The exam will consist of two questions from the list below plus two problems. No calculator, books, lecture notes, or any other material is allowed during the exam. You are allowed to take one A4 page with any formulae, equations and constants you like. The answers to the first two questions should contain, e.g., the derivation of some formulae (if that is asked for) and a short physical description of what the formula and its different terms mean. There is no need to write a long essay on the topic of the question.

1. Minimal mass of the star with the thermonuclear energy source
2. Maximal mass of the solid planet
3. Convection; the Schwarzschild stability condition
4. Degenerate matter. Fermi energy and pressure in the non-relativistic and ultra-relativistic limits. Mass-radius relation for white dwarfs. Chandrasekhar mass.
5. Derivation of the 1-dimensional equations of mass and the momentum conservation. Write Euler's and continuity equations in the general (three-dimensional) form.
6. Sound waves.
7. Shock waves. Jump conditions in the shock frame. The compression (i.e. the ratio of densities) and the ratio of the upstream and downstream velocities for a strong shock. Derive an expression for the gas temperature behind a strong shock.
8. Spherical accretion.
9. Interaction of the stellar wind with the ISM.
10. Strong explosion and supernovae expansion.
11. Radiation intensity, flux, energy density and photon occupation number. Balckbody radiation. Rayleigh-Jeans and Wien limits. The Stefan-Boltzmann law.
12. Basics of radiative transfer: a general form of the radiative transfer equation, emission and absorption coefficients, optical depth. Kirchhoff's law.
13. Radiation from a plane slab. Optically thin and optically thick limits.
14. Radiative diffusion; Rosseland opacity.
15. Spectral lines. Quasi-classical estimate for the rate of radiative transition. Line broadening mechanisms; Lorentz and Doppler profiles.
16. Using the model of damped harmonic oscillator find the natural line shape.
17. Bremsstrahlung.
18. Thomson scattering.
19. Saha's equation.
20. Quasi-classical estimate of the radiation recombination cross section. The total rate of photo-recombination and the recombination coefficient.
21.For a given photo-recombination cross section, find the photo-ionization cross section making use of the detailed balance principle.
22. HII regions. Stromgren radius. Explain in physical terms why direct recombination into the basic state should be excluded.