EXPERIMENT MANUAL

WIND POWER

→ RENEWABLE ENERGY SCIENCE KIT

THAMES & KOSMOS

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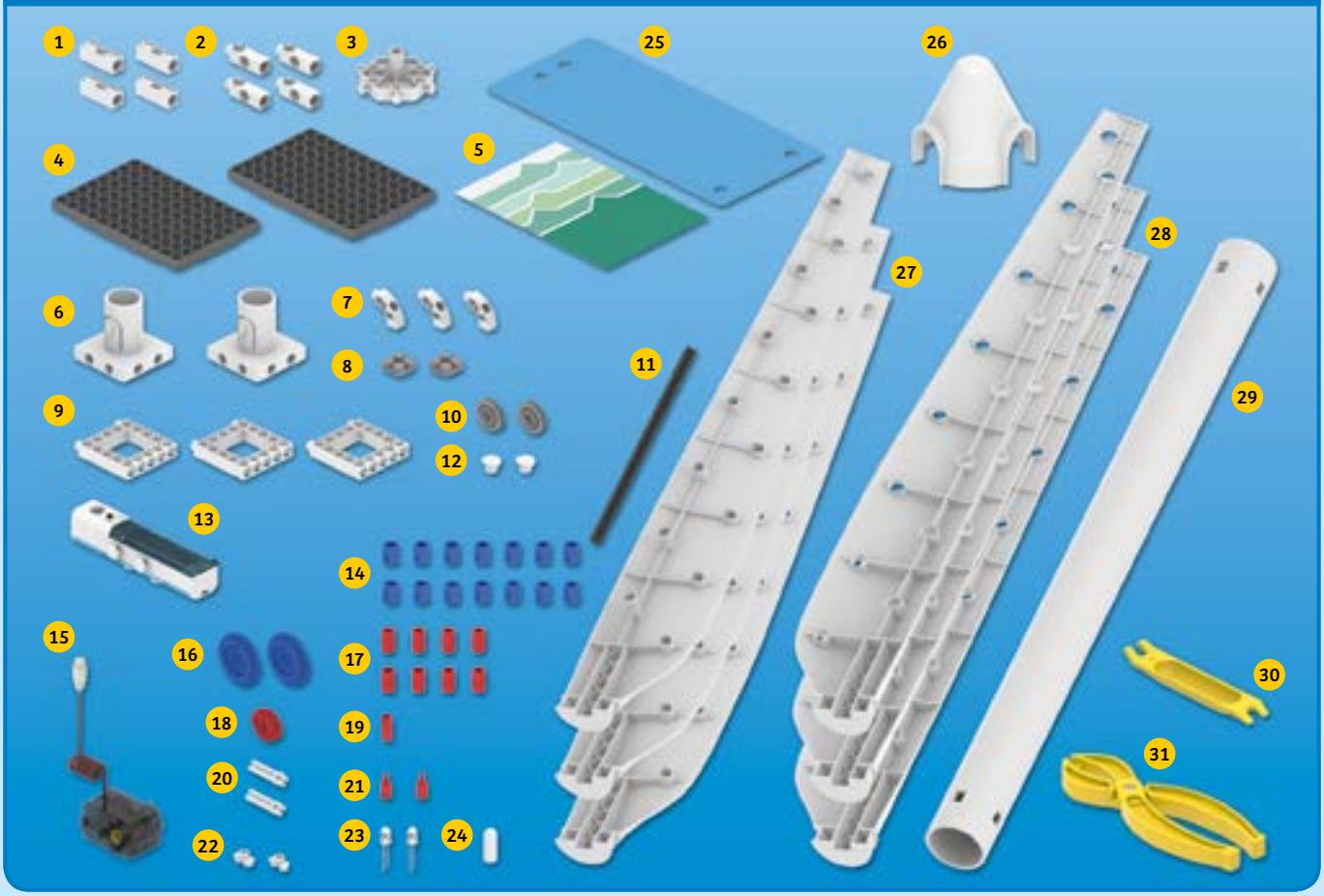
GOOD TO KNOW ! If you are missing any parts, please contact Thames & Kosmos customer service.

Any materials not included in the kit are indicated in *italic script* under the "You will need" heading.

What's in your experiment kit:



Checklist: Find – Inspect – Check off

✔	No.	Description	Qty.	Item No.
❍	1	3-hole cross rod	4	714 127
❍	2	3-hole dual rod (with anchor pin)	4	714 283
❍	3	Hub	1	716 037
❍	4	Base plate	2	703 237
❍	5	Sticker	1	716 042
❍	6	Tube bracket	2	716 029
❍	7	Curved rod	3	714 285
❍	8	Connection plate	2	702 496
❍	9	Square frame	3	714 284
❍	10	Small pulley	2	716 030
❍	11	XL axle	1	703 518
❍	12	Button pin	2	714 329
❍	13	Battery compartment	1	716 041
❍	14	Blue anchor pin	14	714 129
❍	15	Motor	1	716 033
❍	16	Medium gear wheel, blue	2	710 061
❍	17	Red anchor pin	8	702 527
❍	18	Small gear wheel, red	1	710 062

✔	No.	Description	Qty.	Item No.
❍	19	Joint pin	1	702 524
❍	20	Motor shaft	2	715 677
❍	21	Shaft pin	2	702 526
❍	22	Two-to-one connector	2	714 286
❍	23	LED	2	704 072
❍	24	LED cover	1	716 039
❍	25	Plastic film	1	716 040
❍	26	Rotor blade lock (nose cone)	1	716 038
❍	27	Rotor blade part 1	3	716 035
❍	28	Rotor blade part 2	3	716 036
❍	29	Tube	1	716 028
❍	30	Anchor pin lever	1	702 590
❍	31	Pliers	1	710 059

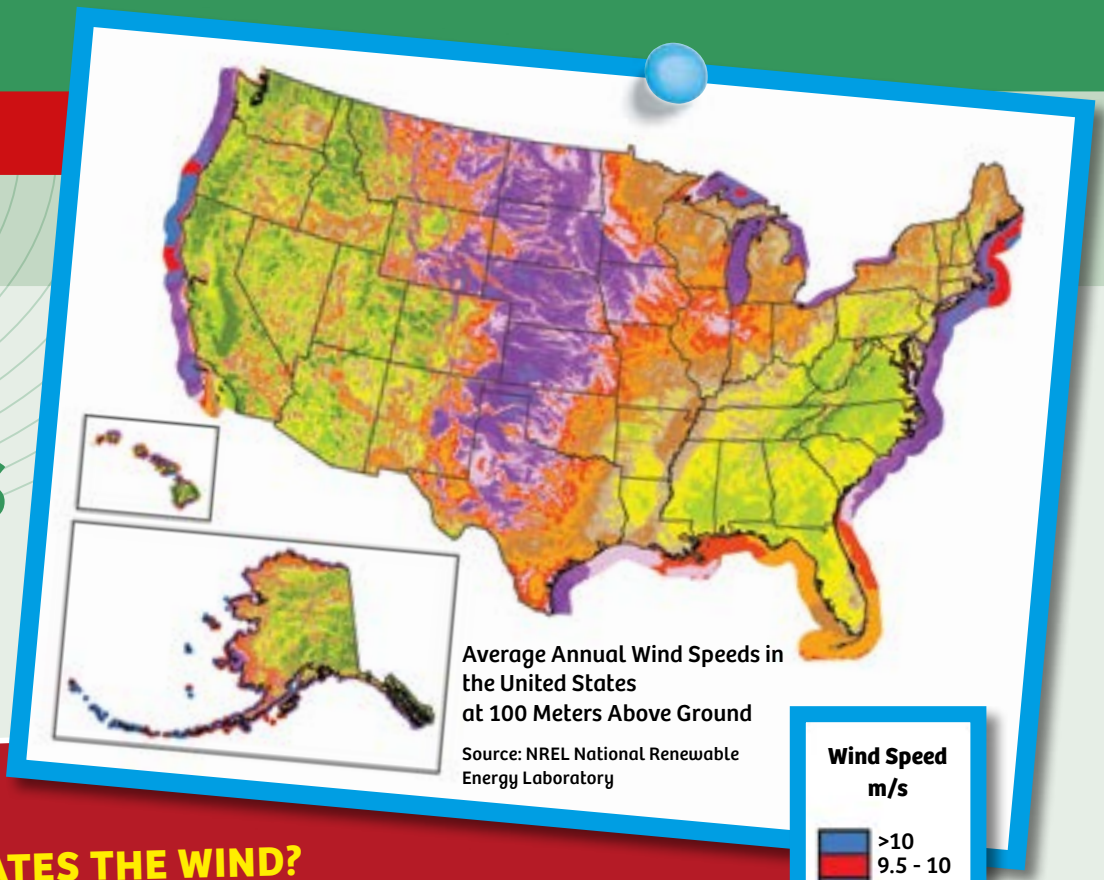
You will also need:

1 x 1.2-volt rechargeable AA battery (HR6/KR6)

For some experiments: Measuring tape or measuring stick, cable tie, tape, weight (rocks or books), two cloth handkerchiefs, fan or hair dryer, writing pad and pen

Optional: Computer with Internet connection, smartphone, compass

Wind and Its Uses



Average Annual Wind Speeds in the United States at 100 Meters Above Ground

Source: NREL National Renewable Energy Laboratory

WHAT CREATES THE WIND?

The surface of the Earth is enveloped in an atmosphere. Because the strength of the sun's radiation is different in different regions of the Earth, those different regions are heated to different degrees. High temperatures cause warm air to rise and air pressure to drop. On the other hand, low temperatures make cold air sink and air pressure rise. This creates high and low pressure areas. As a reaction to this, air particles will move from the high-pressure areas into low-pressure areas until the air pressure evens out. This compensatory movement is what we experience as wind.

WHAT EFFECT DOES THE WIND HAVE AND HOW IS IT MEASURED?

The wind can have many different effects — whether as a mild, cooling breeze, as a powerful headwind that makes it hard to ride your bike, or even as a hurricane ripping the roofs off of houses. As long ago as 1806, the Irishman Sir Francis Beaufort had the idea of using the observed effects of wind for a wind speed scale. His scale is divided into 12 levels, and is the most commonly used wind speed scale to this day. Even though he didn't invent the 12 divisions, he popularized their use among British sailors, for example. In his honor, the scale is therefore known as the "Beaufort scale."

To calculate wind speed from Beaufort wind speed (from 1 to 12), you use the formula $V = 0.836 \times B^{3/2}$, with B standing for Beaufort wind strength and V for wind velocity in m/s. This will be easier if you know the complete Beaufort scale shown on the back cover of this manual.

EXPERIMENT 3

Operating the wind turbine outside

YOU WILL NEED

› **Assembled wind turbine with attached LED**
› *1.2-volt rechargeable AA battery (HR6/KR6)*
› *Cable ties*

HERE'S HOW

1. As soon as you have gotten to know your wind turbine, you can take it outside into its "natural" environment. Take a look out the window. Is the wind blowing? Ideally, maybe a light breeze (see back cover)? Okay, time to go outside.
2. Look for a place where you can attach your wind turbine to something like a wooden stake or a metal pipe. Ideally, find a free-standing lawn umbrella stand or a wooden stake that you can pound into the ground. In that case, be sure to remove the wind turbine's base plate.
3. Secure the wind turbine to the stake or pipe with two cable ties. Make sure that everything is tightly attached. If you do that, it will take a wind strength of at least 4.5 m/s to knock your wind turbine over.

Warning! A few drops of rain will not hurt your wind turbine, but it is best to bring it inside during constant heavy rain.

4. The best thing would be a movable attachment — in other words, if you can easily take your wind turbine along with its stake or pipe to another location and set it up there. If you can move it around, you can easily find out where the wind is blowing the strongest. Right up on top of a hill? Or at the foot of the hill, in its valley? And how about between two buildings standing close together?

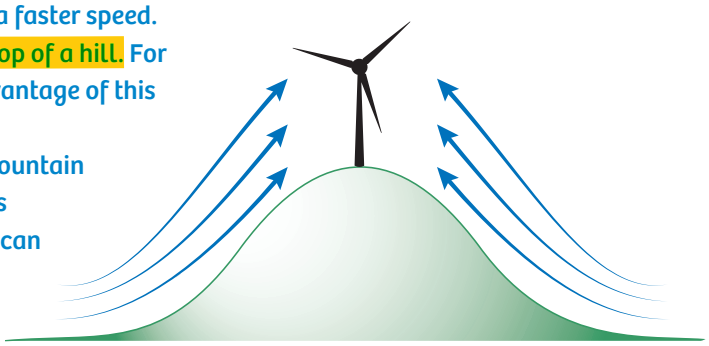
WHAT'S HAPPENING ?

When the wind comes to a hill, it is pushed upward at a faster speed. That's why the ideal location for a wind turbine is on top of a hill. For optimal energy production, it makes sense to take advantage of this "hill effect."

If you stand between high buildings (or in a narrow mountain pass), you can notice the same kind of effect. The air is compressed on the windward side of a building. That can raise its velocity quite a bit as it blows between the obstacles around it. This phenomenon is known as the "tunnel effect."

Here's an example: If the normal wind speed in an open area is 6 m/s, it can reach a speed of 9 m/s in that kind of tunnel. Through skillful selection of a location in a tunnel, in other words, you can increase wind speeds quite a lot relative to the surrounding area.

Hill effect



Tunnel effect