UGS303, Extraterrestrial Life: REVIEW FOR FIRST TEST

Chapter 1 - The Nature of the Subject Matter

1. What does the term "Earth chauvinism" mean? Of what import is it to the course?

2. What is scientific notation? How does it work?

3. What is an equation?

4. What is a light year? Give three examples of distances to objects in light years.

5. Give three definitions of life. What are the advantages and disadvantages of each?

6. A burning candle is usually considered to be a non-living object. Using the first definition of life discussed in class, argue the case for the candle being a living entity, showing how the candle could be said to satisfy each condition.

7. List the 4 most common elements needed in life. What two other elements are needed for all life? Compare the chemical composition of life to that of the crust of the Earth, the atmosphere of the Earth, the oceans of the Earth, and the Sun.

8. What does it mean to say that the Drake equation provides not so much an answer as a guideline to asking questions?

Chapter 2 - Cosmic Evolution: 1. Protons to Heavy Elements

9. What is temperature? At a given temperature, which would move faster on average, a proton or an alpha particle? What does T = 0 K mean?

10. Describe the first 380,000 years of the Universe after the Big Bang.

11. Discuss the fusion reaction of two protons in a main sequence star using the concepts of potential energy and basic forces.

12. If the reaction of two protons to form a deuteron releases energy, why do we need a high temperature for the reaction to proceed? You should use the concept of potential energy in your explanation, as well as the different types of forces.

13. Why does nuclear fusion lead to a stable star rather than an explosion, as happens in a nuclear bomb? How are the heavier elements produced by stars and expelled to interstellar space?

Chapter 3 - Cosmic Evolution: 2. Heavy Elements to Molecules

A. Interstellar Molecules

14. Define and describe atoms, ions, and molecules.

15. Discuss in detail how a molecule is formed from atoms. In what ways is this different from nuclear fusion reactions?

16. What makes a carbon atom special and important for life? Describe in general the kinds of interstellar molecules that have been found. In what ways are these facts important to a study of extraterrestrial life?

17. Why are ionic molecules, like HCO^+ and N_2H^+, able to react with neutral molecules, like H_2, and build more complicated molecules, whereas ordinary, neutral, molecules cannot do this in interstellar clouds? Are such molecular ions common on Earth?

18. Describe three lessons that we can learn from the presence and nature of interstellar molecules.

19. What are the two kinds of dust particles known to exist in interstellar space?

20. How does dust protect interstellar molecules from destruction?

21. Why is dust necessary for the formation of H_2?

B. Molecular Clouds

22. What are some properties typical of molecular clouds?

23. Describe the composition of molecular clouds.

24. What molecules are known to exist in icy mantles on dust particles in molecular clouds? What are some possible implications of these mantles?

C. Star Formation

25. What is R_* ? Show how it can be calculated. How does the average value of R_* compare to the current value? Give your estimate of R_* and explain the reasons for your choice.

26. What role do molecules and dust play in star formation?

27. What have we learned about star formation from infrared studies of molecular clouds?

28. Describe the evolution of a protostar into a star like the Sun. Use the fact that energy is conserved to explain what happens.

29. Describe the role of angular momentum in producing a disk around the protostar. How does the wind keep the star from spinning too fast?

D. Planet Formation

30. What do observations tell us about the likelihood of disks around young stars? What do we know about disks and binary stars? What do the observations of disks imply about likely values for f_p?

31. What advantage do infrared observations have in attempts to detect **directly** planets around other stars?

32. Describe the astrometric and spectroscopic methods for detecting planets around other stars. What are the advantages and drawbacks of each? Which method works better for planets orbiting close to their star and which works better for planets in large orbits? Describe how searches for transits and microlensing can detect planets. Which method was used to detect most of the new planets detected so far?

33. Based on the updates given in class, roughly how many planets are known to exist around other stars? How does their discovery affect our estimates of f_p?

34. Discuss the possible issues for forming planets around binary stars.

E. Properties of our Solar System

35. Explain how formation from a rotating disk can explain many of the facts about our solar system.

36. What are the similarities and differences among the planets of our solar system? How can these be explained in terms of their formation?

37. Based on our own solar system, what properties would we expect planetary systems around stars like our sun to have?

38. Give your estimate for f_p and explain how you arrived at it.

39. Describe the observations that constrain how long disks last around forming stars. What problems do these cause for theories of giant planet formation? What other theory has been suggested?

40. Describe the formation of the Earth and its atmosphere. What were the conditions like on the Earth before the origin of life?

F. Habitable Planets in the Galaxy

41. Discuss the factors that determine the temperature of a planet, including rotation and greenhouse effects.

42. Explain the concept of a continuously habitable zone (CHZ) and give the arguments that the CHZ for the Sun is very small and the counter-arguments that it is larger.

43. What is the difference between the Microbial Habitable Zone and the Animal Habitable Zone? Summarize the argument that life may be much more common than advanced life.

44. Give your estimate for n_p and explain it.

45. What conditions must a star meet for it to have a planet suitable for life? Show how f_s is affected by each requirement. Give your estimate for f_s and explain it.

46. What have we learned about the properties of other planetary systems? What are the implications for the number of habitable planets?

46. Combine your estimates for n_p and f_s to get an estimate for n_e. Explain the implications of your estimate.

Broader Questions:

1. Trace the evolution of complexity at the *microscopic* level from the Big Bang to molecular clouds. Discuss the locations, times, and forces that were involved in each increase in complexity.

2. Trace the evolution of complexity at the *macroscopic* level from the Big Bang to the formation of the Earth.

3. Discuss ways in which microscopic and macroscopic evolution are related.