

Activity 20: Testing the Hardness of Common Minerals

Maine Geological Survey



Objectives:

To give students practice in performing a simple yet effective physical property mineral test. To develop expertise in using this testing procedure for identifying common minerals.

Time:

This activity is designed to last 40-45 minutes.

Background:

While current technology has provided us with a number of sophisticated and very expensive tools for mineral identification, the majority of minerals that most students are likely to encounter can still be positively identified by using basic tests which measure some aspect of the innate physical properties of the minerals. Traditionally these tests have included hardness, density, fracture/cleavage, luster, streak, and an analysis of the crystal form IF the mineral is crystallized. All of these tests can be performed easily, quickly, and with a minimum of equipment given a little practice by the student. The hardness test can be performed with everyday materials and requires no special equipment.

Hardness is the resistance of a substance to scratching by another material. A scratch is a permanent line or groove abraded into the surface of the material being tested. This

property of materials has been known since ancient times and explains why arrowheads were made of flint and obsidian and not shale.

While a number of hardness scales exist, the most commonly used is the Moh's scale; numerical mineral values for the Moh's scale are as follows:

Mineral	Hardness
Talc	1
Gypsum (Selenite)	2
Calcite	3
Fluorite	4
Apatite	5
Orthoclase (feldspar)	6
Quartz	7
Topaz	8
Corundum (sapphire/ruby)	9
Diamond	10

A useful mnemonic device for remembering the mineral names in the correct sequence, 1 - 10, is the sentence "The Girls Can Flirt And Other Queer Things Can Do." This has been the traditional sentence used with this list since its inception by Moh in 1824, and no sexual bias or innuendo is intended by it. People desiring a politically correct sentence may use the following - The Grapes Can Ferment And Other Queer Things Can Do. This may not be acceptable to MADD and the substance abuse counselor. It turns out that a number of household objects have a hardness identical (or nearly so) to those on the scale and are available for use just about everywhere. These include:

Common Substance	Hardness
Fingernail	2
Copper penny	3
Pocket knife blade*	5
Glass plate (window glass)	5.5
Steel file (chain saw file)	6.5
Quartz	7

*If school policy precludes the possession of jackknives, the blade of a dissection scalpel will do fine.

Since the majority of all minerals have a hardness between 2 and 7, it is relatively easy to use the above materials to determine the hardness of an unknown. In practice, it is

always advisable to see if sample A will scratch substance B and then reverse the process and see if substance B will scratch sample A; items of equal hardness should scratch each other. Best results are obtained when using relatively pure samples.

Materials:

Each group of students will need the following: one piece each of quartz, feldspar (microcline), calcite, and the two unknowns (topaz and galena); a copper penny, glass plate, small pocket knife, and a steel file (the triangular files the chemistry instructor uses to score glass tubing work nicely!!). You may wish to purchase one set of professional hardness points to settle any disputes or resolve confusion. (Miners Catalogue #KO685 for roughly \$50; also available from Wards)

Procedure:

After suitable discussion of the hardness test and Moh's scale, student groups will take their materials and proceed to scratch the known samples with the penny, glass plate, their fingernails and so on until they determine that the hardness of quartz, calcite, and feldspar are indeed, respectively, 7, 3, and 5. You may wish to demonstrate an appropriate scratching technique for the entire class prior to starting. Once the known minerals have had their hardness determined the students can proceed to test the unknowns. The galena will have a hardness of about 2.5 and the topaz will have a hardness of 8. Students now have some standards for doing hardness field tests and, if they can recognize quartz and feldspar in the field, they have some additional known hardness standards to use.

Special Safety Procedures:

Glass, pocket knives/scalpels, and quartz specimens can be very sharp and students need to exercise caution in doing these tests so as not to cut themselves. A good procedure is to place the specimen on a stable work surface, hold it steady, and then attempt to make a small scratch on it with the testing implement.

Follow-Up:

Ask students to test other household items for hardness and make a chart of their findings. Test things such as tin cans, aluminum cookware, formica counter tops, ceramics, wooden surfaces, and so on. Why are some household items "destined" to become damaged? What is planned obsolescence?

If time allows have students develop facility in doing other physical mineral tests and use this repertory of skills to do some in depth mineral testing and studies. Do certain mineral families have specific test profiles such as high density and low hardness?

References:

Activity developed by Duane Leavitt.

Name _____



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Student Sheet

Purpose:

To learn how to determine the hardness of a mineral, a useful skill in mineral identification.

Materials:

You will need one specimen of each of the following minerals: quartz, calcite, feldspar, unknown #1, and unknown #2. In addition you will need a fingernail (attached), a copper penny, a glass plate, a jackknife or scalpel, and a steel file.

Procedure:

This activity will teach you how to test a substance and determine its hardness. Hardness, which is the degree of resistance to being scratched by something, is a valuable property in identifying minerals as well as other substances. Using the list of substances of known hardness below, test the quartz, calcite, and feldspar and determine their respective hardness. Record your observations in the charts provided. When scratching or attempting to scratch an item hold the specimen to be scratched on a stable surface and use the test implement in a short digging type motion to make the scratch. A true scratch leaves a permanent mark on the object you are trying to scratch. If you don't recognize the quartz, calcite, and feldspar have your teacher identify them for you before you start.

Common Substance	Hardness
Fingernail	2
Copper penny	3
Pocket knife blade*	5
Glass plate (window glass)	5.5
Steel file (chain saw file)	6.5
Quartz	7

PART I:

These hardness values are relative and based on a scale of naturally occurring minerals. On Moh's scale talc, the softest mineral substance known to man, has a value of 1. Diamond, the hardest natural substance known to man, has a value of 10. All other minerals and natural substances have a value somewhere between 1 and 10. Your teacher will probably discuss Moh's scale with you before you do these tests.

Quartz					
	Fingernail 2	Penny 2	Knife 5	Glass 5.5	File 6.5
Scratches					
Is Scratched by					
Calcite					
	Fingernail	Penny	Knife	Glass	File
Scratches					
Is Scratched by					
Feldspar					
	Fingernail	Penny	Knife	Glass	File
Scratches					
Is Scratched by					

The point where the specimen shifts over from being scratched by the object to scratching the object indicates the hardness of the given mineral. Record the observed hardness for the three minerals tested.

QUARTZ: _____

CALCITE: _____

FELDSPAR: _____

PART II:

Using the techniques that you have developed thus far, test the two unknowns and record the hardness.

Unknown #1					
	Fingernail 2	Penny 2	Knife 5	Glass 5.5	File 6.5
Scratches					
Is Scratched by					
Unknown #2					
	Fingernail	Penny	Knife	Glass	File
Scratches					
Is Scratched by					

PART III:

Using the table below, identify the two unknown minerals.

Mineral	Hardness
Magnetite	6
Topaz	8
Spodumene	6.5
Galena	2.5
Dolomite	4

Unknown #1: _____

Unknown #2: _____

Questions:

1. Obviously a number of minerals will have similar hardness. What other characteristics of quartz will help distinguish it from other minerals of the same hardness?
2. Calcite is a very pretty mineral with some optical properties similar to those of diamond. What prevents calcite from being used as gemstone?
3. Diamonds and the graphite in your pencil are both made of pure carbon. What can you infer about the relative strengths of the chemical bonds between carbon atoms in each mineral?