Minerals They are natural non-manmade inorganic never living where atoms are arranged in an orderly pattern with a definite chemical composition like **SiO_2** or **Quartz**, and they are solid non-gas materials

Minerals are naturally occurring, inorganic solids with a definite chemical composition and crystalline structure. This means that minerals are made up of atoms that are arranged in a repeating pattern, giving them their characteristic geometric shapes and properties. There are over 5,000 known minerals, each with its own unique chemical formula and crystal structure.

Crystals are solids with a regular, repeating arrangement of atoms, molecules, or ions. This arrangement can be found in both minerals and non-minerals, such as synthetic crystals and organic crystals like sugar. However, not all crystals are minerals. For example, crystals of sugar or sodium chloride (table salt) are not considered minerals because they are not naturally occurring.

In summary, all minerals are crystals, but not all crystals are minerals.

Here is a table summarizing the key differences between minerals and crystals:

Feature	Minerals	Crystals
Origin	Naturally occurring	Can be natural or synthetic
Composition	Inorganic	Inorganic or organic
Crystal structure	Definite	Regular, repeating arrangement of atoms, molecules, or ions
Chemical formula	Specific	Can vary
Examples	Quartz, calcite, pyrite	Sugar, sodium chloride, ice

Their physical properties are

- **Color**, the first impressions on color gave not have very reliable results because a lot of them gave multiple color for the same element, a **Streak** is the true color of a mineral (aka the mineral powder), but that system doesn't work with materials with hardness greater than 7, because they are harder than the **porcelain plate**, it's used to dust the minerals into a powder so we can view them, but that won't work on hard materials

- **Hardness** is a material's resistance to being scratched and the Mohs Hardness scale determines that on a range from 1-10, and hardness depends on how atoms are squeezed together

FACTORS OF MINERALS

- **Crystal shape**

  when materials grow freely, they get a usual crystal shape, for example, **Quartz** grow as six-sided hexagonal columns with pointy tops, and **Garnets** grow as twelve-sided shapes, often called **dodecahedra**

- **Hardness**

  is the resistance of materials to scratching, mineralogists use a relative scale of hardness called **mohs scale**

  we test hardness by taking a material with a known hardness and scratching it to a material with unknown hardness, if the

known material scratches, then the unkown one is harder, and otherwise, some known hardness for materials

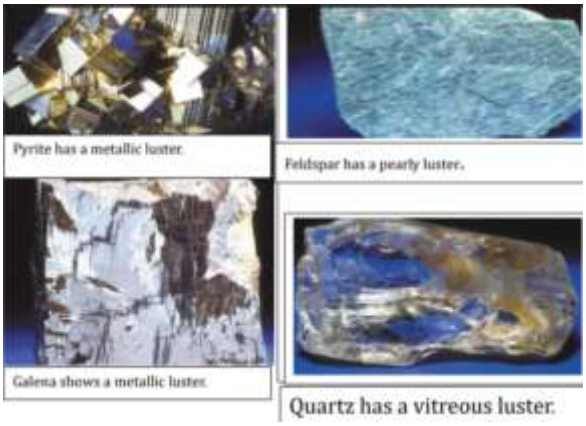
- ▪ **Finger nail 2.5**
- ▪ **Coin 3.5**
- ▪ **Iron nail 4.5**
- ▪ **knife blade a little more than 5**
- ▪ **window glass, masonry nail 5.5**
- ▪ **steel file 6.5**

- **Luster** describes the way the mineral reflects light

Metallic Luster: This type of luster makes a mineral look like polished metal. It's typically shiny and reflective, resembling the appearance of metals like iron or copper. Minerals like pyrite and galena exhibit metallic lusters.

Non-Metallic Lusters:

- **Vitreous:** Also known as glassy luster, it's similar to the appearance of broken glass. It's shiny and reflective like glass. Minerals like Quartz and Calcite exhibit a vitreous luster.
- **Greasy:** This luster appears somewhat like the surface of a finger smudged on glass. It's less shiny and more subdued compared to vitreous luster. Some examples include certain types of Quartz.
- **Pearly:** This luster looks like the inside of a pearl shell. It's a soft, iridescent sheen that's not as shiny as metallic or vitreous lusters. Feldspar showcases a pearly luster.
- **Adamantine:** This luster is exceptionally brilliant and reflective, almost like a diamond. As mentioned, diamonds exhibit an adamantine luster.
- **Earthy or Dull:** These lusters lack the brilliance and shine of the other types. They appear more muted, resembling the appearance of soil or unpolished surfaces.



- ## Streak

  Is the color of the powdered mineral and to determine it, youj scratch it across a piece of unglazed porcelain tile (streak plate) the color, each mineral might have different colors, for example,
  Hematite is **dark gray** but has a **red streak**
  Pyrite is **gold** but has a **black streak**

- ## Specific Gravity

  Is the ratio of the mineral's density to the water's density, water has aapseicf gravity of 1, and galena has a specif gravity of 7.5 that means its 7.5 times bigger, most non-metalic minerals have a specif gravity less than 3, including **quartz, feldspar, calcite**

- ## Cleavage

  It's the way minerals break along certain lines of weakness in their structure, this is due the arrangement of atoms producing a weak connection in parts of the mineral, we have multiple types

  1-**mica** splits into sheets because it's cleavage is in one plane
  2-**Feldspar** has cleavages into
  2-**Feldspar** has cleavages In two directions, because it's on two planes, they may not be perpendicular to each other but that results to it being blocky
  3-**Galena & halite** have cleavages in 3 dimensions and are all right angles, giving them a **cubic shape**

4-**Quartz** break into irregular shapes and it often shows a curved surface called **conchoidal fracture** because it has no cleavages

Color

It's the least reliable property about a mineral because they have different colors depending on the purity, for example

- **Corundum Al_2O_3** can be tinted red by small amounts of chromium making rubies in the process
- **Sapphire** is the same mineral but tinted blue by small amounts of titanium
- **Quartz** are usually transparent but can have many different colors

- some minerals change color when exposed to air
- many minerals share colors, like **gold & pyrite**
- **pyrite** is known as fool's gold because the metallic luster and golden color, but it's density is lower and brittle, and leaves a black streak on white porcelain tiles while gold leaves golden streaks

Magnetism

It’s represented by some minerals that are attracted to magnets, it happens because of the electron movement in their crystalline structure

Magnetite is the most common magnetic material

Chemical Composition

Minerals’ composition can be expressed as a formula of elemental symbols such as SiO_2 for quartz or $CaCO_3$, the atoms are arranged in a 3D array called a crystal structure, for example **Fe_2O_3 for hematite, Fe_3O_4 for magnetite**

Mineral	Formula	Hardness	Color	Streak	Cleavage	Luster	Other
Diamond	C	10	Colorless, white, yellow, orange, pink, blue, green, black	White	None	Adamantine	Transparent
Corundum	Al_2O_3	9	Red (ruby), blue (sapphire), green (emerald), yellow, pink, purple, orange	White	None	Adamantine	Transparent to translucent
Topaz	$Al_2SiO_4(F,OH)_2$	8	Yellow, orange, pink, blue, red	White	One perfect cleavage	Vitreous	Transparent to translucent
Tourmaline	Group of borate minerals	7-7.5	Black, brown, green, blue, red, pink, yellow	White	None	Vitreous	Transparent to translucent
Quartz	SiO_2	7	Colorless, white, pink, purple, yellow, green, blue, black	White	None	Vitreous	Fractures conchoidally
Potassium feldspar (Orthoclase)	$KAlSi_3O_8$	6-6.5	White, pink, orange, yellow	White	Two perfect cleavages at 90° to each other	Vitreous	Often twinned
Plagioclase feldspar	$NaAlSi_3O_8$ - $CaAl_2Si_2O_8$	6-6.5	White, gray, green, brown	White	Two perfect cleavages at 90° to each other	Vitreous	Often twinned
Pyrite	FeS_2	6-6.5	Brass yellow	Black	None	Metallic	Often mistaken for gold
Hematite	Fe_2O_3	6-6.5	Red, brown, black	Red	None	Metallic	Can be magnetic
Garnet	Group of silicate minerals	6.5-7.5	Red, orange, yellow, green, blue, purple, brown	White	None	Vitreous	Transparent to translucent
Olivine	$(Mg,Fe)_2SiO_4$	6.5-7	Green, yellow, brown	White	None	Vitreous	Transparent to translucent
Magnetite	Fe_3O_4	5.5-6.5	Black	Black	None	Metallic	Strongly magnetic

Apatite	$Ca_5(PO_4)_3(F,Cl,OH)$	5	Colorless, white, green, yellow, blue, red, brown	White	None	Vitreous	Transparent to translucent
Fluorite	CaF_2	4	White, green, blue, purple, yellow	White	Octahedral {111} perfect	Vitreous	Fluorescent
Malachite	$CuCO_3 \cdot Cu(OH)_2$	3.5-4	Green	Green	One perfect cleavage	Vitreous	Often forms botryoidal or stalactitic masses
Chalcopyrite	$CuFeS_2$	3.5-4	Brass yellow	Black	None	Metallic	Often mistaken for gold
Sphalerite	ZnS	3.5-4	Yellow, brown, black	White	Six perfect cleavages	Adamantine	Often translucent or transparent
Galena	PbS	2.5-3	Lead gray	Black	Three perfect cleavages at 90° to each other	Metallic	Often tarnishes to black
Halite (Rock Salt)	NaCl	2.5	White, pink, red, yellow, blue	White	Three perfect cleavages at 90° to each other	Vitreous	Salty taste
Gypsum	$CaSO_4 \cdot 2H_2O$	2	White, gray, yellow, red	White	Two perfect cleavages, one at 70° to the other	Pearly	Fibrous or massive