MINERAL IDENTIFICATION KEY

by Alan Plante & Donald Peck

We wish to make this key available to one and all in the hope of correct identification of minerals in collections, rock gardens, and on windowsills everywhere. You may copy it, or any part of it, for non-commercial, personal use.

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Introduction

This Mineral Key is designed and intended for use on-line. It is intended also to be used in conjunction with one or more other field guides to minerals: Once the Key leads the user to one or more "likely suspects" details on them should be looked up in another book in order to make a final determination.

The premise behind this Key is similar to that of the identification keys found in some fern and wildflower books: An artificial key is used to direct the user to the pages in the sections where further information on "likely suspects" are found. The information in the sections on mineral species is then used to narrow the choices to one or a few "most likely" species. Then more detailed information can be found in a mineral guide to make a final determination.

Unlike most keys for wildflowers, this system for the identification of minerals is limited – both in scope and applicability. Only a couple hundred of the most common or "usually seen" mineral species are covered. Users may well come across rare species which are not covered here. The system also requires good enough samples of the minerals to perform the tests in the sections describing mineral species. It is probably not useful for the identification of micro-crystal samples. Still, it can help narrow down the search by eliminating the more common species as possibilities. If a sample of some unknown mineral does not "key out" to one of the common species, then further testing and research to determine its identity might be worth while. But the user is cautioned that every possible effort should be made to key the sample out using this Key before looking elsewhere for help: Many common minerals have varied habits and other characteristics which might lead one to suspect a sample to be something rare, when in fact it is a common species in one of its less-prevalent forms. A close read of guide book information may clue the user in on such samples. Resorting to such things as sending samples in to a lab should be the last thing one does with an unknown. You should be quite certain that it is a rare species, one not covered here or in a mineral guide .

Often a single series of field tests may not key the user in to the correct identification. The odds of making a correct identification will be increased if tests are repeated: Take several streaks, especially if a sample is proving difficult to get a streak from), test the hardness more than once – and do tests both ways, trying to scratch the known hardness tool with the mineral and trying to scratch the mineral with the tool. If possible, when examining samples for cleavage, look at several samples – and try to use fresh breaks, cleavages which you – not nature – have produced. It is often a good idea to examine small cleavage surfaces using a 10X lens. If the first try at determining a hardness is unsuccessful or ambiguous, perhaps the second, third, or fourth will do the trick. The same holds for other tests. Such diligence to repetitive procedure usually pays off where a single try does not.

Finally, if the first run through the tests doesn't seem to be leading you to the correct identification – try again from scratch. A second run through the entire procedure may do the trick – maybe rethinking some aspect of the tests, such as whether or not the sample really has a metallic luster. In the end, care should lead one to the correct identification for species covered in this Key. Also, practice may not always make perfect – but in the case of mineral identification the more you practice the better you will get at it. So try running samples of known species through the procedure to get a feel for how the key leads one step-by-step towards and identification. Practice, practice, practice…

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A Simple Identification Kit

In order to use this identification key you will need to assemble an "Identification Kit". Here's what you'll need:

- A piece of plain white paper (a blank specimen label works great.)
- Your fingernails (preferable still attached to your fingers!)
- A copper penny (or small –½ inch – piece of copper or short piece of heavy copper wire.)
- A small piece of fluorite (a broken cleavage piece is fine.)
- A pocket knife (NOT a Swiss Army knife – the steel in those is harder than in most cheap pocket knives, which can throw hardness tests off.)
- A small section of a steel file (a 2 or 3 inch tip from a triangular file for sharpening chain saws works fine.)
- A piece of a quartz crystal (with at least one good face and a sharp point - a broken section usually has a sharp point on it somewhere, it doesn't have to be a crystal termination.)
- A small piece of a beryl or topaz crystal (with at least one good face and a sharp point or edge.)
- A small piece of a corundum crystal (with at least one good face and sharp point or edge.)
- A "streak plate" (unglazed porcelain tile – a 2 inch square is plenty.)
- A short candle stub and matches (in waterproof container) or a cigarette lighter.
- A small pair of tweezers.
- A small magnet (a refrigerator magnet is fine, but should be a fairly strong one.)
- A 10x hand lens/jeweler's loupe.
- Blank specimen labels.
- Pens or pencils.

Most of these items are for testing hardness, and there are more listed than the key itself requires. But when you get to the sections and have specific minerals in mind the extra hardness tools will help you in determining whether or not your unknown has the specific hardness of one of the minerals listed. A hardness table is provide below showing the relative hardness of the items listed. The streak plate is used for obtaining a colored (or not) powder streak of the mineral. Many minerals give a different powder streak color than the mineral itself. (Such as black hematite giving its characteristic "rust red" streak.) The candle stub or lighter is used for doing basic fusibility tests – will a chip fuse in the flame? The tweezers keep your fingers from getting burned doing the fusibility test! A magnet is used for testing whether or not a sample is magnetic. A loupe is often necessary for examining broken mineral surface to check the cleavage. And figuring out what mineral you have would be a waste of time if you don't label the sample – and forget what it is by the time you get around to looking at it again.

The items can be kept in a leather pouch, a small plastic box – or anything that's the right size and durable. But it is a good idea to keep the kit items together in some sort of container. Then you always know where to find them when you need them.

Mineral Properties

Luster Hardness Streak Cleavage Fusiblity Specific Gravity Habit Tenacity Color Luminescence Radioactivity Magnetism

In order to use this Key and the test kit described above, you need to understand some basic principals of mineralogy. The most important are: luster, streak, hardness, and cleavage. It also good to know a bit about such things as specific gravity, fusibility, mineral "habits," and the types of mineral "environments" different minerals are likely to be found in – what types of rock, under what physical conditions. Brief discussions of the most important properties follow below. Any good mineral book should have more detailed sections discussing them, and the user of this Key is advised to get one and read it before working with this Key and the kit.

Luster: A mineral's luster is the overall sheen of its surface – it may have the sheen of polished metal, or that of an unpolished metal that is pitted by weathering – or it may have the sheen of glass, or look dull or earthy, etc. Luster should not be confused with color: A brass-yellow pyrite crystal has a metallic luster, but so does a shiny grey galena crystal . Quartz is said to have a glassy (or vitreous) luster, but its color may be purple, rose, yellow, or any of a wide range of hues. The different types of luster referred to are: **Metallic,** having the look of a polished metal; **Submetallic**, having the look of a metal that is dulled by weathering or corrosion; and **Non-metallic**, not looking like a metal at all. Nonmetallic luster is divided into several sub-types:

- Adamantine, having the hard, sparkly look of a diamond
- Glassy/Vitreous, having the look of glass;
- Resinous, having the look of amber – not quite glassy;
- Pearly, having the iridescent look of mother-of-pearl (though usually just barely);
- Greasy/Oily, having the look of an oil-coated substance;
- Silky, having the look of silk, fine parallel fibers of mineral – such as chrysotile "asbestos;"
- Dull, having a plain looking surface that is not submetallic;
- Earthy, having the look of soil or clay.

Certain minerals with a resinous or adamantine luster – such as sphalerite and cinnabar respectively – can appear submetallic. Care needs to be taken in deciding which of these lusters a particular mineral has. Return to Key: Step 1

Hardness is a mineralogical term denoting how resistant a mineral is to being scratched. It should not be confused with a mineral's overall "toughness." (Diamond is the hardest known mineral, but it has a perfect cleavage and breaks easily along that cleavage.) Relative Hardness is used in identification by comparing the hardness of the mineral to that of items with known hardness. Mohs Scale of Relative Hardness is used, and is presented here with the addition of a few common materials of known hardness added:

1:	Talc (softest)	6:	Microcline
2:	Gypsum	6½:	Steel File
2½:	Fingernail	7:	Quartz
3:	Calcite or Copper Penny	8:	Topaz
4:	Fluorite	9:	Corundum
5:	Fluorapatite	9-9½:	Carborundum
5+:	Pocket Knife	10:	Diamond
5½:	Window Glass		

One tests for Relative Hardness by scratching the surface of a crystal or cleavage face with an item of known hardness – and vice versa, scratching the item of known hardness with a sharp point, edge, or grain of the mineral being tested. Whenever possible, the test should be done both ways – first trying to scratch the sample, then trying to scratch the item of known hardness, such as scratching a crystal face with a knife point and then trying to scratch the knife blade with the point or a sharp edge of the crystal. Since some minerals may leave a powdered streak on the item being scratched (or the known hardness item may leave a streak on the sample) one must rub the "scratch" with a finger to see if it is really a scratch or just a powder streak that rubs off. If a mineral produces a powder streak on the item being scratched then it is probably softer than that item. (Conversely, if the item leaves a streak on the sample it is softer than the sample.)

Since the "scratch test" is very important to the identification of minerals every effort should be made to get a positive result – be sure that the correct hardness is determined. With some samples, it may take several tries before one can safely conclude the sample's hardness.
Return to Key: Step 2 **Return to Key: Step 3** **Return to Key: Step 5** **Return to Step 7** **Return to Step 10** **Return to Step 14**

Streak is simply the color of a mineral powder. Many minerals have a different color when powdered than they do in crystal or massive forms. The color may be entirely different, or it may be a different shade. Quite a few minerals give a powder streak that is lighter in color than the whole crystal or massive pieces. A streak is usually obtained by dragging a sharp edge, grain, or point of a crystal across a **streak plate** – which is simply an unglazed piece of porcelain tile, such as those used in bathrooms and kitchens. (If you get your streak plate from a home improvement shop be sure what you get is unglazed porcelain – not plastic or some other material.) A porcelain streak plate has a relative hardness of about 6½. So minerals of that hardness and greater can not be tested on it – they'll only scratch it. Some geologists use a file to test the streak of minerals with a hardness of 6 to 6½.

Streak plates tend to end up covered with traces of mineral powder in various colors. They can be "refreshed" by sanding them with fine emery sandpaper – 220 grit or higher. Do not use a coarser grit, as it will roughen the surface of the streak plate.

Some minerals can be difficult to get a good powdered streak from. As with other tests, repetition usually pays off. Always try to use a sharp edge or point, rather than just dragging the mineral across the streak plate willy-nilly. While some soft minerals give a streak easily no matter how you drag them, others will not streak well unless you use a small surface area of the mineral to get the streak. Get in the habit of looking for and using a sharp edge, grain, or the point of a crystal.
Return to Key: Step 4

Cleavage refers to the way some minerals break along certain lines of weakness in their structure. Mica is a good example – breaking along very closely spaced flat planes that yield thin "sheets." Calcite is another good example, breaking along three different planes that yield blocky fragments that look like a rectangular box that has been warped – called a "rhombohedron" or, simply, "rhomb." Galena breaks along three planes at right angles to one another, producing true cubes as fragments.

Cleavages are also described in terms of their quality: How smoothly and easily the mineral breaks. The qualities of cleavages are perfect, imperfect, distinct, good, fair, and poor. Mica is said to have a perfect cleavage (in one direction). Calcite has a perfect cleavage (in three directions). Feldspars – such as microcline – have a perfect cleavage in one direction and a good cleavage in another. Sphalerite has a perfect cleavage in six directions.

Cleavage may also be described in terms of crystallographic type:

- cubic (galena)
- octahedral (fluorite)
- rhombohedral (calcite)
- prismatic (feldspars)
- pinacoidal or basal (micas)
- etc.

These are usually referenced to what are called crystallographic forms, usually using a shorthand known as Miller Indices. This Key does not get that advanced, but the guides many collectors use often have this information in them.

The main thing that needs to be considered in the identification of minerals is whether or not a sample has a cleavage – many minerals don't, breaking without producing smooth surfaces. Next is whether or not there are two or more cleavage surfaces present at angles to one another and, if so, the quality of the various cleavages. Where two or more cleavage surfaces are present, it then becomes important to figure out which crystal form they represent – cubic, prismatic, and so on. This is usually done by "guestimating" the angles between cleavage surfaces. Some are easy, like galena with its three perfect cleavages at 90 degrees to one another being cubic. Others can be hard to determine and may require measurement of the angles. A device called a ***contact goniometer*** can be handy for doing this. It is simply a protractor with an adjustable arm on it that is used to lay along one cleavage surface while the base of the protractor is laid across another. More information on this can be found in some field guides and most mineralogy texts. One can also make simple line drawings on a sheet of paper of the various angles common to minerals and keep the sheet in your guide. This can be used for making "eyeball comparisons" with the angles between cleavage surfaces on samples.

By-and-large, cleavages at 90 degrees to one another indicate a cubic form, cleavages at 120 and 60 degrees in the same sample indicate a rhombohedral form, and cleavages at acute to obtuse angles over long surfaces indicate a prismatic form – such as in feldspars. Nearly rectangular or sharp angles in prismatic minerals may indicate a Pyroxene Group mineral or one of the Feldspars, while more open angles – approximately 120 degrees – may indicate an Amphibole Group mineral. (Not all do, but these three groups are common and frequently seen, so seeing these types of cleavages is likely to mean you have one of them.) A single cleavage at 90 degrees to a crystal face indicates a basal form – such as in micas. See a good guide book

for further information.
Return to Step 6 **Return to Step 8** **Return to Step 11** **Return to Step 13** **Return to Step 14**

Fusibility is a measure of how much heat it takes to melt a mineral into a globule, or at least to melt the sharp edge of a sharp splinter and make it round over. Quite a few minerals are easily fusible in the flame of a candle or typical cigarette lighter: A small, sharp, splinter held in the flame either melts into a globule or its edges round over easily. So this can be a handy test to do; a candle and matches or lighter are no big imposition. Such minerals are said to have a fusibility of "1" or "2" – though for our purposes the degree of difficulty with which a mineral fuses is not particularly important. Either it does or it doesn't.

Other fusibility tests can be performed in the home workshop, using a blowtorch. It takes some practice, but it should not be too hard for most people to become proficient at these tests.
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Density and Specific Gravity are not properties easily determined, requiring special equipment; but a result of them, which might simply be called "**heft**" can come in handy: The denser a mineral is, the heavier it is per given volume. A 1 inch cube of galena is noticeable heavier in the hand than a 1 inch cube of pyrite. A barite crystal of the same size as other similar glassy crystals is likely to feel noticeably heavier. So do cerussite and anglesite crystals. So a mineral's "heft" can be a clue to its identity. With a little practice a collector can become quite proficient at judging the relative weight of minerals and using that to help establish a sample's identity.

In the home lab or workshop, specific gravity (S.G.) can be a very useful property in identifying minerals. Collectors should learn about S.G. and test for it routinely when working on ""mystery minerals" at home. Any good guide or text covers this topic and methods of testing. Probably the easiest is using a standard triple-beam balance, available from any scientific supply house – or perhaps through the local high school chemistry lab.

Habit is the general appearance a mineral tends to have – whether it is found as blocky crystals, long slender ones, or aggregates of some type, etc. If the crystals are glassy and cubic in shape you know they aren't quartz. If they are rounded like a soccer ball you know they aren't tourmaline. And so on…

Distinct crystals may be described as:

- Blocky or Equant – roughly box-like or ball-like, as in pyrite.
- Prismatic – elongated with opposite faces parallel to one another, in which case they may be short and stout, or long and thin.
- Bladed - Long thin crystals may be flattened like the blade of a knife;
- Acicular – needle-like;
- Filiform or Capillary – like hair or thread.

Quartz and tourmaline crystals are prismatic, actinolite is often bladed, millerite is acicular.

Groups of distinct crystals may be described as:

- Druzy – covering a surface in more-or-less outward pointing clusters of small crystals, such as druzy quartz crystals.
- Divergent or Radiating – growing outward from a point in sprays or starbursts, such as some hemimorphite exhibits.
- Reticulated – interconnected like a lattice or trellis, such as rutile.
- Dendritic or Arborescent – Slender divergent branch- or fern-like clusters, such as some native silver crystals.

Compact parallel or radiating groups of individual crystals may be described as:

- Columnar – stout parallel clusters with a column-like appearance, such as some forms of the serpentine minerals.
- Fibrous – aggregates of parallel or radiating slender fibers, such as chrysotile.
- Stellate – long thin crystals radiating outwards in all directions, like a starburst or in a circular pattern, such as astrophyllite.
- Spherical or Globular – compact clusters radiating outwards forming rounded, ball-like, shapes.
- Botryoidal – Globular or ball-like clusters – like a bunch of grapes – that do not have internally radiating fibers.
- Reniform – Radiating compact clusters of crystals ending in rounded, kidney-like, surfaces, such as hematite often exhibits.
- Mammillary – large rounded masses resembling human breasts.

A mineral aggregate composed of scales or flakes may be described as:

- Foliated – looking like overlapping flakes or leaves and easily separable into individual leaves or flakes, usually at least somewhat "wavy" in appearance, such as the chlorite minerals.
- Micaceous – Like foliated, but splits into very thin sheets, like the mica minerals.
- Tabular or lamellar – Flat, platy, grains thicker than flakes or leaves, but overlapping like foliated, such as molybdenite.
- Plumose – Feather-like sprays of fine scales, similar to dendritic but with a much finer structure, such as one form of native silver.

A mineral composed of grains is simply said to be granular. Granular minerals may be composed of rounded or semi-rounded grains, or of angular grains.

A few other descriptive terms are:

- Massive – no crystal structure visible, though the mineral may be crystalline. Some massive minerals may also be granular.
- Banded – showing different bands or layers of color or texture, as in some agates or some fluorite.
- Concentric – in rounded masses showing layers around the mass in shells, working outward from the center, as in some agates.
- Pisolitic – roughly pea-size rounded masses.
- Oolitic – masses of small round spheres about the size of fish eggs.
- Geode – A rock with a hollow, roughly spherical, interior with concentric bands of mineral (usually agate) on the wall and possibly crystals on the interior surface, pointing inwards.
- Concretionary – masses formed by mineral being deposited around a nucleus, may be spherical or rounded but may also be a wide variety of other shapes.

A wide variety of other terms are also used to describe mineral habits. Usually they refer to loose associations with common objects or concepts and are readily apparent when the term is used in context with the form present in the mineral at hand.

Tenacity refers to a mineral’s resistance to breaking, bending, or otherwise being deformed. A mineral may be **brittle**, easily broken or crushed to powder; **malleable**, easily hammered into thin sheets (such as copper or gold); **sectile**, easily cut with a knife; **flexible**, easily bent without breaking and then staying bent; or **elastic**, bending but resuming its original shape once pressure is released.

Tenacity is particularly useful in telling some of the metallic minerals apart. Gold is malleable, pyrite (and most other look-a-likes) is not. Gold is also sectile and – in thin sheets – flexible. Galena is brittle, while platinum is malleable and sectile.

Flexibility and elasticity can be useful with minerals that are commonly found as flakes or acicular crystals. Chlorite flakes and thin crocoite crystals can be bent, and they will stay bent. Mica sheets bend and then snap back to their original shape when released.

Color is often a double-edged sword in mineral identification: There are many minerals which have distinctive colors; but there are also many which come in a variety of hues. And the same color can be seen in several different species. So one needs to use color as a criteria with care. That "malachite-green" mineral may not be malachite… That brass-yellow metallic mineral may not be pyrite… It is always a good idea to try and get a powdered streak from any colored mineral and compare it with descriptions of the streaks for the likely suspects you have in mind. It is also always wise to consider the habit of the mineral in conjunction with the color. A green prismatic crystal with a hexagonal cross-section is more likely to be elbaite than malachite. A brassy wedge-shaped crystal is more likely to be chalcopyrite than pyrite.

Color, in general, should never be taken as diagnostic by itself. While it may be for certain species, more likely than not it isn’t. Else the job of mineral identification would be made easy.

Play of Color can be more helpful than the color itself. Characteristics such as opalescence, iridescence, chatoyancy and asterism are peculiar to a limited number of species, or varieties of species.

Opalescence, as the word suggests, refers to an opal-like play of light, reflections off the mineral producing flashes of color that may appear somewhat like a patch-work of different "grains" of color that aren’t really there: Move the sample minutely and the color disappears from that spot. It is sort of like taking a pearly luster to the nth degree.

Iridescence is similar to opalescence except that it is usually associated with metallic minerals and surface reflections rather than glassy minerals and sub-surface reflections: An exception is the type of iridescence known as **labradoresence** or **schiller**, found in labradorite and a very few other minerals.

Chatoyancy is the play of light off closely packed parallel fibers or parallel inclusions in cavities. The light reflects along lines – which may be straight or curved – giving the mineral a somewhat silky appearance. This characteristic is seen in such minerals as "satin spar" gypsum, "tiger's eye" (fibrous crocidolite replaced by quartz), and chrysoberyl.

Asterism is a type of chatoyancy in which the fibers or inclusions reflecting the light are arranged in a pattern radiating outwards from a point producing a star-like pattern. This is most often seen in rubies and sapphires, and sometimes in phlogopite mica that has rutile inclusions.

Luminescence is the emission of light by a mineral other than the reflected light of the sun or a lamp – the mineral "glows" due to some other reason. The usual reason is reaction to ultraviolet light, though X-rays and cathode rays may produce it as well. The types of luminescence seen in minerals are **fluorescence** and **phosphorescence** – two closely related phenomena. Fluorescence results from electrons orbiting the mineral's atoms being excited by ultraviolet light; the electrons "absorb" the energy and jump to higher orbits, then fall back to their original orbits – giving off light in the visible spectrum as they do. Phosphorescence is basically the same thing, but continues for a time after the source of excitation is removed, giving off energy as visible light more slowly. The fact is that most fluorescent minerals exhibit phosphorescence to some extent, though it usually can only be seen under careful lab conditions. Only a very few minerals phosphoresce well enough to see in a simple darkened room, and the phenomenon is usually rather short lived.

Fluorescence is a useful field identification tool for collectors who have UV lights (and a thick blanket when in the field) Many localities have at least a couple of fluorescent minerals, and some – like Franklin/Ogdensburg, New Jersey, USA – have a wealth of them. Where they are present, the UV light can be put to use in identifying them.

Radioactivity is another property that, while not too common, is found in some minerals and can be useful in identification. Collectors who have a Geiger counter may find it useful at certain localities, particularly pegmatites – where many of the more common radioactive minerals are found.

Magnetism is not too prevalent in minerals, but in those that do exhibit it the property can be useful in making an identification. Carrying a small but strong magnet in a field kit is a good idea, even if it only gets used now and then. The only strongly magnetic mineral collectors are likely to come across is, of course, magnetite. Some other minerals that may exhibit weak magnetism are pyrrhotite, ilmenite and franklinite.

A couple of other electrical properties found in minerals are piezoelectricity and pyroelectricity, though they are not common. They are also rather difficult to test for and won't be covered here. Anyone interested in them can find information in most texts on mineralogy.

Luster **Hardness** **Streak** **Cleavage** **Fusiblity** **Specific Gravity** **Habit** **Tenacity** **Color** **Luminescence** **Radioactivity** **Magnetism**

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Mineral Environments & Associations

Where a mineral is found – the type of rock in which it is found – and with what it is found – the other minerals that occur with it – can be as important to identifying the mineral as its physical properties. While there is not room for much of this information in the Key, the collector should pay close attention to it when they encounter it in field guides or other reference works.

Mineral Environments refers to the "geologic environments" in which minerals occur – the types of rocks in which they are found. While some minerals occur in two or more environments, others tend to be restricted to a single environment. If you think you have found the mineral kyanite in a sedimentary sandstone and see that it is a mineral formed by metamorphic processes you'll know it can't be kyanite. Try celestite… If you think you have found topaz in a cavity in basalt and read that it is largely restricted to pegmatite you'll know it isn't topaz. And so on.

On a smaller scale, environments can vary over the volume of a single deposit. A lode of copper ores may have an oxidized zone, a hydrothermal zone, and a deep primary zone. Each zone tends to produce distinct mineral assemblages. And figuring out what zone a mineral was created in leads to learning about mineral associations.

Mineral Associations are simply that – what minerals occur with one another in what environments. Such as minerals like malachite and brochantite most often being found with chalcopyrite and pyrite. Or secondary phosphate minerals being associated with triphyllite or lithiophilite. If you think you've found vivianite but there is no triphyllite around, maybe that isn't what you have…

So it is always a good idea to pay attention to environmental information and any associations described. Sometimes an identification can be nailed down with that information – or one or more likely suspects eliminated by it. As stated above, this information is as important as the physical properties of the minerals themselves.

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In Conclusion

As hinted at in the sections above, the collector needs to be careful about depending too much on any one or two properties or tests. While a mineral's color, or hardness, or streak, etc., may suggest a likely culprit, a systematic approach – followed methodically – is much more likely to bring you to an accurate conclusion. Many collectors are well aware of the unreliability of "sight identifications" – deciding what a mineral is just by looking at it. Yes, many common minerals can be identified that way with experience – but many more can't, and every now and then something so identified turns out to actually be something else. Even chemical and crystallographic tests have been known to fail to identify a mineral correctly. So it isn't surprising that simpler techniques need to be used carefully in order to get the best results; and sometimes, they too fail.

Finally, while this Key should help the collector correctly identify many minerals, it won't work all the time. Common minerals are found in uncommon forms. Some are closely mimicked by less-common or rare species. And, there is always the chance that a collector will find something that isn't even covered by this Key. If you find yourself correctly identifying 60% of the minerals you find, you will be doing well. And the odds are that the other 40% are species not readily identified with this key – worked on in the home lab with other techniques, maybe even sent in to a professional lab in order to obtain a positive identification.

The trick is to do your best at each stage of the discovery process.

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Organization & Redundancy

Beyond the obvious organization of the mineral listings into sections and sub-sections, there is a rough order of presentation which may help make it easier for the user to key things out.

The main order of presentation is by key features of the minerals – luster, streak, cleavage, and so on. When the key leads you to a particular sub-section based on a key feature you then have to carefully try and match your sample to one or more of the descriptions listed in that subsection. Since some of the subsections have quite a few minerals listed, an attempt has been made to organize them into groupings based on further refinements of the features. For example, if you have a non-metallic mineral with a colored streak and end up at subTable IIA you will see that the minerals are grouped according to color of streak – all the pinks to reds together, all the oranges and yellows next, and so on. Then within a particular group they are listed roughly in order of increasing hardness – softer ones first, hardest last. So you should be able to quickly eliminate anything that doesn't have the color streak of your sample and concentrate on those that do, and if you know the hardness you may be able to focus your search even further, paying closest attention to those species with the same hardness as your sample.

Another example is the way subTable IIB-1 is subdivided: all those that have cleavage in only one direction are first, then those with two cleavages, then those with three. Note that the background color in the table changes with each change in the number of cleavages. Within each group they are again listed in subgroups by color and hardness. So if you have a sample with cleavage in two directions you can quickly skip down to the listings for those and then home in by color and hardness. In places, the subdivisions go even further – like all the Amphibole Group species of similar hardness being listed together.

Several subsections are organized first on Cleavage. In the tables you will note that different background color bands are used with different numbers of cleavage directions. Thus, if you have a sample in which you see three directions of cleavage, it is easy to quickly skip over the minerals with only one or two directions of cleavage and go directly to the group which has three.

Hopefully this organization – which is admittedly not perfect – will help you to refine your search and focus on the most likely minerals that match the sample in your hand.

A number of minerals are listed in more than one place. For example, hematite is listed three times. This is because it has such varied habit and differences in its properties from habit-to-habit that one might key one sample out to one place, but then key out a sample with a different habit and properties to another place. Also, some species sort of fall on the dividing line between sections of the listings. Such minerals might key out to either section, so they are listed in both. And some species may or may not exhibit prominent cleavage, keying out to different spots depending upon which is the case for the sample you have in your hand. Etc…

Hopefully this feature of the key will enhance the odds of keying out any given sample – no matter what it's particular properties may be.

Table of Contents **The Mineral ID Key**

The Mineral Identification Key

Step 1: Is the Luster Metallic or Submetallic?

YES - [Go to Section I: Metallic or Submetallic Luster Key, Step 2]

NO - [Go to Section II: Nometallic Luster Key (Soft), Step 4]

Table of Contents **Luster**

Section I: Minerals with a Metallic or Submetallic Luster

Step 2: Will the mineral leave a mark on paper? (Hardness less than 2½?)

YES - [Go to Table IA]

NO - [Go to Step 3]

Table of Contents **Step 1** **Hardness**

Section I: Minerals with a Metallic or Submetallic Luster & Hardness Greater than 2½

Step 3: Can the mineral be scratched by a knife? (Hardness less than 5½?)

YES - [Go to Table IB]

NO - [Go to Table IC]

Table of Contents **Step 1** **Step 2** **Hardness**

Section II: Minerals with a Non-Metallic Luster

Step 4: Does the mineral have a definitely colored streak? (Leaves a colored powder streak on unglazed porcelain?)

YES [Go to Table IIA]

NO [Go to Step 5]

[Table of Contents] [Step 1] [Step 3] [Streak]

Section II: Minerals with a Non-Metallic Luster

Step 5: Can the mineral be scratched by a fingernail? (Hardness less than 2½?)
YES [Go to Step 6]
NO - [Go to Step 7]

[Table of Contents] [Step 1] [Step 4] [Hardness]

Section II: Minerals with a Non-Metallic Luster & Hardness Less than 2½

Step 6: Does the mineral have prominent cleavage?
YES - [Go to Table IIB-1]
NO - [Go to Table IIB-2]

[Table of Contents] [Step 1] [Step5] [Cleavage]

Section II: Minerals with a Non-Metallic Luster & Hardness Greater than 2½

Step 7: Can the mineral be scratched by a copper penny? (Hardness less than 3?)
YES - [Go to Step 8]
NO - [Go to Step 10]

[Table of Contents] [Step 1] [Step5] [Hardness]

Section II: Minerals with a Non-Metallic Luster & Hardness Greater than 3

Step 8: Does the mineral have a prominent cleavage?
YES - [Go to Table IIC-1]
NO - [Go to Step. 9]

[Table of Contents] [Step 7] [Cleavage]

Section II: Minerals with a Non-Metallic Luster, Hardness Greater than 2½ & No Prominent Cleavage

Step 9: Will a thin splinter fuse in a candle flame? (Fusibility of 1?)
YES - [Go to Table IIC-2a]

NO - [Go to Table IIC-2b]

Table of Contents Step 8 Fusibility

Section II: Minerals with a Non-Metallic Luster & Hardness Greater than 3

Step 10: Can the mineral be scratched by a knife? (Hardness less than 5½?)
YES - [Go to Step 11]
NO - [Go to Step 12]

Table of Contents Step 7 Hardness

Section II: Minerals with a Non-Metallic Luster & Hardness Less than 7

Step 11: Does the mineral have a prominent cleavage?
YES - [Go to Table IID-1]
NO - [Go to Table IID-2]

Table of Contents Step 10 Cleavage

Section III: Minerals with a Non Metallic Luster & Hardness Greater than 5½

Step 12 Can the mineral be scratched by a sharp quartz point? (Hardness less than 7?)
YES - [Go to Nonmetallic Luster Key (Hard): Step 13]
NO - [Go to Nonmetallic Luster Key (Hard): Step 14]

Table of Contents Step 10 Hardness

Section III: Minerals with a Non Metallic Luster & Hardness Less than 7

Step 13 Does the mineral have a prominent cleavage?
YES - [Go to Table IIIA-1]
NO - [Go to Table IIIA-2]

Table of Contents Step 12 Cleavage

Section III: Minerals with a Non Metallic Luster & Hardness Greater than 7

Step 14 Does the mineral have a prominent cleavage?

YES - [Go to Table IIIB-1]

NO - [Go to Table IIIB-2]

Table of Contents **Step 12** **Cleavage**

Table IA: Minerals with Metallic or Submetallic Luster & Hardness of less than 2½: *(Will readily leave a mark on paper.)*

Hardness	Color	Streak	Cleavage	Name	System	Habit	SG	Notes
1+	Dark-red to Vermilion	Rust-red		HEMATITE Fe_2O_3	Trigonal	ocherous masses, granular, often as a pigment – "rust" – in rocks	5.2	exhibits a wide range of H. depending on form; crystalline hematite is harder.
1 to 1½	Steel-grey to Iron-black	Black	one perfect cleavage	GRAPHITE C	Trigonal	may be in small hexagonal plates	2.23	has a greasy feel.
1 to 1½	Bluish-black	Black to Greenish-black	one perfect cleavage	MOLYBDENITE MoS_2	Trigonal	usually in somewhat foliated appearing masses, often leaf-like hexagonal plate	4.7	has a greasy feel; heavier than graphite
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
1 to 2	Iron-black	Black		PYROLUSITE MnO_2	Tetragonal	may be splintery or in radiating fibrous masses	4.7	Sometimes won't mark paper.
1½	Lead-grey	Lead-grey	one perfect cleavage	NAGYAGITE $Pb_{13}Au_2Sb_3Te_6S_{16}$	Orthorhombic pseudo-tetragonal	usually platy masses, may be granular	7.4 to 7.5	flakes flexible. Rare.
1½	Steel-grey	Steel-grey	one perfect cleavage	TETRADYMITE Bi_2Te_2S	Trigonal	usually in foliated to bladed masses, acute rhombohedral crystals rare	7.1 to 7.4	flexible. Relatively rare.
1½ to 2	Silvery-white	Grey		SYLVANITE $(Au,Ag)Te_2$	Monoclinic	usually granular or in bladed aggregates, often appears as skeletal forms on rocks, resembling writing (cuneiform).	8 to 8.2	May not mark paper. Rare.
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
2	Grey-black to Lead-grey	Black to Grey-black		BISMUTHINITE Bi_2S_3	Orthorhombic	in bladed crystals showing cross striations	6.78	similar to stibnite but heavier. Rare
2	Grey-black	Bluish-black to Silvery-black	one perfect cleavage	STIBNITE Sb_2S_3	Orthorhombic	usually as bladed crystals showing cross striations	4.5	fuses in a candle flame, sometimes won't mark paper.
2 to 2½	Grey-black to Lead-grey	Black		ACANTHITE Ag_2S	Isometric	pseudo-cubic, usually massive	7.3	bright-steel-grey on fresh surfaces but darkens upon exposure, easily cut with a knife (sectile). Sometimes won't mark paper

Hardness	Color	Streak	Cleavage	Name	System	Habit	SG	Notes
2 to 2½	Iron-black	Iron-black		STEPHANITE Ag_5SbS_4	Orthorhombic	usually massive, more rarely as short prismatic to tabular crystals	6.2 to 6.5	Rare
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
2 to 2½	Bright-red	Bright-red to Deep-red	one perfect	CINNABAR HgS	Trigonal	usually in granular masses	8.1	luster actually adamantine, sometimes appearing sub-metallic to metallic, May not mark paper.
2 to 2½	Brownish-red to Scarlet or Vermilion	Deep Ruby-red to Bright Ruby-red		PYRARGYRITE/ PROUSTITE $Ag_3(Sb,As)S_3$	Trigonal		5.57 to 5.58	isostructural species difficult to distinguish, though pyrargyrite is usually darker in color and more common than proustite. Rare.
2 to 2½	Silvery-white	Silvery-white with decidedly reddish tones		BISMUTH Bi	Trigonal	usually in laminated granular masses, may be arborescent or reticulated, artificial crystals in pseudo-cubic "hopper" groups	9.8	heavy. Rare. May not mark paper.
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
2½	Brass-yellow to Silvery-white	Yellowish- to Greenish-grey		CALAVERITE $AuTe_2$	Monoclinic	usually granular, rarely in distinct elongated crystals	9.35	very heavy, easily fusible in candle flame. (May not mark paper.) Rare.
2½	Grey-black to Black	Bluish-black to Lead-grey	perfect cleavage in three directions at 90º to each other	GALENA PbS	Isometric	usually in cubic crystals or masses exhibiting cubic cleavage, also in granular masses.	7.6	Sometimes won't mark paper
2 to 3	Black	Black	one imperfect cleavage	POLYBASITE $(Ag,Cu)_{16}Sb_2S_{11}$	Monoclinic, pseudo-hexagonal	usually massive or in crude pseudohexagonal plates	6.1 to 6.2	Rare

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Table IB: Minerals with Metallic or Submetallic Luster & Hardness greater than 2½, but less than 5½: *(Will not easily mark paper, but can be scratched with a pocket knife.)*

Hardness	Color	Streak	Cleavage	Name	System	Habit	SG	Notes
1 to 2	Iron-black	Black		PYROLUSITE MnO_2	Tetragonal	may be splintery or in radiating fibrous masses	4.7	Will sometimes mark paper
1½ to 2	Silvery-white	Grey		SYLVANITE $(Au,Ag)Te_2$	Monoclinic	usually granular or in bladed aggregates, often appears as skeletal forms on rocks, resembling writing (cuneiform)	8 to 8.2	May mark paper. Rare

1½ to 2	Metallic-blue, tarnishes to blue-black	Black		COVELLITE CuS	Trigonal	platy masses or thin six-sided platy crystals	4.6	may be somewhat iridescent, turns metallic-purple when wet. Will sometimes mark paper.
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
2	Bluish-black to Silvery-black	Grey-black	one perfect cleavage	STIBNITE Sb_2S_3	Orthorhombic	usually as bladed crystals showing cross striations	4.5	fuses in a candle flame. Will sometimes mark paper.
2 to 2½	Deep Ruby-red to Bright Ruby-red	Brownish-red to Scarlet or Vermilion		PYRARGYRITE/ PROUSTITE; $Ag_3(Sb,As)S_3$	Trigonal	Prismatic, pyramidal, rhombohedral,and scalenohedral crystals , also massive	5.58 (pyrargyrite), 5.57 (proustite)	isostructural species difficult to distinguish, though pyrargyrite is usually darker in color and more common than proustite, fusible in a candle flame. Rare.
2 to 2½	Grey-black to Lead-grey	Black		ACANTHITE Ag_2S	Isometric	pseudo-cubic, usually massive	7.3	bright steel-grey on fresh surfaces but darkens upon exposure, easily cut with a knife (sectile). Will usually mark paper.
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
2½	Bluish-black to Lead-grey	Grey-Black to Black	perfect cleavage in three directions at 90º to each other	GALENA PbS	Isometric	usually in cubic crystals or masses exhibiting cubic cleavage, also in granular masses	7.6	Will usually mark paper
2½	Brass-yellow to Silvery-white	Yellowish to Greenish-grey		CALAVERITE $AuTe_2$	Monoclinic	usually granular, rarely in distinct elongated crystals	9.35	very heavy, easily fusible in a candle flame. May mark paper. Rare.
2 to 3	Grey-black	Black		JAMESONITE $Pb_4FeSb_6S_{14}$	Monoclinic	usually in fibrous feathery masses	5.5 to 6.0	fuses easily in a candle flame.
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
2½ to 3	Grey-black	Grey to Black		BOURNONITE $PbCuSbS_3$	Orthorhombic	usually in stout prismatic crystals often as intergrown clusters with twinning exhibited by re-entrant angles	5.8 to 5.9	fuses easily in a candle flame
2½ to 3	Steel-grey, may tarnish to black on exposure	Grey to Black		CHALCOCITE Cu_2S	Monoclinic, pseudo-orthorhombic	usually in compact masses, crystals tabular to stoutly prismatic, often with a pseudo-hexagonal outline, vertically striated.	5.7	
2½ to 3	Dark metallic Blue to Black	Black		DIGENITE Cu_2S	Isometric	usually massive as small to tiny irregular grains, very rarely as octahedral crystals	5.5 to 5.7	Very similar to chalcocite, but much rarer in non-microscopic sizes.

Hardness	Color	Streak	Cleavage	Name	System	Habit	SG	Notes
2½ to 3	Steel-grey, tarnishes metallic blue	Dark steel-grey		STROMEYERITE $AgCuS$	Orthorhombic, pseudo-hexagonal	usually massive, granular, rarely as pseudo-hexagonal prismatic crystals	6.2 to 6.3	Rare
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
2½ to 3	Lead-grey	Brown to brownish-grey		BOULANGERITE $Pb_5Sb_4S_{11}$	Monoclinic	usually massive as fibrous bundles, crystals usually needle-like mats, prismatic crystals rarer	6.0 to 6.3	thin acicular crystals flexible. Rare.
2½ to 3	Dark-red to Vermilion	Dark-red		CINNABAR HgS	Trigonal	usually massive, crystals uncommon and usually rhombohedral, often as penetration twins	8.10	luster actually adamantine, appearing metallic, heavy
2½ to 3	Copper-red on fresh surfaces, tarnishes to brown or black	Coppery-red, shiny		COPPER Cu	Isometric	usually in irregular masses, large grains, wires, and crude dendritic crystals, crystals usually octahedral and malformed, may be cubic or other Isometric forms	8.9	malleable
2½ to 3	Deep golden-yellow	Golden-yellow, shiny		GOLD Au	Isometric	usually massive in irregular grains, nuggets, "leaves" and "flakes,", crystals often wires crudely dendritic or as malformed octahedrons	15.0 to 19.3	malleable, very heavy! Rare. Distinguished from pyrite – "fools gold" – by its malleability, softness and weight.
2½ to 3	Silvery-white, tarnishes black	Silvery-white, shiny		SILVER Ag	Isometric	usually massive as irregular grains, wire crystals and dendritic	10.5	malleable, heavy. Rare. May mark paper.
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
3	Grey-black	Black	perfect and distinct cleavages at angles to one another	ENARGITE Cu_3AsS_4	Orthorhombic	usually in bladed masses	4.4	crystals vertically striated
3	Brownish-bronze on fresh surfaces, tarnishing to metallic purple, iridescent ("peacock ore")	Grey-black		BORNITE Cu_5FeS_4	Orthorhombic, pseudo-tetrahedral	crystals usually pseudo-cubic, usually massive	5.1	thin splinters fusible in a candle flame, giving a brittle magnetic globule.
3 to 3½	Brass-yellow	Black, sometimes with a greenish tinge		MILLERITE NiS	Trigonal	usually in radiating groups or mats of needle-like to hair-like crystals	5.5	slender crystals usually have a greenish tinge
3 to 3½	Steel-grey	Steel-grey	one indistinct cleavage	ZINKENITE $Pb_9Sb_{22}S_{42}$	Hexagonal	usually massive, also in columnar and radiating fibrous aggregates of needle-like crystals	5.2 to 5.3	Rare

3 to 3½	Tin-white	Silvery-grey, shiny		ANTIMONY Sb	Trigonal	usually massive, foliated, or granular,rarely as pseudo-cubic or thick tabular crystals	6.6 to 6.7	very brittle
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
3 to 4½	Steel-grey, may tarnish dead black upon exposure	Black (may be Brownish-black)		TETRAHEDRITE-TENNANTITE $(Cu,Fe,)_{12}Sb_4S_{13}$	Isometric	usually massive or granular, crystals uncommon and usually pseudo-tetrahedral	4.6 to 5.1	End members difficult to distinguish without subtle tests – an S.G. above 4.7 is conclusive for tetrahedrite.
3½	Tin-white, tarnishing to Dark-grey	Grey-black		ARSENIC As	Trigonal	usually found in botryoidal fibrous masses	5.7	heated in candle flame it gives off white fumes that have a strong garlic odor (poisonous!) Rare
3½ to 4	Brownish-bronze to Bronze-yellow	Black	no cleavage but large grains exhibit an octahedral parting	PENTLANDITE $(Fe,Ni)_9S_8$	Isometric	usually massive in granular aggregates	4.6 to 5.0	resembles pyrrhotite but is not magnetic, often mixed with pyrrhotite
3½ to 4	Brass-yellow, often iridescent	Black		CHALCOPYRITE $CuFeS_2$	Tetragonal	usually massive, crystals blocky tetrahedrons or wedge-shaped.	4.1 to 4.3	often mixed with pyrite, making a hardness test inconclusive; distinguished from pyrite by softness and shape of crystals.
3½ to 4	Brown to Black	Brown	good cleavage in one direction, poor in another direction	WURTZITE ZnS	Hexagonal	usually massive and as banded botryoidal crusts, more rarely as pyramidal hemimorphic crystals	4.0 to 4.1	Rare
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
3½ to 4	Dark-brown to black, sometimes Olive-yellow or Red to Reddish-black	Dark to Light-brown: streak usually lighter than the color of the sample	perfect cleavage in six directions at angles to one another,three directions usually prominent	SPHALERITE ZnS	Isometric	usually in compact crystalline masses, crystals usually blocky pyramidal, appearing tetrahedral	3.9 to 4.1	luster actually resinous, appearing metallic or submetallic
3½ to 4	Ruby-red to Reddish-brown	Brownish-red		CUPRITE Cu_2O	Isometric	usually massive, crystals usually cubes or octahedrons	6.0	luster may be adamantine rather than metallic in crystals
3½ to 4	Black	Green	one perfect cleavage	ALABANDITE MnS	Isometric	usually massive or granular.	4.0 to 4.1	
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
4	Brownish-bronze to Bronze-yellow	Grey-black		PYRRHOTITE $Fe_{1-x}S$	Monoclinic pseudo-hexagonal	usually massive, crystals as pseudo-hexagonal plates	4.6 to 4.7	magnetic, though may be weak
4	Steel-grey to Iron-black	Black	indistinct cleavage in two directions	STANNITE Cu_2FeSnS_4	Tetragonal	usually massive, rarely as pseudo-octahedral crystals	4.3 to 4.5	Rare

4	Steel-grey to Iron-black	Dark reddish-brown to Black		MANGANITE MnO(OH)	Monoclinic, pseudo-orthorhombic	usually in radiating fibrous masses, crystals often grouped in bundles.	4.3	Often associated with pyrolusite; distinguished from that species by its significantly greater hardness
4 to 4½	White to Steel-grey	Grey, shiny		PLATINUM Pt	Isometric	usually massive in irregular grains or nuggets, crystals rare and usually malformed cubes	14 to 19	malleable, very heavy! Very rare. Distinguished from gold by its color.
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
5	Steel-grey	Black		GLAUCODOT (Co,Fe)AsS	Orthorhombic	usually massive, more rarely as prismatic crystals in cruciform penetration twins	5.9 to 6.1	Rare; alloclasite, monoclinic, is dimorphous with glaucodot and difficult to distinguish from it, but is probably even rarer
5	Yellowish or reddish-brown	Pale-brown to white	cleavage variable, may be good in one direction and poor to good in another direction	MONAZITE $(Ce,La,Nd)PO_4$	Monoclinic	usually massive, granular, may be in crude large crystals	4.6 to 5.3 (approx.)	luster usually resinous to waxy, but may be adamantine and may appear sub-metallic
5 to 5½	Dark-brown to Black: color black in ferberite brown in huebnerite	Dark-brown to Black: streak darkens with increasing Mn content	one perfect cleavage	FERBERITE-HUEBNERITE ("Wolframite" series) $(Fe,Mn)WO_4$	Monoclinic	usually massive, granular, crystals tabular to bladed with vertical striations	7.0 to 7.5	S.G. above about 7.3 indicates ferberite, lower indicates huebnerite
5 to 5½	Pale Copper-red to Pinkish silvery-white, tarnishing to Dark-grey or Black	Black		NICKELINE NiAs	Hexagonal	usually massive, crystals rare and usually pyramidal, often malformed, may also be reticulated or arborescent,	7.78	may be coated with green "nickel bloom."
5 to 5½	Dark brown to black	Yellow-brown or Yellow-ocher		GOETHITE (pronounced "Ger-ta-ite.") FeO(OH)	Orthorhombic	usually in radiating botryoidal aggregates, mammillary, or stalactic	4.37	
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
5½	Dark-brown to Black,	Iron-black to Brownish-black		CHROMITE $FeCr_2O_4$ (Magnesiochromite is closely related, S.G. 4.2, Rare. Manganochromite, H. 6½, is even rarer.)	Isometric	usually massive, rarely as octahedral crystals	4.6	luster usually pitchy, submetallic, usually associated with peridotite rocks and accompanied by green or yellow alteration products.
5½ to 6½	Dark-brown to Steel-grey to black	Rust-red or Indian-red		HEMATITE Fe_2O_3	Trigonal	usually massive in radiating, reniform, or micaceous aggregates	4.8 to 5.3	usually harder than a knife, but some forms can be softer. (See under Sections IA & IC.)

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Table IC: Metallic or Submetallic Luster and Hardness greater than 5½: *(Can not be scratched by a knife.)*

Hardness	Color	Streak	Cleavage	Name	System	Habit	SG	Notes
4 to 5½	Black or Dark greenish or yellowish-brown	Pale yellowish or brownish		BETAFITE $(Ca,Na,U)_2(Ti,Nb)_2(OH)$	Isometric	massive (metamict)	approx. 4 to 6 (variable)	luster usually sub-metallic, but may be resinous to vitreous, highly radioactive
5 to 5½	Pale Copper-red to Pinkish Silvery-white, tarnishing to Dark-grey or Black	Black		NICKELINE NiAs	Hexagonal	usually massive, crystals rare and usually pyramidal, often malformed, may also be reticulated or arborescent	7.78	may be coated with green "nickel bloom."
5 to 5½	Dark-brown to Black, color black in ferberite, brown in huebnerite	Dark-brown to Black	one perfect cleavage	FERBERITE-HUEBNERITE ("Wolframite" series) $(Fe,Mn)WO_4$	Monoclinic	usually massive, granular, crystals tabular to bladed with vertical striations	7.0 to 7.5 above about 7.3 indicates ferberite,lower indicates huebnerite	Streak darkens with increasing Mn content
5 to 5½	Dark-brown to black	Yellow-brown or Yellow-ocher		GOETHITE (pronounced "Ger-ta-ite.") FeO(OH)	Orthorhombic	usually in radiating botryoidal aggregates, mammillary, or stalactic	4.37	
5 to 5½	Dark-brown to Black, Dark yellowish-brown to greenish-brown, Dark reddish-brown	Pale yellowish or brownish		MICROLITE $(Na,Ca)_2Ta2O_6(O,OH,F)$	Isometric	usually massive, granular, crystals octahedral	6.42	luster usually resinous to vitreous, but when resinous may appear sub-metallic, may contain some U and be radioactive
5 to 5½	Brown to Black or Dark yellowish-brown	Light-brown to Yellowish-brown		PYROCHLORE $(Na,Ca)_2Nb_2O_6(OH,F).nH2O$	Isometric	usually massive, granular, crystals usually octahedral, modified by the cube	4.45	luster usually resinous to vitreous, but when resinous may appear sub-metallic, usually contains some U and is radioactive Distinguished from microlite by its lower S.G.
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
5 to 6	Black	Black to Dark-brown		ROMANECHITE $BaMnMnO_{16}(OH)_4$	Orthorhombic	usually massive, botryoidal or stalactic	3.7 to 4.7	distinguished from similar Mn minerals by its greater hardness
5 to 6	Black to silvery-black	Black to Dark-brown		ILMENITE $FeTiO_3$	Trigonal	usually as platy massive or granular, crystals rare, thick tabular or acute rhombohedral	4.72	may be weakly magnetic
5 to 6	Deep blood-red	Black to Dark-brown or Reddish-brown	perfect cleavages in two directions	PYROPHANITE $MnTiO_3$	Trigonal	usually in fine-grained, scaly, masses	4.54	
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**

5½	Tin-white or Silvery-white	Black	one perfect cleavage	COBALTITE/ GERSDORFFITE (Co,Ni)AsS	Isometric	usually massive, granular, cubic and pyritohedral crystals (cobaltite)or octahedral and pyritohedral crystals (gersdorffite)	6.3 (cobaltite), 5.9 (gersdorffite)	difficult to distinguish end members without chemical tests, S.G. may help for samples close to the ideal end members.
5½	Tin-white or Silvery-white	Black	distinct cleavages at angles to one another, poor cleavage at a third angle	SKUTTERUDITE/ NICKEL-SKUTTERUDITE: $(Co,Ni)As_{2-3}$	Isometric	usually massive, crystals cubes or cubooctahedral	6.5 to 6.9 (skutterudite – nickel-skutterudite)	high end S.G. indicates the skutterudite end member, otherwise difficult to distinguish from one another.
5½	Black	Black to Dark-brown		URANINITE UO_2	Isometric	usually massive	9.0 to 9.7	("pitchblende"), luster actually "pitchy may be botryoidal, radioactive
5½	Brownish-black	Dark-brown		CHROMITE $FeCr_2O_4$	Isometric	usually massive, granular	4.6	luster actually "pitchy," often with green alteration products
5½	Pale copper-red	Red-brown		BREITHAUPTITE NiSb	Hexagonal	usually massive, crystals rare, tabular	7.59 to 8.23	Rare
5½ to 6	Tin-white or silvery-white, tarnishing brown or bronzish	Black	one distinct cleavage	ARSENOPYRITE FeAsS	Monoclinic	usually massive, granular, crystals pseudo-orthorhombic prismatic, usually in cruciform twins or star-shaped trillings	6.0 to 6.2	has garlic odor when ground or pounded – poisonous arsenic fumes
5½ to 6	Dark-brown to Steel-grey to black	Rust-red or Indian-red		HEMATITE Fe_2O_3	Trigonal	usually massive in radiating, reniform, or micaceous aggregates, crystals rhombohedral	4.8 to 5.3	usually black and usually harder than a knife. (See under Sections IA & IB.)
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
6	Black	Black		MAGNETITE Fe_3O_4	Isometric	massive or in octahedral crystals	5.18	strongly magnetic
6	Black	Black to Dark-brown	one distinct cleavage	COLUMBITE-TANTALITE $(Fe,Mn)(Nb,Ta)_2O_6$	Orthorhombic	usually massive platy, or as thick tabular crystals	5.2 to 6.76 (ferrocolumbite) 7.95 (ferrotantalite)	A complex solid solution series exists within the Columbite-Group; distinguishing between species is difficult without subtle chemical tests. S.G. may be indicative for some species but not definitive
6	Brownish-black	Dark-brown		FRANKLINITE $(Fe,Zn,Mn)(Fe,Mn)_2O_4$	Isometric	usually massive, granular, or as octahedral crystals	5.15	may be slightly magnetic. Rare outside of Franklin, N. J., USA
Hardness	**Color**	**Streak**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
6 to 6½	Brass-yellow	Black (may be greenish-black)		PYRITE FeS_2	Isometric	massive or in striated cubic or pyritohedral crystals, may be twinned	5.0	most common brass-yellow metallic mineral
6 to 6½	Brass-yellow	Black (may be greenish-black)		MARCASITE FeS_2	Orthorhombic	usually massive, granular, crystals usually "coxcomb" clusters or radiating fibrous aggregates	4.9	Difficult to distinguish from pyrite without tests unless good crystals are present.

6 to 6½	Dark-brown to Black	Pale-brown		RUTILE TiO_2	Tetragonal	usually in prismatic crystals, vertically striated, often needle-like as inclusions in silicate crystals, particularly quartz	4.2 to 4.25	Anatase and brookite are closely related species, but rarer.

Note: The Betafite-Microlite-Pyrochlore Group and Subgroups are complex, species can be difficult to tell apart. S.G. and radioactivity may be indicative for some species, but are rarely definitive.

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Table IIA: Minerals with a Nonmetallic Luster, Definitely Colored Streak, and Hardness 1 to 6:

Streak	Hardness	Color	Cleavage	Name	System	Habit	SG	Notes
Rust-red to Indian-red	1+ to 6½	Dark-brown to Steel-grey to black		HEMATITE Fe_2O_3	Trigonal		4.8 to 5.3	hardness and S.G. lower in earthy massive materials, harder and denser in crystals and crystalline materials, crystals usually 5½ to 6½ with a metallic to sub-metallic luster
Pink	1½ to 2½	Pale-pink to Red	perfect cleavage	ERYTHRITE $Co_3(AsO_4)_2{\cdot}8H_2O$	Monoclinic	usually as earthy crusts or powdery coatings on cobalt minerals, may be reniform	2.95	streak same color as the sample but paler. Rare. (See also annabergite, below.)
Pale-pink to Light-green	1½ to 2½	Apple-green , Grey, Pale-rose	at least one cleavage, perfect	ANNABERGITE $Ni_3(AsO_4)_2{\cdot}8H_2O$	Monoclinic	usually as coatings or crusts of tiny crystals, grainy-appearing, crystals bladed to acicular	3.0 to 3.23	streak same color as sample but lighter; Rare. (See also erythrite above.)
Red	2	Red		LITHARGE PbO	Tetragonal	as alteration crusts on massicot (see below)	9.14	Rare
Streak	**Hardness**	**Color**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
Bright-Scarlet-red or Vermilion to Brownish-red	2 to 2½	Dark Ruby-red or Bright Ruby-red		PROUSTITE/ PYRARGYRITE $Ag_3(Sb,As)S_3$	Trigonal		5.58 (pyrargyrite) 5.57 (proustite)	isostructural species difficult to distinguish, though pyrargyrite is usually darker in color and more common than proustite, fusible in candle flame. Rare.
Dark-red	2½	Dark-red to Vermilion	one perfect cleavage	CINNABAR HgS	Trigonal	usually earthy or granular, commonly impure and dark red or reddish-brown, bright-red and translucent to transparent when pure, crystals rhombohedral or tabular to short prismatic	8.10	luster of crystals adamantine, may appear sub-metallic, heavy

Bright- to Deep-red	2½ to 3	Orange-yellow	one distinct cleavage	CROCOITE $PbCrO_4$	Monoclinic	usually in prismatic crystals with an adamantine to sub-vitreous luster, as parallel to jackstraw clusters, may be hollow	5.9 to 6.1	decrepitates (crumbles explosively) in a candle flame
Dark-red	3½ to 4	Ruby-red to Reddish-brown		CUPRITE Cu_2O	Isometric	usually in octahedral or cubic crystals, may be in slender crystals, may also be massive	6.0	
Streak	**Hardness**	**Color**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
Orange-or Reddish-yellow	1½ to 2	Dark-red	one good cleavage	REALGAR AsS	Monoclinic	usually massive, granular, coarse to fine, and as crusts	3.48	luster resinous, easily fusible in a candle flame; usually associated with Orpiment
Orange-yellow	4 to 4½	Yellow to Orange-yellow to Deep-red	one perfect cleavage	ZINCITE (Zn,Mn)O	Hexagonal	usually massive as irregular grains or rounded masses	5.64 to 5.68	luster sub-adamantine to sub-vitreous, fluoresces green to yellowish-green under long wave ultraviolet light. Rare outside of Franklin, N. J., USA.
Pale-yellow	1½ to 2½	Lemon-yellow	one perfect cleavage giving thin plates	ORPIMENT As_2S_3	Monoclinic	usually in foliated masses or grains	3.49	flexible, luster resinous, pearly on cleavage surfaces, easily fusible in a candle flame, usually associated with Realgar
Pale-yellow	1½ to 2½	Bright-yellow	imperfect cleavage in three directions	SULFUR S	Orthorhombic	usually imperfectly crystallized masses or crusts	2.05 to 2.09	resinous to sub-vitreous luster, may appear somewhat earthy when massive or as crusts, readily burns in a candle flame giving a blue flame.
Pale-yellow	2	Sulfur-yellow		MASSICOT PbO	Orthorhombic	usually earthy or scaly masses	9.56	usually replaces other Pb minerals, particularly galena, scales flexible. Rather rare.
Streak	**Hardness**	**Color**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
Very Pale-yellow to Yellowish-green	2 to 2½	Lemon-yellow to Greenish-yellow	one perfect cleavage and one distinct	AUTUNITE/ META-AUTUNITE $Ca(UO_2)_2(PO_4)_2 \cdot 10\text{-}12H_2O$ /$Ca(UO_2)_2(PO_4)_2 \cdot 2\text{-}6H_2O$	Tetragonal/ Orthorhombic	usually as micaceous or scaly foliated aggregates, crystals thin or thick tabular	3.15 (autunite), 3.44 (meta-autunite)	luster vitreous to adamantine, fluoresces bright greenish-yellow. (See also torbernite/ metatorbernite below, does not fluoresce.) Naturally occurring material is almost invariably meta-autunite

Very Pale-Yellow, Yellowish-white (both rarely seen), White	2½ to 3	Orange-red to Ruby-red, Brownish-red to Brownish-yellow or pale Straw-yellow		VANADINITE (Apatite Group) $Pb_5(VO_4)_3Cl$	Hexagonal	usually in barrel-shaped prismatic hexagonal crystals, either long or short, may be acicular in clusters or mats ("endlichite"), and as hollow prisms– "hopper" crystals	6.88	luster sub-vitreous to sub-resinous
Very Pale-green	2 to 2½	Emerald- to Grass-green, Apple-green, Leek-green	one perfect cleavage and one indistinct	TORBERNITE/ METATORBERNITE $Cu(UO_2)_2(PO_4)_2{\cdot}11H_2O$ / $Cu(UO_2)_2(PO_4)_2{\cdot}8H_2O$	Tetragonal	usually as micaceous or scaly foliated aggregates, crystals thin to thick tabular	3.22 (torbernite), 3.70 (metatorbernite)	luster vitreous to adamantine, similar to autunite/meta-autunite but truly green and does not fluoresce like autunite/meta-autunite. (See also autunite/ meta-autunite above.) Naturally occurring material is almost always metatorbernite
Light-green	3 to 3½	Dark to Bright Emerald-green	one perfect cleavage, a second fair cleavage	ATACAMITE $Cu_2Cl(OH)_3$	Orthorhombic	usually in granular cleavable masses, crystals prismatic and usually very small to microscopic	3.75 to 3.77	fusible in a candle flame. Rare.
Streak	**Hardness**	**Color**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
Light-green	3½	Dark Emerald-green	one perfect cleavage, one poor cleavage	ANTLERITE $Cu_3(SO_4)(OH)_4$	Orthorhombic	usually as mats of tiny acicular crystals, may be granular	3.88	vitreous luster, may appear sub-vitreous or dull in mats. Rare.
Light-green	3½ to 4	Dark Emerald-green to Bright-green		BROCHANTITE $Cu_4(SO_4)(OH)_6$	Monoclinic	usually as crusts or mats of tiny crystals, crystals may be stout prismatic to acicular or tabular	3.97	vitreous luster
Light-green	3½ to 4	Dark- to Bright-green	one perfect cleavage	MALACHITE $Cu_2(CO_3)(OH)_2$	Monoclinic	as either radiating fibrous masses, botryoidal to mammillary, or as slender to stout prismatic crystals, often poorly formed (and often psuedomorphic after azurite), may be crusts, or acicular stellate sprays	3.9 to 4.03	luster adamantine to vitreous, may appear sub-vitreous to dull on surfaces of masses. Often associated with azurite
Pale Bluish-white to White or Colorless	1½ to 2	Deep-blue or Deep Greenish-blue to Bluish green	one perfect cleavage	VIVIANITE $Fe_3(PO_4)_2{\cdot}8H_2O$	Monoclinic	usually as flattened to bladed prismatic crystals, often in stellate clusters or sprays, may also be granular, crusts, or reniform masses	2.68	Streak: darkens to Dark-blue or Brown after exposure, vitreous luster. Rare
Very Pale-blue to Grey or Tan	2 to 4	Pale- to Deep-blue, Blue-green, Green		CHRYSOCOLLA $Cu_2H_2[Si_2O_5](OH)_4$		usually in glassy, opaline, or porcellaneous masses or crusts, often as mats of very fine acicular crystals, may be botryoidal	1.93 to 2.40	luster may be vitreous, waxy, porcellaneous, or dull.
Streak	**Hardness**	**Color**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**

Light-blue	2½	Azure-blue to Bright-blue		LINARITE $PbCu(SO_4)(OH)_2$	Monoclinic	usually as clusters or sprays of tiny elongated prismatic or tabular crystals, bladed, may also be in crusts of crudely formed crystals	5.35	luster vitreous to sub-adamantine, easily fusible in a candle flame
Light-blue	3½ to 4	Deep Azure-blue	one perfect cleavage	AZURITE $Cu_3(CO_3)_2(OH)_2$	Monoclinic	usually as small stout prismatic crystals, may be in sprays or radiating spherical groups	3.77	luster vitreous, may appear sub-vitreous to dull on surfaces of radiating spherical masses; usually associated with malachite
Bright-blue	5 to 5½	Deep-blue to Medium-Blue and Violet-blue	one distinct cleavage	LAZURITE $Na_3Ca(Al_3Si_3O_{12})S$	Isometric	usually massive, compact to granular, crystals rare, dodecahedral	2.38 to 2.45	luster vitreous in crystals, dull in massive material. Rare
Very Pale-blue to White	5½ to 6	Light- to Medium-blue, Violet-blue, Grey, or White	one poor to distinct cleavage	SODALITE $Na_4(Al_3Si_3O_{12})Cl$	Isometric	usually massive granular, crystals rare, dodecahedral, octahedral. Rare	2.14 to 2.30	luster vitreous in crystals to dull in massive material, may fluoresce orange to orange-red
Streak	**Hardness**	**Color**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
Brown	3½ to 4	Light-tan to Dark-brown	perfect cleavages in three directions producing rhombic fragments	SIDERITE $FeCO_3$	Trigonal	usually in cleavable masses, crystals usually rhombohedrons, faces curved	3.83 to 3.88	becomes magnetic when heated in a candle flame
Brown	3½ to 4	Dark-brown to Black	one perfect cleavage	FERBERITE/ HUEBNERITE ("Wolframite" series) $(Fe,Mn)WO_4$	Monoclinic	usually massive, granular, crystals tabular to bladed with vertical striations	7.0 to 7.5 S.G. above 7.3 indicates ferberite, lower indicates huebnerite	color black in ferberite, brown in huebnerite, Streak darkens with increasing Mn content
Light-brown	3½ to 4	Dark to Light-brown, Olive-brown, Reddish brown, Reddish-black	perfect cleavage in six directions	SPHALERITE ZnS	Isometric	usually in cleavable masses, granular, crystals blocky wedge-shaped	3.9 to 4.1	may have an oily, submetallic, luster, streak usually lighter than the specimen
Streak	**Hardness**	**Color**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
Yellow-brown to Ocher-yellow	5 to 5½	Dark-brown to Black	one perfect cleavage	GOETHITE (pronounced "Ger-ta-ite") FeO(OH)	Orthorhombic	usually in reniform or radiating fibrous masses, botryoidal or mammillary, also stalactic	4.4	luster usually dull, may be submetallic.
Light-brown	6 to 6½	Reddish-brown to Black	one distinct cleavage	RUTILE TiO_2	Tetragonal	usually in slender prismatic crystals with vertically striated faces, as "elbow twins" (reticulated) and "sixlings"	4.18 to 4.25	luster adamantine, may appear submetallic, usually translucent

Brown to Black	6 to 7	Light-brown to greyish or white	one imperfect cleavage	CASSITERITE SnO_2	Tetragonal	usually as fibrous, reniform, or irregular masses, stream-worn nuggets, with a dull to submetallic luster, crystals usually twined, with a submetallic or adamantine luster	6.8 to 7.1	streak usually lighter than the specimen

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Table IIB-1: Streak not colored, Cleavage Prominent, Hardness less than 2½: *(Can be scratched with a fingernail, Streak: white or none.)*

Cleavage	Hardness	Luster	Color	Name	System	Habit	SG	Notes
imperfect in four directions (octahedral)	<1 (?)	vitreous to sub-vitreous	Colorless to White (may be stained by impurities	SAL AMMONIAC: NH_4Cl	Isometric	usually as powdery crusts around volcanic vents or in coal seams that have burned, crystals usually trapezohedral, tiny, in skeletal; or dendritic aggregates, may also be gyroidal or dodecahedral (rarely)	1.53	very plastic (difficult to determine hardness); tastes stingingly salty. Rare.
Perfect in one direction	1	waxy to pearly	White to Grey, Sea-green, impure material may be Dark-green to Dark-grey, almost Black	TALC $Mg_3Si_4O_{10}(OH)_2$	Monoclinic	usually as foliated masses of flakes	2.7 to 2.8	will leave a white streak on paper, flexible, has a greasy feel. The cleavage may not be readily apparent due to foliation of the flakes.
Perfect in one direction (rarely seen)	1	vitreous	White to Colorless	ULEXITE $NaCaB_5O_6(OH)\cdot 5H_2O$	Triclinic	usually as masses of fibrous or fine acicular crystals, rounded	1.95	luster vitreous on ends of cleavage pieces, silky on sides, specimens with clear ends placed on print transmit the image through the sample – you can read through it. "TV-stone."
Cleavage	**Hardness**	**Luster**	**Color**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in one direction, good in one direction, poor in one direction (rhombohedral)	1½ to 2	luster vitreous to sub-vitreous	Colorless to White or Grey	NITRATINE (Nitratite, Soda-Niter): $NaNO_3$	Trigonal	usually massive, granular, crystals rhombohedral	2.24 to 2.29	white streak, easily dissolved in water, has a cooling and salty taste, easily fusible in a candle flame. Natratine and niter are difficult to distinguish from one another without tests for Na and K.

Imperfect in three directions (rhombic)	1½ to 2½	resinous to sub-vitreous, may appear somewhat earthy when massive or as crusts	Bright-yellow	SULFUR S	Orthorhombic	usually imperfectly crystallized masses or crusts	2.05 to 2.09	usually gives a pale yellow streak, readily burns in a candle flame giving a blue flame
Cleavage	**Hardness**	**Luster**	**Color**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in one direction	2 to 2½	sub-vitreous to dull.	Green, pale to dark almost black, may be other colors, but rarely	CLINOCHLORE-CHAMOSITE (Chlorite Group) $(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$	Monoclinic	usually as aggregates of foliated flakes, may be in more compact masses of fine scales	2.6 to 2.9	flakes or scales flexible, Difficult to distinguish between these two end members though clinochlore tends to be the more common.
Perfect in one direction, imperfect in one direction good in one direction (prismatic)	2	vitreous	Colorless to White or Grey	NITER (Saltpeter): KNO_3	Orthorhombic	usually as thin crusts, granular to powdery, massive, or columnar, may be in silky tufts or delicate acicular crystals	2.10	white streak, easily dissolved in water, has a cooling and salty taste, easily fusible in a candle flame. Natratine and niter are difficult to distinguish from one another without tests for Na and K.
Perfect in one direction	2	waxy luster.	White to Grey, darker when impure, may be Greenish	PYROPHYLLITE: $Al_2Si_4O_{10}(OH)_2$	Monoclinic	usually as aggregates of foliated flakes, flexible	2.8 to 2.9	greasy feel, May be difficult to distinguish from talc. Cleavage not always readily apparent due to foliation.
Perfect in one direction, good in two directions (prismatic)	2	sub-vitreous to pearly (on cleavage faces) to silky or dull	Colorless to White or Grey (may be stained other colors by impurities)	GYPSUM $CaSO_4{\cdot}2H_2O$	Monoclinic	may be in compact masses without cleavage ("alabaster"), fibrous masses ("satin spar") or prismatic crystals, often twinned ("selenite")	2.32	
Cleavage	**Hardness**	**Luster**	**Color**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in three directions (cubic)	2	vitreous to sub-vitreous	Colorless to White (may be stained by impurities)	HALITE (Common Salt) NaCl	Isometric	usually as granular crystalline masses or small cubic crystals	2.17	tastes somewhat "salty." Halite and sylvite can be difficult to distinguish, but halite tastes noticeably "saltier".
Perfect in three directions (cubic)	2	vitreous to sub-vitreous	Colorless to White (may be stained by impurities)	SYLVITE (Potassium Salt) KCl	Isometric	usually as granular crystalline masses or small cubic crystals	1.97 to 1.99	tastes "salty". Halite and sylvite can be difficult to distinguish, but halite tastes noticeably "saltier" .

Perfect in one direction	2 to 2½	pearly on cleavage surfaces	White, may be Pale-green or Pale-yellow	MUSCOVITE (Mica Group) $Kal_2(Si_3Al)O_{10}$ $(OH,F)_2$	Monoclinic, pseudo-hexagonal	usually in "books" of thin sheets or as aggregates of foliated thin scales, crystals usually elongated stacks of sheets with a hexagonal or "diamond" cross section	2.76 to 2.88	sheets or flakes elastic
Cleavage	**Hardness**	**Luster**	**Color**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in one direction	2 to 2½	pearly on cleavage surfaces	White to Greenish-white or Yellowish-brown	PHLOGOPITE (Mica Group): $KMg_3(Si_3Al)O_{10}(F,OH)$	Monoclinic, pseudo-hexagonal	usually as aggregates of foliated thin scales or "books" of sheets, crystals rare, usually same as for muscovite	2.86	sheets or flakes elastic. Difficult to distinguish from muscovite, which is much more common.
Perfect in one direction	2 to 2½	pearly on cleavage surfaces	Black to Brownish-black	ANNITE ("Biotite Mica Group) $K(Fe,Mg)(Si_3Al)O_{10}(OH,F)_2$	Monoclinic, pseudo-hexagonal	usually in "books" of thin sheets or as aggregates of foliated thin scales; crystals usually same as for muscovite.	2.7 to 3.4	may give a pale brownish streak, sheets or flakes elastic. Note: Materials described previously as "biotite" have been found to constitute a solid solution series, with annite the most common member.
Perfect in one direction (rarely seen)	2 to 2½	earthy	White to Tan, may be Greyish	KAOLINITE $Al_2Si_2O_5(OH)_4$	Triclinic	usually as compact earthy masses	2.6	has an earth odor when moistened, sticks to a dry tongue
Cleavage	**Hardness**	**Luster**	**Color**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in three directions (cubic)	2 to 2½	vitreous	Bright-red to Pale-rose, white streak	VILLIAUNITE NaF	Isometric	usually as small to tiny cubic crystals, sometimes modified by an octahedron, also as cleavable masses (small?)	2.79	granular, dissolves in water: very poisonous! Rare.
Perfect in one direction	2½	pearly on cleavage surfaces	White, Grey, or Greenish-white	BRUCITE $Mg(OH)_2$	Trigonal	usually as foliated masses of flakes or scales (thicker than the micas)	2.39	thin flakes flexible, sectile
Perfect in one direction	2½	sub-vitreous to waxy, may be dull	White to Colorless, Greyish, to Yellowish or Tannish	COOKEITE (Chlorite Group): $LiAl_4(Si_3Al)O_{10}(OH)_8$	Monoclinic	usually as aggregates of tiny flakes or scales, crystals in tiny rosettes or spherical radiating clusters, may be somewhat botryoidal looking	2.58 to 2.69	flakes or scales elastic

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Table IIB-2: Streak NotColored, Cleavage Not Prominent, Hardness less than 2½: *(Can be scratched with a fingernail; Streak: white or none; Cleavage absent or not obvious.)*

Hardness	Color	Luster	Cleavage	Name	System	Habit	SG	Notes

<1 (?)	Colorless to White (may be stained by impurities)	vitreous to sub-vitreous	imperfect in four directions (octahedral), may not be seen	SAL AMMONIAC: NH_4Cl	Isometric	usually as powdery crusts around volcanic-vents or in coal seams that have burned, crystals usually trapezohedral, tiny, in skeletal or dendritic aggregates	1.53	may also be gyroidal or dodecahedral (rarely), very plastic;difficult to determine hardness, tastes stingingly salty. Rare.
1	White to Colorless		Perfect in one direction, may not be seen	ULEXITE $NaCaB_5O_6(OH)\cdot 5H_2O$	Triclinic	usually as masses of fibrous or fine acicular crystals, rounded	1.95	specimens with clear ends placed on print transmit the image through the sample – you can read through it. "TV-stone.
1½ to 2	Colorless to White or Grey	vitreous to sub-vitreous	Perfect in one direction, good in one direction, poor in one direction (rhombohedral), may not be apparent	NITRATINE (Nitratite, Soda-Niter) $NaNO_3$	Trigonal	usually massive, granular, crystals rhombohedral	2.24 to 2.29	white streak; easily dissolved in water, luster, has a cooling and salty taste, easily fusible in a candleflame; Natratine and Niter are difficult to distinguish from one another without tests for Na and K
Hardness	**Color**	**Luster**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
1½ to 2½	Bright-yellow	resinous to sub-vitreous, may appear somewhat earthy when massive or as crusts	Imperfect in three directions (rhombic), may not be apparent	SULFUR: S	Orthorhombic	usually imperfectly crystallized masses or crusts	2.05 to 2.09	usually gives a pale-yellow streak, readily burns in a candle flame giving a blue flame
2	Colorless to White or Grey	vitreous to sub-vitreous	Perfect in one direction, imperfect in one direction, good in one direction (prismatic), may not be apparent	NITER (Saltpeter) KNO_3	Orthorhombic	usually as thin crusts, granular to powdery, massive, or columnar, may be in silky tufts or delicate acicular crystals	2.10	white streak;easily dissolved in water, has a cooling and salty taste, easily fusible in a candle flame; Natratine and niter are difficult to distinguish from one another without tests for Na and K
2 to 2½	White to Tan, may be Greyish	earthy luster	Perfect in one direction, may not be seen	KAOLINITE $Al_2Si_2O_5(OH)_4$	Triclinic	usually as compact earthy masses	2.6	earth odor when moistened, sticks to a dry tongue
Hardness	**Color**	**Luster**	**Cleavage**	**Name**	**System**	**Habit**	**SG**	**Notes**
2 to 2½	Bright-red to Pale-rose	vitreous to sub-vitreous	Perfect in three directions (cubic), may not be seen	VILLIAUNITE: NaF	Isometric	usually as small to tiny cubic crystals, sometimes modified by the octahedron, also as cleavable masses (small?), granular	2.79	white streak;dissolves in water: very poisonous! Rare.

2½	White to Colorless, Greyish, to Yellowish or Tannish	vitreous to waxy luster, may be dull.	Perfect in one direction, may not be seen	COOKEITE (Chlorite Group): $LiAl_4(Si_3Al)O_{10}(OH)_8$	Monoclinic	usually as aggregates of tiny flakes or scales, crystals in tiny rosettes or spherical radiating clusters, may be somewhat botryoidal looking, flakes or scales elastic	2.58 to 2.69	

Note: There are very few common to rare non-metallic species less than 2½ in hardness which do not have at least one good cleavage. Any sample that keys out to this point and is not one of the above listed minerals needs to be re-examined. It probably either has a prominent cleavage or is harder than 2½. Or it is a very rare to extremely rare species not covered here.

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Table IIC-1: Streak not colored, Cleavage prominent, Hardness 2½ to 3: *(Can not be scratched by a fingernail, can be scratched by a copper penny, streak white or one.)*

Cleavage	Hardness	Color	Luster	Name	System	Habit	SG	Notes
Perfect in one direction (basal)	2½ to 4	Lilac, Lavender, Greyish- to Greenish-white	pearly luster on cleavage surfaces	LEPIDOLITE (Mica Group) $K(Li,Al)_3(Si,Al)_4O_{10}(F,OH)_2$	Monoclinic, pseudo-hexagonal	usually as aggregates of tiny flakes, also as "books" of larger sheets, rarely as diamond-shaped or distorted hexagonal shaped crystals, flakes or sheets	2.8 to 3.0	elastic, harder than other common micas – except for margarite (see below).
Perfect in one direction (basal)	3½ to 5	Deep to pale Lilac, Grey to White	pearly on cleavage surfaces	MARGARITE (Mica Group) $CaAl_2(Al_2Si_2)O_{10}(OH)_2$	Monoclinic	usually as flaky aggregates or cross-grain "books" sandwiched in a matrix of chlorite-rich amphibolite schist	3.0 to 3.1	bends little and then breaks – "brittle mica." Hardest of the common micas.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in three directions (cubic)	2	Colorless to White (may be stained by impurities)	vitreous to sub-vitreous	HALITE (Common Salt) $NaCl$	Isometric	usually as granular crystalline masses or small cubic crystals	2.17	tastes somewhat "salty." Halite and sylvite can be difficult to distinguish, but halite tastes noticeably "saltier" than sylvite.
Perfect in three directions (cubic)	2	Colorless to White (may be stained by impurities)	vitreous to sub-vitreous luster	SYLVITE (Potassium Salt) KCl	Isometric	usually as granular crystalline masses or small cubic crystals	1.97 to 1.99	tastes "salty."Halite and sylvite can be difficult to distinguish, but halite tastes noticeably "saltier" than sylvite.
Distinct in one direction (prismatic), good in a second direction (basal) and fair to poor in a third direction (rhombic overall)	2½ to 3	Colorless or White to Greyish-white or Greyish-brown	adamantine to sub-adamantine, may be vitreous to resinous on some surfaces	ANGLESITE $PbSO_4$	Orthorhombic	usually in crystalline masses, crystals usually small and tabular, rarely prismatic	6.2 to 6.4	streak white; Massive material may be difficult to distinguish from cerussite without testing for SO4 vs. CO3 (See cerussite below).

Cleavage	Hardness	Color	Luster	Name	System	Habit	SG	Notes
Perfect in three directions, corners 120º or 60º (rhombic)	3; but may be 2 across the top surface of prismatic crystals with a flat termination	usually Clear or White to Tan or Grey, but may be tinted many colors	vitreous to sub-vitreous	CALCITE $CaCO_3$	Trigonal	may be in cleavable masses producing rhombs, granular masses (limestone and marble),scalenohedral ("dogtooth") crystals, rhombohedral crystals, flattened rhombohedral ("nailhead") crystals, or a wide variety of related shapes; The many varied habits of calcite crystals make this one of the species that can be tough to identify by crystal form alone. Few people, if any, are familiar with all the forms it takes. (there are over 800 crystals forms known for this species to date…)	2.71	White streak; clear rhombs show a doubled image of print viewed through them, effervesces in cold, dilute acid – even in vinegar or Coke to a small degree.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in two directions (prismatic) and fair in a third	3	Colorless, White, or Grey (may be stained other colors)	vitreous to sub-vitreous	KERNITE: $Na_2B_4O_6(OH)_2{\cdot}3H_2O$	Monoclinic	usually in cleavable crystalline masses	1.95	
imperfect in one direction (basal), distinct in another direction (rhombic), may not be seen	3 to 3½	Colorless to White or Greyish-white, may be tinted other colors	vitreous to sub-vitreous	WITHERITE (Aragonite Group) $BaCO_3$	Orthorhombic, pseudo-hexagonal	usually as stout prismatic twinned crystals with a hexagonal cross section, often with pyramidal terminations on both ends, more rarely as globular to botryoidal clusters, coarse fibrous aggregates, and granular	4.29	often hazed, will effervesce in cold acid.
Perfect in two directions, imperfect to good in a third (rhombic)	3 to 3½	Colorless to White or Greyish-white, may be tinted other colors	vitreous and/or pearly	ANHYDRITE $CaSO_4$	Orthorhombic	usually in coarsely crystalline masses exhibiting a pseudo-cubic cleavage, or in granular masses with no cleavage apparent, crystals rare and usually equant or thick tabular	2.9 to 2.98	
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Distinct in one direction (prismatic), good in a second direction (basal) and fair to poor in a third direction (rhombic overall)	3 to 3½	Colorless to White or Greyish-white, may be tinted other colors	vitreous, pearly on basal cleavage surfaces	BARITE $BaSO_4$	Orthorhombic	usually in clusters or aggregates of platy to tabular crystals	4.5	Distinguish from Celestine by SG or a flame test (lime green)

Distinct in one direction (prismatic), good in a second direction (basal) and fair to poor in a third direction (rhombic overall)	3 to 3½	Colorless to White or Greyish-white, Blue, may be tinted other colors	vitreous, pearly on basal cleavage surfaces	CELESTITE (Celestine) $SrSO_4$	Orthorhombic	usually in clusters or aggregates of platy to tabular crystals	3.95 to 3.97	Distinguish from Barite by SG or a flame test (bright red)

Note: The above three members of the Barite Group are most easily told apart by their S.G.s Anglesite is noticeably heavier than the other two, barite may feel heavier than celestite.

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Table IIC-2a: Nonmetallic Luster; Streak Not Colored; Hardness 2½ to 3; Cleavage Not Prominent; Splinter Will Fuse in a Candle Flame.

Fusibility	Color	Hardness	Luster	Name	System	Habit	SG	Notes
swells and fuses to a glassy globule in a candle flame	Usually Snow-white; Colorless to White or Greyish-white, may be tinted other colors	2 to 2½	vitreous to resinous	BORAX: $Na_2B_4O_5(OH)_4{\cdot}8H_2O$	Monoclinic	usually in crystalline or granular masses, crystals short prismatic to somewhat tabular, flattened prisms	1.7	dissolves in water, has a sweetish, alkaline taste
Small splinters fusible in a candle flame	Colorless to White, may be tinted other colors	2½	vitreous to greasy, has an unusual greasy translucence	CRYOLITE: Na_3AlF_6	monoclinic	usually massively crystalline to coarse granular, crystal rare and usually pseudo-cubic	2.95 to 3.0	white streak;small clear fragments seem to disappear when placed in water (nearly identical refractive-index)
Small splinters fusible in a candle flame	Colorless to White or Greyish-White, may be tinted other colors	3 to 3½	adamantine to vitreous, may be resinous on cleavage surfaces, may also appear submetallic when dark colored	CERUSSITE (Aragonite Group) $PbCO_3$	orthorhombic	usually as crystalline to granular masses, crystals usually tabular in platy clusters or aggregates, may be prismatic, rarely acicular (habit widely varied)	6.55	cleavage distinct in one direction and good in another, but rarely seen, effervesces in cold acid. Massive material difficult to distinguish from anglesite without testing for CO3 vs. SO4. Also see strontianite

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Table IIC-2b: Nonmetallic Luster; Streak Not Colored; Hardness 2½ to 3; Cleavage Not Prominent; Infusible in a Candle Flame.

Color	Hardness	Luster	Name	System	Habit	SG	Notes
White to Tan, may be Greyish	2 to 2½	earthy	KAOLINITE $Al_2Si_2O_5(OH)_4$	Triclinic	usually as compact earthy masses	2.6	has an earth odor when moistened, sticks to a dry tongue

Colorless to White or Greyish-white, may be tinted other colors	3 to 3½	vitreous and/or pearly	ANHYDRITE $CaSO_4$	Orthorhombic	usually in coarsely crystalline masses exhibiting a pseudo-cubic cleavage, or in granular masses with no cleavage apparent, crystals rare and usually equant or thick tabular	2.9 to 2.98	
Colorless to White or Greyish-white, may be tinted other colors	3 to 3½	vitreous to sub-vitreous	WITHERITE (Aragonite Group): $BaCO_3$	Orthorhombic, pseudo-hexagonal	usually as stout prismatic twinned crystals with a hexagonal cross section, often with pyramidal terminations on both ends, more rarely as globular to botryoidal clusters, coarse fibrous aggregates, and granular	4.29	often hazed, will effervesce in cold acid. Has cleavage, but it may not be seen.
Colorless to White or Grey, may be tinted other colors	3½ to 4	vitreous to sub-vitreous, silky when fibrous	STRONTIANITE (Aragonite Group) $SrCO_3$	Orthorhombic	usually in granular or fibrous aggregates, may be columnar, crystals short prismatic to acicular, often pseudo-hexagonal in cross-section (Ca-rich)	3.76	effervesces mildly in cold acids, or not at all. Distinguished from cerussite by its notably lower specific gravity, lighter feel. Also it is not as common as cerussite.
Shades of Green, olive, apple, dark to blackish, often mottled	2½ to 4; rarely 5 to 6 in dense massive material	sub-vitreous to greasy luster, feels greasy	ANTIGORITE/ LIZARDITE/AMESITE (Serpentine Group) Generally $(Mg,Al)_3(Si,Al)_2O_5(OH)_4$	Monoclinic, Orthorhombic and Triclinic	usually in crystalline masses, often platy or columnar	2.4 to 2.79 (antigorite), 2.55 to 2.61 (lizardite), 2.71 to 2.80 (amesite)	These serpentine minerals are almost impossible to tell apart, particularly in massive forms. They may co-exist at the same locality. Still, information on the specific locality a specimen comes from may be the best bet for nailing down the ID.
White to Grey, Pale-green to Olive-green, Golden-yellow to Brown	2 to 3	silky	CLINOCHRYSOTILE/ ORHTOCRYSOTILE/ PARACHRYSOTILE (Serpentine Group): $Mg_3Si_2O_5(OH)_4$	Monoclinic & Orthorhombic	usually in fine fibrous aggregates, fibers often very long and "weaveable,"	2.53 to 1.55	"Asbestos." is an industrial term for several long-fiber species (not all Serpentines) that can be made into cloth or mats. These species are extremely difficult to tell apart, although parachrysotile is rare and not likely to be seen. Most specimens are simply labeled with the generic term: CHRYSOTILE

Orange-red to Ruby-red, Brownish-red to Brownish-yellow or pale Straw-yellow	2½ to 3	luster sub-vitreous to sub-resinous	VANADINITE (Apatite Group): $Pb_5(VO_4)_3Cl$	Hexagonal	usually in barrel- shaped prismatic hexagonal crystals, either long or short, may be acicular in clusters or mats ("endlichite"), and as hollow prisms - "hopper" crystals	6.88	streak white, may be yellowish
Dark-green to Yellow-green, Yellow to Orange-Yellow, Brown, White, even Colorless	3½	sub-vitreous to resinous	PYROMORPHITE (Apatite Group): $Pb_5(PO_4)_3Cl$	Hexagonal	usually in barrel- shaped, prismatic hexagonal crystals, may also be spindle- shaped, hollow – "hopper crystals"; – rarely tabular or pyramidal, crystals may exhibit concentric color or structural zones due to zoned variations in composition	7.04	white streak; difficult to distinguish from mimetite without tests for PO4 vs. AsO4.
Pale-yellow to Yellowish-brown, Orange-yellow to Orange-red, White to Colorless	3½ to 4	luster sub-vitreous to resinous	MIMETITE (Apatite Group): $Pb_5(AsO_4)_3Cl$	Hexagonal	usually in simple barrel-shaped prismatic crystals, rarely tabular or acicular, may be botryoidal or globular	7.28	Difficult to distinguish from pyromorphite without tests for AsO4 vs. PO4; Named for the fact that it closely mimics pyromorphite
Green to Yellow, Greenish-white, Yellowish-Brown to Brown, rarely other hues	3½ to 4	vitreous to pearly, sometimes resinous	WAVELLITE: $Al_3(PO_4)_2(OH,F)_3{\cdot}5H_2O$	Orthorhombic	usually in radiating fibrous aggregates or stellate clusters, as crusts, may be stalactic	2.36	streak white; one perfect and one distinct cleavage, but they are rarely seen, dissolves in cold acids.

Note: The above three members of the Apatite Group are difficult to tell apart when they have the color(s) of vanadinite, though usually the colors in vanadinite are deeper, more intense, than the other two. Vanadinite has lower S.G. than the other two as well.

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Table IID-1: Nonmetallic Luster, Hardness Greater Than 3 but Less Than 5½, and Prominent Cleavage: *(Can not be scratched by a copper penny, can be scratched by a knife, streak white or none.)*

Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

imperfect in one direction (basal), may be distinct in another direction (rhombic)but usually not seen	3 to 3½	Colorless to White or Greyish-white, may be tinted other colors	vitreous to sub-vitreous	WITHERITE (Aragonite Group) $BaCO_3$	Orthorhombic, pseudo- hexagonal	usually as stout prismatic twinned crystals with a hexagonal cross section, often with pyramidal terminations on both ends, more rarely as globular to botryoidal clusters, coarse fibrous aggregates, and granular	4.29	often hazed, will effervesce in cold acid.
Distinct in one direction (prismatic)	3½ to 4	Colorless to White or Grey, may be tinted other colors	vitreous to sub-vitreous or resinous	ARAGONITE (Aragonite Group) $CaCO_3$	Orthorhombic	usually in prismatic crystals, sometimes flattened, often acicular, usually twinned producing a pseudo-hexagonal cross section, may also be columnar, radiating or stellate aggregates, also stalactic	2.95	often fluorescent, pale rose, yellow or bluish-white, effervesces in cold acids. Distinguished from calcite by its greater hardness, higher S.G. and different crystal forms and habits – though some crystals may mimic the forms found in calcite.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**Sp. G**	**Notes**
Perfect cleavage in one direction (prismatic)	3½ to 4	Colorless to White, may be Yellow, Brown, and other colors	vitreous, pearly on cleavage surfaces	STILBITE-(Ca) (Zeolite Group) $(Ca_{0.5},Na,K)_9[Al_9Si_{27}O_{72}]\cdot 28H_2O$	Monoclinic	usually as flattened tabular long prismatic crystals, often in sheaf-like groups ("bowties")	2.12 to 2.22	white streak; dissolves in cold acids.
Perfect cleavage in one direction (prismatic)	3½ to 4	Colorless to White, may be Grey, Yellow, Pink, and other colors	vitreous, pearly on cleavage surfaces	HEULANDITE-(Ca) (Zeolite Group) $(Ca_{0.5},Na,K)_9[Al_9Si_{27}O_{72}]\cdot\sim 24H_2O$	Monoclinic	commonly tabular to equant crystals, may be long-prismatic	2.10 to 2.29	white streak; dissolves in cold acids.
Perfect cleavage in one direction (prismatic)	3½ to 4	Colorless to White	vitreous, pearly on cleavage surfaces	CLINOPTILOLTE-(Ca) (Zeolite Group) $(Ca_{0.5},Na,K)_6[Al_6Si_{30}O_{72}]\cdot\sim 20H_2O$	Monoclinic	usually as platy crystals, may be tabular or flattened long prismatic, commonly fine-grained, massive	2.10 to 2.17	white streak; dissolves in cold acids.
Perfect cleavage in one direction (prismatic)	4½	Colorless to White, may be Pink or Brown	vitreous to sub-vitreous	STELLERITE (Zeolite Group) $Ca[Al_2Si_7O_{18}]\cdot 7H_2O$	Orthorhombic	usually in spheres of radiating elongated tabular crystals, often also as aggregates of scaly to platy and small tabular crystals	2.13	white streak; dissolves in cold acids.
Perfect in one direction (prismatic), may have a poor (pinacoidal) cleavage in another direction	4½ to 5½	Colorless to White, Pale-pink, Pale-yellow to Pale-brown	vitreous, pearly on some cleavage surfaces	BREWSTERITE-Sr/ BREWSTERITE-Ba $(Sr,Ba)_2[Al_4Si_{12}O_{32}]\cdot 10H_2O$ – $(Ba,Sr)_2[Al_4Si_{12}O_{32}]\cdot 10H_2O$	Monoclinic & Triclinic	usually as small tabular crystals, may be blocky or prismatic as well	2.32 to 2.45	white streak; S.G. increases with Ba content; Brewsterite-Ba is the far more common of the two.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

Perfect cleavage in one direction (prismatic)	5 to 5½	Pale-pink, Colorless to White, may be Grey or other colors	usually vitreous to silky in finer acicular aggregates, but may be dull or even greasy	NATROLITE (Zeolite Group) $Na_2[Al_2Si_3O_{10}]\cdot 2H_2O$	Orthorhombic	usually as long slender needles in stellate clusters or radial aggregates, may also be in jackstraw clusters	2.20 to 2.27	white streak; dissolves in cold acids.
Poor in one direction, may not be seen	5 to 5½	Colorless to White, may be Yellow, Pink, or other colors	vitreous	ANALCIME (Zeolite Group) $Na[AlSi_2O_6]\cdot H_2O$	Polymorphous (Iso., Tet., Orth., Mon., Tric., Trig.)	usually in cubic or trapezohedral crystals or fine-grained masses, more rarely in other crystal forms	2.22 to 2.63	dissolves in cold acids
Perfect in one direction (may have a distinct cleavage in a second direction)	4 to 4½	Colorless to white or Grey, may be tinted other colors	vitreous to sub-adamantine	COLEMANITE $Ca_2B_6O_{11}\cdot 5H_2O$	Monoclinic	usually in druzy to jackstraw clusters of acicular to prismatic crystals	2.42	decrepitates violently in a candle flame.
Perfect in one direction (may have an imperfect cleavage in a second direction)	4½ to 5	Colorless to White or Grey, Pale-green, may also be other tints	vitreous to sub-vitreous, pearly on cleavage surfaces	FLUORAPOPHYLLITE-HYDROXYLAPOPHYLLITE $KCa_4Si_8O_{20}F\cdot 8H_2O$ - $KCa_4Si_8O_{20}(OH)\cdot 8H_2O$	Tetragonal	crystals usually equant, blocky, may be stout tabular, more rarely prismatic, commonly striated	2.33 to 2.37	It is impossible to tell the two end members apart without subtle chemical tests. Information about which is found at any given locality is the best bet. Fluorapophyllite is probably the more common of the two.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in one direction (may have a good cleavage in another direction)	4½ to 5 parallel to the length of the crystal, 7 to 7½ across the crystal	Blue most common, also Green, may be Grey, even Black, due to inclusions	vitreous to subvitreous	KYANITE Al_2SiO_5	Triclinic	most often as bladed long-prismatic crystals, usually poorly formed and rarely terminated, may be in parallel groupings or randomly oriented in the matrix	3.56 to 3.76	only common mineral with significant hardness difference in two directions.
Two Directions Perfect in one direction (prismatic), good in another direction (prismatic)	3½ to 4	Colorless to White or Grey, may be tinted other colors	vitreous to sub-vitreous, silky when fibrous	STRONTIANITE (Aragonite Group) $SrCO_3$	Orthorhombic	usually in granular or fibrous aggregates, may be columnar, crystals short prismatic to acicular, often pseudo-hexagonal in cross-section (Ca-rich)	3.76	effervesces mildly in cold acids, or not at all. Distinguished from cerussite by its notably lower specific gravity, lighter feel. Also it is not as common as cerussite.
Two Directions Perfect in one direction, imperfect in a second (both prismatic)	4½	Bluish-grey to Greenish-Grey (triphylite), white to greyish-white streak, Clove-brown to Yellowish-brown, Salmon (lithiophilite)	vitreous to sub-vitreous, may be dull in granular massive material	TRIPHYLITE-LITHIOPHILITE $LiFePO_4$ – $LiMnPO_4$	Orthorhombic	usually in cleavable crystalline masses, crystals rare and usually crude with uneven surfaces, stout prismatic	3.56 (triphylite), 3.34 (lithiophilite)	
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

Two Directions: perfect in one direction (prismatic), good in a second direction (cleavages rarely seen)	4½ to 5	Colorless to White, may be Pale-yellow, Pale-green, Sky-blue, Pale-brown	vitreous, pearly on some cleavage surfaces	HEMIMORPHITE $Zn_4Si_2O_7(OH)_2{\cdot}H_2O$	Orthorhombic	usually in radiating clusters of acicular or somewhat flattened long prismatic crystals, may also be in thick botryoidal crusts of thick to almost fibrous radiating crystals	3.4 to 3.5	may resemble prehnite in its botryoidal form, but S. G. is higher
Two Directions: perfect in both directions (prismatic & pinacoidal)	4½ to 5	White, Pale-pink, Pale-tan, Pale-blue	vitreous to silky in fibrous material	PECTOLITE (Wollastonite Group) $NaCa_2Si_3O_8(OH)$	Triclinic	usually in acicular sprays or radial fibrous aggregates	2.84 to 2.90	partly decomposed in acid forming a gelatin
Two Directions: perfect in one direction (prismatic), good in a second (pinacoidal), may exhibit a poor to good third cleavage (rarely seen)	4½ to 5	White to Greyish-white, may also be Pale-green	vitreous luster to somewhat pearly in fibrous material	WOLLASTONITE-1A (Wollastonite Group) $CaSiO_3$	Triclinic	usually in coarsely crystalline cleavage masses, more rarely fibrous	2.86 to 3.09	Most common of the wollasonite polymorphs.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Two Directions: perfect in two directions (prismatic & pinacoidal)	4½ to 5	Orange to Pinkish-orange to Rose	vitreous, pearly on cleavage surfaces	SERANDITE (Wollastonite Group) $Na(Mn,Ca)_2Si_3O_8(OH)$	Triclinic	usually as slightly flattened prismatic crystals in parallel to sub-parallel groups	3.0 to 3.4	Rare
Two Directions: perfect in one direction, imperfect in a second direction (both prismatic)	5 to 5½	Yellowish-brown to Greenish-brown	vitreous to sub-vitreous, may be somewhat resinous or oily	TITANITE ("SPHENE") $CaTiSiO_5$	Monoclinic	usually in crude blocky to stout prismatic crystals, wedge-shaped	3.48 to 3.60	streak white to pale brown
Two Directions: perfect in both directions at nearly 90º to one another (prismatic)	5½ to 6½	Pink to Rose-red, Brownish-red, usually coated with black manganese oxides	vitreous to sub-vitreous, may be somewhat pearly on cleavage surfaces	RHODONITE $(Mn,Fe,Mg,Ca)SiO_3$	Triclinic	usually massive, granular, rarely as tabular crystals	3.55 to 3.76	
Two Directions: perfect in two directions	5½ to 6	Dark Greenish-black to Black	vitreous, splendant.	BABINGTONITE $Ca_2(Fe,Mn)FeSi_5O_{14}(OH)$	Triclinic	usually as equant to stout prismatic to tabular crystals, often crude	3.34 to 3.48	pale greenish to brownish grey streak
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Two Directions: perfect in both directions (prismatic and pinacoidal)	4 to 4½	Colorless to White, may be Pink to Orange-red	silky to vitreous	DACHIARDITE-Ca (Zeolite Group) $(Ca_{0.5},K,Na)_{4-5}[Al_{4-5}Si_{20-19}O_{48}]$ $\cdot{\sim}13H_2O$	Monoclinic	usually fibrous to small bladed prismatic crystals in radiating aggregates or clusters	2.14 to 2.21	white streak; Rare.

Two Directions: distinct in one direction, indistinct in another (both prismatic)	4 to 4½	Colorless to White, may be Pink to Red, Yellow	vitreous	PHILLIPSITE-Ca (Zeolite Group) $(Ca_{0.5},K,Na,Ba_{0.5})_{4-7}[Al_{4-7},Si_{12-9}O_{32}]\cdot 12H_2O$	Monoclinic	usually as small twinned, pseudo-orthorhombic, prismatic crystals	2.2	white streak; Forms a series with harmotome.
Two Directions: good in one direction, fair in another (both prismatic), fair cleavage may not be seen	4½ to 5	Colorless to White or Greyish-white, may be tinted other colors	vitreous	HARMOTOME (Zeolite Group) $(Ba_{0.5},Ca_{0.5},K,Na)_5[Al_5Si_{11}O_{32}]\cdot 12H_2O$	Monoclinic	usually as blocky crystals, but may be twinned, pseudo-orthorhombic, prismatic crystals	2.38 to 2.50 (increasing with Ba content)	streak white; Forms a series with phillipsite
Two Directions: perfect in one direction (prismatic), poor in another, (pinacoidal), second may not be seen	4½ to 5½	Colorless to White, Pale-pink, Pale-yellow to Pale-brown	vitreous, pearly on some cleavage surfaces	BREWSTERITE-Sr/ BREWSTERITE-Ba $(Sr,Ba)_2[Al_4Si_{12}O_{32}]\cdot 10H_2O$ - $(Ba,Sr)_2[Al_4Si_{12}O_{32}]\cdot 10H_2O$	Monoclinic & Triclinic	usually as small tabular crystals, may be blocky or prismatic as well	2.32 to 2.45 (increasing with Ba content)	Brewsterite-Ba is the far more common of the two
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Two Directions: perfect in both directions (both prismatic)	5	Colorless to White, may be Pink to Red, Yellowish or Green	silky when fibrous, vitreous when acicular	MESOLITE (Zeolite Group)$Na_{16}Ca_{16}[Al_{48}Si_{72}O_{240}]\cdot 64H_2O$	Orthorhombic	usually in fibrous radiating aggregates or long slender needles in sprays, stellate clusters, or jackstraw clusters, may also be fibrous tufts	2.25	white streak;
Two Directions: perfect in both directions (both prismatic)	5 to 5½	Colorless to White, Pink to Red or Salmon, Green	vitreous, silky in fibrous material	SCOLECITE (Zeolite Group) $Ca[Al_2Si_3O_{10}]\cdot 3\ H_2O$	Monoclinic	usually as thin flattened prismatic needles in stellate to radiating clusters, may also be in fibrous radiating aggregates	2.24 to 2.31	Rare.
Two Directions: perfect in one direction (prismatic), good to distinct in a second direction (actually a parting, but distinct – prismatic)	5 to 5½	Colorless to White, Pale-pink to Pale-red, may be other colors	vitreous, silky in more fibrous aggregates, more rarely greasy or dull	NATROLITE (Zeolite Group) $Na_2[Al_2Si_3O_{10}]\cdot 2H_2O$	Orthorhombic	usually as long slender needles or prismatic crystals (nearly square cross-section, pseudo-tetragonal) in radial aggregates or stellate or jackstraw clusters	2.20 to 2.27	white streak; partially dissolves in acids producing gelatin.
Two Directions perfect in one direction, good in another (both prismatic), may not be seen	5 to 5½	Colorless to White, may be tinted other colors, white streak	vitreous to pearly	THOMSONITE (Zeolite Group) $Ca_2Na[Al_5Si_5O_{20}]\cdot 6H_2O$	Orthorhombic	usually in granular masses, crystals vary from thin rectangular blades to blocky prismatic	2.25 to 2.44	partially dissolves in acids producing gelatin

Two Directions at ~56º and ~124º , prismatic – Amphibole Group; good to perfect in both directions	5 to 6	Grey to Lavender-blue or Pale-blue	vitreous, silky in asbestiform varieties	GLAUCOPHANE - FERROGLAUCOPHANE $Na_2(Mg_3Al_2)Si_8O_{22}(OH)_2$ - $Na_2(Fe_3Al_2)$ $Si_8O_{22}(OH)_2$	Monoclinic	usually in lath-like crystal aggregates, striated along their length, and in fibrous ("asbestiform") aggregates ("crocidolite")	3.02 to 3.42 (increasing with Fe content)	pale-grey to bluish-grey streak; glaucophane usually light-grey to lavender-blue, ferroglaucophane usually darker. The glaucophanes and riebeckites are impossible to tell apart without subtle chemical or optical tests.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Two Directions at ~56º and ~124º , prismatic – Amphibole Group; good to perfect in both directions	5 to 6	Light-blue to Blue-black	vitreous, silky in asbestiform varieties	MAGNESIORIEBECKITE - RIEBECKITE $Na_2(Mg_3Fe_2)Si_8O_{22}(OH)_2$ - $Na_2(Fe_3Fe_2)$ $Si_8O_{22}(OH)_2$	Monoclinic	usually in lath-like crystal aggregates, striated along their length, and in fibrous ("asbestiform") aggregates ("crocidolite")	3.02 to 3.42 (increasing with Fe content)	pale-grey to bluish-grey streak; magnesioriebeckite usually lighter blue, riebeckite usually darker; glaucophanes and riebeckites are impossible to tell apart without subtle chemical or optical tests.
Two Directions at ~56º and ~124º , prismatic – Amphibole Group; perfect in both directions	5 to 6	White to Light-Green to Dark-green	vitreous, silky in asbestiform varieties	TREMOLITE-ACTINOLITE $Ca_2Mg_5Si_8O_{22}(OH)_2$ – $Ca_2(Fe,Mg)_5Si_8O_{22}(OH)_2$	Monoclinic	usually in bladed crystal aggregates, may also be somewhat acicular, tremolite may be asbestiform ("byssolite") or in fibrous mats ("mountain leather,"mountain cork")	2.89 to 3.44 (increasing with Fe content)	tremolite usually white to greyish-white or pale greenish-white, actinolite medium- to dark-green.
Two Directions at ~56º and ~124º , prismatic – Amphibole Group; good to perfect in both directions	5 to 6	Brown to Greenish-brown to Green or Greyish-green	vitreous, silky in fibrous varieties	CUMMINGTONITE - GRUNERITE $Mg_7Si_8O_{22}(OH)_2$– $Fe_7Si_8O_{22}(OH)_2$	Monoclinic	usually in bladed crystal aggregates or asbestiform, may be acicular	3.1 to 3.6 (increasing with Fe content)	cummingtonite usually green to grey-green, grunerite brown to greenish-brown.
Cleavage	**Habit**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Two Directions at ~56º and ~124º , prismatic – Amphibole Group; perfect in one direction, imperfect in the second	5½ to 6	White to Grey or Pale-green to Clove-brown or Dark-brown	vitreous, silky in asbestiform varieties	ANTHOPHYLLITE - FERROANTHOPHYLLITE $Mg_7Si_8O_{22}(OH)_2$ – $Fe_7Si_8O_{22}(OH)_2$	Orthorhombic	usually columnar aggregates, may be radiating, or asbestiform	3.18 to 3.57 (increasing with Fe content)	anthophyllite usually lighter colors, ferro-antho-phyllite darker.

Two Directions at ~56º and ~124º , prismatic – Amphibole Group; perfect in one direction, imperfect in the other	5½ to 6	Pale Greenish-grey to Greenish-brown and Brown	vitreous, silky when fibrous	GEDRITE-FERROGEDRITE $Mg_5Al_2[Si_6Al_2O_{22}](OH)_2$ – $Fe_5Al_2[Si_6Al_2O_{22}](OH)_2$	Orthorhombic	usually in lamellar to fibrous aggregates	3.18 to 3.57 (increasing with Fe content)	gedrite usually paler shades, ferrogedrite darker.
Two Directions at ~56º and ~124º , prismatic – Amphibole Group; perfect in both directions	5 to 6	Black to Greenish-black or Dark-green	vitreous	MAGNESIOHORNBLENDE - FERROHORNBLENDE Ca2[Mg4(Al,Fe)]Si7AlO22(OH)2 - Ca2[Fe4(Al,Fe)]Si7AlO22(OH)2	Monoclinic	usually in coarsely crystalline cleavable masses, also in prismatic to acicular crystal aggregates with the crystals often displaying a crudely pseudo-hexagonal cross section, otherwise rectangular to nearly square, not asbestiform	3.02 to 3.45 (increasing with Fe content)	may give grey-green streak; magnesiohornblende usually paler than ferrohornblende
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Two Directions at ~56º and ~124º , prismatic – Amphibole Group; perfect in both directions	5 to 6	Pale-green to Dark-green, Greyish-brown to Brown, Yellow-brown to Reddish-brown or Rose-red	vitreous, silky in asbestiform varieties	RICHTERITE - FERRORICHTERITE $Na(Ca,Na)\ Mg_5Si_8O_{22}(OH)_2$- $Na(Ca,Na)Fe_5Si_8O_{22}(OH)_2$	Monoclinic	usually in cleavable prismatic crystal aggregates or stout flattened prismatic crystals, also asbestiform	2.97 to 3.45 (increasing with Fe content)	color darkens with increasing Fe content (ie: ferrorichterite).
Two directions at nearly 90º, prismatic – Pyroxene Group. good to perfect in both directions	5 to 6	Pale-to Medium-green, Pale-yellow to light Yellowish-brown, Pale-bronze ("bronzite")	vitreous to sub-vitreous, may be sub-metallic in the "bronzite" and "hypersthene" varieties	ENSTATITE/ CLINOENSTATITE $Mg_2Si_2O_6$	Orthorhombic & Monoclinic	usually granular in rocks, rarely as short-prismatic crystals	3.21 to 3.60	Enstatite-ferrosilite and clinoenstatite-clinoferrosilite form solid solution series. They are very difficult to tell apart. "Bronzite" and "hypersthene" are varietal names for intermediate members of the series.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Two directions at nearly 90º, prismatic – Pyroxene Group. good in both directions	5 to 6	Greenish-brown or Brown to nearly Black	vitreous to sub-vitreous, may be dull, may be pearly to sub-metallic on cleavage surfaces	FERROSILITE/ CLINOFERROSILITE $(Fe,Mg)_2Si_2O_6$	Orthorhombic & Monoclinic	usually granular in rocks, prismatic crystals rare	3.6 to 4.0	streak pale grey to pale brown; Enstatite-ferrosilite and clinoenstatite - clinoferrosilite form solid solution series. They are very difficult to tell apart. "Bronzite" and "hypersthene" are varietal names for intermediate members of the series.

Two directions at nearly 90º, prismatic – Pyroxene Group: good to perfect in both directions	5½ to 6	Pale- to Dark-green, may be White or Greenish-white to Greyish-white	vitreous to sub-vitreous, may be dull	DIOPSIDE $CaMgSi_2O_6$	Monoclinic	usually as equant to stout prismatic crystals, slender prismatic less common, more rarely tabular, also massive and granular	3.22 to 3.45	white to pale-green streak; may exhibit chatoyancy and 4-ray asterism when cut and polished with the correct orientation. Diopside and hedenbergite form a solid solution series. They can be impossible to distinguish visually. S.G. usually tells them apart, though when of intermediate composition this may not do the trick.
Two directions at nearly 90º, prismatic – Pyroxene Group: good in both directions	5½ to 6	Pale- to Dark-green, Brownish-green to Brownish- or Greenish-black	vitreous to sub-vitreous, may be dull	HEDENBERGITE $CaFe\ Si_2O_6$	Monoclinic	usually as massive, granular, and as fracture fillings in rock, crystals equant to stout prismatic, slender prismatic less common, more rarely tabular	3.45 to 3.56	pale green to tan streak; may exhibit chatoyancy and 4-ray asterism when cut and polished with the correct orientation. Diopside and hedenbergite form a solid solution series. They can be impossible to distinguish visually. S.G. usually tells them apart, though when of intermediate composition this may not do the trick.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Two directions at nearly 90º, prismatic – Pyroxene Group: good in both directions	5½ to 6	Greenish-black to Black, Light- to Dark-brown	vitreous to sub-vitreous, may be dull	AUGITE $(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$	Monoclinic	usually granular in rocks, also as somewhat flattened short-prismatic crystals	3.19 to 3.56	pale brown to greenish grey streak
Two directions at nearly 90º, prismatic – Pyroxene Group: good to perfect in both directions	5½ to 6	Dark-green or Reddish-brown to Black	vitreous to sub-vitreous, may be dull	AEGIRINE (ACMITE) $NaFeSi_2O_6$	Monoclinic	usually as slender prismatic or acicular crystals, either in clusters in cavities or as acicular aggregates in matrix	3.50 to 3.60	pale tan to yellow green to pale green streak
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Three cleavage directions, rhombohedral – Trigonal Carbonates: perfect in all three directions	3, may be 2 across the top surface of prismatic crystals with a flat termination	usually Clear or White to Tan or Grey, but may be tinted many colors	vitreous to sub-vitreous luster, may be waxy or dull on weathered crystals, pearly on cleavage surfaces	CALCITE $CaCO_3$	Trigonal	may be in cleavable masses producing rhombs, granular masses (limestone and marble), scalenohedral ("dogtooth") crystals, rhombohedral crystals, flattened rhombohedral ("nailhead") crystals, or a wide variety of related shapes (there are over 800 crystals forms known for this	2.71	clear rhombs show a doubled image of print viewed through them, , effervesces in cold, dilute acid – even in vinegar or Coke to a small degree. The many varied habits of calcite crystals make this one of the species that can be tough to identify by crystal form alone. Few people, if any, are familiar with all the forms it takes.

Cleavage	Hardness	Color	Luster	Name	System	Habit	SG	Notes
						species to date…)		
Three cleavage directions, rhombohedral – Trigonal Carbonates: perfect in all three directions	3½ to 4½	White to Grey, may be tinted Yellowish to Brownish	vitreous to sub-vitreous, may be pearly on cleavage surfaces	MAGNESITE (Calcite Group) $MgCO_3$	Trigonal	usually massive, granular, crystals may be rhombohedral or prismatic but are rare	3.0	white streak; only slightly soluble in cold acids. No where near as common as calcite or dolomite.
Three cleavage directions, rhombohedral – Trigonal Carbonates: perfect in all three directions	3½ to 4	White to Tan or Pink, Grey, Greenish, tends towards Brown with increasing Fe, Red with Mn	usually vitreous to sub-vitreous, but may be pearly	DOLOMITE $CaMg(CO_3)_2$	Trigonal	usually as massive, granular, or in curved rhombohedral crystal clusters "fingernail" shape, druzes may have a characteristic "saddleback" arrangement	2.85	streak same color as sample, but pale; effervesces in cold acid, though not as vigorously as calcite, may be fluorescent. The Dolomite Group minerals are best told apart – and from calcite – by their S.G. when color and habit coincides.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Three cleavage directions, rhombohedral – Trigonal Carbonates: perfect in all three directions	3½ to 4	White to Tan or Brown	usually vitreous to subvitreous, but may be pearly	ANKERITE (Dolomite Group) $Ca(Fe,Mg,Mn)(CO_3)_2$	Trigonal	usually massive, granular, or as rhombohedral crystals (similar to dolomite)	2.87	white streak; effervesces in cold acids, though not as vigorously as calcite. Not as common as either calcite or dolomite. The Dolomite Group minerals are best told apart – and from calcite – by their S.G. when color and habit coincides.
Three cleavage directions, rhombohedral – Trigonal Carbonates: perfect in all three directions	3½ to 4	White to Pale-rose	vitreous to sub-vitreous, but may be pearly	KUTNOHORITE (Dolomite Group) $Ca(Mn,Mg,Fe) (CO_3)_2$	Trigonal	usually massive crystalline cleavable into rhombs, more rarely as rhombohedral crystals	3.12	white streak; effervesces in cold acids, though not as vigorously as calcite. Rare. The Dolomite Group minerals are best told apart – and from calcite – by their S.G. when color and habit coincides.
Three cleavage directions, rhombohedral – Trigonal Carbonates: perfect in all three directions	3½ to 4	Pink to Red, in various shades, also more rarely Yellow-grey or Tan to Brown	vitreous to sub-vitreous, may be pearly on cleavage surfaces	RHODOCHROSITE (Calcite Group) $MnCO_3$	Trigonal	usually in coarsely crystalline cleavable masses, crystals rhombohedral, may also be botryoidal and globular with concentric banding, and stalactic	3.5 to 3.7(pure)	white streak; only slightly soluble in cold acids. Uncommon.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

Three cleavage directions, rhombohedral – Trigonal Carbonates: perfect in all three directions	4 to 4½	Greyish-white to Dark-grey, Greenish- or Brownish-white, may be Green to Apple-green, Blue to Blue-green, Yellow, Pink or Brown	vitreous to sub-vitreous, may look somewhat porcelain-like	SMITHSONITE (Calcite Group) $ZnCO_3$	Trigonal	usually in botryoidal, reniform, and stalactic masses, rhombohedral crystals rare and usually crude with somewhat curved and rough surfaces, druzy	4.2 (pure)	white streak; soluble in cold acids, though not with the vigorous effervescence of calcite.
Three cleavage directions, rhombohedral – Trigonal Carbonates: perfect in all three directions	3½ to 4	Dark-brown to Tan to Cream, may be Blackish-brown due to weathering	vitreous to sub-vitreous, may be oily to resinous on weathered, oxidized surfaces	SIDERITE (Calcite Group) $FeCO_3$	Trigonal	usually in cleavable coarsely crystalline masses, though not cleavable into rhombs, crystals rhombohedral, more rarely tabular, very rarely prismatic	3.8 to 4.0	white streak; somewhat soluble in cold acids, but with little or no effervescence
Three cleavage directions – perfect to distinct in all three directions, rhombohedral	3 to 5	Colorless to White, may be tinted various colors	vitreous to sub-vitreous	CHABAZITE (Zeolite Group) $(Ca_{0.5},K,Na)_4[Al_4Si_8O_{22}]\cdot 12H_2O$	Triclinic, pseudo-trigonal	usually as distorted cubes or pseudo-rhombohedral crystals (actually composed of six triclinic twins), rarely prismatic or tabular, then somewhat lens- or bean-shaped ("phacolitic")	1.97 to 2.20	streak white; partially dissolved in cold acids producing a gel, may be fluorescent.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Three cleavage directions – perfect to distinct in all three directions, rhombohedral	4 to 4½	Colorless to White, may be tinted various colors	vitreous to subvitreous	LEVYNE (Zeolite Group) $(Ca_{0.5},Na,K)_6[Al_6Si1_2O_{36}]\cdot{\sim}17H_2O$	Trigonal	usually as small to tiny platy hexagonal crystals	2.09 to 2.16	streak white; Rare.
Three cleavage directions – Perfect in two directions, imperfect in a third, all prismatic	3 to 4	White usually tinted other colors	vitreous, pearly on cleavage surface, chalky when dehydrated	LAUMONTITE (Zeolite Group) $Ca_4[Al_8Si1_6O_{48}]\cdot 18H_2O$	Monoclinic	usually as simple prismatic crystals with a square cross section, more rarely as equant crystals	2.20 to 2.41	white streak; crystals may have chalky white coatings due to dehydration, may be fluorescent. Rare.
Three cleavage directions – one cleavage perfect, one imperfect, both prismatic, one good, basal	3 to 3½	Colorless to White, usually tinted other colors	vitreous to sub-vitreous, may be pearly on cleavage surfaces	ANHYDRITE $CaSO_4$	Orthorhombic	usually in coarsely crystalline masses showing pseudo-cubic cleavage, or granular or fibrous, crystals uncommon and usually equant or thick tabular	2.98	white streak; dissolves in cold acids without effervescence
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

Three cleavage directions – Perfect in two directions, basal and prismatic, imperfect in a third, prismatic (rhombic overall)	3 to 3½	Colorless to White or Greyish-white, may be tinted other colors, streak white	vitreous, pearly on basal cleavage surfaces	BARITE $BaSO_4$	Orthorhombic	usually in clusters or aggregates of platy to tabular crystals	4.5	heavy for its size. The three members of the Barite Group are most easily told apart by their S.G.s. Anglesite is noticeably heavier than the other two, barite may feel heavier than celestite.
Three cleavage directions – Perfect in one direction, basal, good in a second and fair to poor in a third, both prismatic (rhombic overall)	3 to 3½	White to Greyish-white, Blue, may be tinted other colors, streak white	vitreous, pearly on basal cleavage surfaces,	CELESTITE (Celestine) (Barite Group) $SrSO_4$	Orthorhombic	usually in clusters or aggregates of platy to tabular crystals	3.95 to 3.97	somewhat heavy for its size. The three members of the Barite Group are most easily told apart by their S. G.s. Anglesite is noticeably heavier than the other two, barite may feel heavier than celestite.
Three cleavage directions – one distinct (prismatic), second direction good (basal), and fair to poor in a third, (prismatic); rhombic overall – may be difficult to see all three	2½ to 3	Colorless to White or Greyish-white to Greyish-brown	adamantine to sub-adamantine, may be vitreous to resinous on some surfaces	ANGLESITE (Barite Group) $PbSO_4$	Orthorhombic	usually in crystalline masses, crystals usually small and tabular, rarely prismatic	6.2 to 6.4	streak white; very heavy. Massive material may be difficult to distinguish from cerussite if cleavages can't be seen. The three members of the Barite Group are most easily told apart by their S.G.s. Anglesite is noticeably heavier than the other two, barite may feel heavier than celestite.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Three cleavage directions – perfect in two directions, prismatic, good to imperfect in a thrid, basal	3 to 3½	Colorless to White or Greyish-white, may be tinted other colors	vitreous and/or pearly.	ANHYDRITE $CaSO_4$	Orthorhombic	usually in coarsely crystalline masses exhibiting pseudo-cubic cleavage, or in granular masses with no apparent cleavage, crystals rare and usually equant or thick tabular	2.9 to 2.98	white streak;
Four cleavage directions - perfect in all four directions, octahedral	4	Colorless, Green, Purple, Blue, Yellow, Pink	vitreous	FLUORITE CaF_2	Isometric	usually in cubic crystals or coarsely crystalline masses exhibiting octahedral cleavage, crystals may also be octahedral	3.18	streak white; often fluorescent. The term fluorescent is derived from this mineral's name.

Four cleavage directions - imperfect to distinct in two directions, good in two directions, all prismatic	5 to 6	White to Grey, Yellowish, Brownish, Orange, Purple	vitreous to subvitreous, may be dull also	MARIALITE-MEIONITE (Scapolite series) $3NaAlSi_3O_8{\cdot}NaCl$ – $3CaAl_2Si_2O_8{\cdot}CaCO_3$	Tetragonal	usually massive, either columnar or fibrous, with columnar masses exhibiting cleavage surfaces, also as short to medium prismatic crystals with bipyramidal terminations, usually somewhat crude	2.55 to 2.72	may fluoresce yellow. It is almost impossible to tell the end members of this complex series apart without subtle chemical or optical tests. Intermediate member, wernerite, is probably the most common chemical form found – though it is not recognized as a species in spite of evidence that it should be. It is probably best to label samples of these materials simply as scapolite, unless specific locality information dictates otherwise
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Six cleavage directions - perfect in all six directions, dodecahedral, but difficult to produce in some of them	3½ to 4	Brown to Black, Yellow-brown to Greenish-yellow-brown, may also be Red in small crystals	resinous, but may be oily or sub-metallic on cleavage surfaces and adamantine in small crystals	SPHALERITE (Zn,Fe)S	Isometric	usually in coarsely crystalline cleavable masses exhibiting seemingly chaotic cleavage surfaces, and as small tetrahedral (wedge-shaped) or dodecahedral (soccer ball-shaped) crystals, larger crystals tend to be somewhat crude and rough surfaced aggregates	3.9 to 4.1	brown to yellow streak
Six cleavage directions - poor to distinct in all six directions, dodecahedral, may not be seen	5½ to 6	Medium-Blue to Violet-blue, Greyish-white to White, more rarely Greenish- or Yellowish-white	vitreous to subvitreous, may be somewhat dull in massive material	SODALITE $Na_8Al_6Si_6O_{24}Cl_2$	Isometric	usually as granular masses or grains in matrix, sometimes crudely cleavable, crystals rare, usually dodecahedral to cubo-dodecahedral, rarely octahedral	2.14 to 2.30	white to very pale blue streak; usually associated with nepheline – never with quartz.
Six cleavage directions - poor to distinct in all six directions, dodecahedral, may not be seen	5 to 5½	Deep-blue to Medium-Blue or Violet-blue, may be Greenish-blue, Colorless	dull to vitreous	LAZURITE (Sodalite Group) $(Na,Ca)_{7-8}(Al,Si)_{12}(O,S)_{24}[(SO_4),Cl_2,(OH)_2]$	Isometric, Triclinic, and Monoclinic polytypes	usually as compact massive material or grains, crystals rare, usually well-formed dodecahedral to cubo-dodecahedral	2.38 to 2.45	bright blue streak; usually found with pyrite.

Notes:
Single and double cleavage direction Zeolites can be difficult to tell apart. Hardness may help to distinguish the harder and softer species from one another, and crystal habit and form may help to tell some species apart. In general, habits and forms taken with hardnesses are the best indicators.

Amphiboles are a large and difficult group to tell apart. The best bet is site-specific knowledge.

Pyroxenes can be difficult to distinguish from one another. Locality information is usually the best bet for determining what you have.

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Table IID-2: Nonmetallic Luster; Hardness greater than 3 but less than 5½, Cleavage not prominent: *(Can not be scratched by a copper penny, can be scratched by a knife, streak white or none.)*

Hardness	Color	Luster	Name	System	Habit	SG	Notes
2½ to 3	Bright-yellow, Orange-yellow, Orange, Red, Grey, Green, White	sub-adamantine to vitreous, may be greasy	WULFENITE $PbMoO_4$	Tetragonal,	usually as thin platy to thin tabular crystals, rarely pyramidal, more rarely prismatic	6.7 to 7.0	
2½ to 3	Orange-red to Ruby-red, Brownish-red to Brownish-yellow or pale Straw-yellow	sub-vitreous to sub-resinous	VANADINITE (Apatite Group) $Pb_5(VO_4)_3Cl$	Hexagonal	usually in barrel-shaped hexagonal crystals, long or short prismatic, may be acicular in clusters or mats ("endlichite"), and as hollow prisms – "hopper" crystals	6.88	streak white, may be yellowish
2½ to 4, rarely 5 to 6 in dense massive material	Apple-green to Yellow-green, Dark-green to Dark Grey-green, Greenish-black, White, often mottled	sub-vitreous to greasy	ANTIGORITE/LIZARDITE/ AMESITE (Serpentine Group) Generally $(Mg,Al)_3(Si,AL)_2O_5(OH)_4$	Monoclinic, Orthorhombic and Triclinic	usually as crystalline masses, often platy or columnar	2.4 to 2.79	white streak; feels greasy. These Serpentine minerals are almost impossible to tell apart, particularly in massive forms. They may coexist at the same locality. Specific locality information may be the best bet for the ID.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
3, but may be 2 across the top surface of prismatic crystals with a flat termination	usually Clear or White to Tan or Grey, but may be tinted many colors	vitreous to sub-vitreous	CALCITE (certain massive forms) $CaCO_3$	Trigonal	may be in banded masses or stalactic ("flowstone"), granular masses (limestone and marble), or fibrous	2.71	White streak; effervesces in cold, dilute acid – even in vinegar or Coke to a small degree
3 to 3½	Colorless to White or Greyish-white, may be tinted other colors	vitreous to sub-vitreous	WITHERITE (certain massive forms - Aragonite Group) $BaCO_3$	Orthorhombic, pseudo-hexagonal	in coarse fibrous aggregates, may be radiating, and granular, more rarely as globular to botryoidal clusters	4.29	often hazed, will effervesce in cold acid.
3½	Bright-green to Yellow-green, Yellow to Orange-yellow, Brown, White, colorless	sub-vitreous to resinous	PYROMORPHITE (Apatite Group) $Pb_5(PO_4)_3Cl$	Hexagonal	usually in barrel-shaped hexagonal crystals, may also be spindle-shaped, hollow – "hopper" crystals – and rarely tabular or pyramidal, crystals may exhibit concentric color or structural zones due to zoned variations in composition	7.04	white streak; difficult to distinguish from mimetite without tests for PO4 vs. AsO4.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

3½ to 4	Pale-yellow to Yellow-brown, Orange-yellow to Orange-red, White or Colorless	sub-vitreous to resinous	MIMETITE (Apatite Group) $Pb_5(AsO_4)_3Cl$	Hexagonal	usually in simple barrel-shaped crystals, rarely tabular to acicular, may be botryoidal or globular	7.28	streak white; Difficult to distinguish from pyromorphite without tests for AsO4 vs. PO4. Named for the fact that it closely mimics pyromorphite.
3½ to 4	Colorless to White or Grey, may be tinted other colors	vitreous to sub-vitreous or resinous	ARAGONITE (certain massive forms) $CaCO_3$	Orthorhombic	in columnar, radiating or stellate aggregates, also stalactic	2.95	often fluorescent, pale rose, yellow or bluish-white, effervesces in cold acids. Distinguished from calcite by its greater hardness and higher S.G.
3½ to 4	Colorless to White or Grey, may be tinted other colors	vitreous to sub-vitreous, silky when fibrous	STRONTIANITE (Aragonite Group) $SrCO_3$	Orthorhombic	in granular or fibrous aggregates, may be columnar, crystals short prismatic to acicular, often pseudo-hexagonal in cross-section (Ca-rich)	3.76	effervesces mildly in cold acids
3½ to 4½	White to Grey, may be tinted Yellowish to Brownish	vitreous to sub-vitreous, may be pearly on cleavage surfaces	MAGNESITE (Calcite Group) $MgCO_3$	Trigonal	usually massive, granular, crystals may be rhombohedral or prismatic but are rare	3.0	white streak; only slightly soluble in cold acids.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
3½ to 4	White to Greyish-white, Reddish to Reddish-brown, Yellowish	dull to sub-vitreous	ALUNITE $KAl_3(SO_4)_2(OH)_6$	Trigonal	usually massive, granular to dense, as a rock with quartz, kaolinite, etc	2.6 to 2.9	
3½ to 4	Yellowish-green, Green to Yellow, Yellow-brown, Brown, more rarely Blue, White, Colorless	vitreous to pearly or resinous	WAVELLITE $Al_3(PO_4)_2(OH,F)_3{\cdot}5H_2O$	Orthorhombic	usually stellate or hemispherical radial fibers or acicular crystals	2.36	white streak; dissolves in cold acids with no effervescence.
4 to 4½	Greyish-white to Dark-grey, Greenish- or Brownish-white, may be Green to Apple-green, Blue to Blue-green, Yellow, Pink or Brown	vitreous to sub-vitreous, may look somewhat porcelain-like	SMITHSONITE (Calcite Group) $ZnCO_3$	Trigonal	usually in botryoidal, reniform, and stalactic masses, rhombohedral crystals rare and usually crude with somewhat curved and rough surfaces, druzy	4.2 (pure)	white streak; soluble in cold acids, though not with the vigorous effervescence of calcite
4½ to 5	Colorless to White, may be Pale-yellow, Pale-green, Sky-blue, Pale-brown	vitreous, pearly on some cleavage surfaces	HEMIMORPHITE $Zn_4Si_2O_7(OH)_2{\cdot}H_2O$	Orthorhombic	usually in radiating clusters of acicular or somewhat flattened long prismatic crystals, may also be in thick botryoidal crusts of thick to almost fibrous radiating crystals	3.4 to 3.5	may resemble prehnite in its botryoidal form, but S.G. is higher.

4½ to 5	White to Colorless, Pale-yellow, Pale-green, Pale-orange	vitreous to adamantine	SCHEELITE $CaWO_4$	Tetragonal	usually as grains or flakes, crystals rare and usually either platy to thin tabular or short-prismatic bipyramids	6.1	white streak; fluoresces intense blue-white, more rarely yellowish white.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
4½ to 5	White, Pale-pink, Pale-tan, Pale-blue	vitreous to silky in fibrous material	PECTOLITE (Wollastonite Group) $NaCa_2Si_3O_8(OH)$	Triclinic	usually in acicular sprays or radial fibrous aggregates	2.84 to 2.90	partly decomposed in acid forming a gelatin
5 to 5½	Pale-pink, Colorless to White, may be Grey or other colors	usually vitreous to silky in finer acicular aggregates, but may be dull or even greasy	NATROLITE (Zeolite Group) $Na_2[Al_2Si_3O_{10}]\cdot 2H_2O$	Orthorhombic	usually as long slender needles in stellate clusters or radial aggregates, may also be in jackstraw clusters	2.20 to 2.27	white streak; dissolves in cold acids
5 to 5½	Colorless to White, may be Yellow, Pink, or other colors	vitreous	ANALCIME (Zeolite Group) $Na[AlSi_2O_6]\cdot H_2O$	Polymorphous (Iso., Tet., Orth., Mon., Tric., Trig.)	usually in cubic or trapezohedral crystals or fine-grained masses, more rarely in other crystal forms	2.22 to 2.63	dissolves in cold acids
5 to5½	White, usually tinted Pale-green, may be Pale-blue	vitreous to greasy	DATOLITE (Gadolinite Group) $Ca_2B_2Si_2O_8(OH)$	Monoclinic	may be either platy to short prismatic or blocky crystals, more rarely as spherical aggregates or massive, granular to compact	2.9 to 3.0	white streak; may show an imperfect basal cleavage, may fluoresce
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
5 to 6	White, Yellow, Red, Brown, Black		OPAL $SiO_2\cdot nH_2O$	Amorphous	glassy massive material, as fracture fillings, coatings, "nodules," etc.	1.9 to 2.1	distinguished from massive quartz by lower hardness and S.G. Precious opal has an intense internal play of colors – flashes off minute fracture surfaces beneath the surface; in fire opal the flashes are predominantly reds, yellows and oranges against a black background. Common opal is "opalescent," but without the intense flashes of colors.
5 to 6	White to Grey, Yellowish, Brownish, Orange, Purple	vitreous to subvitreous, may be dull	MARIALITE-MEIONITE (Scapolite series) $3NaAlSi_3O_8\cdot$ NaCl - $3CaAl_2Si_2O_8.CaCO_3$	Tetragonal	usually massive, either columnar or fibrous, (columnar masses may exhibit prismatic cleavage surfaces), also as short to medium prismatic crystals with bipyramidal terminations, usually somewhat crude	2.55 to 2.72	may fluoresce yellow. It is almost impossible to tell the end members of this series apart without subtle chemical or optical tests. Intermediate member, wernerite, is probably the most common , though it is not recognized as a species. It is best to label samples of these materials simply as scapolite, unless specific locality information dictates otherwise.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

5	White to Colorless, Greens, Blues, Lavender, Yellows, Purples	vitreous to sub-vitreous, may be dull in massive material	FLUORAPATITE (Apatite Group) $Ca_5(PO_4)_3F$	Hexagonal	variable, may be massive, compact or granular, and may be in short- to long-prismatic crystals with a wide variety of habits, the hexagonal prism with pyramidal termination(s) being the most common, but may also be short-prismatic and even bipyramidal without the prism in between, also acicular	3.1 to 3.2	white streak; Closely related members of the Group include chlorapatite, hydroxyl-apatite, carbonate-fluorapatite and carbonate-hydroxylapatite, which can be difficult to distinguish from fluorapatite – but they are rare
5 to 5½	Yellowish- or Reddish-brown to Brown, Pale-green to nearly White	resinous to waxy	MONAZITE $(Ce,La,Y,Th)PO_4$	Monoclinic	usually in crude blocky to tabular crystals, may be large, also as rounded grains	4.6 to 5.3, increasing with Th content	streak very pale brown; may be radioactive.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
5 to 5½	Light-green to Yellow-green, Yellow-brown to Reddish-brown, Colorless	vitreous, occasionally resinous	WILLEMITE Zn_2SiO_4	Trigonal	usually massively crystalline or granular, rarely in prismatic hexagonal crystals	4.05 to 4.20	fluoresces bright green
5½ to 6	Medium-Blue to Violet-blue, Greyish-white to White, more rarely Greenish- or Yellowish-white	vitreous to subvitreous	SODALITE $Na_8Al_6Si_6O_{24}Cl_2$	Isometric	usually as granular masses or grains in matrix, sometimes crudely cleavable, crystals rare, usually dodecahedral to cubo-dodecahedral, rarely octahedral	2.14 to 2.30	white to very pale blue streak; may be somewhat dull in massive material, usually associated with nephaline – never with quartz.
5 to 5½	Deep-blue to Medium-Blue or Violet-blue, may be Greenish-blue, Colorless		LAZURITE (Sodalite Group) $(Na,Ca)_{7-8}(Al,Si)_{12}(O,S)_{24}[(SO_4),Cl_2,(OH)_2]$	Isometric, Triclinic, and Monoclinic polytypes	usually as compact massive material or grains, crystals rare, usually well-formed dodecahedral to cubododecahedral	2.38 to 2.45	luster dull to vitreous, usually found with pyrite

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Table IIIA-1: Hardness greater than 5½ but less than 7; Cleavage prominent *(Can not be scratched by a knife, can be scratched by quartz.)*

Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in one direction (prismatic)	4 to 5 parallel to cleavage and crystal faces, 6 to 7 across crystal and cleavage faces	Blue, Green, Grey, White, very rarely Black	Vitreous to sub-vitreous	KYANITE Al_2SiO_5	Triclinic	Usually in bladed aggregates, parallel or radiating, may also be single flattened prismatic crystals	3.56 to 3.67	only common mineral in which the hardness is so notably different along its length vs. across its width.

Perfect in one direction (prismatic)	5 to 6½	Light-brown to Black	Resinous or pitchy/ submetallic	ALLANITE-(Ce) (Epidote Group) $(Ce,Ca,Y)_2(Al,Fe,Fe)_3(SiO_4)_3(OH)$	Monoclinic	usually in coarsely crystalline massive form, crystals not seen (metamict), may also be finer grained with no apparent cleavage	3.4 to 4.2	may give a light brown streak; Allanite-(La) and Allanite-(Y) are closely related species, but extremely rare. Most of the Epidote group minerals may exhibit a second, poor, cleavage, but it is usually not seen. See also clinozoisite below.
Perfect in one direction (prismatic)	6½ to 7	Green to Yellow-green, Yellow, Grey, Brownish-green, Greenish-black, Black	vitreous to sub-vitreous , dull in weathered crystals and massive materials	EPIDOTE $Ca_2(Fe,AL)_3(SiO_4)_3(OH)$	Monoclinic	usually in short to long prismatic crystals, may also be thick tabular or acicular; also massive, coarse to fine granular, rarely fibrous	3.38 to 3.49	Over 200 different forms are known; Commonest of the Epidote Group species. Most of the Epidote group minerals may exhibit a second, poor, cleavage, but it is usually not seen. See also clinozoisite below.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	Habit	SG	Notes
Perfect in one direction (prismatic)	6 to 7	Grey, Green to Yellowish-green, Pinkish, Brown, Blue, Purple, Colorless	vitreous, may be pearly on cleavage surfaces	ZOISITE (Epidote Group) $Ca_2Al_3(SiO_4)_3(OH)$	Orthorhombic	usually in aggregates of crude parallel crystals with vertical striations on the faces, more rarely as well-formed prismatic crystals in clusters or singly	3.15 to 3.36	The blue gem variety "tanzanite" and pink gem variety "thulite" are rare. Most of the Epidote group minerals may exhibit a second, poor, cleavage, but it is usually not seen. See also clinozoisite below.
Perfect in one direction (prismatic)	6½ to 7	Colorless to White, Grey, Pale-brown to Pale-yellow, more rarely Pale-blue to Pale-green	vitreous to subvitreous, silky in fibrous material, may be dull on weathered surfaces	SILLIMANITE Al_2SiO_5	Orthorhombic	usually as crude prismatic crystals with a nearly square cross-section, may be in columnar to fibrous aggregates ("fibrolite")	3.23 to 3.27	surfaces often rough and altering to muscovite, restricted to high-temperature and pressure metamorphic environments
Cleavage	Hardness	Color	Luster	Name	System	Habit	SG	Notes
Two cleavage directions at or nearly 90º. Perfect in one direction (prismatic)	6½ to 7	White to Greyish-white, Colorless, Pinkish-white to Pale-lavender, more rarely Greenish to Yellowish, Brown, Rose-red to Dark-red	vitreous to sub-adamantine, "brilliant"	DIASPORE $AlO(OH)$	Orthorhombic	usually in thin platy crystalline aggregates, crystals thin, platy, may be prismatic or acicular, rarely tabular	3.35 to 3.45	very brittle. Often mistaken for milky to greyish quartz.
Perfect in two directions (prismatic)	6	Brown to Greenish-brown, Colorless, Black	Vitreous	PIGEONITE (Pyroxene Group) $(Mg,Fe,Ca)(Mg,Fe)Si_2O$	Monoclinic	Usually as matrix-bound crystalline grains in cooled lavas	3.17 to 3.46	Often inverts to augite after cooling. Relatively rare compared to other Pyroxenes

Perfect in two directions (prismatic)	6½ to 7	Grey to White, Colorless, Tan, Yellow, Pale-green to Bright-green ("hiddenite"), Pink to Lilac to Violet ("kunzite")	vitreous to sub-vitreous	SPODUMENE (Pyroxene Group) $LiAlSi_2O_6$	Monoclinic	usually in crude two-faced crystals with a wedge-shaped cross section, third face of triangle not developed, also as prismatic flattened crystals, terminations rare	3.03 to 3.23	Crystals often very large, to 1 meter or more, crystals faces usually have a wood-grain look to them, gem quality material often with acid-etched crystal faces, heavily vertically striated.
perfect in two directions (prismatic), often not apparent	6 to 7	Dark-green to Medium-Green to (more rarely) Pale-green, White to Grey or Bluish-grey, Lavender to Violet	vitreous to sub-vitreous, may be dull in granular material	JADEITE (Pyroxene Group) $Na(Al,Fe)Si_2O_6$	Monoclinic	usually in compact massive material, granular or short fibrous, with cleavage not apparent	3.24 to 3.43	massive material often a mix of jadeite and diopside, crystals extremely rare. [See also the softer Pyroxene Group minerals, IID, two cleavage directions, The hardness of many of them spans the 5 to 6 range, so they may key out to this point.]
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in one direction, good in the second (prismatic)	6 to 6½	White to colorless, Cream to Tan and Pale-yellow, Salmon-pink to Red, Green to Blue-green	vitreous to sub-vitreous, may exhibit opalescence ("adularia")	MICROCLINE (Feldspar Group) $KAlSi_3O_8$	Triclinic	usually as coarsely crystalline rock-forming masses or macro-crystals in the 1 meter to 10s of meters range, smaller crystals usually short-prismatic to blocky, often twinned	2.54 to 2.57	Microcline and orthoclase can be difficult to tell apart, particularly when they occur together in granites and pegmatites. The best bet in such cases is locality specific information.
Perfect in one direction, imperfect in the second (prismatic)	6 to 6½	White to colorless, Cream to Tan to Pale-yellow, Pink to Brownish-red	vitreous to sub-vitreous, may be dull in granular masses, may exhibit pale blue to white opalescence ("moonstone")	ORTHOCLASE (Feldspar Group) $KalSi_3O_8$	Monoclinic	usually massive, coarsely crystalline to granular, crystals usually short prismatic, blocky, often twinned	2.55 to 2.63	Microcline and orthoclase can be difficult to tell apart, particularly when they occur together in granites and pegmatites. The best bet in such cases is locality specific information.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

Perfect in one direction, good in the second (prismatic)	6 to 6½	White to Light-grey and Colorless, in albite, may be tinged blue or green, darkening to Dark-grey to Black in anorthite, intermediate members medium to darker greys (rarer than end members)	vitreous, labradorite exhibits opalescence/ "labradorescence"	ALBITE – ANORTHITE (Plagioclase Series) $NaAlSi_3O_8$ – $CaAl_2Si_2O_8$	Triclinic	usually massive, coarsely crystalline, platy lamellar habit in albite ("cleavlandite"), more randomly oriented and smaller grains in anorthite end of the series, including labradorite, crystals usually tabular and usually twinned in albite, usually short-prismatic and twinned in anorthite, crystals rare in intermediate members	2.60 to 2.65 (albite) 2.63 to 2.66 (oligoclase) 2.66 to 2.68 (andesine) 2.68 to 2.74 (labradorite) 2.72 to 2.75 (bytownite) 2.74 to 2.76 (anorthite)	S.G. increases with replacement of Na by Ca and addition of Al, members to the albite end of the series most easily distinguished from other feldspars by fine, closely-spaced striations on the {001} cleavage plane, members towards the anorthite end of the series by their dark color and randomly oriented grains in massive materials. Intermediate members usually difficult to distinguish from one another.
Perfect in one direction (prismatic), good in the other (pinacoidal)	5½ to 6½	Pink to Rose-red to Brownish-red, may also be Orangish-red in some weathered material	vitreous to sub-vitreous, may be dull in massive material	RHODONITE (Mn,Fe,Mg,Ca) SiO_3	Triclinic	usually massive, coarse to fine granular, crystals tabular to equant, rare	3.55 to 3.76	often coated and/or veined with black Mn-oxides due to chemical weathering ("spider-web" veining).
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Perfect in one direction (prismatic), imperfect in the other (pinacoidal)	5½ to 6	vitreous to splendant	Black to dark Greenish-black	BABINGTONITE (Rhodonite Group) $Ca_2(Fe,Mn)FeSi_5O_{14}(OH)$	Triclinic	usually as equant to short-prismatic crystals	3.34 to 3.48	may give a greenish to brownish-grey streak; usually associated with zeolites in basalts ("traprock") more rarely in granitic rocks. Rare.
Perfect in one direction, imperfect in the second direction (both prismatic)	5 to 5½	Yellowish-brown to Greenish-brown	vitreous to sub-vitreous, may be somewhat resinous or oily.	TITANITE ("SPHENE") $CaTiSiO_5$	Monoclinic	usually in crude blocky to stout prismatic crystals, wedge-shaped	3.48 to 3.60	streak white to pale brown;
Perfect in two directions (prismatic and pinacoidal)	6½	Pale Yellowish-grey to Yellowish-green, Colorless, Pale-rose to Red	vitreous to sub-vitreous	CLINOZOISITE (Epidote Group) $Ca_2Al_3(SiO_4)_3(OH)$	Monoclinic	usually as massive, granular to fibrous, crystals prismatic, often striated	3.21 to 3.38	distinguished from other common Epidote group minerals by its second perfect cleavage.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

perfect in one direction (prismatic), imperfect in another (pinacoidal), distinct in a third (prismatic), and may have a fourth, good, direction (prismatic)	5½ to 6	White to Milky- or Cream-white, Grey, Yellowish to Tan or Beige, Salmon-pink, may also be Greenish or Bluish, Colorless	vitreous to greasy	AMBLYGONITE-MONTEBRASITE $LiAl(PO_4)F$ – $LiAl(PO_4)(OH)$	Triclinic	usually as crude equant to short-prismatic crystals, may be extremely large (meter scale), and as massive crystalline, coarse to fine granular	3.11	It is impossible to tell the two end members apart without subtle optical tests. Locality info may not help; eg. "amblygonite" specimens from Maine pegmatites have been shown to actually be montebrasite. It is probably best to label specimens as shown under Name unless there is proof positive of which end member you have

Note: Two cleavage directions at ~56º and ~124º = Amphibole Group. A number of the Amphiboles have hardnesses in the 5 to 6 range, spanning previous sections and this one, and may key out to this point. See IID-1.

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Table IIIA-2: Nonmetallic Luster; Hardness Greater Than 5½ and Less Than 7; Cleavage not prominent. *(Can not be scratched by a knife blade, but can be scratched by quartz)*

Hardness	Color	Luster	Name	System	Habit	SG	Notes
5 to 5½	Colorless to White, usually tinted Pale-green, may be Pale-blue	vitreous to greasy	DATOLITE (Gadolinite Group) $Ca_2B_2Si_2O_8(OH)_2$	Monoclinic	may be either platy to short-prismatic or blocky crystals, more rarely as spherical aggregates or massive, granular to compact	2.9 to 3.0	white streak, may show an imperfect basal cleavage, may fluoresce.
5 to 6	White, Yellow, Red, Brown, Black	glassy	OPAL $SiO_2{\cdot}nH_2O$	amorphous	massive, as fracture fillings, coatings, "nodules," etc.	1.9 to 2.1	distinguished from massive quartz by lower hardness and S.G.; Precious opal has an intense play of colors – flashes of minute fracture surfaces beneath the surface; in fire opal the flashes are predominantly reds, yellows and oranges against a black background. Common opal is "opalescent," but without the intense flashes of color.
5 to 5½	Azure-blue to Sky-blue, more rarely Bluish-white to Bluish-green	vitreous to sub-vitreous	LAZULITE-SCORZALITE $MgAl_2(PO_4)_2(OH)_2$ – $FeAl_2(PO_4)_2(OH)_2$	Monoclinic	usually as finely crystalline crusts or granular, crystals rare and usually millimeter size, acutely pyramidal, tabular	3.08 to 3.38 (increases with Fe content)	white streak; Rare.

5 to 6	Sky-blue to Bluish-green to Apple-green, Green-grey	vitreous to sub-vitreous	TURQUOISE $CuAl_6(PO_4)_4(OH)_8{\cdot}4H_2O$	Triclinic	usually massive in crusts and fracture fillings, dense to finely crystalline, crystals rare, short-prismatic	2.6 to 2.8	white to pale-green streak, may exhibit a perfect cleavage (pinacoidal), but rarely seen.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
5 to 6	White to Grey, Yellowish, Brownish, Orange, Purple		MARIALITE-MEIONITE (Scapolite series) $3NaAlSi_3O_8.NaCl – 3CaAl_2Si_2O_8.CaCO_3$	Tetragonal	usually massive, either columnar or fibrous (columnar masses may exhibit prismatic cleavage surfaces), also as short to medium prismatic crystals with bipyramidal terminations, usually somewhat crude	2.55 to 2.72	may fluoresce yellow. It is almost impossible to tell the end members apart without subtle chemical or optical tests. An intermediate member, wernerite, is probably the most common chemical form found – though it is not recognized as a species. It is probably best to label samples of these materials simply as scapolite, unless specific locality information dictates otherwise.
5½	Light-green to Yellow-green, Yellow-brown to Reddish-brown, Colorless	vitreous, to resinous	WILLEMITE (Phenakite Group) Zn_2SiO_4	Trigonal	usually massively crystalline or granular, rarely in prismatic hexagonal crystals	4.05 to 4.20	fluoresces bright green
5½ to 6	Greyish-white to White, Colorless	vitreous to sub-vitreous, may be dull	LEUCITE $K(AlSi_2O_6)$	Tetragonal and Isometric	usually massive, granular, disseminated grains, crystals equant or blocky (soccer ball shaped), often multiply twinned	2.45 to 2.50	restricted to mafic and ultramafic volcanic and hypabyssal rocks.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
5½ to 6	White, often tinted yellowish or greenish, Grey, Reddish-brown	vitreous to greasy	NEPHELINE $(Na,K)AlSiO_4$	Hexagonal	usually as crystalline grains or massively crystalline, crystals rare, hexagonal prisms with pinacoidal or pyramidal terminations	2.55 to 2.67	may exhibit a distinct prismatic cleavage in massively crystalline material, but rarely seen.
5½ to 6	Black to Light-brown	resinous or pitchy, may appear sub-metallic	ALLANITE-(Ce) (Epidote Group) $(Ce,Ca,Y)_2(Al,Fe)_3(SiO_4)_3(OH)$	Monoclinic	usually massive, may be platy, metamict, crystals extremely rare or unknown?	3.4 to 4.2	may give a light-brown streak, Allanite-(La) and allanite-(Y) are closely related species, but very rare.
5½ to 6½	Colorless to White or Greyish-white, Pale-tan	vitreous	EUCRYPTITE (Phenakite Group) $LiAlSiO_4$	Trigonal	usually coarsely crystalline, granular or compact, crystals equant	2.66	soluble in acid producing silica gel, fluoresces bright pink to red.
5 to 6½	Green or Chartreuse, Yellow to Yellow-green to Yellow-Brown to Brown, Pink to Red, Black, White, Purple, Blue	vitreous to sub-vitreous	VESUVIANITE ("Idocrase") $Ca_{10}Mg_2Al_4(SiO_4)_5(Si_2O_7)_2(OH)_4$	Tetragonal	usually as stout prismatic crystals	3.32 to 3.43	usually restricted to skarns, rodingites, and certain alkali syenites, and calc-silicate rocks.

6 to 6½	Pale-yellow, Brownish-red to Reddish- or Greenish-brown, Pale-orange	vitreous to greasy	CHONDRODITE (Humite Group) $(Mg,Fe)_5(SiO_4)_2(F,OH)_2$	Monoclinic	usually in equant crystalline grains, crystals equant, blocky	3.1 to 3.23	soluble in acids producing silica gel, may fluoresce yellowish-white to yellow.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
6 to 6½	Yellow to Dark-orange, Reddish-orange	vitreous to sub-vitreous	HUMITE $(Mg,Fe)_7(SiO_4)_3(F,OH)_2$	Orthorhombic	usually in equant crystalline grains, crystals extremely rare, also equant, blocky	3.20 to 3.32	soluble in acids producing silica gel. Relatively rare.
6 to 6½	Pale- to Medium-green, Pale-yellow, Tan to Pinkish-tan, Grey to White	vitreous to sub-vitreous, may be somewhat pearly on freshly broken exposures	PREHNITE $Ca_2Al_2Si_3O_{10}(OH)_2$	Orthorhombic	usually botryoidal to mammillary aggregates encrusting matrix, also stalactic and as radiating "bowtie" or "hourglass" aggregates, crystals extremely rare, short-prismatic to tabular	2.90 to 2.95	Slowly soluble in HCl producing silica gel. Often associated with Zeolites in traprock.
6 to 6½	Dark Reddish-brown to Black	usually sub-adamantine to adamantine, but may also be metallic	RUTILE TiO_2	Tetragonal	usually as prismatic to acicular crystals, often reticulated, may be vertically striated	4.18 to 5.25	Often as an inclusion in quartz
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
6½	Black	metallic to submetallic	PYROLUSITE (Rutile Group) MnO_2	Tetragonal	usually in earthy masses with a much lower hardness (2), but actual crystals are 6½, rare, short-prismatic to equant, usually in druzes of small crystals	5	may exhibit one perfect cleavage, prismatic
6 to 7	Black to Dark-brown, may also be Yellowish-grey, more rarely Red, White or Colorless	adamantine to metallic in crystals, greasy on fracture surfaces, may be earthy or submetallic in botryoids, concretions, and massive forms	CASSITERITE (Rutile Group) SnO_2	Tetragonal	usually massive as botryoidal crusts or concretions ("wood tin"), crystals usually short prismatic and complexly twinned producing unusual shapes ("knees," stubby five-pointed "stars," etc.)	6.8 to 7.1	
6½ to 7	Grey to Bluish-grey, Brown to Honey-brown or Yellow to Golden-brown, more rarely Green or Violet	vitreous to sub-vitreous	FERRO-AXINITE – MANGANAXINITE $Ca_2FeAl_2BSi_4O_{15}(OH)$ – $Ca_2MnAl_2BSi_4O_{15}(OH)$	Triclinic	usually as thin wedge-shaped "axhead" crystals, often arranged in rosettes	3.23 to 3.32 (ferro-), 3.30 to 3.36 (mangan-)	End members difficult to distinguish, though low end and high end S.G. may do the trick. Magnesio-axinite and tinzenite are two rare related species.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

6½ to 7	Pale-yellow to Olive-green to Olive-brown, Black	vitreous to sub-vitreous (forsterite) or submetallic to dull (fayalite)	FAYALITE – FORSTERITE (Olivine Group) $Fe_2(SiO_4)$ – $Mg_2(SiO_4)$	Orthorhombic	usually as crystalline massive or granular, crystals short-prismatic	4.39 (fayalite) to 3.24 (forsterite)	End members distinguished by S.G. and luster. "Peridot" is the name for gem material in the fayalite-forsterite series, usually forsterite. Names for intermediate members of the series, such as "chrysolite" and "hortonolite" are based on chemical composition and should not be used unless the composition is known.

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Table IIIB-1: Nonmetallic Luster; Hardness 7 to 10; Has a Prominent Cleavage. *(Can not be scratched by quartz.)*

Cleavage	Hardness	Color	Luster	Name	System	Habit	SG	Notes
One cleavage direction: perfect (prismatic)	6 to 7	Grey, Green to Yellowish-green, Pinkish, Brown, Blue, Purple, Colorless	vitreous, may be pearly on cleavage surfaces	ZOISITE (Epidote Group) $Ca_2Al_3(SiO_4)_3(OH)$	Orthorhombic	usually in aggregates of crude parallel crystals with vertical striations on the faces, more rarely as well-formed prismatic crystals in clusters or singly	3.15 to 3.36	The blue gem variety "tanzanite" and pink gem variety "thulite" are rare.
One cleavage direction: perfect (prismatic)	6½ to 7	Green to Yellow-green, Yellow, Grey, Brownish-green, Greenish-black, Black	vitreous to sub-vitreous, dull in weathered crystals and massive materials	EPIDOTE $Ca_2(Fe,Al)_3(SiO_4)_3(OH)$	Monoclinic	usually in short to long prismatic crystals, may also be thick tabular or acicular (over 200 different forms are known), massive, coarse to fine granular, rarely fibrous	3.38-3.49	Commonest of the Epidote Group species. Most of the Epidote group minerals may exhibit a second, poor, cleavage, but it is usually not seen.
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
One cleavage direction: perfect (prismatic)	6½ to 7	Colorless to White, Grey, Pale-brown to Pale-yellow, more rarely Pale-blue to Pale-green	vitreous to subvitreous, silky in fibrous material, may be dull on weathered surfaces	SILLIMANITE Al_2SiO_5	Orthorhombic	usually as crude prismatic crystals with a nearly square cross-section,surfaces often rough and altering to muscovite, may be in columnar to fibrous aggregates ("fibrolite")	3.23 to 3.27	restricted to high-temperature and pressure metamorphic environments.
One cleavage direction: perfect (prismatic)	6½ to 7	White to Greyish-white, Colorless, Pinkish-white to Pale-lavender, more rarely Greenish to Yellowish, Brown, Rose-red to Dark-red	vitreous to sub-adamantine, "brilliant"	DIASPORE AlO(OH)	Orthorhombic	usually in thin platy crystalline aggregates, crystals thin, platy, may be prismatic or acicular, rarely tabular	3.35 to 3.45	very brittle. Often mistaken for milky to greyish quartz.
One cleavage direction: perfect (pinacoidal, basal)	8	Colorless to Milky-white, Yellowish, to Brownish, Pinkish, Bluish, Greenish	vitreous, may be somewhat greasy on fracture surfaces	TOPAZ $Al_2SiO_4(F,OH)_2$	Orthorhombic	usually as stout prismatic to equant crystals, with or without pyramidal terminations	3.4 to 3.6	largely restricted to granites, granite-pegmatites, and rhyolites.

Cleavage	Hardness	Color	Luster	Name	System	Habit	SG	Notes
Two cleavage directions: perfect in both directions (prismatic)	6 to 7	Dark-green to Medium-Green to (more rarely) Pale-green, White to Grey or Bluish-grey, Lavender to Violet	luster vitreous to sub-vitreous, may be dull in granular material	JADEITE (Pyroxene Group) $Na(Al,Fe)Si_2O_6$	Monoclinic	usually in compact massive material, granular or short fibrous, with cleavage not apparent	3.24 to 3.43	massive material often a mix of jadeite and diopside, crystals extremely rare.
Two cleavage directions: perfect in both directions (prismatic)	6½ to 7	Grey to White, Colorless, Tan, Yellow, Pale-green to Bright-green ("hiddenite"), Pink to Lilac to Violet ("kunzite")	vitreous to sub-vitreous	SPODUMENE (Pyroxene Group) $LiAlSi_2O_6$	Monoclinic	usually in crude two-faced crystals with a wedge-shaped cross section, third face of triangle not developed, also as prismatic flattened crystals, terminations rare	3.03 to 3.23	crystals often very large, to 1 meter or more, crystals faces usually have a wood-grain look to them, gem quality material often with acid-etched crystal faces, heavily vertically striated.
Two cleavage directions: one perfect (basal) and one good (prismatic)	6½ to 7	Colorless to White, more rarely Pale-yellow, Pale-ping or Pale-brown	vitreous	BERTRANDITE $Be_4Si_2O_7(OH)_2$	Orthorhombic	usually as tiny to micro tabular crystals, also granular aggregates	2.57 to 2.63	usually associated with beryl in pegmatites. Cleavage often not seen
Cleavage	**Hardness**	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
Three parting directions: fair rhombohedral and basal (looks like cleavage on a small scale)	9	Dark-grey to Light-grey to Blue-grey to Blue (sapphire), Red (ruby), and Yellow, Brown and Green in sapphire	vitreous to sub-vitreous and dull	CORUNDUM Al_2O_3	Trigonal	usually massive, granular (emery) and as barrel-shaped prismatic hexagonal crystals	4.0	extremely hard – can only be scratched by silicon carbide and diamond.
Four cleavage directions: perfect in four directions (pyramidal)	10	Colorless to Yellow, Brown or Grey, may be Pink, Red, Blue, Green, and Black due to inclusions	adamantine	DIAMOND C	Isometric	typically in octahedral crystals, usually appearing somewhat rounded on the edges, also as dodecahedral, tetrahedral, and cubic crystals, also often appearing somewhat rounded	3.50 to 3.53	extremely hard – no other mineral or material will scratch it. Limited to blue-earth pipes and alluvial deposits eroded out of those pipes.

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Table IIIB-2: Nonmetallic Luster; Hardness 7 to 10; Cleavage not prominent.. *(Can not be scratched by quartz.)*

Hardness	Color	Luster	Name	System	Habit	SG	Notes
6 to 7	Black to Dark-brown, may also be Yellowish-grey, more rarely Red, White or Colorless	adamantine to metallic in crystals, greasy on fracture surfaces, may be earthy or submetallic in botryoids, concretions, and massive forms	CASSITERITE (Rutile Group) SnO_2	Tetragonal	usually massive as botryoidal crusts or concretions ("wood tin"), crystals usually short prismatic and complexly twinned producing unusual shapes ("knees," stubby five-pointed "stars," etc.)	6.8 to 7.1	

6½ to 7	Grey to Bluish-grey, Brown to Honey-brown or Yellow to Golden-brown, more rarely Green or Violet	vitreous to sub-vitreous	FERRO-AXINITE – MANGANAXINITE $Ca_2FeAl_2BSi_4O_{15}(OH)$ – $Ca_2MnAl_2BSi_4O_{15}(OH)$	Triclinic	usually as thin wedge-shaped "axhead" crystals, often arranged in rosettes	3.23 to 3.32 (ferro-), 3.30 to 3.36 (mangan-)	End members difficult to distinguish, though low end and high end S.G. may do the trick. Magnesio-axinite and tinzenite are two rare related species.
6½ to 7	Pale-yellow to Olive-green to Olive-brown, Black	vitreous to sub-vitreous (forsterite) or submetallic to dull (fayalite	FAYALITE – FORSTERITE (Olivine Group) $Fe_2(SiO_4)$ – $Mg_2(SiO_4)$	Orthorhombic	usually as crystalline massive or granular, crystals short-prismatic	4.39 (fayalite) to 3.24 (forsterite)	End members distinguished by S.G. and luster. "Peridot" is the name for gem material in the fayalite-forsterite series, usually forsterite. Names for intermediate members of the series, such as "chrysolite" and "hortonolite" are based on chemical composition and should not be used unless the composition is known.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
6½ to 7	Color: Colorless to White, more rarely Pale-yellow, Pale-pink or Pale-brown	vitreous	BERTRANDITE $Be_4Si_2O_7(OH)_2$	Orthorhombic	usually as tiny to micro tabular crystals, also granular aggregates	2.57 to 2.63	usually associated with beryl in pegmatites. May exhibit basal and prismatic cleavages.
7	Colorless, Milky, Smoky-grey to Black, Amethyst, Rose, Yellow to Brownish-yellow, may be tinted other shades by inclusions	vitreous	QUARTZ (Crystalline) SiO_2	Trigonal	usually in pyramidaly terminated prismatic hexagonal crystals or glassy massive, "rock crystal," "smoky" and "amethyst" varieties may be very large, "citrine" usually small to medium in size, "rose" usually rather small to micro-scale	2.65	Abundant! in milky and massive forms. Common in rock crystal, smoky and amethyst forms, citrine rare, rose crystals very rare. (See also immediately below for crypto- and non-crystalline forms.)
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
7	Colorless, Milky, Grey to Black, Red, Yellow to Brownish-yellow, Brown, Green, Blue, may be tinted other shades by inclusions	vitreous to waxy to dull	QUARTZ (Crypto- and Non-crystalline) SiO_2	Trigonal	"Chalcedony" as cryptocrystalline fibrous amorphous to sub-botryoidal masses, un-banded or un-patterned, with a waxy luster ("carnelian" is red, "chrysoprase" is green due to nickel, "heliotrope" or "bloodstone" is green with small red jasper flecks in it, "sard" is brown); "chalcedony, sub-variety agate" in circular, concentrically banded to intricately patterned masses with considerable color variation in single samples, waxy to vitreous luster; "chalcedony sub-variety onyx" has parallel layers instead of concentric ones	2.65	In massive, non- crystalline forms: "Jasper" red or blue, rarely yellow, dull luster; "flint" dark grey to black, dull to subvitreous luster; "chert" medium to light grey, dull to sub-vitreous luster; "aventurine" green due to inclusions, vitreous luster.

					("sardonyx" has alternating white and black layers).		
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
7	Colorless, Milky-white, Pale-grey, Yellowish, and Brownish	vitreous	CRISTOBALITE SiO_2	Tetragonal (pseudo Isometric)	usually as micro-spherical aggregates, may be botryoidal or stalactic, crystals very rare, usually micro-octahedra	2.2 to 2.33	largely restricted to siliceous volcanic rocks. Cristobalite is only partially stable at typical terrestrial temperatures, inverting to quartz. Most finds are actually quartz pseudomorphs of the original crystals
7	Colorless, Milky-white	vitreous	TRIDYMITE SiO_2	Orthorhombic & Hexagonal	usually as thin to thick tabular or twinned pseudo-hexagonal crystals	2.26 to 2.33	largely restricted to felsic volcanic rocks; Tridymite is only partially stable at typical terrestrial temperatures, inverting to quartz. Most finds are actually quartz pseudomorphs of the original crystals
7 to 7½	Black to Bluish-black or Brownish-black or Greenish-black	vitreous to sub-vitreous, may appear somewhat oily on fracture surfaces	SCHORL – UVITE (Tourmaline Group) $NaFe_3Al_6 (BO_3)_3(Si_6O_{18})(OH)_4$ – $(Ca,Na)(Mg,Fe)_3Al_5Mg(BO_3)_3(Si_6O_{18})(OH,F)_4$	Trigonal	schorl usually in stout long-prismatic hexagonal crystals with a nearly triangular cross-section, uvite usually in stubby short-prismatic crystals, sometimes appearing almost pyramidal or dipyramidal, but may take identical habits, both may also be massively crystalline or granular.	3.13 (schorl) 2.96 to 3.06 (uvite)	These two end members are best distinguished by their S. G.s. Foitite, feruvite, and povondrite are three rare to very rare black Tourmaline Group members.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
7 to 7½	Black to Brownish-black or Brown	vitreous to sub-vitreous, may appear oily on fracture surfaces	DRAVITE (Tourmaline Group) $NaMg_3Al_6(BO_3)_3(Si_6O_{18})(OH)_4$	Trigonal	usually as stout prismatic hexagonal crystals, often with a pyramidal termination at one end and a pedial termination at the other	2.9 to 3.3	largely restricted to marbles, schists and slates. Best distinguished from schorl and uvite by environment when black. Buergerite is a rare bronze-brown Tourmaline Group member.
7 to 7½	Dark Emerald-green to Greenish-black to Black	vitreous, may appear oily on fracture surfaces	CHROMEDRAVITE (Tourmaline Group) $NaMg_3(Cr,Fe)_6 (BO_3)_3 (Si_6O_{18})(OH)_4$	Trigonal	usually as small to tiny nearly equant short-prismatic crystals and grains	3.39 to 3.40	usually distinguished by its deep emerald green color – largely restricted to chromium bearing micaceous metasomatites. Very rare. Distinguished from dark greenish-black schorl or uvite by its higher S.G

7 to 7½	Light- to Medium-green, Pink to Red, Light- to Medium-blue to Dark-Blue, more rarely Light-brown to Yellow, Colorless	vitreous to oily	ELBAITE (Tourmaline Group) $Na(Li,Al)_3Al_6 (BO_3)_3(Si_6O_{18})(OH)_4$	Trigonal	usually in slender prismatic hexagonal crystals with a nearly triangular cross-section, often appearing somewhat rounded, terminations may be pyramidal or pedial, or both at different ends of the crystal	3.05 to 3.10	distinguished from most other Tourmaline Group species by its lighter colors – also, largely restricted to granite-pegmatites. Dark-blue elbaite is almost impossible to distinguish from dark blue schorl, and both can occur together. Olenite, pale pink, and liddicoatite, light-pink or light-green, are two rare to very rare colored Tourmaline Group species.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
7 to7½	Deep-green to "Rusty"-green	vitreous	UVAROVITE (Garnet Group) $Ca_3Cr_2(SiO_4)_3$	Isometric	usually as small to tiny dodecahedral crystals	3.40 to 3.83	largely restricted to chrome-bearing deposits, particularly serpentinite ultramafics containing chromite. Rare. Goldmanite and knorringite are very rare dark-green and blue-green Garnet Group species, but are found in different mineral environments than uvarovite.
7 to7½	Pink to Red, Brownish-orange to Orange, Cinnamon, Yellow to Yellow-green, Pale-green to Grass-green to Emerald-green, Colorless	vitreous	GROSSULAR (Garnet Group) $Ca_3Al_2(SiO_4)_3$	Isometric	usually as small dodecahedral crystals	3.42 to 3.80	largely found in contact and regionally metamorphosed impure calcareous rocks, and in serpentinite and rodingite ultramafic rocks. Hibschite and katoite are very rare Garnet Group species that can be similar greens or milky to colorless, but they are found in different mineral environments than grossular.
7 to7½	Brown, Brownish-red to Brownish-yellow, Yellow to Yellow-green, Greyish-green to Medium- or Deep-green, Black	vitreous	ANDRADITE (Garnet Group) $Ca_3Fe_2(SiO_4)_3$	Isometric	usually as small to medium sized dodecahedral crystals	3.45	usually from Ca and Fe rich contact metamorphic rocks and skarns, also from alkaline and ultrabasic igneous rocks. Calderite is a very rare Garnet Group species with color similar to andradite, but it is found in a different mineral environment.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

7 to 7½	Black to Brownish-black	vitreous	SCHORLOMITE (Garnet Group) $Ca_3Ti_2(Fe_2Si)O_{12}$	Isometric	usually as small dodecahedral crystals	3.77 to 3.93	largely restricted to alkaline igneous rocks. Morimotoite and kimzeyite are very rare Garnet Group species that may be the same color as schorlomite, but they are found in different environments
7 to 7½	Dark-red to Violet Red or deep Rose-Red, also Reddish-orange	vitreous	PYROPE (Garnet Group) $Mg_3Al_2(SiO_4)_3$	Isometric	usually as small to tiny dodecahedral crystals	3.65 to 3.82	usually found in high temperature and high pressure metamorphic rocks, ultrabasic igneous rocks, and kimberlites and peridotites. Uncommon. Majorite is a very rare Garnet Group species that can be purplish-violet, but is found in a different environment than pyrope.
7 to 7½	Brown to Brownish-red to Red, Violet-red or Orangish-red	vitreous	ALMANDINE (Garnet Group) $Fe_3Al_2(SiO_4)_3$	Isometric	usually as dodecahedral crystals	3.85 to 4.20	occurs in a number of metamorphic and igneous environments – most common of the Garnet Group species.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
7 to 7½	Orangish-red to Reddish-orange, Rose-red to Ruby-red or Hyacinth-red, Reddish-brown, Pale-yellow	vitreous	SPESSARTINE (Garnet Group) $Mn_3Al_2(SiO_4)_3$	Isometric	usually as medium to tiny dodecahedral crystals	3.90 to 4.20	occurs in metamorphic and igneous rocks rich in Mn.
7 to 7½	Medium- to Dark-brown, Reddish-brown	vitreous to sub-vitreous, may also be dull	STAUROLITE $(Fe,Mg,Zn)_2Al_9(Si,Al)_4O_{22}(OH)_2$	Monoclinic pseudo. Orthorhombic	usually as either short- to long-prismatic crystals, frequently twinned ("fairy crosses"), with twining at either 90º or 60º	3.74 to 3.83	usually in intermediate grade pelitic metamorphic rocks
7 to 7½	Greyish-blue to Blue, Grey, Greenish-blue, Violet	vitreous to oily	CORDIERITE (Beryl Group?) $(Mg,Fe)_2Al_3[AlSi_5O_{18}] \cdot H2O$	Orthorhombic	usually granular or massively crystalline aggregates, crystals short-prismatic	2.53 to 2.65	largely restricted to contact metamorphic rocks and high-grade regional metamorphic rocks.
7½	Reddish-brown to Pale-Pink to Deep-pink/Flesh-colored, White to Grey to Bluish-grey to Blue, Olive-green, Green, Violet, Yellow	vitreous to sub-vitreous, may be dull	ANDALUSITE Al_2SiO_5	Orthorhombic	usually as prismatic crystals with a nearly square cross-section, may be tapered in both directions from the center and exhibit a cross-like pattern on the cross section due to carbonaceous inclusions ("chiastolite")	3.13 to 3.21	largely a mineral of low to intermediate grade metamorphic rocks, but also known from granites and granite-pegmatites
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**

7½	Brown, White, Yellow, Orange, Green, Blue	adamantine, oily on fracture surfaces	ZIRCON $ZrSiO_4$	Tetragonal	usually as small tetragonal prisms with pyramidal terminations, may also be bipyramidal without the prism	4.6 to 4.71	fluoresces orange-yellow, yellow and orange. This mineral may also be metamict (structurally disrupted by radiation) and then exhibits a lower H. (6 to 7) and S.G 3.9 to 4.6 range.
7½ to 8	Pale-blue to Pale-green (gem: "aquamarine") Yellow to Golden-yellow (gem: "heliodore"), Pink to light-red (gem: "morganite"), White to Tan, Emerald-green (gem: "emerald") Colorless	vitreous	BERYL $Be_3Al_2Si_6O_{18}$	Hexagonal	usually as stout prismatic hexagonal crystals, also granular in matrix	2.63 to 2.78	most often found in granite-pegmatites and rhyolites, but known from other environments as well.
Hardness	**Color**	**Luster**	**Name**	**System**	**Habit**	**SG**	**Notes**
7½ to 8	White to colorless	vitreous	PHENAKITE Be_2SiO_4	Trigonal	usually massive, granular, and as modified flattened rhombs, more rarely as prismatic crystals	2.97 to 3.0	usually found with beryl.
7½ to 8	Dark-green to Greenish-black, more rarely Dark-yellow to Pale-Yellow	vitreous to sub-vitreous, may be dull	GAHNITE (Spinel Group) $ZnAl_2O_4$	Isometric	usually massive, granular, also as octahedral crystals, may be rounded or sharp	4.57	usually in high-temperature ore deposits in crystalline schists or in pegmatites.
7½ to 8	Red, Black, Brown, Blue, Green	vitreous to sub-vitreous	SPINEL $MgAl_2O_4$	Isometric	usually massive, granular, and as octahedral crystals,often twinned	3.56	distinguished from gahnite by it's lower specific gravity
8½	Yellow to Emerald-green	vitreous	CHRYSOBERYL $BeAl_2O_4$	Orthorhombic	usually as tabular or prismatic crystals, often twinned in heart or fish-tail shapes, may also be cyclically twinned in pseudo-hexagonal crystals	3.75	may appear red or brownish-pink in incandescent light ("alexandrite").
9	Dark-grey to Light-grey to Blue-grey to Blue (sapphire), Red (ruby), and Yellow, Brown and Green in sapphire	vitreous to sub-vitreous and dull	CORUNDUM Al_2O_3	Trigonal	usually massive, granular (emery) and as barrel-shaped prismatic hexagonal crystals	4.0	extremely hard – can only be scratched by silicon carbide and diamond.

Notes:
The **Tourmaline Group** species can be difficult to tell apart without specific locality data. The overlap of color and habit can make crystals without matrix very difficult to distinguish without lab tests.

Most of the **Garnet Group** species can be very difficult to tell apart. Color alone is rarely – if ever – diagnostic; and S.G.s overlap too much to make them useful alone or with color. Mineral environment information is usually needed in conjunction with S.G. and color to even begin to guess the species. The best bet is specific knowledge of what is found at any given locality – or lab tests in the absence of that. (Far too many "visual identifications" prove to be wrong…)

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Bob Keller