# Craters of the Moon

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## Abstract

Images of the lunar surface were used to measure the diameter and length of shadow cast by lunar craters. The heights of craters were calculated. Using this data, a range of impact energies and masses was attained for object colliding with the moon. Mare regions of the lunar surface were observed and the number of impacts to the moon by objects larger than 16km in diameter was statistically estimated to be 1500.

## Introduction and Theory

The Lunar surface is covered but craters due to impacts from smaller bodies, primarily during the early phases of the Solar systems formation. A series of images of craters on the lunar surface is provided as part of the experiment. The photos were all taken at times other than the full moon, as during the period the suns light is incident along the normal, hence casting no shadows. By taking the length of the shadow cast by a crater wall for a known incident angle of solar light, the height of the crater wall can be calculated as follows:

From figure 1 the height of the crater can be calculated using the relation:

$$h=\frac{S}{tan⁡(θ)}$$

The heights of several craters will be plotted as a function of their diameter on log-log plots and any correlation will be outlined.

 This height of the craters, along with its diameter can be used to calculate the impact energy of the asteroid that formed the respective craters. The equation

$$D=2.5(\frac{E}{ρg\_{M}})^{\frac{1}{4}}$$

Was used to calculate the impact energy of objects which created craters. In this equation D is the diameter of the crater (in m); E is the kinetic energy of the body (in joules), $ρ$ is the mean density of moon rock (taken as 2\*103 kg m-3) and $g\_{M}$ is the acceleration due to gravity on the moon, 1.62m s-2. The equation was rearranged to give E as follows:

$$E= ρg\_{M}(\frac{D}{2.5})^{4}$$

The validity of this equation was explained using dimensional analysis, where the units of either side of the equation were shown to correlate:

$$kg m^{2} s^{-2}=\frac{kg}{m^{3}} \frac{m}{s^{2}} (m)^{4}=kg m^{2} s^{-2}$$

Then, by taking the range of average velocities of asteroids in this part of the solar system, the range of masses of bodies which collided with the moon can be calculated.

This range of masses can be used to indicate the masses of object which were present in the early solar system.

## Experimental Method

The heights of different craters were calculated and their respective diameters recorded. These values were plotted against each other logarithmically.

The impact energies of the impacts were calculated. The velocities of bodies in the vicinity of the moon and the earth were taken to be in the range of 10 to 100kms-1. By taking the average value of velocity to be 55 kms-1, a sample of the range of masses to collide with the moon was calculated.

The number of impacts larger than 16km was statistically estimated by logarithmically plotting the number of impacts larger than 8km, 4km and 2km.

The ratio of number of craters in the dark mare regions of the moon to the number on the rest of the surface was estimated.

## Results

The logarithmic ratio of crater height to diameter was plotted as follows:

The kinetic energy of each impact was calculated. Taking the possible range of velocities to be 10kms-1 to 100kms-1 the range of masses of impacting bodies was between 107kg and 1013kg.

The radius of the moon was taken to be 1,737.10 km .The surface area of the moon covered in each of the photographs used was 100455.4km. The total surface area observed was 301366.3km. This was calculated to be 0.794758% percent of the total lunar surface. Using this percentage, and assuming a uniform distribution of craters, the number of impacts larger than 16km on the entirety of the lunar surface was estimated to be ~1500.This was achieved using a logarithmic plot of the number of impacts larger than 2km, 4km and 8km against the crater size.

The ratio of craters on the mare regions of the moon to the number on the rest of the surface was estimated to be roughly 1:4.

## Discussion and Conclusions

A linear relationship was observed between the diameter and height of lunar craters.

The masses of objects which collided with the moon, creating the craters observer in the experiment, were estimated to fall in the range of 107kg and 1013kg.

The number of impacts by objects larger than 16km in diameter across the entirety of the lunar surface was estimated to be.

The mare regions are areas of the lunar surface which have been made uniform by volcanic activity (lava flow) during the period in which the moon was seismically active. In these areas, craters from impacts previous to a lava flow would be covered up. This was supported by the observation of fewer craters in these areas.

The measurements taken in this experiment suffered from a high margin of error for a number of reasons. Low quality images, parallax error and a larger-than-necessary scale all contributed to the experimental error. Also, the calculation of the shadow length was particularly inaccurate due the low image quality and non uniform formations within craters. These accuracy issues were more sever for smaller craters.