MiniLab – Net Force

1. An object of mass m is lifted by a person and accelerates upward amount a. Derive an expression for the force F applied by the person in terms of m, a, and any appropriate constants.

2. Test your result by using the Force and Acceleration sensor. Connect to Graphical Analysis – either by Bluetooth or USB connection. (see screenshots). Use ONLY sensor channels Force and x-axis Acceleration.

3. Once the sensor is connected, adjust the display to show two meters – notice the force and acceleration readouts. If held at rest on the table with the x-axis pointed upward, both should read zero (but probably will not). Click on the sensor control and Zero the acceleration. Also, still vertical and at rest, click to Zero the force reading as well (nothing should be touching the force "bumper").

4. Once the sensors are zeroed, hold the sensor hanging by the force "bumper" (with a firm grip!). Click on the Collect button and then move the sensor smoothly up and down. Zoom in and inspect the graphs of Force and Acceleration vs. time – notice similarities? You should!

5. Create a single graph of force as a function of acceleration including line of best fit.

6. Attach the 50 gram mass to the bottom of the sensor using the thumbscrew. Collect new data as before – how does this affect the line of best fit?

7. Explain how the experiment supports or refutes the equation derived in question #1.

8. The slope equals what? The y-intercept equals what?

Vernier Graphical Analysis

Sensors ✕

No Devices Connected

Connect to a wireless device below or connect via USB.

Discovered Wireless Devices

🪄 **PROXIMITY CONNECT**

Filter Device List

e.g., 007 or TMP

❋ GDX-FOR 072051R8   Connect

DONE

Untitled

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

0   1   8   9   10

Vernier Graphical Analysis

Untitled

COLLECT

Sensors ✕

Connected Devices

✱ GDX-FOR 072051R8 ⓘ   **Disconnect**

▼ **SENSOR CHANNELS**   Force, X-axis acceleration
☑ Force
☑ X-axis acceleration
☐ Y-axis acceleration
☐ Z-axis acceleration
☐ X-axis gyro
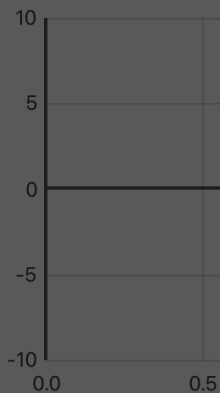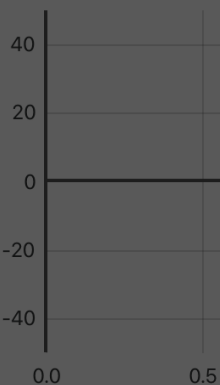☐ Y-axis gyro
☐ Z-axis gyro
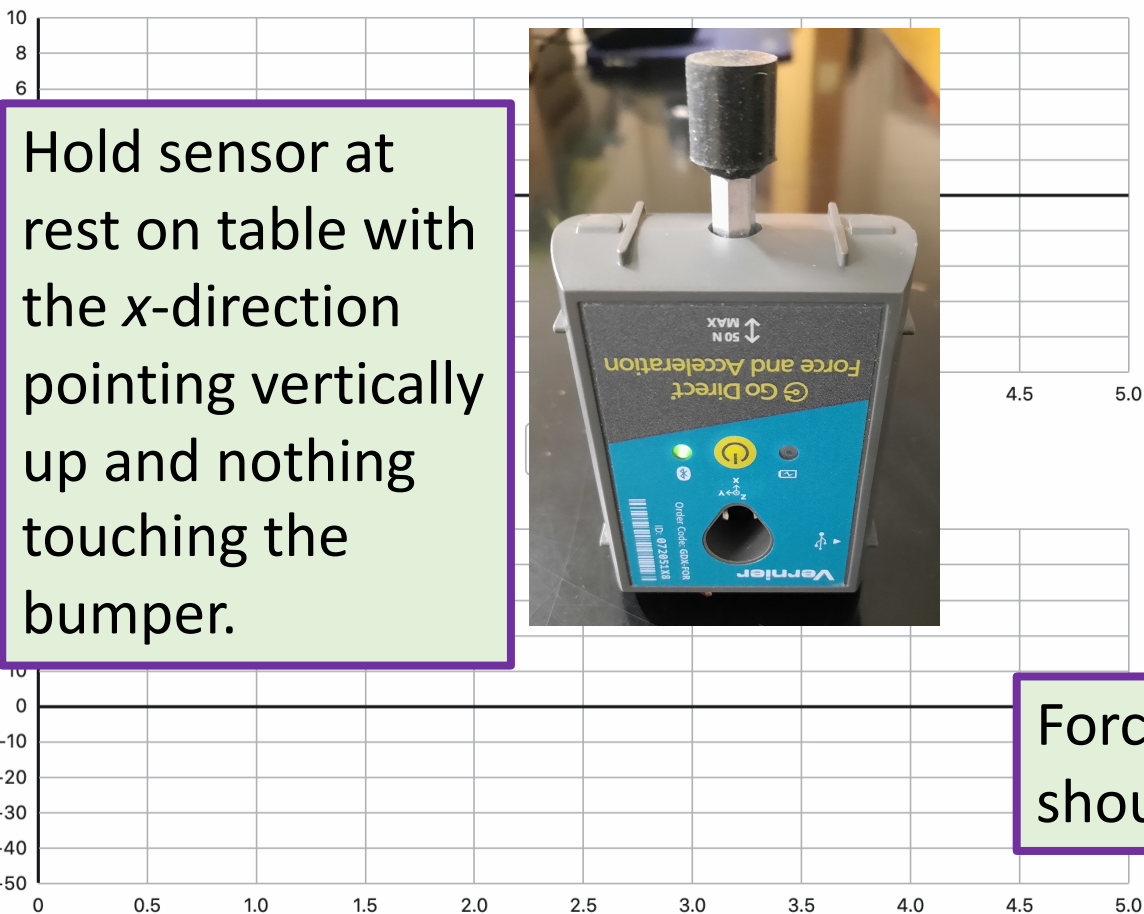
Discovered Wireless Devices

🪄 **PROXIMITY CONNECT**

Searching for devices...

DONE

Mode: Time Based   Rate: 50 samples/s   Force: **-0.13 N**   X-axis acceleration: **0.12 m/s²**

Vernier Graphical Analysis
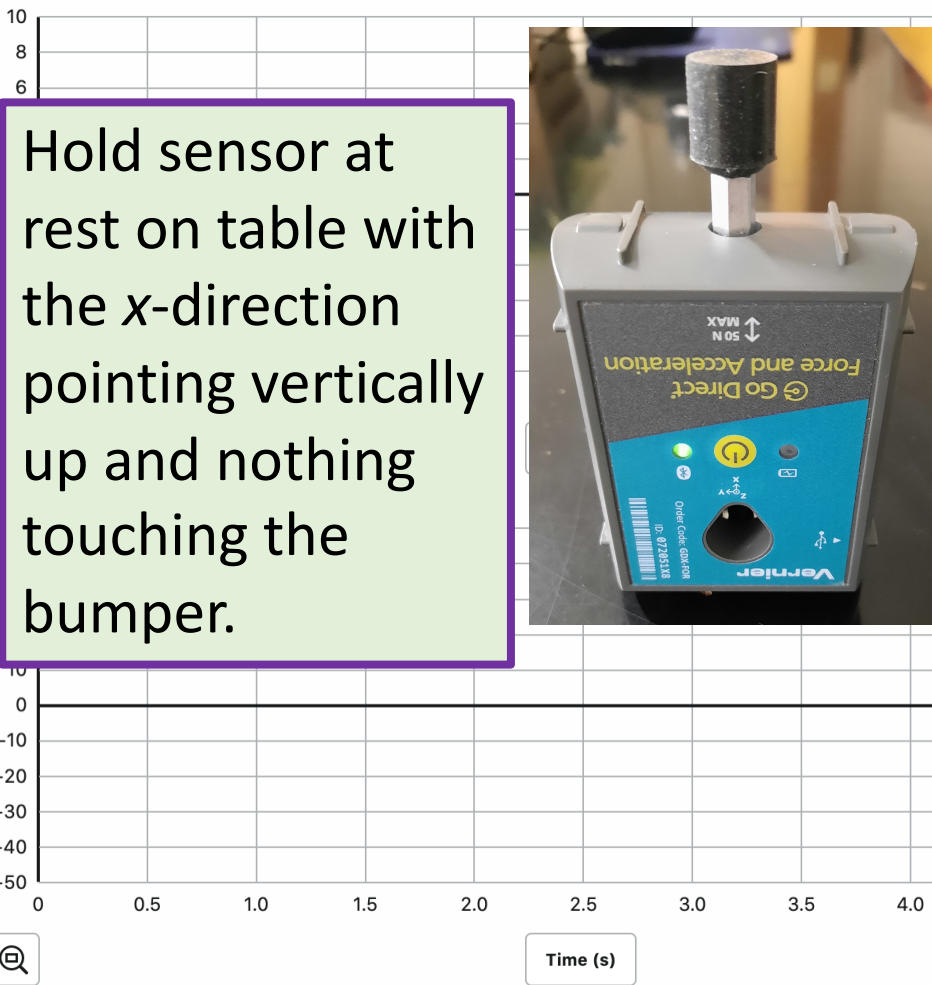
Untitled

COLLECT

Force:
-0.22 N

X-axis acceleration:
9.93 m/s²

Hold sensor at rest on table with the *x*-direction pointing vertically up and nothing touching the bumper.

Force and acceleration should both equal zero...

Mode: Time Based   Rate: 50 samples/s

Force: **-0.22 N**   X-axis acceleration: **9.93 m/s²**

Untitled

COLLECT

10
8
6

Force (N)

Hold sensor at rest on table with the *x*-direction pointing vertically up and nothing touching the bumper.

4.5   5.0

Force:
0.00 N

X-axis acceleration:
-0.05 m/s²

Go Direct
Force and Acceleration

50 N MAX

Order Code: GDX-FOR
ID: 072051X8

Vernier

FORCE
GDX-FOR 072051R8

Calibrate

Zero

Reverse

Units   N

X-AXIS ACCELERATION
GDX-FOR 072051R8

Calibrate

Zero

Units   m/s²
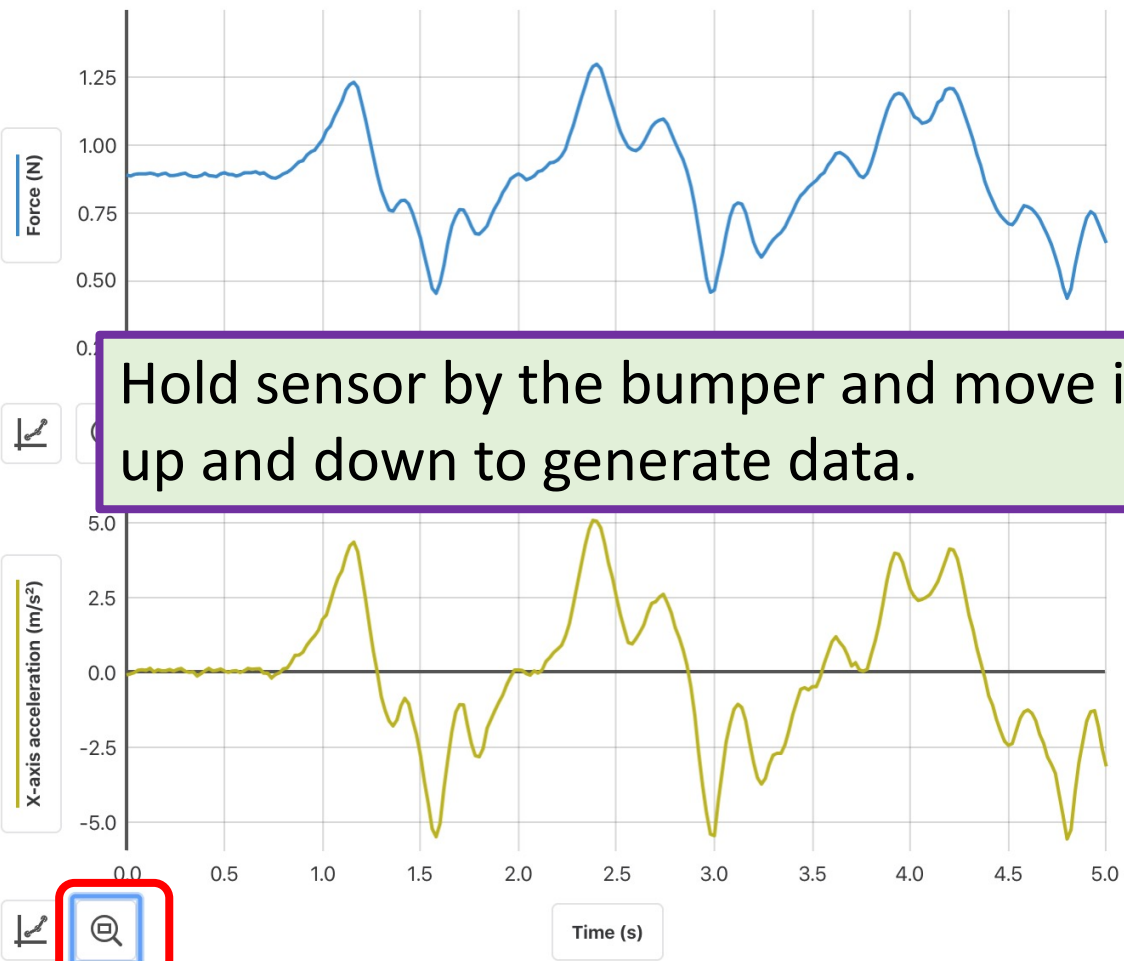
X-axis acceleration (m/s²)

10
0
-10
-20
-30
-40
-50

0   0.5   1.0   1.5   2.0   2.5   3.0   3.5   4.0

Time (s)

Mode: Time Based   Rate: 50 samples/s

Force: **0.00 N**   X-axis   X-axis acceleration: **-0.15 m/s²**

Vernier Graphical Analysis

COLLECT
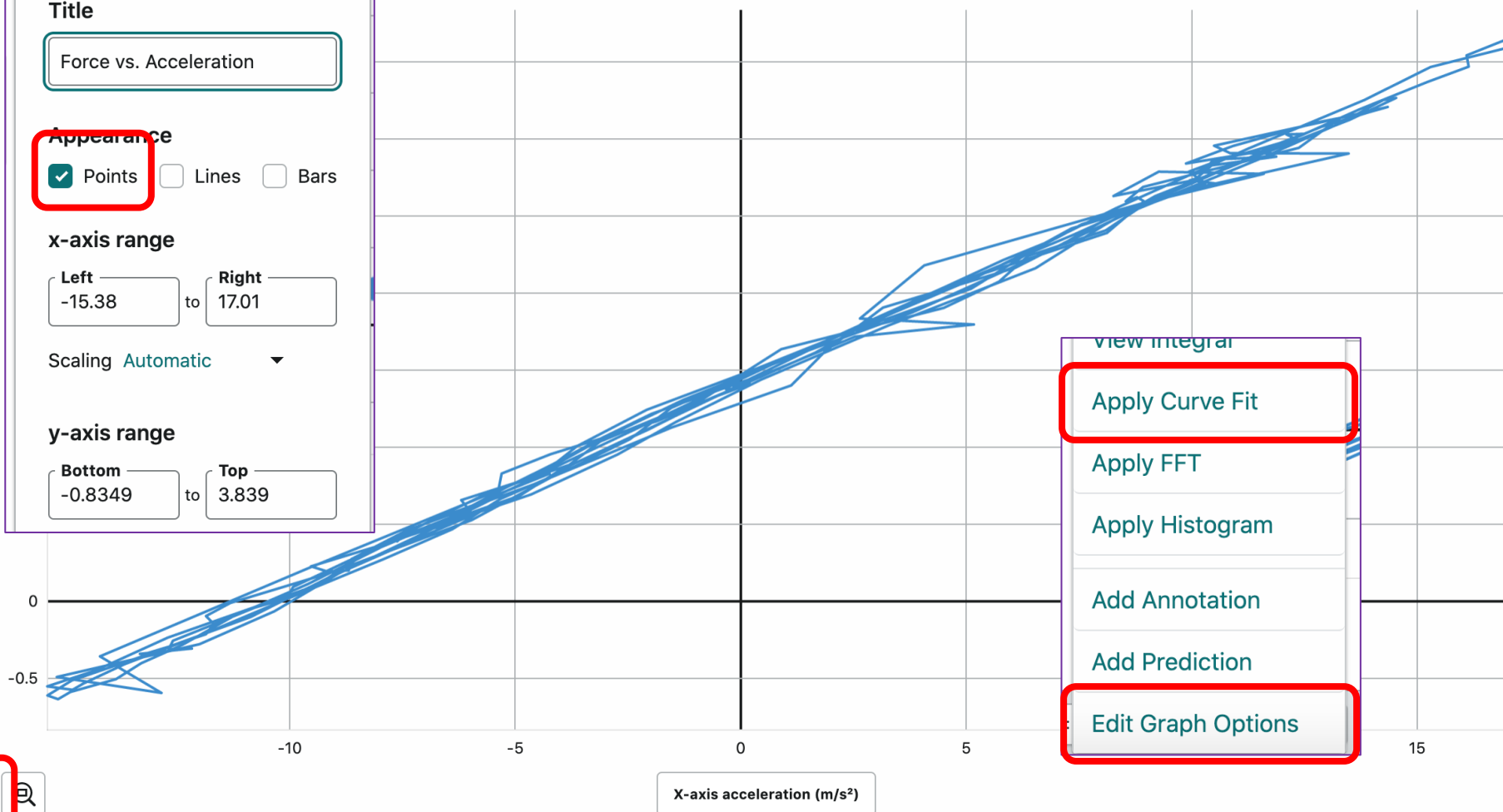
Force vs. Acceleration

LINEAR ⊖ ✕

x-range: -15.38 - 17.01 m/s²

$y = mx + b$

m: 0.1322
b: 1.399
r: 0.9985
RMSE: 0.06303

Force (N)

X-axis acceleration (m/s²)

Mode: Time Based   Rate: 50 samples/s

Force: **0.01 N**   X-axis acceleration: **0.04 m/s²**