Goniometer
(Order Code GNM-BTA)

The Goniometer measures the angle of a joint, such as the knee or elbow. Use it to measure the range of motion of a joint. A set of elastic straps can be used to secure the sensor to the subject for dynamic measurements of joint angle during different types of physical activity. You can also use it with a Vernier EKG Sensor to measure muscle activity during different phases of limb motion. In addition, the sensor head can be detached from both arms of the sensor for use in STEM and engineering activities.

What is Included with the Goniometer
- One Goniometer: joint angle sensor attached to metal stationary arm
- One 12-inch flexible joint arm (comes attached to sensor)
- One 10-inch flexible joint arm
- One 8-inch flexible joint arm
- Two 24-inch elastic hook and loop straps
- Two 14-inch elastic hook and loop straps

NOTE: Vernier products are designed for educational use. Our products are not designed nor recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

Collecting Data with the Goniometer
This sensor can be used with the following interfaces to collect data.
- Vernier LabQuest® 2 or original LabQuest as a standalone device or with a computer
- Vernier LabQuest Mini with a computer
- Vernier LabPro® with a computer or TI graphing calculator
- Vernier Go!®Link
- Vernier EasyLink®
- Vernier SensorDAQ®
- CBL 2™
- TI-Nspire™ Lab Cradle

Here is the general procedure to follow when using the Goniometer.
1. Connect the Goniometer to the interface.
2. Start the data-collection software.
3. The software will identify the Goniometer and load a default data-collection setup. You are now ready to collect data.

Data-Collection Software
This sensor can be used with an interface and the following data-collection software.
- **Logger *Pro* 3** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go! Link.
- **Logger Lite** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go! Link.
- **LabQuest App** This program is used when LabQuest 2 or LabQuest is used as a standalone device.
- **DataQuest™ Software for TI-Nspire™** This calculator application for the TI-Nspire can be used with the EasyLink or TI-Nspire Lab Cradle.
- **EasyData App** This calculator application for the TI-83 Plus and TI-84 Plus can be used with CBL 2, LabPro, and Vernier EasyLink. We recommend version 2.0 or newer, which can be downloaded from the Vernier web site, www.vernier.com/easy/easydata.html, and then transferred to the calculator. See the Vernier web site, www.vernier.com/calc/software/index.html for more information on the App and Program Transfer Guidebook.
- **LabVIEW™** National Instruments LabVIEW™ software is a graphical programming language sold by National Instruments. It is used with SensorDAQ and can be used with a number of other Vernier interfaces. See www.vernier.com/labview for more information.

This sensor is equipped with circuitry that supports auto-ID. When used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, Go! Link, SensorDAQ, TI-Nspire™ Lab Cradle, EasyLink, or CBL 2™, the data-collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor.

Attaching the Goniometer to a Person
1. Select one member of the group to be the test subject. Thread two 24-inch elastic straps through the slots that can be found on the stationary arm of the Goniometer.
2. Secure the stationary arm of the Goniometer to the upper leg or arm of the subject using the elastic straps, as shown in Figure 1.
3. Make sure the dial on the sensor is centered on the joint being studied. Reposition and secure the Goniometer, if necessary.
4. Using a single 14-inch elastic strap, secure the flexible arm of the Goniometer to the foreleg or forearm.
5. Verify that the subject can move freely with the Goniometer attached to the limb being studied.

Figure 1

Collecting Data

1. Connect the Goniometer to the data-collection interface.
2. Start the data-collection software. The software will identify the sensor and load a default data-collection setup.
3. Zero the sensor to report positive and negative joint angles from the subject's starting position.
   - Computer Users: Choose Zero from the Experiment menu.
   - LabQuest Users: Choose Zero from the Sensors menu on the Meter screen.
4. Start data collection.

Optional Calibration Procedure

Calibrating the Goniometer may not be necessary for some activities. If you are evaluating the range of motion of a joint, such as the knee or elbow, then the stored calibration should work well. For dynamic analysis of a joint you may want to calibrate the sensor before attaching it to a subject.

The instructions for calibration are dependent on the data-collection software you are using.

Calibrating the Goniometer with a Computer

1. Choose Calibrate from the Experiment menu. Click Calibrate Now in the Sensor Settings dialog box.
2. Select the box marked One Point Calibration. Click the Calibrate Now button.
3. Rotate the flexible arm of the Goniometer until it is positioned 180º from the stationary arm, as shown in Figure 2.
4. Verify that the set screw on the side of the dial is aligned with the silver dot on the baseplate. Reposition the dial if necessary.
5. Enter 180º for Value 1. Click Keep, and then click OK.

Figure 2

Calibrating the Goniometer with LabQuest App

1. Choose Calibrate from the Sensors menu. Select the box marked One point calibration. Tap the Calibrate Now button.
2. Rotate the flexible arm of the goniometer until it is positioned 180º from the stationary arm. Verify that the set screw on the side of the dial is aligned with the silver dot on the baseplate of the sensor.
3. Enter 180º for Value 1. Tap Keep, and then tap OK.

Helpful Hints

You can easily reverse the reporting direction of the Goniometer using the data-collection software. This is very useful for comparing joint activity from left and right limbs. The instructions for reversing direction are dependent on the data-collection software you are using.

- Computer Users: Choose Set Up Sensors from the Experiment menu, then select your interface (LabQuest, LabPro, etc.). Click the image representing the Goniometer. Select Reverse Direction, and then close the dialog box.

- LabQuest Users: Tap the angle reading on the Meter screen. Choose Reverse Direction. Select the box for the Goniometer.

You can easily increase the length of the 14-inch strap if it is too short to comfortably wrap around the foreleg or forearm. Thread the second 14-inch strap through the eyelet of the first strap. Fold the second strap over itself so that the hook and loops lock. This will increase the length of the strap by 8 inches.

Changing the Flexible Arm of the Goniometer

The Goniometer comes with a set of flexible arms that vary in size. For subjects with smaller limbs, you may want to use one of the smaller joint arms on this sensor. To change the flexible arm, simply loosen and remove the screw that secures the arm to the dial. Select the appropriate joint arm and fasten it to the sensor with the screw provided. Verify that the terminal edge of the joint arm is aligned with the set screw on the side of dial. Reposition the flexible arm of the Goniometer, if necessary. Follow the directions for calibrating the sensor.

Specifications

Range	0–340º (or ±170º)
Accuracy	±3º
	±1º (with calibration)
Resolution	
13-bit (SensorDAQ)	0.06º
12-bit (LabPro, LabQuest, LabQuest 2, TI-Nspire™ Lab Cradle, LabQuest Mini)	0.12º
10-bit (CBL 2™)	0.5º
Stored calibration values	
slope	90º/V
intercept	–45º

How the Goniometer Works

The flexible arm of the Goniometer is attached to a metal dial on the sensor head that can rotate 360º. A magnet inside the sensor rotates with this dial. A magnetic encoder is used to report the position of the magnet. As the magnet rotates, the encoder produces a voltage that is converted into the position (angle) of the dial by the data-collection software.

Suggested Experiments

Measure the range of motion of various anatomical joints

Students measure the range of motion of different anatomical joints in this exercise. The knee, elbow, hip, wrist, ankle, and hand can all be measured using the Goniometer. Standard bony landmarks are used to mark the axis of rotation for each joint. As a result, the Goniometer does not need to be attached to the subject for this exercise.

Measure the range of motion of the elbow or knee during physical activity

In this type of activity, the Goniometer is attached to the subject's arm or leg. The range of motion of the joint is then recorded during physical activity. Standard weight lifting exercises can be used for the leg and arm, such as squats, leg extensions, bicep curls, dips, and triceps extensions. As shown in Figure 3, dynamic range of motion can be studied during running. Dynamic range of motion can also be studied while cycling.
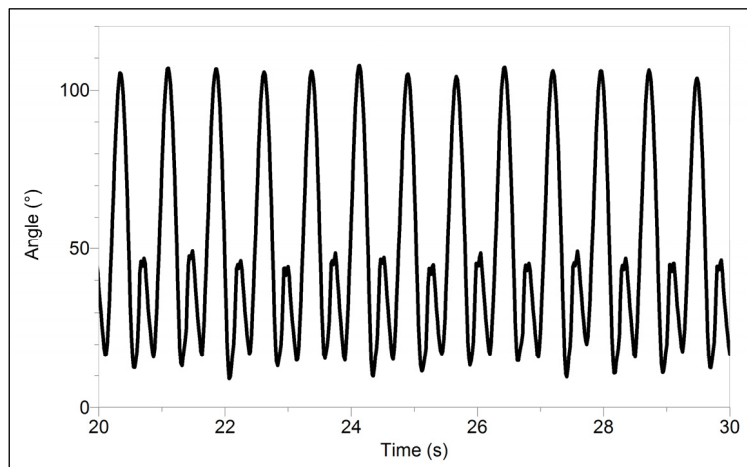
Figure 3 Goniometer data from knee while running

Measure the activity of different muscle groups during limb movement

In this type of activity, the Goniometer is used with one or more EKG Sensors to measure the electrical activity of different muscle groups during physical activity. Standard weight lifting exercises can be used for the leg and arm. The bicep curl is an excellent exercise for this lab. As shown in Figure 4, bicep activity increases during flexion and will decrease during extension.
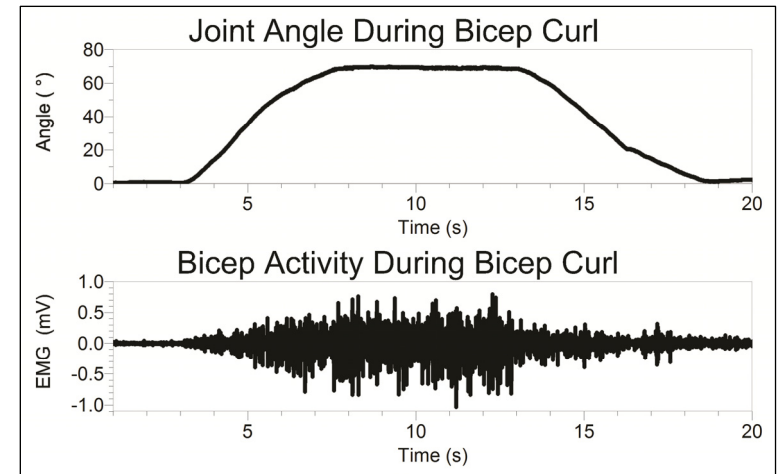

Figure 4

Measure heart rate and dynamic motion of the knee during physical activity

In this type of activity, an Exercise Heart Rate Monitor and the Goniometer are used to measure heart rate and dynamic range of the knee during physical activity. As shown in Figure 5, a standard exercise bike work well for this exercise. Treadmills and rowing machines can also be used in this type of activity.
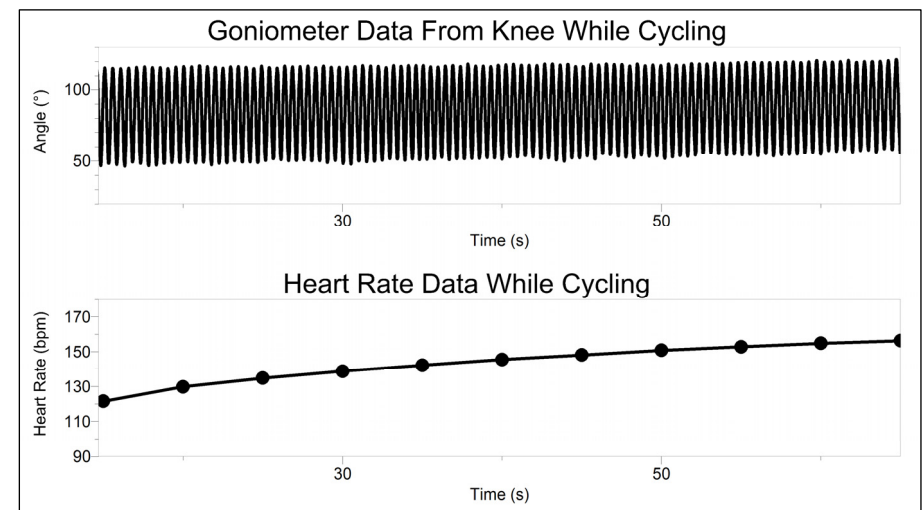

Figure 5

Replacement Parts

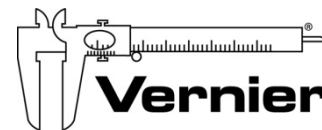| Name	Order code
Goniometer Replacement Arms (3 flexible arms)	GNM-ARMS
Goniometer Replacement Straps (4 elastic straps)	GNM-STRAPS

Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.