

THE RISE OF THE LEGENDS

Sail Car STEM Activity

When George Mendoza sails solo to the mysterious island of Anuhe´ to uncover the source of the voice the Legends heard on the crystal radio, he relies on more than courage — he uses real sailing science to get there and back. He reads the wind, trims his sail to the right angle, times the tides, and navigates through fog using dead reckoning and triangulation.

The same forces at work on his boat — wind, lift, drag, and friction — are the ones you'll explore in this project using sail-powered cars. You'll discover why sail angle matters more than wind strength, how sailors can move *toward* the wind by zig-zagging in a technique called tacking, and how physics and smart thinking together can get you where you're going — even when the wind isn't cooperating.

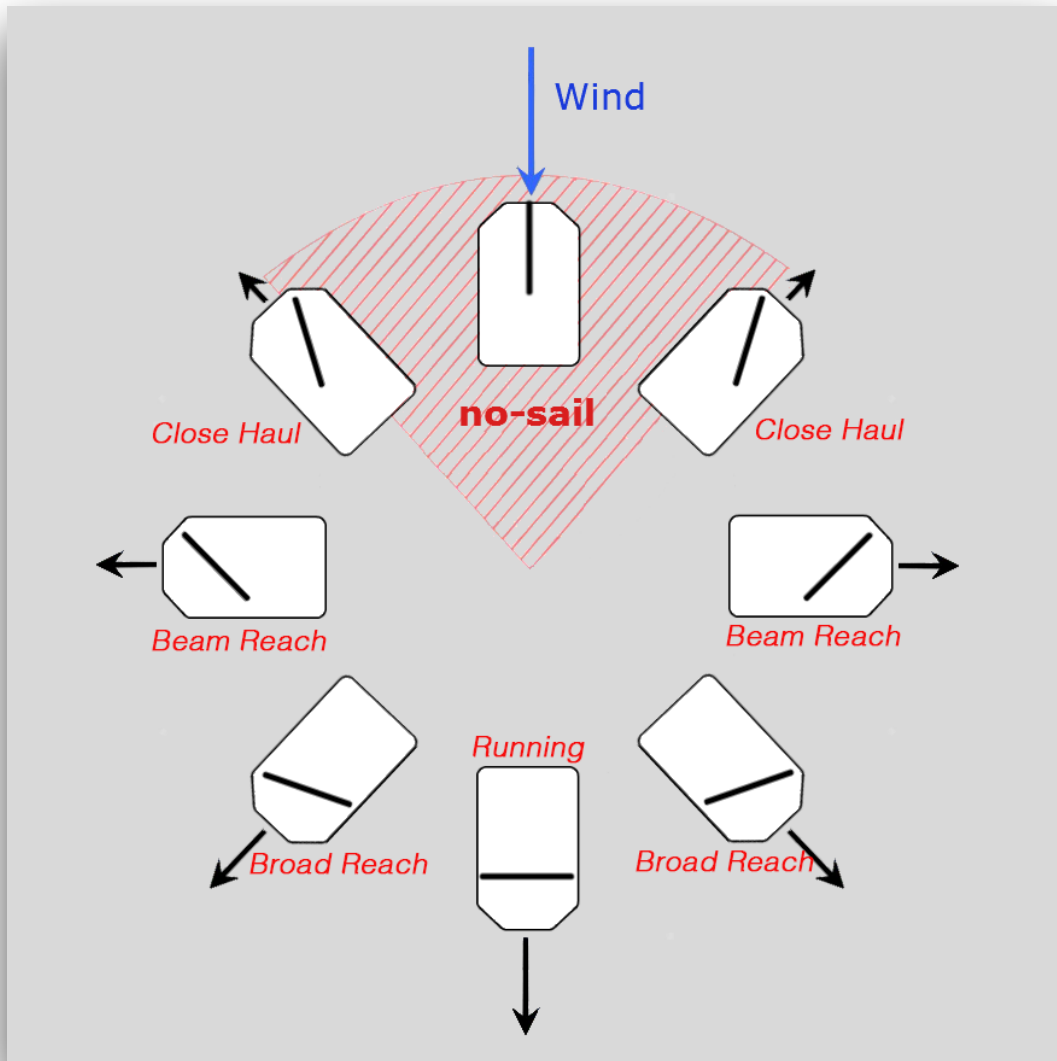
Points of Sail — The different directions a boat (or sail car) can travel relative to the wind, each requiring a different sail angle. From "Close Haul" (angled sharply into the wind) to "Beam Reach" (wind from the side, the fastest point) to "Running" (wind from behind), every point of sail is a physics lesson in action.

Tacking — The zig-zag technique sailors use to travel upwind. Since no vessel can sail directly into the wind, sailors angle across it first one way, then the other, making forward progress toward their destination with each turn.

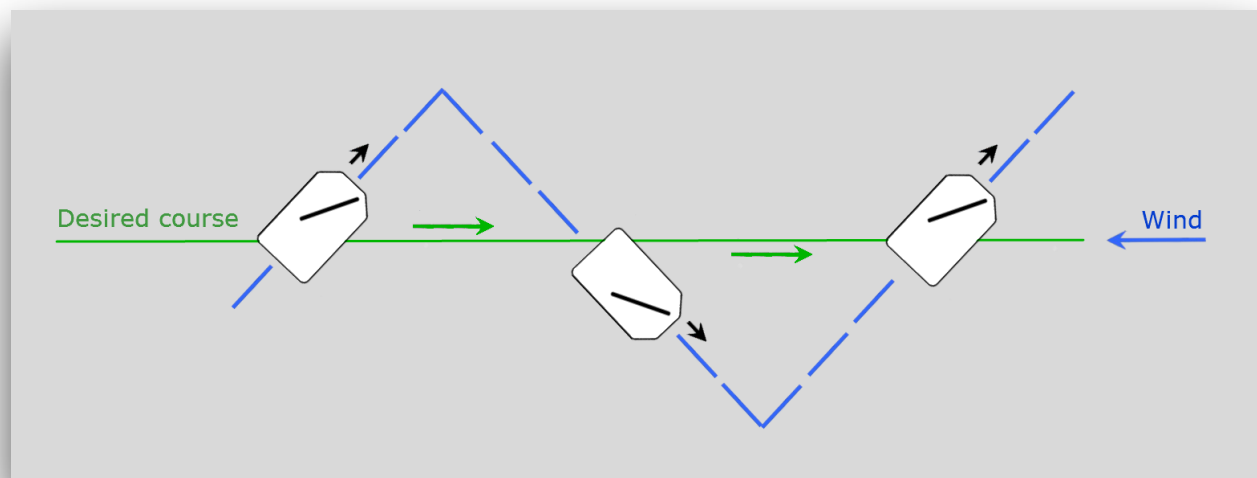
You'll need a sail car such as the one pictured below to complete this project. This one is available from Teacher Geek.



Positions of Sail



Tacking



Sailing Fundamentals Program

Lesson 1: Wind & Motion Basics

Concept: Newton's Laws of Motion, Forces

Activities:

- Intro Demo: Blow on a piece of paper vs. a sail-shaped object— observe movement.
- Build & Test: Assemble basic sail cars.
- Experiment: Use a fan to push sail cars at different wind speeds and measure distance/speed.
- Discussion: Which forces are acting on the car? What makes it move?

Key Vocabulary: Force, Motion, Friction, Air Resistance

Lesson 2: How Sails Work – Push vs. Lift

Concept: Bernoulli's Principle, Airfoil effect

Activities:

- Demo: Compare flat sail vs. curved sail.
- Experiment: Test different shaped sails (flat, curved, angled) and compare performance.
- Diagram Tie-in: Use diagram to show how angle to wind affects performance.

Key Vocabulary: Lift, Drag, Airfoil, Bernoulli's Principle

Lesson 3: Points of Sail

Concept: Optimal sail angles for different wind directions

- Activities:
- Mini-Lecture: Use diagram to explain points of sail.
- Experiment: Place sail cars at different wind positions and observe movement.
- Chart Activity: Record how well cars moved in each position.

Key Vocabulary: Points of Sail, No-Sail Zone, Apparent Wind

Lesson 4: Tacking & Sailing Upwind

Concept: Zig-zag (tacking) to move against the wind

Activities:

- Diagram Review: Explain tacking and the no-sail zone.
- Experiment: Try to reach a destination using tacking maneuvers.
- Challenge: Who can reach the upwind goal in the fewest tacks?

Key Vocabulary: Tacking, Windward, Leeward, No-Sail Zone

Lesson 5: Design Challenge & Race Day!

Concept: Engineering, Optimization, Teamwork

Activities:

- Final Challenge: Redesign or optimize sail cars.
- Race Events: Sprint (Running), Zig-zag (Tacking), Curved course.
- Wrap-up Reflection: What worked best?

Key Vocabulary: Optimization, Efficiency, Sail Design

Sail Car Instructor Cheat Sheet

1. Newton's Laws of Motion

- Things move when forces act on them.
- Wind is the force pushing the sail car.
- Friction and air slow it down.

2. Forces on a Sail Car

- Wind Force: Pushes forward.
- Friction: Slows down.
- Air Resistance: Slows down.
- Lift: Helps pull forward if angled correctly.

3. How Sails Work

- Sails can both push and pull.
- Curved sails create lift.
- Angle matters!

4. Points of Sail

- No-Sail Zone: Directly into the wind.
- Close Haul: Sharp angle, slow but powerful.
- Beam Reach: Fastest.
- Broad Reach: Good speed.
- Running: Wind from behind, OK speed.

5. Tacking (Zig-Zagging Upwind)

- Can't sail directly into the wind.
- Zig-zag (tack) back and forth to move upwind.

6. Quick Instructor Tips

- Ask: 'Where is the wind coming from?'
- Use push/pull terms.
- Let them experiment.
- Celebrate small wins!