OpenStax Astronomy, Ch.16: WS Problems (Apr-2021)

Review Questions

1. How do we know the age of the Sun?

2. Explain how we know that the Sun's energy is not supplied either by chemical burning, as in fires here on Earth, or by gravitational contraction (shrinking).

3. What is the ultimate source of energy that makes the Sun shine?

4. How is a neutrino different from a neutron? List all the ways you can think of.

5. Describe in your own words what is meant by the statement that the Sun is in hydrostatic equilibrium.

6. Two astronomy students travel to South Dakota. One stands on Earth's surface and enjoys some sunshine. At the same time, the other descends into a gold mine where neutrinos are detected, arriving in time to detect the creation of a new radioactive argon nucleus. Although the photon at the surface and the neutrinos in the mine arrive at the same time, they have had very different histories. Describe the differences.

7. What do measurements of the number of neutrinos emitted by the Sun tell us about conditions deep in the solar interior?

8. Do neutrinos have mass? Describe how the answer to this question has changed over time and why.

9. Neutrinos produced in the core of the Sun carry energy to its exterior. Is the mechanism for this energy transport conduction, convection, or radiation?

10. What conditions are required before proton-proton chain fusion can start in the Sun?

11. Describe the two main ways that energy travels through the Sun.

12. Earth's atmosphere is in hydrostatic equilibrium. What this means is that the pressure at any point in the atmosphere must be high enough to support the weight of air above it. How would you expect the pressure on Mt. Everest to differ from the pressure in your classroom? Explain why.

13. What mechanism transfers heat away from the surface of the Moon? If the Moon is losing energy in this way, why does it not simply become colder and colder?

14. Suppose you are standing a few feet away from a bonfire on a cold fall evening. Your face begins to feel hot. What is the mechanism that transfers heat from the fire to your face? (Hint: Is the air between you and the fire hotter or cooler than your face?)

15. Give some everyday examples of the transport of heat by convection and by radiation.

16. Suppose the proton-proton cycle in the Sun were to slow down suddenly and generate energy at only 95% of its current rate. Would an observer on Earth see an immediate decrease in the Sun's brightness? Would she immediately see a decrease in the number of neutrinos emitted by the Sun?

17. The Sun converts 4×10^9 kg of mass to energy every second. How many years would it take the Sun to convert a mass equal to the mass of Earth to energy?

18. Every second, the Sun converts 4 million tons of matter to energy. How long will it take the Sun to reduce its mass by 1% (the mass of the Sun is 2×10^{30})? Compare your answer with the lifetime of the Sun so far.

19. Raymond Davis Jr.'s neutrino detector contained approximately 10^{30} chlorine atoms. During his experiment, he found that one neutrino reacted with a chlorine atom to produce one argon atom each day.

A. How many days would he have to run the experiment for 1% of his tank to be filled with argon atoms?

B. Convert your answer from A. into years.

C. Compare this answer to the age of the universe, which is approximately 14 billion years (1.4×10^{10} years).

D. What does this tell you about how frequently neutrinos interact with matter?