September 12, 2003 Name:_____

Astronomy 102: Stars and Galaxies

SAMPLE Review Examination 1 – REVISION 2

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.

Possibly Useful Constants and Formulae

Radius of the Sun: 6.96×10^5 km

Mass of the Sun: 2.00×10^{30} kg

Average Distance from the Sun to the Earth: 1.000 AU

Average Distance from the Sun to Mars: 1.524 AU

Radius of Mars: 3.40×10^6 m

Mass of Mars: 6.24×10^{23} kg

Mass of Quaoar: 2.5×10^{21} kg

Latitude of Nashville: 36°

$$F = m\,a$$

$$F = \frac{G\,M_1\,M_2}{r^2}$$

$$G = 6.67 \times 10^{-11}\,\frac{\mathrm{m}^3}{\mathrm{kg\,s}^2}$$

$$1\,\mathrm{AU} = 1.496 \times 10^{11}\,\mathrm{m}$$

$$1\,\mathrm{pc} = 3.26 \text{ light-years}$$

$$P^2 = A^3$$

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

1. 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

2. 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 accurately reflects somebody's speculation about how something might work.

3. 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) Within minutes of 12 hours.
   (d) Less than 12 hours.
   (e) More than 12 hours in the summer, less than 12 hours in the winter.

4. 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.

5. 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.

6. 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 orbital radius moves faster relative to the sun than does a planet in a near-circular orbit with a larger orbital radius.

7. You wake up at night with no idea where on Earth you are. As you watch, you notice that all the stars appear to be rotating *counter-clockwise* about a point at your zenith. Where are you?

(a) At the North Pole.

(b) Somewhere in the Northern Hemisphere, but not necessarily at the North Pole.

(c) At the equator.

(d) Somewhere in the Southern Hemisphere, but not necessarily at the South Pole.

(e) At the South Pole.

(f) It is impossible to tell from the information provided.

8. Unlike the Earth, the orbit of Mars is eccentric enough that how close it is to the Sun *does* somewhat affect its seasons (making the southern summer more intense than the northern summer). Consider a hypothetical planet with *no* axial tilt, but an elliptical orbit, so that the seasons were entirely governed by how far the planet is from the Sun. Which statement would be true about the seasons on this hypothetical planet?

(a) The summer would be longer than the winter.

(b) The winter would be longer than the summer.

(c) The summer and winter would be about the same length.

(d) The Northern hemisphere summer would be more intense than the Southern hemisphere summer.

(e) The Southern hemisphere summer would be more intense than the Northern hemisphere summer.

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. [6 points]

(a) Sirius is the brightest star in the sky; it is visible at night in the Northern hemisphere spring and summer. (As the brightest star in the constellation Canis Major (Big Dog), it is sometimes called the "Dog Star"— from this comes the expression "the dog days of summer".) It has a measured parallax of $0.379''$. How far away is Sirius?

(b) The star Betelgeuse is about 430 light-years from the Sun. What parallax (in arcseconds) would we measure for this star?

12. [6 points] Quaoar is a large Kuiper Belt Object (an icy/rocky body similar to Pluto) in our outer solar system which was discovered last year. Except for Pluto, it is the largest known object in the Kuiper Belt. It is in an orbit with an average distance from the Sun of 43 AU (in comparison to Pluto, 39 AU, and Neptune, 30 AU). If you want to learn more about Quaoar, see `http://www.gps.caltech.edu/~chad/quaoar/`

(a) How long does it take Quaoar to go around the Sun?

(b) As you know, Pluto is in an elliptical orbit eccentric enough that it is sometimes closer to the Sun than Neptune is, sometimes farther. From the information provided in this problem, can you state whether Quaoar is sometimes closer to the Sun than Neptune is?

13. [6 points] Assume for this problem that the orbit of Quaoar (see previous problem) is circular.

(a) What is the gravitational force on Quaoar due to the Sun?

(b) The acceleration necessary to keep an object moving in a circle of radius r at speed v is $a = v^2/r$, pointed towards the center of the circle. What is Quaoar's orbital speed about the Sun?

(c) How many times faster is Earth's orbital speed about the Sun?

14. [4 points] Drawn on the diagram below is the Sun, the orbit of the Earth, and the orbit of Mars. An asteroid is discovered which is closer to the Sun than the Earth is. Measurements indicate that the asteroid will take 2 years to go around the sun. Sketch the orbit of this asteroid on the diagram below.