

Lesson 5	Gearing		
Level	Key Stage 2	Time required	1 hour
National Curriculum Links			
Science, Maths, English (view scheme of work for full details of links)			
Aims			
<ul style="list-style-type: none"> The students will discover size of cogs (gear ratio) affect the wind turbine's output 			
Resources required			
Pen, record sheet (one per group), Wind Turbine Kit, electric fan, safety goggles			
Web search keywords			
Wind turbine gears, cogs, gearing, gear ratios			

Task

The students are asked to experiment with gear combinations.

Bring in a bicycle with Derailleur gears and let the students have a look at the gears. Notice that with the same speed of rotating the peddles, the configuration of the gears enables the back wheel turn slowly with a lot of effort or fast with less effort. How do the students think they work?

Ask the students to set up the Wind Turbine Kit according to the instructions and connect the voltmeter. Set up an electric fan (ideally 15" diameter) as described in the activity sheets.

Instructions are included with the Wind Turbine Kit. These can be downloaded in PDF format from: http://www.ecostyle.co.uk/products/wind_turbine_kit/wind_turbine_kit_activity_sheets_v2.15.pdf

Once the fan is in position, do not move it or the Wind Turbine Kit. Ensure the fan is always used on the highest (fastest) setting. It is important to keep all these settings constant in order to achieve meaningful results.

From the students previous findings, ask them to select the most efficient number of blades and blade pitch.

Make sure the students have connected the turbine into the voltmeter. Explain that this simply tells us how much electricity is being generated by the turbine.

Ask the students to record their findings methodically. Test each gear combination at least twice to check and record.

The students will need to record the gear combination and the reading on the voltmeter.

Gear combinations

There are 5 possible gear combinations:

- 50-tooth gear and 10-tooth gear (5:1 ratio)
- 40-tooth gear and 20-tooth gear (1:2 ratio)
- 30-tooth gear and 30-tooth gear (1:1 ratio)
- 20-tooth gear and 40-tooth gear (2:1 ratio)
- 10-tooth gear and 50-tooth gear (1:5 ratio)

Changing cogs

It is easiest to change the cogs with the wind turbine hub face down against the table top. The cogs may be stiff the first time they are used and the students may need adult assistance.

Be careful not to push the gears on too far, either on the turbine shaft or the black motor pin: both should spin freely. If the black generator pin is pushed back against the white metal body, the generator will not spin freely. If this occurs, pull the black generator pin free with pliers.

Risk assessment

Ensure the rotor blades are pushed firmly into the rotor hub. If the rotor blade spokes become loose, squashing the spoke slightly with pliers will achieve a tighter fit. Safety goggles should be worn by students operating the equipment and by those in the surrounding area.

Suggestion

Ask the children to make their own record sheet. However, if you do need a record sheet you can use the one provided. You can also record this information on an Excel spreadsheet and show the children how to generate a graph of how output varies with different gear combinations. You could put all the results from several turbines onto one sheet.

Extension

Ask the children to represent their data by drawing a graph. Depending upon the age and ability this could be a simple histogram or a line graph.

Conclusion

- Discuss the students' results
- Which combination gives the most efficient energy production?
- Why do they think this setting gives the best performance?
- Is there any thing noticeable about the rotor speed or generator speed with the different configurations?
- The task may be repeated with fewer blades, different wind speeds or blade pitch angle

Record sheet

Turbine cog teeth	Generator cog teeth	Voltmeter reading
50	10	
40	20	
30	30	
20	40	
10	50	
Observations during experiment		