Astro 102/104 **Our Solar System** **Spring 2008**

Name:_____ Section:_____

Homework 3: The Moon, Eclipses, Tides, Radiation, Spectra.

Due: In your section the week of **February 11th**. Be neat and concise, show your work, and remember units. An answer without the correct units is wrong.

Readings: Ch 2.3, 5, and lectures 5,6 and 7.

1.. [1 point] Which of the following are leap years: 1600 AD, 1900 AD, 2006 AD, 2020 AD?

1600 and 2020 are leap years

2. [3 points] Imagine that you are the far side of the Moon. Would you see the Sun during a
(a) solar eclipse?
(b) lunar eclipse?
Explain why or why not.

a) Yes! If you were on the far side of the moon you would see the Sun during the solar eclipse, because for the solar eclipse to occur, the Moon must be between the Earth and the Sun. When this happens the far side is pointing towards the Sun so the Sun would be visible.

b) No! If you were on the far side of the Soon during a lunar eclipse you would not see the Sun. For the lunar eclipse to occur the Earth must be between the Moon and the Sun. This occurs when the far side of the Soon is not facing the Sun, in other words the far side would be looking out way form the Sun and it would be on the "dark side of the moon"

3. [3 points] The Earth's rate of spin is slowing down and the Moon is getting further from Earth.
(a) Explain why this is happening and
(b) How much further away from Earth will the Moon be in 1000 years?
(c) How much slower will the Earth be rotating in 1000 years?

a) Tidal Friction causes the Earth slowing down and the Moon getting further away. Because of Tidal Forces, the Moon slightly distorts the Earth, but because the Earth rotates faster than the Moon orbits, the Earth's distortion changes (hence this is why we have ocean tides). This changing of Earth's shape creates friction and a torque against Earth's rotation, gradually making Earth spin slower. However, due to conservation of angular momentum, the Moon must get further away from Earth an amount proportional to the amount that Earth's spin decreases.

*b) The moon is getting 3.8cm/year further away: The moon will be **3800 cm, or 38 meters further away***

*c) Earth is slowing at 2msec/centery: The earth will spin **20 msec slower***

4. [2 points] Will there always be total solar eclipses on the Earth? Explain why or why not.

NO! The fact that total solar eclipses can occur depends on the fact that the Moon's angular size, as viewed from Earth, is at least equal to the angular size of the sun. It is purely coincidence that this is the case. Since the Moon is slowly moving further from Earth, because of tidal friction, the angular size of the moon is slowly decreasing. Right now the angular size of the Moon is approximately that of the Sun, but eventually, far enough in the future, the angular size of the moon will be significantly smaller than that of the Sun, and total solar eclipses will no longer occur.

5. [2 points] Explain why we on Earth only see one side of the moon. If you were on the near side of the Moon, would you see only one side of the Earth? Would you see the Earth at all? Explain.

We only see one side of the moon because the moon rotates at the same rate that it orbits. In other words it takes 29 days to complete one orbit around Earth, and it takes the same amount of time to complete one revolution. Therefore the same side of the moon is always pointed at the Earth. If you were on the near side of the Moon you would see all sides of the Earth as long as on you were on the Moon for approximately 24 Earth hours

6. [2 points] The peak wavelength of electromagnetic radiation emitted by the Sun is around 500 nm. Calculate the energy in Joules that corresponds to a single photon of this wavelength. (Use: h = 6.63 × 10^{-34} Js, c = 3 × 10^{8} m/s). A typical rechargeable AA-battery stores 9000 Joules of energy. If you could convert the entire energy of a photon into electrical energy, how many photons would be needed to completely charge a AA-battery?

$$E = hc/\lambda = \frac{(6.63\times10^{-34}\,Js)(3\times10^{8}\,m/s)}{500\times10^{-9}\,m} = 3.97\times10^{-19}\,J$$

$$N = \frac{9000J}{3.978\times10^{-19}\,J} = 2.26\times10^{22}\,photons$$

7. [3 points] Suppose we have a blackbody at temperature T. Which two laws of physics will govern its behavior? If we double the temperature to 2T, what will happen to the total energy emitted per unit area per unit time (E)? What would happen to the wavelength of maximum energy emission (λ_{max})?

1st law is the Stefan Boltzmann Law that tells us the total amount of energy emitted as a function of temperature

$$E = \sigma T^4$$

2nd Law is Wien's Law that tells us the wavelength of the light that emits the maximum amount of energy

$$\lambda_{max} = 2{,}900{,}000 / T$$

*The total energy will **increase** by a factor of 16 and the wavelength will **decrease** by a factor of 1/2*

8. [1 point] What does the Bohr model of an atom say about electron orbits? What does this mean?

Electron orbits are quantized. This means that there are very specific distances(or energy levels) from the nucleus where an electron is allowed to be.

9. [3 points] In hydrogen, the transition from level 2 to level 1 has a rest wavelength of 121.6 nm. Suppose you see this line at a wavelength of 120.5 nm in Star A and at 122 nm in Star B. Calculate each star's speed. Are the stars moving toward or away from us?

$$\Delta\lambda = \lambda v / c$$

A: $$v = \frac{(\lambda_{obs} - \lambda)}{\lambda} c = \frac{(120.5nm - 121.6nm)}{121.6nm}(3\times10^8 m/s) = -2.71\times10^6 m/s$$ (toward us)

B: $$v = \frac{(\lambda_{obs} - \lambda)}{\lambda} c = \frac{(122nm - 121.6nm)}{121.6nm}(3\times10^8 m/s) = 9.872\times10^5 m/s$$ (away from us)