




Experiment P-47 Acceleration of an Elevator



Objectives

- To learn about acceleration and the principles of an acceleration sensor (accelerometer).
- To analyze the acceleration of a moving elevator or vehicle.

Modules and Sensors

- PC + NeuLog application
- USB-200 module 
- BAT-200 Battery module 
- NUL-227 Acceleration logger sensor 

Note:

This experiment is performed in an elevator. It is also possible to conduct a similar experiment in a moving vehicle (while working in a horizontal axis).

Introduction

Acceleration is the rate at which an object changes its velocity and it is marked by the letter a . The acceleration is determined by the ratio between the change in velocity and the time it took. The formula is:

$$a \text{ (average)} = \frac{v \text{ (final)} - v \text{ (initial)}}{t \text{ (final)} - t \text{ (initial)}}$$

The formula above describes average acceleration (or constant acceleration). In order to calculate the object's momentary acceleration ($a(t)$), we divide a very small section of the velocity change by the time difference.

The direction of the acceleration vector depends on two things, whether the object is speeding up or slowing down, and the direction of motion (+ or -). If an object is slowing down, its acceleration is in the opposite direction of its motion.



Direction of motion	Positive	Negative	Positive	Negative
Speeding up / slowing down	Speeding up	Speeding up	Slowing down	Slowing down
Positive / negative acceleration	Positive	Negative	Negative	Positive

The NeuLog acceleration sensor (an accelerometer) measures static acceleration due to gravity and dynamic acceleration due to the sensor's motion (as described above). By measuring static acceleration, one can find out the angle the sensor is tilted with respect to the Earth. By measuring dynamic acceleration, one can find out how the velocity of the sensor changes with time.

When the sensor is not moving and is facing upwards, the reading is 9.8 m/s^2 (because it includes static acceleration). When the sensor is at free fall and is facing upwards, the reading is 0 m/s^2 . If we are interested only in the vertical axis (Z axis) and in the dynamic acceleration, we can subtract 9.8 m/s^2 from the readings and get 0 m/s^2 when the sensor is not in motion and -9.8 m/s^2 when the sensor is at free fall.

Procedure

Sensor setup

1. Connect the USB-200 module  to the PC.
2. Check that the acceleration logger sensor  is connected to the USB-200 module.

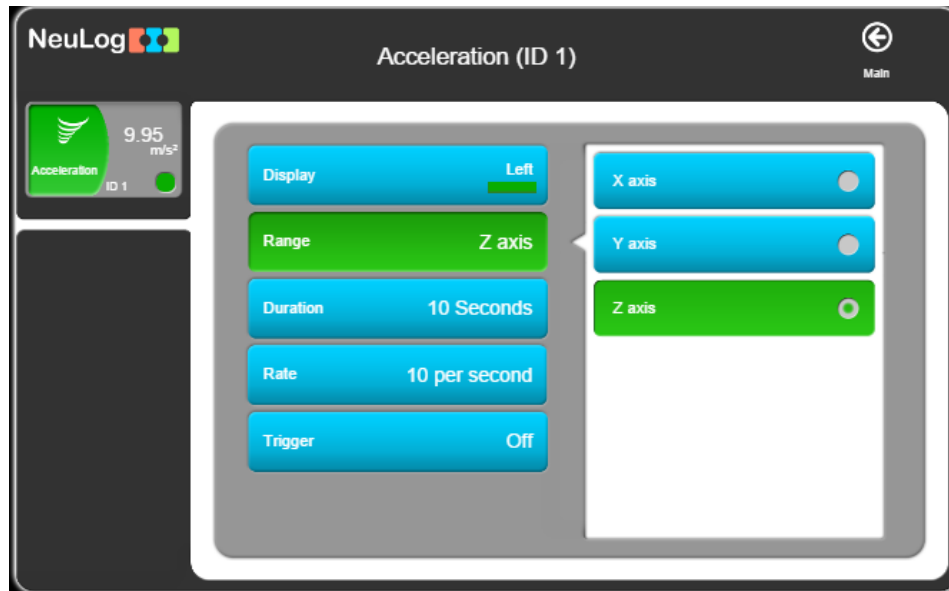
Note:

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 acceleration sensor is identified.

Settings

4. Click on the **Sensor's Module** box.
5. Click on the **Range** button.
6. Select the **Z axis** button to change the sensor's mode.




7. Set the:
Experiment duration to 1 minute
Sampling rate to 50 per second

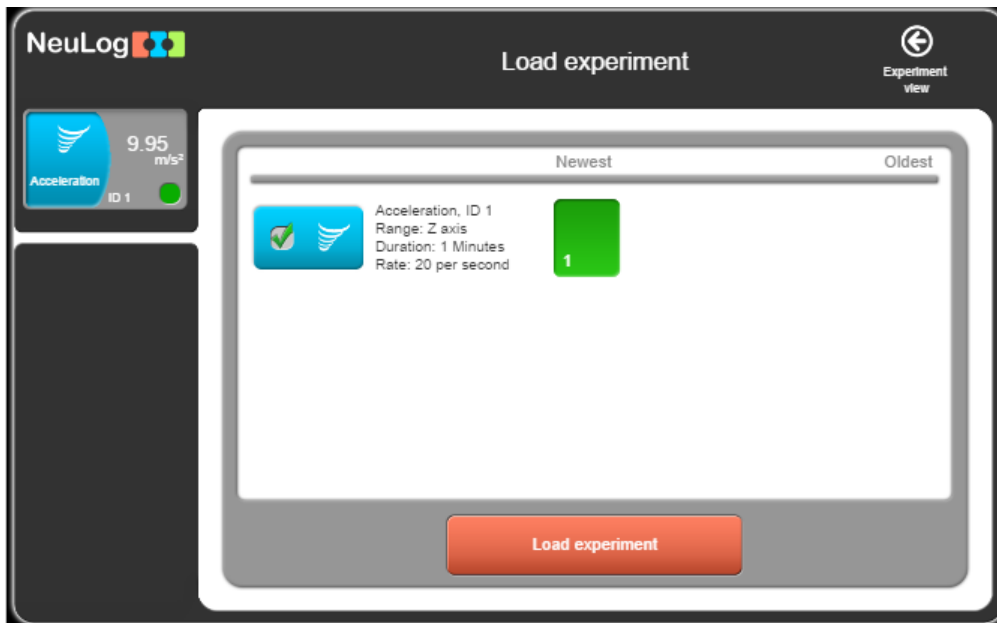
Testing and measurements


8. Disconnect the sensor from the USB-200 module and connect it to the battery module.

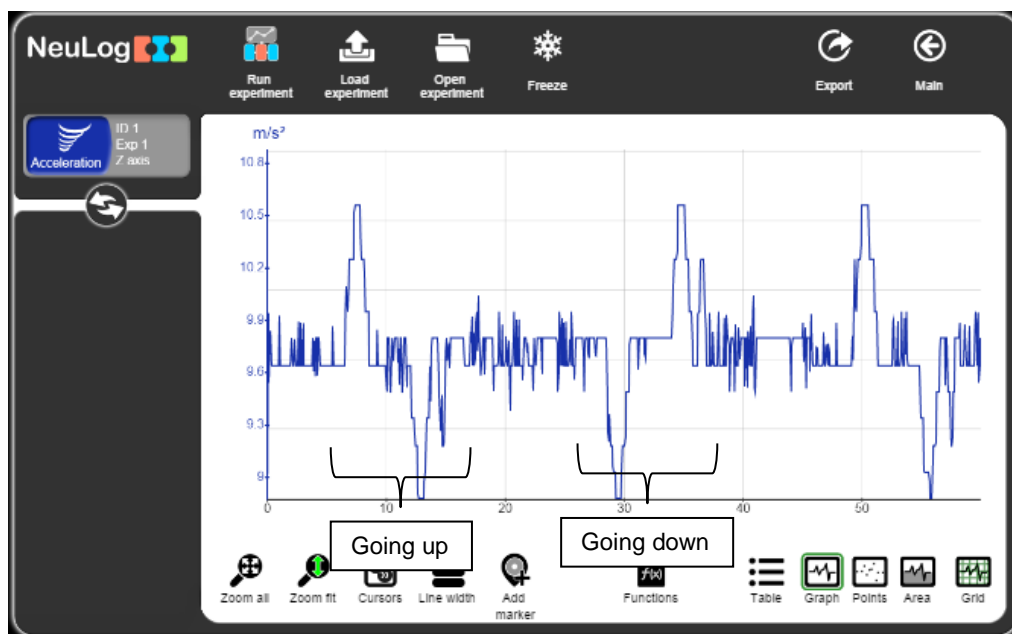


9. Locate the sensor on the elevator's floor, facing upwards.
10. Begin the measurement by pressing the sensor's **Start/stop** button. The sensor's LED should turn on.
11. Press the elevator's button in order to make it to go up one floor.
12. Now make it go down one floor. Keep making these rounds a few more times until the experiment is over (3 minutes).
13. Connect the acceleration sensor back to the USB-200 module.
14. Click on the **Load Experiment** icon .

The menu shows a list of stored experiments in the sensor's memory (up to 5).



15. Choose the required experiment and click on the **Load Experiments** button.
16. Click on the **Zoom fit** icon .
17. Your graph should be similar to the following:



18. Save your graph.

19. The acceleration increases while speeding up towards the positive direction (up). When the elevator reaches the designated floor, it slows down until it stops; in this part the acceleration decreases (if we subtract 9.8 m/s^2 from the reading we will see it is actually negative).

Summary questions

1. Describe what happens to the acceleration while the elevator is going down.
2. What will be the reading on the acceleration sensor if the elevator fell without a cord? What would be the dynamic acceleration in this case?
3. Draw a graph describing the dynamic acceleration in the following scenario:

A car is moving in a straight line, it is first speeding up and then stops. It is speeding up in reverse and stops. It is speeding up in reverse again and then stops.

