Experiment B-19
Heart Rate and Physical Activity

Objectives

- To measure a student's heart rate at rest.
- To study the effect of two levels of physical activity on the heart rate.

Modules and Sensors

- PC + NeuLog application
- USB-200 module
- NUL-208 Heart rate & pulse logger sensor

Introduction

The heart is a muscular organ that pumps blood to the body. Besides the heart, the circulatory system consists of arteries, veins and capillaries. The blood is pumped by the contraction of the heart's walls. Blood carries oxygen and nutrients to cells in the body, and carbon dioxide to the lungs (for exhalation).

The term heart rate is used to describe the frequency of the cardiac cycle. Heart rate is determined by the number of heart beats per minute (BPM). When the body is relaxed, the parasympathetic nervous system sets a heart rate of around 60-80 BPM. During exercise (or stress), the heart rate increases and more oxygen is delivered to the muscles. This is triggered by the sympathetic nervous system.

In this experiment, you will measure your heart rate while resting and after two different levels of physical activity.

Procedure

Sensor setup

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

2. Connect the heart rate & pulse sensor  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 heart rate & pulse sensor is identified.

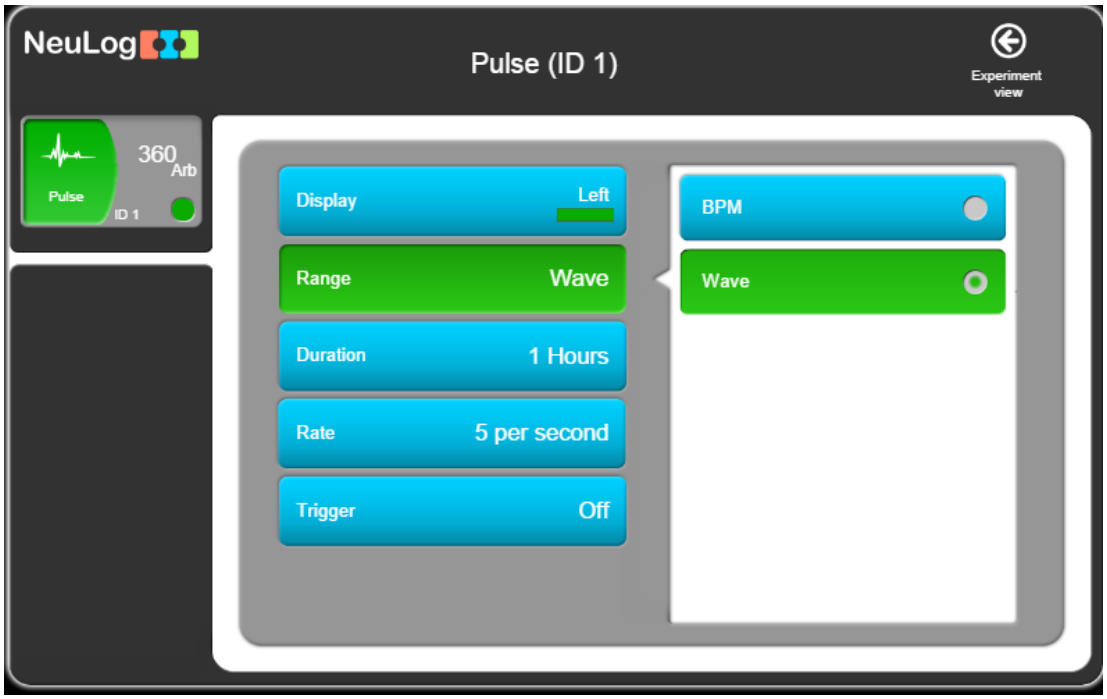
Settings

Note:

You can choose to see the pulse wave showing changes of blood volume/flow in the finger or earlobe with time (and calculate the heart rate) or get the value of the heart rate directly through the application. The operating mode is changed by clicking on the **sensor's Module** box.

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

5. Select the Wave button to change the sensor's mode to pulse waves.



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

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

   Experiment duration to 10 seconds
   Sampling rate to 100 per second

Note:

The experiment will be done in BPM mode but in order to determine the position of the sensor's clip on the finger we will first look at the heart rate as pulse waves.

Testing and measurements

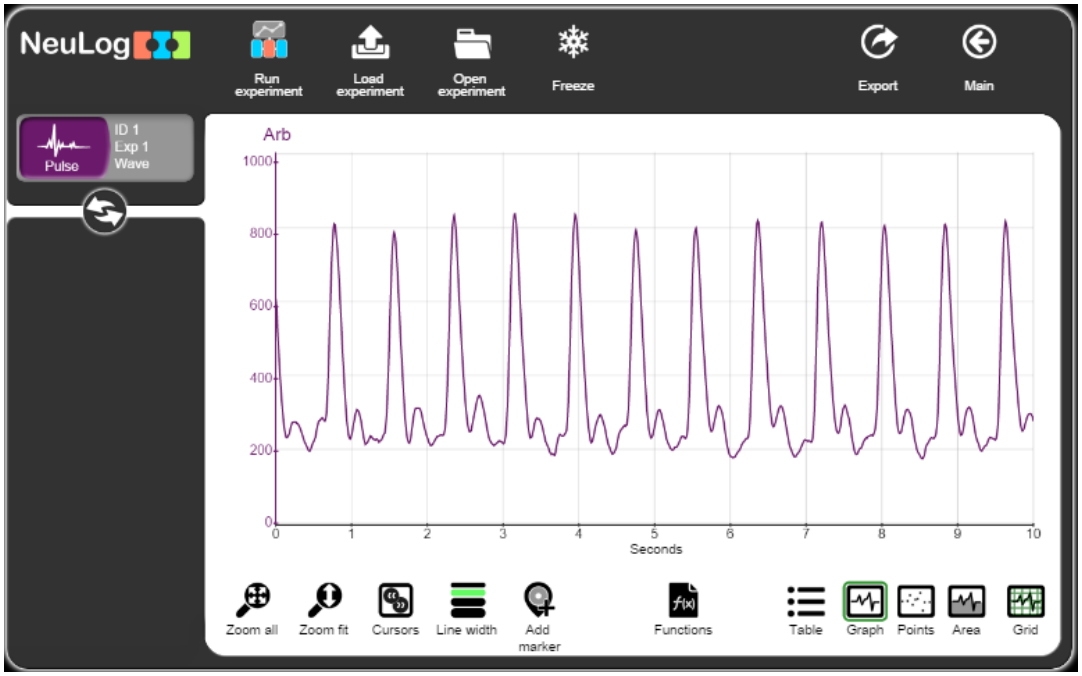
8. Put the sensor's clip on your finger (the little finger is preferred). Make sure that the infrared LED transmitter and the phototransistor receiver (located on the clip) are placed steadily on your finger.

   The LED emits infrared light to the finger, and the phototransistor receiver detects this light beam and measures the change of blood volume through the finger's blood vessels.

9. Keep your hand steady during the measurement and avoid high intensity lights.

10. Click on the **Record** icon to start the measurement.

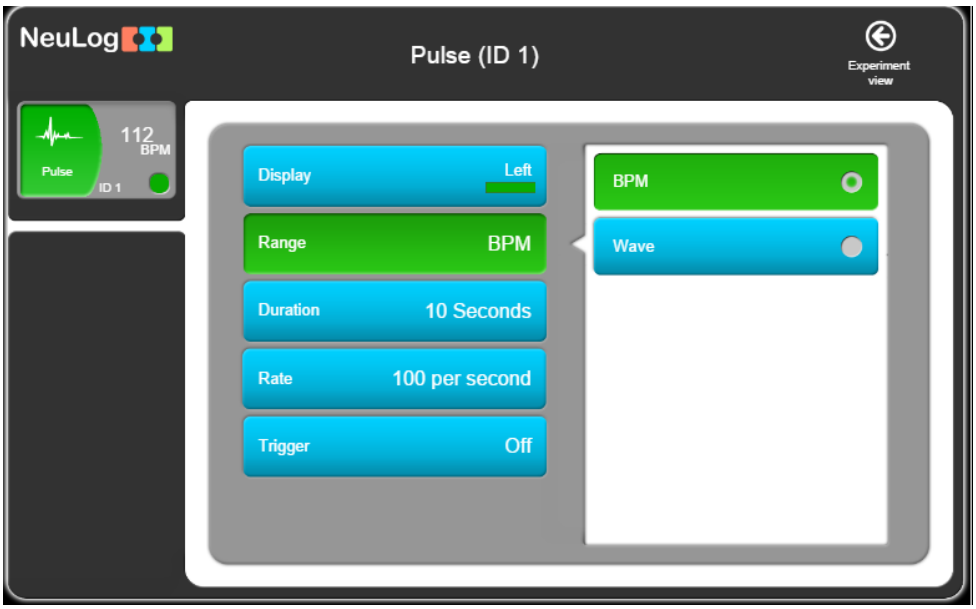
Click on the **Zoom fit** icon and observe the waves.



11. See if the waves look repetitive. If they do not, try to change the position of the sensor's clip or select a different finger.

12. Click on the **Arrows** icon .

13. Click on the **Sensor's Module** box to change the sensor's mode to BPM (beats per minute).



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

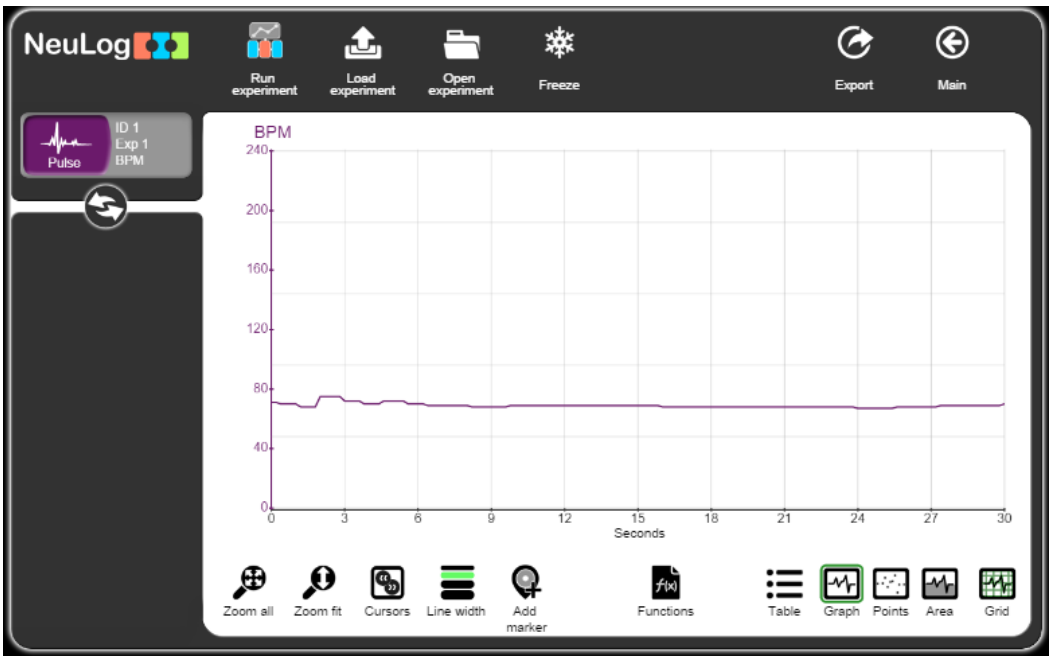
15. Click on the **Run Experiment** icon and set the:

    Experiment duration to 30 seconds
    Sampling rate to 5 per seconds

16. Observe the heart rate values that already appear on the module window. Since heart rate values refer to beats per minute, it may take a few seconds for them to stabilize.

17. Click on the **Record** icon to start the measurement.

18. Your graph should be similar to the one below. If you see sudden changes to extreme values during the measurement, repeat it until you get a stable one.

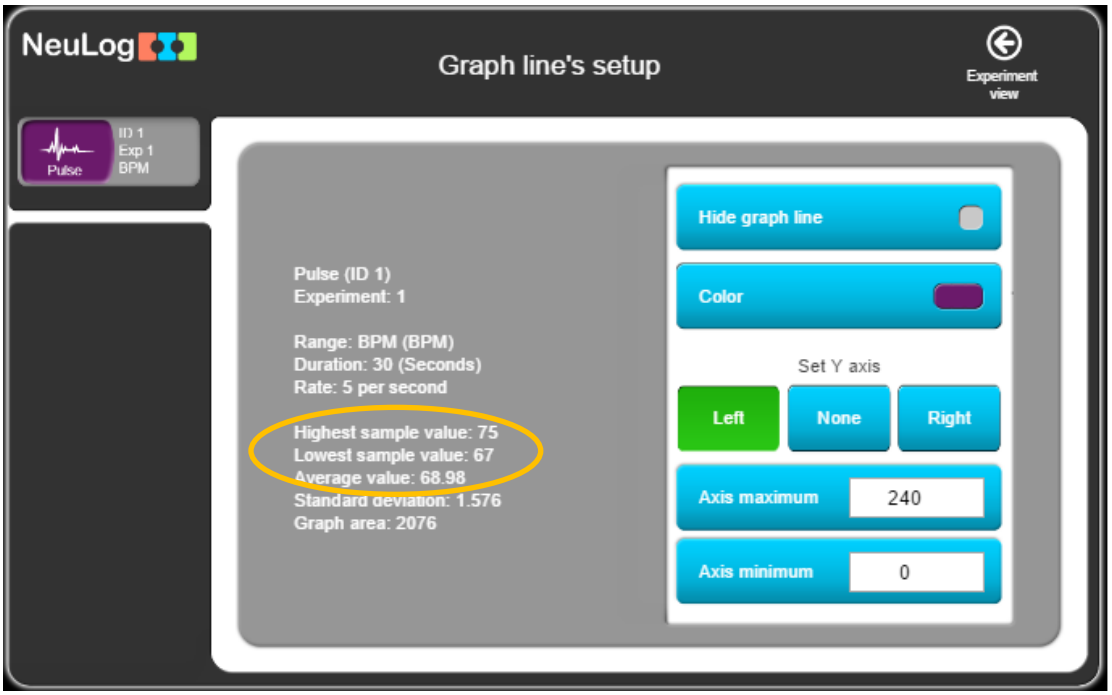


19. Click on the **Export** Icon and then on the **Save value table (.CSV)** button to save your graph.

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

21. Take off the sensor's clip.

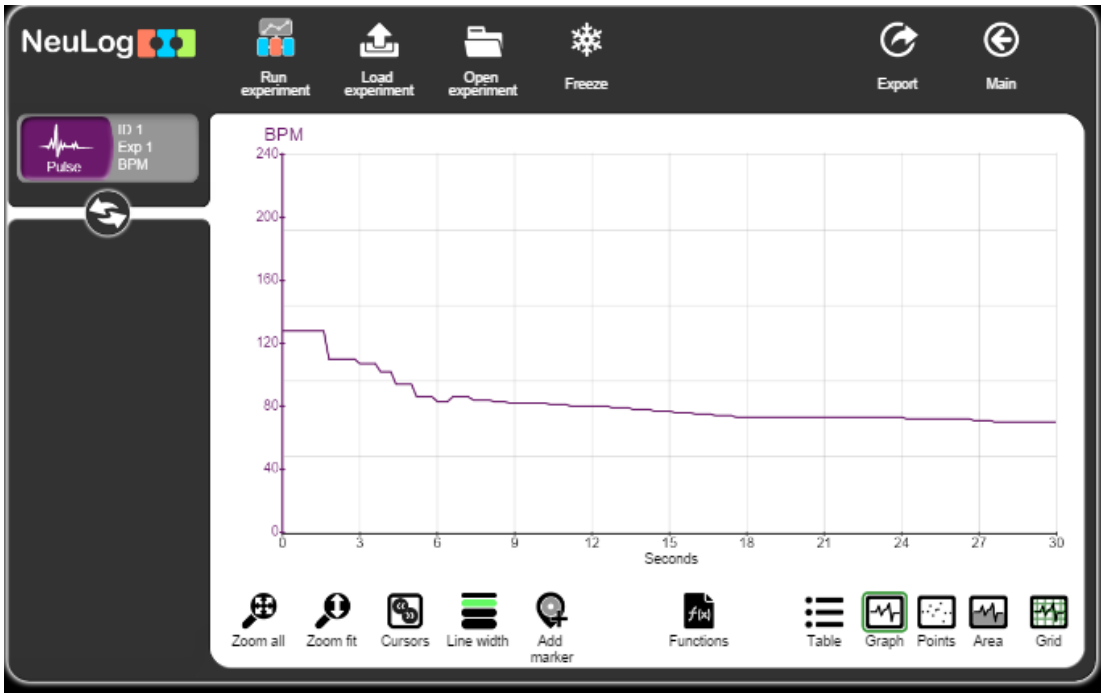
22. Click on the **Experiment's module box** on the left of the screen. You will see the minimum and maximum values.



23. Repeat the measurement among other members in your group.

24. Choose one student from the group (that measured his/her heart rate at rest), who will perform physical activity. The student should run for 30 seconds, then he/she should repeat the measurement (wait a few seconds after putting the clip on the finger but not too much since you should measure the heart rate as soon as possible after the physical activity).

25. Your graph should be similar to the following:



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

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

28. We can see that compared to the first graph, which was relatively stable and showed an average of 68.98 BPM, this graph starts with around 120 BPM and continues with a decrease in the heart rate.

    When we perform physical activity, the heart rate rises along with blood pressure and respiration. Active muscles need a lot more oxygen and nutrients than inactive ones. That is why the heart works harder in physical activity in order to meet these needs.

    Exercise improves the health of the heart, which becomes stronger so it can pump more blood with every beat; therefore, people who exercise regularly usually have a relatively low heart rate at rest and also during exercise.

Challenge experiment

29. Repeat the physical activity experiment but instead of running, walk for 30 seconds. Try to guess what will be your heart rate after walking.

Summary questions

1. According to your results, is the heart rate a good indication of physical fitness?

2. Explain why did we see a decrease in the heart rate during the physical activity measurement?

3. Compare the measurements of the two levels of physical activity.