Reach for the Stars 2002 Grading Rubrics. Each question is worth 3 points.

1. T Tauri stars have strong emission lines of which elements? Which of these lines are not found in normal stars? What does this tell us about T Tauri stars.

1. H, Ca II, and K.
1. Also show Fe I, Fe II, S, and Ti II which are forbidden lines in normal stars.
1. Seen in objects of low density like gaseous nebulae.

2. Where can T Tauri stars be found on an H-R diagram? What does this tell us about them?

1. Above the main sequence.
1 Brighter than normal stars, and younger.
1 Low mass, collapsing to approach the main sequence.

3. List all the steps of fusion in the Proton-proton 1 chain reaction. Based on the change in mass between the starting and ending particles in this reaction, "calculate" (and show your work) the energy released in this reaction.

1 H1 + H1 >> D2 + e^+ + neutrino
D2 + H1 >> He3 + gamma
He3 + He3 >> He4 + H1 + H1
1 Change in mass = 1 He4 - (4 H1 + 2 electrons)
M>>He4 = 4.0282
FINISH THIS UP
1. Energy =mc^2

4. Approximately much time does it take a 1 solar mass protostar to arrive on the main sequence? How much time does it take a 5 solar mass protostar to arrive on the main sequence?

1.5 30 million years,
1.5 0.7 million years

5. Consider a cloud of gas that may collapse to form a star. In its early stages, the temperature of this cloud of Hydrogen gas is 10 K. What is the average speed of the hydrogen atoms in this cloud? Hint:Use the Boltzmann relationship.

1.0 3/2 kT= 1/2 mv^2
1 k=1.38^-23 m=1.67^-27
1 v=0.5 km/s

Draw on the following H-R diagram where you would find

6: The nuclei of planetary nebulae
7: White Dwarfs
8: The Main Sequence
9: Red Giants
10: Red Super giants

11: What physical principles keep a white dwarf from collapsing? What is the maximum mass of a white dwarf in solar masses?

1 A white dwarf is a degenerate electron gas.
1 Due to the Pauli Exclusion princple, the electrons cannot pack into a tighter volume.
1 Maximum mass is 1.4 solar masses.

12: A Type II Supernovae is found in what kind of galaxy? At maximum brightness, what is the wavelength of its most prominent emission line?

2pts Found only in Spiral Galaxies (especially in the spiral arms, they are Population I).
1 pt They emit the Hydrogen Alpha Line at 656.3 nm which is1st line in the Balmer sers

13: Why if a stellar corpse has a mass greater than 1.4 solar masses does it form a neutron star. Why is it made of neutrons, and why does the neutron star not collapse?

1 pt Enough density/gravity to overcome electron degeneracy,
1 pt so they fuse with protons into neutrons.
1 pt Neutron degeneracy prevents it from collapsing.

14: Why does a pulsar pulse?

a. what is the physical source of this radiation
b. why is it pulsing?

1 pt As the pular spins, its enormous magnetic field induces an enormous electric field at its surface which pulls charged particles (mostly electrons) off the solid crust of iron nuclei. They flow of electrons into the magnetosphere.

1 pt The accelerated electrons emit synchrotron radiation.
1 pt The star is rotating.

15. Derive the Schwarzchild radius from conservation of energy. Express the radius in terms of mass of the star, the speed of light, and the Universal Gravitational Constant.

1 pt 1/2 mv^2 = GmM/R
2 pts R=2GM/c^2

16. Globular Clusters contain what population of stars? Are they old or young stars (how old)? How can we tell this from the spectrum?

1 pts Population II stars,
1 pt very old 12 to 15 billion years,
1 pt low metal abundance in the spectra

17. What is the sum of the stellar masses in a visual binary of period 40 years, maximum separation of 5.0", and parallax 0.3"? Assume an orbital inclination of zero and a circular orbit.

1 pts Kepler's Law says: (M1+M2)P^2=a^3 = (a"/pi")^3
2 pts 115 Solar Masses

18. How do we find the ratio of masses in a spectroscopic binary system?

1 pts Double spectral line due to Doppler Shifting. This gives us the orbital velocity.
1 pts We can find the mass if we can find the radius of the orbit,
1 pts and we can do that if we know the orbital velocity and the period.

19. If the stars at the turn-off point in a star cluster have masses of about 4 solar masses, how old is the cluster?

1 pts T=1/m^2.5 =
2 pts 1/32 solar lifetime = 1/ 32 * 10EE9 yrs = 3. 10 EE8 years
Its actually 1/m^2.3 = 1/24.2 solar lifetimes = 1/24.2 * 10EE9 yrs = 4.13 EE 8 years

20. Gliese 229B is what type of star? Why is it difficult to see?

1 pts Brown Dwarf.
1 pts Not enough mass (only 20 to 60 Jupiter masses) to obtain solar ignition.
1 pts Drowned out by 229A

21. Identify the following object. What is its name? What is it? Where is it?

1 pts NGC 2244, also called the Rosetta Nebulae.
1 pts It is an Open Cluster in
1 pts Monoceros. The open cluster is within the Nebulae.

22. What type of star is SS Cygni? What is the usual period of oscillation for this type of star? Why does this star oscillate?
    1 pts Cataclysmic Variable star of the dwarf nova class.
    1 pts 40 to 100 days,
    1 pts Consists of a red dwarf and a white dwarf, the RD accretes onto the WD.
    Brightness is the result of a sudden mass transfer which is not well understood.

23. What is Mayall II? Where is it? In what was does it exceed all other objects like it in which area?
    1 pts Globular Cluster G1
    1 pts in M31, The Androemeda Galaxy.
    1 pts Brightest Globular Cluster in the Local Group.

24. What is Circinus X-1? What are the two types of stars in this system? Circinus X-1 has spectral lines named after what star?
    1 pts X-Ray Binary System.
    1 pts Consists of a normal star with a neutron star which has an accretion disk.
    1 pts Spectral X-ray line after P cygni.

25. What is the name of this object, what is this object, and in what constellation is it located?
    1 pts NGC 6543 or the Cat-eye nebulae,
    1 pts it is a planetary nebular,
    1 pts and it is located in Draco.

26. Why is Eta Carinae prone to such great variable oscillations. There are those who claim that a near-by type 2 supernova could finish us off. How close is too close to be to a Type 2 Supernova explosion, and is Eta Carninae a concern?
    1 pts Is has such variability because of its large mass, 100-150 solar masses.
    1 pts 50 LY is too close for a type 2 Supernovae.
    1 pts Eta Carinae is 3700 LY away.

27. LP944-20 is what kind of star found is what constellation? Is the pride of being the first of its kind to be observed to do what, and at what wavelength was this observation made?
    1 pts Brown dwarf
    1 pts found in Fornax.
    1 pts X-Ray observation of 1st Brown Dwarf to Flare.

27. What is the second largest and second brightest globular cluster in the sky? Who cataloged it as a nebulous object and when? What constellation is it in?
    1 pts 47 Tucanae,
    1 pts Discovered in 1751
    1 pts by Lacaille

28. What is M4, where is it, and what was discovered here in 1987?
    1 pts Globular cluster
    1 pts in Scorpius,
    1 pts and a millisecond pulsar discovered there.

29. What happens in the rho Ophiuchi molecular clouds? What wavelengths does the dust in the clouds absorb and emit in?
    It is a stellar nursery. Emits in the infrared, absorbs in the visible and X-ray.

30. Why does the gas in the Trapezium Glow? Why has star formation in the Trapezium stopped? Why is there star formation in the Orion Molecular Clouds?

1 pts The hot O and B stars emit large amounts of UV radiation which ionizes the hydrogen gas which creates the glowing clouds.

1 pts The hot ionized gas expands and cools, and thus is not dense enough for star formation.

1 pts However the ionized gas pushing against the rest of the molecular clouds will trigger more protostar collapse.

31. Prove that pulsars must have neutron star densities (4 x 10^16 kg/m3) using geometry, centripetal force, Law of Gravitation. Suppose that the period of the pulsar is 2 milliseconds.

TIE BREAKER QUESTION

1 pts $V^2/R = GM/R^2$

$V= (GM/R)^{1/2}$

1 pts $P=2piR/V$

$P=2piR/(GM/R)^{1/2} = 2piR^{3/2}/(GM)^{1/2}$

But $M = (4/3)\ piR^3\rho$

$P= \ 2piR^{3/2}/[G\ (4/3)\ piR^3\rho)]^{1/2}$

1 pts $= 3.8 \text{ x } 10\text{^}5 / \rho^{1/2}$

Thus for a period of say 2ms ➔ $\rho=$ 4 x 10^16 kg/m3

32. The Crab pulsar was the first pulsar discovered which had what property about the type of radiation its pulses emits? It was also the first pulsar to exhibit what phenomena in the timing of its pulsing? Where is the rotational kinetic energy of the pulsar going?

1 pts It has both optical and radio pulses.

1 pts Its pulsing is slowing down.

1 pts The rotational KE is being converted into kinetic and radiative energy of the nebula.

33. The radiation from the Crab nebulae is a continuous spectrum and highly polarized. The nebula is also a strong radio emitter and both its optical and radio emission has a wavelength emission that does not follow the Plank blackbody curve. What type of radiation is emitted from the nebula and how are the above statements proof of this?

1 pts Synchrotron radiation, which is non-thermal radiation.

1 pts When energetic electrons are accelerated by a magnetic field, they spiral along the magnetic field lines, thus emitting strongly polarized continuous radiation.

1 pts The intensity as a function of wavelength depends upon the magnetic field strength and the energy of the electrons.