Santa's Windy Dilemma

NGSS:

Middle School (Grades 6-8):

- **MS-PS3-1**: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and its speed.
- **MS-PS3-5**: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
- **MS-ETS1-2**: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

High School (Grades 9-12):

- **HS-PS3-3**: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- **HS-ETS1-3**: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics.

Time Period: 120 minutes

1. **Introduction and Explanation (15 minutes):**
   - Introduce Santa's problem and explain the objective, materials, and constraints.
   - Briefly discuss energy concepts (potential and kinetic energy, joules, wind energy).
2. **Design Phase (30 minutes):**
   - Students brainstorm and sketch designs.
   - Use "Santa Bucks" to purchase materials and start building.
3. **Build Phase (35 minutes):**
   - Students construct their wind propeller systems and attach them to their sleighs.
   - Instructors provide guidance as needed.
4. **Testing Phase (20 minutes):**
   - Each team tests their design using the energy sensor and fan.
   - Record results and observe how designs differ in performance.
5. **Reflection and Award Ceremony (20 minutes):**
   - Discuss what designs performed best and why.
   - Announce winners and distribute Santa's Cookies and other awards.

Opening Story: example

It was a crisp December evening at the North Pole. Santa sat in his workshop, stroking his beard and staring at the weather reports coming in from around the world. The forecast was not good—howling winds were predicted for Christmas Eve.

“These winds are going to slow down my sleigh!” Santa exclaimed. “If I can’t stay on schedule, children won’t wake up to their presents on Christmas morning!”

Mrs. Claus, always full of good ideas, chimed in. “Why not use the wind to your advantage, dear? If we could find a way to harness it, your sleigh could fly faster and smoother than ever!”

Santa’s eyes twinkled with excitement. “You’re right, my love! But who could help me figure that out?”

Just then, one of the elves ran in, holding a stack of letters from schools all over the world. “Santa, look! These students have been studying energy and wind power. Maybe they can help solve your problem!”

Santa smiled. “Perfect! We’ll ask them to design a wind-powered propeller system to help my sleigh soar through the storm. The system with the best energy output will get a special reward—Santa’s Cookies, straight from Mrs. Claus’s kitchen!”

And with that, the challenge was set. Santa sent word to classrooms everywhere: *"Help me save Christmas by designing a wind propeller system that can generate the most energy! Let’s see your creativity and engineering skills in action!"*

Santa's Wind Challenge: Power Up the Sleigh!

Group Name: _____

Team Members: _____

Date: _____

Part 1: Setting the Scene

Santa needs your help! Strong winds are expected on Christmas Eve, and his sleigh might struggle to stay on course. Your challenge is to design a wind-powered propeller system to give his sleigh the extra boost it needs.

The system must:

1. Generate measurable energy using a wind turbine and energy sensor.
2. Be creative and efficient in design.
3. Produce the most joules to win Santa's Cookies!

Part 2: Planning Your Design

1. Sketch Your Propeller Design

Draw your propeller system below. Label each part and include the materials you plan to use.
Sketch area

2. Materials List
List the materials your group will use for the propeller system:

Material	Quantity Needed	Purpose (e.g. structure, blade design)

Part 3: Prediction

How many joules do you predict your design will generate?

Prediction: _____ joules

What makes you confident in your design? *Write your explanation here:*

Part 4: Testing Your Design

Testing Procedure:

1. Set up your wind propeller system with the energy sensor.
2. Position the system in front of the fan.
3. Run the fan for 30 seconds.
4. Record the joules generated.
5. Repeat the test twice more and calculate the average.

Testing Data Table:

Test #	Joules Generated	Observations (e.g. blade performance, stability)
Average:	_____Joules	

Part 5: Reflection and Improvement

1. What worked well about your design?

Write your answer here:

2. What would you change to improve your design?

Write your answer here:

3. What did you learn about wind energy and design efficiency?

Write your answer here:

Bonus Challenge

If you could redesign Santa's entire sleigh to make it more energy-efficient, what would you change?

Write your answer here: