Wood for Guitars Hardness Properties

**Description of Activity**

* Participants will measure the hardness of various types of wood.
* The purpose for this activity is to demonstrate the material property of hardness as it relates to wood.
* This activity is suitable for ages 6-12

**Learning Objectives:**

1. Participants will Formulate a hypothesis on which wood is harder
2. Participants will recognize that various woods have different hardness levels.
3. Participants will measure Hardness on a comparative scale and then compare those results with known values.
4. Participants will create a hardness scale for the woods available for use on their guitars.

**Standards:**

List The Common Core Math, Next Generation Science Standard and/or SME Competency Gaps.

Matter and Its Interactions

2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.\* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [Assessment Boundary: Assessment of quantitative measurements is limited to length.]

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.\* [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]:

[CCSS.Math.Content.HSF-IF.C.7e](http://www.corestandards.org/Math/Content/HSF/IF/C/7/e) Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

[CCSS.Math.Content.HSF-LE.A.2](http://www.corestandards.org/Math/Content/HSF/LE/A/2) Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

**Materials Required:**

* .4375” Diameter Steel Ball
* Wood Samples
* Digital Calipers
* Arbor Press with hydraulic Pressure Gauge
* Force Testing System (Optional)

**Safety:**

**safetys:**

Be sure to keep hands clear when using the Arbor Press.

**References:**

* Wood Database <http://www.wood-database.com/>
* Warmoth Custom Guitar <http://www.warmoth.com/Guitar/Bodies/Options/BodyWoodOptions.aspx>
* Arbor Press Force Pressure Gauge

<http://www.skylighter.com/fireworks/arbor-press-force-gauge.asp>

**Procedure:**

The objective is to observe and compare the material hardness of several samples of different wood spices. Hardness is a material property similar to stiffness and compressive strength. There are many different standards for measuring Hardness in various materials. In wood materials Hardness is measured using the Janka Scale. This is the force (N) required to embed a .444” diameter steel ball halfway into the sample. So a piece of hardwood with a Janka Hardness of 1200 would be harder than a piece of wood with a Janka Hardness of 800.

While we do not have the ability to perform a Janka Hardness Test we can recreate a similar experiment to determine which sample is the Hardest.

Prepare the Samples:

Cut Test Samples of wood ¾” x 2” x 2” of various species of wood. (samples can be obtained from local hardwood supply or home center)

Participants should form a hypothesis on which Wood will dent the most and if there will be a correlation to stiffness as determined in the Wood for Guitars Stiffness Activity.

Create a spreadsheet with 3 columns.

List each sample in Column A.

In Column B Participants will record the Diameter of the dent generated during the test.

In Column C Participants will find and record the Wood Janka Number

Test Procedure:

Place the steal ball on top of the sample of wood.

Gently apply pressure using the arbor press. (Note: too much pressure will crack the wood.)

Be sure to use the same amount of pressure for each sample. *Note the actual amount of pressure applied is not important because we a comparing the size of the dimple.*

Using a digital caliper record the size of the dimple generated during the test; then record the number on the sample.

Create a chart for each sample and rank them based on the size of the dimple. What does this tell you about each sample?

Using the website “Wood Database” look up the Janka number for each sample.

Do your ranking results correspond to the Janka Scale Number?

Going Deeper

Want to learn more? Calculate the amount of pressure applied to your sample.

Measure the diameter of the Pressure guage cylinder to calibrate your reading.

Then calculate the surface area of the dent you created in the wood.

Divide the dent surface area by the actual pressure gauge reading.

**Quiz:**

* Include at least 10 quiz questions with answer key. (Questions must be Multiple Choice, and/or Matching).
1. The terms “Hardwood Tree” and “Softwood Tree” relate to physically how hard a piece of wood cut from a tree really is.
	1. True
	2. False
2. Hardness is defined as the ability to withstand an impact force, scratch or dent.
	1. True
	2. False
3. A large dent left in a piece of wood by someone swinging hammer could indicate a hard wood.
	1. True
	2. False

1. Wood Hardness is based on what scale?
	1. Bernelli
	2. Janka
	3. Rockwell
	4. Molhs
2. A wood sample with a High Hardness rating would also be easy to bend.
	1. True
	2. False
3. Force can be measured using all of the following except:
	1. Newton
	2. Pound
	3. Kilogram
	4. Kelvin
4. Soft (Silver) Maple is softer than Hard Maple.
	1. True
	2. False
5. In order to prevent the guitar from scratching or being dented a guitar should use Harder wood on the back and top of the guitar.
	1. True
	2. False
6. Open grain woods are not as hard as closed grain woods.
	1. True
	2. False
7. Silver Maple has a Hardness scale of \_\_\_\_\_\_\_\_\_\_\_N.
	1. 200
	2. 311
	3. 2000
	4. 3110

**Quiz:KEY**

* Include at least 10 quiz questions with answer key. (Questions must be Multiple Choice, and/or Matching).
1. The terms “Hardwood Tree” and “Softwood Tree” relate to physically how hard a piece of wood cut from a tree really is.
	1. True
	2. False : Hardwood signifies that the tree will lose its leaves each season.
2. Hardness is defined as the ability to withstand an impact force, scratch or dent.
	1. True
	2. False
3. A large dent left in a piece of wood by someone swinging hammer could indicate a hard wood.
	1. True
	2. False: It could indicate a low level of hardness or that a large force was used.

1. Wood Hardness is based on what scale?
	1. Bernelli
	2. Janka
	3. Rockwell
	4. Molhs
2. A wood sample with a High Hardness rating would also be easy to bend.
	1. True
	2. False: There is a correlation between hardness and stiffness
3. Force can be measured using all of the following except:
	1. Newton
	2. Pound
	3. Kilogram
	4. Kelvin
4. Soft (Silver) Maple is softer than Hard Maple.
	1. True
	2. False
5. In order to prevent the guitar from scratching or being dented a guitar should use Harder wood on the back and top of the guitar.
	1. True
	2. False
6. Open grain woods are not as hard as closed grain woods.
	1. True
	2. False: This is not always the case.
7. Silver Maple has a Hardness scale of \_\_\_\_\_\_\_\_\_\_\_N.
	1. 200
	2. 311
	3. 2000
	4. 3110

**Reviewing Faculty Cohort Members:**