Name(s): _____ _____

_____ _____

Date: _____ Course/Section: _____

Grade: _____

Properties of Nebulae

Objectives:

Students will examine images of a supernova and a planetary nebula to learn about differences between the two astronomical phenomena.

Checklist:

- ☐ **Complete the pre-lab quiz with your team.**
- ☐ **Compile a list of resources you expect to use in the lab.**
- ☐ **Work with your team to complete the lab exercises and activities.**
- ☐ **Record your results and mark which resources you used.**
- ☐ **Share and discuss your results with the rest of the class.**
- ☐ **Determine if your team's answers are reasonable.**

Pre-Lab Quiz

1.
2.
3.
4.

Part 1: Supernovae

1. A typical supernova releases 10^{44} Joules of energy within a few seconds. Compare this yield to how much energy the Sun will produce over its entire main sequence lifetime, assuming a constant luminosity of 3.8×10^{26} J/s and an age of 15 Gyr. Show your work. (Hint, keep track of your units.)

2. Explain the differences between Type Ia and core-collapse supernovae. Be sure to include details about the progenitors as well as what is left after the supernova.

3. If the angular radius of the Crab nebula is 172 arcseconds, what is the radius of the Crab nebula? Show your work.

4. If the supernova that produced the Crab was observed in 1054 A.D., find the expansion rate in km/s for the post SN phase. Show your work.

5. If the Sun could supernova, how long would it take for the explosion to reach Earth's orbit? Assume the expansion speed you found in the Question 4 for the Crab. Show your work.

Part 2: Planetary Nebulae

1. How do planetary nebulae form?

2. If the angular radius of the Ring is 46 arcsec, what is the radius of the Ring Nebula in light years and km? Show your work.

3. Assuming that the white dwarf associated with the Ring nebula is located at the center and that the nebula has been expanding constantly at v=30 km/s, find the age of the nebula in years. Show your work.

4. If the progenitor star that created the Ring nebula was 2.2 $M_\odot$ and the white dwarf is 0.6 $M_\odot$, what percentage of its mass was ejected to create the Ring Nebula, assuming $M_{progenitor} = M_{nebula} + M_{white\ dwarf.}$

5. What is the Chandrasekhar limit and how much more mass does the white dwarf require to reach the Chandrasekhar limit?

Part 3: Discussion

1. Based on your knowledge of stellar evolution, what is the fate of our Sun?

2. Find how long a planetary nebula, formed by the Sun, would take to each Earth's orbit assuming an expansion rate of 30 km/s. Show your work.

3. How long would it take the planetary nebula to expand outside of the solar system? Show your work and give your answer in years. (Note, the solar system is about 80 AU.)