STELLAR PHYSICS

IMPORTANT REVISION TOPICS: NOT EXHAUSTIVE!

CHAPTER 1:

Understand that all metals are made in stars, Big Bang nucleosynthesis makes approximately 75% H and 25% He.

Understand the virial theorem, and in particular equation (1.11). Also understand how and why the adiabatic index γ (ratio of specific heats) enters, and the consequences of $\gamma = 4/3$ and $\gamma = 1$, together with the circumstances in which these values may be approached.

Understand the concepts of free-fall collapse time and Jeans Instability.

The definition of effective temperature, and how to obtain expressions for mean pressure in stars etc.

Understand random walk.

Understand Fig 1.3, Binding Energy per nucleon.

Understand the HR Diagram, Fig 1.6.

CHAPTER 2:

Maxwell-Boltzmann statistics and the velocity/speed distributions for classical gas.

Ideal gas equation of state; pressure proportional to (kinetic) energy density with different constants for non-relativistic and relativistic.

Quantum concentration, equation of state for non-rel degenerate fermions and for relativistic degenerate fermions.

Photon statistics, expressions for radiation energy density and pressure.

Understand that Saha equation gives the relative populations in different ionization stages, and that can assume fully ionized in stellar interiors, but not in outer regions/atmospheres.

Understand derivations of the approximate expressions for number density of particles, mean mass per particle etc when fully ionized e.g. equations (2.68), (2.69).

CHAPTER 3:

Understand meaning of opacity, relation to mean free path. How random motions and a temperature gradient lead to energy transport, and the differences between photons, electrons and ions.

Understand the derivation of equation (3.27), radial dependence of luminosity when in radiative equilibrium.

Understand criterion for convection, including concept of 'adiabatic temperature gradient'.

CHAPTER 4:
Understand Coulomb barrier, quantum tunneling, and the importance of Maxwellian tail. Look back to Table 1.3 for temperature thresholds for different nuclear reactions.
Understand there are two main ways of going from H to He: p-p and CN(O) cycle. Understand neutrinos emitted, and led to 'Solar neutrino problem' and evidence that neutrino are not massless.
Understand that need 'triple-alpha' process to form He-4.

CHAPTER 5:
Understand the Fundamental Equations of Stellar Structure (section 5.1).
Understand how to have a polytropic star: either equation of state, or some condition e.g. adiabatic.
Understand why Fig 5.1 has the form shown.
Homology scalings are very important. Understand why these are for zero-age main sequence stars. Minimum and maximum masses of stars. Location of main sequence on HR diagram. Subdwarfs.

CHAPTER 6:
Most of what you should know here we did in Chapter 2, and in the midterm you derived the maximum mass of a white dwarf. Neutron stars were briefly discussed; know what they are and that max mass is larger.

STELLAR EVOLUTION:
Understand successive stages of core burning, plus shell burning. Main sequence is longest-lived stage. How mass affects both rates and when degeneracy reached in core. Be able to match location in HR diagram to evolution stage. Main sequence turn-off as age indicator for clusters, and star formation history for galaxies. Tip of red giant branch as distance indicator for old systems.
Different types of supernovae and chemical elemental production.