Name: ______________________________

Please answer the following questions in the space provided. In the case of multiple choice questions, please circle your answer clearly. Try to show *all* your work or thoughts, *even on multiple choice problems*, for chances for partial credit! Good luck!

(1) 1. The vast majority of the light we see coming from the Sun originates from the Sun's:

A. Core

B. Radiation Zone

C. Photosphere

D. Corona

(1) 2. What keeps the Sun's outer layers from continuing to fall inward due to gravitational collapse?

A. Neutrinos produced in the core drag gas outward as they exit the Sun

B. Electromagnetic repulsion between protons

C. Outward pressure due to super-heated gas

D. Electron degeneracy pressure

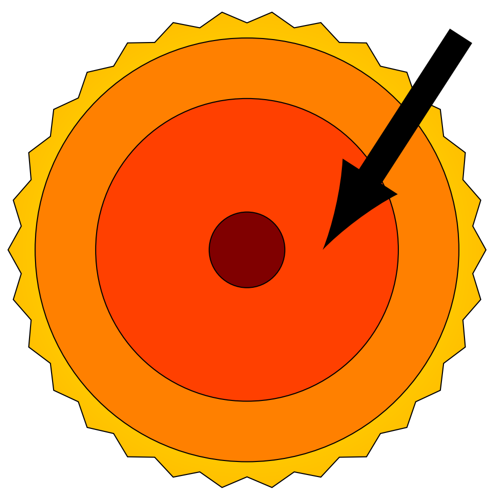
(1) 3. Given the image below, what form of energy movement or creation is happening in the indicated region?

A. Fusion

B. Convection currents

C. Fission

D. Radiation



(1) 4. The force that binds atomic nuclei together is known as the:

A. Gravitational Force

B. Strong Force

C. Electromagnetic Force

D. Dark Side of the Force

5. The giant star Betelgeuse appears to be about 65% as bright as the star Vega.

(2) (a) What is the magnitude of Betelgeuse?

(1) (b) Sirius has a magnitude of -1.46. Will Sirius or Betelgeuse appear brighter in the night sky?

A. Sirius
B. Betelgeuse
C. They will be about the same brightness
D. It will depend on the time of month

(1) (c) Based on the above, which object (Sirius or Betelgeuse) has the greater luminosity?

A. Sirius
B. Betelgeuse
C. They have the same luminosity
D. It depends on the distance they are away

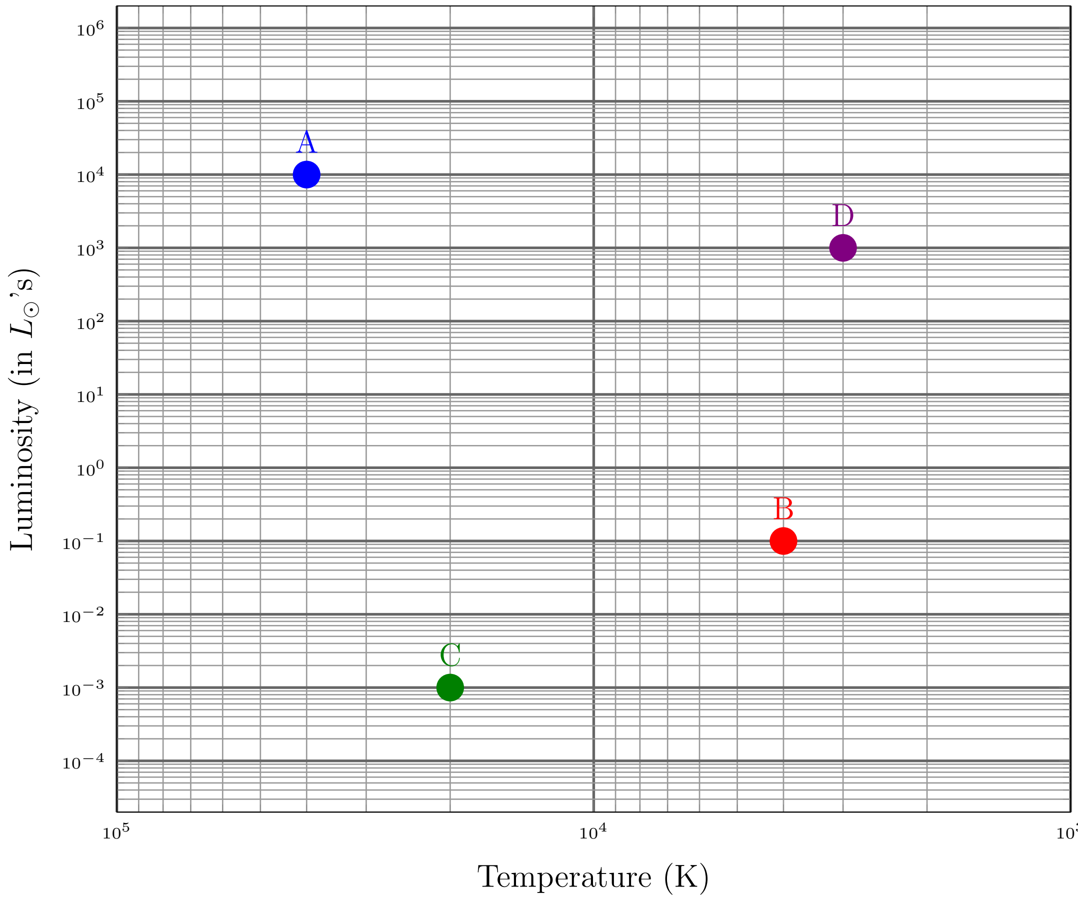
(2) 6. In a high-mass star, which of the following elements can be fused to release energy? Check all that apply.

- ○ Hydrogen (Atomic number 1)
- ○ Helium (Atomic number 2)
- ○ Oxygen (Atomic number 8)
- ○ Aluminum (Atomic number 13)
- ○ Calcium (Atomic number 20)
- ○ Iron (Atomic number 26)
- ○ Silver (Atomic number 47)
- ○ Gold (Atomic number 79)
- ○ Uranium (Atomic number 92)

(1) 7. In June, I measure the position of Star A and Star B relative to background stars. When I do the same measurement the following December, I find that Star A is $10'$ from its original location, whereas Star B is $3'$ from its original position. What can be concluded?

A. Star A is closer to Earth than Star B
B. Star B is closer to Earth than Star A
C. Star A is traveling through space faster than Star B
D. Star B is much more luminous than Star A

8. Use the below Hertzsprung-Russell Diagram to answer the following questions. Please note that the temperature range of this diagram is identical to all those we drew in class, it just may be labeled differently.



(2) (a) Write in the stellar spectral types along the x-axis. You don't need to get them perfectly on the correct temperatures, but at least make sure they are in the correct order.

(1) (b) Put a star next to all the main sequences stars.

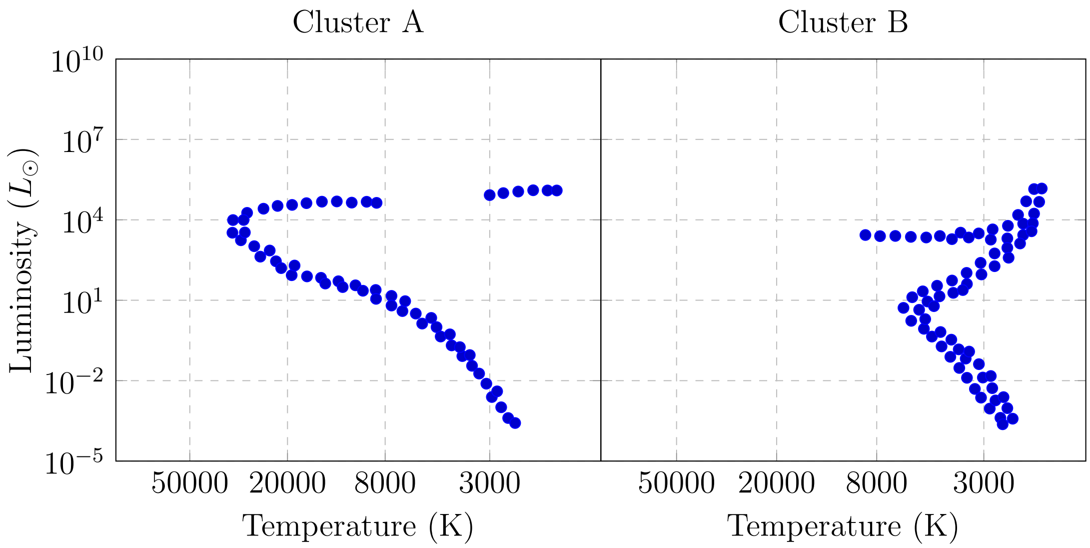
(1) (c) Circle the largest star.

(1) (d) Draw a triangle around the star most likely to be a White Dwarf.

(1) (e) Draw a baby near the main sequence star with the shortest lifetime.

(3 (bonus)) (f) **Extra Credit:** What is the radius (in meters) of the largest star?

9. The two plots below depict stars from two different star clusters. Use them to answer the following questions.



(1) (a) What can be said about the relative age of the clusters?

A. Cluster A is older.

B. Cluster B is older.

C. Cluster A and B are about the same age.

D. It is impossible to say anything about age from these plots!

(1) (b) Which cluster is most likely to be an open cluster?

A. Cluster A

B. Cluster B

(1) 10. You measure the masses of several main sequence stars. Which mass would be most surprising, given what you expect for the masses of main sequence stars?

A. $0.5M_\odot$

B. $10M_\odot$

C. $120M_\odot$

D. $200M_\odot$

(1) 11. What eventually halts the gravitational collapse of a protostar that is *not* massive enough to become a start and reach the main sequence?

A. Hot gas pressure

B. Electron degeneracy pressure (crowding electrons)

C. The central object becomes hot enough to sustain nuclear fusion in its core

D. Nothing, all collapsing gas clouds eventually become black holes

(1) 12. Why are we so interested in detecting solar neutrinos and erecting solar neutrino observatories?

A. Neutrino's carry important information about what is happening in the photosphere of the Sun, and may help us better explain the causes of solar flares.

B. Neutrino's carry important information about what is happening in the core of the Sun, where we can otherwise not see.

C. Neutrino's travel at nearly the speed of light, and thus could be some of our earliest indicators about changes in the behavior of the Sun.

D. Neutrino's carry a large amount of energy with them, and upon striking atoms on Earth give us a chance to study similar fusion reactions to those happening in the Sun.

(1) 13. Solar Flares are thought to be the result of:

A. An outburst of energy from the star, similar to a bubble in a pot of boiling water reaching the surface.

B. Turbulence in the solar wind, causing eddies that swirl around the hot solar gases.

C. Magnetic field lines untangling and dragging hot solar gases with them.

D. Asteroids striking the surface of the Sun and causing a small explosion on the surface.

(1) 14. What is necessary for a white dwarf to potentially explode into a Type Ia supernova?

A. It must spin at a speed faster than the Chandrasekhar limit.

B. It must have a neighboring star to steal mass from.

C. It must have originally formed from a star between 2 and 8 solar masses.

D. It must experience a starquake on its surface that fractures the carbon crust.

(1) 15. What causes the radio pulses of a pulsar?

A. Vibrations in the neutron star crust cause powerful magnetic flares to occur, emitting a powerful radio pulse.

B. The neutron star has beams of radio emission that sweep through space as it spins. If one of the beams crosses Earth, we observe a pulse.

C. The neutron star undergoes periodic explosions of nuclear fusion, generating radio pulses.

D. The neutron star has an orbiting companion that periodically eclipses the radio waves that the neutron star emits.

16. I am approaching a $3M_\odot$ black hole.

(2) (a) How close can I approach the black hole before never being able to return? Answer in kilometers.

(1) (b) Which of the following would *not* happen as I crossed the black hole's event horizon?

A. An observer from Earth would see me slow down as I approached the event horizon until I simply faded from view.

B. I would be stretched into a long, thin string by the black hole's tidal forces.

C. I would experience time to be flowing normally from my viewpoint as I plunged across the event horizon.

D. Looking into the black hole I'd see the history of the universe played back in reverse up until the moment I crossed the event horizon.

Have a terrific Thankgiving break! I'm thankful for all of you! See you on the flipside!