Zero-Emission Vehicle Challenge

Due Date:
Thursday, April 28, 2022

Welcome to the Zero-Emission Vehicle Challenge

In California, 40% of all greenhouse gas emissions come from transportation. As global temperatures continue to rise and weather patterns change, reducing emissions is a necessary step to avoid climate catastrophe. For this project, you will design and create a zero-emission vehicle (ZEV) that is powered by a solar panel. You will also test your ZEV and share your idea with others by documenting your progress using pictures and videos. Teams will earn points for creativity, effective design, and practicality. Teams may only submit one response to this Challenge.

Background
California recently announced its goal to end sales of cars and trucks that use an internal combustion engine (ICE) by 2035. Your ZEV design could help to reach this target. In California, light duty vehicles account for 59% of transportation-related emissions, compared to 23% from medium and heavy-duty vehicles. The remainder comes from shipping, rail, and aviation. For this project, you will be working on a larger vehicle that can carry a heavy load at a suitable speed.

Although ZEVs do not emit greenhouse gases from a tailpipe like ICEs, they do have environmental consequences. This can include emissions from electricity production, emissions from the mining, production and disposal of ZEVs and their components and other ecological impacts not directly related to emissions.

Still, in terms of greenhouse gases, ZEVs are superior to ICE, especially over a long-time frame and if the electricity used to power the car is produced using a low emission technology like wind or solar.

Document It ~ Extra Credit

Use video or photos to document your work. Get creative. Examples include a time-lapse video of you conducting the challenge, a selfie with the finished product, or a self-narrated video about your work.

Metropolitan may post selected submissions on our social media accounts to promote Solar Cup and the work students are doing. Be sure to avoid profanity and inappropriate or copyrighted images or music. For a required media release, and upload instructions contact Julie Miller Kalbacher at jamiller@mwdh2o.com. You also may post your videos and photos on your own social media account, or your school's account. Be sure to tag Metropolitan at @mwdh2o and use the hashtag #SolarCup. Students that turn in a signed media release and upload their finished product to their school folder can earn up to 100 extra points. The more creative your idea, the more points you will earn.

In this challenge, you will use a SunnySide Up Solar Car Kit along with improvements/materials from repurposed/recycled items around your home to create your very own ZEV.

Design Criteria and Constraints

Your design must follow these guidelines:

- Vehicle must be able to travel on a flat surface without being pushed, pulled, or assisted.
- Vehicle must be **at least** 16 inches long.
- You may not use the main rectangular frame as the base of your vehicle (it can still be repurposed into your design).
- You must incorporate **at least** two components to your design that are not included in the SunnySide Up Kit.
- Vehicles must travel **at least** 10 feet and carry 50 quarters / 283.5 grams of weight and must have a **compartment** to carry this load.
- Vehicle must use the motor and solar panel provided in the SunnySide Up Kit and the solar panel from the Electronics Challenge
    - No additional motors/solar panels beyond what is listed above.
- Must be powered by solar without batteries.
- Your submission will largely be judged on creativity, speed and how much it can haul
- One submission per team

Note to returning schools: Feel free to use last year's models for prototypes and testing.

Deliverables and Scoring

This Challenge is worth up to **600 points**. Your challenge submission must include the following components:

- Responses to questions within Challenge ~ **worth up 200 points**
- Video of your vehicle operating without assistance ~ **worth up to 50 points**
- A complete list of parts with dimensions ~ **worth up to 50 points**
- A CAD/Onshape drawing or hand drawn sketch of the final design ~ **worth up to 100 points**
- Social Media Post Template that includes:
    - Vehicle Name, Company Name, Slogan, your Position/Title, Vehicle Image (or drawing), Caption.
    - **Worth up to 50 points**
- Vehicles also evaluated for creativity, practicality and effectiveness using rubric on last page of this Challenge ~ **worth up to 150 points**

Challenge Worksheets

Part 1: Start your company

1. Come up with a name for your zero-emission vehicle company (e.g.: “Solarge Motors”).
    a. Optional: Design a simple logo for your company.
2. Give yourself a title/position within the company (ex: Engineer, Researcher, Lab assistant, sales etc.).
3. Create a company slogan (ex: “The biggest name in Zero-Emission Vehicles”).
4. You will use this information in Part Four to help you fill out the “Social Media Post Template.”

Logo	Name: _____ Slogan: _____ Title/Position: _____

Part 2: Planning and Designing

1. Observe the final design presented by the Sunnyside Up solar car kit (pictured above) and answer the following questions.

What changes to the design could make the ZEV go faster and/or travel farther?

Can these changes be accomplished by replacing, removing, or adding a component in the design?

2. Based on question 1, you can begin to make a list of materials around your home or school that you can upcycle or repurpose into parts for your design.

List materials you've found in your home or school that you might be interested in using for your design.

3. Now that you have a list of your components, you can begin to make measurements. This will help you make a more accurate drawing.
    a. Use a ruler or tape measure to obtain dimensions of all your upcycled components: length, width, and height of each component.
        i. If you do not have a ruler, try to make your best estimations. The measurements for the components in the kit are already listed in the appendix, which can be used as references.
    b. Add the dimensions of your additional parts in the "Parts List" provided.
4. Next, create a drawing of your intended design. This can be done either through a CAD software, such as Onshape, or a detailed hand-drawn sketch.
    a. Don't worry about it looking perfect just yet, you may end up making changes to your design later.
5. Now with your ZEV fully planned out, you can begin to assemble.
    a. Follow the instructions for the SunnySide Up car kit and make any of your own changes. See an instructional video on how to build the car.

Part 3: Testing and Reiterating

1. We're off to the races! Now is the time to take your ZEV out for a test run. Try to find a time and day with direct overhead sunlight and minimal cloud coverage.

What role does cloud coverage play in solar panel efficiency (i.e. how much power is produced with your panel)? Hint: The amount of solar power produced by your panel impacts the speed of your ZEV.

What orientation (North, South, East, West) resulted in the most solar production?

What angle resulted in the most solar production? An estimate is acceptable (i.e. 90 degrees, 45 degrees, etc.).

Why do you think the orientations and angles you determined above resulted in the most and the least production?

Most solar panels are fixed installations, meaning they do not move throughout the day or year to follow the sun as plants do. In the northern hemisphere solar panels should be tilted slightly towards the south to catch the most sun possible. The optimal tilt angle can be calculated by subtracting 15 degrees from your current latitude. *Latitude - 15 degrees = optimal angle.* Find your latitude and calculate the optimal angle for a fixed solar panel in your region.

2. On flat sidewalk or pavement (no slope), place two markers (i.e. tape, pencils, etc.) to represent the start and finish line of your racetrack. The distance should be at least 10 feet. Convert the 10 feet to units of inches.

3. Speed Challenge: Place your vehicle so that it will travel directly from one marker to the next. Write down the time it takes to reach the second marker in units of seconds. The markers should be 10 feet apart.

    a. Do you think your ZEV could be improved? How?

4. Now use your observations/conclusions you made to tweak/improve your design. (This is known as the iterative design process). Continue to make changes and test them until you are satisfied with the results of your design.
5. Strength Challenge: Now test how much mass your ZEV can carry.
    a. Take your vehicle's fastest time and multiply by 1.5.
        Example: 4 seconds x 1.5 = 6 seconds
    b. Continue to add quarters to your ZEV until this new time is how long your ZEV takes to complete the racetrack.
    c. How much mass can your vehicle hold?
        i. Obtain the mass with this formula:

$Mass = (Number\ of\ quarters)\ x\ (5.67g)$ $Example: Mass = (20)\ x\ (5.67g) = 113.4g$

6. Lastly, give your ZEV a name and make any changes necessary to your CAD design or sketch.
    a. Be sure to record a video and take pictures of your design.

b. Complete the “Parts List” located in the Appendix of this document.
    i. If there are some parts from the kit that you ended up not using, feel free to cross them out.
c. To send large files, email Julie, jamiller@mwdh2o.com for access to the OneDrive Folder so that you may upload the following:
    a. A Picture of your ZEV
    b. A video and/or YouTube Link of your ZEV racing

Part 4: Spread the word

1. Complete the “Social Media Post Template” located in the Appendix, for your ZEV. Be sure to address the following in your caption:
    a. Should California switch to ZEVs, such as your design (Environmental, Economic, etc.)?
    b. The Governor of California issued an Executive Order requiring sales of all new passenger vehicles to be electric by 2035 and additional measures to eliminate harmful emissions from the transportation sector. How does your design relate to California’s goal?
2. Submit your responses to the questions in this challenge and your social media template to Julie Miller Kalbacher at jamiller@mwdh2o.com.

Appendix:

Parts List (* All radii are the outermost radius.)

Item:	Length	Width	Height/Thickness	Radius
000 - Coroplast Frame	4.71in	2.75in	0.15in	-
002 - Screw Eyes	0.8in	-	0.1in	1.75in
003 - Wood Block	2.73in	0.4in	0.4in	-
004a - Shorter axle shaft	3.45in	-	-	0.085in
004b - Longer axle shaft	3.75in	-	-	0.085in
004c - Tweazle stick	1.45in	-	-	0.085in
005 - Wooden Wheels	-	-	0.1in	0.75in
006 - Sandpaper	2.78in	2.3in	-	-
007 - Tubing	2.4in	-	-	0.1in
008 - Pulley	-	-	0.2in	0.5in
009 - Motor	-	-	-	0.45in
010 - Motor Mounting Clip (BASE)	1in	1in	0.05in	-
011 - Elastic Bands	-	-	0.05in (no tension)	-
012 - Solar Panels	2.75in	2.55in	0.1in	-

Social Media Post Template

Logo (optional)	**Company Name - Name - Position**

Image of ZEV:
Caption:

Energy for What's Ahead

Judging Criteria

Zero Emission Vehicle Challenge

- Creativity (0-5)
- Effectiveness (0-5)
- Practicality (0-5)

Category	5	3	1	0
Creativity (score x 5)	Vehicle is almost unrecognizable from the base model and has creative replacements.	Vehicle has many different changes in design and composition.	Vehicle features some minor changes in design.	Essentially made the kit version.
Effectiveness~ Velocity (score x 10)	Vehicle travels fast, without turning.	Vehicle travels at a moderate speed, with good direction.	Vehicle travels slowly and not in a straight line.	Vehicle does not move.
Effectiveness ~ Hauling (score x 10)	Vehicle travels distance with full load, without turning or stalling	Vehicle travels with full load most of the distance with good direction.	Vehicle travels but cannot make it with full load	Vehicle does not move