BHARATA MATA COLLEGE THRIKKAKARA

PROJECT

DEPARTMENT OF PHYSICS

DETERMINATION OF CRATER DEPTH OF MOON USING SHADOW LENGTH

PROJECT REPORT SUBMITTED TO,

MAHATMA GANDHI UNIVERSITY, KOTTAYAM

SUBMITTED BY

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Certificate

This is to certify that the project report entitled Determination of crater depth of moon using shadow length is a work carried out by Dilshana Sherin (200021039168) in the Department of Physics Bharata Mata College, Thrikkakara under my guidance during the year 2022-23 the period for the partial fulfilment of the requirements of award of the degree of Bachelor of final year .

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I acknowledge with gratitude that the cooperation and sincere help obtained from my teachers and lab assistants .

CONTENT

Chapter 1

MOON

Moon is the only natural satellite of planet earth. It is the fifth largest satellite of solar system and most massive relative to it's parent planet .It has a diameter of about one- quarter that of earth. (Approximately the width of Australia).It is a planetary- mass object with a hard and rocky body .It is considered as the largest of all known dwarf planets in the solar system .Along with that it lacks an atmosphere and magnetic field .It's gravity is approximated of about $1/6^{th}$ that of planet earth.Luna, selena, cynthia are the alternative names of moon. The average distance between moon and earth is 384, 500km or about 30 times earth's diameter. Moon's gravitational influence is the main reason for earth's tides and it also slowly lengthen's earth's day. One of the peculiarity of moon is that during a full rotation around the earth on it's own axis causes its same side to always face earth.

MAJOR FEATURES :

Diameter – 3474.8 km

Density – 3.34 g/cm 3

Orbital period – 27 days

Age – 4:53 billion years

Gravity – 1 . 60 m / s^2

Surface area – 3 – 793 x 10 km^2

Structural characteristics of moon

A partially molten layer with a thickness of 150 km surrounding the iron core .

Inner core

▼

Partial melt.

▼

Outer core

▼

Mantle

▼

Crust

The mantle which lies between the bottom part of crust to the partially molten layer

It is made up of minerals like olivine and pyroscene which are constituted from magnesium, iron, silicon and oxygen atoms

CRATERS

The moon's surface is covered of many craters, all of which were formed by impacts .craters on the moon are formed by asteroids and meteorites colliding with the lunar surface .

As compared to earth, moon has more number of craters . The reason for this is said to be, unlike the earth, the moon has no atmosphere to protect itself from these impacting bodies like asteroids and meteorites. It also lacks certain geologic activity like volcanoes or weathering so It remain intact from billions of years. The earth is also covered in water and vegetation which covers the impact craters.

Since the moon has been hilted by impactors , the surface is also covered by a layer of broken socks called regolith and a fine layer of dust .

Below the surface lies a thick lager of Fractured rock,

The largest Crater on the moon is knop as south pole- Aitkin Basin. It is about 2500 km. It is also one of the oldest of the moon's craters and formed just a few hundred million years or after the moon itself was formed. Scientists suspect that it was formed when a slow- moving impactor got hit In to the surface .The crater nomenclature is governed by the international Astronomical union

Some of the lunar craters are

- Tycho
- Langvenus
- AD- Marrakushi
- acosta
- Clavius
- Copernicus

Tycho

It shows up as a splendid spot in the southern high land with beams of brilliant material that stretch across a large part of the nearside. Tycho's speciality isn't because of its size. At 53 miles (85 kilometres) in width, it is just one among thousands similarly -sized holes. Tycho is relatively youth which makes it stand out. It was formed recently enough that the debris that was ejected during the impact event, which formed its lovely rays, is still discernible as bright streaks. All craters initially have this appearance once they develop, but as they remain on the surface exposed to the space environment over time, their rays progressively fade away until they disappear into the background.

Clavius

Clavius, which is second in size on the visible near side of the Moon and one of the largest crater formed there, it is quite similar in size to Deslandres. It is situated south of the well-known ray crater Tycho in the rough southern highlands of the Moon.

Copernicus

In eastern Oceanus Procellarum locates the lunar impact crater, known as Copernicus. Its prominent ray system is a hallmark of it ,that emerged during the Copernican era. It might have been produced by leftovers from the asteroid 495 Eulalia's parent body's which collapsed 800 million years ago.

Sub solar points

The area of the Moon's surface when the Sun is directly overhead is known as the sub solar point. When describing it, the selenographic longitude and latitude of that location are typically given. It can be obtained by drawing an imaginary line from the centre of the Moon to the centre of the Sun. The sub solar point can never stray more than 1.5° from the equator of the Moon because the Moon's spin axis is only 1.5° inclined to the plane containing the Sun. But it is capable of travelling through all longitudes and does so. At a pace of around 12.2° per day, this motion is moving westward (in the direction of decreasing selenographic longitude).

Moon orientation

Due to the Moon's great distance in relation to the separation of observers on Earth, it appears virtually identical from every point on Earth. When viewed from different parts of the world, though, it appears to be oriented differently. The Earth is a sphere, which explains why different viewers aren't on the same plane and have different orientations. Some proponents of the flat Earth have trouble with spatial awareness and use the moon’s different orientation as “evidence” of the flatness of the planet. They are in error. We should be able to observe the different moon faces from different locations on Earth if the Moon is close in their model. We obviously don’t, though.

Seleno graphic coordinate system

The selenographic coordinate system is used to refer to locations on the surface of Earth's moon. Any position on the lunar surface can be referenced by specifying two numerical values, which are comparable to the latitude and longitude of Earth. The longitude gives the position east or west of the Moon's prime meridian, which is the line passing from the lunar north pole through the point on the lunar surface directly facing Earth to the lunar south pole. (See also Earth's prime meridian.) This can be thought of as the midpoint of the visible Moon as seen from the Earth. The latitude gives the position north or south of the lunar equator. Both of these coordinates are given in degrees.

CHAPTER 2

HOW CRATERS DEPTH DETERMINED!

Expensive astronomical equipment is frequently needed for experimental work related to the study of astronomical objects and processes. This, together with a lack of understanding of sophisticated working procedures, is the primary cause of the absence of such experimental activity in the field of education. The diameter and depth of craters on the Moon's surface are being measured with particular attention.

Galileo Galilei, who built his first telescope in 1609 and used it to examine the Moon, made the first observation of craters on the Moon. Contrary to popular belief at the time, he learned that the Moon was not a perfect sphere,

But also had mountains and cup-shaped depressions, which he called craters. Galileo modelled the word "crater" after the Greek word for "vessel," "K," which was the name of a Greek vessel used to combine wine and water.

Today, it is possible to obtain a wealth of information about the individual craters on the Moon through a variety of images, catalogues and widely accessible free application. This highlights the utilisation of scientific data that can be used as a foundation for theoretical deductions or as confirmation of different conclusions. Data published by Pike (1976) in a database of crater proportions, drawn primarily from panoramic images obtained on the final three Apollo flights, is discussed multiple times in the context of the study of craters on the Moon. Our goal is to research how to determine the diameter and depth of craters on the Moon.

The importance of determining a crater's diameter-to-depth ratio is the first point we make in the paper. We next go into greater detail about the working technique, introducing the experimental work's course and outlining the main working practises that are the subject of the inquiry. The outcomes are then presented.

The diameter D and depth h, or their ratio, are the two most important measurable factors in the description of the crater .The two major structural components of the crater are connected when the depth and diameter are measured. As there is a problem with measurement accuracy However, our experimental techniques are perfectly acceptable if we are merely interested in the statistical link between the diameter and depth of the craters.

Numerous craters on the surface of the Moon have had their diameter and depth determined using images taken by terrestrial observatories and artificial satellites orbiting the Moon as well as information on the angle of the sun's rays with respect to the Moon's surface.

Only at the initial stage of crater formation, known as the compression phase, when the projectile collides with the Moon's surface , the material in the area of the impact is compressed, are the projectile and crater sizes comparable. The location is condensed. The projectile's momentum and electromagnetic energy play a direct role in this phase. When a projectile collides with the surface of the Moon, its normal projectile speed ranges from 13 km/s to 18 km/s. Following the compression stage, the projectile has a negligible impact on the material removal that follows and the crater's final shape. Due to the projectile's high speed and kinetic energy, some of its material evaporates close to the point of impact. A crater with a diameter a few times greater than the projectile's diameter develops as a result of material being dug up by the shock wave. The compressed material expands once more during the subsequent phase, creating a slight elevation. And the relationship between the crater's diameter and depth typically follows a power law .

But we are just making use of the simplest way to determining the depth of the crater, which is by using the shadow length in the crater .

THEORY

The determination of height of a crater is calculated using this equation.

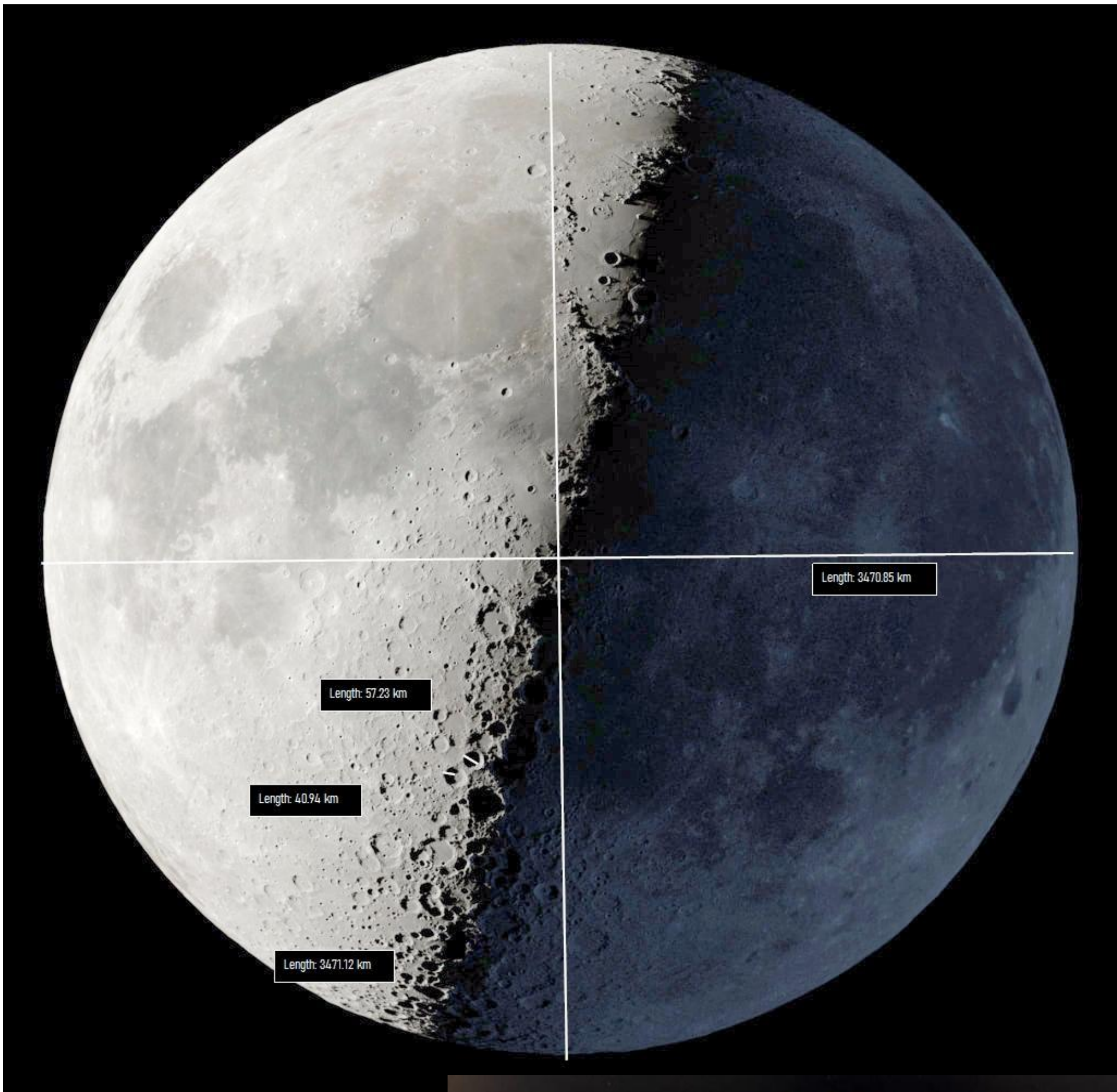
$$Al = L \tan(S)$$

Where,
Al is the Depth of the Lunar Crater.
L is the Shadow Length.
S is the angle formed between the sunrays and the Moon's surface.
Shadow length is determined using the software named IC Measure. To determine the angle (S) between the sunrays and the moon surface. This angle could be determined using the method of trigonometric relations to calculate the angle using the formula

$$S = \arcsin(\sin b * \sin c + \cos c * \cos b * \cos(\alpha - \beta))$$

Where (β,b) determines the position of the crater on the moon.
The pair (c, α) gives the position of so called "sub solar point, which is the point on the Moon where the Sun is at its zenith. The above values that is the sub solar point varies each day because the position Of sun and moon changes to some angle each day. The values of position of crater on the moon is remain invariant with respect to the moon so we only want to measure is the sub solar point ad substitute the values obtained in the above equation of S,the angle. The value of Sand L (shadow length) obtained is substituted on the equation of Al (which is the depth of the crater).

CALCULATIONS



Time	Saturday, January 01, 2022, 00:00 UT
Phase	4.7% (27d 16h 17m)
Diameter	1997.1 arcseconds
Distance	358876 km (28.16 Earth diameters)
J2000 Right Ascension, Declination	16h 55m 1s, -23° 53' 7"
Subsolar Longitude, Latitude	-156.684°, -0.994°
Sub-Earth Longitude, Latitude	-1.820°, 1.696°
Position Angle	4.927°

S= arc sin (Sin b * Sin c+ cos C * cos b* (cos **(α** - **β**))

b , **β** = (- 23 , - 53)

(C , **α**) = (- 156 684" , - 0.994)

: S = arc sin(Sin (- 23) * sin (- 156 ' 684 ;) + (cos (- 156 "684)" COS(-23) *cos (-0.994- - 53))

=arc sin((- 0.3907 4 x – 0. 3958) + (- 0. 91833 x (0. 9205) x 0. 6155 7))

= > - 21.4469

1. Shadow length from image L = 40.94

Height of Crater 1,AL = L tan S

=[-0.396896237× 40.94]

=-16.2489 km

The negative sign can be neglected due to trigonometric assumptions.

Therefore height of crater 1 is 16.2489 Km

2. Shadow length from image L =57.23

Height of Crater 2,Al = L tan S

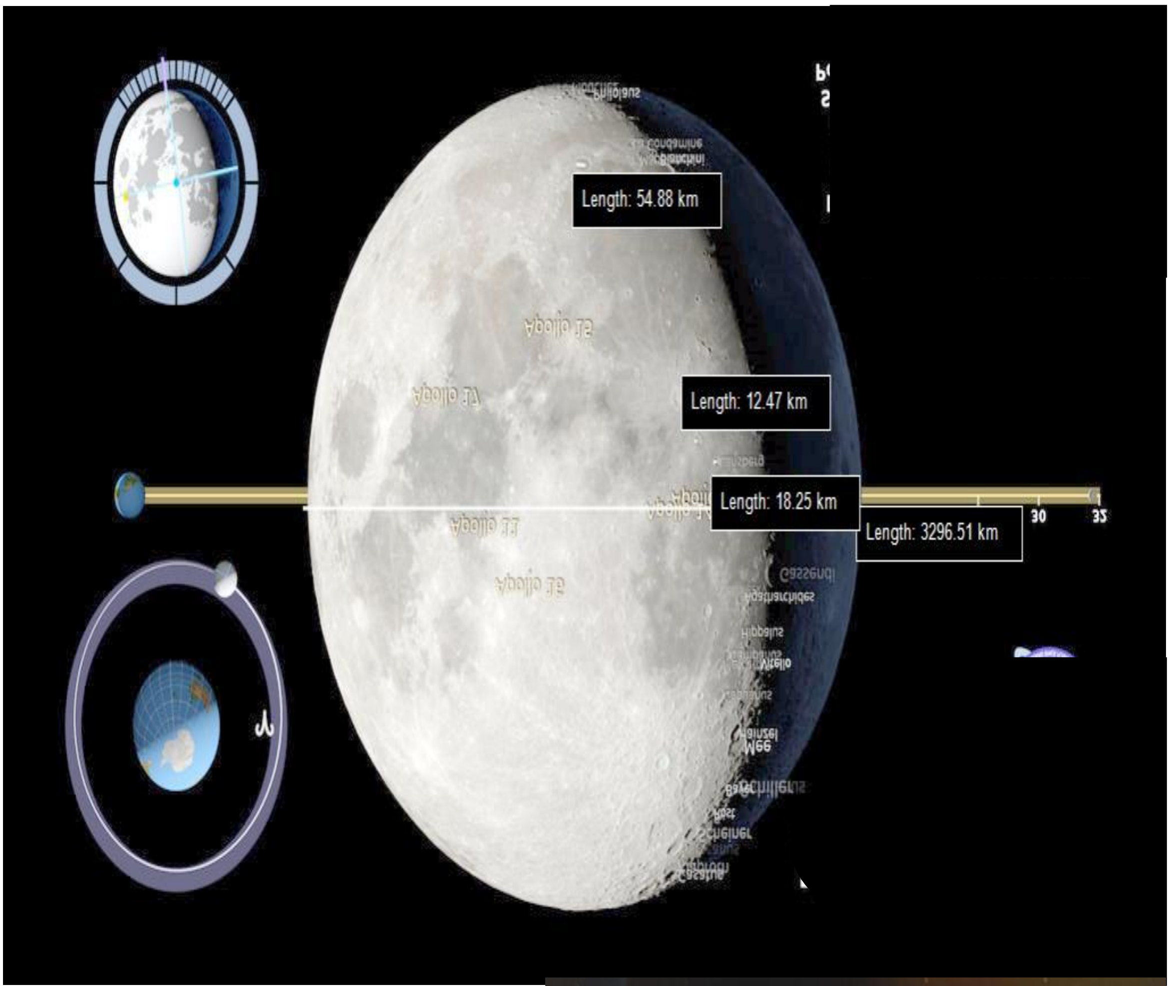
=[-0.396896237 × 57.23]

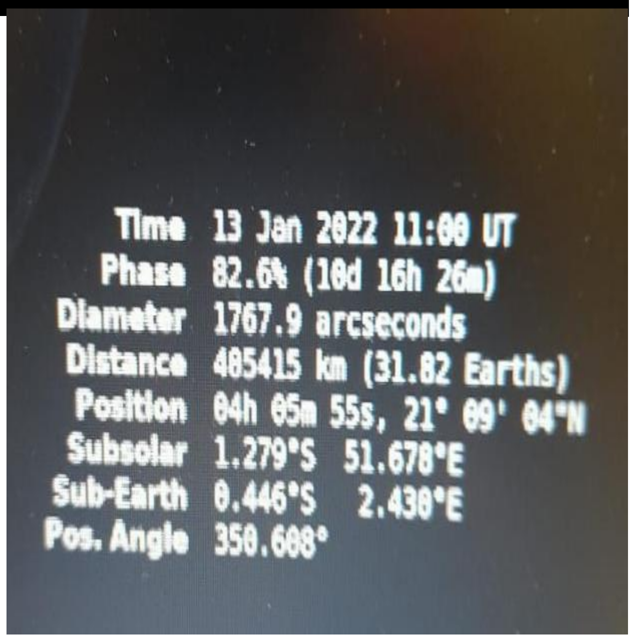
= -22. 714 Km

Negative sign can be neglected.

Therefore height of crater 2 is 22.714 Km.

2.


Length: 54.88 km
Length: 12.47 km
Length: 18.25 km
Length: 3296.51 km
30
32


Time 13 Jan 2022 11:00 UT
Phase 82.6% (10d 16h 26m)
Diameter 1767.9 arcseconds
Distance 405415 km (31.82 Earths)
Position 04h 05m 55s, 21° 09' 04"N
Subsolar 1.279°S 51.678°E
Sub-Earth 0.446°S 2.430°E
Pos. Angle 350.608°

$s = \text{arc sin}\ (\text{Sin } b * \text{Sin } c + \cos C * \cos b * (\cos\ (\alpha - \beta)\ )$

$B\ ,\ \beta = (\ 21\ ,\ 69\ )$

$(\ C\ ,\ \alpha\ ) = (1.279\ S\ ,\ 51.678E)$

$S = \text{arc sin}\ (\text{Sin}\ (69) * \sin\ (\ 1.279\ ) + (\text{Cos}\ (\ 1.279\ ) * \text{COS}(69) * \cos\ (51.679 - 21))$

$= \text{arc sin}((0.9335 * 0.223) + (\ 0.999 x\ (\ 0.3583)\ x\ 0.86003)\ )$

= > . 3286

=19.1838

Tan s =0.347920298

1.Shadow length from crater 1 =54.88 km

Height of Crater 1,Al = L tan S

$= [0.347920298 \times 54.88]$

= 19.09Km

Chapter 3

CONCLUSION

Astronomy is a quick creating science field where significant developments and disclosure's are made. Subsequently a huge part of youthful age is looking in to this field. A portion of the disclosure's and developments made in this field is valuable to facilitate our human existence and we are additionally close to the space venture. As a little step to the field of astronomy, we are doing our undertaking to compute the profundity of a lunar hole by the method for hardware's which are accessible to us. An inquiry may emerge, what is the meaning of deciding the profundity of a cavity. Well the answer is it gives us a thought regarding geology of moon's surface and it will help us to concentrate on the stratigraphy of moon's surface. The strategy we used to see as the profundity of lunar cavity is the conditions of geometry. The qualities which is required is acquired from doing computations from the information accessible to us. We had the option to get the profundity of lunar cavity with a precision of around 90%.

As I told before ,by finding the profundity of crater we can figure out the geography which might assist us with arriving on moon sometime in the future. we welcome all astrophysicist and researcher of our country for gaining a great headway in the field of science.