PTYS/ASTR 206 – Section 3 – Homework 2 – Assigned 2/5/09

NAME:_____

(PRINT CLEARLY)

- Homework is due <u>in class</u> on Thursday February 12th.
- Late homeworks can be turned in class on Tuesday February 17th for 50% credit.
- Homeworks turned in later than this receive 0%.
- Students are encouraged to discuss approaches to solving homework problems with each other; however, all work submitted must be the student's own. Do not turn in identical homeworks! See the syllabus for more information.

Hint: Each of these questions should be quick to answer. If you find yourself engaged in a long chain of complicated reasoning or more than a few lines of math then something is probably wrong! Make sure to start this early and talk to the TA or myself with any questions.

Another hint: Some questions require you to calculate the volume of a sphere. A simplified version of the formula to calculate the volume of a sphere, with a radius r, is:
$4.19 * r^3$

Question 1: Craters on Asteroids

The mass of the asteroid Ceres (the largest asteroid) was just measured at $9.04*10^{20}$ Kg and its radius is 476 km. Assume that Ceres is a sphere and calculate its volume. What is the average density of this object? Is it closer to ice (1000 kg m^{-3}) or rock (3000 kg m^{-3})?

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Given its mass and radius, the gravitational acceleration at the surface is 0.27 ms^{-2}. Rock and *cold* water ice are both quite strong (assume a strength of $2*10^8$ Pascal). Use the formula in the lecture on cratering to figure out at what diameter craters on Ceres will transition from simple to complex.

Compare this crater size to the size of Ceres. The Dawn mission will visit Ceres in a few years; do you expect us to find many complex craters there? Why?

Question 2: Wavelengths of light emission?

The Earth's surface and lower atmosphere have a temperature of about 300K and radiate like a blackbody. What wavelength of the spectrum do they radiate most at? Use Wien's law from the lecture notes.

At this wavelength, is the Earth or the Sun radiating more energy from each square meter? Why?

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Why can't we observe astronomical objects at a wavelength of 10-11 microns? What do we 'see' if we try that?

Question 3: Energy in vs. energy out

The solar power at 1AU is 1370 W m^{-2}. The Moon absorbs 90% of the radiation that hits it. When the sun is directly over a patch of the lunar surface how much energy is each square meter absorbing?

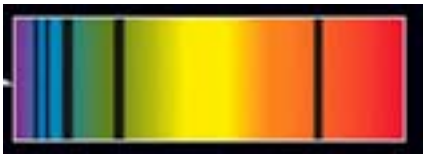
The temperature of this patch is 350K, how much energy is each square meter emitting? (Use the formula in the lecture notes). Is this patch of surface warming up or cooling down?

When the emitted and absorbed radiations are the same then the temperature of the surface isn't changing. What is this 'equilibrium temperature' in this situation?

Question 4: Spectra

We observe two patches of gas, their spectra are shown below. One of these patches is in front of the sun and the other is off to one side. Which is which? Why?

A



B

When we measure absorption lines in the light reflected from a planet's surface, what are the three locations where that absorption could be taking place?

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A grey body reflects all wavelengths equally. What visible color would a body like that have if it were orbiting a star that radiated mostly in the ultraviolet? Would it change if the star radiated mostly in the infrared? Why?

Question 5: Asteroid Energies

Meteor crater was created by an iron meteorite 50m in diameter, traveling at about 12 km s^{-1} (lower than once thought!). Calculate the energy of such an impact? Assume the asteroid is spherical and that its density is 6000 kg m^{-3}.

The asteroid that finished off the dinosaurs and created the crater Chicxulub was 10km across and traveling at 20 km s^{-1} with a rocky composition (density of 3000 kg m^{-3}). How much energy does this correspond to? How many meteor-crater events add up to one Chicxulub event?

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Under what conditions will an asteroid break up in the atmosphere? If we double the speed of the impact does that increase or decrease the likelihood of an atmospheric breakup? Why?