Name: .....

# ASTRONOMY 1102 – 1

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**Third Test –FALL 1999– Friday November 12**

**Part I – Multiple Choice questions** (3 pts/question; total = 60 pts)
Identify the correct answers by placing a check between the brackets [ ]. Check **ALL** correct answers in the questions identified by a *.

*1) Some are wrong; which are correct?
- [ ] The sun will die as a neutron star.
- [x] The sun will die as a white dwarf.
- [x] brown dwarfs and white dwarfs cool to become black dwarfs.
- [ ] low mass stars produce black holes.
- [ ] A 20 $M_\odot$ star will die as a white dwarf.

2) The absolute magnitude of a star is a measure of the star's
- [x] luminosity.
- [ ] surface temperature.
- [ ] mass.
- [ ] apparent brightness.
- [ ] density.

3) The apparent magnitude of a star is a measure of the star's
- [ ] luminosity.
- [ ] surface temperature.
- [ ] mass.
- [x] apparent brightness.
- [ ] density.

4) As a star cluster ages
- [x] the bluest MS stars are the first to evolve to red supergiants.
- [ ] the red dwarfs leave the MS first.
- [ ] the white dwarfs become red dwarfs.
- [ ] white dwarfs are produced before neutron stars.
- [ ] all stars experience the Helium flash sooner or later.

5) Cepheids are pulsating variables
- [ ] whose luminosity is the same for all periods.
- [ ] whose luminosity is smaller the shorter the period.
- [x] whose luminosity is larger the longer the period.
- [ ] only found in globular clusters.
- [ ] because they are binary stars.

6) The net effect of the CNO cycle is to fuse
- [ ] $4\,{}^4\mathrm{He}_2 \rightarrow \mathrm{H}$.
- [x] $4\,{}^1\mathrm{H}_1 \rightarrow {}^4\mathrm{He}$.
- [ ] Carbon to Oxygen.
- [ ] Carbon to Iron.
- [ ] Carbon to Nitrogen and Nitrogen to Oxygen .

7) A binary that can be resolved by telescopes is known as
[x] a visual binary.
[ ] a spectroscopic binary.
[ ] an eclipsing binary.
[ ] double-lined spectroscopic binary.
[ ] a Cepheid.

8) The essence of the Algol Paradox in a binary is that
[ ] the more massive star is more evolved.
[x] the less massive star appears more evolved.
[ ] the more massive star is larger.
[ ] the more massive star is more luminous.
[ ] the donor is a blue star.

9) Which evolutionary stage occurs earlier in the life of a low mass star?
[ ] Helium flash.
[ ] Horizontal Branch (HB).
[ ] Asymptotic Giant Branch (AGB).
[x] Main Sequence (MS).
[ ] White Dwarf (WD).

10) These processes immediately precede and lead to the formation of a neutron star:
[ ] core degeneracy and Helium flash.
[x] photodisintegration, neutronization and bounce.
[ ] conduction, radiation and convection.
[ ] thermal pulses and the expulsion of a planetary nebula.
[ ] core exhaustion of Hydrogen and the formation of a H-burning shell.

*11) True statements about the evolution of high mass stars:
[x] they do not experience the Helium flash.
[x] the Fe core is surrounded by multiple shells burning different fuels.
[ ] they produce white dwarfs.
[ ] they die in a Type I or Carbon detonation supernova.
[x] they die in a Type II or core collapse supernova.

12) A nova explosion occurs when
[ ] a low mass star produces a white dwarf.
[x] a white dwarf accretes enough H-rich material from a companion.
[ ] a massive star collapses to yield a black hole.
[ ] a neutron star accretes enough material from a companion.
[ ] a neutron star forms.

13) The redder the main-sequence turnoff,
[x] the older the cluster.
[ ] the younger the cluster.
[ ] the smaller the number of RGB stars in the cluster.
[ ] the bluer the main-sequence.
[ ] the more black holes form.

14) The internal structure of an asymptotic red giant:
[x] Inert C core, He shell burning, H shell burning, inert H-rich envelope.
[ ] Inert He core, H shell burning, inert H-rich envelope.
[ ] core He burning, H shell burning, inert H-rich envelope.
[ ] core H burning, inert H-rich envelope.
[ ] Inert C core, He shell burning, inert H-rich envelope.

15) A white dwarf is supported against its own gravity by
[ ] the strong force.
[ ] the neutron degenerate pressure.
[x] the electron degenerate pressure
[ ] the thermal pressure of an ordinary gas .
[ ] the electromagnetic force.

16) A Type I Carbon detonation supernova occurs when
[ ] a HB star exhausts its He.
[ ] the iron core of a massive star collapses.
[ ] every time a white dwarf has accreted a small amount of H-rich material.
[x] the mass of a white dwarf is driven over the Chandrasekhar limit by accretion.
[ ] a black hole forms.

17) Single isolated pulsars are extraordinarily good, stable clocks, and yet as they age,
[ ] they spin faster and the pulse period decreases.
[x] they spin slower and the pulse period increases until pulsed emission ceases.
[ ] they are spun up again by accretion.
[ ] they become red giants.
[ ] their rotation frequency increases.

18) The absorption lines of hydrogen are strongest in stars of spectral class
[ ] A because they are the hottest.
[ ] O because they are the hottest.
[ ] B because the temperature is just right.
[x] A because the temperature is just right.
[ ] M because they are the coolest.

19) What is a black hole candidate?
[ ] A massive star which is about to collapse.
[x] An X-ray binary where the mass of the accretor exceeds 3 $M_{\odot}$..
[ ] An intermediate mass star.
[ ] A cataclysmic variable.
[ ] A supernova of Type I.

20) An X-ray burst occurs when
[ ] enough H has accumulated on the surface of a white dwarf.
[x] enough He has accumulated on the surface of a neutron star.
[ ] enough H has accumulated on the surface of a black hole.
[ ] enough C has accumulated on a red dwarf.
[ ] a massive star goes supernova.

**Part II – Problems** (10 pts/problem; total = 40 pts) **NO CALCULATORS!**

*Problem 1:* The H-R diagrams of four star clusters are shown schematically below. Based on these sketches, which one is the youngest and which is the oldest cluster

*See Figure*

*Problem 2:* The following table shows data for several well-known bright stars. Note that $M_v$ is the absolute magnitude and $m_v$ is the apparent magnitude.

| Name | $m_v$ | $M_v$ | Spectral Type |
|---|---|---|---|
| Canopus | -0.72 | -3.9 | F0I |
| $\alpha$ Cen A | -0.01 | +4.4 | G2V |
| $\alpha$ Sco | +0.9 | -4.5 | M1I |
| Sirius | -1.4 | +1.4 | A1V |
| Spica | +0.9 | -1.4 | B1V |
| $\alpha$ Tau | +0.9 | +0.9 | K5III |

a) Which of the stars appears brightest in the sky? *Sirius: it has the smallest (most negative) APPARENT magnitude* $m_v$

b) Which is the most luminous star? $\alpha$ *Sco: it has the smallest (most negative) ABSOLUTE magnitude* $M_v$

c) Which is the star with the largest radius? $\alpha$ *Sco: it is on the top right of the HRD.*

d) Which stars have exahusted H in their cores? *Canopus,* $\alpha$ *Sco,* $\alpha$ *Tau: they are NOT MS stars.*

e) Which star has the highest surface temperature and appears bluest? *Spica: is the leftmost spectral type listed.*

*Problem 3:* On the diagram shown overleaf plot and label clearly the approximate position of the following stars:

*See Figure*

a) B9V
b) M0V
c) K5I
d) A central star of a planetary nebula whose surface temperature is $10^5$ K and whose luminosity is 1000 $L_\odot$.
e) A white dwarf of spectral type A0.

*Problem 4:* The diagram overleaf shows the luminosities of stars plotted against their surface temperature. The thick curved line with embedded arrows shows the evolutionary track of a star like the sun from protostar to white dwarf. Answer the following questions:

*See Figure*

1.– What is the name given to this kind of diagram?
*Hertzsprung–Russell Diagram (Ejnar Hertzsprung and Henry Norris Russell)*

2.– *Mark and label the point at which this star reaches the ZAMS.*

3.– *Mark and label the point at which this star experiences the He flash.*

4.– *Mark and label the point at which this star is burning steadily He to C in the core and H in a shell surrounding the core.*

5.– *Identify which portion of the track corresponds to the RGB.*