STUDY GUIDE FOR PART 4

The Sun and Stars

INTRODUCTION:

We continue our journey through the universe in this part by looking at those lights in the sky, the stars. What are they made of? How do they work? How far away are they? Are there different kinds of stars? We ask all of these questions.

In Section A we look at our own star, the sun. It is the closest, and so the most important star to us, and at the same time the easiest star to observe. By knowing something about the sun, we will have a standard by which we can compare other stars.

In Section B we consider the properties of stars in general. By considering these properties we can begin to determine how far away the stars are and how our sun fits into the general scheme.

In Section C we study multiple star systems to see what additional information we can obtain when two (or more) stars orbit each other.

In Section D we consider the things other than stars that are out there: interstellar atoms, dust, and nebulae. These are related to the birth and death of stars considered above and will be important when we consider galaxies and the universe in Part 5.

In Section E we try to first of all categorize all the different types of stars. We then try to relate these categories into an evolutionary scheme for stars that is based on how we think a star works.

A. The Sun and its Radiation

OUTLINE:

1. Size of the Sun (diameter ≈ 1.4 million km, or ≈ .01 AU)

2. Structure
    a) core (where the energy is "generated")
    b) radiative zone
    c) convective zone
    d) photosphere ("surface" of the sun)
    e) atmosphere (transparent)
        (1) chromosphere
        (2) corona

3. Solar activity:
    a) sunspots (cooler areas [only 4500 K instead of 6000 K associated with areas of magnetic field on the surface of the sun)
        sunspots run in cycles that last ≈ 11 years
    b) prominences
    c) flares
    d) solar wind

4. Earth-Sun Relationships
    a) intensity in space above atmosphere ≈ 1350 Watts/m^2
    b) average intensity on earth's surface ≈ 230 Watts/m^2
    c) variability of sun's intensity - related to sunspots
    d) X-rays, UV, visible range, IR & radio all come from sun

Study Questions for Part A:

1. What is a sunspot?
*2. What is the sunspot cycle? How long is it?
3. Describe a solar flare.
4. What is the solar wind?
*5. Be able to discuss possibilities and limitations of solar energy.

B. Basic Properties of Stars

OUTLINE:

1. Distances to stars
    a) parallax (1 parsec = distance that would make an angle of 1 arc sec = 3.24 light years)
    b) stellar motions
    c) brightness and luminosity
        (1) apparent magnitudes (depends on luminosity and distance)
        (2) absolute magnitudes (measure of intrinsic luminosity, depends on surface area and Temperature)

2. Classifications
    a) colors of stars
    b) the H-R diagram

Study Questions for Part B:

*1. What is parallax?
2. Distinguish between proper motions and parallax.
*3. Distinguish between brightness and luminosity.
*4. Distinguish between apparent and absolute magnitudes.
5. Know the spectral classifications and how they relate to the color and temperature of the stars.
**6. Draw the H-R diagram and indicate the position of the main sequence, the sun and the two stars in question #7 below.
**7. Choose two stars excluding the sun and know (1) their distances from earth; (2) their absolute and apparent magnitude; (3) their stellar classifications; and (4) in what constellation each is.

C. Binary and Multiple Star Systems

OUTLINE:

1. Binaries
    a) visual
    b) spectroscopic (red/blue shifts)
    c) eclipsing
    d) astrometric

2. How many are there?

3. Importance of binaries
    a) determine mass to get mass-luminosity relationship
    b) look for stellar evolution

4. Theories
    a) fission
    b) capture
    c) common condensation

Study Questions for Part C:

1. What are the three ways of detecting a binary star system?
2. Be able to interpret a light-curve from a binary star system.
3. Know what the mass-luminosity relation is.
4. What is the percentage of single versus multiple star systems?

D. Interstellar Atoms, Dust, and Nebulae

OUTLINE:

1. Effects on light
2. Relation to stellar formation and stellar death.

Study Questions for Part D:

1. Name two effects of stellar matter on light.
2. How are nebulae related to star formation?
3. How are nebulae related to star death?

E. Stellar Evolution

OUTLINE:

1. Energy generation in stars
    a) gravity
    b) nuclear energy (fission and fusion)
    c) equilibrium

2. Birth of stars
    a) theory: gravitational collapse
    b) on the H-R diagram
    c) observations

3. Life on the Main Sequence
    a) theory: 'burning' Hydrogen into Helium
    b) on H-R diagram
    c) observations

4. Death of stars
    a) theory: alternate 'burning' of other elements and gravitational collapse
    b) giants and variable stars: observations
        (1) giants and supergiants (make heavier elements)
        (2) variables
            (a) Cepheid I and Cepheid II
            (b) RR Lyrae
            (c) others
        (3) on the H-R diagram
    c) final death
        (1) dwarf: gradual fading
        (2) supernova: explosion
            (a) neutron star
            (b) black hole

Study Questions for Part E:

*1. Distinguish between fission and fusion. Which process does the sun employ? Which process do today's nuclear power reactors employ?
*2. What does the sun "burn" as fuel?
*3. How is a star born, and where does it get its energy to light the nuclear fires?
*4. How long will the sun be on the main sequence (total time)? How long has it been on the main sequence? How long before it moves off the main sequence?
5. What determines a star's position on the main sequence?
*6. What is the source of energy after a star has exhausted its hydrogen supply in its core?
*7. What is a Cepheid variable? Locate it on the H-R diagram.
*8. What is the period-luminosity relationship for a Cepheid variable, and how is it useful?
9. Be able to locate giants, supergiants, and white dwarfs on the H-R diagram.
10. What is a nova?
*11. What is a supernova?
12. What is a dwarf star?
13. What is a neutron star?
14. What is a pulsar?
*15. What is a black hole?
*16. What determines whether a star will die as a dwarf, neutron star, or black hole?
*17. Be able to show the life cycle of a star like the sun on the H-R diagram.

Study TRUE/FALSE Questions for all of Part 4:
(questions similar to these may appear on the test)

_____ a) The diameter of the sun is approximately 0.1% of the earth-sun distance. [Here "about" means within a factor of 5 either way.]

_____ b) The nearest star is about 250,000 A.U. from the earth. [Here "about" means within a factor of 5 either way.]

_____ c) Absolute Magnitude is a measure of a star's brightness.

_____ d) Planetary nebulae are clouds of dust and gas out of which the planets form.

_____ e) The sun will probably go supernova sometime, probably in about 5.5 billion years.

_____ f) Vega is a star that has a stellar classification of A0 V. From this we can infer that Vega is more massive than the sun.

_____ g) The heaviest elements (gold, lead, uranium, etc.) are thought to be made in supernova explosions and not in the interior of stars like carbon and oxygen are.

_____ h) The sun will eventually (in about 5.5 billion years) turn into a red giant whose radius will reach out to about the earth's orbit.

_____ i) Closed or globular clusters of stars are groups of tens to hundreds of young often massive stars often found in dust clouds.

_____ j) A K9 Ia star has approximately the same surface temperature as a K9 V star.

_____ k) More massive stars last longer on the main sequence than less massive stars because they have more fuel (mass).