Formula Sheet for the Fianl

$M_{sun} = 1.99 \text{ x } 10^{30}$ kg	1 pc = 3.26 ly	$E = \frac{hc}{\lambda}$	$\alpha > \frac{0.02\lambda}{D}$
$M_{earth} = 5.97 \text{ x } 10^{24}$ kg	1 pc = $3.09 \text{ x } 10^{16}$m	$T = \frac{2.9 \text{ x } 10^6 nm\cdot K}{\lambda_{max}}$	$M_A + M_B = \frac{a^3}{p^2}$
$M_{moon} = 7.35 \text{ x } 10^{22}$ kg	d = vt	$v = c \cdot \frac{\Delta\lambda}{\lambda_o}$	$d_{pc} = \frac{1}{p_{acrsec}}$
$R_{sun} = 6.96 \text{ x } 10^{8}$ m	$F = \frac{GMm}{d^2}$	frac left = $2^{-\frac{t}{H}}$	$E = mc^2$
$R_{earth} = 6.38 \text{ x } 10^{6}$ m	$V = \sqrt{\frac{GM}{d}}$	$\rho = \frac{M}{V}$	$b = \frac{L}{4\pi d^2}$
$R_{moon} = 1.74 \text{ x } 10^{6}$ m	$V = \sqrt{\frac{2GM}{R}}$	$\text{Area}_{sphere} = 4\pi R^2$	$L = \sigma T^4$ x Area
$d_{earth \rightarrow moon} = 3.84 \text{ x } 10^{5}$ km	$g = \frac{GM}{R^2}$	$c = \lambda\nu$	
$G = 6.67 \text{ x } 10^{-11} \frac{m^3}{s^2 kg}$	$p^2 = a^3$	$\frac{r_A}{r_B} = \frac{L_A^{1/2}}{L_B^{1/2}} \frac{T_B^2}{T_A^2}$	$r = \sqrt{\frac{L}{4\pi\sigma T^4}}$
$g = 9.80$ m/s^2	$M = \frac{4\pi^2 a^3}{Gp^2}$		
$c = 3.00 \text{ x } 10^{8}$ m/s	$\frac{L}{2\pi d} = \frac{\alpha}{360^o}$		$L \propto M^{3.5}$
10^9 nm = 10^6 μm = 1 m	$V_{sphere} = \frac{4}{3}\pi r^3$		
1 AU = $1.5 \text{ x } 10^{11}$ m	$A_{circle} = \pi r^2 = \pi D^2/4$		$t \propto \frac{1}{M^{2.5}}$
1 ly = $9.46 \text{ x } 10^{15}$ m	$C = 2\pi r$		
1 y = $3.16 \text{ x } 10^{7}$ s	$\sigma = 5.671 \text{ x } 10^{-8} \frac{W}{m^2 K^4}$		
1000 m = 1 km	$h = 6.62 \text{ x } 10^{-34}$ J s		
1 m = 100 cm			
3600 arcsec = 1 degree	$d = \sqrt{\frac{L}{4\pi b}}$		

Multiple Choice Questions

1. The expected seasonal changes on Uranus because of its orbital and spin-axis alignments, compared to those on Earth, will be
   (A) the same, because the tilt of the spin axis is the same as that of Earth.
   (B) much less, because its orbit is circular.
   (C) absent, because the spin axis is perpendicular to the orbital plane.
   (D) very much exaggerated, because the spin axis is almost in the orbital plane.

2. Which is the eighth planet from the Sun in order of increasing semi-major axis?
   (A) Pluto
   (B) Saturn
   (C) Uranus
   (D) Neptune

3. Most meteor showers occur when Earth moves through the
   (A) orbit of a comet (or of a former comet).
   (B) Kuiper belt.
   (C) asteroid belt.
   (D) Oort cloud.

4. The Sun will leave the main sequence in about ______________ years from now.
(A) 5 million
(B) 100 billion
(C) 100 million
(D) 5 billion

5. The Sun's composition by mass is 71%_______ , 27% _______ and 2% _______.
(A) helium; hydrogen; metals
(B) helium; metals; hydrogen
(C) hydrogen; metals; helium
(D) hydrogen; helium; metals

6. A neutrino produced in the nuclear furnace in the core of the Sun can
(A) penetrate easily through both the gas of the Sun's interior and the solid Earth.
(B) penetrate easily through both the gaseous Sun's interior and the solid Earth but will be easily stopped by chemicals containing chlorine.
(C) penetrate easily through the Sun's gaseous interior but will be stopped just below the surface of the solid Earth.
(D) penetrate easily through the Sun's interior but will be deflected away from Earth by its magnetic field.

7. The space between the stars is known to contain
(A) a large quantity of dust but no gas at all.
(B) a variable amount of gas but no dust at all.
(C) a perfect vacuum.
(D) both gas (atomic or molecular) and dust.

8. Prior to reaching the main sequence, a protostar's energy comes mostly from
(A) gravitation.
(B) nuclear fusion.
(C) nuclear fission.
(D) natural radioactivity.

9. In which binary system can we observe both stars separately and follow their orbits around each other?
(A) Visual binary system
(B) Spectroscopic binary system
(C) Eclipsing binary system
(D) Apparent binary system

10. Parallax of a nearby star is used to estimate its
(A) distance from Earth.
(B) apparent magnitude.
(C) physical size or diameter.
(D) surface temperature.

11. The chemical makeup of a star's surface is usually determined by
(A) spectroscopy of the light emitted by the star.
(B) examining the chemicals present in a meteorite.
(C) theoretical methods, considering evolution of the star.
(D) measuring the Zeeman splitting of ions on its surface.

12. After a star becomes a red giant, hydrogen fusion
(A) no longer occurs.
(B) occurs in the core.
(C) occurs in a shell around the core.
(D) occurs only during the helium flash.

13. The ^{12}C and ^{16}O, which now form part of living matter, were part of the cold, dark nebula from which the Sun formed. How did they get there?
(A) They were part of the original Big Bang and thus part of everything formed since then.
(B) They were formed by earlier generations of stars while they were on the main sequence.
(C) They were formed by earlier generations of stars while they were in their red giant phase.
(D) They were formed in an earlier supernova explosion and dissipated through space.

14. A "carbon star" has more carbon on its surface than does the Sun. This is the result of
(A) neutrinos, which escape easily from the core of a star but react with the cool hydrogen at its surface to form carbon.
(B) helium flash, in which the explosion blasts carbon from the core into the surface layers.
(C) dredge-up, in which the convective envelope transports material from a star's core to its surface.
(D) mass loss, which strips away the outer envelope from an old star and reveals the carbon-rich core.

15. The final remnant of the evolution of a red giant star that has ejected a planetary nebula is a
(A) blue supergiant.
(B) neutron star.
(C) supernova.
(D) white dwarf star.

Short Answer Questions

1. What is unusual about the axis of rotation of Uranus?

   The axis of rotation of Uranus is tilted at over 90^o (97.9^o) with respect to the planets orbital plane. In effect it has been knocked on its side. This leads to extremely long seasons.

2. What causes meteor showers to occur at certain points as the Earth moves around its orbit.

   Meteor shows occur when the Earth's orbit passes through the debris left in a comet orbit. The comet can be intact that has passed by or a comet that has broken up due to the gravity of the Sun or Jupiter.

3. What powers a **protostar**?

   A protostar is powered mainly by gravitational energy (Kelvin Helmholtz energy) before hydrogen fusion begins.

4. What important information can be determined from a visual binary star system.

   Visual binary star systems can be used to determine the mass of each star. The period (T) and separation (a) of the orbits determine the sum of the masses from Newton's version of Kepler's law. By plotting the orbits, the ratio of the masses can be determined. This allows the mass of each star to be determined.

5. Where do stars form?

   Stars form in dark nebula which are cold (10 K) and relatively density (100 to 10,000 particles per cm^3)

6. What type of star is the most common (85% of all stars) and what are their mass and lifetime.

   Red dwarf starts are the most common. The have small masses (0.08 - 0.4 $M_\odot$) and low temperature (M spectral class or < 3900 K). Red dwarf stars have lifetimes of trillions of years (much longer than the age of the universe.)

7. What are Cepheid variable stars and how are they used to determine distance?

   The luminosity of a Cepheid variable changes periodically. By measuring the period of the change in brightness, the luminosity can be determined. If the luminosity is known, the the $\frac{1}{d^2}$ law give the distance to the star.