Junior Solar Sprint
Science & Engineering Fun

Philadelphia Solar Energy Association
www.phillysolar.org
Junior Solar Sprint

• Students grades 5-8 design, build, & race model solar cars
• Kits from Pitsco or Solar Made obtained by the teachers
• Students work in small teams of 1 - 4 students
• Double elimination race decides the fastest car!
• More than a race! Local artists, engineers, and the Eastern Electric Vehicle Club judge the cars and teams for awards in the following categories:

  Artistic Merit, Technical Merit, Re-use Merit and Best Overall
Three Basic Rules

1. One motor (1.5-3VDC at 330 mA)
2. One solar panel (3 volts, 1,100 mA)
3. Must stay hooked onto a guideline & carry an empty aluminum can to the finish line on a 75 foot track.
How To Volunteer

Assist on Race Day: May 18, 2019
• Set-up tables, tracks, & race board
• Help trouble shoot car problems at the starting line
• Manage the flow of teams and cars
• Judging

Assist in Car Building Workshops: Jan – May, 2019
• Approximately 2 hours long in partnership with teachers
• Class of ~15 – 5th to 8th grade students
• Kits are supplied by the schools. Tools to build cars are supplied by PSEA

Assist with Teacher Trainings Nov - March
• Work with experienced trainer to help teachers learn
Objective #1

• Guide students through the functional process of building a car SAFELY!

• Connect each element of car building to a concept in math, engineering and science
  – Chassis: aerodynamics, what shape makes the car faster?
  – Wheels: materials, what will give the car more grip?
  – Engine: gear ratios, low gear ratio for acceleration
  – Soldering: joining metals
  – Solar Energy: How is the energy from the sun converted into electricity to provide forward motion of your car?
  – Solar Energy: How to maximize speed by matching the car’s weight to the motor’s output
Objective #2

• Guide students through the *creative process* of building a car

• Encourage the students to put a personal stamp on their vehicles
  – Does their car have a name or a theme?
  – Cargo compartment design & functionality?
  – How can they best compete for the various awards?
    • Artistic Merit
    • Re-use Merit
    • Technical Merit
    • Best Overall
Bring **real life concepts** into the conversation

- What is Sustainable & Renewable energy?
- Do they see electric vehicles (Evs) on the road today?
- Climate Change: How does solar energy help solve it?
- Solar Energy at Home: Do they know anyone who has solar energy at home? At school?
- What’s more expensive? Solar or Coal?

Project based learning starts with the students’ innate nature to be inquisitive about “how the world works”. Our job is to show them that it is not magic and that the laws of science & math can help us determine the future, in this case, building a fast, solar powered car. This last objective is definitely the stretch goal and will be most applicable for the more advanced students.
What Is Solar Energy?

• Radiant Light
• Radiant Heat

The sun radiates more energy in 1 second than humans have used since the beginning of time!

How Is Solar Energy Captured?

• Photosynthesis
• Passive Solar Heating
• Solar Hot Water
• Photovoltaic
Innovation or Invention

Henry Ford Model T 1908

GM Electric Cars & Solar charging 2017

“While invention might be where the Nobel Prize is created, innovation is where the money is.” CTO Dow Chemical 12-2009

Innovation = Invention + Entrepreneurship

www.theinnovationeconomy.org
Innovation

Diversity

Critical Thinking

Team Work

Creativity

Education for Sustainability
https://www.philasd.org/greenfutures/focus-areas/education-for-sustainability/

Eco Schools USA

Energy Innovation Hubs www.energy.gov/hubs/
Sustainability

“A sustainable global society is one in which people today meet their needs without compromising the ability of future generations to live equally as well.”

Chemical & Engineering News, August 18, 2008
Clean Renewable Energy

Solar energy is the most rapidly growing form of energy in the USA - 2017
High School Solar Car Challenge
Texas Motor Speedway

http://www.solarcarchallenge.org/challenge/
The Solar Car Kits

Pitsco (800-835-0686)  
www.pitsco.com
Ray Catcher Sprint Kit  
W21211
- Solar panel, 2 shafts, 4 wheels, 2 x 8 gears, bushings balsa wood, clips, motor 1.5-3VDC at 330 mA

Solar Made (800-246-7012)  
www.solarmade.com/store/product/junior-solar-sprint-kit
JSS-KIT
- Solar panel, 1.5-3VDC motor at 330 mA with mount & 3 gears  
  JSS-ACC
- 2 shafts, 4 wheels/tires & 2 spur gears
How to Build a Solar Car

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Chassis

Weight - Stiffness - Strength – Shape - Orientation

Components attached to the chassis are:
Motor – Bushings – Cargo Compartment

Gears must engage through a hole in the chassis or along side the chassis.

All chassis modifications should be made before components are added.

Chisels and Xacto knife work well with balsa wood
Wheels & Bushings
Build a Skateboard

Wheel & Gear Alignment
• Use a vise to assemble the wheels and gears onto the axles and motor shaft

Wobble & Friction Reduction
• Bushings are attached so that they extend outside of the frame of the chassis to prevent the wheels from rubbing into the chassis.
Axle Alignment

Axles are parallel to each other & perpendicular to side of chassis

Drive Axle Assembly
Electromagnetic Motor

Provides Power & Torque

- Clips are soldered to each of two wires
- The other end of the wires is soldered to the leads on the motor
  - Soldering prevents sparks. Energy transferred to sparks is energy NOT used to propel the car forward
- A gear is attached to the shaft on the motor before the motor is “mounted” onto the chassis
  - Additional support to the motor is needed to prevent the motor from vibrating off the chassis. Extra pieces of wood may be glued on each side of the motor for support.
Transmission

- A transmission can change:
  - RPM delivered by the motor
  - Torque provided by the motor
  - Direction

- It *does not* change the *power* provided by the motor.
  Power is lost only through friction.

Types of Transmissions
Gear Ratio

Speed vs. Torque

Torque is a measure of the force needed to cause an object to rotate.
Forces at Work

Gravity

Momentum

Torque / RPM

Drag

Friction

Gravity
Power Source

6 – 0.5 volt solar cells connected in series.

Maximum power is 3 volts, 1,100 mA

Angle of Incidence

To reflect or not to reflect?
How a Solar Panel Works

- Properties of the material allow sunlight to energize electrons (into the conduction band).

- The panels are engineered to move energized electrons to the top of the cell.

- Electron movement forms about 0.5 volts from top to bottom of the cell.

- The larger the panel, the more energized electrons are available to form a current.

- The more panels attached in series (front-to-back), the higher the voltage.
Final Assembly

- Cargo Compartment Integration
- Aerodynamics & Panel Position
- Battery Pack & Wiring
- Guidance System & Wheel Play
- Gear Tightness
- Weight & Balance
Tips

✱ Glue sparingly at first
  Tape is a poor substitute but a good temporary fastener
✱ Remove all plastic nubs that may be on wheels & gears
✱ Solder clips to wire leads for motor
✱ Solder wire leads to motor then tape them down
  Prevent metal motor tabs from breaking
✱ Robust guidance system that hooks onto the line (not threaded)
✱ Adjustable & removable solar panel
  Maximize energy from the sun & lower costs by sharing panels
✱ Keep a notebook
  Good science | Helps with problem-solving
✱ Use emery cloth to smooth axles and lube with graphite
✱ Perform test runs on a guide line 5/8 inch off ground
Junior Solar Sprint Awards

Technical Merit: 1st, 2nd, 3rd

Artistic Merit: 1st, 2nd, 3rd

Re-use Merit: 1st, 2nd, 3rd

Best Over All Vehicle

Open Division Award

1st place speed