1. The sun produces energy in its core by:
(A) burning hydrogen with oxygen.
(B) splitting hydrogen apart to make lighter elements.
(C) combining hydrogen together to make heavier elements.
(D) the radioactive decay of unstable elements.
(E) (Unsure/guessing/lost/help!)

2. To maintain a stable size, the sun uses __________ to counteract gravity.
(A) hydrogen fusion.
(B) degenerate matter.
(C) convection currents.
(D) strong winds.
(E) (Unsure/guessing/lost/help!)

3. Fusion requires high temperatures such that nuclei can:
(A) break heavy elements apart.
(B) undergo convection.
(C) capture electrons.
(D) overcome repulsion.
(E) (Unsure/guessing/lost/help!)

4. A __________ main-sequence star has the [dimmest luminosity / brightest luminosity / slowest fusion rate / fastest fusion rate / shortest lifetime / longest lifetime].
(A) low-mass (red dwarf).
(B) medium-mass (sunlike).
(C) massive.
(D) (There is a tie.)
(E) (Unsure/guessing/lost/help!)

5. Massive main-sequence stars [are more luminous / have shorter lifetimes] than low-mass main-sequence stars because massive main-sequence stars:
(A) lack hydrostatic equilibrium.
(B) have unstable heavy elements.
(C) have more convection.
(D) fuse hydrogen more rapidly.
(E) (Unsure/guessing/lost/help!)

6. There are no main-sequence stars less than 0.08 solar masses because these stars would not:
(A) be bright enough.
(B) have heavy elements.
(C) be hot enough.
(D) have convection.
(E) (Unsure/guessing/lost/help!)

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7. The main-sequence lifetime of a $\begin{bmatrix} 0.5 \\ 2.0 \end{bmatrix}$ solar mass main-sequence star is __________ the main-sequence lifetime of the sun.
(A) more than twice.
(B) twice.
(C) about the same as.
(D) one-half.
(E) less than one-half.
(F) (Unsure/guessing/lost/help!)

Spectral type	Mass (the sun = 1)	Luminosity (the sun = 1)	Main-sequence lifetime
F0 (medium-mass)	1.7	6.4	3 billion years
G2 (the sun)	1.0	1.0	10 billion years
M0 (low-mass)	0.5	0.08	56 billion years

8. The rate of hydrogen fusion in the core of a $\begin{bmatrix} 0.5 \\ 2.0 \end{bmatrix}$ solar mass main-sequence star is __________ the rate of hydrogen fusion in the core of the sun.
(A) more than twice.
(B) twice.
(C) about the same as.
(D) one-half.
(E) less than one-half.
(F) (Unsure/guessing/lost/help!)

9. The [pink color of an emission nebula / blue color of a reflection nebula / dark brown color of a dark nebula] is caused by:

(A) electrons moving to lower orbitals.
(B) scattered light from stars.
(C) light blocked by dense clouds of gas and dust.
(D) supernovae shockwaves.
(E) (Unsure/guessing/lost/help!)

10. A reflection nebula appears to be blue because its dust particles:

(A) emit blue photons.
(B) absorb red light.
(C) scatter blue light.
(D) have cool temperatures.
(E) (Unsure/guessing/lost/help!)

11. A nebula is observed to have regions of pink, blue, and dark brown colors.

The composition of the [pink / blue / dark brown] color regions is:

(A) hydrogen gas.
(B) very small dust particles.
(C) dense clumps of large dust particles.
(D) helium gas.
(E) (Unsure/guessing/lost/help!)

12. __________ light can be seen from stars behind a dark nebula.

(A) Infrared.
(B) Ultraviolet.
(C) Blue.
(D) Doppler shifted.
(E) (Unsure/guessing/lost/help!)

13. ____________ is evidence that supernova explosions trigger star formation.
(A) Interstellar reddening.
(B) Very dense, giant molecular clouds.
(C) Observations at non-visible wavelengths.
(D) Young stars at shockwave edges.
(E) (Unsure/guessing/lost/help!)

14. __________ provides the energy that heats up a protostar before it becomes a main-sequence star.
(A) Hydrogen fusion.
(B) Supernovae shockwaves.
(C) Gravitational contraction.
(D) Convection currents.
(E) (Unsure/guessing/lost/help!)

15. As a protostar becomes a main sequence star, its size will __________ and its surface temperature will _________.
(A) decrease; decrease.
(B) decrease; increase.
(C) increase; decrease.
(D) increase; increase.
(E) (Unsure/guessing/lost/help!)

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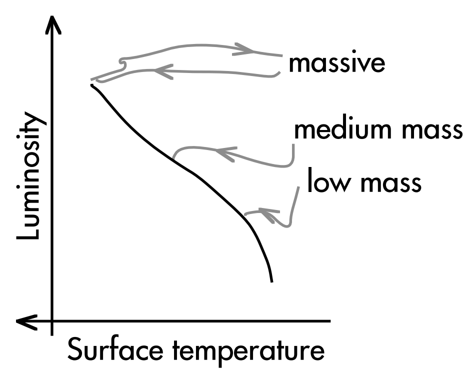
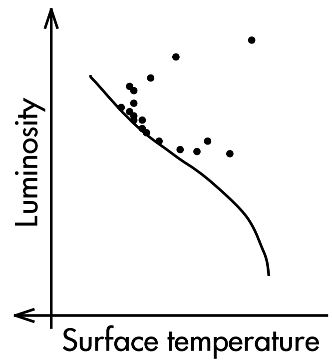
16. At right is an H-R diagram of the evolutionary tracks of stars of different masses.

Which track takes the [shortest / longest] time?



(A) The massive protostar as it becomes a main sequence star, and then becomes a supergiant.
(B) The medium mass protostar as it becomes a main sequence star.
(C) The low mass protostar as it becomes a main sequence star.
(D) (There is a tie.)
(E) (Unsure/guessing/lost/help!)

17. At right is an H-R diagram of a star cluster with stars that are:
(A) all old.
(B) all young.
(C) a mixture of young and old stars.
(D) (This H-R diagram is not possible for a star cluster.)
(E) (Unsure/guessing/lost/help!)



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18. __________ main-sequence stars will be found in an extremely [young / old] star cluster.

(A) Massive.
(B) Medium-mass.
(C) Low mass.
(D) (All of the above choices.)
(E) (Unsure/guessing/lost/help!)

19. __________ will be found in an extremely [young / old] star cluster.

(A) Supergiants.
(B) Medium-mass main-sequence stars.
(C) Red dwarfs.
(D) Giants.
(E) (Unsure/guessing/lost/help!)

20. Low-mass stars in an old star cluster will be in their __________ stage.
(A) protostar.
(B) red dwarf.
(C) white dwarf.
(D) giant.
(E) (Unsure/guessing/lost/help!)

21. The luminosity of a star will remain approximately the same as it becomes a giant (or supergiant) because its outer layers:
(A) expand and heat up.
(B) expand and cool off.
(C) contract and heat up.
(D) contract and cool off.
(E) (Unsure/guessing/lost/help!)

22. A $\begin{bmatrix} \text{massive} \\ \text{medium mass} \\ \text{low mass} \end{bmatrix}$ star will (eventually) end its main-sequence lifetime when:

(A) gravity is too strong.
(B) convection currents stop.
(C) no hydrogen is left.
(D) core temperatures get too cold.
(E) (Unsure/guessing/lost/help!)

23. The energy source of a(n) $\begin{bmatrix} \text{protostar} \\ \text{main - sequence star} \\ \text{supergiant} \\ \text{giant} \\ \text{red dwarf} \\ \text{isolated white dwarf} \end{bmatrix}$ is:

(A) hydrogen fusion.
(B) fusion of elements heavier than hydrogen.
(C) gravitational contraction.
(D) radioactive decay.
(E) (Does not produce energy.)
(F) (Unsure/guessing/lost/help!)

24. A red dwarf will never become a giant because:
(A) no red dwarfs have died yet.
(B) it is made of degenerate matter.
(C) its core will never get hot enough to fuse helium.
(D) it will never run out of hydrogen to fuse.
(E) (Unsure/guessing/lost/help!)

25. A giant will form a planetary nebula by:
(A) expelling its outer layers.
(B) imploding, then exploding.
(C) forming an accretion disk.
(D) breaking down degenerate matter.
(E) (Unsure/guessing/lost/help!)

26. An isolated white dwarf cannot fuse its carbon and oxygen because:
(A) its core will never get hot enough.
(B) it has run out of helium to fuse.
(C) its planetary nebula phase expended its energy.
(D) it is made of degenerate matter.
(E) (Unsure/guessing/lost/help!)

27. As an isolated white dwarf gets older and dimmer, its surface temperature __________, while its size ___________.
(A) cools off; decreases.
(B) cools off; remains the same.
(C) remains the same; decreases.
(D) remains the same; remains the same.
(E) heats up; decreases.
(F) heats up; remains the same.
(G) (Unsure/guessing/lost/help!)

28. In the final stages of fusion energy production, [supergiants / giants / red dwarfs] will fuse:
(A) hydrogen.
(B) helium.
(C) carbon, and heavier elements up to iron.
(D) (None of the above choices.)
(E) (Unsure/guessing/lost/help!)

29. The energy source for a [nova / type Ia supernova / type II supernova] is:
(A) the fusion of an outer layer of hydrogen around a white dwarf.
(B) the fusion of an entire white dwarf.
(C) gravitational contraction.
(D) the fusion of elements heavier than iron.
(E) (Unsure/guessing/lost/help!)

30. A $\begin{bmatrix}\text{nova}\\ \text{type Ia supernova}\\ \text{type II supernova}\end{bmatrix}$ begins when a star:

(A) accumulates enough hydrogen from a companion star.
(B) generates strong stellar winds.
(C) has too much radioactivity.
(D) removes energy from its core using fusion.
(E) (Unsure/guessing/lost/help!)

31. The iron core of a supergiant will collapse because fusion past iron:

(A) removes energy.
(B) generates radioactive elements.
(C) creates too much gravity.
(D) is impossible.
(E) (Unsure/guessing/lost/help!)

32. The sun will never explode as a $\begin{bmatrix}\text{nova}\\ \text{type Ia supernova}\\ \text{type II supernova}\end{bmatrix}$ because it:

(A) will have nothing left after its planetary nebula phase.
(B) did not start with enough mass.
(C) has no companion star.
(D) has a main sequence lifetime that is too long.
(E) (Unsure/guessing/lost/help!)

33. A __________ main-sequence star will become a $\begin{bmatrix}\text{black hole}\\ \text{giant}\\ \text{neutron star}\\ \text{planetary nebula}\\ \text{red dwarf}\\ \text{supergiant}\\ \text{white dwarf}\end{bmatrix}$.

(A) massive.
(B) medium-mass.
(C) low-mass.
(D) (Two of the above choices.)
(E) (All of the above choices.)
(F) (None of the above choices.)
(G) (Unsure/guessing/lost/help!)

34. Which type of compact object $\begin{bmatrix}\text{is the most massive}\\ \text{has the largest size}\\ \text{has the greatest density}\end{bmatrix}$?

(A) White dwarf.
(B) Neutron star.
(C) Black hole.
(D) (There is a tie.)
(E) (Unsure/guessing/lost/help!)

35. A white dwarf with a __________ companion can have a $\begin{bmatrix}\text{nova}\\ \text{type Ia supernova}\\ \text{type II supernova}\end{bmatrix}$ explosion.

(A) giant.
(B) protostar.
(C) neutron star.
(D) black hole.
(E) (This type of explosion is impossible.)
(F) (Unsure/guessing/lost/help!)

36. A __________ with a companion star can have $\begin{bmatrix}\text{nova explosions}\\ \text{a type Ia supernova explosion}\\ \text{a glowing x-ray accretion disk}\\ \text{x-ray pulses}\\ \text{mass} > 3.0 \text{ solar masses}\\ \text{ejected jets}\end{bmatrix}$?

(A) white dwarf.
(B) neutron star.
(C) black hole.
(D) (Two of the above choices.)
(E) (All of the above choices.)
(F) (None of the above choices.)
(G) (Unsure/guessing/lost/help!)

37. Evidence of a $\begin{bmatrix}\text{white dwarf}\\ \text{neutron star}\\ \text{black hole}\end{bmatrix}$ in a binary system would be:

(A) a mass greater than 3.0 M_{Sun}.
(B) regularly timed x-ray pulses.
(C) zero mass.
(D) repeated nova bursts.
(E) (Unsure/guessing/lost/help!)