Astronomy
Learning Objectives and Study Questions for Chapter 10

1. Sketch a neat, well labeled cross section of the Sun that shows both its major internal regions (core, radiative transfer zone, convective transfer zone) and the major subdivisions of its atmosphere (photosphere, chromosphere, corona).
2. Explain how the development of sunspots is related to the convective motion of plasma beneath the photosphere and local variations of the Sun’s magnetic field.
3. Given a history of recent maxima and minima in the sunspot cycle, predict when future maxima or minima are likely to occur.
4. Using Einstein’s equation for the equivalence of mass and energy — \( E = mc^2 \) — calculate the amount of energy released when a given mass is converted to energy during the fusion of H to He.
5. Explain why the Sun appears to be emitting fewer electron neutrinos than its overall energy emission rate would suggest.

1. The _____ is/are the hottest part(s) of the Sun’s atmosphere.
   A. granules
   B. chromosphere
   C. spicules
   D. corona
   E. photosphere

2. Within the Sun, photons are transferred slowly through the _____.
   A. convective zone
   B. core
   C. photosphere
   D. radiative zone
   E. corona

3. Calculations indicate that the Sun will convert about _____% of its mass to energy during its 10 billion year lifetime as a main sequence star.
   A. 70
   B. 7
   C. 0.7
   D. 0.07
   E. indeterminate, cannot tell from what we know

4. Sunspots are cool areas on the photosphere where convection has been stopped by locally intense _____.
   A. gravity
   B. magnetism
   C. fusion
   D. chemical reactions
   E. rotational instability
5. If the last sunspot maximum occurred in 2013 the next maximum, regardless of polarity, is expected in _____.
   A. 2016
   B. 2020
   C. 2024
   D. 2035
   E. 2046

6. The hydrostatic equilibrium that enables the Sun to maintain its current size and shape balances _____ and _____.
   A. electromagnetism, fusion
   B. gravity, electromagnetism
   C. gravity, fusion
   D. gravity, strong nuclear force
   E. strong nuclear force, fusion

7. The observation that the Sun emits fewer neutrinos than its energy output rate would suggest indicates _____.
   A. fusion really is not occurring as we think
   B. our detectors are inadequate
   C. the Sun is already shutting down inside
   D. electron neutrinos change type spontaneously
   E. none of the above