Exercise 34

- List the 3 conditions for a sustained fusion and explain why these conditions are satisfied in the sun.
  - High temperature of the plasma for the plasma ions to have the speed needed to over the Coulomb barrier
  - High plasma density for frequent collisions between ions
  - Confinement. The plasma of the reacting nuclei must remain together for a sufficiently long time

  These conditions are satisfied in the sun. Extremely high temperature, a large source of hydrogen as fuel and the gravitational confinement
- List 2 fusion cycles that generate energy in the sun
  - p-p cylce and CNO cycle
- Explain why fusion is not possible a room temperature
  - Not high speed of the plasma ions to overcome the Coulomb barrier of the ion repulsions
- Explain how the high temperature helps overcome the Coulomb barrier in fusion. Use your knowledge of statistical mechanics.
  - The Boltzman factor. The velocity distribution of ions as function of temperature ~ exp(-E/KT)
- Explain why fusion has not being used successfully as a source of energy on Earth
- What are breakeven and ignition in fusion reactors?
  - Breakeven when energy input equals energy output, no loss no gain
  - Ignition when fusion is self-sustained

Exercise 34

- Describe the motivation and the objectives of ITER. Explain how ITER plans to achieve the 3 conditions for sustained fusion
  - Motivation : to provide electrical energy from man-made self-sustained fusion
  - Thru magnetic and laser confinement, laser hearting and D-D and D-T fusions

- What are the possible fusion reactions that can be used to generate fusion energy on Earth?
  - D-T might be the first to be used due to high Q-value. The T will requirement Li to be produced since we have light source of natural T on Earth.
- Explain the different methods of confinement fusion. What is responsible for confinement in the sun?
  - Generally 3 methods. Gravitational such as in the sun. For fusion reactors on Earth, use magnetic confinement (toroidal and poloidal fields) and inertial confinement
- Are there any disadvantages for fusion reactors? Explain.
  - Yes. Large release of neutrons and helium waste
- Why would we be interested in fusion reactors when we have already mastered fission reactors? Explain.
  - Fusion reactors relatively non-polluting, safe and the oceans supplying the source of fuel, D. Furthermore, fusion can release more energy than fission per kilogram of starting materials

References

Concepts of Modern Physics, 5th edition, Arthur Beiser, 1995, McGraw-Hill, Chapter 12

Introductory Nuclear Physics, Kenneth S. Krane, 1988, John Wiley & Sons, Inc. Chapter 20