October 6, 2006 Name:________________________

# Astronomy 102: Examination 2

## Do not open the test until instructed to begin.

*You must do this test on your own without consulting any outside notes. You may not discuss this test with anybody else either before or during your taking of the test. You are allowed a calculator for purposes of arithmetic, but you may not use any device that connects you to a network or allows you to communicate with any other people.*

**I confirm that I did not receive any help, nor did I reference any disallowed materials in doing this test.**

**Signature:**______________________________

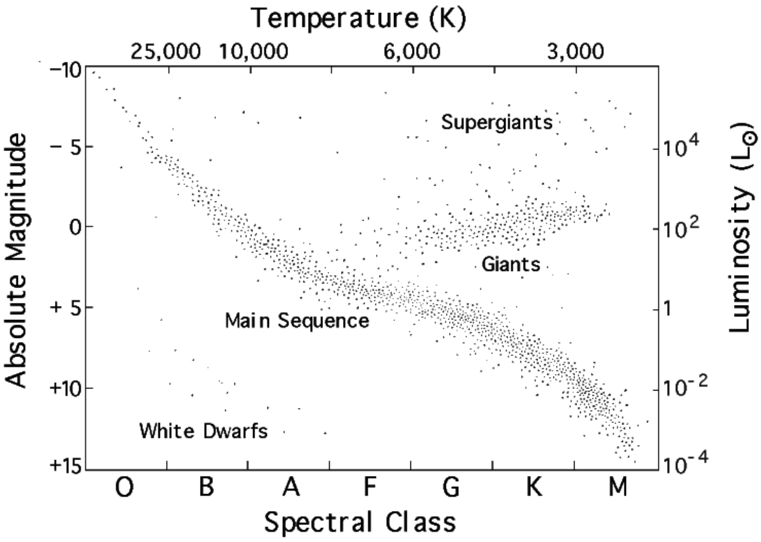
**Instructions:** Write your answers in the space provided. If you need additional space, continue on the back of each page, but indicate **clearly** that you have done so. No books, notes, or assistance from anyone is allowed. You are allowed to use, and will need, a calculator. Please **write legibly and be brief and to the point!** The exam has four questions; each question has equal weight.

**Possibly Useful Constants and Formulae**

$$R_\odot = 6.96 \times 10^5 \text{ km}$$
$$M_\odot = 1.99 \times 10^{30} \text{ kg}$$
$$L_\odot = 3.8 \times 10^{26} \text{ W}$$
$$c = 3.00 \times 10^8 \text{ m s}^{-1}$$
$$h = 6.626 \times 10^{-34} \text{ J s}^{-1}$$
$$1\,\text{pc} = 3.26 \text{ lyr}$$
$$1\,\text{pc} = 206,265 \text{ AU}$$
$$1\,\text{pc} = 3.086 \times 10^{16} \text{ m}$$
$$1\,\text{AU} = 1.496 \times 10^{11} \text{ m}$$
$$1\,\text{km} = 1,000\,\text{m}$$

$$E = m\,c^2$$
$$\lambda\,f = c \qquad f = \frac{c}{\lambda} \qquad \lambda = \frac{c}{f}$$
$$E = h\,f$$
$$L = A\,\sigma\,T^4$$
$$L = (4\pi\,R^2)\,\sigma\,T^4$$
$$B = \frac{L}{4\pi\,d^2}$$
$$z = \frac{\Delta\lambda}{\lambda} = \frac{\lambda_{\text{obs}} - \lambda_{\text{orig}}}{\lambda_{\text{orig}}}$$
$$z = \frac{v}{c} \quad (\text{for v} \ll \text{c})$$

| | |
|---|---|
| Age of Solar System: | $4.6 \times 10^9$ years |
| Age of Universe: | $13.7 \times 10^9$ years |
| Lifetime of 1 $M_\odot$ star (type G on main sequence): | $10^{10}$ yr (10 Gyr) |
| Lifetime of 3 $M_\odot$ star (type A on main sequence): | $4 \times 10^8$ yr (400 Myr) |
| Lifetime of 8 $M_\odot$ star (type B on main sequence): | $4 \times 10^7$ yr (40 Myr) |
| "High-mass" star (will go supernova): | $M > 8\,M_\odot$ |




**1.** You observe three stars. One star is a G-type very similar to the Sun. The second star is a bluish star with a surface temperature of 15,000 K. The third star is a reddish star with a surface temperature of 3,500 K.

You will probably find it convenient to refer to the H-R diagram above in answering this question.

**(a)** What are the spectral classifications (OBAFGKM) of the reddish and bluish stars?

**(b)** Assume that the Sun-like star has not only the same temperature, but also the same radius as our Sun. It is only $2.4 \times 10^{-13}$ as bright as the Sun in our sky. (That's why it's day when the Sun is up!) How far away is this star in pc?

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**(c)** Suppose that all three stars have the same observed brightness in our sky. You've measured the distance to the bluish star to be 100 pc. Is this star a supergiant, a main sequence star, or a white dwarf? Justify your answer.

**(d)** Suppose that all three stars have the same observed brightness in our sky. You've measured the distance to the reddish star to be 100 pc. Is this star a giant or a main sequence star? Justify your answer. (Hint: before you start cranking numbers, think about how this question relates to (c).)

**2.** Spiral galaxies are forming stars all the time; a galaxy like ours will have stars that were formed billions of years ago, and stars that have just formed, and everything in between. Most elliptical galaxies, however, last formed stars a few billion years ago. If you look at the overall color of a spiral and an elliptical galaxy, how do you expect them to compare? Explain.

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**3.** The 6563Å line of Hydrogen from the Andromeda galaxy is observed at 6556Å.

**(a)** Is the Andromeda galaxy moving towards us or away from us?

**(b)** How fast (at what speed) is the Andromeda galaxy moving along the line of sight?

**(c)** If the Milky Way and Andromeda galaxies are 2.6 million light-years (800,000 pc) apart, and you assume that the velocity of the Andromeda Galaxy is entirely along our line of sight, how long (in years) will it be before the two galaxies collide, or until the distance between them doubles? (Indicate which will happen.)

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**4.** Astronomers often trace star formation in our Galaxy and in other galaxies by looking at the spectral lines that come from these Galaxies. Where stars have recently formed, short-lived very hot O and B stars heat up and excite the very low density gas left over and spread widely (over several pc) around the newly formed stars. It is the light from this gas that astronomers use to detect where recent star formation has happened (or is happening).

**(a)** Given the information above, is it an emission or absorption spectrum that astronomers see as evidence of ongoing star formation? Explain briefly.

**(b)** Consider the three following facts: **(1)** The low-density gas in many star-forming regions appears pinkish or reddish in color, as a result of the strength of the H$\alpha$ line that has a wavelength in red light (6563Å). **(2)** The temperature of the gas in star-forming regions is typically 10,000–15,000 K. **(3)** A blackbody at a temperature of 10,000 K should have its peak at about 3,000 Å, and thus should appear whitish or bluish.

Is there any contradiction implied by these three facts? Is it a real contradiction? Explain the contradiction or lack thereof.

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