Israel Open Astronomy Olympiad 2025

Junior age group set

In this problem, you will have to select one of several options in multiple text fields, so that the text is correct from the astronomical point of view. Each correct answer will give you 1.25 p.

The first star (20 p.)

According to the [Aristotle] / [Newton's laws] / [Big Bang theory] / [Star Wars], the matter and energy were first almost homogeneously distributed in the space of the Universe. Later, due to [gravity] / [nuclear forces] / [friction] / [heat conduction], the dark matter formed the first denser clumps, but the normal (baryonic) matter was stopped from forming structures by the radiation pressure. Only after the first 300 thousand years, when the cosmic [neutrino] / [microwave] / [X-ray] / [ultraviolet] background radiation was emitted, the normal matter started to fall into gravity influence of the dark matter and form the first matter structures. This was the time before the first [stars and galaxies] / [chemical elements] / [atoms] / [photons] formed.

As the baryonic matter clumps attracted, neared each other and merged, the shock waves heated the matter, stopping further collapse. The heated clumps gradually radiated away the heat energy and continued shrinking. The cores of the clumps became ever denser and hotter. Finally, when temperature in the core exceeded about one [degree] / [thousand degrees] / [million degrees] / [billion degrees], the nuclear reactions started. This was the birth of a first generation star that, due to historical reasons, we call [Population I]/[Population II]/[Population III]/[Population Z] star. In contrast to the next star generations, it consisted almost exclusively from [hydrogen] / [helium] / [carbon and oxygen] / [hydrogen and helium] / [hydrogen, helium, carbon and oxygen].

In the center of the star, the [nuclear fusion]/[nuclear fission]/[chemical]/[ionization] reactions produced helium from hydrogen. Then, when the hydrogen in the center was exhausted, the star started to produce [hydrogen] / [dust] / [heavier chemical elements] / [black holes] from helium.

Nuclear fuel burning gave rise to an immense amount of energy. This energy penetrated to the stellar envelope and then was emitted from the star [solid surface] / [liquid surface] / [center] / [photosphere] mostly in the form of ultraviolet radiation that ionized the surrounding medium. Gradually, during next one [year] / [thousand years] / [million years] / [billion years], the early stars ionized most of the normal matter in the Universe, and it has been ionized since then.

The first-generation stars were very massive, about 300 solar masses, and burned out its nuclear fuel in only a few [years] / [thousand years] / [million years] / [billion years]. After that, the star was not able to withstand the gravity of its core and collapsed into a [planet] / [nebula] / [red dwarf] / [black hole]. During the collapse, the external layers enriched with heavy elements (carbon, oxygen, and others) were expelled from the stars in [nova explosion] / [supernova explosion] / [quasar explosion] / [galactic destruction event]. Another option for the end of life of even more massive first stars is core collapse without explosion, when part of the star matter is ejected in relativistic jets, like we see in many [nova stars] / [supernovas] / [quasars] / [galaxies].

Nowadays, astronomers look for signals from these first-generation stars in [our Solar system] / [high-redshift galaxies] / [gamma-ray bursts] / [fast radio transients] and in the outskirts of our

own galaxy called the [Milky Way] / [Sagittarius] / [Coma] / [Laniakea], but all searches so far did not lead to any definite find.