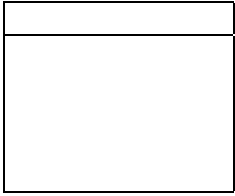
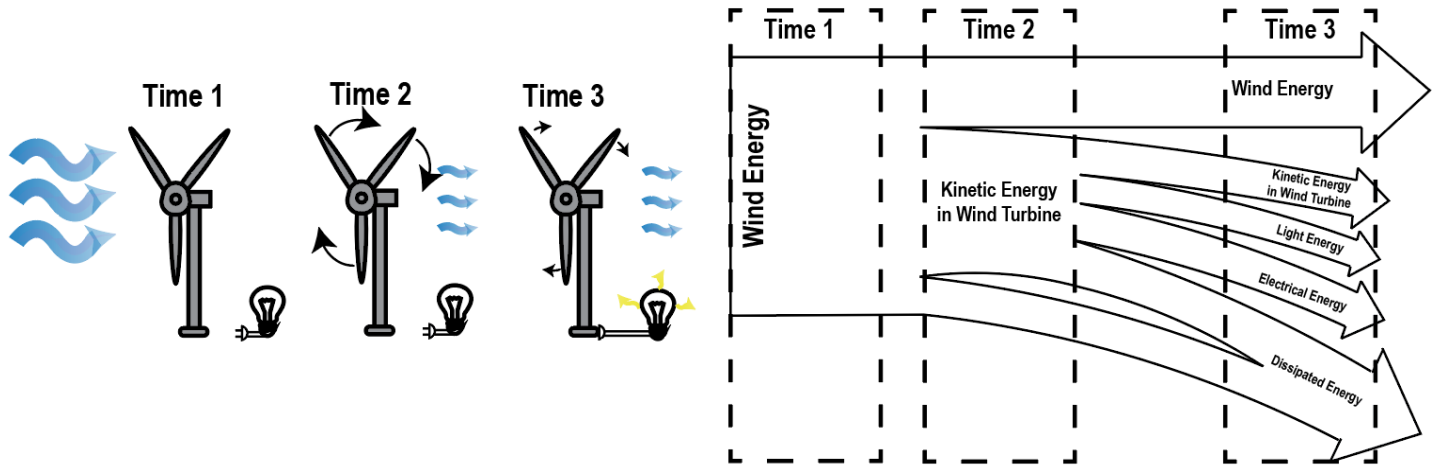


## 6Q2 - Quiz on the Physics and Design of a Wind Turbine



Name: \_\_\_\_\_  
 Period: \_\_\_\_\_  
 Date: \_\_\_\_\_

The image below left shows at **Time 1** a gust of wind travels towards a wind turbine, at **Time 2** the gust of wind has passed and the generator and light bulb are not plugged in, lastly at **Time 3** the generator is on and the light bulb plugged in. The image below right shows a Sankey diagram of the wind turbine described. Use the images below to answer questions 1-4.



1. Use the Sankey diagram to estimate the overall efficiency of the wind turbine.  
 A. 15%      B. 40%      C. 65%      D. 90%
2. Which of the changes below would BOTH create a more efficient wind turbine?

	Wind Energy being harnessed to turn blades (Time 1 to Time 2)	Turbine converting kinetic energy into electrical energy (Time 2 to Time 3)
A.	Wind turbine placed in a location with higher wind energy.	A more efficient light bulb is plugged in.
B.	Wind turbine placed in a location with higher wind energy.	The generator is lubricated to reduce the dissipated energy.
C.	Blades are curved to capture more of the wind's kinetic energy transferring it to the wind turbine's kinetic energy.	A more efficient light bulb is plugged in.
D.	Blades are curved to capture more of the wind's kinetic energy transferring it to the wind turbine's kinetic energy.	The generator is lubricated to reduce the dissipated energy.

3. Applying your learning to a large scale wind farm, which of the following factors would likely increase its power output?
 

a. More wind turbines b. More efficient wind turbines c. More input wind energy d. More output wind energy e. More kinetic energy in the wind turbine	f. Less energy needed by consumers g. Less electrical energy out h. Less dissipated energy i. Less efficient generators j. Less direct sunlight
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4. The wind farm has now installed more efficient generators. Mark on the Sankey diagram between Time 2 and Time 3 above:  
 + For an arrow that will grow      = For an arrow that will stay the same size      - For an arrow that would shrink

**Communicating your Design Choices**

## Claim, Evidence, Reasoning for Wind Turbine Design

The City of Tigard would like to build a more efficient wind turbine on Bull Mountain. They plan to use the existing tower, but would like to replace the old blades with blades that will be able to produce more power. The following data was taken by an apparatus that was slightly different from our original towers. Use the following data and pricing to design the optimal wind turbine to generate power of at least 75 Watts within a \$25,000 budget.

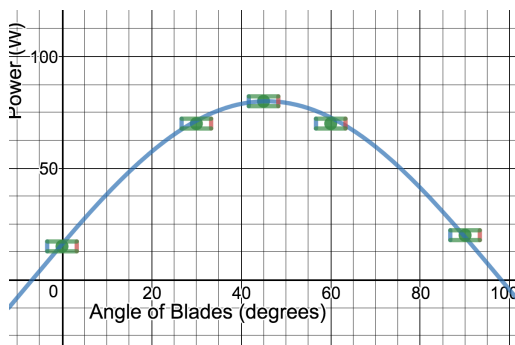
**Figure 1: Material Costs**

Number of Blade Holders (# of Pegs)	Total Cost of Blade Holders (\$)
2	5,000
3	7,500
4	10,000
6	12,500

Total Area of All Blades (cm <sup>2</sup> )	Total Cost of Paper on All Blades (\$)
50	10,000
75	15,000
100	20,000
125	25,000

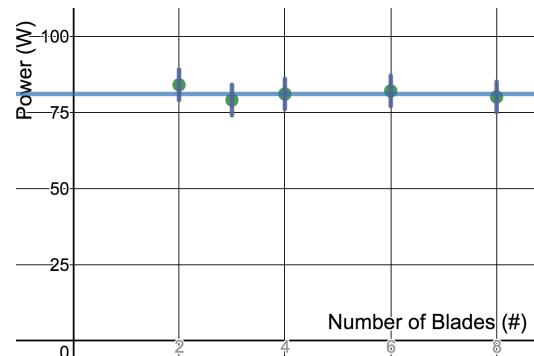
**Graph 1: Power vs Angle of Blades**

(controlled: 2 blades with a total area of 80 cm<sup>2</sup> and no curvature)



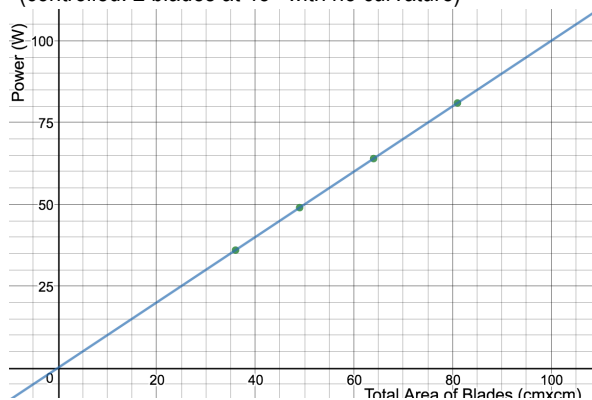
**Graph 2: Power vs Number of Blades**

(controlled: Total area 80 cm<sup>2</sup> and blades at 45° with no curvature)



**Graph 3: Power vs Total Area of All Blades**

(controlled: 2 blades at 45° with no curvature)

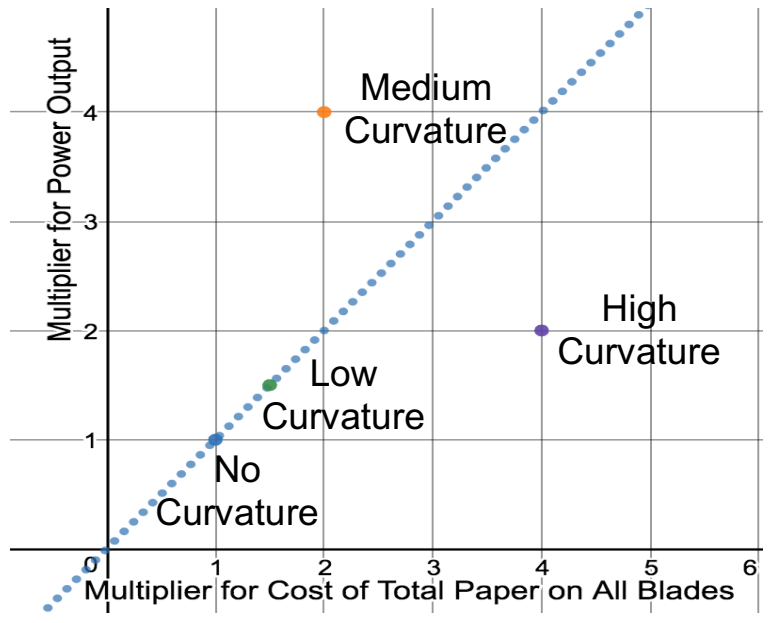


1. For this question you will use the claim, evidence, reasoning format to communicate your wind turbine design; specifically including the total area of the blades, the angle of blades, and the number of blades.

Claim. Evidence. Reasoning.

After creating your first design above, a new technology is developed to curve blades that you may want to consider incorporating into a your design proposal. Graph 4 below shows how the curvature multiplies the power output versus how the curvature multiplies just the cost for the total area of blades (paper).

**Graph 4: Multiplier for Power Output vs Multiplier for Cost of Curvature of Blades**  
(controlled: 2 blades with total area of 100 cm<sup>2</sup> at 60°)



2. For this question you will use the claim, evidence, reasoning format to communicate only what changes you would make to your original design described above in question 1 in light of this new information about the effects of curvature.

Claim. Evidence. Reasoning.

Rubric	4	3	2
Claim	The design recommendation describes a wind turbine that optimizes the power. (2.5)	The design recommendation describes a wind turbine meets the power criteria for three parameters. (2)	The design recommendation describes a wind turbine that almost meets the power criteria. (1)
Evidence & Reasoning	+ Cites evidence and reasoning in communicating a design that accurately accounts for all trade-offs between price and performance. (1.5)		Cites evidence and reasoning in communicating a design that accounts for the blade angle and number of blades. (1)

**Helpful Consideration:** Use the color keyed instructions below to develop you CER paragraph

**Claim:** Write a sentence stating the parameters that would best create an optimal design.

**Evidence:** Summarize relevant data or trends in the graphs that inform your claim.

**Reasoning:** Write a statement that explains how your evidence leads to your claim about your design.

Optional, helpful sentence starters...

I claim the optimal design is ...

My first piece of evidence is ... that shows ...

Since .... my design recommendation is ....

My second piece of evidence is ... that demonstrates ...

Considering this and ... , I recommend building a wind turbine with ....

My final piece of evidence is ... which establishes that ...

Therefore the optimal design should have ...

Additional Optional, helpful sentence starters...

Under the given criteria and constraints the optimal design of the wind turbine is ...

Graph 1 shows that, given all other parameters equal, the optimal ... , because ...

Considering this and the fact that ... my design recommendation for ...

Graph 2 indicates that ...

In light of this and ..., I recommend building the wind turbine with ...

Graph 3 reveals a ... pattern between ....

Considering this pattern and the budget I recommend ... so the overall design will have a power ...