

# Topic Introduction



**Summarize your understanding of each paragraph.**

Most people can easily name the three classic matter states of liquid, solid, and gas. Those who took a few more science courses will add plasma to that list. But over the years, scientists have expanded the list of possible states of matter beyond the big four. Here are examples:

**Amorphous solids** are an intriguing subgroup of the well-known solid state. In a normal solid object, the molecules are highly organized and cannot move around very freely. An amorphous solid exists halfway between solid and liquid.

Other than possibly recognizing the expression **degenerate matter**, this state is beyond the scope of this curriculum. Even so, it is an interesting subject for later. Degenerate matter only exists within certain types of stars.

An expression you have likely already heard about somewhere is a superfluid. A **superfluid** is a state of matter that exists when certain isotopes of helium, rubidium, and lithium are cooled to almost absolute zero.

# Read/Summarize Text



1. Read the passage.
2. Underline key expressions in each sentence.
3. Re-write each word (or expression) you underlined.
4. Summarize the passage.

*Uhhh ... Not so fast*

So far in this workbook (and earlier studies) students have been shown that matter exists as plasma, gas, liquid, or solid.

Here though, we explore some "not-so-cut-and-dry" categories of matter including non-classical states of matter, low-temperature states of matter, and high-energy states of matter.

Following this introduction, students might choose to research, explore, and discuss matter which is not as easily categorized: glass, crystals with some degree of disorder, liquid crystal states, microphase-separated matter, magnetically ordered matter, degenerate matter, and superfluids.

Adapted from Honeycutt Science Chemistry Virtual Online Textbook.

*Re-write words you underlined*

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*Using a complete sentence, summarize or rephrase the passage*

# Read Text for Comprehension

Read this article for deeper understanding. No summary is required, although you may want to circle, underline, or mark key ideas and words.

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The “**Contents Index**” shown here is adapted/cut/paste from wikipedia:

[https://en.wikipedia.org/wiki/State\\_of\\_matter](https://en.wikipedia.org/wiki/State_of_matter)

*Three interesting examples described in detail by the article are:*

### **Glass**

Glass is a non-crystalline or amorphous solid material that exhibits a glass transition when heated towards the liquid state.

### **Liquid crystal states**

Liquid crystal states have properties intermediate between mobile liquids and ordered solids. Generally, they are able to flow like a liquid, but exhibiting long-range order.

### **Magnetically ordered**

Transition metal atoms often have magnetic moments due to the net spin of electrons that remain unpaired and do not form chemical bonds. In a ferromagnet—for instance, solid iron—the magnetic moment on each atom is aligned in the same direction. If the domains are also aligned, the solid is a permanent magnet. But, the magnetization disappears when the magnet is heated to the Curie point, which for iron is 768 °C.

# Copy the Text



Copy the text into space provided – use extra paper if needed.

## Low Temperature States

- **Superfluid.** A liquid that takes on a state of zero viscosity (or infinite fluidity; i.e., flowing without friction) when cooled to very low temperatures.
- **Fermionic condensate.** A state similar to the Bose–Einstein condensate but composed of fermions.
- **Rydberg matter.** An exotic phase of matter formed by Rydberg atoms usually consisting of hexagonal planar clusters.
- **Quantum Hall state.** An electromagnetic state related to the Hall effect.
- **Photonic matter.** A phenomenon where photons interacting with a gas develop apparent mass, and can interact with each other, even forming photonic “molecules.” This is opposed to photons moving through empty space with no-rest mass or interactions with other photons.
- **Dropleton.** A “quantum fog” of electrons and holes that flow around each other and even ripple like a liquid, rather than existing as discrete pairs

<http://factmyth.com/factoids/there-are-more-than-four-states-of-matter/>