# MLGW 2017 A-BLAZING MODEL SOLAR CAR RACE
# RULES AND VEHICLE SPECIFICATIONS

The object of the **MLGW A-BLAZING MODEL SOLAR CAR RACE** is to design and build a vehicle that will complete a race in the shortest possible time using available power. Each team must submit a notebook (three-ring binder) that contains the items, in order, as noted below in the Documentation section. Sections of the binder may be organized by dividers. Teams use a kit containing a solar panel, motor, eyelet, and a battery holder. Using any other materials, competitors will design and build a solar powered vehicle that will race on a 60 foot racecourse. The winner of the competition will be the team whose vehicle is the top finisher in a series of head-to-head elimination rounds.

**NOTE:** All cars must be built by the student with limited assistance from the mentor, teacher or other adults. **This is a student competition!**

**Documentation:**

1. Title page with team name, team members, and year

2. Table of contents

3. Project Log that indicates preparation for the competition, as noted by date, task, time involved, obstacles/issues encountered, modifications made, team member responsible, and any comments.

4. Design drawings; drawings show the model with a minimum of two views. The drawings are developed using standard engineering practices and procedures. This will include measurements/dimensions. The drawings may be produced using traditional drafting methods or CAD. Rough sketches should be included on a separate page or pages.

5. A separate specification page will include design details of the model, including size, wheel size, gear ratio, specifications of motor and solar collector used, etc.

6. Components list

7. Design process description; this includes pre-testing of various configurations of the model and revision notes about the model design throughout the process.

8. The model car must meet the following specifications:

**Materials:**

1. The motor, solar panel, eyelet, and battery holder must be used without any modification. Panels cannot be shaved, drilled or delaminated; motors cannot be rewound or disassembled. One solar panel, one motor, two eyelets, and one battery holder per car.

2. The remainder of the vehicle must be your own design and can be made from any other material. Materials will cost less than $20 and be easy to find. Original receipts for all materials purchased should be put in an envelope and placed in the notebook. The total cost of construction materials should be clearly written on the outside of the envelope. Model cars that exceed this construction cost limit will be disqualified from the competition.

**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: 12 inch wide by 24 inch long by 12 inch high.

3. The sun's light is the only energy source that may be used to power the vehicle, unless MLGW determines that batteries will be used. MLGW will supply the batteries if batteries are used. No other batteries or energy storage devices are permitted.

4. Any energy-enhancing devices, like mirrors, must be attached to vehicle.

5. The vehicle must be steered by the guide wire **using two eyelets affixed to the vehicle, one at the front center and one at the back center** of the vehicle with the center of the eyelet ¾" from the ground. The vehicle must be easily removable from the guide wire, without disconnecting the guide wire.

6. Two 1 inch x 1 inch surfaces must be available for the car number, which should be easily visible when the vehicle is in the ready race position.

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 chassis of the car.

**Track Specifications:**

1. The race lane is 2 feet wide and 60 feet long over flat terrain (typically asphalt).

2. The guide wire will be located in the center of the track and will not be more than ¾ inch above the track surface. The wire will be small diameter line, such as masons line or fishing line. The line will go through the eyelets, attached to the underside of car, and serve as a steering mechanism to keep the car in its lane.

**Conduct of the Race:**

1. Middle School Teams (grades 6-8) will race against other Middle School Teams. High School Teams (9-12) will race against other High School Teams. **Teams racing are comprised of a minimum of 4 students in grades 6-8 and 9-12 and a maximum of 8 students.** Each team must have a coach (teacher, parent, or other volunteer) who can assist the students, and be at the race.

2. The races will be run in a double elimination format. Thus you will have a minimum of two opportunities to race before you are eliminated from the competition.

3. **Only two members of the race team will be allowed on the track** during the race: both members must be at the finish line.

4. The vehicle will start from behind the starting line with all wheels touching the track. The solar panel will be covered by an opaque sheet which will be held above the panel by a line judge to block the sunlight. The vehicle should not be touched by the sheet or any member of the team at this time. When the race official gives the signal to start the race, the line judge will remove the sheet so the panel will be exposed to the sunlight.

   If MLGW determines that batteries will be used, MLGW will supply the batteries. Batteries will be installed in battery holder. Line judge will keep one of the alligator leads unconnected until the line judge gives the signal to start the race. When the race official gives the signal to start the race, the line judge will connect the alligator clip.

5. There will be a 3-minute time limit from the time your name is called to be at the end your lane. The heat will start at the end of this time limit regardless of whether the team members are present or not.

6. Once the heat has begun, team members are **not allowed** to touch their vehicle or be on the race lanes until their vehicle has crossed the finish line and the judges have determined the heat completed. Pushing the vehicle after the race has begun will result in disqualification from the heat.

7. Any car that leaves its lane will be disqualified from the heat in question. However, the offending vehicle may compete in its second trial if not having done so already. If the car leaving its lane interferes with any other cars, this will trigger an automatic re-run of the same heat.

8. Winner of a heat will be the first vehicle to cross the finish line or the vehicle to travel the furthest down the track. Generally speaking, the top two finishers will advance to the next heat. In the event of a tie, the judges may determine multiple winners and admit multiple cars or require a head-to-head race, to advance to the next round of competition.

**Awards:**

1. Entries will be evaluated in three (3) areas: 1) notebook, 2) artisanship and engineering of the model, and 3) model's racing performance.

2. Trophies will be given for Speed (1st, 2nd and 3rd place), Design, and Notebook categories.

3. The Design award winner will be selected by a technical judge.

# Solar-Powered Vehicle - Design Tips

Welcome to the MLGW A-Blazing Model Solar Car Race. By competing in this event, you will learn how to make your own model solar car that will run entirely from the power of the sun. You must attach the battery holder to the car.

## Design

When you design your car, you will start with some ideas in your head and turn them into real-life models that work. Design is different than normal problem solving, because:

1. You don't know what the problems are (you discover and solve problems as you go along – everyone's challenges will be different)
2. There is never one right answer

There are five key parts you will need to think about when it comes to designing your vehicle:

1. **Chassis:** how to build the frame of the car
2. **Wheels and Bearings:** how to make wheels that turn
3. **Power Source:** how the solar panel and motor work
4. **Transmission:** how to transfer power from the sun to the wheels
5. **Body Shell:** how the shell effects car performance

## The Chassis

First you need something on which to mount your solar panel, motor, battery holder, gears, and wheels. This main support structure is called the chassis. One obvious consideration is that you don't want your car too heavy. It is easier for your motor to push a light car than a big, heavy one. In solar cars, efficiency is very important, and you don't want to waste energy. But something you must also keep in mind is that a light car can be pushed easily by the wind too. Even if the wind does not blow the car over, it may make it harder to go in a straight line.

**Suggested Materials for the Chassis:** foam core (available at most art supply places), wood (Balsa and pine are good choices), corrugated cardboard, Styrofoam, and some plastics.

## Wheels and Bearings

Friction keeps things from sliding against each other. When you build your cars, there are some parts that you want to slide easily, and there are other parts you don't want to slide at all.

**Tire Traction**: When you have two things that must roll against each other, like a wheel rolling along the road, friction keeps them from slipping. This type of friction is also called "traction," and is important to remember when building your wheels. If any of your wheels are spinning rather than rolling, you probably need more traction. Traction can be increased by adding a non-slip material around the wheels (like a tire or rubber band) or by moving weight over the

drive wheels. But, remember, it is also important to have efficient wheels, which are usually thin and lightweight.

**Bearings:** When you have two things rubbing against each other and you want them to move freely, friction slows things down and wastes energy. For example, try sliding a coin and an eraser across the table. The reason the coin slides much more easily is there is less friction between the coin and the table than there is between the eraser and the table.

One case where friction is very undesirable is in the wheel axle. The axle must be supported and attached to the chassis, but still must be able to turn. Components that allow the relative motion of two parts are called bearings. Look at a bicycle or a skateboard. Hold it above the ground and spin one of the wheels. Between each wheel and its center axle is a type of bearing called a "ball bearing." The bearing holds the wheel on the axle, but reduces the friction between them, so the wheel can spin for a long time without slowing down.

**Wheel Alignment:** Another problem that wastes energy is poor wheel alignment. When the wheels on your vehicle are not lined up properly, some of the wheels must slide sideways. When the driven wheels try to pull the car one way, but the rest of the car wants to roll the other way, the traction in the wheels (normally a good thing) wastes quite a bit of energy. Also, make sure that the axle goes through the center of the wheel. Taking time to align the wheels carefully the first time will make a huge difference in how well your car runs.

**Materials for the wheels**: Look around for anything round, or things that can be cut into circular shapes or already circular items... look at home, arts and crafts stores, and hardware stores. Some ideas include: thin plywood balsa wood; foam core; stiff plastic sheet; Styrofoam; cardboard tubes; toy/model wheels; tape spool; thread spool; brass tube; plastic pipe; and wood dowels.

**Materials for the axle**: The axle must be stiff, narrow and round. Some ideas: nails, brass rods, brass tubing, cooking skewers and coat-hanger wire.

**Materials for the bearing**: Some ideas of things that would support the axle: Screw eyes/eyebolts (hardware store), brass tubing, drink straws, hard material (wood, aluminum, etc.) with a hole drilled into it, brackets with screw holes pre-drilled, or holes drilled directly into the chassis.

## Power Source

The purpose of the solar panel is to capture energy from the sun and to turn this energy into electrical energy. The electric motor then uses this electrical energy to power the wheel of the solar car. Batteries will only be used if MLGW determines that they need to be used. If batteries are used, MLGW will supply the batteries.

**Maximizing Power**: How can we build the solar car so it gives us the most power from the solar panel? One way is to try to get the solar panel to produce more current. If more sunlight hits the solar panel, more current is produced! How can we do this? One way is to tilt the solar

panel towards the sun. The more of the sun's rays hit the panel, the more current will flow and the more power will be produced.

**Transmission**

A car's transmission transfers the power from the motor to the wheels. While doing so, it may make the wheels spin at a different speed than the motor. You can use different types of transmissions:

1. **Direct drive:** the wheel is directly connect to motor, so every time the motor rotates once the wheel rotates once.
2. **Pulley (or Belt) drive**: The motor turns a pulley, which is connected by a belt (like a rubber band that doesn't stretch) to another pulley, which is connected to the wheel. So the motor turns the first pulley, which turns the second pulley, which turns the wheel. The size of the pulleys affects how many motor rotations it takes to make the wheel rotate once.
3. **Gear drive:** The motor turns a gear, which turns a second gear, which then turns the wheel. Like the pulley drive, the size of the gears affects how many motor rotations it takes to make the wheel rotate once. The difference in the size of the two gears (or pulleys) is called the gear ratio.

**Selecting the Proper Gear Ratio**: So, how can you choose the best gear ratio? Experimentation is probably the easiest way to find out. The idea is that your motor works best at a certain speed. They also have a limit as to how much force they can exert. First you must find the speed at which the motor gives the most power (this is usually half the speed the motor will rotate if there is no load, or force, exerted on the motor shaft). Try to keep the motor turning at approximately that speed as you experiment with different gear ratios.

Remember, the ideal gear ratio may change some if you change different characteristics of your car (size, weight, etc.). Just remember, if your car is not going very fast it can either be that the wheel speed is too slow, or the force required to turn the wheel is too high. Try a different gear ratio!

**Materials for the transmission:** The materials you choose vary greatly depending on the type of transmission you build. If you decide to build a belt drive, try stiff, rubbery materials for the belt - such as a slice of inner tube or an o-ring. Make sure your pulleys are pulled away from each other so that the belt is tight.

**Body Shell**

The shape of the shell changes how the car performs, because a well-designed shell can reduce the force of air, or wind resistance, on the car as it moves. This is known as aerodynamics. So

how do you reduce the force of air on your solar car? One way might be to add a body or shell to it that deflects the air around the car. This generally means a smooth surface, where nothing sticks out. Also, a small curved front will help make the vehicle more aerodynamic.

**Materials for the shell**: poster board, cardboard, foam core, stiff insulation foam, Mylar, or plastic sheet.

**Putting It Together**

What about putting it all together? Hot glue is great in the speed of assembly department, but you may find that wood glue is stronger and lighter. Screwing the chassis together works well too, but you'll pay a weight penalty there as well. If you do use screws put a little glue on the threads before screwing them in and they will hold better.

A trouble free way to attach your solar panel is using "Velcro." It will make it easy to remove and re-attach your panel to your chassis. Alligator clips on your power leads from your panel to your motor allow you to quickly detach the entire panel from your car, and are a convenient on/off switch.

Find more tips for car design visit:
http://www.nrel.gov/docs/gen/fy01/30828.pdf