

ward's science+ DataHub

The Power of Twelve
The Convenience of One

Biology & Chemistry



922005-03

Quick Start Guide

Plus Ward's DataHub Analysis Software



wardsci.com

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1. DataHub Hardware Overview

1.1 What's in the Pack

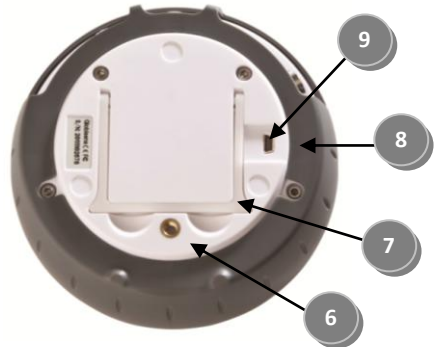
- | | | |
|-----------------------|---|-----------------------|
| ① DataHub data logger | ⑦ Air pressure tube | ⑬ Heart rate ear clip |
| ② DataHub AC charger | ⑧ Temperature probe | ⑭ Thermocouple |
| ③ USB cable | ⑨ Colorimeter 5 cuvettes set | |
| ④ Software CD | ⑩ pH electrode | |
| ⑤ Quick Start Guide | ⑪ Conductivity electrode | |
| ⑥ Warranty page | ⑫ Dissolved oxygen electrode
<i>(Must be ordered separately)</i> | |














1.2 Ports and Controls










The picture below reviews the **DataHub** ports, sensors, keypad and display:




- ① Select key
- ② On/Off and Escape key
- ③ Scroll key
- ④ Graphical display 128 x 64 pixels
- ⑤ Sensor selection keys
- ⑥ MS screw insert
- ⑦ Plastic leg
- ⑧ Rotating ring
- ⑨ USB port
- ⑩ GPS
- ⑪ Colorimeter & turbidity
- ⑫ Relative humidity
- ⑬ Heart rate & ext. temperature
- ⑭ Thermocouple & ambient temp.
- ⑮ Light & universal input
- ⑯ pH, dissolved oxygen & conductivity
- ⑰ Air pressure



1.3 Built-in Sensors

<i>Icon</i>	<i>Type</i>	<i>Range</i>	<i>Description</i>	<i>Max. Sample Rate</i>	<i>External Accessories (supplied with DataHub)</i>
	Air pressure	0 to 300 kPa	Measuring air pressure	10/s	 Plastic tube
	Ambient temp.	-10 °C to 50 °C	Measuring ambient temperature	100/s	Not required
	Barometric pressure	300 to 1100 mB	Measuring barometric air pressure	1/s	Not required
	Colorimeter	10 - 90 % transmittance (3 colors)	Measuring solution transmittance in 3-light wavelength: Red, Green, Blue	1/s	 Cuvette set
	Conductivity	0 to 20ms	Measuring solution conductivity	10/s	 Conductivity electrode
DO_2	Dissolved oxygen	0 to 14 mg/l	Measuring dissolved oxygen	10/s	 Dissolved oxygen electrode
	External temp.	-25 °C to 125 °C	General purpose stainless steel temperature probe	100/s	 Temp. probe

<i>Icon</i>	<i>Type</i>	<i>Range</i>	<i>Description</i>	<i>Max. Sample Rate</i>	<i>External Accessories (supplied with DataHub)</i>
 GPS	GPS	N/A	Measuring 6 different parameters: Longitude, latitude, course, speed, date and time	1/s	Not required
	Heart rate	0 to 200 bpm	Measuring heart rate	100/s	 Ear clip
	Light	0 to 55,000 lux	Measuring light level	24,000/s	Not required
	pH	0 to 14 pH	Measuring pH level	10/s	 pH electrode
	Relative humidity	0 to 100% RH	Measuring relative humidity	10/s	Not required
	Thermocouple	-200 °C to 1,200 °C	Measuring a wide range of temperature	25/s	 Thermocouple K probe

	Turbidity	0 to 1000 NTU	Measuring water turbidity level	1/s	 Cuvette set
	Universal input (not included)	0 to 5 V	Connecting Fourier or Vernier analog sensors	24,000/s	Universal input adapter cable

1.4 Using the DataHub

CHARGE THE DATAHUB BATTERY BEFORE STARTING

Before working with the **DataHub** for the first time, the unit should be charged for six hours with the supplied 6 V charger. The **DataHub** charging input is located to the left of the **On/Off** key. Simply rotate the orange ring until the charging input on the **DataHub** is exposed and then connect the charger plug to the charging input.

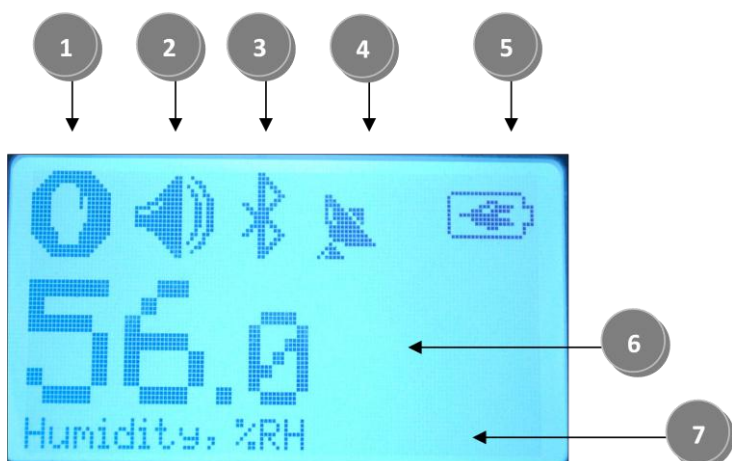
The **DataHub** charger will accept any input voltage ranging from 100 to 240 VAC 50/60 Hz, making it functional worldwide.







DataHub charging input



1.4.1 DataHub display



The **DataHub** LCD display allows users to see the different sensor readings and to setup or re-configure the **DataHub** parameters.







① **Run/Stop icon** – shows  when the **DataHub** is logging data, or  when the **DataHub** is not logging sensor data.

② **Sound Status** – shows  active sound beep when the key is pressed and  when the sound beep is disabled.

③ **Communication Status** – shows  when Bluetooth communication is enabled, or  when the USB cable is connected from the host computer to the **DataHub**.

④ **GPS Status** – shows  when the GPS is enabled,  when locked to GPS satellites and provides valid positioning parameters.

⑤ **Battery Level** – shows battery capacity at 3 levels   , or  when the **DataHub** is connected to the external charger.

⑥ **Sensor Value** – shows the selected sensor value.

⑦ **Sensor Name and Unit** - shows the selected sensor name and unit.

1.4.2 DataHub keys

The **DataHub** 10 keys are divided into 7 sensor keys and 3 control keys. Using the sensor keys users can select and view different sensor readings. The control keys are used to turn on/off the **DataHub**, setup the device for the next logging session and configure all its parameters. The 3 control keys are:



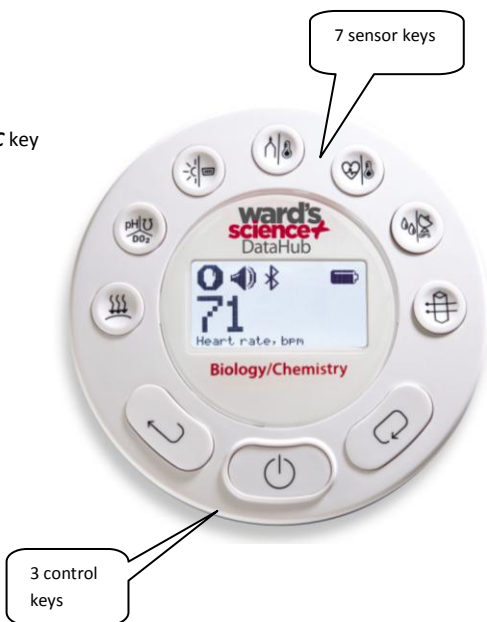
Select key



On/Off and **ESC** key



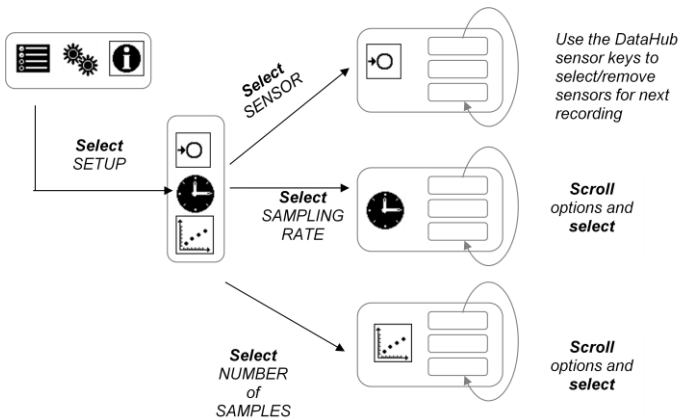
Scroll key



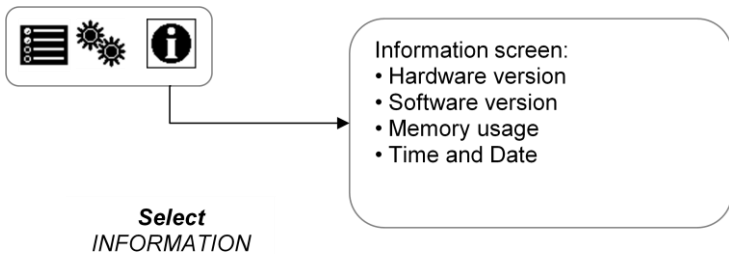
1.4.3 DataHub menu

Press the **Scroll** key to enter the DataHub menu. Then use the **Scroll** key to scan menu options, the select key to choose a menu option and the **ESC** key to go one level up in the menu.

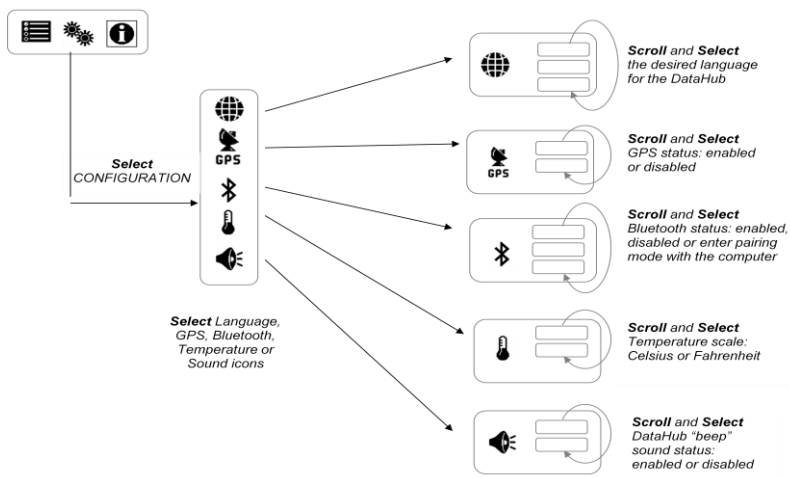
1.4.3.1 Setup the DataHub for the next logging session



1.4.3.2 DataHub information



1.4.3.3 Configuration of the DataHub



2. Ward's DataHub Analysis Software

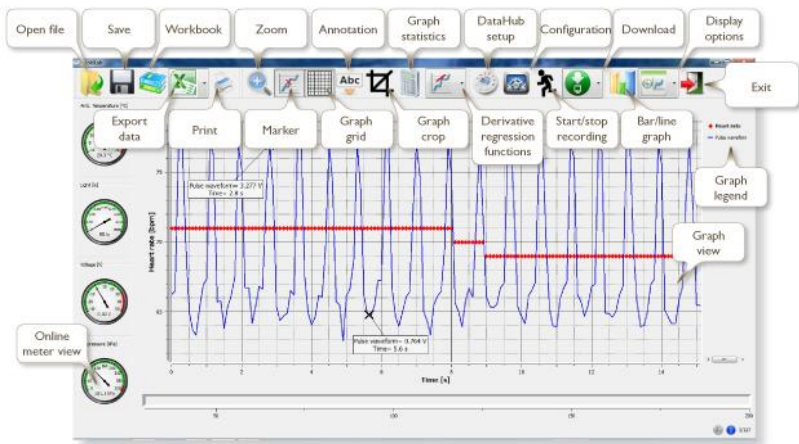
2.1 Software Installation

To install the software, users should run the following installers:










- For PC: Ward's DataHub-en-1.0-setup.exe
- For Mac: Ward's DataHub-en-1.0-setup




Then follow the simple installation instructions. These instructions take the user through the installation of the **Ward's DataHub** software and the USB driver needed for USB communication with the **DataHub**.








2.2 Software Functions




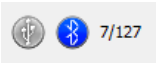


2.3 Software Popular Icons and their Functions

	<p>Selecting the Open-project icon opens the stored activity *.XML files and displays all its graphs and graphical attributes.</p>
	<p>Selecting the Workbook icon opens the activities folder, where users can choose from a variety of PDF activities.</p>
	<p>Clicking the Display-options small triangle icon allows the user to select one of the following six display options:</p> <ol style="list-style-type: none"> 1.  Meter view 2.  Table view 3.  Graph view 4.  Map view 5.  Mixed Meter and Graph view 6.  Mixed Table and Graph view

	<p>Selecting the Sensor legend:</p> <ol style="list-style-type: none"> 1. A left click on the sensor name will set it as the active sensor and will change the y-axis to reflect this sensor's units and scale 2. First right click on the sensor name will change the line graphs to symbols 3. Second right click on the sensor name will remove this sensor graph from the display 4. Third right click on the sensor name will return to the default view for this sensor and will show it as a line graph on the display <p>The graphic window includes a graph title. The default title is New Experiment. Changing this title is done with a double left mouse click over the title. A small text dialog box will open where the user can type in the new title.</p> <p>When displaying two or more sensors – a right click on the graph x-axis title will open a dialog box for assigning a sensors or time as the x-axis.</p>
	<p>Selecting the Meter view:</p> <p>A left mouse click on the four bottom blue dot icons will change the number of meters on the screen to: 1, 2, 4 or 6 meters.</p> <p>A left click on any of the meters will open a dialog box for meter type selection and assigning a sensor for this meter.</p>
	<p>Selecting the Marker icon enters into Marker mode. Left mouse click, near any of the graphs, will place a marker on the graph. Hovering over any of the markers, while pressing and holding the left mouse button and dragging the mouse, will move the marker over the graph. Selecting the Marker icon again, exits the Marker mode.</p>

	<p>Selecting the Annotation icon activates the Annotation mode. Left mouse click opens a dialog box where users can enter text and images. Pressing the Annotation icon again exits the Annotation mode.</p>
	<p>Pressing the Function-options small triangle icon allows the user to apply the mathematical functions listed below between the graph markers:</p> <ol style="list-style-type: none"> <li data-bbox="360 475 878 667">  <p>1. Selecting the Linear regression icon will display the best linear line that fits the graph between the locations of two markers. Next to the line the software will open a small text box displaying the linear line equation: $Y = aX + b$.</p> <li data-bbox="360 700 878 918">  <p>2. Selecting the Quadratic regression icon will display the best parabolic line (2nd degree) that fits the graph between the locations of two markers. Next to the line the software will open a small text box displaying the parabolic line equation: $Y = aX^2 + bX + c$.</p> <li data-bbox="360 951 878 1143">  <p>3. Selecting the FFT icon will split the graphic display and show the original measurement on a time scale in the top graphic window, and its harmonics, on a frequency scale in the bottom graphic window.</p>
	<p>Selecting the Run icon launches a new data collection session.</p>
	<p>Selecting the Stop icon ends the current data collection session.</p>



	<p>Selecting the Selective download icon opens a table listing all stored recordings. Selecting one of the lines on the table and pressing download will download this specific recording to the computer.</p>
	<p>Setting up the DataHub is done by selecting the Setup icon. The software will open a dialog box, where users can select/remove sensors, set the sampling rate and the amount of samples for the next data recording.</p>
	<p>Selecting the EXCEL icon saves the file in a *.CSV format, prompts the user for a file name and then automatically opens EXCEL and exports the experiment data into the spreadsheet.</p>
	<p>Ward's DataHub status bar, is located at the bottom right corner of the software. It includes 3 icons:</p> <ol style="list-style-type: none"> 1. USB indicator – where blue indicates a USB communication between the computer and the DataHub. 2. Bluetooth indicator – where blue indicates a Bluetooth wireless communication between the computer and the DataHub. A right mouse click on this icon will open a list of recognized DataHubs, click on one to connect. 1. Memory info – shows how many experiments are stored in the DataHub memory, out of a maximum of 127. In the example above there are 7 stored experiments out of 127. A right mouse click on this section will allow users to erase all stored data or just the last recording.

3. Ward's DataHub for iPad

3.1 Initial Setup

3.1.1. Download the Ward's DataHub Application Install

This is a one-time action needed to install the DataHub application on your iPad.

1. Tap the iPad App Store Icon  .
2. Search for "Ward's DataHub"  .
3. Press the FREE download green key to install the application.

3.1.2. Pairing the Ward's DataHub with the iPad

This is a one-time action needed when you connect your Ward's DataHub to the iPad for the first time.

On the Ward's DataHub...







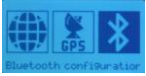


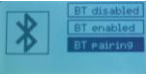

= Select Key


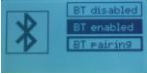



= On/Off & ESC Key



= Scroll Key

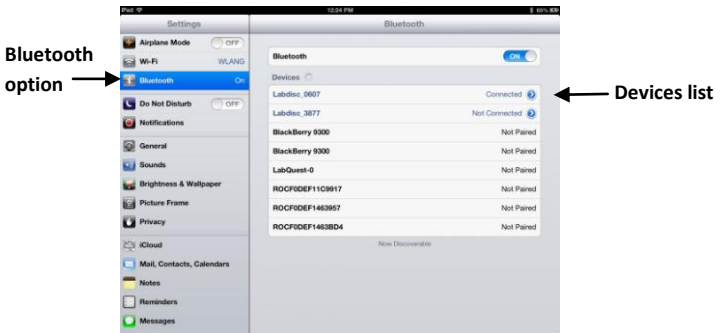
<p>1. Press the Scroll key on the Ward's DataHub to launch the Ward's DatHub menu.</p>	
<p>2. Press the Scroll key again.</p>	
<p>3. Then press the Select key to access the configuration menu.</p> 	
<p>4. Once in the configuration menu, press the Scroll key twice until the Bluetooth icon is highlighted.</p> 	 <p>X2</p>
<p>5. Then press the Select Key.</p>	
<p>6. In the Bluetooth menu, press the Scroll key until "BT pairing" is highlighted.</p> 	

<p>7. Then press the Select key.</p>	
<p>8. Once connected to the Bluetooth, the Ward's DataHub will produce a long "beep" sound, indicating that it is in "pairing" mode and switch to "BT Enabled"</p> 	
<p>9. Now, press the Escape key three times.</p>	

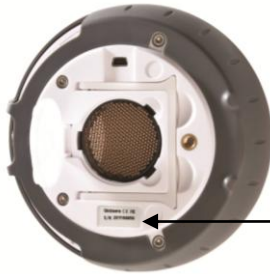
On the iPad...



1. Tap the iPad "Settings" icon .
2. Go to the Bluetooth option and tap it to turn it on.
3. Tap the Bluetooth option to reveal the Devices List. This shows all the devices in range.



4. Locate the serial number on the sticker on the back of the DataHub.



Last four digits of serial number should match on both devices

On the Devices List on the iPad, a list of active DataHubs will appear. Four numbers will appear next to each listing. Select the device whose numbers match the last four digits of the serial number on your DataHub.

5. The iPad will ask for a PIN code. Enter "1234" and tap "Pair".
6. The iPad will show the Ward's DataHub connected for your device's serial number.



Last four digits of serial number

7. Close "Settings" and tap the Ward's DataHub Analysis Software icon to open this



Note: If the iPad has been successfully paired with the Ward's DataHub, the Bluetooth icon will appear next to the setup icon.



3.2. Downloading Ward's DataHub Stored Measurements to the iPad

The Ward's DataHub can store up to 127 different experiments. This is useful when conducting multiple experiments and/or collecting measurements over a long period of time.

1. Tap the iPad "Download" icon  .

- The iPad will list all Ward's DataHub stored experiments. Each line on this list shows which sensors were recorded, at what sampling rates, and for how many samples, as well as the date and time of each recording.



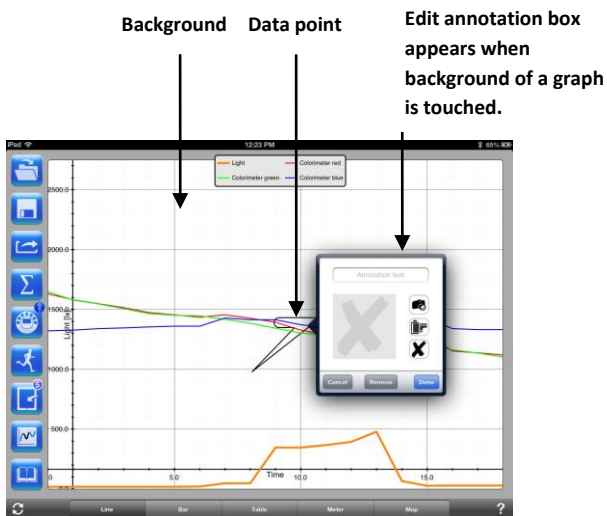
- Tap on one of the lines in the list. The Ward's DataHub transfers the data to the iPad.
- After all the data is transferred, the iPad will show a graph of the collected measurements.

3.3. Annotating Graphs on your iPad

- When a screen with a graph is showing, touch and hold on the background (in other words, do not touch any data point on the graph) to create an empty annotation box.
- The edit annotation box opens automatically. You can then use the keyboard and/or touch-screen to:
 - Write or edit an annotation.
 - Add an image using the camera or the image gallery.
 - Remove an annotation.

(Additional instructions for annotating a graph are listed on the following page).

- To label a data point, touch and hold directly on the data point.



3.4. Opening a Stored Experiment File

This instruction uses the Physics Free Fall experiment as an example. The procedure for opening an experiment file and annotating a graph would be similar for all other experiments.



- Tap the iPad "Open" icon and select "Free Fall". A graph will appear. For this experiment, the graph shows a real-time Ward's DataHub Distance Sensor recording of a ping-pong ball bouncing on a table.

2. Touch and hold on the graph to add a marker.
3. Touch the marker cross, and drag it with your finger. As the marker follows the graph line, notice the data in the text box changing.
4. Tap the graph twice to view the actual sampling points.
5. Touch and hold on the graph to add a second marker.
6. Place a marker at the beginning and end of a single ball jump.



7. Tap the Curve Fitting icon and select a Quadratic Regression to get the mathematical equation for the ping-pong ball jump. From this equation you can calculate Earth's gravitational force.

3.5. Accessing the “HELP” Screen and Menu

1. Tap on the “?” on the bottom right-hand corner of the iPad screen.
2. Open the appropriate view.
3. Tap on the HELP icon to access a list of features and controls.



4. Ward's DataHub for Android

The DataHub software for Android 4 and above is available for download from the Ward's website and from Google Play.

The software wirelessly integrates between the DataHub and the Android tablet, allowing full DataHub management (setup of all data logging parameters, online display of current measurements and download of the sample memory), together with graph manipulations (markers, zoom, crop and text annotation) and data analysis (statistics and curve fitting etc.).

4.1 Initial Setup

Set wireless communication between the DataHub and the Android tablet

- Make sure the DataHub is paired to the Android (see section 5.2.4)
- Turn on the DataHub
- Launch the application
- Tap the **options icon** in the top action bar (rightmost, three vertical dots)
- Tap and select the name of the DataHub you would like to connect with (e.g. DataHub_6588)

The App name (top right) will change to the named DataHub, indicating that the connection is established

4.2 Meter View

- Tap the **Meter view** to see the current values of the DataHub probeware
- Tap one of the meters and scroll the probe wheel to select a different probe type for an existing meter

Select a different meter type from the horizontal line of icons

4.3 Data Collection

- Tap the **SETUP** icon and enter the **SETUP** screen. This dialog box allows you to select the probes, sampling rate and amount of samples for the next data recording.
- Tap the **RUN** icon to start recording and observe the graph build up on the screen

- You may switch the display to a Bar Graph view by tapping the **Bar Graph** key
- You may switch the display to a Table view by tapping the **Table** key
- To stop recording tap the **STOP** icon

4.4 Download DataHub Stored Measurements to the Tablet

The DataHub can store up to 127 different experiments. This is very useful when conducting outdoor data collection or long measurements.

- Tap the **Download** icon
- The application will list all DataHub stored experiments. Each line on this list shows what probes were recorded, at what sampling rate and for how many samples. In addition it indicates the date and time of the recording.
- Click on one of the lines in the list and the DataHub transfers the data to the tablet.

After all the data is transferred, the tablet will show a graph of the collected measurement

4.5 Use of Data Analysis (markers, curve fitting)

- Tap the **Open** icon and select "**Free Fall**". This graph describes a real recording of a ping-pong ball bouncing on a table, as recorded by the DataHub distance probe.
- Long touch on the graph to add a **marker**
- Touch the **marker** to cross and drag it with your finger. View the marker text box data changing while the marker follows the graph line.
- Tap the graph legend and select "**Dots**" to view the actual sampling points
- Long touch the graph to add a second marker
- Place both the markers at the beginning and end of a single ball jump
- Tap the **Curve Fitting** icon and select a **Quadratic Regression** to get the mathematical equation representing the ping-pong ball jump. From this equation we can calculate earth's gravitation.

4.6 Use of Graph Annotation

- Use a long touch anywhere on the background (not on a graph), create an empty **annotation**. The edit annotation box opens automatically. From here:
 - Edit or write an annotation
 - Remove the annotation

4.7 Use of Map view on a Field Trip

Recording GPS together with other DataHub probes enables the DataHub software to plot these sensors over the Google maps.

- Make sure the tablet is connected to the Internet
- Tap the **Open** icon and select “Walk in the Park”. In this experiment the different climate in a city park compared to a nearby cross road was measured.
- Tap the color scale on the left and select Amb. Temperature. Observe the dramatic temperature change while walking from the city cross-road to the park.
- Tap the colored samples on the map to get a marker with the temperature value
- Pinch to zoom in/out the map

See the experiment data in a table, by tapping the **Table View** and observe the GPS longitude and latitude values

4.8 Workbook Section

- Tap the **Workbook** icon to view DataHub experiment guides
- Tap on one of the experiments on the list and view a comprehensive PDF guide of that experiment.

4.9 Online Help

DataHub analysis software offers a PDF quick start guide. To open the quick start guide, tap on the **HELP** icon.

5. DataHub – Ward’s DataHub Communication

5.1 USB Communication

Upon USB cable connection between the computer and the DataHub, the Ward’s DataHub software automatically detects the USB connection and begins communicating with the DataHub.



5.2 Bluetooth Wireless Communication



Before wireless communication with a DataHub for the first time, the DataHub should be added as a device to the computer in a process called pairing. Pairing need be done only once for each DataHub, after which the computer stores the connection information, including a unique name for each DataHub. When no DataHub is connected via USB, the computer will automatically try to wirelessly connect to the last connected DataHub. To connect to a different or a new DataHub, right click on the **Bluetooth** icon in the Ward’s DataHub **status**





bar, located at the bottom right corner of the screen, then click on the DataHub you want to connect to.



5.2.1 Pairing with a PC running Windows OS

1. Turn on the DataHub. Make sure the DataHub is not showing the **sleep** icon . If it does, please press any button to leave the sleep mode.
2. Start the DataHub software.
3. Right click the **Bluetooth** icon located on the status bar at the bottom right corner of the screen 
4. From the new pop-up menu select **"Find more DataHubs and sensors"**. The computer opens the **"add a device"** dialog box and starts searching for the Bluetooth device.
5. Your DataHub will be displayed as **"DataHub-xxxx"**, where **"xxxx"** are the last four digits of the DataHub serial number sticker.
6. Select this device and press **"Next"**




7. On the DataHub: Press and hold the SCROLL  key to put the DataHub in Pairing mode. The DataHub will produce a long "beep" while its screen shows "**BT pairing**".
8. On the computer dialog box select the 2nd option: "**Enter the device pairing code**" and click "**Next**".
9. In the next dialog box enter "1234" as the pairing code, click "**Next**".
10. Wait for the computer to finish the process and announce "**Your device is ready to use**".
11. Right click the **Bluetooth** icon on the status bar. Choose the DataHub you've just paired and click on it.
12. The computer will connect to the DataHub and turn the **Bluetooth** icon blue  7/127.

5.2.2 Pairing with a Mac OS



1. Turn on the DataHub. Make sure the DataHub is not showing the sleep icon . If it does, please press any button to leave the sleep mode.
2. Open the Bluetooth menu from the Mac menu and select "**Set Up Bluetooth Device...**".
3. A dialog box opens. Your DataHub will be displayed as "**DataHub-xxxx**" where "xxxx" are the last four digits of the DataHub serial number sticker.
4. Select this device and press "**Continue**".
5. Mac will try a quick default attempt to pair. This attempt will not succeed as the DataHub requires a pairing code.
6. Press the "**Passcode options...**" button and select the option "**Use a specific passcode**". Enter the passcode "1234", and don't press "OK" yet.
7. On the DataHub: Press and hold the SCROLL  key to put the DataHub in Pairing mode. The DataHub will produce a long "beep" while its screen shows "**BT pairing**".
8. Press the "**OK**" button in the Mac dialog box.
9. Open the DataHub software.

- Right click the **Bluetooth** icon  located at the bottom right corner of the software.
- Choose the DataHub you've just paired and click on it. The computer will connect to the DataHub and turn the **Bluetooth** icon blue .



5.2.3 Pairing with an iPad

- Turn on the DataHub. Make sure the DataHub is not showing the sleep icon . If it does, please press any button to leave the sleep mode.
- Launch the iPad Setting .
- Open Bluetooth. Make sure the iPad Bluetooth is on.
- From the devices list click the "**DataHub-xxxx**", where the xxxx digits match the last 4 digits of your DataHub S/N sticker on the DataHub back cover.
- On the DataHub: Press and hold the SCROLL  key to put the DataHub in Pairing mode. The DataHub will produce a long "beep" while its screen shows "**BT pairing**".
- The iPad will ask for a PIN code. Enter "1234" and click Pair.
- The iPad will show **DataHub-xxxx** connected.
- Start the iOS DataHub software application. The application will automatically connect to the DataHub you have paired.

5.2.4 Pairing with Android OS


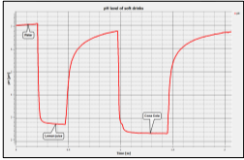
- Turn on the DataHub. Make sure the DataHub is not showing the sleep icon . If it does, please press any button to leave the sleep mode.
- On the tablet go to setting  and select "**Bluetooth**".
- Make sure the Bluetooth radio is "ON", then turn on "**Search for Devices**".

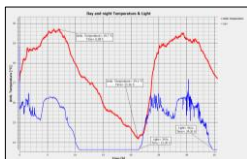


4. On the DataHub: Press and hold the SCROLL  key to put the DataHub in pairing mode. The DataHub will produce a long "beep" while its screen shows **"BT pairing"**.
5. From the devices list on the tablet tap the **"DataHub-xxxx"**, where the xxxx digits match the last 4 digits of your DataHub S/N sticker on the DataHub back cover.
6. The tablet will open the **"Bluetooth pairing request"** dialog box and display **"Type the device's required PIN"**
7. Enter the pairing code "1234" and tap **"OK"**
8. Pairing process is complete and the DataHub will appear on the tablet **"paired devices"** list.
9. Open the DataHub software application on the tablet.
10. Tap on the options icon at the top Action Bar  (rightmost, 3 vertical dots)
11. Tap on **"Connect DataHub"**, and select the name of the DataHub you'd like to connect (e.g. DataHub_1052).
12. The App name will change to show the DataHub you selected **(DataHub_xxxx)"** to indicate connection.

6. Experiment Samples

The Wards DataHub analysis software includes experiment samples, for teachers and students to view, analyze, modify or repeat. In this section some interesting Ward's DataHub analysis software recorded experiments are reviewed. To open a recorded experiment, simply press the **Open** icon in the software and select the files below:

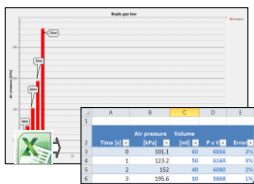
	<p style="text-align: center;"><u>Walk in the Park</u></p> <p>Micro climate activity. Comparing temperature and relative humidity at a city cross-road and park</p> <ul style="list-style-type: none"> • Sensors selected: External temperature, relative humidity, GPS • Sampling rate: 1/sec • Amount of samples: 1000 • Experiment duration: 15 minutes • Communication: Offline, data downloaded at recording's end • Data Analysis: Show temperature and humidity changes on Wards DataHub analysis software map view
	<p style="text-align: center;"><u>pH level of Soft Drinks</u></p> <p>A fun and interesting activity, comparing the acidity of water, lemon juice and Coca-Cola.</p> <ul style="list-style-type: none"> • Sensors selected: pH • Sampling rate: 10/sec • Amount of samples: 1000 • Experiment duration: 2 minutes approx. • Communication: Online, preferably with Bluetooth wireless communication • Data Analysis: Using Markers to measure the acidity level of the different liquids



Day and Night Temperature Changes

A long 48-hour recording of temperature and light levels, with the DataHub located on the window shelf:

- **Sensors selected:** Light, ambient temperature
- **Sampling rate:** 1/min
- **Amount of samples:** 1000
- **Experiment duration:** 48 hours
- **Communication:** Offline, data downloaded at recording's end
- **Data Analysis:** Use the **Markers** to show min/max. values



Boyle's Gas Law

Verifying the ideal gas law: $P \times V = \text{CONSTANT}$. Using a 100ml syringe connected to the air pressure sensor. Manually recording air pressure while decreasing the syringe volume by 10ml at a time.

- **Sensors selected:** Air pressure
- **Sampling rate:** Manual
- **Amount of samples:** 10
- **Communication:** Online, preferably via wireless Bluetooth
- **Data Analysis:** Use **Bar-Graph** view to see air pressure values. Use **Annotation** to add the volume for each bar and **Export to Excel** to calculate $P \times V$ multiplication.



The FCC Wants You to Know:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- a) Reorient or relocate the receiving antenna.
- b) Increase the separation between the equipment and receiver.
- c) Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- d) Consult the dealer or an experienced radio/TV technician.

FCC Warning

Modifications not expressly approved by the manufacturer could void the user authority to operate the equipment under FCC Rules.

NOTE: THE MANUFACTURER IS NOT RESPONSIBLE FOR ANY RADIO OR TV INTERFERENCE CAUSED BY UNAUTHORIZED MODIFICATIONS TO THIS EQUIPMENT. SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

INSTRUCTIONS CONCERNING HUMAN EXPOSURE TO RADIO FREQUENCY ELECTROMAGNETIC FIELDS

A distance of at least 20cm. between the equipment and all persons should be maintained during the operation of the equipment.



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Made for
iPad (3rd generation)
iPad 2
iPad

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