Math Extension Activity: Penny Power

Students will collect and calculate the power of their turbine.

Additional Materials: Timer, calculator, Penny Power Student Worksheet

Note: If completing the extension activity, pennies must be the item put in the lift and students will need to time how long it takes for the cup to be lifted .5 meters.

Calculating the power of a wind lift is easy, but the formulas and units are probably not familiar to students:

FORCE = Mass x Gravity	The unit for force is **NEWTONS**.
WORK = Force x Distance	The unit for work is **JOULES**.
POWER = Work ÷ Time	The unit for power is **WATTS**.

Since energy is the ability to do work, you are calculating how much energy is needed to lift the weight. To figure out the power, you need to know how long it takes. If you do the same work (energy) faster, then you have more power. Power is measured in watts.

Force = mass (kilograms) X the force of gravity (9.8 m/s^2).

- To make finding the force less complicated, students should use the chart to calculate their FORCE. *NOTE: Pennies were measured in grams and the force was rounded for ease in multiplication.*
- Notice the pattern in the chart. With that pattern in mind, students should be able to calculate the force if their wind machine lifted 21 pennies. How about if it lifted 30 pennies?

Number of Pennies	Force (Newtons)
4	0.1
6	0.15
8	0.2
10	0.25
12	0.3
14	0.35
16	0.4
18	0.45
20	0.5

Work= Force (newtons) X Distance (meters)

- Work is a measure of the energy expended in applying a force to move an object.
- Work = Force (from the chart above) X .5 meters

Power = Work (joules) ÷ Time (seconds)

- Power is how fast you do work. If you dig a hole that is 2 meters wide and 2 meters deep and it takes you one hour to do it, you are not as powerful as a steam shovel that can dig the same size hole in 5 minutes.
- Power = Work (calculated above) divided the time it took to raise the lift.

Example: Let's try a sample calculation.

Sally's design lifted 16 pennies in 8 seconds. Let's calculate her wind lift's power.

Force	.4 newtons (from chart)
Work	.4 newtons X .5 meters = .2 joules
Power	.2 joules ÷ 7 seconds = .025 watts

On the datasheet, students record three trials. Calculations from sample data might look like this:

Trial	# of pennies	Force (newtons) Copied from chart	X	Length of string (meters)	=	Work (joules)	÷	Time (seconds)	=	Power (watts)
Design #1	**16**	**.4**		**.5**		**.2**		**8**		**.025**
Design #2	**10**	**.25**		**.5**		**.125**		**12**		**.010**
Design #3	**25**	**.625**		**.5**		**.313**		**9**		**.035**

Remember, when you enter the data on the KidWind portal, you will enter the weight lifted, not the force. If using pennies as your weight, each penny is 2 grams.

Name: _____

Penny Power Student Worksheet

Note: You will need the chart from your teacher to enter the Force

Trial	# of pennies	Force (newtons) Copied from chart	X	Length of string (meters)	=	Work (joules)	÷	Time (seconds)	=	Power (watts)
Sample	**16**	**.4**	X	**.5**	=	**.2**	÷	**8**	=	**.025**
Design #1			X	.5	=		÷		=	

Trial	# of pennies	Force (newtons) Copied from chart	X	Length of string (meters)	=	Work (joules)	÷	Time (seconds)	=	Power (watts)
Design #2			X	.5	=		÷		=	

Trial	# of pennies	Force (newtons) Copied from chart	X	Length of string (meters)	=	Work (joules)	÷	Time (seconds)	=	Power (watts)
Design #3			X	.5	=		÷		=	

Results:

Power for Design #1	
Power for Design #2	
Power for Design #3	