Homework 1
AST 301, Sections 46845 and 46850, Spring 2016
Due Thursday, February 4, 2016

Homework 1 Help Session: Wednesday, February 3, 2016 from 3 to 5 PM in Welch 2.224

NAME and EID

A. Convert the following numbers to scientific notation. (2 points each)

(a) 4,571,000,000,000 ______________________________

(b) 9.5 million ______________________________

(c) 3 ______________________________

(d) 0.007 ______________________________

(e) 0.0000000196 ______________________________

B. Do the following arithmetic in scientific notation. (5 points each)

(a) $3.25 \times 10^{12} \quad \times \quad 2 \times 10^{6} \quad =$ ______________________________

(b) $3.25 \times 10^{12} \quad \times \quad 10^{-12} \quad =$ ______________________________

(c) $3.25 \times 10^{-5} \quad / \quad 10^{4} \quad =$ ______________________________

(d) $5.60 \times 10^{44} \quad / \quad 8 \times 10^{14} \quad =$ ______________________________

C. Answer the following questions, showing clearly how you got the answer. (10 points each) Don't try to fit the answer in the space below. Draw big diagrams on separate sheets of paper.

(a) How much bigger does Venus look when we see it as a thin crescent than when it is almost full phase? You can use the table on the last page of this homework to help you to get the answer.

(b) When can we see Jupiter at 1/4 phase, like a first-quarter moon? Explain.

D. Recall from class that Kepler's 3rd law tells us that

$$\frac{a^3}{P^2} \text{ is the same for all of the planets.}$$

If the orbital period P is in years and the semi-major axis size a of the orbit is in AU, then the constant is 1. If different units are used, the constant is different from 1 but the law still applies. For example, the moons of Jupiter obey Kepler's 3rd law, too. You can prove this to yourself by doing the following exercise:

Calculate a^3 and P^2 for each of the following moons. What is a^3/P^2? (5 points)

Moon	a (10^6 km)	a^3	P (days)	P^2	$\frac{a^3}{P^2}$
Io	0.422	________	1.769	________	________
Europa	0.671	________	3.551	________	________
Ganymede	1.071	________	7.155	________	________
Callisto	1.884	________	16.689	________	________

The above numbers are taken from the table on Principal Satellites of the Solar System in the Appendices of the textbook. Now suppose that a new moon were discovered that orbits Jupiter with a semi-major axis of $a = 2.5 \times 10^6$ km. What would its orbital period be? (5 points)

P = ______________

Halley's comet returns to the inner Solar System approximately every 76 years. What is the semi-major axis length of its orbit? Given that Halley's comet comes to within 0.6 AU of the Sun, how far from the Sun does it get? (5 points)

Maximum distance = ______________

How does this compare to the distances of the outer planets from the Sun?

E. Exam-style questions. For each question, circle the correct answer. (5 points each)

1. It is warmer in summer than in winter because
   (A) the Earth is closer to the Sun in summer than it is in winter.
   (B) the Sun rises higher in the sky in summer than it does in winter.
   (C) the Sun is above the horizon every day for a longer time in summer than in winter.
   (D) B and C only
   (E) A and B only

2. The constellations we see in the night sky are
   (A) physical groups of stars that are all at about the same distance.
   (B) random patterns of stars that are at very different distances.
   (C) visibly changing from night to night as stars move around.
   (D) the same as the constellations observed from planets orbiting other stars.
   (E) none of the above

3. If you stand facing the full Moon as it rises above the horizon, the Sun must be
   (A) directly above you.
   (B) above the horizon, on your left.
   (C) above the horizon, on your right.
   (D) below the horizon, in front of you.
   (E) on the horizon, behind you.

4. When and where does the Sun remain well above the horizon for 24 hours?
   (A) On the (Northern) Winter solstice, at the north pole
   (B) On the (Northern) Summer solstice, at the equator
   (C) On the (Northern) Winter solstice, at the south pole
   (D) On the (Northern) Spring equinox, in the tropics
   (E) On the (Northern) Fall equinox, at the north pole

5. From our point of view, it looks as if (1) the entire Universe rotates about the Earth once a day, (2) the Sun circles the Earth once a year, and (3) the Moon circles the Earth once a month. Which of these are due to motions of the Earth (either rotation or revolution)?
   (A) 1 and 2
   (B) 2 and 3
   (C) 3 and 1
   (D) 1 only
   (E) 1, 2, and 3

6. Imagine that you live on a planet whose mass is the same as the mass of the Earth but whose radius is only half as big as Earth's radius. The planet's moon is exactly like Earth's moon (that is, same mass, same size, and same distance). Which of the following statements is true?

   (A) Your weight is 4 times smaller than it would be on the Earth.

   (B) Your weight is 4 times bigger than it would be on the Earth.

   (C) Your mass is 4 times bigger than it would be on the Earth.

   (D) The tides are 4 times higher than they would be on the Earth.

   (E) None of the above.

7. If you stood on the Moon and simultaneously dropped a rock and a feather from the same height above the Moon's surface, what would happen?

   (A) The rock would hit the Moon's surface first because it is heavier.

   (B) The feather would hit the Moon's surface first because there is no air.

   (C) Both would hit the Moon's surface at the same time.

   (D) Nothing: they would be weightless on the Moon.

   (E) The feather and the rock would start to move toward the Earth because the Earth's gravity is stronger than the Moon's.

Table A-10 | Properties of the Planets

ORBITAL PROPERTIES

Planet	Semimajor Axis (*a*) (AU)	Semimajor Axis (*a*) (10^6 km)	Orbital Period (*P*) (y)	Orbital Period (*P*) (days)	Average Orbital Velocity (km/s)	Orbital Eccentricity	Inclination to Ecliptic
Mercury	0.387	57.9	0.241	88.0	47.9	0.206	7.0°
Venus	0.723	108	0.615	224.7	35.0	0.007	3.4°
Earth	1.00	150	1.00	365.3	29.8	0.017	0°*
Mars	1.52	228	1.88	687.0	24.1	0.093	1.8°
Jupiter	5.20	779	11.9	4332	13.1	0.049	1.3°
Saturn	9.58	1433	29.5	10,759	9.7	0.056	2.5°
Uranus	19.23	2877	84.3	30,799	6.8	0.044	0.8°
Neptune	30.10	4503	164.8	60,190	5.4	0.011	1.8°

* By definition.

PHYSICAL PROPERTIES (Earth = ⊕)

Planet	Equatorial Radius (km)	Equatorial Radius (⊕ = 1)	Mass (⊕ = 1)	Average Density (g/cm³)	Surface Gravity (⊕ = 1)	Escape Velocity (km/s)	Sidereal Period of Rotation	Inclination of Equator to Orbit
Mercury	2440	0.383	0.055	5.43	0.38	4.2	58.6d	0.0°
Venus	6052	0.950	0.815	5.20	0.90	10.5	243.0d	177.3°
Earth	6378	1.00	1.000	5.52	1.00	11.2	23.93h	23.4°
Mars	3396	0.533	0.107	3.93	0.38	5.0	24.62h	25.2°
Jupiter	71,492	11.21	318	1.33	2.53	59.5	9.92h	3.1°
Saturn	60,268	9.45	95.2	0.69	1.06	35.5	10.57h	26.7°
Uranus	25,559	4.01	14.5	1.27	0.89	21.3	17.24h	97.8°
Neptune	24,764	3.88	17.1	1.64	1.14	23.5	16.11h	28.3°