

## Mineral Identification

### Mineral Identification

A *mineral* is any naturally occurring inorganic solid that possesses an orderly internal structure and a definite chemical composition. A *rock* is any solid mass of mineral (or mineral-like) matter that occurs naturally. The classification of rocks requires the identification of its constituent minerals. Minerals may be identified by different physical and chemical properties. It is important to understand that a mineral is usually identified by a variety of properties. No single property is diagnostic for all minerals.

**Color.** Color seems like an easy property but it is risky to identify a mineral by its color alone.

Most minerals can have a wide range of colors due to small amounts of impurities in them such as these examples of quartz.

**Streak.** A mineral's streak is the color of a powdered mineral on a streak plate (unglazed porcelain tile). This property can be diagnostic for a small number of minerals (usually those with a metallic luster).

Although the color of a mineral may vary, the color of the streak remains surprisingly constant.

**Luster.** Luster describes the way that the surface of the mineral reflects light. There are many types of lusters but the common ones are:

*Metallic* – opaque minerals generally with a high luster in colors of black, gray, copper, silver and yellow.

*Nonmetallic* – there are a wide variety of nonmetallic lusters. If a mineral's luster is nonmetallic, you must be specific about the type of luster. The two most common nonmetallic lusters are;

- *Glassy or vitreous* – reflective or shiny luster that is not metallic (commonly transparent or translucent).
- *Dull* – the surface of the mineral is not reflective or shiny.

**Hardness.** Hardness is a mineral's ability to resist being scratched (not its resistance to being broken). The Mohs hardness scale is a unitless 10-point scale with each hardness value represented by a common mineral. An easy way to determine the hardness of a mineral is relative to your fingernail (H~3) and glass (H~5.5).

**Crystal Form.** Some minerals that grow without being impeded by their environment develop characteristic crystal shapes or crystal form that represents the symmetry of the crystal structure. Crystal form can be a diagnostic property for some minerals.

**Cleavage.** Cleavage is the tendency of minerals to break parallel to crystallographic planes along which chemical bonds are weaker than others. Cleavage surfaces are not necessarily parallel to crystal faces and may be difficult to distinguish between them. The cleavage of a mineral is noted by the number of unique directions and the angles between them.

**Fracture.** Fracture is the way a mineral breaks in the absence of a cleavage plane. In some crystals, the strength of bonds is approximately equal in all crystallographic directions. Several types of fracture can be described:

- conchoidal – smooth curved surfaces resembling shells
- fibrous – common with asbestos
- hackly – jagged fractures with sharp edges
- irregular or uneven – rough or irregular surfaces

**Specific Gravity.** Specific gravity is a measure of the density of a mineral and is a number that represents a ratio of the mass of a mineral relative to water. For example, a mineral with SG=3.0 weighs 3 times more than an equivalent volume of water.



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**Other Properties.** There are some special properties that are less common but may be diagnostic for some minerals.

Magnetism – a few minerals are magnetic and this property is very diagnostic

Taste – some minerals have a diagnostic taste (ex. Halite); do not taste any minerals in class!

Reaction to acid – some minerals that contain the chemical component carbonate ( $\text{CO}_3^{2-}$ ) and react to acid by effervescing. Be very careful using HCl acid in class. Do not apply acid to minerals unless you are certain that you will get a reaction and blot the mineral afterward with a paper towel.

Minerals with Metallic Luster			
Hardness	Streak	Other Diagnostic Properties & Notes	Name & Formula
Harder than glass (H>5.5)	<b>Black</b>	Black or gray with brownish tint; H=5.5-6.5; SG~5.2; <b>magnetic</b> ; commonly small granular crystals, octahedra, or massive; uneven fracture; may have poor cleavage (parting); iron ore	<b>Magnetite</b> Fe <sub>3</sub> O <sub>4</sub>
	<b>Greenish black</b>	<b>Pale brass yellow</b> ; tarnishes darker; H=6-6.5; SG~5; commonly massive; <b>commonly forms cubic crystals that may be striated</b> ; uneven fracture; also known as “fool’s gold”	<b>Pyrite</b> FeS <sub>2</sub>
	<b>Reddish Brown</b>	Metallic grey (may have parts that are dull to bright red); H=5-6; SG=5; commonly massive, granular or tabular crystals; uneven fracture; note occurrence of variety with nonmetallic luster; iron ore	<b>Hematite</b> Fe <sub>2</sub> O <sub>3</sub>
Harder than fingernail, softer than glass (H=2.5-5.5)	Greenish black	<b>Brass yellow (more yellow than pyrite)</b> ; H=3.5; SG~4; commonly massive; <b>iridescent purplish tarnish is common</b> ; copper ore	<b>Chalcopyrite</b> CuFeS <sub>2</sub>
	Gray black	<b>Lead gray to silvery</b> ; H~2.5; <b>SG~7.5</b> ; commonly forms <b>cubic</b> or octahedral crystals or may be massive; <b>cleavage in 3 directions at right angles</b> ; lead ore	<b>Galena</b> PbS
	Gray black	Copper red to bronze brown; <b>iridescent tarnish in shades of blues and purple</b> ; H~3; SG~5; commonly granular or massive; uneven or conchoidal fracture; poor cleavage; copper ore	<b>Bornite</b> Cu <sub>2</sub> FeS <sub>4</sub>
Softer than fingernail (H<2.5)	Black to dark gray	Black to dark gray; <b>H=1-2; SG=2.2</b> ; commonly tabular crystals or granular;	<b>Graphite</b> C

Dark Minerals with Nonmetallic Luster			
Hardness	Cleavage	Other Diagnostic Properties & Notes	Name & Formula
Harder than glass (H>5.5)	Cleavage prominent	<b>Black to greenish black</b> ; H=5.5-6; SG~3.4; commonly stubby prismatic crystals; <b>cleavage in 2 directions at ~90°</b> ; glassy luster; pyroxene is a large group of minerals with augite being one of the most common; common in igneous and metamorphic rocks	<b>Augite</b> (Pyroxene group) Ca, Mg, Fe, Al silicate
		<b>Most commonly black</b> (may range from brown to dark green); H=5-6; SG~3; long, prismatic crystals common; <b>cleavage in 2 direction at 60° and 120°</b> ; glassy luster; amphibole is a large group of minerals with hornblende being one of the most common;	<b>Hornblende</b> (Amphibole group) Ca, Mg, Fe, Al silicate

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		common in igneous and metamorphic rocks	
		<b>White to dark gray</b> ; H~6; SG=2.6; commonly massive or granular; <b>cleavage in 2 directions at ~90°</b> ; glassy luster; plagioclase is a complex mineral in the feldspar group; generally Ca-rich varieties are darker in color; plagioclase is the most common mineral in the Earth's crust	<b>Plagioclase</b> (Feldspar group) $(\text{Na, Ca})\text{Al}(\text{Al, Si})_2\text{Si}_2\text{O}_8$
		Cleavage absent or not prominent	<b>Quartz</b> $\text{SiO}_2$
		Red to brown common (various colors); H=6.5-7.5; SG=3-4; <b>commonly forms 12-sided crystals</b> ; uneven or conchoidal fracture; glassy luster; characteristic of metamorphic rocks	<b>Garnet group</b> Fe, Mg, Ca, Al silicate
Harder than fingernail, softer than glass (H=2.5-5.5)	Cleavage prominent	<b>Various shades of green</b> ; H=6.5-7; SG=3.2-4.5; commonly massive to granular; uneven or conchoidal fracture; glassy luster; common in ultramafic igneous rocks	<b>Olivine</b> $(\text{Mg, Fe})_2\text{SiO}_4$
		Black to brown to yellowish brown; H=4; SG=3.9-4.2; Commonly massive, granular or well-formed crystals; cleavage in 6 directions; glassy or resinous luster; <b>yellowish streak that smells of sulfur</b> ; zinc ore	<b>Sphalerite</b> (Zn, Fe)S
	Cleavage absent or not prominent	<b>Black to brown</b> ; H=2.5-3; SG=2.7-3.1; commonly platy crystals; <b>cleavage in 1 direction</b> ; glassy luster; <b>flexible and elastic in thin sheets</b>	<b>Biotite</b> (Mica group) $\text{K}(\text{Mg, Fe})_3(\text{AlSi}_3\text{O}_{10})(\text{F, OH})_2$
		Red to reddish brown; H=1-5; SG=4-5; commonly earthy or granular; uneven fracture; <b>dull luster</b> ; <b>reddish brown streak</b> ; may test harder due to presence of silicate grains; may test softer due to disaggregation of sample; note occurrence of variety with metallic luster; iron ore	<b>Hematite</b> $\text{Fe}_2\text{O}_3$
		<b>Yellowish-brown to dark brown</b> ; H=4-5.5; SG=3-4; commonly compacted earthy mass; uneven fracture; dull luster; <b>yellowish-brown streak</b> ; may test harder or softer; mineraloid	<b>Limonite</b> $\text{FeO}(\text{OH}) \cdot n\text{H}_2\text{O}$

Light Minerals with Nonmetallic Luster			
Hardness	Cleavage	Other Diagnostic Properties	Name & Formula
Harder than glass (H>5.5)	Cleavage Prominent	<b>White to dark gray</b> ; H~6; SG=2.6; commonly massive or granular; <b>cleavage in 2 directions at ~90°</b> ; glassy luster; plagioclase is a complex mineral in the feldspar group; generally Na-rich varieties are lighter in color; plagioclase is the most common mineral in the Earth's crust	<b>Plagioclase</b> (Feldspar group) $(\text{Na, Ca})\text{Al}(\text{Al, Si})_2\text{Si}_2\text{O}_8$
		<b>White to pink</b> ; H=6; SG=2.6; granular to massive crystals; <b>2 directions of cleavage at ~90°</b> ; glassy luster; feldspars are the most common minerals in	<b>K-feldspar</b> (Feldspar group) $\text{KAlSi}_3\text{O}_8$

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		the Earth's crust	
	Cleavage absent	Various colors - transparent, white (milky quartz), pink (rose quartz), yellow (citrine), gray (smoky quartz), purple (amethyst); H=7; SG=2.6; <b>common 6-sided crystals</b> or massive; <b>uneven or conchoidal fracture</b> ; glassy luster; color varies due to impurities in structure;	<b>Quartz</b> SiO <sub>2</sub>
		<b>Various shades of green</b> ; H=6.5-7; SG=3.2-4.5; commonly massive to granular; uneven or conchoidal fracture; glassy luster; common in ultramafic igneous rocks	<b>Olivine</b> (Mg, Fe) <sub>2</sub> SiO <sub>4</sub>
Harder than fingernail, softer than glass (H=2.5-5.5)	Cleavage Prominent	Various colors – transparent, purple, white yellow and green; <b>H=4</b> ; SG=3.2; commonly forms cubic crystals; <b>cleavage in 4 directions</b> ; glassy luster	<b>Fluorite</b> CaF <sub>2</sub>
		Transparent or white common, rarely yellow to blue; H=3; SG=2.7; forms large crystals or fine-grain aggregate; <b>3 directions of cleavage not at 90°</b> ; glassy luster; <b>reacts readily to acid</b> ; common in sedimentary rocks; <b>double refraction</b>	<b>Calcite</b> CaCO <sub>3</sub>
		White to pink, H=3.5-4; SG=2.8; forms tabular crystals or fine-grain aggregate; 3 directions of cleavage not at 90°, glassy luster; <b>reacts to acid when powdered</b> ; common in sedimentary rocks	<b>Dolomite</b> CaMg(CO <sub>3</sub> ) <sub>2</sub>
Softer than fingernail (H<2.5)	Cleavage prominent	Colorless to white; <b>H=2-2.5</b> ; SG=2.2; commonly forms cubic crystals; <b>3 directions of cleavage at 90°</b> ; glassy luster; <b>soluble in water</b> ; <b>salty taste</b> ; ordinary table salt; common in evaporite deposits	<b>Halite</b> NaCl
		<b>Colorless in thin sheets and tan in thicker sheets</b> ; H=2-2.5; SG=2.7-3; may form 6-sided platy crystals; <b>1 direction of cleavage</b> ; glassy luster; <b>flexible and elastic in thin sheets</b>	<b>Muscovite</b> (Mica group) KAl <sub>2</sub> (AlSi <sub>3</sub> O <sub>10</sub> )(F,OH) <sub>2</sub>
		White to <b>transparent</b> ; <b>H=1.5-2</b> ; SG=2.3; selenite is transparent with 3 directions of cleavage not at 90° and glassy luster; satin spar has fibrous fracture with silky/glassy luster; alabaster consists of granular mass; common in evaporite deposits	<b>Gypsum</b> CaSO <sub>4</sub> ·2H <sub>2</sub> O
	<b>White to light green</b> ; <b>H=1</b> ; SG=2.6; commonly forms fibrous masses or platy crystals; one direction of cleavage; pearly or glassy luster; common in metamorphic rocks	<b>Talc</b> Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	
	Cleavage absent	<b>Commonly white</b> ; H=2-2.5 ( <b>tests softer due to disaggregation of sample</b> ); SG~2.5; <b>looks like earthy masses due to microscopic crystals</b> ; although kaolinite has cleavage it is not visible in microscopic crystals; <b>appears to have uneven fracture</b> ; earthy smell and slippery feel when moistened; clay mineral	<b>Kaolinite</b> Al <sub>2</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>