Get A Grip!
Activity 1D

Activity Objectives:
Students will be able to:
- Determine grip strength using a homemade grip meter
- Design a measurement scale for the grip meter to quantify grip strength
- Investigate factors that affect grip strength
- Collect, graph, and analyze data

Activity Description:
The ability to grasp objects is an important part of upper body mobility and functionality. Grip strength is also an indicator of general health as we develop into adults and then later in life as we age. In this activity, students will construct a homemade grip meter from common materials and will calibrate the device to determine how much force they apply with their grip. Once students create a calibration scale and can quantify grip strength, they will investigate some of the factors that affect grip strength, such as grip style.

Activity Background:
Arm and hand movements such as reaching, grasping, transporting and manipulating are a significant part of our daily lives. Consistent hand strength contributes to good quality of life. Research has shown that hand strength declines with age-related musculoskeletal changes. In fact, after the age of forty, we can lose more than 1% of our grip strength annually and males lose grip strength faster than females. With much of our daily function depending upon our ability to grasp and manipulate objects, it is important to monitor this aspect of our mobility and to take steps to preserve grip strength throughout our lifespan.

One characteristic that sets primates apart from other animals is the opposable thumb. This feature is key to our ability to grasp and

manipulate objects in our environment with precision. There are many types of grip and they are determined primarily by the combination of fingers used. Some grip styles include the **Lateral Pinch**, using thumb and index finger; the **Chuck Pinch**, using thumb, index and middle fingers; the **4-Finger Pinch**, using thumb and all fingers but the little finger; and the **5-Finger Pinch**, using thumb and all fingers. These four predominate grip styles are shown in ***Figure 1 Pinching Styles*** on the following page.

Activity Overview

MO-BILITY

Lesson 2
Activity 1D

Pinching Styles

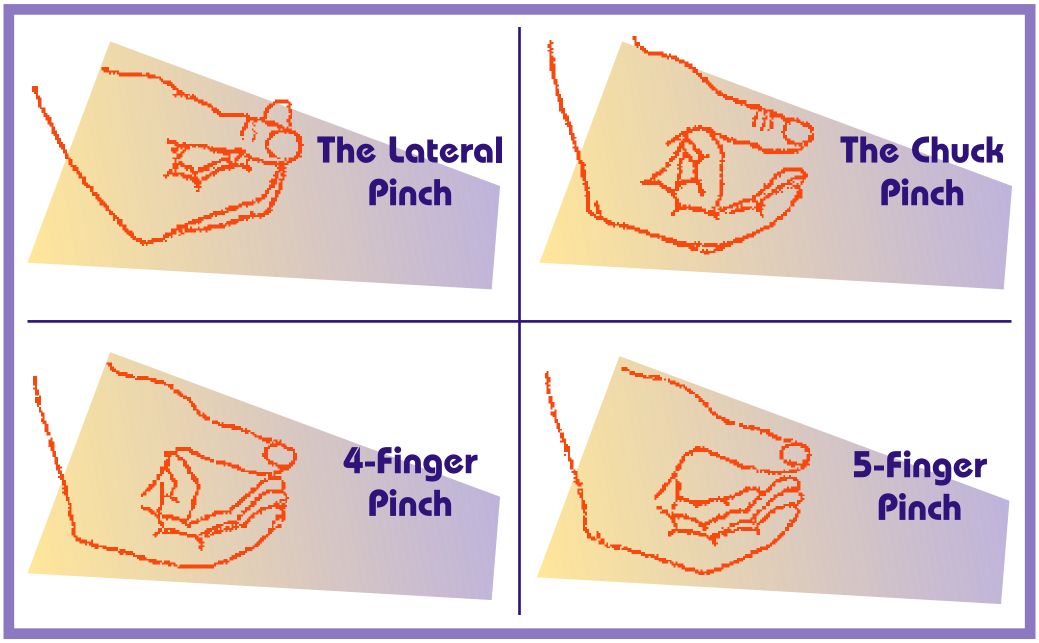


Figure 1

Cylindrical grip, as used in this activity, can be ***circular*** or ***prismatic***. ***Circular grip*** involves placing the thumb and fingers radially around an object. ***Prismatic grip*** involves using the thumb and finger(s) to grasp an object. (This activity will involve using circular grip). Finger position in circular grip styles has been shown to be constant and is determined by anatomical constraints. Fingers will have their maximum grip when oriented *toward* the thumb. Each finger contributes a different magnitude of force with the ring and little fingers exerting the least amount of force and the index and middle fingers exerting the most. The fewer fingers used in a grip, the larger the force each must exert and the thumb must generate a force equal to that produced by the other finger(s) used in the grip. A 4-finger grip or 5-finger grip produces less muscle fatigue over time, because each finger uses less force (with the exception of the thumb). Another factor that affects the grip strength required to grasp objects is the diameter of the object. A larger diameter object requires a larger grip span, which can reduce overall grip strength. Theses findings have significant implications for muscle fatigue in people doing repetitive tasks, such as athletes, factory workers, and office workers.

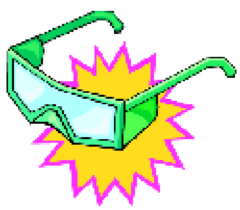
Muscle fatigue can limit the amount of work athletes, office workers and others can accomplish. Muscle fatigue is defined as a reduction in muscle force production. Awkward posture or prolonged muscle contraction can lead to muscle fatigue. Sustained muscle contraction may reduce blood flow and oxygen supply to the muscle, which has been determined to be a common cause of muscle fatigue. People experiencing muscle fatigue often report a "shaky, trembly, strained" feeling in their muscles.

Force, which will be measured in this activity, is defined as an action that causes an object to accelerate (change its velocity). In this activity, it is useful to think of force in a slightly different way – it is an action that makes an object move or change shape. There are several units used to measure force; they include Newtons, kilograms, pounds, and dynes. For this lesson, students will measure force in Newtons (N). A Newton is a metric unit of the force required to accelerate a mass of 1 Kg at the rate of 1 meter per second squared. (1 N = .1 Kg = 7.2 pounds)

This activity will give students the opportunity to explore grip strength and to develop an awareness of the importance of a firm grip in their everyday lives. They will also have the chance to calibrate a handmade instrument to measure grip strength, to collect and analyze data, practice graphing skills and to plan an experimental design to extend this investigation.

Activity Materials (per group):

- 1 Flotool by Hopkins Manufacturing Corporation (Available at Wal-Mart Automotive Department)
- 1 23.7 FL. OZ. Empty Propel® Fitness Water Bottle (Available at grocery store)
- 23.7 FL OZ Tap Water
- Hose clamp to fit around the plastic Propel® bottle
- Small screwdriver tethered to hose clamp with string or coil cord
- 50 N Spring scale
- Ring stand
- Duct tape
- Permanent Marker
- Erasable marker
- Ruler
- Clear cellophane tape
- 60# non-elastic fishing leader line
- Safety Goggles



Activity Management Suggestions:

Arrange students in groups of two for this activity. Have students review the instructions and determine how they will divide the tasks equally. Stress to students that they will have plenty of time to finish the activity provided that each partner completes his or her share of the tasks.

Modifications:

For highly able students, this activity can be given as a problem solving exercise with few instructions given. Simply show students how to make the grip meter, give them all of the supplies needed, and then have students develop a calibration scale for the device.

For students needing more support, provide detailed instructions, and work with them in a step-by-step fashion to ensure that they can fully participate in the activity.

Extensions:

Ask students to devise another method to measure grip strength or to develop another way to calibrate the grip meter. Also, students can determine intermediate measuring points on their scale to increase accuracy. For example, they could determine the points half-way or one-third of the way between the marks on their scale.

Activity References Used:

Bear-Lebman, J, Miller, P., Adler, M., Buonocore, M., Coles, N., et. al. ((2003). An Exploration of Hand Strength and Sensation in Community Elders. *Topics in Geriatric Rehabilitation*, 19(2):127-136.

Gilles, M., Wing, A. (2003). Age-Related Changes in Grip Force and Dynamics of Hand Movement. *Journal of Motor Behavior*, 35(1):79-85.

Kinoshita, H., Tomohiko, M., Takao, B. (1996, Sept.). Grip posture & forces during holding cylindrical objects w/ circular grips. *Ergonomics*, 39(9):1163-77.

Matheson, L., Isernhagen, S., Hart, D. (2002). Relationships Among Lifting Ability, Grip Force, and Return to Work. *Physical Therapy*, 82(3):249-256.

Yan, J., Downing, J. (1999, May). Effects of Aging, Grip Span, and Grip Style on Hand Strength. *Research Quarterly for Exercise and Sport*, 72(1):71-77.

Activity "Administrivia":

Intended Grade Level:

6-8

Key Concepts:

Grip
Measurement
Calibration
Collecting data

Relevant TEKS:

Under Development

Process Skills utilized in lesson:

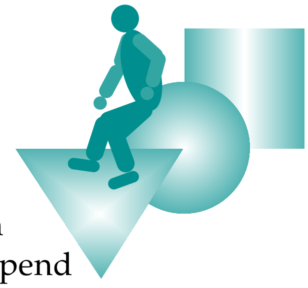
Measurement
Collecting data
Analyzing data
Graphing

Previous learning assumed:

Unit of force
Measurement skills
Muscular and skeletal systems working together to allow movement

Get A Grip!

Student Activity 1D

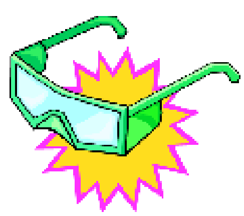


Introduction:

Think for a minute about all of the sports and daily activities that depend on a strong grip! Baseball, bowling, golf, gymnastics, football, hockey, mountain biking, racquetball, rowing, softball, tennis, volleyball and water skiing all depend on forearm and grip strength. Opening jars, turning a key in a lock, turning doorknobs, picking up a glass and many other common activities all depend on your ability to grasp objects firmly. People who use a computer keyboard too much can develop a "repetitive strain injury" that causes loss of grip strength. Getting older and not exercising can also cause loss of grip strength. It is important to be able to easily measure grip strength and to be able to monitor grip strength changes over your life span. Therefore, in this activity, you will make a grip meter, devise a measurement scale for the grip meter and finally, will look at some factors that can affect grip strength.

Materials: (per group)

- 1 Flotool by Hopkins Manufacturing Corporation (Available at Wal-Mart Automotive Department)
- 1 23.7 FL. OZ. Empty Propel® Fitness Water Bottle (Available at grocery store)
- 23.7 FL OZ Tap Water
- Hose clamp to fit around the plastic Propel® bottle
- Small screwdriver tethered to hose clamp with string or coil cord
- 50 N Spring scale
- Ring stand
- Duct tape
- Permanent Marker
- Erasable marker
- Ruler
- Clear cellophane tape
- 60# non-elastic fishing leader line
- Safety Goggles



Instructions:

Read all steps and check off as completed.

Part I – Making the Grip Meter

- ❐ 1. Remove the top, consisting of the plastic lid and plastic tube from the Flo-Tool.
- ❐ 2. Remove the lid from the Propel™ water bottle, fill the bottle until it begins to overflow with tap water, and attach the plastic top and tube from the Form-Tool device onto the Propel™ bottle.
  (See *Figure 1 Making a Grip Meter*)
- ❐ 3. Measure the distance from the bottom of the bottle to the bottom of the bottle cap. Find the point that is half-way between and draw a line around the bottle at this height with permanent marker.
- ❐ 4. This device will now form the basis of your homemade grip meter.
- ❐ 5. Now, place your dominant hand (the one you write with) around the bottle. Lift the bottle off the table, hold your arm at your side with the elbow bent at 90^{o} angle.
- ❐ 6. Using all four fingers and your thumb, with palm touching the sides of the bottle, apply even pressure on the bottle. As you squeeze the bottle, you will see that the water rises up the plastic tube.
- ❐ 7. Hold your grip for 10 seconds and the water level in the tube will be the level you will use to indicate the strength of your grip. Mark the water level with an erasable marker.
- ❐ 8. The only problem is that your grip meter doesn't have any numbers, so how do you know the strength of your grip? Parts II, III and IV of this activity will help you calibrate (devise a measurement scale) your grip meter.

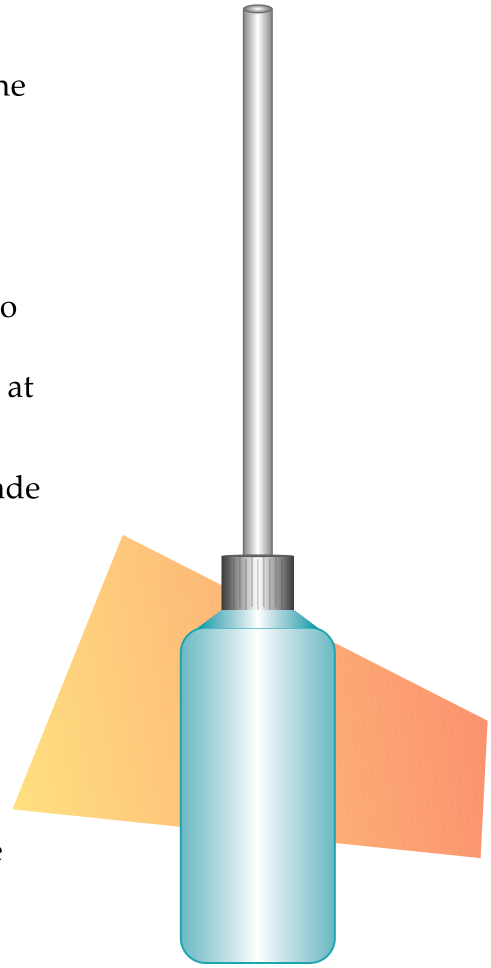
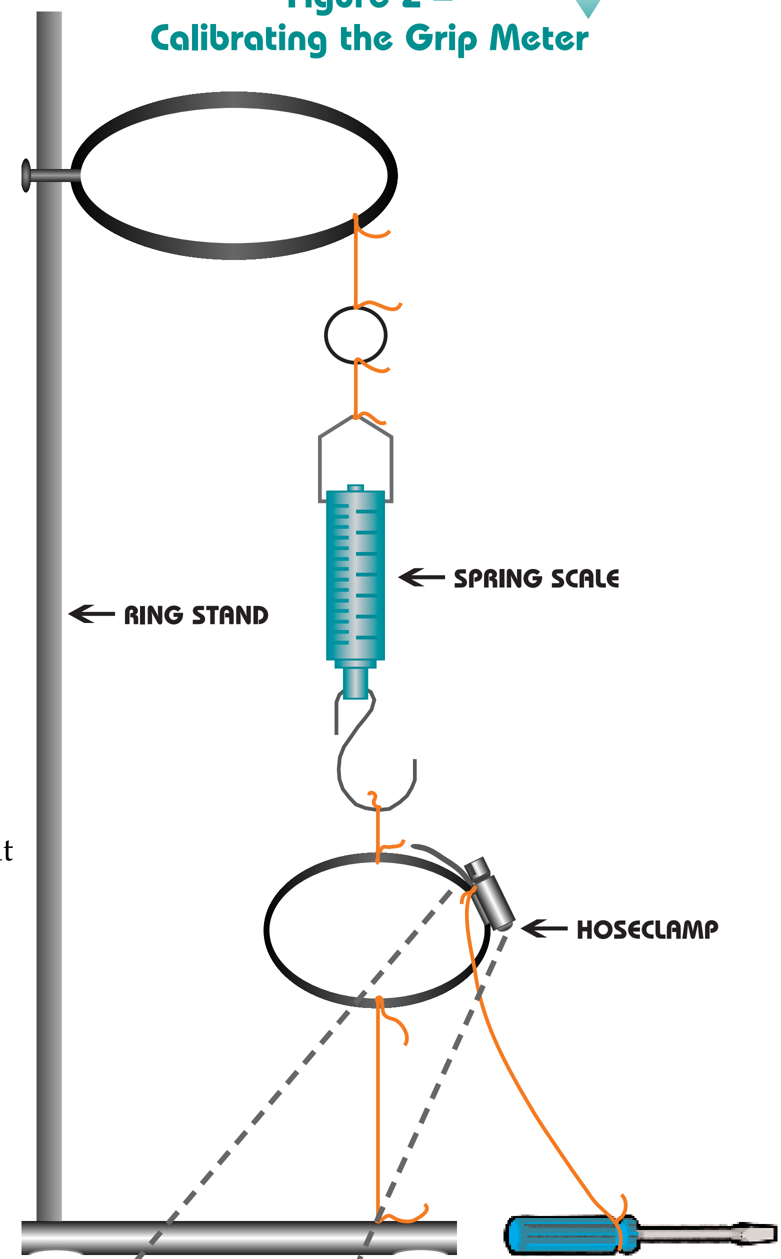


Figure 1 – Making a Grip Meter

Part II – Relating Size of Hose Clamp to Newtons of Force

- ❏ 1. Working with your group, you will devise a numerical scale for the grip meter so you can tell how many Newtons of force you are applying to the grip meter to make the water rise to a certain level.
- ❏ 2. Attach the spring scale to a ring stand as shown in ***Figure 2 Calibrating the Grip Meter***.
- ❏ 3. Attach the hose clamp to the spring scale and to the bottom plate of the ring stand as shown in ***Figure 2 Calibrating the Grip Meter***. Hose clamp and spring scale are tied to the ring stand with 60# non-elastic fishing leader line.
- ❏ 4. Using the permanent marker, carefully make a mark on the top of the screw and on the metal bracket holding the screw as shown in ***Figure 3 Calibrating the Grip Meter***.
- ❏ 5. Use the tethered screw driver to turn the screw on the hose clamp. Turn the screw on the hose clamp enough times to pull the spring scale to a measurement of 50 N. (Be sure to end with the permanent ink marks lined up.) Slowly, turn the screw the opposite direction, keeping a careful count of the number of complete turns it takes to release the spring scale back to 0 N. (One complete turn occurs when the permanent marker lines are aligned.) The number of complete turns you count will equal the number of turns it takes to equal 50 N of force.
- ❏ 6. Repeat step 5 five more times.
- ❏ 7. Record your data and calculate the average as indicated on the ***Student Data Page***.

Figure 2 – Calibrating the Grip Meter



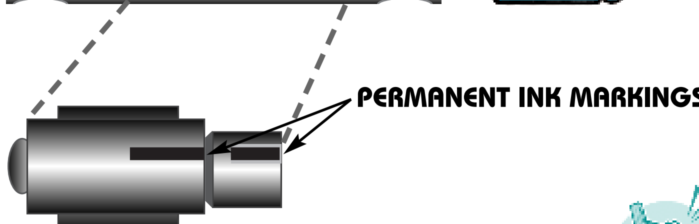


Figure 3 – Calibrating the Grip Meter

Part III – Relating Height of Water to Force Applied

- ❐ 1. Place the hose clamp around the bottle until snug, but not tight enough to cause the water to rise.
- ❐ 2. Use the screwdriver to secure the hose clamp around the bottle. Turn the screw the exact number of times it took to pull the spring scale with a force of 50 Newtons.
- ❐ 3. Allow the grip meter to sit for 10 seconds, mark the water line with erasable marker, and then measure the exact height the water rose (measure in centimeters).
- ❐ 4. Record this number on your ***Student Data Page***.
- ❐ 5. Now, turn the screw on the hose clamp the exact number of times needed to apply another 50 N of force to the bottle.
- ❐ 6. Repeat steps 2-5 **six** times (until a total of 350 N of force is applied to the bottle).
- ❐ 7. Repeat steps 1-6 **three** times and calculate an average height of water for each amount of force listed in the table in Section III of your ***Student Data Page***.

Part IV – Making the Grip Meter Measurement Scale

- ❐ 1. Cut a strip of paper 3 cm wide and 28 cm long.
- ❐ 2. Make a mark 1 cm from one end of the paper strip and label it 0.
- ❐ 3. On the paper strip, mark off the exact height the water rose with 50 N of force applied and label it 50N.
- ❐ 4. Again, on the paper strip, mark off the exact height the water rose with 100 N of force applied and label it 100 N.
- ❐ 5. Continue marking off the heights on the paper strip until all the heights you recorded on the ***Student Data Page*** are recorded on the paper strip.
- ❐ 6. Congratulations, you have just made a calibration (measurement) scale for your grip meter!
- ❐ 7. By affixing the scale to your grip meter with clear cellophane tape as shown in ***Figure 4 Calibrating Your Grip Meter***, you will be able to measure your own grip strength.

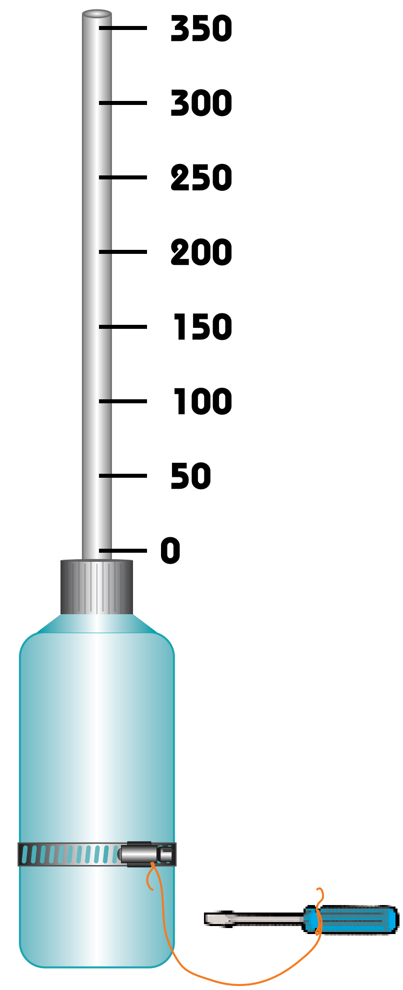


Figure 4 – Calibrating Your Grip Meter

Part V: Testing Grip Strength

❒ 1. There are many types of grip and they are determined primarily by the combination of fingers used. Some grip styles include the **Lateral Pinch**, using thumb and index finger; the **Chuck Pinch**, using thumb, index and middle fingers; the **4-Finger Pinch**, using thumb and all fingers but the little finger; and the **5-Finger Pinch**, using thumb and all fingers. (*See Figure 5 Grip Styles*)

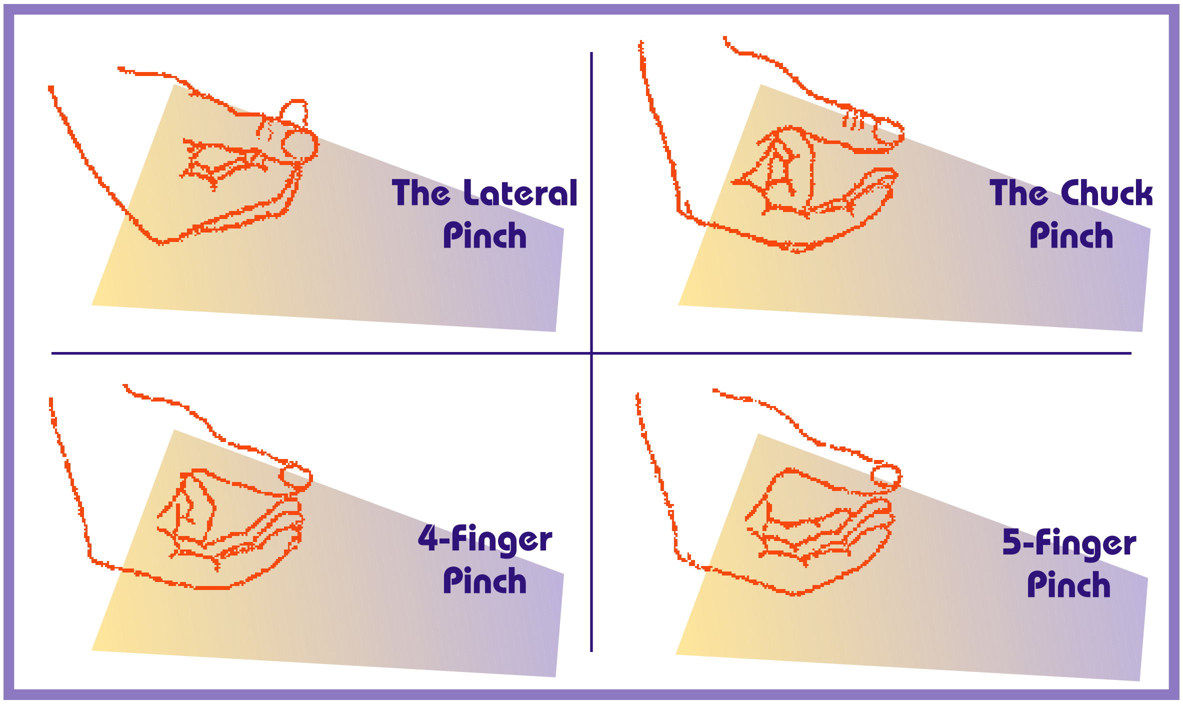


Figure 5 – Grip Styles

❒ 2. In this part of the activity, you will test these grip combinations and others to see how they affect overall grip strength. Look at the *Student Data Page* and find the data table for **Part V** entitled **The Effect of Grip Combination on Force (N) Produced**. This is where you will record your results.

- [ ] 3. The first grip style you will test is the **5-Finger Pinch**. Open the end cap of the grip meter tube and open the twist valve in the bottle cap.
    a. Grasp the grip meter with your thumb and all four fingers.
    b. Keep the top of your hand on the line that marks the halfway point between the bottom of the bottle and the bottom of the bottle cap.
    c. Also, keep your palm pressed into the side of the bottle so you are using a circular grip.
    d. Hold grip meter so that your arm is straight by your side and elbow is bent at 90^{o} angle. See *Figure 3 Holding the Grip Meter*.

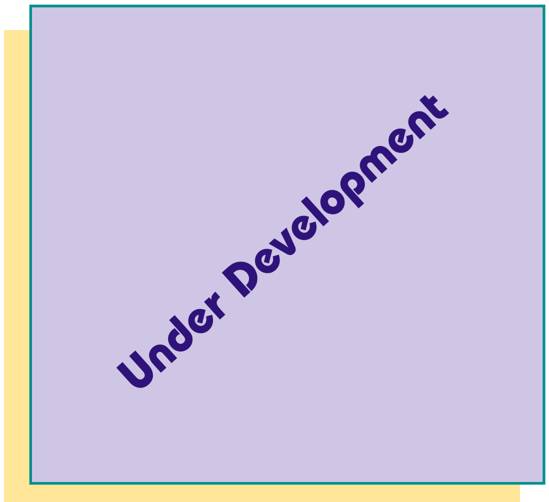


Figure 3 – Holding The Grip Meter

    e. Press as hard as you can on the grip meter and hold your grip for 10 seconds. Allow the water in the grip meter tube to stabilize and read the force in Newtons from your scale. Record this number in the data table. Repeat four more times.

- [ ] 4. Now, look at the data table and find the next grip style that is listed. Keeping arm in same position as in step 3 and with the bottle off the table, grasp the grip meter bottle in the grip style being tested. (Remember to keep your palm against the side of the bottle). Exert as much force as possible for 10 seconds and read the force in Newtons. Record this number in your data table and repeat four more times.
- [ ] 5. Repeat step 5 for all grip combinations in the data table.
- [ ] 6. When all data is recorded, find the average for each grip style.
- [ ] 7. Graph your results on the graph paper provided with the *Student Data Page*.

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Data Page

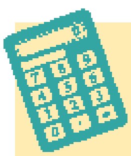
Part II - Relating Size of Hose Clamp to Newtons of Force

(Record your data in the Table Below)

The Number of Turns on Hose Clamp to Equal 50 N of Force

Trial Number	Number of Turns Equal to 50 N Force
1	
2	
3	
4	
5	
Average	

Calculate average here and record in the table above:



1. Why did you repeat this measurement five times and calculate an average?

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2. Why is it necessary to know how many turns on the hose clamp equals 50 N of force?

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Part III – Relating Height of Water to Force Applied

Force (N)	Height of Water in Tube (cm)			
	Trial 1	Trial 2	Trial 3	Average
0				
50				
100				
150				
200				
250				
300				
350				

Calculate averages here and record in the table above:

1. Why did you repeat these measurements three times and calculate an average?

2. Why is it necessary to know how the height of water in the tube of the grip meter is related to force in Newtons?

Part V – Testing Grip Strength

Record the data you collect using the Grip Meter to test grip combinations in the Table below entitled **The Effect of Grip Combination on Force (N) Produced**.

Look at the grip combinations listed in the Table below entitled **The Effect of Grip Combination on Force (N) Produced** and *predict* which will produce the most force.

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The Effect of Grip Combination on Force (N) Produced

Trial	Thumb & all Fingers	Thumb, Index, & Middle Fingers	Thumb & all but Little Finger	Thumb & Index Finger	Thumb & Ring Finger	Thumb & Middle Finger	Thumb & Little Finger
1							
2							
3							
4							
5							
Average							

Next, Graph the results you recorded in the Table (**The Effect of Grip Combination on Force (N) Produced**) above on the graph paper provided in this *Student Data Page*.

Student Name ________________________________

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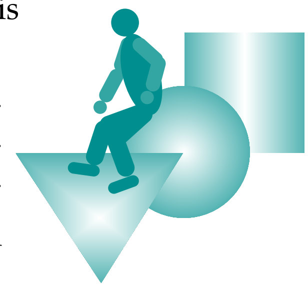

1. Which digit was included in every grip combination? Why do you *think* it is used so often?

2. Which grip combination produced the greatest grip strength? Why do you *think* this combination allowed you to exert the most force?

3. Which grip combination produced the smallest grip strength? Why do you *think* this combination produced the least force?

4. In looking at the grips that used the thumb and only one other finger, which finger is capable of exerting the most force? Can you be certain that this finger is the strongest? Why or why not?

5. When you held the grip meter with two fingers and then with all fingers, which grip produced the least amount of fatigue? Why do you *think* this happened?

6. In a factory where workers must grip objects on an assembly line all day, which grip combination would be best for them to use? Why?

7. If the diameter of the grip meter bottle were twice the size, how might that affect grip strength? Why?

8. What other factors might affect grip strength? How could you design an experiment to test one of these other factors?