

Wind Energy Challenge

Level/Grade: 6th, 7th/8th, 9th/10th, 11th/12th

Teams: 2-3 students per team

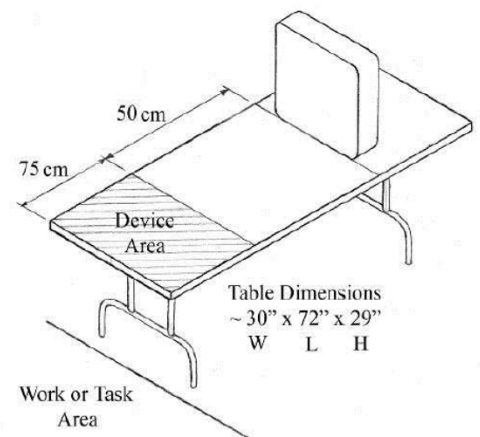
Overview: Students build a Windmill solely powered by a fan with the objective to lift a mass of the students' choosing

Materials:

- Students may use any materials as long as they are not hazardous
 - Students will choose their own mass to lift with their windmill
- A box fan will be provided by the Pacific MESA Center
- A standard 6-ft table will be provided

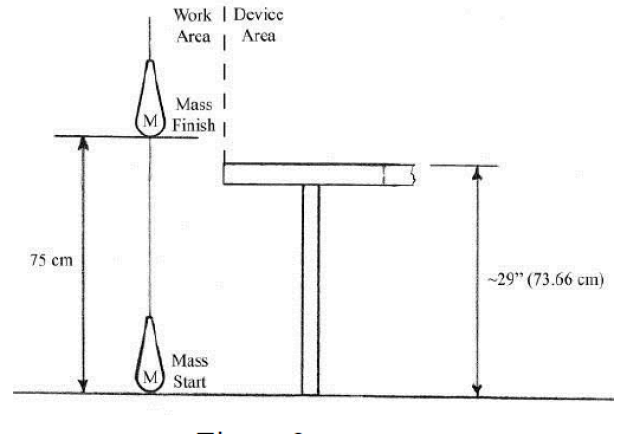
Rules:

1. Teams must research windmills then design, build and operate their own windmill device.
 - a. Device includes all parts necessary to capture wind energy to lift the chosen mass
 - b. Device may include multiple turbine assemblies
2. The device must be **solely** powered by the wind energy from the provided box fan
 - a. No additional energy may be applied
3. Once trial begins, teams may not have contact with anyone other than the judges until the end of their trial.
 - a. i/e: students cannot receive help from teachers, onlookers, etc.
4. Fan, Device, Working Area:
 - a. Approximate dimensions of the 6-ft table will be: 30" x 72" x 29"
 - b. All parts of the windmill device must remain behind a line 75 cm from the end of the table.
 - c. The device area shown is intended as a platform for the devices.
 - d. The device may extend off the table edges to the sides and into the working area to complete the task.
 - e. Devices **may** be taped to the table surface.
 - f. Teams may not touch their device once the trial has begun.
 - g. Teams will be given 2 minutes to configure their device before each trial.



5. Raising the Mass (Mechanical Power)

- a. The shape and volume of the object(s) and windmill device design must allow the object(s) to be raised from contact with the ground to a point completely above the target height of 75 cm.
- b. The teams provide their own object to be raised.
 - i. They will select the mass and shape for this object.
- c. Judges will weigh the detachable object and record the mass.
- d. Teams will be allowed 2 minutes to setup their device and mass for each trial.
- e. Fan speed will be set to high.
- f. Judge will use power strip to start the box fan wind source and start the timer.
- g. Judge will stop the timer when the entire mass is above 75 cm and record the time it took to get to that point.
- h. Judge will use power strip to stop the box fan wind source.
- i. The object's mass and the time taken to lift the object will determine the power achieved (mJ/s).
- j. The mass must be raised above the table in one (1) minute or less.
- k. Objects failing to reach 75 cm receive zero mass for that trial.
- l. Two trials will be recorded and the best performance is used in scoring.



Task Details:

Design Efficiency:

- The device mass will be measured as part of the device inspection.
 - All parts used to complete the tasks will be included **except** the object to be lifted and tape used to secure the device during performance.
 - The total performance score from the task will be divided by the mass in kilograms to determine device efficiency in points per kilogram.

Assigning Points to Performance

- The total performance score will be determined by the highest Team Power Score
- Using the mass of the lifted object and the time to lift the object, Team Power Score will be calculated in mJ/s

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Calculations:

- Team Power Score (P_{tm}) = (Trial mass [grams] / Trial time) x (9.8m/s²) x (0.75 m) [units: mJ/s]
 - Note: Trial mass is the mass of the object being lifted

Judges:

- Record the mass of the device before students begin setting it up.
- Record the mass of the object being lifted.
- Start the stopwatch as soon as you switch the power strip to the fan on.
- Stop the stopwatch as soon as the object is lifted above the table.
- Record the time to lift the object on the rubric.
- Calculate each teams' power score
- The team with the highest power score is the winner
- In the event of a tie, the lightest device will win

Team Member Names/Grades:

Judging Rubric

Wind Turbine

School:

Middle School or High School

6th 7th/8th 9th/10th 11th/12th

Mass of Device: _____ g

Trial 1:

Mass of lifted object (Trial Mass): _____ g

Time to lift object (Trial Time): _____ s

Team Power (P_{tm}) = ($\frac{\text{_____}}{\text{Trial mass}}$ / $\frac{\text{_____}}{\text{Trial time}}$) x (9.8 m/s²) x (0.75 m) [mJ/s]

Trial 1 Team Power (P_{tm}) = _____ mJ/s

Trial 2:

Mass of lifted object (Trial Mass): _____ g

Time to lift object (Trial Time): _____ s

Team Power (P_{tm}) = ($\frac{\text{_____}}{\text{Trial mass}}$ / $\frac{\text{_____}}{\text{Trial time}}$) x (9.8 m/s²) x (0.75 m) [mJ/s]

Trial 2 Team Power (P_{tm}) = _____ mJ/s

Best Trial:

FINAL TEAM SCORE = _____ mJ/s

*highest score wins