Experiment B-1
Blood Pressure

Biology

Objectives

- To understand the basics of blood pressure.
- To compare the blood pressure of students in the class.
- To investigate how external parameters such as exercise affect the blood pressure.

Modules and Sensors

- PC + NeuLog application
- USB-200 module
- NUL-222 Blood pressure logger sensor

Introduction

Blood pressure is the pressure of the circulating blood against the walls of arteries, veins and the chambers of the heart. It results from the force created by the heart as it pumps blood into the arteries through the circulatory system and the force of the arteries as they resist the blood flow. Blood pressure is expressed as systolic pressure, on contraction and as diastolic pressure, on relaxation.

For adults, a normal reading can be anywhere from 120/70 (systolic/diastolic) to 140/90 and can vary throughout the day. Blood pressure readings that are consistently 140/90 or above, are considered high and indicate the need for medical intervention.

Physical activity causes the blood pressure to rise for a short time and then return to normal. People with high blood pressure are often advised to try to become more active to lower it with time. It is important to follow the doctor's advice because high blood pressure

can lead to serious problems like a heart attack, stroke, heart failure or kidney disease.

The NeuLog blood pressure sensor consists of a blood pressure cuff, a hand pump and a pressure release valve. When the user pumps, a pressure is applied directly to the blood pressure monitor cuff's bladder and detected by the internal sensing unit. The pressure in the cuff is equal to the pressure operated on the subject's arm.

The cuff is inflated to reach a pressure above the expected systolic value. When the cuff is fully inflated to this pressure, blood does not flow through the artery. The cuff is slowly deflated to allow the blood to flow and push the arterial wall. The heart beats affect the pressure in the cuff and create very small fluctuations. An algorithm is used to calculate the systolic and diastolic values by the fluctuations pattern.

The three ranges of the sensor show the real measured pressure (in mm Hg.), only the pressure amplified fluctuations (Arb), and the combined signal of both of them.

With the "mm Hg + Arb" mode you can calculate these parameters:

MAP:
MAP (Mean Arterial Pressure) is the pressure where the fluctuations are maximum (between the systolic and diastolic values)

Systolic:
The pressure which blood exerts on the arterial walls while the heart is beating (the maximum pressure achieved).

Diastolic:
The pressure which blood exerts on the arterial walls while the heart is relaxed in between beats (the minimum pressure achieved).

Procedure

Experiment setup

When performing the blood pressure measurements, it is best to work with a partner.

Make a loop of the cuff around your partner's arm as shown in the following picture:

Wrap the cuff tightly, without causing discomfort, around your partner's upper arm. Ensure that the rubber tubing (connected directly to the blood pressure cuff) is situated a couple of centimeters above the inner elbow. The subject's arm should be supported and the cuff around it should be at the same level as the heart.

Sensor setup

1.   Connect the USB-200 module ⬛ to the PC.

2.   Check that the blood pressure sensor ⬛ is connected to the USB-200 module.
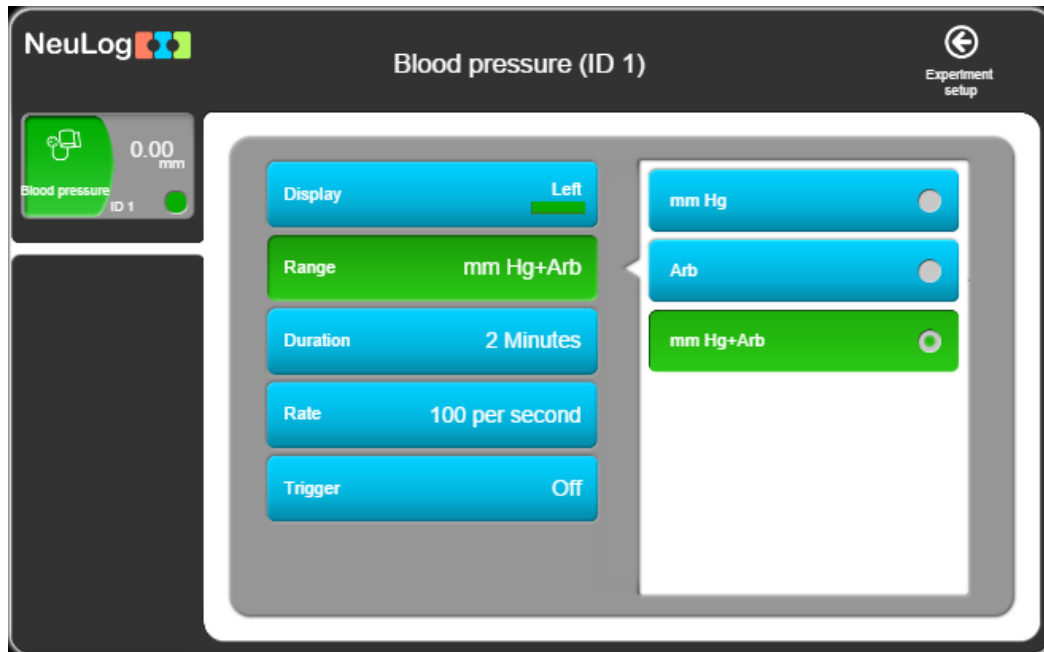
Note:

The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

3.   Run the NeuLog application and check that the blood pressure sensor is identified.

Settings

4. Click on the **Sensor's Module** box.

5. Select the mm Hg + Arb button to change the sensor's mode.

6. Click on the ⊙ icon to go back to the graph.

7. Click on the **Run Experiment** icon 🖼️ and set the:

   Experiment duration to 2 minutes
   Sampling rate to 50 per second

Testing and measurements

Procedure:

8. Close the air pressure release valve by twisting the metallic knob until it tightens (step number 1 in the figure below).

9. Click on the **Record** icon ⬛ to start the measurement.

10. Using the hand-pump fill the blood pressure cuff's bladder until it forms a snug but not uncomfortable fit (around 170 mm Hg should suffice).

11. When the maximum pressure is reached, loosen the pressure valve to allow a pressure decrease of about 3 to 4 mm Hg per second (around 20° to the other way as shown in step 2).
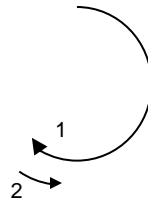
12. If the rate is different than approximately 3-4 mm Hg per second, stop the experiment and try again loosening the valve less or more than before.

13. At the end of the measurement, click on the **Zoom fit** icon 🔍 if needed.

14. Your graph should be similar to the following:
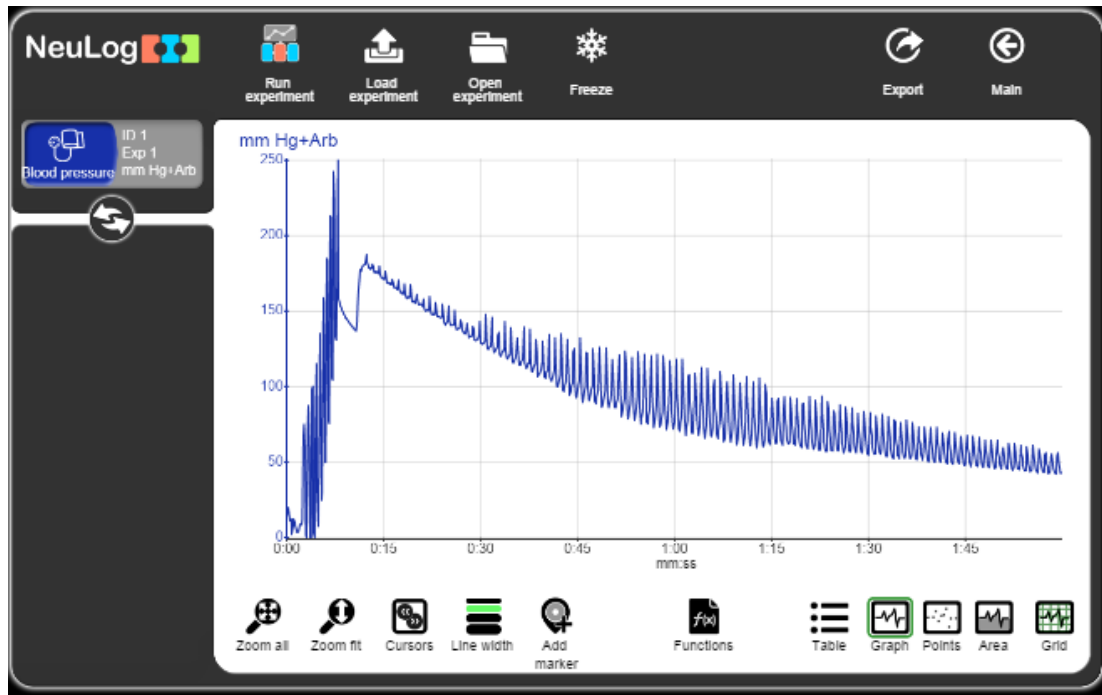
The pressure at the end of the measurement should be around 40 mm Hg. If the pressure did not go that low, you have to repeat the measurement opening a little more the release valve or increasing the duration of the measurement to 3 minutes.

15. To analyze the data, you have to select the relevant section of the measured values. Use the **Cursors** icon [icon] and choose the section between the two extremes of the pressure after the cuff was inflated. See the graph on the next page.

16. Click on the **Blood pressure module box** and then on the Calculate icon.
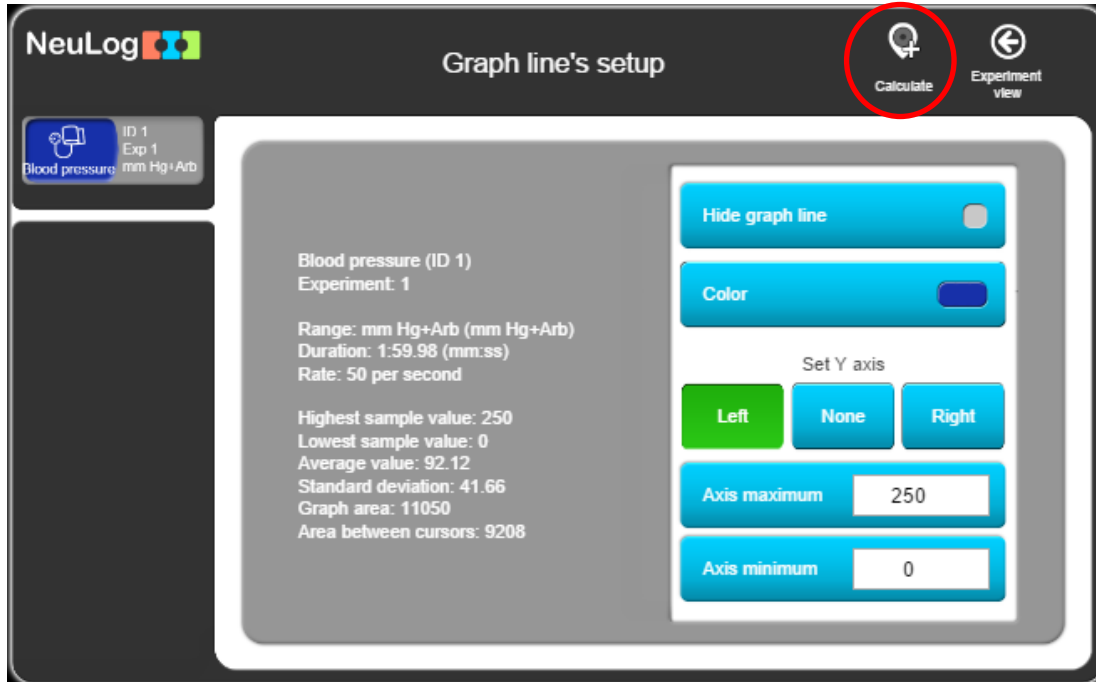
17. Click on the [icon] icon to go back to the graph.

18.   Three markers will appear on the graph. The markers represent the Systolic pressure, Diastolic pressure and MAP (mean arterial pressure). If you click on the markers, the relevant value appears along with the heart rate.
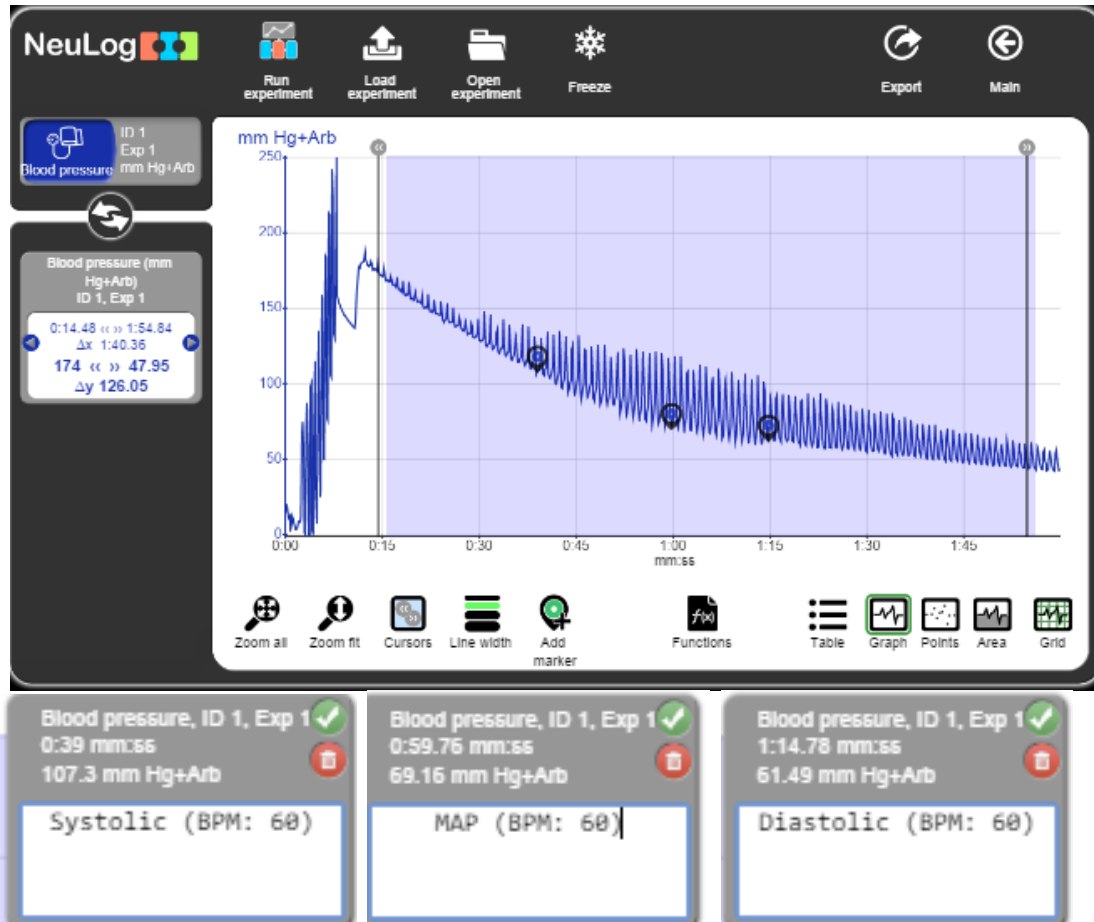
19.   Write down the results in the following table:

First subject:

Parameter Measured	Value
Heart rate in beats per minute	
Systolic Pressure in mm Hg	
Diastolic Pressure in mm Hg	
MAP in mm Hg	

20.   Click on the **Export** Icon and then on the **Save value table (.CSV)** button to save your graph.

21.   Click on the icon to go back to the graph.

22. Switch with your partner and let him measure your blood pressure. Write down the values and compare with your partner's.

Second subject:

Parameter Measured	Value
Heart rate in beats per minute	
Systolic Pressure in mm Hg	
Diastolic Pressure in mm Hg	
MAP in mm Hg	

Challenge research

23.   Perform 5 minutes of exercise and immediately afterwards measure the blood pressure and pulse. Compare your results. Calculate the percentage of change (second value/first value X 100%) in all the measured parameters and explain the changes.

First subject:

Parameter Measured	Value	Percentage of change
Heart rate in beats per minute		
Systolic Pressure in mm Hg		
Diastolic Pressure in mm Hg		
MAP in mm Hg		

Second subject:

Parameter Measured	Value	Percentage of change
Heart rate in beats per minute		
Systolic Pressure in mm Hg		
Diastolic Pressure in mm Hg		
MAP in mm Hg		

Summary questions

1.   Compare the blood pressure of all the students in your class and try to find physical patterns to the measured blood pressure. For example try to relate height, sportiveness, etc. to blood pressure.

2.   How can the temperature of the environment affect your blood pressure?