

# Junior Solar Sprint 8-Week Syllabus



## WEEK 1

### JSS PROGRAM INTRODUCTION AND BASICS OF VEHICLE DESIGN

- Alternative Energy and Junior Solar Sprint (JSS): show videos
  - 300 Years of Fossil Fuels in 300 Seconds  
[www.youtube.com/watch?v=cJ-J91SwP8w](http://www.youtube.com/watch?v=cJ-J91SwP8w)
  - Thayer School of Engineering at Dartmouth  
[www.youtube.com/watch?v=lyJKC6A4pGA](http://www.youtube.com/watch?v=lyJKC6A4pGA)
  - Bill Nye, why use solar?  
[www.youtube.com/watch?v=av24fEMhDoU](http://www.youtube.com/watch?v=av24fEMhDoU)
  - Lesson: [AlternativeEnergy.pdf](#)
- Discuss Hands-on Design and Design Process
  - Relate to professional engineering
  - Relate to work and/or hobbies
  - Lesson: [AlternativeEnergy.pdf](#)
- JSS Schedule
  - School Race approx. date
  - Area Race approx. date
  - Lesson: [AlternativeEnergy.pdf](#)
- Discuss Vehicle Design, Define Goals and Constraints
  - Kit materials  
[www.pitsco.com/Ray-Catcher-Sprint-Kit](http://www.pitsco.com/Ray-Catcher-Sprint-Kit)
  - Race rules
    - Event Guidelines  
[www.usaeop.com/jss-resources](http://www.usaeop.com/jss-resources)
  - Vehicle specifications
    - Preliminary Round Model Car  
[www.usaeop.com/jss-resources](http://www.usaeop.com/jss-resources)
  - Lesson: [CarDesign.pdf](#)
- Discuss vehicle components
  - Chassis: frame which supports all parts
  - Body: not necessary but sometimes helps students visualize vehicle
  - Motor: converts electrical energy into rotary motion
  - Wheels: discs which allow vehicle to roll
  - Axles: rods to which wheels are attached
  - Bearings: support axles and allow them to spin
  - Transmissions: moves rotary motion of motor to wheels as well as reduces motor speed

- Photovoltaic panel: converts sunlight to electric current
- Guidance system: directs vehicle from start gate to finish gate
- Lesson: [CarDesign.pdf](#)
- Student Work
  - Individually brainstorm overall car concepts and sketch them
  - How might your model solar car look?
- Demonstrations and Discussion
  - How do motors make things move?
  - Find examples of machines, toys, vehicles, etc. with mechanical components
  - Come up with lists of questions that need answers before selecting a design
  - Lesson: [CarDesign.pdf](#)

## WEEK 2

### WHEELS, AXLES, BEARINGS, AND CHASSIS

- Form teams of three students
  - Students share their previously developed individual design concepts with group members
  - Groups combine design concepts into a their initial whole vehicle design.
  - Create new vehicle sketches.
- Weekly Design Review
  - Each team present new vehicle sketches to class.
  - Class suggest questions that need answers before selecting design
- Friction Labs
  - Friction Investigation #2 and #3 pg. 9-11  
[www.nrel.gov/docs/gen/fy01/30830.pdf](http://www.nrel.gov/docs/gen/fy01/30830.pdf)
  - Lesson: [www.usaeop.com/wp-content/uploads/2015/01/Friction-Investigation1.pdf](http://www.usaeop.com/wp-content/uploads/2015/01/Friction-Investigation1.pdf)
- Investigating Materials
  - Investigating-Model-Car-Materials  
[www.usaeop.com/wp-content/uploads/2015/01/Investigating-Model-Car-Materials.pdf](http://www.usaeop.com/wp-content/uploads/2015/01/Investigating-Model-Car-Materials.pdf)
  - Structure Investigation pg. 16-18  
[www.nrel.gov/docs/gen/fy01/30830.pdf](http://www.nrel.gov/docs/gen/fy01/30830.pdf)
  - Lesson: [www.usaeop.com/wp-content/uploads/2015/01/Investigating-Model-Car-Materials.pdf](http://www.usaeop.com/wp-content/uploads/2015/01/Investigating-Model-Car-Materials.pdf)

- Ask students to consider the fate of the materials they choose to use to make their vehicles
- Vehicles will be disassembled at the end of the unit and divided into recyclable, reusable and landfill items
- Student Work
  - Build a prototype chassis and mount prototype wheels, axles and bearings
  - Build something that rolls
  - Come up with additional lists of questions to be answered before a design can be selected
  - Continue sketching concepts
- Class discussion
  - Brainstorm list of questions

## WEEK 3

### MOTORS, TRANSMISSIONS AND SOLAR PANELS

- Demonstrations and Discussion
  - How do motors work?  
[www.youtube.com/watch?v=d\\_aTC0iKO68](http://www.youtube.com/watch?v=d_aTC0iKO68)
- Transmission (gear) ratio  
[www.youtube.com/watch?v=B4j2VPHVm6o](http://www.youtube.com/watch?v=B4j2VPHVm6o)
  - Photovoltaics (Solar panels), how do solar panels work?
    - [www.youtube.com/watch?v=JOkly6ADOA](http://www.youtube.com/watch?v=JOkly6ADOA)
    - [www.youtube.com/watch?v=UJ8XW9AgUrw](http://www.youtube.com/watch?v=UJ8XW9AgUrw)
- Class experiments
  - Solar insolation experiment: see effect on voltage produced as panel angle to sun is changed
  - Lesson: [www.usaeop.com/wp-content/uploads/2015/01/Suns-Angle-Investigation.pdf](http://www.usaeop.com/wp-content/uploads/2015/01/Suns-Angle-Investigation.pdf)
  - Calculate distance traveled per motor revolution (taking into account gear ratio and wheel size)
  - Construct different transmission types and ratios
  - Transmission Investigation pg. 3-7  
[www.nrel.gov/docs/gen/fy01/30830.pdf](http://www.nrel.gov/docs/gen/fy01/30830.pdf)
  - Study the effect of wheel diameter on transmission ratios ([doolittle.icarus.com/jss](http://doolittle.icarus.com/jss))
  - Lesson: [www.usaeop.com/wp-content/uploads/2015/01/Transmission-Investigation1.pdf](http://www.usaeop.com/wp-content/uploads/2015/01/Transmission-Investigation1.pdf)
  - Lesson: [www.usaeop.com/wp-content/uploads/2015/01/Transmission-Investigation2.pdf](http://www.usaeop.com/wp-content/uploads/2015/01/Transmission-Investigation2.pdf)

- Design system for solar panel mounting and angle adjusting
- Class generate design criteria for vehicles
  - Lightweight
  - Sturdy
  - Good acceleration
  - High top speed
  - Low friction
    - bearings
    - gears
    - guidewire
  - Steers straight
  - Can accommodate guide wire
  - Easy to build
  - Aesthetics
  - etc.
- Combine best features from various concepts
- Make working drawing (actual size) of vehicle and bill of materials (spreadsheet)

## WEEK 4

### SELECT OVERALL VEHICLE DESIGN AND PLAN/BEGIN CONSTRUCTION

- Vehicle construction demonstrations, part one
  - Chassis layout and cutting
  - Bearing cutting and deburring
  - Motor mounts
  - Solar panel mounts
- Each team member takes on lead engineer role for one vehicle system
  - Chassis (frame, axles, bearings, guidance system)
  - Transmission (motor, motor leads, motor mount, gears or pulleys, wheels)
  - Solar Collection (panel support system, panel adjustment system)
- Correct working drawing (actual size) of vehicle and bill of materials (spreadsheet)
- Weekly Design Review
  - Each team present vehicle to class
  - Class suggest questions that need answers before continuing

## WEEK 5

### DEMONSTRATIONS AND VEHICLE CONSTRUCTION

- Vehicle construction demonstrations, part two
  - Axle cutting and chamfering
  - Bearing mounting
  - Soldering leads to motor terminals
- Weekly Design Review
  - Each team present vehicle to class.
  - Class suggest questions that need answers before continuing
- Teacher Guidance
  - Assist students in selecting designs to build
  - Help teams split up building tasks
- Obtain materials
- Build vehicles

## WEEK 6

### CONSTRUCTION OF VEHICLES

- Check progress of cars
  - Find out problem areas and give design advice
  - Review race rules
- Teacher Guidance
  - Assist students to building vehicles and using tools
  - See that all team members are contributing
- Weekly Design Review
  - Each team present vehicle to class.
  - Class suggest questions that need answers before continuing
- Remind students to consider the fate of the materials they choose to use to make their vehicles
- Vehicles will be disassembled at the end of the unit and divided into recyclable, reusable and landfill items
- Student Work
  - Build Vehicle

## WEEK 7

### COMPLETE CONSTRUCTION OF VEHICLES AND BEGIN TESTING

- Check progress of cars
  - Check that vehicles are “legal”
  - Find out problem areas and give design advice
  - Review race rules

- Teacher Guidance
  - Assist students to building vehicles and using tools
  - See that all team members are contributing
- Weekly Design Review
  - Each team present vehicle to class.
  - Class suggest questions that need answers before continuing
- Prepare for School Race
- Student Work
  - Finish building vehicles

## WEEK 8

### OPTIMIZE VEHICLES

- Weekly Design Review
  - Each team present vehicle to class.
  - Class suggest questions that need answers before continuing
- Discuss performance measures from rules
- Teacher Guidance
  - Assist students in building vehicles and using tools
  - Set up test track for optimization experiments
- Student Work
  - Rework components as necessary to optimize vehicle
  - Complete vehicle
- In-class race
- Fate of the materials presentations
  - Disassembled vehicles and divide into
    - recyclable
    - reusable
    - landfill items
  - Present material determinations
- Debrief
  - What was learned
    - alternative energy
    - problem solving
    - STEAM areas
  - Improvements to activity