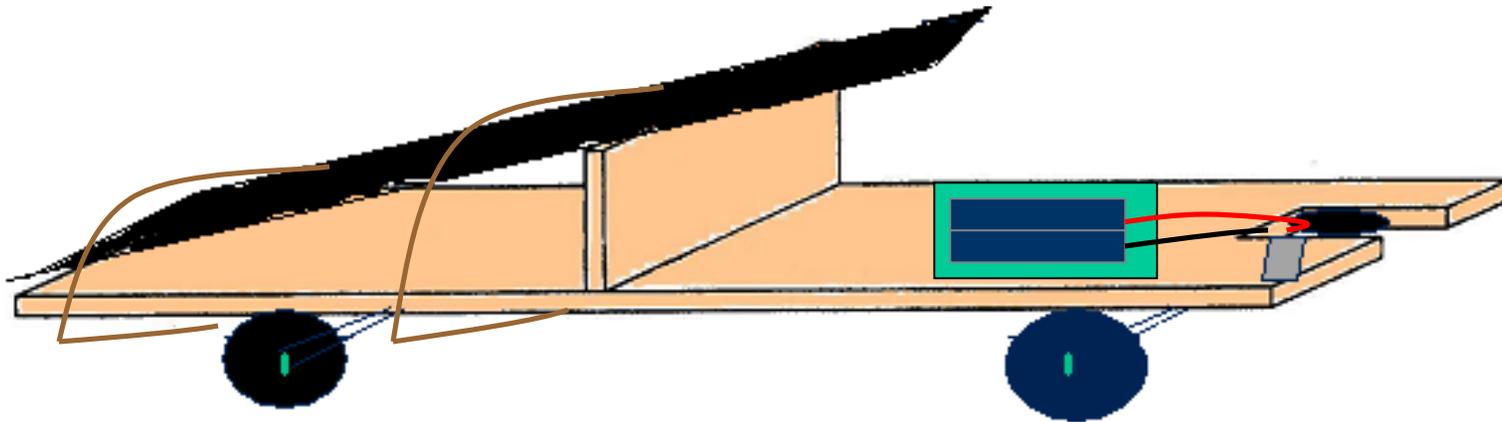
- Connect the battery pack alligator clip with the red lead to the motor terminal that has a round dot.



# Final Assembly

## Step 7

- Connect the battery pack alligator clip with the black lead to the other motor terminal.



# Congratulations!

You have completed a  
Junior Solar Sprint car!

# Troubleshooting

- If the car does not go, check the following:
- Are all electric connections solid and soldered? If not, reconnect or solder and try again.
- Is the sun shining? If not, wait until the sun shines or use battery packs.
- Are the gears meshing freely? If not, pry the motor and glue from the chassis and reposition.
- If the car goes backward, reverse the positions of the two alligator clips on the panel.
- If you break a piece of balsa while constructing the chassis, use the second piece of balsa for the chassis and use the broken piece for the panel support member.
- If the wheels do not spin freely, reposition them on the axles to provide clearance between the wheel and nylon sleeves.
- If the gears or wheels spin without the axle moving, use a spot of cool-melt glue at the joint to connect them. If you are sure of the position, you can use super glue to permanently bond them.
- If the car does not go fast enough, try different gear combinations, wheels, and chassis styles. Try to make a car with front-wheel drive! Experiment and find out what works best!!

# Junior Solar Sprint Resources

- NREL maintains the web site that has student/ teacher resource material and ordering information.
- National Site: <http://www.nrel.gov/education/natjss.html>
- Colorado competition:  
<http://www.nrel.gov/education/cojss.html>
- Chimacum School District No. 49:  
<http://eagle.chimacum.wednet.edu>
- How a Photovoltaic Cell Works:  
<http://www.eren.doe.gov/pv>
- Alternative Fuel Matters – Florida Solar Energy Center:  
<http://www.fsec.ucf.edu/ed/teachers>
- Minnesota Renewable Energy Society's JSS Site:  
<http://tcfreenet.org/org/mres/carmanual>
- Iowa's Energy Center Solar Car  
[www.energy.iastate.edu/renewable/solar/ravses/index2.htm](http://www.energy.iastate.edu/renewable/solar/ravses/index2.htm)

# Examples of JSS Cars



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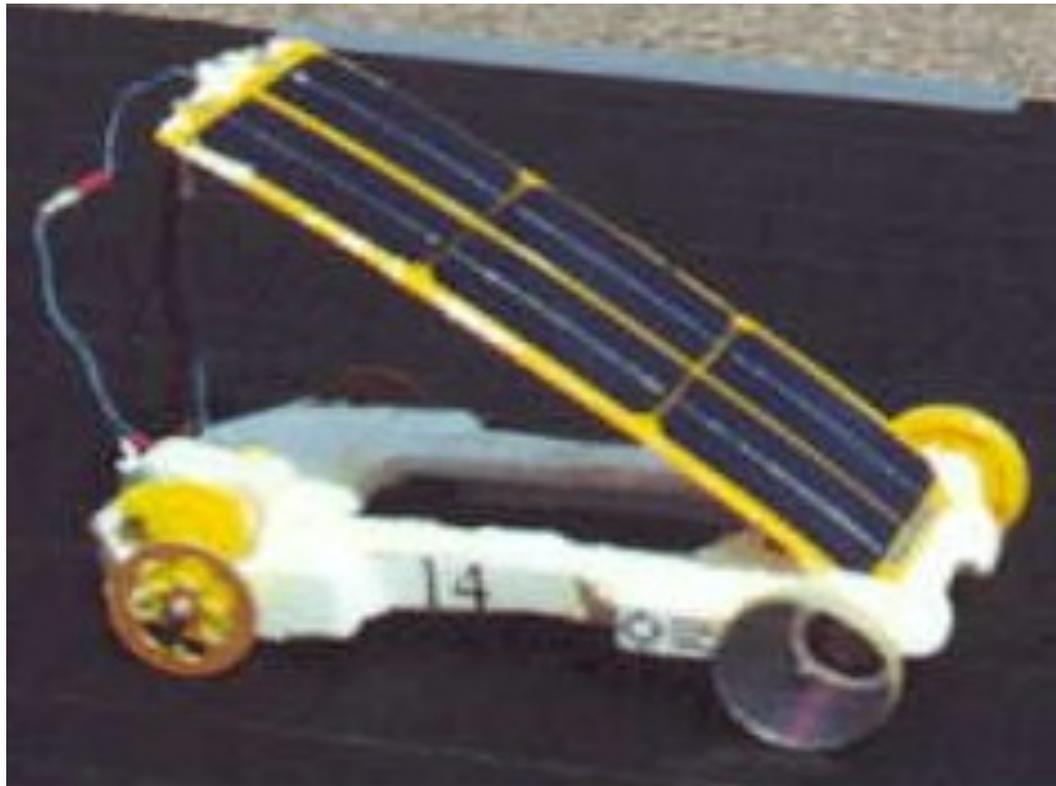
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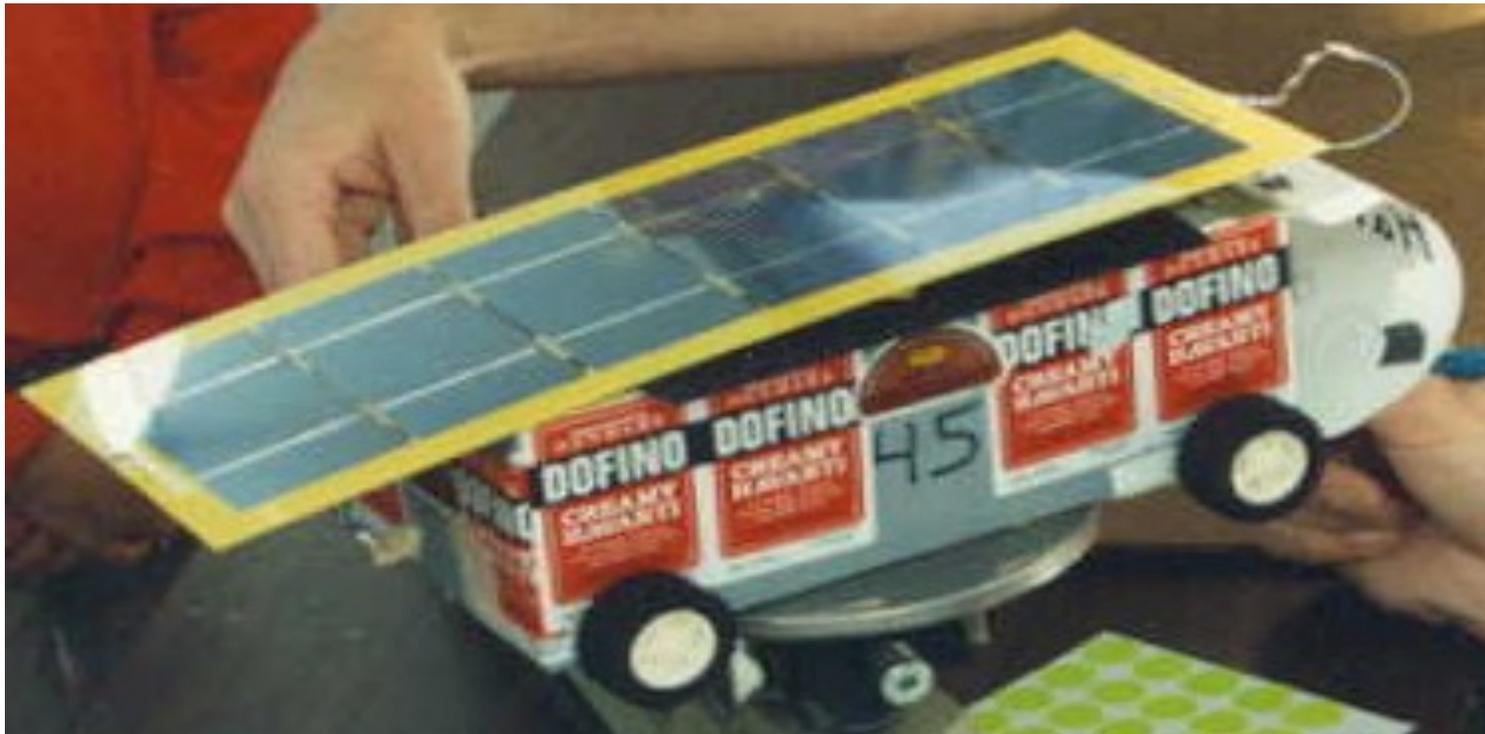
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