Astronomy 0113: Exam 1

6-Oct-1997

Please write clearly. Marks will be deducted for untidy work. The marks for each question are indicated.

In Section A, only the answer need be given unless explicitly stated otherwise. If a justification is needed, it need only be a few lines long. Do **NOT** spend more than 15 to 20 minutes on Section A.

Questions in Sections B and C require a longer answer, and are worth more. A simple answer for these questions will **NOT** suffice — **you must indicate your reasoning**. All working must be shown, and units must be provided for the final answer. Partial marks will be awarded for incomplete or incorrect answers. If you feel that your answer is incorrect because you may have made some mistake, indicate why you think this.

Questions may be answered in ANY order provided they are clearly numbered. Leave a few lines between each question in Section A. **Start a new page for each question from Sections B and C.**

The EXAM is worth a TOTAL of 100 marks.

Section A

1. Which celestial object moves approximately 1° East each day with respect to the background stars?

   (2 marks)

2. Suppose your mass on Earth is 75 kg. What would be your mass on a planet with four times the surface gravity of Earth?

   (2 marks)

3. It is the Vernal Equinox. At what latitude (or latitudes) will the Sun be at the zenith at noon?

   (2 marks)

4. A gas cloud has a linear diameter of 5AU, and is located at 5pc from the Earth. What is its angular diameter?

   (2 marks)

5. Which of the following masses [10 kg, 70 kg, 90 kg] requires the highest velocity so that it can escape the gravitational pull of the Earth?

   (2 marks)

6. The moon is observed to be on the observer's meridian near midnight. What moon phase is it?

   (3 marks)

7. Arrange the following [Infrared, radio, x-ray, visible, ultraviolet] in order of increasing wavelength (i.e. smallest to largest). In which direction is the photon energy increasing? In which direction does the frequency increase?

(2+1+1 marks)

8. Clarify the following statement: The color of an object indicates its temperature.

(4 marks)

9. A star is approaching the Earth with a velocity v_A. An absorption line in the star's spectrum is shifted by 4 nm relative to its laboratory wavelength. Is it shifted to the red or blue? What would be the change in wavelength (size and direction) if the star were moving with twice the velocity AWAY from us?

(4 marks)

10. What is an annular eclipse? (4 marks)

11. What is the Synodic period of a planet? Draw a diagram showing the Synodic period of the outer planet Jupiter.

(3+3 marks)

Section B

Answer all questions

12. Evaluate the following expression:

$$GM_* R_* / c^2 \tag{1}$$

where M_* is $10\,M_\odot$, and $R_* = 0.5R_\odot$. Half marks will be awarded for the correct numerical answer, and the other half for deriving the correct SI units. Tabulate all numerical constants.

(10 marks)

13. Star A has the following parameters: Radius=$3R_\odot$, Mass=$5.0M_\odot$, $T_{\rm sur} = 16,000$ K. Star B has a surface temperature of 8,000 K and a Mass of $3.0M_\odot$. What radius (in solar units) does Star B have to have so that its luminosity is TWICE that of Star A?

(12 marks)

14. A star, with a declination of 10 degrees, is observed to be on the meridian by an observer with a latitude of 60 degrees. Draw a diagram of the Earth and the celestial sphere. Show the star on the celestial sphere, indicating its declination. Show the observer's location on Earth, indicating their latitude. Draw in the observer's horizon, and their sight line to the star (be careful) explaining your reasoning. On the diagram indicate the altitude the observer would measure. What would be this altitude? NB: Only 3 marks are for deriving the numerical value, the rest is for the diagram. The diagram should take at least half a page.

(12 marks)

Section C

Answer any 2 of the following 3 questions

15. An electron undergoes a transition from the n=2 to the n=4 level in the hydrogen atom. Is a photon absorbed or emitted? Using the expression for the energy of the atomic levels in hydrogen given in the formula sheet, DERIVE an expression for the energy of the photon. Use this expression to calculate the energy of the photon. What is the photon's frequency (in Hz), and wavelength (in nm)? In what part of the spectrum does this wavelength occur?

(15 marks)

16. A planet orbits a star (NOT the SUN) in an elliptical orbit with a period of 5 years. The minimum distance of the planet from the star is 10 AU, while its maximum distance is 20 AU. Draw a diagram showing the orbit, and the location of the star. Suppose another planet orbited in a circular orbit at 30 AU. What would be its period?

(15 marks)

17. Discuss our solar system. Topics you might like to discuss include the composition of the planets, their orbits, the formation of the planets and solar system, the atmospheres of the planets, etc. You may write in point form, and you should aim to have at least 8 important facts. NB: The number and name of the planets constitutes 1 fact only!

(15 marks)