**Guided Notes: Star Evolution**



**Key Terms:**

* Define protostar: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Define red giant: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Define planetary nebula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Define white dwarf: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Define supernova: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Define neutron star: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Define black hole: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Key Concepts:**

* While stars are not alive, all stars do change over time.
* Because of this, scientists use to the term "life cycle" to metaphorically describe these changes: stars' \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and ” \_\_\_\_\_\_\_\_\_\_\_\_\_\_.“
* When you look up at the night sky, every star you see is in some \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of its life \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Every star is "\_\_\_\_\_\_\_\_\_\_\_\_\_\_ " in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ —a giant cloud of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Eventually, \_\_\_\_\_\_\_\_\_\_\_\_\_\_ pulls the cloud’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_ together and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ gas starts to \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_ the gas \_\_\_\_\_\_\_\_\_\_\_\_\_\_, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ it becomes until a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ forms.
* When the temperature of the protostar reaches \_\_\_\_\_\_\_\_\_\_\_\_\_\_ ° Celsius, it triggers \_\_\_\_\_\_\_\_\_\_\_\_\_\_ fusion in its \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* By converting \_\_\_\_\_\_\_\_\_\_\_\_\_\_ into \_\_\_\_\_\_\_\_\_\_\_\_\_\_, the protostar achieves the next stage in its life cycle: now it is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_, brightly-glowing star.
* This is called the main \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Stars remain in this main \_\_\_\_\_\_\_\_\_\_\_\_\_\_ stage, creating heat through \_\_\_\_\_\_\_\_\_\_\_\_\_\_ fusion, for \_\_\_\_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of years. Our sun is currently in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ sequence stage.
* Eventually, stars have no more \_\_\_\_\_\_\_\_\_\_\_\_\_\_ left to \_\_\_\_\_\_\_\_\_\_\_\_\_\_, ending the main sequence.
* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a star determines what happens at this point.
* When a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star has no more hydrogen to fuse, and it has become only \_\_\_\_\_\_\_\_\_\_\_\_\_\_, it is too small to fuse helium together.
* Nuclear \_\_\_\_\_\_\_\_\_\_\_\_\_\_ ends and it is no longer considered a \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* It expels its \_\_\_\_\_\_\_\_\_\_\_\_\_\_ layers and becomes a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ dwarf, a small remnant of its former self.
* Over time, no longer able to make any energy, it \_\_\_\_\_\_\_\_\_\_\_\_\_\_ until it no longer emits any \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* When an \_\_\_\_\_\_\_\_\_\_\_\_\_\_ -sized star has used up its \_\_\_\_\_\_\_\_\_\_\_\_\_\_ fuel, it is big enough to use helium for nuclear \_\_\_\_\_\_\_\_\_\_\_\_\_\_ instead.
* It becomes a red \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star, burning \_\_\_\_\_\_\_\_\_\_\_\_\_\_ for \_\_\_\_\_\_\_\_\_\_\_\_\_\_ billion years until all the helium fuses into \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Medium stars are not big enough to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ carbon.
* So at this point, medium stars “\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”
* Their cores \_\_\_\_\_\_\_\_\_\_\_\_\_\_, expelling the stars' outer \_\_\_\_\_\_\_\_\_\_\_\_\_\_, which form a planetary \_\_\_\_\_\_\_\_\_\_\_\_\_\_. The cores become \_\_\_\_\_\_\_\_\_\_\_\_\_\_ dwarves.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_ stars have more spectacular endings to their life cycles.
* These stars are 10 times or more the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* When a massive star runs out of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ fuel, its outer shell expands into an \_\_\_\_\_\_\_\_\_\_\_\_\_\_ super red \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star.
* Nuclear \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the core continues until it eventually creates an \_\_\_\_\_\_\_\_\_\_\_\_\_\_ core.
* At this point, all \_\_\_\_\_\_\_\_\_\_\_\_\_\_ stops, and the star “\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”
* But massive stars do not die \_\_\_\_\_\_\_\_\_\_\_\_\_\_ as white dwarves.
* Instead, their cores rapidly \_\_\_\_\_\_\_\_\_\_\_\_\_\_, triggering a massive \_\_\_\_\_\_\_\_\_\_\_\_\_\_ known as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The resulting shock \_\_\_\_\_\_\_\_\_\_\_\_\_\_ causes more \_\_\_\_\_\_\_\_\_\_\_\_\_\_, which creates the elements heavier than \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and sends a cloud of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements hurtling into space.
* The remaining \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star continues to \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* At this point, the star can become a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star.
* A \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star can be only a few kilometers across, but its matter is so \_\_\_\_\_\_\_\_\_\_\_\_\_\_ that a teaspoon can weigh a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ tons.
* If the star is even \_\_\_\_\_\_\_\_\_\_\_\_\_\_, it becomes a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ hole.
* The powerful gravity of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ hole pulls all nearby \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ into its \_\_\_\_\_\_\_\_\_\_\_\_\_\_. Nothing, not even light, can escape.

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| **Star with Small Mass** | **Star with Medium Mass** | **Star with Large Mass** | **Star with Largest Mass** |
| Born in a nebula | Born in a nebula | Born in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Born in a nebula |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Protostar | Protostar | \_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Main sequence star which fuses \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Main sequence star which fuses hydrogen | Main sequence star which fuses \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Main sequence star which fuses hydrogen |
| Death as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ dwarf | Red \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star, which can fuse \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Super red \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star, which can fuse helium and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements. | Super red \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star, which can fuse \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and heavier elements |
|  | Death as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ dwarf | Death through a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Death through a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
|  |  | Can become \_\_\_\_\_\_\_\_\_\_\_\_\_\_ star | Becomes a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ hole |

* The evolution of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ stars in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ ends in one of two ways—the red \_\_\_\_\_\_\_\_\_\_\_\_\_\_ either become \_\_\_\_\_\_\_\_\_\_\_\_\_\_ stars or \_\_\_\_\_\_\_\_\_\_\_\_\_\_ holes.
* But the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ that precedes one of these outcomes is the largest explosion that happens in \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* With the exceptional technology available, astronomers \_\_\_\_\_\_\_\_\_\_\_\_\_\_ find \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* In 2013, one was discovered by chance a mere \_\_\_\_\_\_\_\_\_\_\_\_\_\_ hours after it \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* What scientists understand about \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and stellar \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a mixture of what they have observed and theories they have developed.
* The more data scientists can gather, the clearer the picture will become.
* Stellar \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is inevitable because stars \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* To burn, they need \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and as they burn, they \_\_\_\_\_\_\_\_\_\_\_\_\_\_ their fuel sources.
* The stages of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ can be thought of as stages of fuel \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* These stages are extremely important, because they are responsible for the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of most of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the universe—which in turn form new \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, solar \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ like the Milky Way.
* The solar system that contains Earth revolves around one star, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_, which will eventually end its \_\_\_\_\_\_\_\_\_\_\_\_\_\_ as a white \_\_\_\_\_\_\_\_\_\_\_\_\_\_.