

## Hurricane force Teachers' Notes

### Introduction

Working with and converting between compound units such as metres per second and kilometres per hour is an unexciting but necessary task in both mathematics and science. TI-Nspire can make the process easier to understand by the use of formulas in spreadsheets and conversion graphs. Hopefully the context of this activity, live weather station data and wind speed scales including those for hurricanes and tornadoes, can make the task more relevant and interesting.

This activity is in two parts initially with a further extension (part 3) for more advanced work.

#### Part 1 Weather station information

This gives an introduction to weather information by looking at live weather station data and offering an opportunity to discuss the information shown and the units used. Teachers can decide the extent to which they wish to use the weather station and other background information as well as the depth of the discussion and follow up activities. There is a supplementary sheet of background information.

#### Part 2 Using TI-Nspire

Weather forecasters need to be able to collect weather data from around the world where it may be displayed in a variety of different units varying from miles per hour, metres per second, knots and using the Beaufort scale (such as Hurricane Force) in shipping forecasts. Students are given a task to 'set up TI-Nspire so that a weather forecaster could use it to quickly convert the wind speeds here in m/s into other units including the Beaufort scale'.

#### Part 3 More about the Beaufort scale

Interesting results can be obtained by trying to fit a function to the mean wind speeds for each wind force on the Beaufort scale. More information about this is given later in 'additional notes for teachers'

## The activity

#### Part 1 Weather station information

The London Grid for Learning Networked Weather Station <http://weather.lgfl.org.uk/> displays live weather data updated every minute from a number of weather stations in England and Wales. The default view shows a number of dials to read and interpret. Reading these dials and interpreting the information is a valuable functional skill for both mathematics and science. The data collected also provide a starting point for discussions about weather—barometric pressure; humidity; rainfall; ultraviolet index; solar radiation; wind speed. The data give a real context for exploring the scientific units used and methods for converting from one compound unit such as metres per second to others such as miles per hour or knots.

## Information given on the weather station

**Temperature** in degrees Celsius and wind chill temperature.

**Barometric pressure** in hectoPascals (equivalent to millibars).

**Rain rate** in mm/hr.

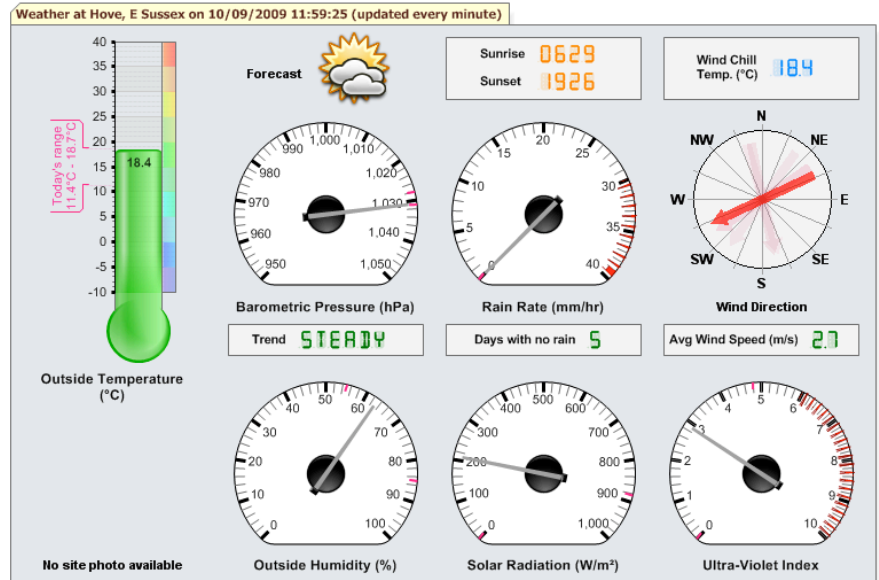
Days with no rain.

**Wind direction and average speed** in metres per second.

Outside **humidity** as a percentage.

**Solar radiation** in Watts per square metre.

**Ultra violet index** on a scale from 1 to 10.



**Introduction:** Find a weather station on the LGfl site that has live data. This could be the nearest one to where you live. Note that not all the stations are recording all the time. Look at the dials and see what you can find out about the weather. Try weather stations in different parts of the country. How does the weather compare?

### Some possible questions to ask

- ✚ What do you notice?
- ✚ Which dials are easy to read? Which need a bit more thought? What do they mean?
- ✚ What do you already know about weather from listening to weather forecasts? Terms? Units of measurement?
- ✚ What do you know about pressure—what would a high or low figure be? What effect is this likely to have on the weather?
- ✚ What do you think the solar radiation dial shows? How could this be useful?
- ✚ What does UV index mean? Why would you want to know this?
- ✚ What about relative humidity?
- ✚ What about wind speed? These are given in metres per second. How are they usually given on weather forecasts? What about shipping forecasts? Which would mean the most to you?
- ✚ How would you describe the information given here to someone else so that they understood the weather in this location? Which units would you use? For example:- **Wind speeds** can be given in a variety of ways. The LGfl weather station gives the speed in metres per second. Is this the usual way it is shown on weather maps? How is it given on television forecasts? Sometimes wind speeds could be in miles per hour, kilometres per hour, knots (nautical miles per hour) and also using the Beaufort scale (Force 1-12) or higher for hurricanes using the Torro scale.

## Part 2

## Using TI-Nspire – Instructions for students

### The task

Your task is to set up TI-Nspire so that a weather forecaster could use it to quickly convert the wind speeds here in m/s into other units including the Beaufort scale? You could use spreadsheets and formulae, conversion graphs or conversion algorithms.

What instructions would you give to the weather forecaster so that they could use the TI-Nspire.?

### Getting started

#### 1. Entering data into a spreadsheet

Wind speeds from a variety of locations could be entered into the first column of a 'Lists & Spreadsheet' page and then further columns set up to convert these into different units.

The example below has taken values for wind speeds in metres per second from the Beaufort scale. For example **Force 5** on the Beaufort scale (described as *fresh breeze*) varies **between 8.0 and 10.7 metres per second**. 8.0 is the lower speed in mps entered into column B and 10.7 is in column C

More information at <http://www.metoffice.gov.uk/weather/marine/guide/beaufortscale.html>

A	B	C	D
beaufortscale	lowermps	uppermps	terms
0	0	0.2	calm
1	0.3	1.5	lightair
2	1.6	3.3	lightbreeze
3	3.4	5.4	gentlebreeze
4	5.5	7.9	moderatebreeze
5	8.0	10.7	freshbreeze
6	10.8	13.8	strongbreeze
7	13.9	17.1	neargale
8	17.2	20.7	gale
9	20.8	24.4	severegale
10	24.5	28.4	storm
11	28.5	32.6	violentstorm
12	32.7		

(Note that TI-Nspire will only accept single words in spreadsheet cells. Hence violentstorm!)

#### 2. Converting the wind speed data into other units

Could you set up a table or charts that others could use to convert this information into other units for example change metres per second into km per hour?

These are some possibilities:-

1. **You could insert a calculator page** and try out a calculation for one of the speeds shown in the table. Does the answer seem reasonable? Can you find an alternative method that you could use to check? Can you express this as a general rule?
2. **You could set up extra columns on the spreadsheet and put formulas into each column.** There are instructions for doing this in the introduction to this booklet. There is also an example for this below.
3. **You could set up conversion graphs to change from one unit to another,** or to convert a speed to the Beaufort scale. There are two examples for this below. One uses a 'Data & Statistics' page to obtain a graph and the other uses a 'Graphs' page.

## 2.1 Conversion formulas

### Using a Lists & Spreadsheet page

- Open the tns file or set up one of your own by entering data into a 'Lists & Spreadsheet' page like the one shown earlier.
- Add names in the white cells at the top of extra columns for converting the data –such as  
Kmp/hr  
Mph  
Knots
- Enter a formula in the grey formula cell below the column title for example to convert the figures in column b to kilometres per hour you could type in  $b[]*3600/100$  Why does this work? Could it be written in a simpler way?
- What other columns and formulas could you add?

	A	B	C	D	E
	beaufortscale	lowermps	uppermps	terms	kmp/hr
					$=b[]*3600/1000$
1	0	0	0.2	calm	0
2	1	0.3	1.5	lightair	1.1
3	2	1.6	3.3	lightbreeze	5.8
4	3	3.4	5.4	gentlebreeze	12.2
5	4	5.5	7.9	moderatebreeze	19.8
6	5	8.0	10.7	freshbreeze	28.8
7	6	10.8	13.8	strongbreeze	38.9
8	7	13.9	17.1	neargale	50.0
9	8	17.2	20.7	gale	61.9
10	9	20.8	24.4	severegale	74.9
11	10	24.5	28.4	storm	88.2
12	11	28.5	32.6	violentstorm	102.6
13	12	32.7			117.7
14					
15					
16					

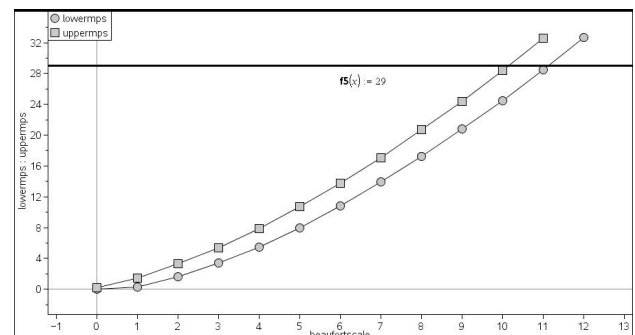
Type square brackets [] to indicate a column.

## 2.2 Conversion graphs – Beaufort scale

### Using a Data & Statistics page.

One way to convert speeds to the Beaufort Scale is to use the data in the table.

- From the menu ('Insert' for software) select '5: Data & Statistics'.
- Move to the x-axis, select 'Enter variable' and choose Beaufortscale.
- Move to the y-axis and choose 'lowermps' then select ctrl menu (right click for software) and 'Add y variable'. Then select 'uppermps'.
- To convert a particular speed, say 29mps, to the scale select menu 4 and 'Plot Function' enter  $f(x) = 29$ . This is Force 11 on the Beaufort scale. How can you tell from the graph?
- If you have more columns on your table you could do this for other units.



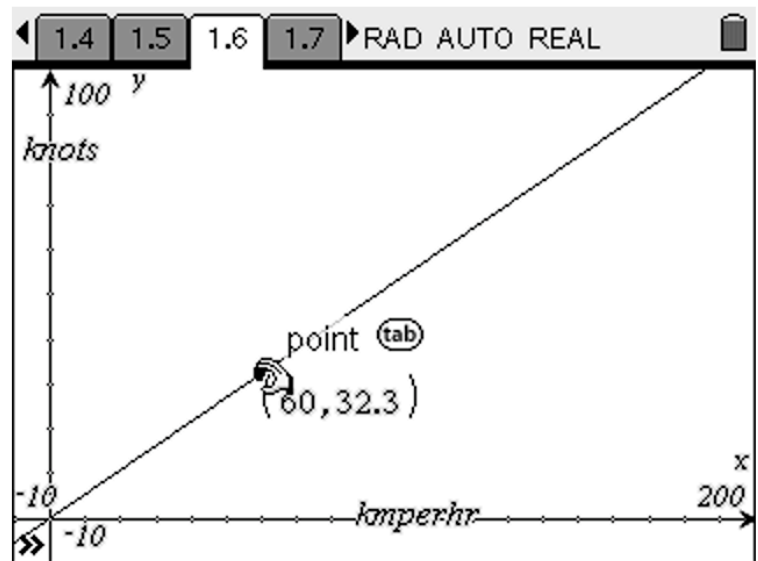
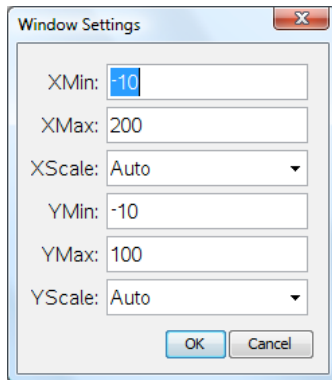
The data in the table could also be used to set up conversion graphs for other pairs of units, but if formulas have been used in the table then these could be used as functions in a Graphs page.

## 2.3 Conversion graphs – Graphs of functions

### Using a Graphs page.

- Insert a 'Graphs' page using Menu and 2 on the handheld or 'Insert' on the software.
- From menu 4 select 'Window Settings'. Then set the window to the required size depending on the units to be converted. Use the arrow keys to move down the settings table. The example below is for converting from km per hour to knots.
- From menu 1 select '6: Text' and label the x-axis as the value that you know and the y-axis as the value you want to find out.

- Next enter the formula you have worked out to convert from x to y. Your formula should contain an 'x'. In this case from km per hour(x) to knots(y). One possible formula for y would be  $y = \frac{x}{1.86}$  Why? Can you find other ways? Is this formula accurate enough?
- To use the conversion graph: from menu 5 select '2: point on', move to the graph line and put a point on the graph. Then using the hand tool (for software- select the pointer from menu 1), grab the point and drag it to an appropriate point on the graph to read off the figures. In the example shown 60 km per hour is approximately 32.3 knots.



## Part 3 Hurricanes, tornadoes and fitting functions

You can find out more about the Beaufort scale at [http://en.wikipedia.org/wiki/Beaufort\\_scale](http://en.wikipedia.org/wiki/Beaufort_scale)

The foot of this web page has links to hurricane scales such as the Saffir-Simpson hurricane scale and the Torro scale for classifying tornado wind speeds. These scales could be used to extend the Beaufort scale to higher numbers.

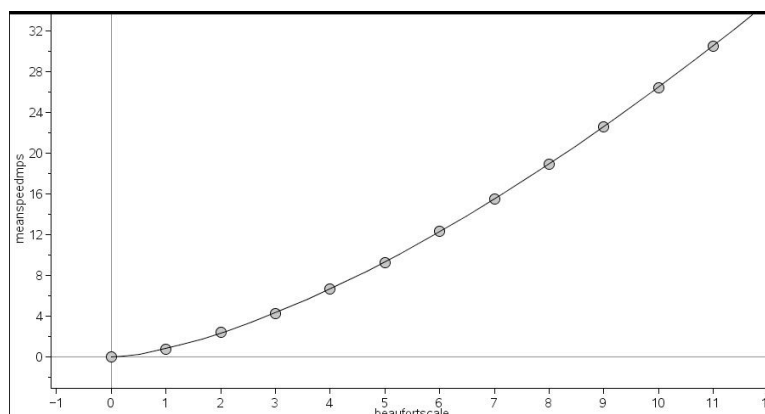
### The task

If you use a 'Data & Statistics' page to plot the mean speeds (average of the lower and upper speeds) in metres per second for each point on the Beaufort scale, can you find a function that will fit this data?

Some possibilities are:-

- use the plot function option on menu 4 to try to find a function that will fit the Beaufort scale data.
- use one of the regression options to find a suitable function.

The page on the Torro scale may give you some ideas to check out. You could try this for different units.



## Additional notes for teachers

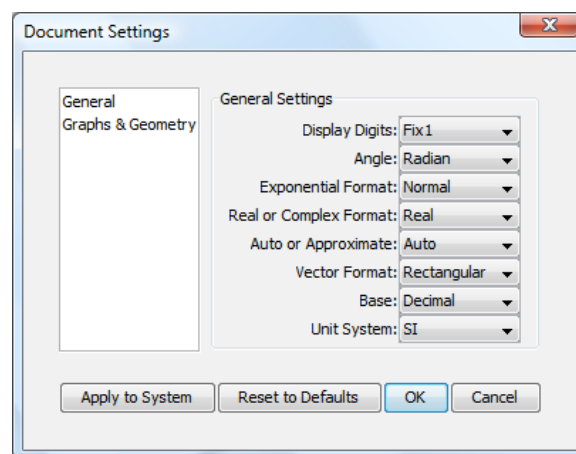
**Further information** about the terms and the units used together with useful web links is in the document 'Weather data facts and figures'

### Accuracy

Teachers may feel it is useful to discuss with students issues relating to the degree of accuracy required and how and whether to fix the document settings. This could also apply to upper and lower bounds such as those used for the Beaufort scale e.g. 5.5-7.9 and 8.0 – 10.7 and whether to plot these as 5.45-7.95 and 7.95 -10.75 etc (Note that the tns file has been set to one decimal place to fit the Beaufort scale figures but this may not be accurate enough for other calculations. )

Alternatively you may prefer just to fix the number of decimal places to 1 and to leave the Beaufort scale figures as they are without further discussion.

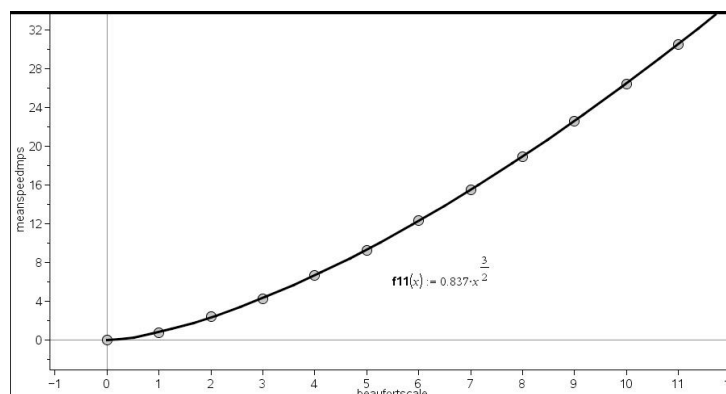
To fix the document settings go to 'File'; then 'settings'; then 'document settings'; then 'display digits'.



**Calculations:** There are many different ways to go about the calculations and encouraging students to look for alternatives or simplifications will help self checking. There are a variety of different possibilities in the information on the Weather data facts and figures sheet. The simplest forms will also be easier to insert into the spreadsheet or as functions for conversion graphs.

### Task 3 Extension ideas

Graph fitting for the mean speed in mps on the Beaufort scale [http://en.wikipedia.org/wiki/TORRO\\_scale](http://en.wikipedia.org/wiki/TORRO_scale)



The function shown from the Torro page gives a good fit to the mean speed in metres per second. Students could try out other formulas from this link or fit their own function to graphs in different units.