Experiment HM-5: Flexibility and Range of Motion (ROM)

Background

The movement of body parts by the action of muscles on bones occurs around articulations in the skeletal system that are known as **joints**. The directions from which muscles pull on bones, the locations where muscles are attached to bones, and the shape of the joint determine the direction in which a joint normally bends. The connective tissue that covers the muscles and the tendons that connect the muscles to the bones limit the movement within a joint. The **flexibility** of a joint is the ability of a body part to move through its normal range of motion. This flexibility can be determined by simple **range of motion** (**ROM**) tests. ROM exercises can aid physical therapists, athletic trainers, and physicians when they are examining joint dysfunction. Unlike aerobic and anaerobic fitness where the goals is maximum endurance and strength, respectively, maximum flexibility or range of motion may not be the best condition that can occur to a joint being tested. Physical therapists and athletic trainers often use the term *optimal* flexibility, which implies that too much or too little flexibility are both potentially harmful. There is a a certain ROM for each joint that is classified as *optimal*.

Athletes and individuals who participate in physical activities generally are classified as being *flexible* due to the fact that their joints function over wide ranges of movement. Good flexibility may improve body position and awareness, enhance athletic performance, and help prevent injuries during and soreness after exercise. Some people have extremely flexible joints with wide ranges of motion. This **hyperflexibility** can eventually lead to damage to joints by *over-stretching* the joint connective tissue. Gymnasts and figure skaters train to increase the ROM of their joints which can lead to joint dysfunction later in life. As individuals age, there is usually a decrease in physical activity and tissues lose their elasticity. Maintaining flexibility becomes more challenging with age, and loss of flexibility can severely impair normal range of motion in older individuals.

A joint's ROM is expressed as the number of degrees of rotation that occur when the joint goes from its starting position, which is usually full flexion, through its full range of motion to its end position, which is usually full extension. The most common device used to measure range of motion is the single-axis goniometer. This type of goniometer has two arms, one stationary and one moving. The stationary arm, which holds a sensor or electronic protractor, is placed parallel to the stationary portion of the joint. The movable arm is placed along the moveable side of the joint. The axis of the goniometer is placed directly over the joint. This type of goniometer can make accurate measurements of the ROM of the joint along a single axis. Examples of the types of movements that can be measured include: flexion/extension/hyperextension, abduction/adduction, and plantar flexion/dorsiflexion.

In this experiment, students will use a single-axis goniometer to measure the flexibility and range of motion of the wrist, elbow, ankle, and knee of various subjects.

Equipment Required

PC Computer

IWX/214 data acquisition unit

USB cable

IWX/214 power supply

GN-100 Single-axis goniometer

Velcro straps

Protractor

Small weight (optional)

IWX/214 Setup

1. Place the IWX/214 on the bench, close to the computer.
2. Check Figure T-1-1 in the Tutorial Chapter for the location of the USB port and the power socket on the IWX/214.
3. Check Figure T-1-2 in the Tutorial Chapter for a picture of the IWX/214 power supply.
4. Use the USB cable to connect the computer to the USB port on the rear panel of the IWX/214.
5. Plug the power supply for the IWX/214 into the electrical outlet. Insert the plug on the end of the power supply cable into the socket on the rear of the IWX/214. Use the power switch to turn on the unit. Confirm that the power light is on.

Start the Software

1. Click on the LabScribe shortcut on the computer's desktop to open the program. If a shortcut is not available, click on the Windows **Start menu**, move the cursor to **All Programs** and then to the listing for **iWorx**. Select **LabScribe** from the **iWorx submenu**. The LabScribe **Main window** will appear as the program opens.
2. On the **Main window**, pull down the **File menu** and select **Open.**
3. Locate the folder on the hard drive of the computer that contains the settings file for this experiment. Select the **Settings (*iwxset)** file type from the menu at the bottom of the **Choose a file window**. Select the **Range of Motion-LS2** settings file from the list of available settings in the window. Click the **Open button** in the lower right corner of the window.

4 After a short time, LabScribe will appear on the computer screen as configured by the **Range of Motion-LS2** settings.

5 For your information, the settings used to configure the LabScribe software and the IWX/214 unit for this experiment are listed in Table HM-5-1 on page HM-5-2 These settings are programmed on the **Preferences Dialog window** which can be viewed by selecting **Preferences** from the **Edit menu** on the LabScribe **Main window**.

Table HM-5-1: Settings on the Channel Window of the Preferences Dialog Used to Configure the iWorx Recording System for Experiment HM-5.

Parameter	Units/Title	Setting	Mode/ Function
Acquisition Mode		Chart	
Start		User	
Stop		User	
Display Time	Sec	20	
Speed	Samples/Sec	200	
Channel 3	Range of Motion	S	BNC

Goniometer Set Up and Calibration

1 Locate the GN-100 single-axis goniometer (Figure HM-5-1 on page HM-5-2).

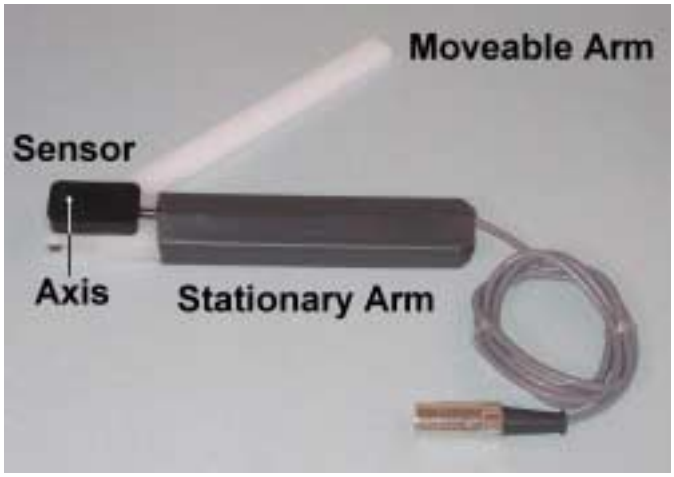

Figure HM-5-1: The GN-100 Single-axis Goniometer.

2 Insert the DIN-8 connector on the GN-100 goniometer into Channel 3 of the IWX/214 (Figure HM-5-2 on page HM-5-2).

3 Place the GN-100 Goniometer on the table with the 2 arms in the **closed position**. Use a protractor to measure the angle between each arm.

4 Type **Closed** and the **angle** (**in degrees**) between the two arms in the **Mark box** to the right of the **Mark button**.

5 Make sure the GN-100 goniometer arms are in the **closed position**. Click the **Record button** in the upper right corner of the LabScribe **Main window**.

6 Record with the GN-100 goniometer in the closed position for 5 seconds. Either click on the **Mark button** or press the **Enter key** on the keyboard to label the recording. Continue recording.

7 Open the arms of the GN-100 as far as possible. Use a protractor to measure the angle between each arm.

Figure HM-5-2: The GN-100 goniometer connected to an IWX/214.

8 Type **Open** and the **angle** (**in degrees**) between the two arms in the **Mark box** to the right of the **Mark button**. The open angle should be **180 degrees or greater**.

9 Make sure the GN-100 goniometer arms are in the **fully open position**. Record for 5 seconds. Either click on the **Mark button** or press the **Enter key** on the keyboard to label the recording when the trace reaches a plateau.

10 Click the **Stop** button.

11 Select **Save As** in the **File menu**, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder). Designate the file type as ***.iwxdata**. Click on the **Save** button to save the data file.

Units Conversion

1 Scroll to the beginning of the calibration data for the GN-100 single-axis goniometer.

2 Use the **Display Time** icons to adjust the **Display Time** of the **Main window** to show the complete calibration data on the same window. The required data can also be selected by:

- Placing the cursors on either side of data required

- Clicking the **Zoom between Cursors button** on the LabScribe toolbar to expand the calibration data to the width of the **Main window**.

3 Click the **2-Cursor icon** (Figure HM-5-3 on page HM-5-3) on the LabScribe toolbar so that two blue cursors appear on the **Main window**.

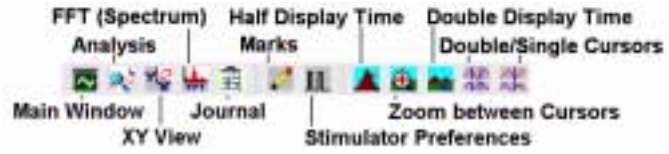

Figure HM-5-3: The LabScribe Toolbar.

4 Place one cursor on the section of data collected when the goniometer was in the closed position, and the second cursor on the section of data collected when the goniometer was in the open position (Figure HM-5-4 on page HM-5-3).

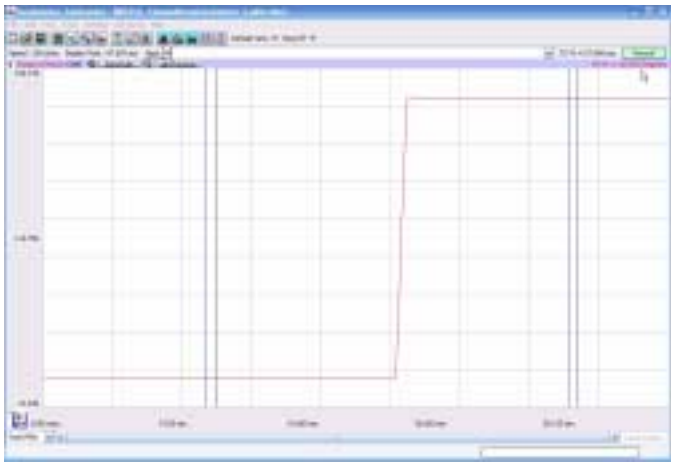

Figure HM-5-4: GN-100 goniometer calibration data with cursors in the correct positions for converting the Y-axis angle of deflection (in degrees).

5 Open the **Channel menu** of the **Goniometer Angle** channel by clicking on the **down arrow** to the left of the channels's title. Select **Units** from this menu and **Simple** from the submenu to open the **Simple Units Conversion dialogue window** (Figure HM-5-5 on page HM-5-3).

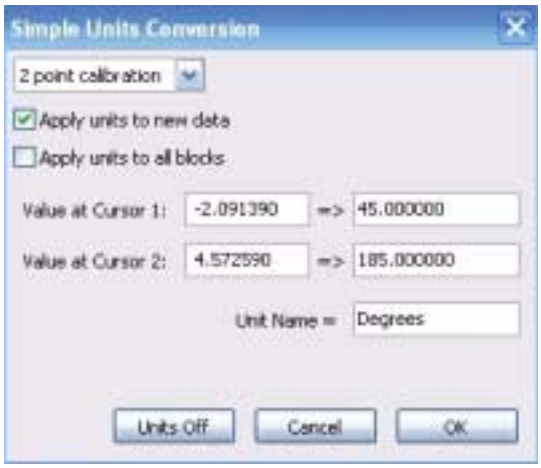

Figure HM-5-5: The Simple Units Conversion dialogue window with the voltages at the cursors set to equal the closed and open angles of the GN-100 goniometer.

6 On the **Simple Units Conversion dialogue window**, make sure **2 point calibration** is selected in the pull-down menu in the upper left corner of the window. Put check marks in the boxes next to **Apply Units to new data** and **Apply Units to all blocks**.

7 Notice that the voltages from the positions of the cursors are automatically entered into the value equations. Enter the values for the two angles used in the calibration recording in the corresponding boxes on the right side of the conversion equations.

- For **Cursor 1,** the value is the angle when the goniometer is closed.
- For **Cursor 2**, the value is the angle when the goniometer is fully open.
- Enter the name of the units, **Degrees**, in box below the values.
- Click on the **OK button** in the lower right corner of the window to activate the units conversion.

8 Select **Save As** in the **File menu**, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder). Designate the file type as ***.iwxdata**. Click on the **Save** button to save the data file.

Exercise 1: Palmar Flexion and Extension of the Wrist

Aim: To study the range of motion (ROM) in the wrist.

Procedure

1 Strap the GN-100 goniometer to the right wrist of the subject using the Velcro straps so that the goniometer axis is located at the joint of the carpals with the radius and ulna. The straps should hold the goniometer firmly to the wrist but not restrict any movement.

Figure HM-5-6: Position of the GN-100 on the right wrist.

2 Instruct the subject that he or she will be doing the following during this exercise:

- Before the recording begins, the subject extends his or her arm in front of their body with the palm facing upward. This position is defined as the **neutral position** (Figure HM-5-7 on page HM-5-4).
- Keep his or her hand open (fingers extended) during the recording.
- Move his or her hand upward (**palmar flexion**) from the neutral position as far as possible and hold it in this position for five seconds (Figure HM-5-7 on page HM-5-4).
- Return the hand to the neutral position (**extension**) for five seconds.

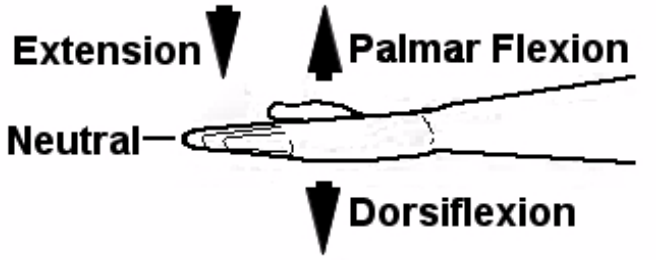

Figure HM-5-7: Movements performed while recording palmar flexion and extension of the wrist.

• Continue recording as the subject repeats the cycle of flexion and extension two more times.

3 Before starting the recording, type **Neutral-Open** in the **Mark box** to the right of the **Mark button**. Instruct the subject to place his or her hand in the **neutral position**.

4 Click the **Record button** in the upper right corner of the LabScribe **Main window**. Click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

5 While the subject's hand is in the neutral position, type **Palmar Flexion-Open** in the **Mark box**.

6 Instruct the subject to flex his or her hand. When the subject's hand reaches the flexed position, click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

7 While the subject's hand is in the flexed position, type **Neutral** in the **Mark box**.

8 Instruct the subject to extend his or her hand to the neutral. When the subject's hand reaches the neutral position, click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

9 Repeat Steps 3 through 8 for two more cycles of palmar flexion and extension.

10 Instruct the subject to curl his or her fingers into a tight fist. Repeat Steps 3 through 8 three times while the subject the subject is forming a tight fist. Mark the recording with appropriate comments to indicate when the subject's fist underwent palmar flexion or extension to the neutral position.

11 When the last cycle is completed, click the **Stop** button.

12 Select **Save As** in the **File menu**, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder). Designate the file type as ***.iwxdata**. Click on the **Save** button to save the data file.

13 **Optional Exercise 1**: Repeat Steps 3 through 9 while the subject is holding a one pound weight in his or her right hand.

14 **Optional Exercise 2**: Attach the goniometer to the inside of the subject's left wrist. On this wrist, the moveable arm of the GN-100 can go below the neutral position. Use the same techniques used in Steps 3 through 9 to measure the range of motion of the subject's left hand as it undergoes dorsiflexion (Figure HM-5-7 on page HM-5-4).

Data Analysis

1 Scroll through the recording and find the section of data recorded while the subject was flexing and extending his or her hand (Figure HM-5-8 on page HM-5-4).

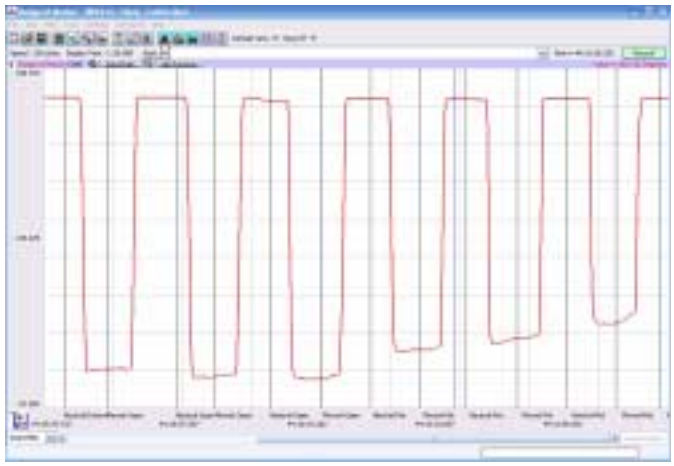

Figure HM-5-8: Recording of the range of motion of a subject's wrist when moved from neutral to full flexion, while the subject's hand was open (first three flexions) and then curled into a tight fist (last three flexions).

2 Use the **Display Time** icons to adjust the **Display Time** of the **Main window** so that the three extension-flexion cycles performed while the subject's hand was open appear on the **Main window**. The three extension-flexion cycles can also be selected by:

• Placing the cursors on either side of the three adjacent cycles; and

• Clicking the **Zoom between Cursors** button on the LabScribe toolbar to expand the segment with the three cycles to the width of the **Main window**.

3 Click on the **Analysis window icon** in the LabScribe **toolbar** (Figure HM-5-9 on page HM-5-4) or select **Analysis** from the **Windows menu** to transfer the data displayed in the **Main window** to the **Analysis window** (Figure HM-5-10 on page HM-5-5).

Figure HM-5-9: The LabScribe toolbar.

4 Look at the **Function Table** that is above the channel displayed in the **Analysis** window. The mathematical functions, **Value1**, **Value 2**, and **V2-V1** should appear in this table. The values for **Value1**, **Value 2**, and **V2-V1** are seen in the table across the top margin of the channel.

5 Once the cursors are placed in the correct positions for measuring the angles for extension, flexion, and range of motion of the wrist, the values for these angles can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the **Journal**.

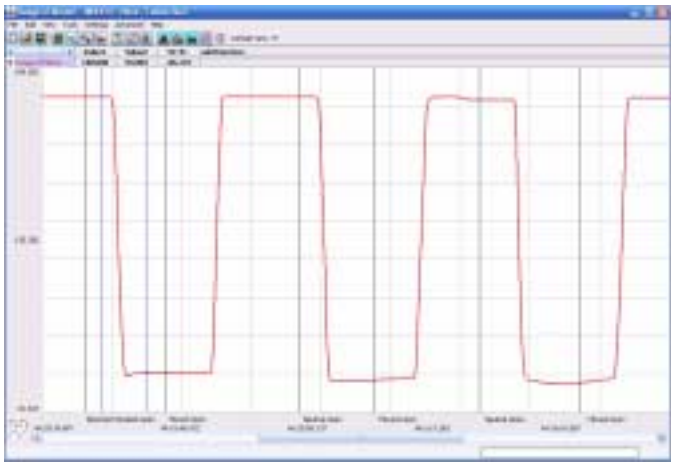

Figure HM-5-10: Recording of the angle of motion of a subject's wrist displayed in the Analysis window.The range of motion for the first flexion, while the subject's hand was open, was 93.803 degrees (V2-V1)

6 The functions in the **channel pull-down menus** of the **Analysis window** can also be used to enter the names and values of the angles in the **Journal**. To use these functions:

• Place the cursors at the locations used to measure the angles.

• Transfer the names of the mathematical functions used to determine the angles to the **Journal** using the **Add Title to Journal** function in the **Range of Motion channel pull-down menu**.

• Transfer the values for the angles to the **Journal** using the **Add All Data to Journal** function in the **Range of Motion channel pull-down menu**.

7 Use the mouse to click and drag the cursors to the first extension-palmar flexion cycle displayed in the **Analysis window**. Place one cursor on the data recorded during the extension and the other cursor on the data recorded during the palmar flexion (Figure HM-5-10 on page HM-5-5). The angles of extension (**Value1**), palmar flexion (**Value2**), and range of motion (**V2-V1**) are listed in the table under the names of these parameters. Record the names of the parameters and the angles in the **Journal** using the one of the techniques described earlier in this exercise, and on Table HM-5-2 on page HM-5-5.

8 Repeat Steps 5 through 7 on the other two cycles of extension and palmar flexion recorded while the subject's hand was open.

9 Scroll to the data recorded while the subject was flexing and extending his or her hand when it was formed into a tight fist. Use the same techniques used earlier to measure and record the angles of extension, palmar flexion, and range of motion for the three extension-palmar flexion cycles recorded in this section of the experiment.

10 Select **Save** in the **File** menu.

11 Determine the averages of the angles of extension, palmar flexion, and range of motion for the wrist when the hand is open and closed. Record the averages in the **Journal** and Table HM-5-2 on page HM-5-5.

Questions

1 Compare the values of palmar flexion and extension of the wrist from your subject to the values on Table HM-5-4 on page HM-5-8. Does your subject have average, above average, or below average range of motion?

2 Does extension or flexion of the fingers (open hand or tight fist) affect the range of motion of the joint?

3 If the subject used a weight, was there any difference in palmar flexion or extension while holding the one pound weight?

4 What happens if the subject keeps his or her elbow stationary and rotates the palm of the hand so that it is facing the midline of the body rather than upward? Is there any difference in the range of motion during palmar flexion when the palm is up or inward? During dorsiflexion?

Table HM-5-2: Angles of Flexion and Extension of the Wrist and Elbow.

	Wrist Angles (degrees)			
Action	1st	2nd	3rd	Average
Extension Hand Open (V1)				
Palmar Flexion, Hand Open (V2)				
Range of Motion, Open (V2-V1)				
Extension Hand Closed (V1)				
Palmar Flexion Hand Closed (V2)				
Range of Motion, Closed (V2-V1)				
Extension Weight (V1)				
Palmar Flexion Weight (V2)				
Range of Motion Weight (V2-V1)				
Dorsiflexion (V1)				
	Elbow Angles (degrees)			
Action	1st	2nd	3rd	Average
Extension (V1)				
Flexion (V2)				
Range of Motion (V2-V1)				
Hyperextension (V1)				

Exercise 2: Flexion and Extension of the Elbow

Aim: To study the flexibility and range of motion (ROM) in the elbow.

Procedure

1 Firmly strap the GN-100 goniometer to the inside of the subject's right elbow using the Velcro straps (Figure HM-5-11 on page HM-5-6). Make sure:

- The axis of the goniometer is on the inside of the elbow joint
- The stationary arm, with the sensor, is on the inside of the upper arm;
- The moving arm is on the inside of the forearm.
- The motion of the elbow is not restricted.

Figure HM-5-11: Position of the GN-100 on the right elbow.

2 Before starting the recording, type **Extension** in the **Mark box** to the right of the **Mark button**. Instruct the subject to stand with his or her arm in an extended position so that the elbow joint is as close to an angle of **180 degrees** as possible.

3 Click the **Record button** in the upper right corner of the LabScribe **Main window**. Click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

4 While the subject's arm is in the extended position, type **Flexion** in the **Mark box**.

5 Instruct the subject to slowly flex his or her elbow by bringing the forearm as close to the upper arm as possible. When the subject's elbow reaches the flexed position, click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

6 While the subject's elbow is in the flexed position, type **Extension** in the **Mark box**.

7 Instruct the subject to fully extend his or her forearm. When the subject's arm reaches the extended position, click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

8 Repeat Steps 5 through 8 for two more cycles of flexions and extensions.

9 Click **Stop** to halt the recording.

10 Select **Save** in the **File** menu.

Warning: Not everyone can hyperextend their elbows. Subjects who cannot hyperextend their elbows should not attempt this optional exercise.

11 **Optional Exercise**: Ask the subject if he or she can hyperextend the elbow past 180 degrees. If he or she can, use the same techniques used in Steps 2 through 8 to measure the range of motion of the subject's elbow as it undergoes hyperextension.

Data Analysis

1 Scroll through the recording and find the section of data recorded from the elbow.

2 Use the same techniques used in Exercise 1 to measure and record the angles of extension (**Value1**), flexion (**Value2**), and range of motion (**V2-V1**) during flexion and hyperextension.

3 Select **Save** from the **File menu**.

4 Determine the averages of the angles of extension, flexion, and range of motion for the elbow. Record the averages in the **Journal** and Table HM-5-2 on page HM-5-5.

Questions

1 What anatomical parameters allow the elbow joint to be hyperextended, but not the wrist?

2 Would holding a weight have any effect on the way the elbow flexes or extends?

3 Compare your subject's values to those on Table HM-5-4 on page HM-5-8? How does your subject compare to these known values?

Exercise 3: Dorsiflexion and Plantar Flexion of the Ankle

Aim: To study the flexibility and range of motion (ROM) of the ankle.

Procedure

1 Firmly strap the GN-100 goniometer to the inside of the subject's right ankle using the Velcro straps (Figure HM-5-12 on page HM-5-7). Make sure:

- The axis of the goniometer is on the inside of the ankle joint
- The stationary arm, with the sensor, is on the inside of the lower leg;
- The moving arm is on the inside of the foot.
- The motion of the ankle is not restricted.

2 Before starting the recording, type **Neutral** in the **Mark box** to the right of the **Mark button**. Instruct the subject to sit with the lower leg not touching the floor. The angle of the ankle should be approximately **90 degrees**.

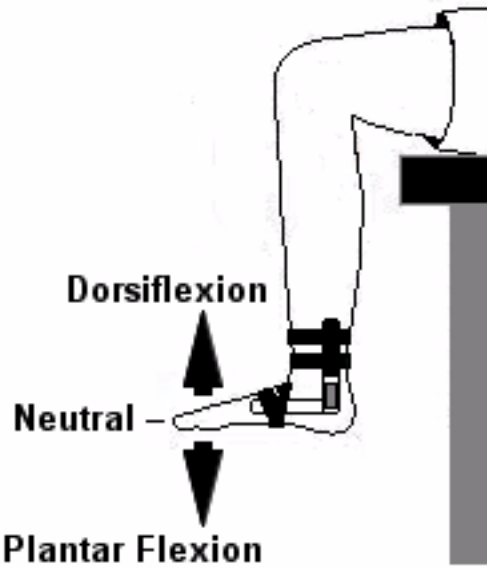

Figure HM-5-12: Position of the GN-100 on the right ankle.

3 Click the **Record button** in the upper right corner of the LabScribe **Main window**. Click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

4 While the subject's ankle is in the neutral position, type **Plantar Flexion** in the **Mark box**.

5 Instruct the subject to slowly point his or her foot towards the floor as far as possible. When the subject's foot reaches the plantar flexed position, click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

6 Instruct the subject to return his or her foot to the neutral position.

7 While the subject's foot is in the neutral position, type **Dorsiflexion** in the **Mark box**.

8 Instruct the subject to slowly pull his or foot upward towards the shin as near as possible. When the subject's foot reaches the dorsiflexed position, click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

9 Instruct the subject to return his or her foot to the neutral position.

10 Repeat Steps 4 through 9 for two more cycles of plantar flexion and dorsiflexion.

11 Click **Stop** to halt the recording.

12 Select **Save** in the **File** menu.

Data Analysis

1 Scroll through the recording and find the section of data recorded from the ankle.

2 Use the same techniques used in Exercise 1 to measure and record the angles of full plantar flexion (**Value1**), full dorsiflexion (**Value2**), and the complete range of motion (**V2-V1**) from full plantar flexion to full dorsiflexion.

3 Select **Save** from the **File menu**.

4 Determine the averages of the angles of full plantar flexion, full dorsiflexion, and the complete range of motion for the ankle. Record the averages in the **Journal** and Table HM-5-3 on page HM-5-7.

Questions

1 Compare the values of plantar flexion and dorsiflexion of the ankle from your subject to the values on Table HM-5-4 on page HM-5-8

2 Which movement generated the greater range of motion, plantar flexion or dorsiflexion?

3 Are there any anatomical parameters that would allow a for a greater ROM in one direction or the other?

Table HM-5-3: Angles of Flexion and Extension of the Ankle and Knee.

	Ankle Angle (degrees)			
Action	1st	2nd	3rd	Average
Plantar Flexion (V1)				
Dorsiflexion (V2)				
Range of Motion (V2-V1)				
	Knee Angle (degrees)			
	1st	2nd	3rd	Average
Extension (V1)				
Flexion (V2)				
Range of Motion (V2-V1)				
Hyperextension (V1)				

Exercise 4: ROM and Flexibility of the Knee

Aim: To study the ROM of both the knee.

Procedure

1 Firmly strap the GN-100 goniometer to the outside of the subject's right knee using the Velcro straps (Figure HM-5-13 on page HM-5-8). Make sure:

- The axis of the goniometer is on the outside of the knee joint
- The stationary arm, with the sensor, is on the outside of the upper leg;
- The moving arm is on the outside of the lower leg.
- The motion of the knee is not restricted.

2 Before starting the recording, type **Extension** in the **Mark box** to the right of the **Mark button**. Instruct the subject to stand with his or her leg in an extended position so that the knee joint is as close to an angle of **180 degrees** as possible.

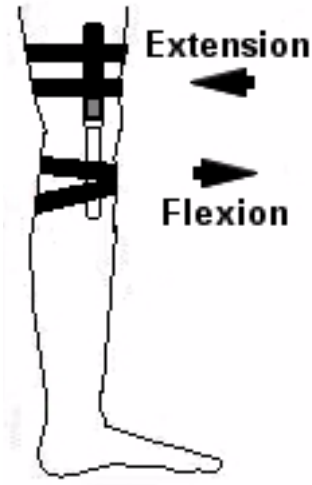

Figure HM-5-13: Position of the GN-100 goniometer on the outside of the right knee

3 Click the **Record button** in the upper right corner of the LabScribe **Main window**. Click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

4 While the subject's leg is in the extended position, type **Flexion** in the **Mark box**.

5 Instruct the subject to slowly flex his or her knee by squatting to bring the thigh as close to the lower leg as possible. The subject may hold onto the table or lab bench for balance. When the subject's knee reaches the flexed position, click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

6 While the subject's knee is in the flexed position, type **Extension** in the **Mark box**.

7 Instruct the subject to stand up and fully extend his or her leg. When the subject's leg reaches the extended position, click on the **Mark button** or press the **Enter key** on the keyboard to label the recording.

8 Repeat Steps 4 through 7 for two more cycles of flexions and extensions.

9 Click **Stop** to halt the recording.

10 Select **Save** in the **File** menu.

Warning: Not everyone can hyperextend their knees. Subjects who cannot hyperextend their knees should not attempt this optional exercise.

11 **Optional Exercise**: Ask the subject if he or she can hyper-extend the knee past 180 degrees. If he or she can, use the same techniques used in Steps 2 through 8 to measure the range of motion of the subject's knee as it undergoes hyper-extension.

Data Analysis

1 Scroll through the recording and find the section of data recorded from the knee.

2 Use the same techniques used in Exercise 1 to measure and record the angles of extension (**Value1**), flexion (**Value2**), and range of motion (**V2-V1**) during flexion and extension.

3 Select **Save** from the **File menu**.

4 Determine the averages of the angles of extension, flexion, and range of motion for the knee. Record the averages in the **Journal** and Table HM-5-3 on page HM-5-7.

Questions

1 What anatomical parameters allow the knee joint to be hyperextended, but not the ankle?

2 Would a weight strapped to the lower leg have any effect on the way the knee flexes or extends?

3 Compare your subject's values to those on Table HM-5-4 on page HM-5-8? How does your subject compare to these known.

Table HM-5-4: Average Ranges of Motion (ROM); (Adapted from Luttgens & Hamilton, 1997 and the American Academy of Orthopaedic Surgeons, 1994)

		Source			
Joint	Movement	1*	2*	3*	4*
Wrist	Dorsiflexion	60	70	70	50
	Palmar Flexion	60	90	80	60
Elbow	Flexion	140	145	150	145
	Hyperextension	0	0	0	0-5
Knee	Flexion	150	130	135	130
	Hyperextension	0	0	0-10	5
Ankle	Plantar flexion	40	45	45	50
	Dorsiflexion	30	15	20	20