

# Practice Problems

## Stellar Evolution & Lookback Time

### Exercise #1

**Description:** Imagine that the four stars listed below all became Main Sequence (MS) stars at exactly the same time 10 billion years ago but in different locations of the universe.

**Cosmo Star** is an O spectral class star with a MS lifetime of 3 million years. Its life will eventually end as a SN type II and become a black hole. Cosmo Star is located in a galaxy 10 billion light years (ly) from Earth.

**Ollie Star** is a K spectral class star with a MS lifetime of 30 billion years. Its life will eventually end as a slowly cooling white dwarf. Ollie Star is located in the MW at a distance of 10,000 ly from Earth.

**Sullivan Star** is an F spectral class star that is part of a binary star system. It has a MS lifetime of 5 billion years. Its life will eventually end in a SN type I that completely destroys Sullivan Star. Sullivan Star is located in a galaxy 6 billion ly from Earth.

**Sliver Star** is a B spectral class star with a MS lifetime of 20 million years. Its life will eventually end as a SN type II and become a neutron star. Sliver is located in the MW at a distance of 40,000 ly from Earth.

**A. Ranking Instructions** Rank the stars (from first to last) based on when they became main sequence stars.

**Ranking Order:** First 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ Last

Or, all the stars became main sequence stars at the same time. \_\_\_\_\_ (indicate with check mark).

**Carefully explain** your reasoning for ranking this way:

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**B. Ranking Instructions** Rank the stars (from first to last) based on when they reach(ed) their final end state.

**Ranking Order:** First 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ Last

Or, all the stars reach(ed) their final end state at the same time. \_\_\_\_\_ (indicate with check mark).

**Carefully explain** your reasoning for ranking this way:

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**C. Ranking Instructions** Rank the stars (from longest time to shortest time) based on how long it takes light to travel to Earth from the star.

**Ranking Order:** Longest time 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ Shortest time

Or, the time it takes light to get to Earth from the star is the same for all the stars. \_\_\_\_\_ (indicate with check mark).

**Carefully explain** your reasoning for ranking this way:

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**D. Ranking Instructions** Rank the stars (from first to last) based on when an observer on Earth would see their final end states.

**Ranking Order:** First 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ Last

Or, the final end state of the star will all be visible at Earth at the same time. \_\_\_\_\_ (indicate with check mark).

**Carefully explain** your reasoning for ranking this way:

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**E.** Is the star with the longest total lifetime also the farthest away from Earth? Explain.

**F.** Out of the four stars, is the star that meets its end first also the first to be observed on Earth in its end state? Why or Why not?

**G.** Out of the four stars, is the star that will be observed in its end state last also the one that is closest to Earth? Is this answer always true for all stars? If not, describe a case where it would be different.