Quiz 2

NAME: _____ SCORE: _____

Subject: Introduction to Astrophysics and Cosmology
Date: Thursday 16 December 2022
Duration: 60 minutes
Credits: 24 points, Type of evaluation: Quiz

This quiz consists of closed-book concept questions. Provide answers to the following items. Each question is 1 point.

1. Which 4 concepts do the basic stellar structure equations describe?
   - mass conservation
   - hydrostatic equilibrium
   - energy conservation
   - energy transport
2. What does the Virial theorem specify for a star?
   $2E_T + E_G = 0$ → or half of the gravitational potential energy is converted into thermal energy
3. What is the criteria for convection to happen? (also specify the physical phenomena not just the name)
   Schwarzschield stability criteria
   → steepness of the temperature gradient
4. What is the Voight-Russel theorem of stellar models?
   → that stellar models have unique solutions
5. Is the Voight-Russel theorem valid? Shortly say why.
   No. Stellar models don't have unique solutions. There is a solution for regular matter and at least one for degenerate matter.
6. What does the mass-luminosity relation say about stars?
   $L \propto M^3$ ⇒ more massive stars are more luminous
7. How does the lifetime of a star relate to the mass of the star?
   $\tau \propto M^{-2}$ ⇒ more massive stars have shorter lives

8. What is the spectral type of the Sun?

G

9. What type of stars are O stars? Young, or old stars? Low mass or high mass stars?

Young, high mass stars.

10. Shortly describe how we can use globular clusters to measure distances.

→ making an HR diagram of a globular cluster → matching the main sequence to the main sequence of nearby stars → gives the absolute luminosity for glob. cluster → gives absolute mag → use distance modulus to calculate distance

11. How can we observationally determine the composition of stars? Does the composition stay the same during the lifetime of a star?

→ trough spectral lines in a stars spectra

→ no, the composition doesn't stay the same, because of the continous nuclear fusion inside the star

12. What effect can we use to measure the strength of the magnetic field in a star?

Zeeman splitting of spectral lines

13. What kind of stars are on the main sequence of the Herzsprung-Russell diagram?

Stars that burn hydrogen into He ~~at their proton~~ in their centres.

14. What are brown dwarfs?

Objects that are between the mass of a star and a planet. They are too small to start nuclear fusion in their centres

15. In which part of the Herzsprung-Russel diagram is a star located if it is burning He for energy production?

In the red giant section → upper right side of the diagram.

16. What defines the upper limit for the mass of stars? (also specify the physical process not just the name)

Eddington luminosity limit → the limit on radiation pressure before it destroys a star.

17. What is the name of the quantum mechanical process that makes nuclear fusion inside of stars possible?

tunneling

18. How does the nuclear energy generation rate change with temperature?

The nuclear energy generation rate increases (gets more effective) with temperature.

19. In which part of massive stars does convection happen?

In the core.

20. Name the 3 most important chains/cycles of nuclear fusion inside of stars.

① pp: pp1, pp2, pp3 (proton-proton chain)
② CNO cycle
③ triple α process

21. Which one of the 3 nuclear fusion chains/cycles occurs at the lowest temperature? Is this the most efficient process to produce energy?

pp chain, it is not the most efficient.

22. Can uranium be produced trough nuclear fusion inside of a star?

No. Iron is the heaviest element that can be produced though nuclear fusion.

23. How can we observationally probe the nuclear reactions happening inside of a star?

By detecting neutrinos from the Sun.

24. How can we observationally map the density distribution inside of a star?

With asteroseismology → observing oscillations of a star.

25. Bonus question (for extra point): What does the phrase "We are all stardust" refer to?

All heavy elements (after He) are produced either inside of a star or by an exploding star (supernova).