Name:____________________ Partners:____

Cratering and The Age of Planetary Surfaces:

We can tell how old meteorites are by radioactive dating (more on that later). When we do this, we discover that all but a few meteorites are very old - **4.55 Billion Years Old**, in fact, about as old as the Solar System itself! A few, however, give us younger ages (in some cases very much younger - **from 150 Million years to 4.45 billion years old**). That means at least some meteorites could actually have been knocked off existing planetary bodies. But how can we be sure?

A first step toward answering this question is finding out how old the **Surfaces** of existing planets are. While we think planets we find in the solar system originated with the Solar System, it's clear that the surfaces of planets change with time, both due to internal processes (on Earth, Plate Tectonics and the internal planetary convection that drives it recycles surface rocks on timescales as short as 100 million years), erosion on planets with atmospheres, and due to one particular externally derived process: **Meteor Impacts**. How do we recognize the effects of meteor impacts? We look for **Craters!**

As we'll discuss in this class, impact cratering is and has been the most common "geologic" process which occurs on planetary bodies in our solar system. It has gone on since the planets formed by a process called accretion (essentially impacting and piling up of small bodies via gravitational effects), and continues today. Basically, there is still a significant amount of planetary debris floating around out there (most of it now coming from the Asteroid Belt), and over time it is drawn into the gravity fields of planets, where it lands explosively, making craters. The rates of impacts have declined through time as a function of meteor density **(see https://www.planetary.org/blogs/emily-lakdawalla/2015/1130-favorite-astro-plots-3-lunar-cratering.html)**, and, most importantly, **the longer planet's surface has been undisturbed by other geologic forces within or on the planet, the more impact craters that surface will accumulate!** That means we can infer at least the relative the ages of planetary surfaces from the degree of cratering (which we might quantify by looking at crater density in craters per unit area)!

So, what we're going to do is look at planetary surfaces, and make some inferences about their ages (actually, about their age distributions, as determining a real age via Crater Stratigraphy requires many hours of work!). This can be also be complicated by the fact that the entire surface of a solar system body may not be the same "age" due to more or less localized surface erasing processes.

You must work in groups as you and a partner must both categorize (and come to agreement!) on each other's images. Each person should take 2 regional-scale pictures of planetary bodies (the Moon, Mars, Europa and Venus). Make sure all pictures your group has are different from each other (different body or different image number).

Your first task will be to decide what on the pictures constitutes a crater. As a group, decide on how you will decide what on the pictures you will call a crater. You all will probably want to look over all your pictures to see what sort of features you will be categorizing. Write below the description you agree on of how you will decide if a given thing on your picture is a crater or not.

Now you should look over your pictures and group them based on crater density. To make sure results are consistent, every picture should have at least 2 people assess it. Distinguish the groups as follows:

- Group 1: Craters on top of craters on top of craters (high density)
- Group 2: Craters abundant, but not overlapping,
- Group 3: Craters present but not abundant (>20 in the picture)
- Group 4: 10-20 craters
- Group 5: 1-10 craters
- Group 6: No craters at all!

Record in the space below the 4 pictures you analyzed and which group you sorted them into. Example: "Europa1:Group 6"

Come to a common agreement as a group on how your group's images will be reported. After about 30 minutes, report your group's data on the board according to planet/moon and image number. After every group has put results up, <u>record the class totals in a table</u> on the last sheet in this handout. Using this data, you should INDIVIDUALLY answer the following questions:

1) Which planetary body of those examined is the most heavily cratered, generally? Explain your reasoning.

2) Which planetary body shows the most diversity in cratered surfaces, and which one shows the least? Explain your reasoning.

3) The Galileo space probe data on the surface of Europa suggests that its icy surface gets extensively reworked by tidal forces from Jupiter, so that on average its surface is not older than about 30 million years. Based on the class cratering data, are there other bodies in the Solar system with surfaces or regions that young? Explain your reasoning.