Properties of Common Minerals

Overview:

Imagine if we didn't have minerals: say goodbye to your iPod, your high definition TV, and to your future car. Even you would cease to exist without those precious dissolved minerals that are so vital for the proper functioning of your body. Our world depends on these solid, inorganic substances. Minerals can be an element, like gold or copper, or a simple compound like halite (NaCl); they can also be a more complex compound, as in the mineral hornblende (amphibole). Mineral properties are controlled by the internal arrangement of the atoms, or simply, how the atoms are bonded together. For example, the composition of diamond and graphite is the same, having only carbon atoms, but their internal atomic arrangements are different. This difference produces two vastly different minerals. The brilliant diamond is the hardest mineral known, and graphite is a soft, greasy, dull mineral.

When minerals are joined together, the solid mass forms a rock. The rock granite is composed of the minerals potassium feldspar, quartz, biotite, and amphibole in various amounts. Mineralogists have identified more than 3,000 minerals, but only 100 minerals are common and only about 10 elements make up most minerals. So, how do we identify minerals? By testing their physical and chemical properties. These tests might include the mineral's appearance; the crystal shape, luster, hardness, streak, acid test, cleavage or fracture; its form of breakage; and at times how the mineral feels or smells. These properties and others, along with the mineral composition, can be found in the Properties of Common Minerals chart.

The Chart:

The 21 given minerals are classified first by their luster – the way they reflect light. This classification, Metallic or Non-Metallic, is given on the far left of this chart. The next identifying property is hardness, based on a scale of 1 to 10. A mineral can scratch any mineral with a hardness that is less than its own rating. Following this is whether the mineral shows cleavage or fracture. If the mineral shows at least one smooth face (side), it has cleavage. Common color is given, but one needs to be careful because many minerals show more than one color due to different impurities within the mineral. The Distinguishing Characteristics column gives additional information about the mineral. Look in this column for unusual properties. The Use(s) column lists the particular uses for the mineral. The Composition column shows the element or chemical formula of the mineral. At the bottom of this chart, the chemical symbols of elements are given. In the Mineral Name column, locate Potassium feldspar; it also goes by the name orthoclase. Two other minerals are shown to be identified by other names.

Additional Information:

- Four minerals on this chart are considered to be ores. Ore deposits contain valuable substances that are mined for economic purposes. Most metals are found in ores.
- The common color of a mineral may not be the same as the powder of the mineral, its streak.
- Limestone and marble will react by bubble with hydrochloric acid because both rocks have the mineral calcite in their composition.
- Minerals are non-renewable and need to be recycled.

Set 1 — Properties of Common Minerals

1. Part of a gemstone's value is based on the way a gemstone shines in reflected light. The way a mineral reflects light is described as the mineral's

   (1) fracture (3) luster
   (2) hardness (4) streak 1 _____

2. Which mineral will scratch glass (hardness = 5.5), but not pyrite?

   (1) gypsum (3) orthoclase
   (2) fluorite (4) quartz 2 _____

3. The table below shows the hardness of four common materials.

Hardness of Four Materials

Material	Hardness
human fingernail	2.5
copper penny	3.0
window glass	4.5
steel nail	6.5

   Which statement best describes the hardness of the mineral dolomite?

   (1) Dolomite can scratch window glass, but cannot be scratched by a fingernail.
   (2) Dolomite can scratch window glass, but cannot be scratched by a steel nail.
   (3) Dolomite can scratch a copper penny, but cannot be scratched by a fingernail.
   (4) Dolomite can scratch a copper penny, but cannot be scratched by a steel nail. 3 _____

4. An unidentified mineral that is softer than calcite exhibits a metallic luster and cubic cleavage. This mineral most likely is

   (1) galena (3) halité
   (2) pyrite (4) pyroxene 4 _____

5. Which mineral leaves a green-black powder when rubbed against an unglazed porcelain plate?

   (1) galena (3) hematite
   (2) graphite (4) pyrite 5 _____

6. Which mineral scratches dolomite and is scratched by olivine?

   (1) galena (3) potassium feldspar
   (2) quartz (4) muscovite mica 6 _____

7. Which statement about the minerals plagioclase feldspar, gypsum, biotite mica, and talc can best be inferred from the chart?

   (1) These minerals have the same chemical and physical properties.
   (2) These minerals have different chemical properties, but they have similar physical properties.
   (3) These minerals have different physical and chemical properties, but they have identical uses.
   (4) The physical and chemical properties of these minerals determine how humans use them. 7 _____

8. Minerals from this chart are found in several different rocks. Which two rocks are primarily composed of a mineral that bubbles with acid?

   (1) limestone and marble
   (2) granite and dolostone
   (3) sandstone and quartzite
   (4) slate and conglomerate 8 _____

9. Which home-building material is made mostly from the mineral gypsum?

(1) plastic pipes
(2) window glass
(3) drywall panels
(4) iron nails 9 _____

10. The internal atomic structure of a mineral most likely determines the mineral's

(1) hardness, cleavage, and crystal shape
(2) origin, exposure, and fracture
(3) size, location, and luster
(4) color, streak, and age 10 _____

11. The accompanying table shows some observed physical properties of a mineral. Based on these observations, the elements that make up this mineral's composition are

Physical Property	Observation
color	white
hardness	scratched by the mineral calcite
distinguishing characteristic	feels greasy
cleavage/fracture	shows some definite flat surfaces

(1) sulfur and lead
(2) sulfur, oxygen, and hydrogen
(3) oxygen, silicon, hydrogen, and magnesium
(4) oxygen, silicon, aluminum, and iron 11 _____

"Herkimer Diamonds"

Gem-quality "Herkimer Diamonds" are hexagonal-shaped quartz crystals found in some of the surface bedrock of Herkimer, New York. The oldest of these gemstones are believed to be approximately 500 million years old. These quartz crystals are magnificent works of nature that have a natural diamond like geometric shape formed when the quartz crystallized. Natural "Herkimer Diamonds" were not cut or shaped by humans. Due to their appearance, "Herkimer Diamonds" are commonly used in jewelry. These quartz crystals are not true diamonds.

Mineral Characteristics of "Herkimer Diamonds" (Quartz) and True Diamonds

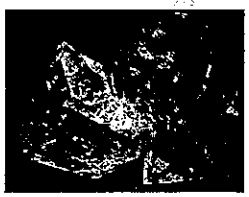
Mineral	Color	Chemical Composition	Luster	Hardness	Dominant Form of Breakage
"Herkimer Diamond" (quartz)	Colorless or variable	SiO_2	Glassy	7	Fracture
True diamond	Colorless or variable	C	Glassy	10	Cleavage

12. *a*) List two mineral characteristics that differ between "Herkimer Diamonds" and true diamonds.

1) _____

2) _____

Photographs of "Herkimer Diamonds" (Quartz)



b) State two use for "Herkimer Diamonds" (quartz), other than their use in jewelry.

1) _____ 2) _____

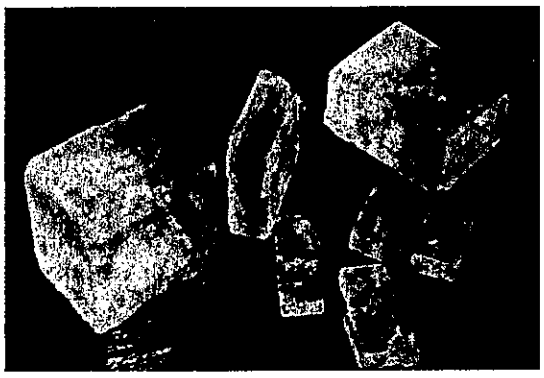
13. A human fingernail has a hardness of approximately 2.5. Which two minerals are softer than a human fingernail?

(1) calcite and halite
(2) sulfur and fluorite
(3) graphite and talc
(4) pyrite and magnetite 13 _____

14. How are the minerals biotite mica and muscovite mica different?

(1) Biotite mica is colorless, but muscovite mica is not.
(2) Biotite mica contains iron and/or magnesium, but muscovite mica does not.
(3) Muscovite mica scratches quartz, but biotite mica does not.
(4) Muscovite mica cleaves into thin sheets, but biotite mica does not. 14 _____

15. The photograph below shows a piece of halite that has been recently broken.



Which physical property of halite is demonstrated by this pattern of breakage?

(1) hardness (3) cleavage
(2) streak (4) luster 15 _____

16. Mohs mineral hardness scale and the chart below showing the approximate hardness of some common objects.

Moh's Mineral Hardness Scale		
Talc	1	
Gypsum	2	
Calcite	3	
Fluortie	4	
Apatite	5	
Feldspar	6	
Quartz	7	
Topaz	8	
Corundum	9	
Diamond	10	

Approximate Hardness of Common Objects
Fingernail (2.5)
Copper penny (3.5)
Iron nail (4.5)
Glass (5.5)
Steel file (6.5)
Streak plate (7.0)

Which statement is best supported by this scale?

(1) A fingernail will scratch calcite, but not quartz.
(2) A fingernail will scratch quartz, but not calcite.
(3) A piece of glass can be scratched by quartz, but not by calcite.
(4) A piece of glass can be scratched by calcite, but not by quartz. 16 _____

17. The mineral graphite is often used as

(1) a lubricant
(2) an abrasive
(3) a source of iron
(4) a cementing material 17 _____

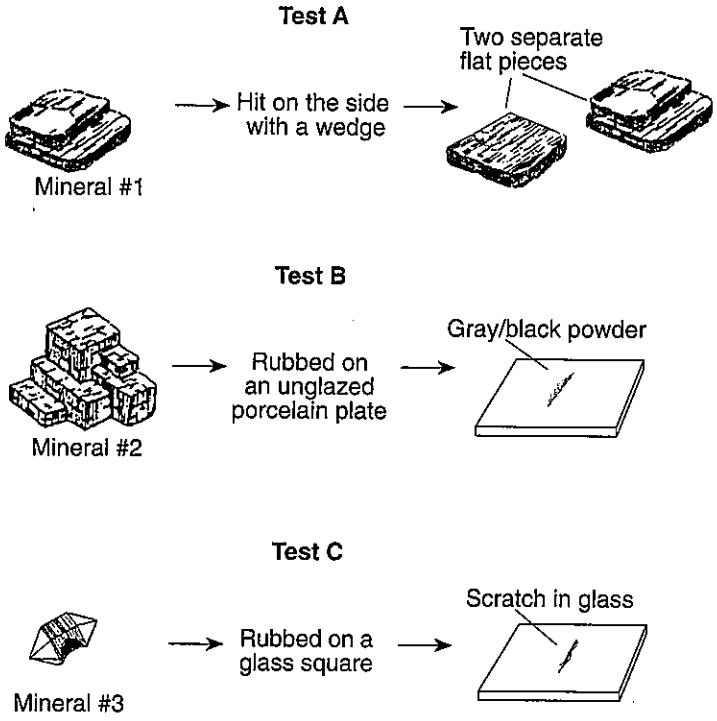
18. Quartz and halite have different crystal shapes primarily because

(1) light reflects from crystal surfaces
(2) energy is released during crystallization
(3) of impurities that produce surface variations
(4) of the internal arrangement of the atoms 18 _____

19. Which two minerals have cleavage planes at right angles?
(1) biotite mica and muscovite mica
(2) sulfur and amphibole
(3) quartz and calcite
(4) potassium feldspar and pyroxene

19 _____

Base your answers to question 20 on the accompanying diagram, which shows three minerals with three different physical tests, *A*, *B*, and *C*, being performed on them.



20. *a*) Which sequence correctly matches each test, *A*, *B*, and *C*, with the mineral property tested?

(1) *A*—cleavage; *B*—streak; *C*—hardness
(2) *A*—cleavage; *B*—hardness; *C*—streak
(3) *A*—streak; *B*—cleavage; *C*—hardness
(4) *A*—streak; *B*—hardness; *C*—cleavage

a _____

b) The results of all three physical tests shown are most useful for determining the

(1) rate of weathering of the minerals
(2) identity of the minerals
(3) environment where the minerals formed
(4) geologic period when the minerals formed

b _____

21. Explain the difference between luster and streak.

_____

_____

_____

22. How can you tell the difference between calcite and halite.

_____

_____

23. What is an ore?

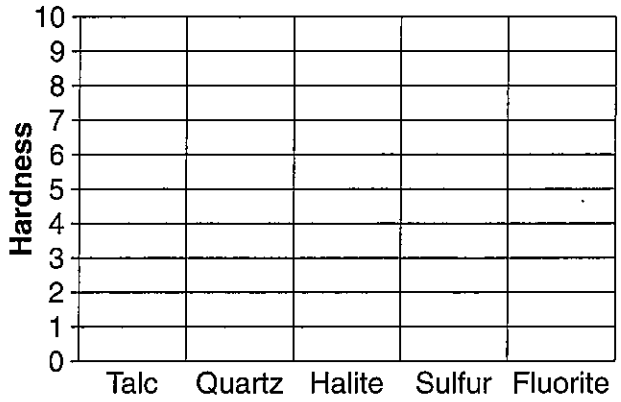
_____

_____

24. What element is present in dolomite that is not present in calcite? _____

Base your answers to question 25 on the hardness of the minerals talc, quartz, halite, sulfur, and fluorite.

25. *a*) On the grid below, construct a bar graph to represent the hardness of these minerals.



b) Which mineral shown on the grid would be the best abrasive? State one reason for your choice.

Mineral: _____

Reason: _____

c) Which mineral(s) would halite be able to scratch? _____

d) If a diamond was included on the above bar graph, up to what hardness number would be shade in? _____

26. A student created the accompanying table by classifying six minerals into two groups, *A* and *B*, based on a single property. Which property was used to classify these minerals?

_____

Group A	Group B
olivine	pyrite
garnet	galena
calcite	graphite

Properties of Common Minerals

LUSTER	HARDNESS	CLEAVAGE	FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	COMPOSITION*	MINERAL NAME
Metallic luster	1–2	✔		silver to gray	black streak, greasy feel	pencil lead, lubricants	C	**Graphite**
	2.5	✔		metallic silver	gray-black streak, cubic cleavage, density = 7.6 g/cm^3	ore of lead, batteries	PbS	**Galena**
	5.5–6.5		✔	black to silver	black streak, magnetic	ore of iron, steel	Fe_3O_4	**Magnetite**
	6.5		✔	brassy yellow	green-black streak, (fool's gold)	ore of sulfur	FeS_2	**Pyrite**
Either	5.5 – 6.5 or 1		✔	metallic silver or earthy red	red-brown streak	ore of iron, jewelry	Fe_2O_3	**Hematite**
Nonmetallic luster	1	✔		white to green	greasy feel	ceramics, paper	$Mg_3Si_4O_{10}(OH)_2$	**Talc**
	2		✔	yellow to amber	white-yellow streak	sulfuric acid	S	**Sulfur**
	2	✔		white to pink or gray	easily scratched by fingernail	plaster of paris, drywall	$CaSO_4 \cdot 2H_2O$	**Selenite gypsum**
	2–2.5	✔		colorless to yellow	flexible in thin sheets	paint, roofing	$KAl_3Si_3O_{10}(OH)_2$	**Muscovite mica**
	2.5	✔		colorless to white	cubic cleavage, salty taste	food additive, melts ice	NaCl	**Halite**
	2.5–3	✔		black to dark brown	flexible in thin sheets	construction materials	$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	**Biotite mica**
	3	✔		colorless or variable	bubbles with acid, rhombohedral cleavage	cement, lime	$CaCO_3$	**Calcite**
	3.5	✔		colorless or variable	bubbles with acid when powdered	building stones	$CaMg(CO_3)_2$	**Dolomite**
	4	✔		colorless or variable	cleaves in 4 directions	hydrofluoric acid	CaF_2	**Fluorite**
	5–6	✔		black to dark green	cleaves in 2 directions at 90°	mineral collections, jewelry	$(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$	**Pyroxene** (commonly augite)
	5.5	✔		black to dark green	cleaves at 56° and 124°	mineral collections, jewelry	$CaNa(Mg,Fe)_4(Al,Fe,Ti)_3Si_6O_{22}(O,OH)_2$	**Amphibole** (commonly hornblende)
	6	✔		white to pink	cleaves in 2 directions at 90°	ceramics, glass	$KAlSi_3O_8$	**Potassium feldspar** (commonly orthoclase)
	6	✔		white to gray	cleaves in 2 directions, striations visible	ceramics, glass	$(Na,Ca)AlSi_3O_8$	**Plagioclase feldspar**
	6.5		✔	green to gray or brown	commonly light green and granular	furnace bricks, jewelry	$(Fe,Mg)_2SiO_4$	**Olivine**
	7		✔	colorless or variable	glassy luster, may form hexagonal crystals	glass, jewelry, electronics	SiO_2	**Quartz**
	6.5–7.5		✔	dark red to green	often seen as red glassy grains in NYS metamorphic rocks	jewelry (NYS gem), abrasives	$Fe_3Al_2Si_3O_{12}$	**Garnet**

*Chemical symbols: Al = aluminum, C = carbon, Ca = calcium, Cl = chlorine, F = fluorine, Fe = iron, H = hydrogen, K = potassium, Mg = magnesium, Na = sodium, O = oxygen, Pb = lead, S = sulfur, Si = silicon, Ti = titanium

✔ = dominant form of breakage