Racing with the Wind

Objectives
Students will be able to:

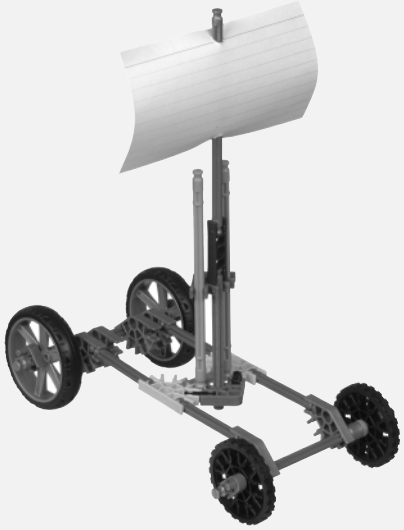
- Identify ways to increase the kinetic energy of a wind-powered vehicle.
- Design and implement a "fair test" procedure to test the impact of inferred variables.
- Create and interpret appropriate data displays.
- Apply knowledge to solve a new problem.

Materials
Each group will need:

- K'NEX Education Forces, Energy and Motion materials
- Building Instructions Pages 6-7: Wind Racer (or CD-ROM file)
- File cards (3 x 4, 4 x 6, 5 x 8)
- Hole punch for preparing the file cards
- Masking tape
- Box fan/fans
- Adding machine tape
- Graph paper
- Metric tape
- Stop watch or clock with second hand
- Copies of:
  Student Response Sheet 13
  'The Wind Bag Express' Design Brief

You will need:

- Completed model of the Wind Racer
- A box fan



Time to Build:
Less than 15 minutes

Length of Lesson:
45 - 50 minutes

Design Brief:
1 x 45 minutes

Process

Engage

1. Set up the Wind Racer model in front of a box fan. Ask the students to:
   - Observe the wind powered racer being pushed by a current of air from the fan.
   - Make suggestions regarding the potential and kinetic energy of the vehicle and how that energy is transferred. Field the student responses and record their ideas.
   - Discuss, in their teams, two ways to increase the kinetic energy of the wind-powered racer and consider **how they could tell that the kinetic energy was increased.** *(Measure the speed.)*
   - Report their ideas back to the class. Record the students' thoughts, and query them as to their rationale.

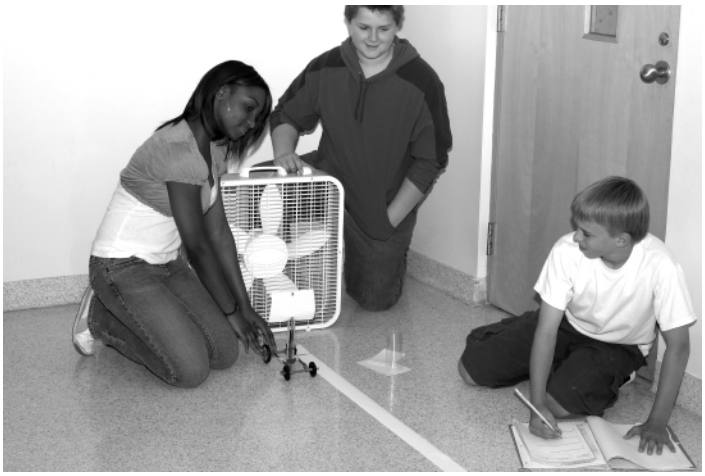
2. Distribute copies of **Student Response Sheet 13** once all teams have reported back.

Explore

3. Teams will select one of the Wind Powered Challenge Cards, then design and carry out a "fair test" procedure for answering their chosen question.

EXPLAIN

4. Students are individually responsible for communicating the results of their investigation through the construction of a graph and a written interpretation.



ELABORATE

5. If there are questions yet unanswered allot additional time to resolve these queries.

6. Once all questions have been answered it is time to share and compile the data obtained from each of the team investigations. You may want to use a large data chart, such as the one shown below, for this.

Increasing the Kinetic Energy of the Wind Powered Racer

VARIABLE INVESTIGATED	RESULTS
Size of card	
Type of sail material	
Etc.	

EVALUATE

7. The evaluation phase of this lesson focuses on a design brief.
   - In an attempt to produce the most efficient model, **'The Wind Bag Express' Design Brief** challenges students to employ two, or more, of the variables that have been proven to increase the kinetic energy of the wind-powdered racer.
   - Remind students of the design loop as this is an open-ended challenge and lends itself to multiple modifications of the designed model.

EXTEND

8. The wind powered racer lesson could be extended by asking the students to:
   - Create a wind-powered racer that is able to move in the slightest breeze.
   - Investigate the efficiency of hard plastic sails*.
   - Modify the wind-powered racer to work in a cross wind.

Teacher's Notes

* *These sails can be crafted easily from two-liter beverage containers:*

- *Cut off the top and bottom of the bottle leaving a plastic cylinder. The cylinder can then be cut in half lengthwise creating two curved sails.*
- *Have the students experiment with other shapes and sizes of these bottle sails.*
- *Keep safety in mind and provide safety glasses for students. It is strongly recommended that the teacher use a knife to create a slit in the top and bottom sections of the bottle as a "starter" so that the students do not have to force their scissors through the plastic.*

Name:_____

Date:_____

As a Team

1. Select one of the following challenge cards.

2. Design a "fair test" investigation to answer the selected question.

Note: Your team also has the option of creating a question.

Wind-Powered Challenge Cards

Does the size of the sail - 3x5, 4x6, and 5x8 - increase or decrease the kinetic energy of the wind racer?	Does the shape of the sail make a difference in the kinetic energy of the wind racer? *Note: To be a fair test, the area of each shape must be the same.*
Does the speed of the fan make a difference in the kinetic energy of the wind racer?	Does the orientation of the sail, vertical or horizontal, make a difference in the wind racer's kinetic energy?
Does its placement in front of the fan make a difference in the racer's kinetic energy?	Will the speed of the fan change the kinetic energy of the wind racer?
Will the type of sail material, such as cloth, paper, or plastic, make a difference in the kinetic energy of the wind racer?	Will a curved or folded sail increase the kinetic energy of the wind racer?

Name:_____

Date:_____

EXPLORE

3. Write out your "fair test" plan of action using the outline below. Be sure to use complete sentences in your answers so that this outline can be used as your lab report.

   a. Which question will your team investigate?

   b. What materials will you need to answer this question?

   c. Which variables do you think should be held constant?

   d. Which variable will you make your independent variable? Which will be your dependent variable?

   e. What kind of information (data) will you collect? How will you know that the kinetic energy of the racer has changed?

   f. How many trials will your team conduct?

   g. How will you display this data? Show your display here.

Name:_____

Date:_____

Explain

On Your Own

4. Use your team's data to construct a graph. (Your teacher will provide the graph paper for this activity.)

5. Describe the results of your investigation:

Elaborate

6. What other changes can you suggest that might increase the kinetic energy of your wind-powered racer?

'The Wind Bag Express' Design Brief

The Context:
Each time oil prices increase, inexpensive and alternative sources of energy attract more attention.

The Scenario:
The popularity of hybrid cars and alternative fuels is helping our country become less dependent on oil as an energy source. Wind energy is also growing in popularity as a way to generate electricity. Could the power of the wind be harnessed to help power our cars as well?

The Challenge:
There are places in our country where the wind blows much of the time and your research company, 'Geeks Galore,' has decided that a car with wind-powered capabilities would be a viable project to investigate. Prior tests with wind-powered models have confirmed that certain variables can increase the kinetic energy of such a car. Your challenge is to apply this previous research to create the fastest wind powered vehicle possible.

The Limitations:

- Each team will have a total of three lesson periods for this project:
  - 1 lesson to design and create an action plan.
  - 2 lessons to construct, test, and refine the wind racer design.
- Teams may use any materials to construct their vehicle.
- Vehicles must stay inside the track (two strips of adding machine tape 60 cm apart).
- Final time trials, consisting of a single run, will be conducted at the end of the third lesson period.
- All teams will be responsible for computing and averaging the speed of all the racers.

The Rules:

- Every team member must keep a 'Wind Bag Express' Journal. All design changes, sketches, test results, data, conclusions, and ideas for further modifications should be recorded.
- There are no weight requirements for the vehicle.
- Teams will be responsible for supplying additional materials.
- Should the vehicle stray off the track, a 1-second penalty will be added to the total vehicle travel time.