

**Answer all questions in the space provided. If you have any questions, raise your hand.  
134 points possible. No calculators or electronic devices of any type.**

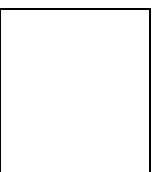
You have discovered a new planet orbiting the Sun at a distance of 1.0 AU. This planet is two-thirds ( $2/3$ ) the size of the Earth, and is one-eighteenth ( $1/18$ ) as massive. The planet has an uncompressed density of  $3.3 \text{ g/cm}^3$  and a moment-of-inertia factor of 0.39.

**1** (6 pts) How does the gravity of this planet compare to the Earth's gravity? [Be quantitative; show your work.]

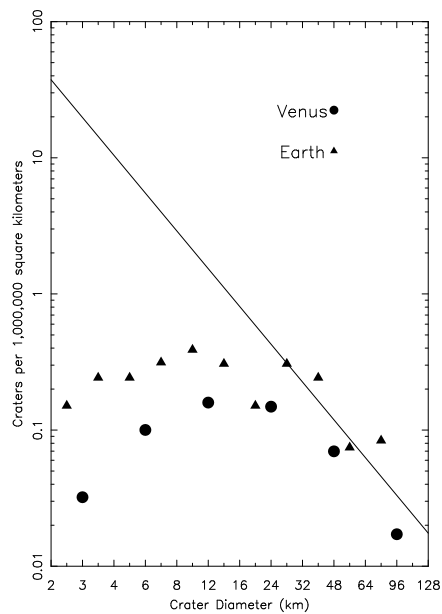
**2** (4 pts) What is the most likely composition of this planet? [Remember to give a qualitative indication of the amount of each substance.]

**3** (2 pts) How is the mass distributed in the interior?

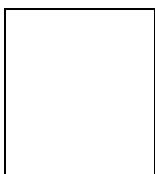
**4** (4 pts) Explain why it is unlikely that this planet has a thick atmosphere today.



5 (8 pts) Explain why primitive asteroids are never spherical.

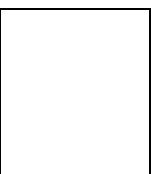


6 (8 pts) The plot of the left shows the crater density plot of the surface of Venus (circles) and the Earth (triangles) with a fit to ages of the surfaces. Explain why we are ignoring the left-most points in using craters to determine the ages of these surfaces.



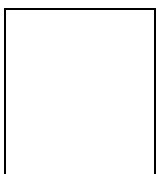
**7** (8 pts) I have said many times in class that the solar system has far more small bodies than large ones. Explain how we know this by looking at the Moon.

**8** (8 pts) Apollo 11 landed on a Mare surface. Apollo 16 landed in the lunar highlands. Describe how the **types and ages** of the samples returned from these two missions would be different.



**9** (8 pts) Explain why we think all the worlds in the inner solar system were bombarded by large objects 3.8 billion years ago.

**10** (8 pts) I have said that the Mars Rovers found that the soil on Mars is “global later than local”. Explain what this statement means and why this is not the case on the Moon.



**11 (3 pts)** The volcanic activity on the surface of asteroids

- (a) is still going on today.
- (b) lasted much longer than that on the Earth's Moon.
- (c) propelled fragments to the Earth that fell as meteorites.
- (d) never occurred because they are too large.
- (e) occurred long ago.

**12 (3 pts)** The most common gasses that are outgassed by volcanos in the inner solar system are:

- (a) H and He
- (b) Si and Fe
- (c) N<sub>2</sub> and O<sub>2</sub>
- (d) H<sub>2</sub>O and O<sub>3</sub>
- (e) CO<sub>2</sub> and H<sub>2</sub>O

**13 (3 pts)** Volcanoes on Mars are taller than volcanoes on the Earth because

- (a) the higher atmospheric pressure on Earth keeps them smaller.
- (b) Mars is more geologically active.
- (c) few impacts have occurred on Mars, allow large volcano growth.
- (d) the basalt on Earth is more viscous.
- (e) Mars has lower gravity.

**14 (3 pts)** Large planets are geologically active longer than small planets because large planets

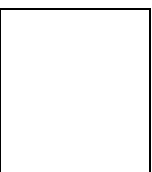
- (a) have more angular momentum and are more primitive.
- (b) have more volatile elements and higher gravity.
- (c) have more surface area and have differentiated.
- (d) have more radioactive elements and lose heat slower.
- (e) have more outgassing and have a higher escape velocity.

**15 (3 pts)** An artificial satellite in orbit around the Earth that is in a 2:1 resonance with the Earth's Moon has an orbital period of about

- (a) one month.
- (b) 12 hours.
- (c) one day.
- (d) two weeks.
- (e) one year.

**16 (3 pts)** The Mare surface on the Moon are dominated by \_\_\_\_\_ craters that formed \_\_\_\_\_.

- (a) large ... about 3.8 billion years ago
- (b) small ... greater than 4 billion years ago
- (c) large ... less than 0.5 billion years ago
- (d) small ... less than 2 billion years ago
- (e) large ... greater than 4 billion years ago



**17** (3 pts) Why did every Apollo mission to the Moon explore simple impact craters?

- (a) It is easier to land by simple impact craters.
- (b) Simple impact craters tend to collect meteorites.
- (c) Impacts bring deep-seated materials to the surface
- (d) Simple impact craters shield the astronauts from the Sun.
- (e) No real reason, they are just very common on the Moon

**18** (3 pts) The fact that Mars had water on its surface in the past implies that the atmosphere of Mars in the past was thicker. A thicker atmosphere means a warmer surface because

- (a) thicker atmosphere means more outgassing means more hot volcanoes.
- (b) thicker atmosphere means more surface pressure crushing and heating the rocks.
- (c) thicker atmosphere means more CO<sub>2</sub> means more greenhouse effect.
- (d) thicker atmosphere means thicker polar caps insulating the surface.
- (e) thicker atmosphere means more impacts would heat the surface.

**19** (3 pts) Impact Breccia rocks on the Moon are **most** commonly formed during which stage of planetary evolution?

- (a) Origin
- (b) Differentiation
- (c) Late Heavy Bombardment
- (d) Geological Activity
- (e) Big Chill

**20** (3 pts) Pristine Highland rocks on the Moon are **most** commonly formed during which stage of planetary evolution?

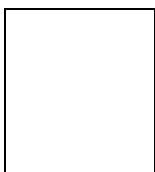
- (a) Origin
- (b) Differentiation
- (c) Late Heavy Bombardment
- (d) Geological Activity
- (e) Big Chill

**21** (3 pts) The current regolith on the Moon is **most** commonly formed during which stage of planetary evolution?

- (a) Origin
- (b) Differentiation
- (c) Late Heavy Bombardment
- (d) Geological Activity
- (e) Big Chill

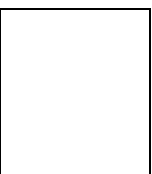
**22** (3 pts) Basaltic rocks on the Moon are **most** commonly formed during which stage of planetary evolution?

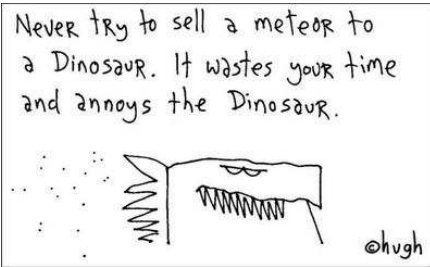
- (a) Origin
- (b) Differentiation
- (c) Late Heavy Bombardment
- (d) Geological Activity
- (e) Big Chill



**23** (8 pts) Explain why a world that has been heated has **less** volatile elements and **more** refractory elements than the average composition of the solar system.

**24** (8 pts) Explain why crater counting is not a very useful way to determine the age difference between the surfaces of different asteroids.





The K-T boundary layer on the Earth, separates the Cretaceous period (lots of dinosaurs) from the Tertiary period (no dinosaurs). This layer is rich in the element iridium and was deposited all over the Earth 65 million years ago.

**25** (8 pts) The iridium in the K-T boundary layer is thought to come from the meteorite that impacted the Earth. Explain why this meteorite could **not** have been an achondrite meteorite.

**26** (8 pts) Without Jupiter in our solar system it is very unlikely we have the K-T boundary impact. Explain why this is.

