Name:_____

Astronomy 102: Stars and Galaxies

Examination 1

February 3, 2003

Do not open the test until instructed to begin.

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 14 questions (eight multiple choice and six short answer); you have 50 minutes in which to answer them. All exams must be turned in at the end of the period. The number of points each question is worth is provided for your information; there are a total of 64 points.

Useful Constants and Formulae

$$1 \text{ radian } = 206,265'' \qquad (\text{where } 1'' = 1 \text{ arcsecond})$$

$$1 \text{ mile} = 1,609 \text{ meters}$$

$$1 \text{ light-year} = 9.461 \times 10^{12} \text{ km}$$

$$\text{Speed of Light } = c = 3.00 \times 10^8 \text{ meters/second}$$

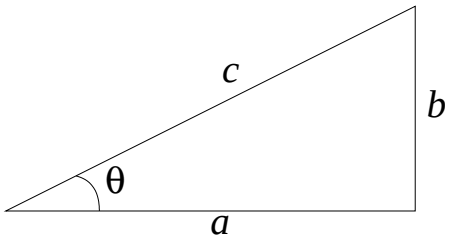
$$\text{Radius of the Sun: } 6.96 \times 10^5 \text{ km}$$

$$\text{Small Angle Formula: } \tan\theta \approx \sin\theta \approx \theta \qquad (\text{for } \theta \text{ in radians})$$

$$\text{Kepler's Third Law: } P^2 = A^3$$

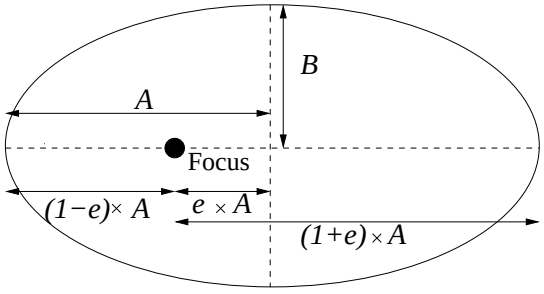
(P = period in years ; A = semi-major axis in AU)

Right Triangle and Trigonometry:



$$\sin\theta = \frac{b}{c} \quad \cos\theta = \frac{a}{c} \quad \tan\theta = \frac{b}{a}$$

Ellipse:



A = Semi-Major axis
B = Semi-Minor axis
e = Eccentricity

Multiple Choice Questions: The first eight questions are multiple choice. Only one answer is correct for each question. Circle the letter of the correct answer. Each multiple choice question is worth **4 points**

1. Halfway between the celestial poles lies the:
(a) Horizon
(b) Observer's zenith
(c) Celestial equator
(d) Ecliptic
(e) Meridian

2. What would you have to change about the Earth to stop the planet from having significantly different seasons?
(a) Its distance from the Sun
(c) The eccentricity of its orbit
(b) The rotational period (i.e. the length of the day)
(d) The tilt of the axis
(e) The orbit of the moon

3. If you know that the distance from the Earth to the Sun is 93 million miles (9.3×10^7 miles), which best expresses what you know about how long it takes the light from the Sun to reach the Earth?
(a) The Sun's light reaches the Earth instantaneously.
(b) It takes 0.3 seconds for the Sun's light to reach the Earth.
(c) It takes 0.31 seconds for the Sun's light to reach the Earth.
(d) It takes 8.3132 minutes for the Sun's light to reach the Earth.
(e) It takes 8.3 minutes for the Sun's light to reach the Earth.
(f) The Sun's light never reaches the Earth; that's why it's been so cold.

4. Which of the following qualities is necessary for a useful scientific theory?
(a) It is consistent with all existing theories accepted by the scientific community.
(b) It is falsifiable, i.e. it predicts the outcome of future experiments or observations.
(c) It obeys Occam's Razor.
(d) It obeys the Cosmological Principle.

5. In Nashville (latitude=36°), a star at 0° declination is above the horizon for which of the following? Assume a view of the horizon unobstructed by buildings, trees, mountains, etc.
(a) Always (i.e. it is circumpolar).
(b) More than 12 hours.
(c) Exactly 12 hours.
(d) Less than 12 hours.
(e) More than 12 hours in the summer, less than 12 hours in the winter.

6. A friend of yours (who has not had the benefit of an astronomy course) tells you about a report he has read in a tabloid newspaper. They claim that on the dark side of the Moon, which is never in sunlight, there is a secret base of aliens who send UFOs to Earth to perform abductions (followed by other, less savory, activities). Ignoring the UFO claim for the moment, what is the scientific error in this story?

(a) All sides of the Moon are illuminated by sunlight in the course of a month; there is no permanent dark side.

(b) The space programs of the world's countries have landed thousands of spacecraft on the dark side of the Moon, and would have encountered such a base.

(c) The dark side is the one that faces the Earth and our telescopes would have spotted such a base.

(d) Since the Moon is turning, we see all sides of it from the Earth in the course of a month and our telescopes would have spotted the base.

(e) There are no scientific problems with that story.

7. You are in Nashville (latitude=36°), facing the due western horizon. Looking at the sky, how would you describe which way is north on the Celestial Sphere?

(a) Straight up.

(b) Level, to the right.

(c) Up and to the right.

(d) Down and to the right.

(e) Up and to the right in the summer, down and to the right in the winter.

8. Which of the following statements is correct about planetary orbits in the solar system?

(a) Each planet's orbit is an ellipse with the Sun at the center of the ellipse.

(b) Planets move faster when they cross the semi-minor axis of an ellipse than when they cross the semi-major axis of an ellipse.

(c) By Kepler's third law ($P^2 \propto A^3$), planets which are further form the Sun have shorter years.

(d) The gravitational attraction of the Sun is causing the planets to spiral in slowly towards the center of the solar system.

(e) A planet in a near-circular orbit with a smaller semi major axis moves faster relative to the sun than does a planet in a near-circular orbit with a larger semi-major axis.

Short Answer Questions: Answer questions in the space provided. Indicate clearly if you must continue on the back of the page. Include any calculations or diagrams necessary. Some questions require only a word or a few words, others will require a sentence or two of explanation, and others will require a calculation. **Be brief and to the point.**

9. [4 points]

(a) From where on Earth could you observe all of the stars in the sky during the course of a year?

(b) What fraction of the sky can be seen from the North Pole over the course of a year?

10. [6 points] You are one of the fortunate humans who gets to travel to the Moon. Your spacecraft has landed inside the crater Copernicus on the side of the Moon facing the Earth.

(a) How often would the Sun rise? (Give the approximate time between two sunrises.)

(b) How often would the Earth set?

11. [4 points] If, in flagrant defiance of our understanding of stellar evolution, the Sun were to suddenly collapse into a Black Hole (an extremely dense object) of the same mass, what would happen to the orbit of the Earth? Explain, with reference to Newton's Universal law of Gravitation.

12. [4 points] What is the altitude of the Sun above the horizon at noon on December 22, as seen from a place on earth at latitude=23.5°?

13. [6 points] One of the largest stars known is Betelgeuse in the constellation Orion. We have measured its distance to be 650 light-years. Astronomers have also determined that its diameter is 500 times larger than the Sun's. Determine the apparent diameter of Betelgeuse (in arcseconds) as seen from the Earth.

14. [8 points] Astronomers observe a comet passing through the solar system in a highly elliptical orbit. They measure its eccentricity to be $e = 0.99$, and they measure that the closest it comes to the Sun is 0.5 AU (where 1 AU is one *astronomical unit*, or the semi-major axis of Earth's orbit). After that, it passes out far into the outer solar system.

(a) What is the furthest the comet will get from the Sun?

(b) How many years will it be after the comet's closest pass to the Sun before it is again that close to the Sun?