

Vickers Hardness Tester (Cornell)



Hardness Tester (Model)

Title: Investigating and Modeling Hardness

Author: Linda J. Carey (WS Hackett Middle School, Albany, NY)

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Subject: Hardness Testing of Aspirin 81mg Tablets

Grade Level: 6-8

Standards: NYS Intermediate Science Core Curriculum

- Standard 1 – Analysis, Inquiry, Design
- Standard 4 – General Skills
- Standard 4 – The Living Environment
1.2c The digestive system consists of organs that are responsible for the mechanical and chemical breakdown of food. The breakdown process results in molecules that can be absorbed and transported to cells.
- Standard 4 – The Physical Setting
3.1a Substances have characteristic properties. Some of these properties include color, odor, phase at room temperature, density, solubility, heat and electrical conductivity, hardness, and boiling and freezing points.
- Standard 6 – Interconnectedness: Common Themes
- Standard 7 – Interdisciplinary Problem Solving

Schedule: 40-60 minutes

Description:

Vickers hardness testing will be investigated and modeled. The relative hardness of Chewable Aspirin 81mg and Enteric Coated Aspirin 81mg will be predicted and determined. The relationship between hardness and rate of solubility, and the use of and differences in aspirin tablets will be discussed.

Objectives:

Students will:

- define hardness
- understand the Vickers Hardness Test Equipment and relative units
- model hardness testing using Aspirin 81mg Chewable Tablets and Aspirin 81mg Enteric Coated Tablets
- explain what would happen if Aspirin Tablets were too hard or not hard enough
- relate hardness to rate of solubility
- explain where chewable and enteric coated tablets dissolve in the human body
- discuss the use of different aspirin products

Vocabulary:

Hardness – measure of the ability of a material to resist indentation

Enteric Coating – material around a tablet that dissolves in pH 7 - 9

Materials:

Hardness tester designed with an 8 inch length of 1/2" PVC pipe (Home Depot item # 611942112579) and 6" galvanized common nail (Home Depot item # 0000-676-787)
 See instructions for design and setup.

Chewable Aspirin 81mg (Equate-Walmart)

Enteric Coated Aspirin 81mg (Top Care-Wegmans)

Scotch Tape

Duct Tape

Small Staples note pad

Safety:

Eye protection and gloves.



Science Content for the Teacher:

Hardness is an important and valuable mechanical test for evaluating the properties of a material because it relates to a material's strength and its resistance to permanent deformation, penetration, wear, scratching, and machining. Hardness testing helps to determine whether a material is appropriate for a given application. Hardness of a material can vary based on the conditions upon which the material has been subjected. Hardness testing is a valuable test and often preferred because it is simple and easy to perform and because of the relationship it has with other properties of the material.

Aspirin (acetylsalicylic acid) has analgesic, antipyretic, anti-inflammatory, and antiplatelet effects. Aspirin, at low doses, is used daily, long term, in adults, to help prevent heart attacks, strokes and blood clot formation. As a result of its antiplatelet action, there is a reduction in the formation of platelet patches over damaged walls of blood vessels thus reducing the chance of blocked blood flow.

Aspirin is available in many forms including chewable 81 mg and enteric coated 81mg. The original chewable formulation was for children but because of the risk of Reye's Syndrome, it is no longer indicated for use in children. The enteric coated formulation is designed to dissolve in a pH 7 – 9 so that the tablet does not dissolve in the digestive system until it is in the small intestine, providing less irritation to the stomach.

Tablet hardness testing is used by the pharmaceutical industry to ensure integrity of the tablet for storage, transportation, handling, and dissolution. If a tablet is too hard, it may not dissolve fast enough in the digestive system. If a tablet is not hard enough, it may not hold up during packaging, transportation and storage.



Hardness Tester Design



Tape and wrap enough paper around the nail to bulk up the nail to be almost as wide as the head of the nail then tape over the paper with Duct Tape.



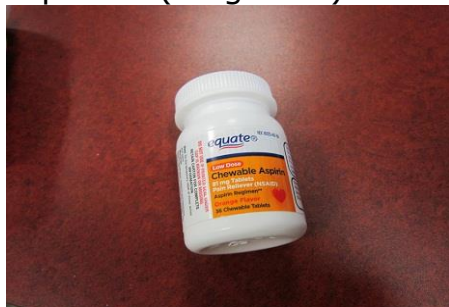
PVC pipe and wrapped nail



Wrapped nail will drop down the PVC pipe and indent/break the target tablet to model hardness testing.



Top Care (Wegmans) Enteric Coated 81mg Aspirin



Equate (Walmart) Chewable 81mg Aspirin



Place one tablet on a piece of tape and center and attach it to the bottom of the PVC pipe.



Use the cardboard of the Staples note pad as a base and drop the nail through the PVC pipe to hit the target tablet. Remove the tape and observe the tablet.

Classroom Procedure:

An outline of the classroom procedure is indicated below including the terms for the guided notes. See the Student Lesson Packet at the end of this document.

- Do It Now – initial engaging questions
- Introduction and Guided Notes – introduction and background

_____ *Hardness* _____ is a characteristic of a _____ *material* _____ that is a _____ *measure* _____ of the ability of the material to resist _____ *indentation* _____.

There are many types of hardness tests and each test/tester has its own values and units that depend on the method and equipment used for measurement.

Hardness is a _____ *relative* _____ value based on the force of the _____ *indenter* _____ and the area of the _____ *indentation* _____ made.

The _____ *Vickers* _____ Hardness Tester uses a pyramid shaped _____ *diamond* _____ indenter and units of _____ *HV* _____ (Hardness Vickers). It uses a microscope to view and help measure the size of the indentation.

- Vickers Hardness Test Video – You Tube video demonstration of a Vickers Hardness Test
- Hands-On Testing of Aspirin Samples – opportunity to model hardness using 81mg aspirin tablets
- Discussion Questions – opportunity for students to reflect on practical applications of hardness for the pharmaceutical industry, relationship of tablet hardness and coating on rate of solution and location of dissolution and absorption in the human body



Assessment and Scoring Guide:

The objective of this lesson is to provide students with the opportunity to investigate and model hardness. It provides students with the opportunity to connect the relationship between hardness and rate of solution, and to understand the effect of an enteric coating. It also requires students to consider the impact that hardness has on the selection of a material for a given application.

The student lesson packet will be graded based on 10 points:

Item Completed	Possible Points
Attempted the Do It Now Questions	1
Accurately completed the Guided Notes	1
Recorded Initial Observations and predicted the hardest tablet	1
Accurately completed discussion question #1	1
Accurately completed discussion question #2	1
Accurately completed discussion question #3	1
Accurately completed discussion question #4	1
Accurately completed discussion question #5	1
Accurately completed discussion question #6	1
Accurately completed discussion question #7	1

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Resources:

- Alumatter www.aluminum.matter.org
- Aspirin, Wikipedia.org
- Introduction to Hardness Testing www.asminternational.org
- NYS Intermediate Science Core Curriculum
- Tablet Hardness Testing, Wikipedia.org
- Vickers Hardness Test Video www.youtube.com Materials Science 2000



Student Name _____

Investigating and Modeling Hardness - Student Lesson Packet

Do It Now – Complete these three questions before the lesson starts.
What is the hardest material that you can think of?

What part of a car do you think is harder, the frame of the car or the front bumper? Explain.

Name or describe the test used to determine the relative hardness of minerals?

Introduction and Guided Notes

_____ is a characteristic of a
_____ that is a _____ of the ability of
the material to resist _____.

There are many types of hardness tests and each test/tester has its own values and units that depend on the method and equipment used for measurement.

Hardness is a _____ value based on the force of the _____ and the area of the _____ made.

The _____ Hardness Tester uses a pyramid shaped _____ indenter and units of _____ (Hardness Vickers). It uses a microscope to view and help measure the size of the indentation.

Video – Vickers Hardness Test

Watch the YouTube video “Vickers Hardness Test” Materials Science 2000



Hands – On Activity

During the video, the hardness of a compressor wheel for a turbo charger was determined using a Vickers Hardness Tester with a pyramid shaped diamond indenter and a defined force. The indentation was observed and based on the force and the area of the indentation, the Vickers Hardness was determined.

During today’s activity, hardness will be modeled using a PVC pipe, and a modified nail. Gravity will be used for the force and the nail will be the indenter. Aspirin tablets will be tested and then observed for indentation, cracks, and breakage.

1. Make an initial observation of the Aspirin tablets and make a prediction of which sample you think is the hardest.

Initial Observations

Chewable Aspirin 81mg Tablet (Equate)	Enteric Coated Aspirin 81mg Tablet (Wegmans)

2. Which tablet do you predict is the hardest?





3. Place one tablet on a piece of tape and center and attach it to the bottom of the PVC pipe.



4. Use the cardboard of the Staples note pad as a base and drop the nail through the PVC pipe to hit the target tablet. Remove the tape and observe the tablet.

5. Record your observations after hardness testing.

Chewable Aspirin 81mg Tablet (Equate)	Enteric Coated Aspirin 81mg Tablet (Wegmans)

Discussion Questions

1. Which tablet did you determine to be the hardest? Explain.

2. Define hardness.

3. One of the 81mg tablets tested was a chewable formulation and one was an enteric coated formulation. At one time the chewable formulation was used in children but, because of the risk of Reye's Syndrome, it is no longer used in children. Instead, 81mg aspirin is used in adults to reduce the risk of heart attacks and strokes. One of the tablets was enteric coated. An enteric coating is used on some tablets to allow them to dissolve only in a pH of 7-9. The chewable tablet does not have an enteric coating.

Based on this information and your knowledge of the human digestion system, where does the chewable tablet dissolve and absorb into the bloodstream? Explain.

4. Where does the enteric coated tablet dissolve and absorb into the bloodstream? Explain.



5. What is the relationship between tablet hardness and rate of solution?

6. In addition to affecting the rate of solution, why else do you think that pharmaceutical companies need to be concerned with the hardness of their tablets? What would be the concern if the tablet is too hard? What would be the concern if the tablets were not hard enough?

7. The hardness of a material is an important characteristic because it helps to determine the appropriateness of a material for a given use or application. Identify a material in the classroom and explain in terms of hardness, why it is an appropriate choice for the function it serves.

