Junior Solar Sprint – Introduction & Overview

Students Objective
The student
- will be able to explain the rules governing the construction and racing of Junior Solar Sprint vehicles
- will be able to explain the basic design processes necessary to building a JSS vehicle

Key Words
disqualification
innovation
Junior Solar Sprint
parameter
photovoltaic

Materials (this lesson)
- Junior Solar Sprint video (available online–see Procedure section)
- race rules
- large sheets of paper
- team journals
- Researcher's Portfolio

Time (this lesson):
1 class period
Time (entire Junior Solar Sprint project):
2 - 6 weeks

Materials (future sessions)
- solar panel and motor (from kit)
- wheels – found, recycled or purchased
- gears – found, recycled or purchased
- various materials for car body and chassis such as balsa wood, styrofoam, foam core, aluminum, plastic, heavy paper, and recycled containers
- rods for axles
- plastic and metal tubing for bearings and bushings
- various glues such as hot glue, wood glue, and contact cement
- various tools such as soldering iron and solder, needle nose pliers, screwdriver, razor knife, scissors, wire cutters, small adjustable wrench, electric drill & bits (inc. hole saw)
- small vice or clamps
- wire
- alligator clips
- electrical tape
- velcro
- safety glasses

Background Information

If you are unfamiliar with the Junior Solar Sprint, you may want to preview the video and read the rules before class.

The Junior Solar Sprint competition was started by the US Department of Energy in 1991 to expose students to photovoltaics and its potential for their future. The competition challenges students to design, build and race model solar cars powered entirely by solar energy. The students are challenged to use scientific know-how, creative thinking, experimentation and teamwork to design and build a solar-powered electric vehicle.

Procedure

1. Show Junior Solar Sprint video. The video is available online in streaming video at: **http://www.energywhiz.com/index.htm** or a dvd copy may be purchased from the Florida Solar Energy Center.
2. Lead a classroom discussion about the Junior Solar Sprint
3. Assign students to small groups of 2 - 4 students per team
4. Distribute the *Race Rules* pages to each team
5. Students should complete the *Science Journal* pages
6. Students should brainstorm and sketch their ideas on the large sheets of paper.

Related Research

1. How can photovoltaics be utilized in full sized cars? Research full sized solar race cars. When and where is the next race going to be held?
2. How could solar be used to charge an electric car? Draw a diagram or find a photograph on the internet of an electric car that charges its batteries using photovoltaics.

Internet Sites

http://www.nrel.gov/education/jss_hfc.html

National Junior Solar Sprint web site sponsored by the National Renewable Energy Laboratory

http://www.fsec.ucf.edu/en/education/k-12/events/jss.htm

Florida Solar Energy Center's Junior Solar Sprint web page.

http://doolittle.icarus.com/jss/

Larry Doolittle of Lawrence Berkeley National Laboratory has written a program that simulates a Junior Solar Sprint race based on the variables of your car.

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Benchmarks and Grade Level Expectations are listed for each sub activity of this unit in that specific unit. Listed below are the benchmarks and GLEs for the Junior Solar Sprint activity in general, if none of the sub activities are used in the process.

			.1	.2	.3	.4	.5	.6	.7
Nature of Matter	Standard 1	SC.A.1.3-		X					
	Standard 2	SC.A.2.3-			X				
Energy	Standard 1	SC.B.1.3-	X	X	X	X			
	Standard 2	SC.B.2.3-	X						
Force and Motion	Standard 1	SC.C.1.3-	X						
	Standard 2	SC.C.2.3-	X		X	X	X	X	X

Benchmark SC.A.1.3.2: The student understands the difference between weight and mass.
Grade Level Expectations
The student:
Sixth
- understands that mass is the amount of material in an object

Seventh
- understands that weight is the result of gravitational pull on an object.

Benchmark SC.A.2.3.3: The student knows that radiation, light and heat are forms of energy used to cook food, treat diseases and provide energy.
Grade Level Expectations
The student:
Sixth
- knows forms of radiant energy and their applications to everyday life

Seventh
- knows uses of radiation, light and thermal energy to improve the quality of life for human beings

Eighth
- extends and refines knowledge of uses of forms of energy to improve the quality of life.

Benchmark SC.B.1.3.1: The student identifies forms of energy and explains that they can be measured and compared.

Grade Level Expectations

The student:

Sixth

- knows different types of energy and the units used to quantify the energy
- understands that energy can be converted from one form to another

Seventh

- knows examples of uses of energy in the home and ways to measure its use

Eighth

- understands that energy can be transferred by radiation, conduction, and convection
- knows examples of natural and man-made systems in which energy is transferred from one form to another.

Benchmark SC.B.1.3.2: The student knows that energy cannot be created or destroyed, but only changed from one form to another.

Grade Level Expectations

The student:

Sixth

- understands that energy can be changed in form
- uses examples to demonstrate common energy transformations

Seventh

- knows the difference between potential and kinetic energy
- knows ways to change energy from potential to kinetic.

Benchmark SC.B.1.3.3: The student knows the various forms in which energy comes to Earth from the Sun.

Grade Level Expectations

The student:

Sixth

- knows types of radiant energy that come to Earth from the Sun

Seventh

- knows the characteristics, effects, and common uses of ultraviolet, visible and infrared light

Eighth

- knows ways to measure the various forms of energy that come from the Sun.

Benchmark SC.B.1.3.4: The student knows that energy conversions are never 100% efficient.

Grade Level Expectations

The student:

Seventh

- knows that useful energy is lost as heat energy in every energy conversion

Eighth

- knows that energy conversions are never 100% efficient and that some energy is transformed to heat and is unavailable for further useful work.

Benchmark SC.B.2.3.1: The student knows that most events in the universe (e.g., weather changes, moving cars, and the transfer of a nervous impulse in the human body) involve some form of energy transfer and that these changes almost always increase the total disorder of the system and its surroundings, reducing the amount of useful energy.
Grade Level Expectations
The student:
Sixth
- understands that energy moves through systems

Seventh
- knows that as the amount of useful energy of a system decreases, the total disorder in the system increases

Eighth
- understands that as energy is transferred from one system to another there is a reduction in the amount of useful energy
  knows that energy transfer is not efficient.

Benchmark SC.C.1.3.1: The student knows that the motion of an object can be described by its position, direction of motion, and speed.
Grade Level Expectations
The student:
Sixth
- knows that a change in motion and position can be measured
- knows ways to measure time intervals
- knows ways to estimate speed

Seventh
- knows that the motion of an object can be described by its position, direction of motion, and speed

Eighth
- knows that speed, velocity, and acceleration can be calculated, estimated, and defined
- knows that the magnitude of linear acceleration can be calculated.

Benchmark SC.C.2.3.2: The student knows common contact forces.
Grade Level Expectations
The student:
Eighth
- knows some common contact forces (for example friction and tension).

Benchmark SC.C.2.3.3: The student knows that if more than one force acts on an object, then the forces can reinforce or cancel each other, depending on their direction and magnitude.
Grade Level Expectations
The student:
Sixth
- recognizes the result of several forces acting on an object
- knows that the net force is dependent on the direction and magnitude of forces acting on a body

Eighth

- recognizes the forces that act on a given object
- knows that the overall effect of a force can be predicted
- knows that forces may be balanced or unbalanced
- understands that unbalanced forces cause objects to accelerate.

Benchmark SC.C.2.3.4: The student knows that simple machines can be used to change the direction or size of a force.

Grade Level Expectations

The student:

Sixth

- knows uses of simple machines
- knows advantages and disadvantages of simple machines

Seventh

- understands uses and combinations of simple machines in complicated machines

Eighth

- knows that simple machines can be used to change the direction or size of a force.

Benchmark SC.C.2.3.5: The student understands that an object in motion will continue at a constant speed and in a straight line until acted upon by a force and that an object at rest will remain at rest until acted upon by a force.

Grade Level Expectations

The student:

Sixth

- knows that an object at rest will stay at rest unless acted upon by an outside force
- knows objects in motion will remain in motion unless acted upon by an outside force

Eighth

- understands that an object in motion will continue at a constant speed and in a straight line until acted upon by a force and that an object at rest will remain at rest until acted upon by a force.

Benchmark SC.C.2.3.6: The student explains and shows the ways in which a net force (that is, the sum of all acting forces) can act on an object (e.g., speeding up an object traveling in the same direction as the net force, slowing down an object traveling in the direction opposite of the net force).

Grade Level Expectations

The student:

Eighth

- knows ways in which a net force can act on an object.

Benchmark SC.C.2.3.7: The student knows that gravity is a universal force that every mass exerts on every other mass.

Grade Level Expectations

The student:

Sixth

- knows that gravity causes an object to have weight

Seventh

- understands that gravity is a force exerted on a mass that causes and object to have weight

Eighth

- knows that gravity is a universal force that every mass exerts on every other mass.

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disqualification - to become ineligible to participate

innovation - to use something in a new or unique way

Junior Solar Sprint - a program begun in the early 1990s by the U.S. Department of Energy. The program was created for teams of middle school students who design and construct model sized, solar powered vehicles for competition.

parameter - characteristic

photovoltaic - the effect of producing electric current using light

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Each team is responsible for designing and building a solar powered race car. The kit your team purchases will contain a motor and solar panel; the chassis, wheels and transmission are made from any other materials that you choose. Cars are judged on design, innovation and performance. Each team's effort is focused toward the final event – a 20 meter, wire-guided sprint race where the best design and construction techniques will pay off with the win!!

Car Parameters

The dimensions of a Junior Solar Sprint car **cannot exceed**:

- 30 cm. in width
- 60 cm. in length
- 30 cm in height

The car must have a three dimensional body. No open frame bodies or chassis are permitted. Teams will not be allowed to bolt the axles and wheels to the solar cell. Each side must have a space big enough for a 3cm x 3cm number decal which will be provided by the race committee.

Each entry begins construction with a kit containing:

- a 3V photovoltaic panel
- a motor matched to the PV panel

The solar panel may not be modified. The motor may not be modified (i.e. rewound, lightened, etc.). The specific motor supplied with the panel (in the kit) must be used. If a replacement motor is needed, it must be purchased from the company who supplied the panel. One solar cell and motor are permitted per car. Any modification to the solar panel or motor will result in disqualification.

At least one wheel must be driven by the motor.

Construction

Each team, on their own, will provide the additional parts needed for the construction of the car:

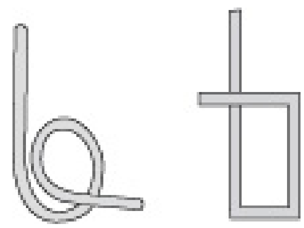
- wheels
- car body/chassis
- axles
- wiring
- connectors
- gears
- brackets

Individual decals may be affixed, and the body may be decorated at the teams discretion, but a 3 cm. square space must be left free on each side and the bottom for the Sprint decal number.

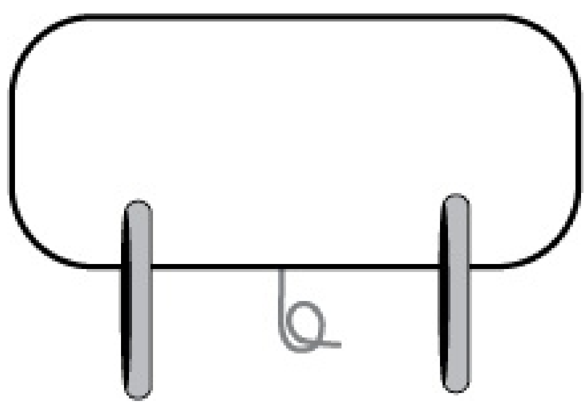
The material for the body of the car can be any type of light material.

Steering

An eyelet (see examples below) must be attached to the bottom front of the car. A guide wire, 1 cm. from the surface of the track, will go through the eyelet, serve as the steering mechanism, and keep the car in its lane. The vehicle must be easily removable from the guide wire, without disconnecting the guide wire. This is the only allowable method of steering the car. No radio control is permitted in Junior Solar Sprint cars. Lane changing/crossing will result in disqualification.



Embed the eyelet in the bottom of your car near the front (or use two eyelets--one near the front and one near the rear). The guide wire will pass through the eyelet to keep your car in its lane.



Front of Car (End View)

The vehicle must be safe to contestants and spectators (i.e. no sharp edges, projectiles, etc). Any energy-enhancing devices, like mirrors, must be attached to the vehicle.

Failure to meet these expectations will result in disqualification.

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Race Parameters

The Track:
The racetrack is 20 meters long and 60 centimeters wide
The track is set up on a hard, flat, smooth surface such as a tennis court. For the Florida Regional competition, a non-slick vinyl surface will be used for the track lanes.

The Starting Line:
- One team member will hold a piece of cardboard or other shading device over the panel, and remove it when the start signal is given.
- Team members may not push a vehicle to start it.
- Team members may not accompany the vehicle in its lane during the race.

During the Heat:
- One team member may free the vehicle from wire binding or track imperfections should such problems occur.
- One team member may make repairs if a mechanical or electrical failure occurs.
- Team members may not push the vehicle or give any other physical assistance.
- Team members may not change the vehicle's mechanical or electrical characteristics (e.g. shift a transmission) after the start of the heat.

The Finish Line:
- One team member must be present at the finish line to stop the vehicle, preventing any damage to it.
- The vehicle must remain in its lane at the finish line until the order of the race vehicles has been established.

Failure to meet these expectations will result in disqualification.

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Track Specifications:

Lane Length:
20 meters

Lane Width:
60 centimeters

Number of Lanes:
- Depends upon the total number of entrants and the time available.
- Each heat takes about 5 minutes, and each vehicle should run at least twice in a double or triple elimination heat format.

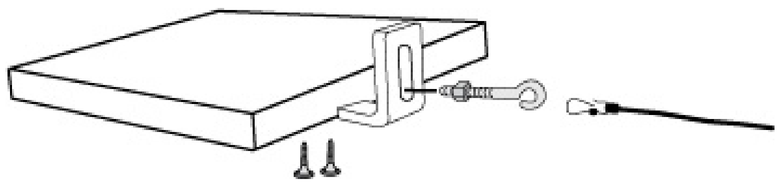
Track Surface:
- As smooth as possible, flat and level or slightly downhill in the direction of the race.
- Fully exposed to the sun all day.
- Oriented if possible, so that prevailing winds are behind the vehicles as crosswinds can be a problem.

Layout:
- Security roping should be placed around the perimeter of the track, as the guide wires are difficult to see.
- A second level of security roping should be used for team movement and to keep spectators off the track.
- A staging area near the start line and a run-off area beyond the finish line is necessary.
- A pit area is needed for tune-ups between races. This area should have two practice guide lines.

Guide Lines:
- Monofilament fishing line, 60-lb test is adequate.
- The line should be suspended about 1 cm (+/- .5 cm) off the ground.
- Lines must be kept taut.

One way that the guide lines may be attached (see diagram following instructions):
- A 12" x 12" piece of 3/4" plywood may be used to anchor both ends of the guide wire.
- A threaded eye-bolt can be attached to a comer-reinforcing bracket to allow for height adjustment of the guide wire.
- Pre-measured guide wires can be attached to the eye bolts with fishing tackle clips.

- Once assembled, plywood should be anchored with 40lbs. of ballast (concrete blocks are acceptable) and moved apart to give the desired line tension.



Detail of guide wire ends

Timer:
- Some method is needed to determine placement of vehicles at the finish line.
- The timer need not measure speed but must be able to determine each vehicle's place.

Communication:
- Efficient communication is needed between the starting line, the finish line, and the scoreboard.
- A loudspeaker or bullhorn is helpful for public announcements and crowd control.

Intramural Racing:
- The purpose of the intramural race is to determine your class or school's entry to the regional race conducted by your local Society of Automotive Engineers (SAE) or Junior Solar Sprint host site.
- There are several options for determining your school's entry:
    - Teacher decision – It is not mandatory to conduct an intramural race.
    - By the clock – A school may set up one lane and race each vehicle against the clock. The vehicle with the best average time becomes the entry to the regional race.
    - Lane races – Construct lanes and conduct a double elimination race.
    - Full-scale intramural race – The JSS is a great opportunity for publicity at many levels. Invite as many people as possible to the event including parents, scientists, teachers, students, and the media.

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You will be designing and building a solar powered vehicle to compete in a 20-meter, wire guided race.

1. List below topics you would like to research, questions that you want answered, and experts you would like to contact. Write down which team member is responsible for gathering information on each item.

    1.

    2.

    3.

    4.

    5.

    6.

    7.

    8.

2. Junior Solar Sprint vehicles use many different materials in their construction, many of them recycled and found materials. You will need to be thinking of items that you may already have around the house, as well as how to use common everyday items in a new way. Make a list below of items that you want to bring in to investigate and possibly use in the design of your vehicle.

3. As you conduct your research make notes below of the important information you learn and the source you used. You may use the internet, textbooks, magazines, books and experts in their field. Make sure to include a variety of resources. You may also download or copy printed material and highlight the relevant facts. Include your research information in this portfolio.