PTYS/ASTR 206 – Section 3 – Homework 4 – Assigned 3/12/09

NAME:_____

(PRINT CLEARLY)

- Homework is due in class on Thursday March 26th.
- Late homeworks can be turned in class on Tuesday April 2nd 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.

Question 1: Density of the planets

Use the information in this table to figure out the volume and density of these planetary objects.

Planet	Mass (kg)	Radius (km)	Volume	Density
Mercury	3.3×10^{23}	2438		
Venus	4.9×10^{24}	6052		
Earth	6.0×10^{24}	6371		
Mars	6.4×10^{23}	3396		

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The density of regular surface rock is about 2700 to 3000 kg m^{-3}. Are the planetary values you figured out above higher or lower than regular surface rocks? What does that tell you about the interiors of these objects?

If we used the above method on asteroids we would find that the density of asteroids is much lower than the density of meteorites. Why is this? (you need to think a bit beyond the lecture material for this one).

Question 2: Plate Tectonics

North America drifts westward and Europe drifts eastwards, each by about 1cm per year. If the Atlantic Ocean is about 3000km wide today then how long ago has it been since these two continents split apart?

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The dinosaurs were killed off by a giant impact in Mexico about 65 million years ago. Did the Atlantic Ocean exist at that time? If so, how wide was it?

How is continental crust made? A few years ago a continental rock (Andesite) was found to be common on Mars. This has since been disputed, but why would this be so significant if it were true?

Question 3: Ancient Mars and Earth

The past climate of Mars was much more favorable for liquid water. Why did this favorable climate disappear whereas on the Earth it persisted?

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Ancient rocks on Mars show that the planet once had a magnetic field. Why did this field disappear whereas on the Earth it persisted?

Currently the heat flow from the interior of Mars is 0.03 Wm^2 and from the Earth is 0.08 Wm^2. Use values in the table for question 1 to figure out the surface area (area of a sphere is $12.6*R^2$, where R is the radius) of each planet and use that to figure out how much energy each planet is producing per second.

How much energy per second is being produced per kilogram for each planet (the masses of these planets are also in that table)? Are these numbers very different? Why do you suppose that is?

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Question 4: Moon and Asteroids

Mars has two Moons Phobos and Deimos, which are thought to be captured asteroids. They orbit the planet in 7.7 and 30.2 hours respectively. What does their motion look like as seen from the martian surface? Think about the spin rate of Mars here.

How would the phase of Jupiter vary as seen from a Trojan asteroid over the course of one Jupiter year?

Asteroids in a 3:1 resonance with Jupiter orbit the sun three times everytime Jupiter orbits once. Use the formula for Kepler's third law in earlier lectures/homeworks to figure out what the semimajor axis of these asteroids is (Jupiter's semi-major axis is 5.2 AU).

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Question 5: Earth

What three things set the Earth apart from the other planets (two of these things are linked)?

Earth probably had many smaller tectonic plates in its early history. Why do we think this is? Extrapolate this forward a few billion years. What will happen to plate tectonics as the Earth ages?

Occasionally Earth enters a climatic state called snowball-Earth. Here the Earth gets a snow cover that is bright and reflects away most of the sunlight. As less sunlight is absorbed the Earth gets even colder and the snow cover expands to cover more area etc… pretty soon the whole Earth is covered with ice and is very cold. How did Earth escape from these periods? This isn't in the lecture notes so you need to think a bit to get the answer, comparisons to Mars would be useful.