

Zip-A-Dee-Doo-Dah

Grades: 2nd - 5th

Team Size: 1-3 competitors

Duration: 30 minutes

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Summary Description

Given a few household materials, each team will construct a cable car capable of safely carrying a ping-pong ball down a zip line. The objective will be to achieve a target run time which will be revealed on the day of the event. There will be a short written portion testing the physics concepts of the zip line, including an average velocity calculation.

Concepts Covered

- Physics concepts for zip line (friction, air resistance, gravity, average velocity)
- Creativity and flexibility in building a cable car with materials unknown in advance
- Teamwork

Rules/Competition Format

This event will take place in one large room. Each team will have a table for building and modifying their cable car, and may use one of two frames for testing the cable car.

Phase 1: Written Test (Grades 4 & 5 only)

Duration: 5 minutes

- The test will consist of 2-3 multiple choice questions and 1 free response question. The multiple choice questions will test the physics concepts of the zip line (friction, air resistance, gravity). The free response question will be an average velocity calculation using sample data.
- The average velocity should be calculated along the zip line, and all data will be given according to this axis (no trigonometric calculations necessary!). The formula for average velocity is $v_{avg} = \Delta x / \Delta t$, where Δx is change in position and Δt is change in time. This formula will **not** be provided on the test.
- The sample data will be in SI units, and the final answer should be provided in SI units as well.

Phase 2: Building the Cable Car

Duration: 8 minutes

The following materials will be provided to each school on the day of the competition:

- scissors
- tape
- glue
- calculator
- zip line harness

A **subset** of the following materials will also be provided:

- 3oz Dixie Bath Cups
 - straws
 - construction paper
 - washers
 - cardboard tubes
 - paper clips
 - yarn
 - zip ties
 - rubber bands
 - pipe cleaners
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- Using the materials listed, each team will build a cable car. The cable car will have to carry a ping-pong ball safely down the zip line.
 - Target time and zip line dimensions will be disclosed to teams in this area.
 - There will be 2 test zip lines in the build area of the room. This test line will not have the same dimensions as the competition zip line, but can be used, if teams wish, to ensure their cable car slides as they wish it to do.
 - Each team is free to use any of the materials provided for the cable car, but should keep in mind that
 - Each team will have no longer than 30 seconds to attach the cable car to the harness.
 - Since there will be multiple runs, the cable car must be able to be returned to a “ready position” quickly.
 - When the teams are satisfied with their cable car, they may queue for Olympiad Zip line.

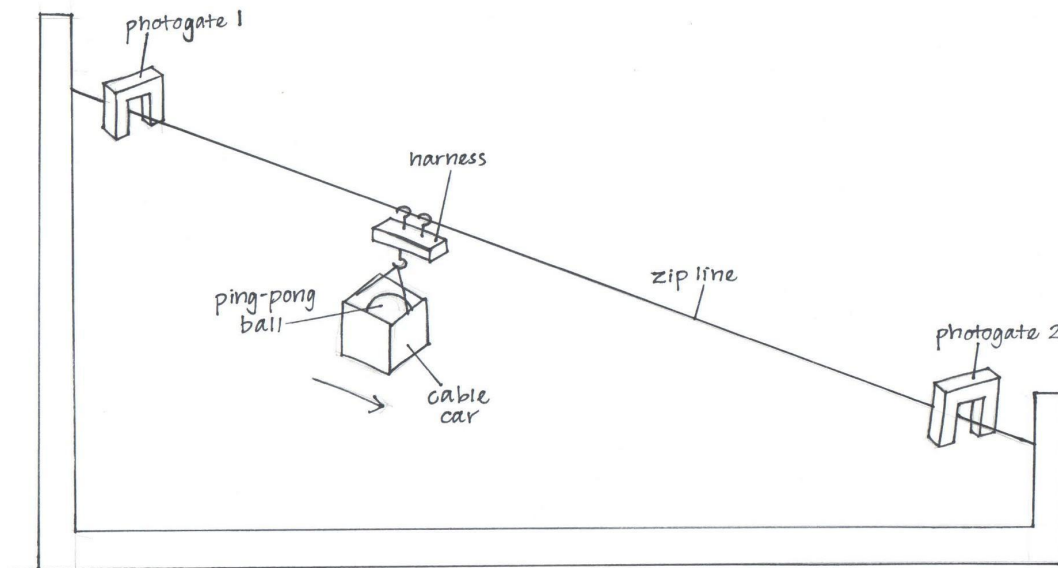
Phase 3: Testing and Modifying the Cable Car

Duration: 15 minutes

- One area of the room will contain two zip line setups. Each team will perform 3 cable car runs. They may use any of the zip lines they wish, but may find more consistency if they do all of their runs on the same line.

- Each team will have no longer than 30 seconds to place the ping-pong ball in the cable car and attach their cable car to the harness on the zip line. Teams will release their own cable car. A step ladder will be positioned by the start for teams that need it. Volunteers will write the run time on an index card and return it to the team. Each team will then be responsible for detaching their cable car from the zip line.
- After the first and second runs, each team will have no longer than 2 minutes to modify their cable car as needed. No extra materials will be provided; each team is responsible for rationing their original materials.

Zip Line Setup



The runtime of the cable cars will be measured using a system of two photogates (<http://www.arborsci.com/timer-and-photogates.html?ff=4&fp=636>). The zip line frame is constructed from Unistrut beams to provide rigidity and allow for flexibility in length and drop. The zip line itself is Hillman Fasteners invisible cord (15 lb rating).

The vertical drop of the zip line will be about 1.2-1.5 meters (4-5 feet) and the horizontal distance covered between the photogates will be 3.0-4.6 meters (10-15 feet). The height of the cable car should not exceed 0.3 meters (1 foot), as that will be the approximate distance from the second photogate to the base of the setup. The line will be tensioned to approximately 5 lbs.

Scoring

Each team score will have two components:

Cable car score: Only the best run time (closest to the target time) of the three trials for each team will be considered. The team(s) with the least deviation from the target time will be given a cable car score of 1. The team(s) with the second lowest deviation will have a score of 2, and so on.

Written test rank (grades 4&5): Teams will be ranked based on their written test score, with the highest scoring team(s) receiving a rank of 1.

The final score for each team in grades 4&5 will be computed as follows:

$$\text{Final score} = \text{cable car score} + 0.2 * \text{written test rank}$$

The team with the lowest final score will be the winner.

The following penalties will apply:

Runs where the cable car does not successfully traverse the entire distance of the zip line or where the ping-pong ball falls out of the cable car will **not** be considered in determining that team's best time. Teams will **not** be permitted to rerun their cable cars in these cases.

Tie Break Criteria

In the case that teams have the same final scores, the range of the three run times will be used as a tiebreaker. The team with the lowest range will win the tie. If any of the participating teams have one or more penalties, the following rules will apply:

- The team with the most penalties automatically loses the tie.
- If there are multiple teams with the same number of penalties, the team with the lowest run time range over the non-penalized trials will win the tie.
- The written score will be used to break the tie as a last resort for grades 4 and .

Materials Distributed by WESO

- Invisible Cord for Zip Line (Hillman Fasteners Invisible Cord, 25foot long, 15lb rated). Available at many local hardware stores (Stadium Hardware, True Value, etc.)
- Cable Car Harness (1.5" x 3" Komatex block with 2 cup hooks for Zip line and one cup hook to hang the cable car).

Additional Materials useful for practices

- See list of potential materials

- Scissors
- Ping Pong Ball
- Photogate system or other timer. We are using <http://www.arborsci.com/timer-and-photogates.html?ff=4&fp=636>. The students will not be interacting with the Photogate system.

Materials to be brought to competition

n/a

Additional Resources/References

Open practice times on the competition equipment will be announced. Sign-up for the updates blog and/or visit wesoscience.org for specific dates.

Reference video from Zip-A-Dee-Doo-Dah Workshop:

<https://www.youtube.com/watch?v=FbI54LYZ3bU&t=2s>

? Event Questions

Event Coaches should submit any questions about the event to weso.events@gmail.com. Please enter the event title in the subject line. Answers will be posted on the WESO Blog. You can sign up to receive blog posts at <https://wesoscience.org>.

Example Question

What force causes the cable car to accelerate down the zip line?

- a). Friction
- b). Gravity
- c). Air resistance (drag)
- d). Spring force