COMMENTS:

This set of questions serves as the preparation for midterm as well as (later) final exams in ASTB23, from the first part of the course. There are two versions of this file, prepQ–midterm2023.pdf (questions) and prepA–midterm2023.pdf (most Q's answered; to be used later for verifying correctness of your answers). Do not memorize these questions. They are a guide to what kinds of questions you'll encounter and which topics will be emphasized. Study your own notes from lectures and our textbook #1.

In the quiz part, your work is that of a scientific editor of a text somebody wants to publish. You should judge the scientific correctness of the sentence, ignore typos or grammatical errors.

In a real midterm test, if you judge a sentence to be right, you will circle letter Y, and if wrong, circle letter N. But if you think something is wrong in the sentence, you MUST not only put N in front of [1], but ALSO CIRCLE at least on word which makes the sentence false. If you forget about circling words, you get no points! Also, in a real test if you think a Y/N question is ambiguous, both answers could be right (they should not!) then please state your opinion briefly next to the question, while choosing one answer, the Y or N.

Sample questions for the preparation to midterm, MOST ANSWERED ASTB23. Stellar Astrophysics.

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Part II – TRUE-OR-FALSE test questions (please mark with Y or N for Yes or No **in front** of the statement).

All questions contribute equally to the final score. Please read the questions very carefully! They are sometimes a bit tricky. If truths are mixed with disinformation, you must give it an N and circle at least some incorrect word(s).

Y [1] Photosphere is the surface of last scattering for photons escaping from the sun into the space.

Y [1] Limb darkening happens because of two things: (i) solar gas is opaque, and (ii) the lower lying levels of the sun are hotter than those above them.

N [1] The total number of random walk steps an typical photon has to make in order to reach the surface of a sun starting from its center is of order $Napprox(R/L)$ where R is the radius of the star, while L is the mean free path of the photon.

Y [1] The equation of mechanical balance of a star was worked out more than a hundered years ago by J. Homer Lane, and R. Emden.

[1] The central temperature of the sun is roughly 15 million K

[1] The hydrostatic equation of stellar structure reads

$$\frac{dP}{dr} = -GM(r)/r^2$$

[1] The Kelvin-Helmholtz contraction time scale was calculated to be $\sim$ 20 billion years

N [1] Four nuclei of hydrogen are slightly less massive than one nucleus of helium. This means they can undergo a nuclear reaction, and release the mass difference in the form of energy of radiation

Y [1] Ideal equation of state is satisfied by the gas inside main-sequence stars

Y [1] Eddington luminosity of the sun is much larger than its actual luminosity

N [1] The well-known M-L scaling law of Eddington (mass-luminosity relation $L \sim M^3$) is an empirical relationship obtained from observations in Mt Wilson observatory near Pasadena in 1924.

[1] Gustav Kirchhoff in 19th century has formulated three laws of radiation: one about continuous radiation, the second about emission lines from rarefied gas, and the third about absorption lines if a luminous source shines light through a colder gas.

Y [1] Vega is rapidly rotating and thus flattened. We see it more or less from the top, i.e. from near its axis.

[1] Eddington found a way to derive the characteristic mass scale for stars ($\sim 30 M_o dot$) from physical constants. This provided an explanation of why stars tend to have masses contained in the interval from $10^{-6} M_o dot$ to about $10^2 M_o dot$.

Y [1] Virial theorem states that the global gravitational potential energy in a star in equilibrium will equal its kinetic energy times (-2)

[1] Kelvin and Helmholtz believed that the sun derives energy from a slow contraction over billions of years

Y [1] Opposition to timescales of Kelvin-Helmholtz contraction of the sun was offered by geologists and geneticists

[1] Astrophysicists know the age of the sun from the fossil record in rocks.

Y [1] Virial theorem states that the total energy in a star in equilibrium will equal its kinetic energy times minus one.

[1] Virial theorem states that the global gravitational potential energy in a star in equilibrium equals its kinetic energy times (-1)

N [1] The basic difficulty for nuclear energy production is that the mean kinetic energy of particles in the sun's core (for instance) is $\tilde{1}0$ times smaller than that needed to jump over the electrostatic repulsion barrier of proton-proton pair.

[1] Gamov peak is a mountain in California, which has been named after the person who deciphered the energy generation secrets of normal stars.

Y [1] Neutrinos were detected twenty-six years after Pauli had postulated the existence of the neutrino. It took forty more years for the Nobel Committee to recognize this important discovery!

[1] The probability of two protons to merge and produce deuterium, when they approach each other inside the sun, is tiny, $\sim 10^{-20}$.

N [1] Compton scattering is an important contributor to the opacity in the solar interior

N [1] Thomson scattering is a process of free-free scattering of photons off nuclei (ions)

[1] Pressure is always proportional to the average product of speed and momentum of particles making up a gas

Y [1] Ideal black body absorbs 100 percent of radiation falling on it.

[1] Ideal black body emits thermal radiation with maximum possible efficiency at each wavelength, i.e. more than a non-black body at each wavelength.

[1] The deuterium (heavy hydrogen) nucleus has one proton and two neutrons.

Y [1] The deuterium (heavy hydrogen) nucleus is part of a p-p reaction chain

[1] The CNO cycle requires the presence of some carbon, nitrogen or oxygen which act as catalysts in chemical reactions.

N [1] The CNO cycle is the dominant mechanism for the synthesis of helium in stars less massive than the sun

[1] The opacity of the solar material is such that there are $\sim 10^{22}$ scatterings (absorptions and reemissions) of a photon born near the center of the sun, before it escapes into space.

[1] The opacity of the solar material is such that there are $\sim 10^{11}$ scatterings (absorptions and reemissions) of a photon born near the center of the sun, before it escapes into space.

N [1] Two stars have optical depth differing by a factor of 2. Diffusion of photons from the center to surface takes twice as long in the one with larger optical depth.

[1] If opacity changes everywhere in a star by 50%, then its optical depth changes by the same factor.

Y [1] Quantum tunneling occurs with exponentially decreasing probability, when the height of the energy barrier increases

Y [1] Inside a nucleon, neutron may decay producing proton and electron, as well as electron antineutrino (that last particle appears because lepton number is conserved in particle transformations)

Y [1] Isotopes are variants of a given element with a varying number of neutrons in the nucleus

N [1] Neutrinos only participate in weak interactions, and have tiny mass and very short mean free paths in the dense stellar matter.

Y [1] In the CNO cycle, the input is hydrogen, the output is helium, and the isotopes of C N O are only catalysts and intermediate products, their is no net production of them in the cycle.

[1] Adiabatic index γ is the constant in the following equation of state of gas: $P = K\rho^{\gamma}$

[1] Adiabatic index γ for the normal monatomic gas is 3/5

[1] Adiabatic index γ for relativistic matter (e.g., gas of photons) is 4/3

[1] Ideal equation of state does not apply to relativistic gases

[1] English astronomer Lockyer discovered bright-yellow emission line, and proposed that this line was produced by a new element in the Sun, helium.

Y [1] Mean density of stars is sometimes larger, sometimes smaller than the density of water

[1] Hydrostatic equilibrium equation reads: $dP/dr = -GM(r)r^{-2}$.

N [1] Radiation pressure depends on temperature of photon gas T, and number densiity n of photons.

[1] Hydrostatic equilibrium equation reads: $dP/dr = \rho(r)GM(r)r^{-2}$.

N [1] $P = (3/2)nk_BT$

[1] Mean free path is the product of number density and cross section σ of the scattering center

N [1] Equation $dL/dr = 4\pi\epsilon\rho r^2$ is a radiation transfer equation of stellar structure.

[1] Aston discovered experimentally that the mass of the helium nucleus is less than four times the mass of the hydrogen nucleus

N [1] The sun will spend the next 20 Gyr on the main sequence

to t he red end of the spectrum. It is related to the expansion of the universe.

Y [1] Statistical distribution of energies in a system at thermal equilibrium is given by Boltzmann distribution $f(E) \sim 1/e^{+E/kT}$

N [1] Flash spectrum is the absorption spectrum of solar corona

Y [1] The mass-luminosity relationship for stars, according to Eddington, is $L \sim M^3$

Y [1] Eddington was instrumental in proving Einstein's theory of gravity in around 1919.

[1] Einstein's formula $E = mc^2$ connects the total energy of a particle with its relativistic mass.

[1] Adiabatic index γ for the relativistic matter is 4/3: $P \sim \rho^{4/3}T$

Y [1] Received flux of radiation from a star, I, can be translated into its magnitude according to $m = -2.5 \log I + const.$

N [1] The most important formula in dynamical astronomy connects the speed on a circular orbit v with the mass and distance to the central mass M : $v = GM/r$