Navigation Plan: Earth to Moon

Team name: Silver Stars

Spacecraft name: Cygnus

Launch time and date: 10th April at 12 o'clock

Duration of journey: 6 days

Expected impact time: 16th April at 8 o'clock

Cape Canaveral, we have a take off!

Navigation instruments:

Cygnus is a powerful spacecraft made of components that perform various essential functions to achieve our goal. The components are the following (from top to bottom): the command module, service module, lunar module and lunar module adapter.

The LCROSS shepherding spacecraft, following four minutes behind, will fly through the debris and collect data with a suite of instruments including **spectrometers**, **cameras**, and a **radiometer**.

With accurate information on the spacecraft's position and velocity, mission teams can decide whether it is necessary to correct its course, and by how much. They compute the precise duration and direction needed to fire the craft's small onboard thrusters, and they translate this information into a set of commands that are relayed from the DSN to the spacecraft. Aboard the spacecraft, there are instruments to allow the craft to orient itself properly, using the sun and stars, before firing its thrusters.

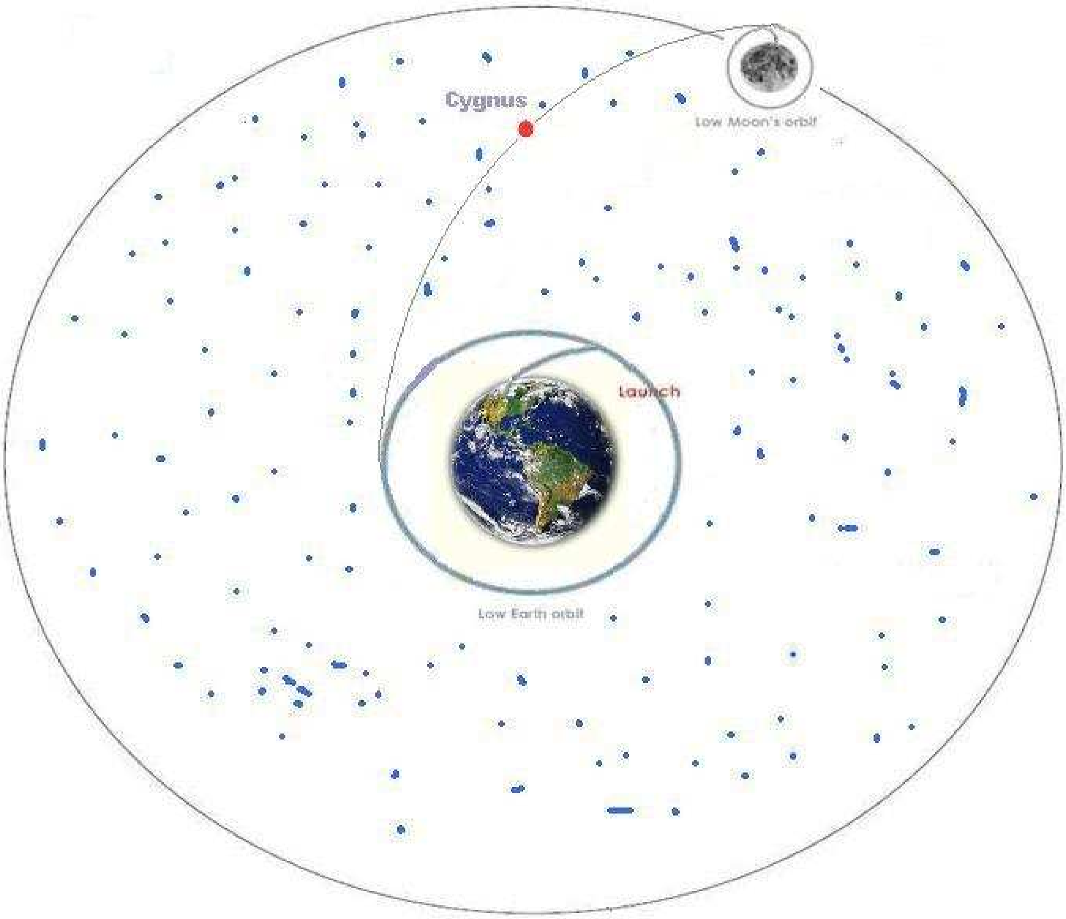
Methods of guidance, navigation, control, and tracking:

After launching the spaceship, it will follow (and circle) Earth's orbit. Next it will continue by passing on a tangent elliptic one. After completing this one as well, it will follow it's journey's final orbit, the Moon's. Once reaching Moon's lunar surface the robot receives from Earth information and coordinates of the most recent comet hitting the moon near permanently shadowed lunar craters. When reaching the crater, he scans the chemical composition. If it finds hydrogen in proportion of 66.6% and oxygen, 33.3% then it found water and takes a sample to bring it on Earth for further investigation.

Description of route and orbital paths:

In order to be able to reach the Moon, our spacecraft must pass from the initial orbit to a tangent one, and then to the final orbit. The next step will be hitting the Moon, in its North Pole.

Navigation Map: Earth to Moon



[See our flash animation (http://nasacnitv7.ws43.com/salt.swf)](http://nasacnitv7.ws43.com/salt.swf)

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Cape Canaveral, we have a problem!

During the launch we faced the next problem: our starship is deviated from the right course with 10 km. We have 8 hours to correct this.

Required correction:	10 km = 10 000 m
Time for correction:	8 h = 28,8 s
Velocity change v:	10 km / 8h = 0.35 m/s
Total spacecraft weight:	7 275 lb = 32 360.81 N
Total rocket thrust:	10 lbs of force = 44.5 N

This problem will be solved using the following laws:

$$\vec{F} = m \cdot \vec{a}$$
$$F = m \cdot a$$

$$v = a \cdot t$$

Also we will use that weight (w) equals mass (m) times gravity (g):

$$w = m \cdot g$$

At this point we can calculate the mass of the spacecraft:

$$m = \frac{w}{g}$$

The spacecraft acceleration will be:

$$a = \frac{F}{m}$$

$$a = \frac{F \cdot g}{w}$$

Furthermore we will use the velocity change mathematical expression:

$$v = a \cdot t$$

$$\Rightarrow \quad t = \frac{v}{a}$$

Finally, we can calculate how long must fire the onboard thrusters to get back on target:

$$t = \frac{v \cdot w}{F \cdot g}$$

The numerical solve of the problem:

$$\left.\begin{array}{l} v = 0.35 \text{ m/s} \\ w = 32{,}360.8 \text{ N} \\ F = 44.5 \text{ N} \\ g = 9.8 \text{ m/s}^2 \end{array}\right\} \Rightarrow \quad t = \frac{0.35 \cdot 32{,}360.8}{44.5 \cdot 9.8} = 25.97 \text{ s}$$

In our opinion, the thrusters should be fired for t = 25.97 seconds in order to correct the course error.

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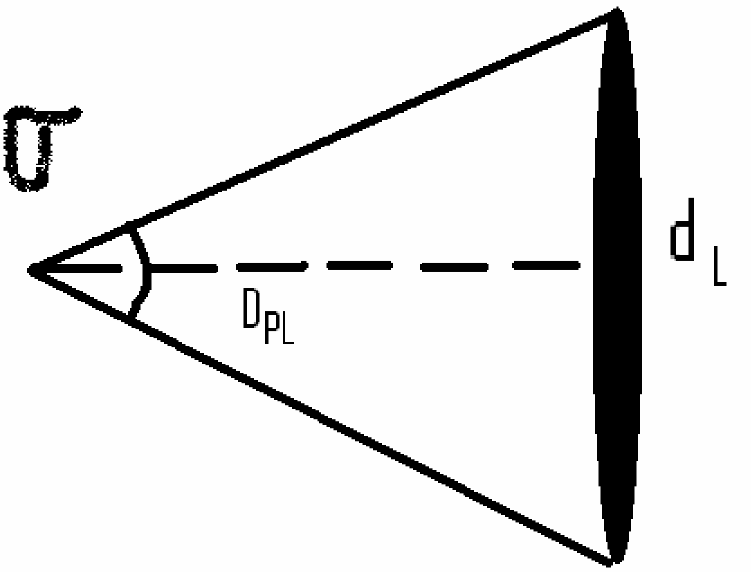
During this project, as beginner scientists, we were glad to face the following challenges:

Answer to question number 1

Astronomers measure the apparent size of celestial objects using degrees.
Just as a circle contains 360 degrees, you can see what one degree on the sky looks like by slicing the horizon into 360 slices.

From Earth, the moon's apparent diameter is half a degree. What is the apparent diameter of the Earth as seen from the moon?

D_{PL} = the distance between Earth and Moon
d_P = the diameter of the Earth
d_L = the diameter of the Moon
σ = Moon's angular diameter
α = Earth's angular diameter



$$tg\left(\frac{\sigma}{2}\right) = \frac{d_L}{2D_{PL}} \quad (1)$$

$$\sigma < 6 \Rightarrow tg\left(\frac{\sigma}{2}\right) \cong \frac{\sigma}{2} \quad (2)$$

FROM (1) AND (2) =>

$$\frac{\sigma}{2} = \frac{d_L}{2D_{PL}} \quad (*)$$

Using the same method, we find

$$\frac{\alpha}{2} = \frac{d_P}{2D_{PL}} \quad (**)$$

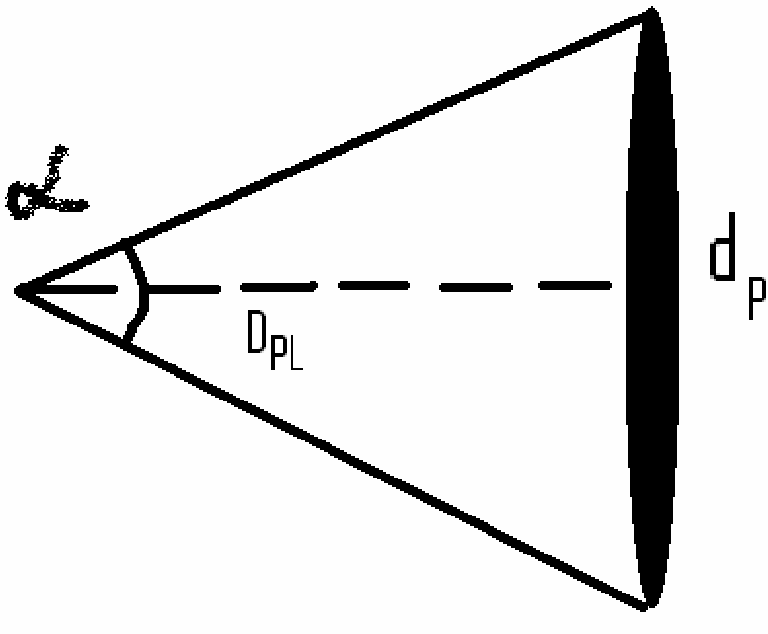
From (*) AND (* *) =>

$$\frac{\sigma}{\alpha} = \frac{d_L}{d_P} \quad \Rightarrow \quad \alpha = \frac{\sigma * d_P}{d_L}$$

$$\sigma = 0{,}5^{\circ}$$
$$d_P = 12740\,km$$
$$d_L = 3476\,km$$

$\Rightarrow$

$$\alpha = \frac{0{,}5^{\circ} * 12740\,km}{3476\,km} \cong 1{,}832^{\circ}$$



Answer to question number 2

1. How are they different, besides their color (the dark&bright side of the Moon)?

The Maria is about 2 miles lower in elevation, on average than the Terrae (highlands). The lowlands are darker and younger. The Maria had lava flows between 3 and 3.8 billion years ago after the end of the intense bombardment.
Even though the Terrae occupy two thirds of the visible or Earth facing hemisphere (and about 85 percent of the entire surface), less was known about them than about the Maria. This is so because of their older age and apparent complexity and partly because only one of the five successful Surveyor spacecraft landed in the Terrae.

2. What are the compositions (rock types) of the bright and dark areas of the moon?

Meteoritic impacts brought a variety of "exotic" rocks to the Moon so that samples obtained from only some locations produced many different rock types for study. Moon rocks fall into two main categories, based on whether they underlie the lunar highlands (Terrae) or the Maria. Typical rocks are : **dunites** (an igneous, plutonic rock, of ultramafic composition, with coarse-grained or phaneritic texture), **troctolites** (a rare ultramafic intrusive rock type.), **gabbros** (refers to a large group of dark, coarse-grained, intrusive igneous rocks), **alkali anorthosites** (a phaneritic, intrusive igneous rock, and more rarely), **granite** (is a common and widely occurring type of intrusive, igneous rock.).

3. What are the Latin words scientists use to refer to these areas, and what do they mean?

We noticed that that the moon is divided in two parts: the dark side also called Maria and the bright side named Terrae.
Our team also found some words in Latin, which refer to the composition of the rocks from Terrae and Maria :

- **Luna** (in Romanian is the same) = Moon
- **Mensis** = Month
- **Maria** = Sea
- **Terrae** = Earth
- **Saxum** = Rock
- **Glacies** = Ice
- **Collis** = Hill
- **Aqua** = Water
- **Solum** = Ground

Answer to question number 3

We have studied websites and books succeeding together to find appropriate answers to your questions…

A) *How old are the oldest rocks found on the Moon?*

Through the last years, there have been discovered lots of rocks. The ages of Earth and Moon rocks were first measured by the astronauts who went on the Moon, using special devices to detect radioactivity that occurs naturally in rocks and minerals.

These dating techniques, which are known collectively as radiometric dating, are used to measure the last time that the rock that is being dated were either melted or disturbed sufficiently to rehomogenize its radioactive elements.

The oldest dated moon rocks have ages between 4.4 and 4.5 billion years and provide a minimum age for the formation of our nearest planetary neighbor.

There are currently three sources of Moon rocks on Earth:

1) Those collected by US Apollo missions;

2) Samples returned by the Soviet Union Luna missions;

3) Rocks that were ejected naturally from the lunar surface by cratering events and subsequently fell to Earth as lunar meteorites.

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b) How old are the oldest rocks found on the Earth?

Ancient rocks which date over 3.5 billion years in age are found on all of Earth's continents. The oldest rocks on Earth found so far are the Acasta Gneisses in northwestern Canada near Great Slave Lake and the Isua Supracrustal rocks in West Greenland. Well-studied rocks nearly as old are also found in the Minnesota River Valley and northern Michigan (3.5-3.7 billion years), in Swaziland (3.4-3.5 billion years), and in Western Australia (3.4-3.6 billion years).

C) Why don't we find rock on the Earth as old as those on the moon?

Earth has younger rocks than the Moon because of the volcanic activities on the moon that shut down many years ago. Our earth has an active volcanic activity and constantly regenerates the earth crust , while the moon has rocks that are getting older and older, day by day.

After reading many sources regarding this topic we have reached the conclusion that in general, the rocks collected from the Moon are extremely old compared to rocks found on Earth, as measured by radiometric dating techniques. They range in age from about 3.16 billion years old for the basaltic samples derived from the lunar maria, up to about 4.5 billion years old for rocks derived from the highlands. The Moon is scarred with ancient craters that, on Earth, must have long ago weathered away. Because the Moon lacks weather or tectonic activity, that debris might still be there. While some has undoubtedly been destroyed by subsequent impacts of asteroids or comets on the Moon, some might have survived in the lunar soil.

The geology of the Moon is quite different from that of the Earth. The Moon lacks a significant atmosphere and any bodies of water, which eliminates erosion due to weather; it does not possess any form of plate tectonics, it has a lower gravity, and because of its small size, it cools more rapidly.

ALSO CHECK OUR FLASH ANIMATION ABOUT MOON ROCKS

(http://nasacnitv7.ws43.com/rock.swf)

Answer to Question Number 4

Q: Why don't we see the far side of the moon from Earth?

A: Because the revolution period of the moon around its axis is equal with moon's rotation around Earth (27 days, 7 hours, 43 minutes, 11 seconds), we can only see 59 % of the Moon's surface. The unseen part is called "The Far Side ".We have also noticed that the Russian satellite "Moon 3" took the first photo of the Far Side of the Moon.


The Near Side


The Far Side

Q: Which are the differences between the far side and the dark side?
A: Many people think that the Dark Side is the same as the Far Side, but this is wrong. Considering that, we found two differences:
The primary difference between the two sides is that the Near Side contains more maria. Secondly, we found that there's a difference of temperature between them. The temperature at the surface, on the Near Side is 400 K, and on the Far Side is 130 K.

Also check our flash animation (http://nasacnitv7.ws43.com/orbita.swf)

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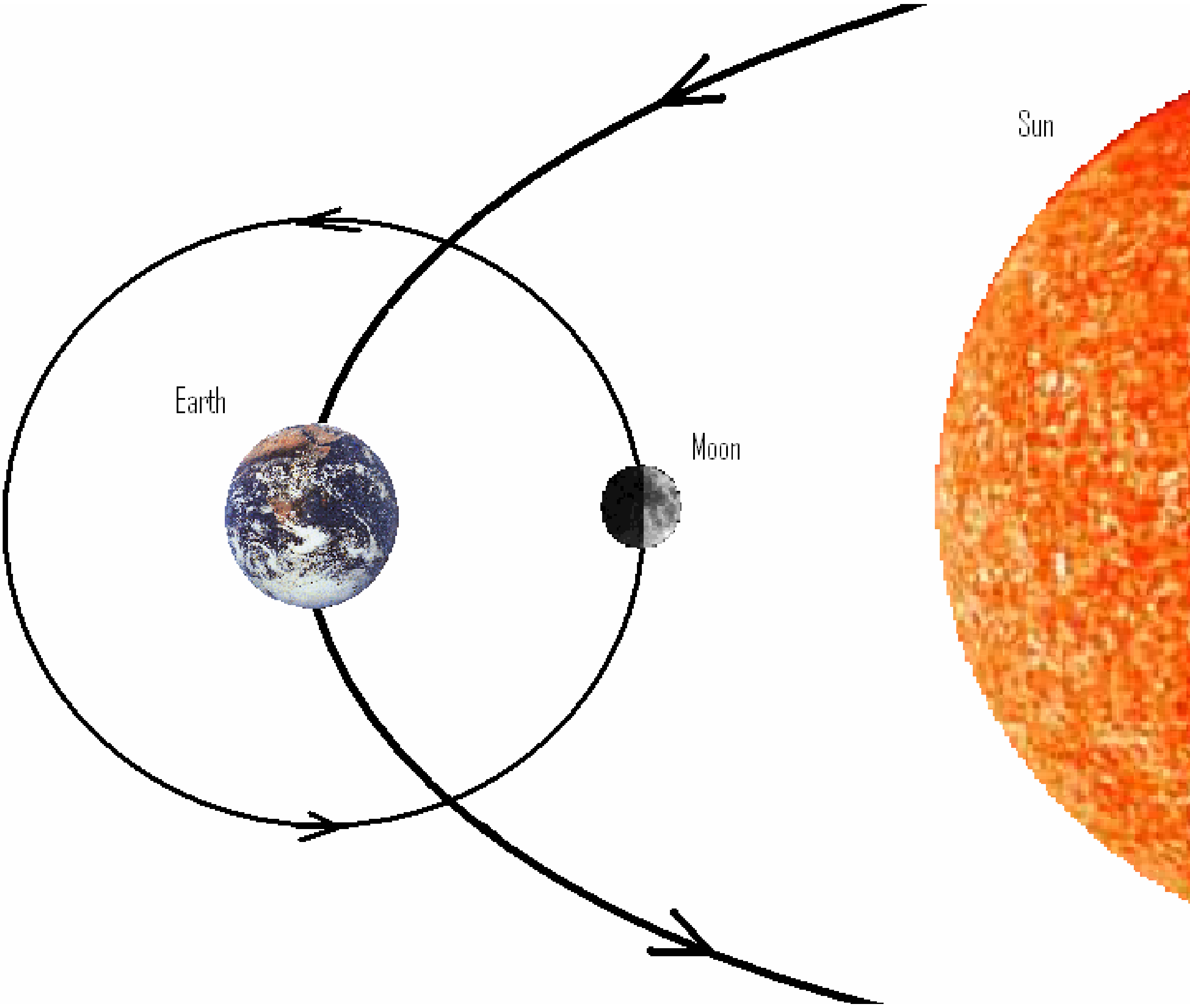

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Answer to Question Number 5

Starting assumptions:

- Assume it costs $100,000 to transport one pound of supplies from Earth to a base on the surface of the moon.
- Assume each astronaut requires 0.8 gallons of water on any day when that astronaut remains inside the base all day, and 1.2 gallons of water on any day when the astronaut goes outside for a seven-hour moonwalk, working inside a pressurized space suit.
- Assume each astronaut does a moonwalk every other day (so that half the crew does a moonwalk one day, the other half does a moonwalk the following day, and so on).

a) For an early lunar expedition with four people staying on the lunar surface for 8 days, how much does it cost to carry enough water for the crew's stay on the lunar surface?

We know that each day half of the crew (2 members) does a moonwalk each day.

*2*0.8=1.6 for the 2 members who remain inside the base*
*2*1.2=2.4 for the 2 members who exit the base*

=>1.6+2.4=4 gallons of water/day=>

*=>for 8 days they need 4*8=32 gallons*
but 1 gallon = 8.33 pounds

*=>for 8 days they need 8.33*32=266.56 pounds*

=>the total cost is ***266.56 * 100.000$ =26.656.000$***

Question:

b. For a lunar base crew of 6 people, living on the moon for 180 days, how much does it cost to supply the base with enough water, carried from Earth, for that crew?

There are several steps to calculate the total cost:

1) Converting physical quantities:
   1 Gallon=3,785 L
   1 Lbs=0,454 kg (one pound)
   1 Kg=2,2 Lbs

2) Taking into account the equivalence, valid for water
   1 L=1 Kg
   1 L=2,2 Lbs
   => 1 gallon= 8,327 Lbs

3) Amount of water used by the crew of 6 people in a day will be:
   3*0,8+3*1,2=3(0,8+1,2)=6 gallons per day

4) The crew will need for 180 days:
   6* 180= 1020 gallons

5) Which will have:
   1080*8,327 Lbs=8993 Lbs

6) The Total cost will be:
   8993 * $100,000=$899,316,000

   FINAL ANSWER: $899,316,000

Question:

C. To save the cost of transporting water from Earth, suggest one way that astronauts on the moon might obtain water locally, assuming there is NOT any ice buried under the surface.

In our opinion, in order to reduce the costs of transporting water, the humans reaching the Moon should try to recycle as much water as possible.

Water recyclers made by NASA can recycle 93% of the water it receives meaning that it can cut of the need of transporting the water by 65% meaning it reduces cost by 65%. Recycle means that the water needed to be transported is cut to 14.4 gallons meaning that the cost is 1 440 000 $ for case a). For case b) the cost is lowered to 486 gallons meaning it costs only 48 600 000$.

Also many chemical reactions result in water. One example is burning hydrocarbons.

We can also create water, but since gases take up greater volumes, it takes HUGE amounts of the gases hydrogen and oxygen to make a small amount of liquid water.

It would be easier to transport water to moon in gas state, by evaporation, because the mass would be smaller. The force F = mass (g + evade speed) + the friction force with the air would be smaller so automatically we need less combustible and we can save a part of cost.

Answer to Question Number 6

Starting assumptions:

Assume that the concentration of ice contained in the lunar soil within permanently shadowed craters is 2 percent by weight.
Assume that the ice exists only in the top 2 meters of soil.
Assume that the density of lunar soil is 2.9 grams per cubic centimeter (Earth weight).

Questions:

a) Scientists have estimated that the total area of the moon that is permanently in shadow, at both north and south poles, is 12,500 square kilometers. Based on the above assumptions, how many gallons of water are contained in the lunar Polar Regions?

We assume that both poles of the moon are covered with craters.

$$m_{moon\_soil} = V * \rho, \quad V = A * h \;\Rightarrow\; m_{moon\_soil} = h * A * \rho, \quad m_{ice} = \frac{2}{100} * m_{moon\_soil} \;\Rightarrow\; m_{ice} = \frac{2}{100} * h * A * \rho, \quad V_{water} = \frac{m_{ice}}{\rho_{water}} \;\Rightarrow$$

$$\Rightarrow\; V_{water} = \frac{\frac{2}{100} * h * A * \rho}{\rho_{water}} = \frac{\frac{2}{100} * 2m * 125 * 10^8 m^2 * 29 * 10^2 kg/m^3}{10^3 kg/m^3} = \frac{145 * 10^{10} kg}{10^3 kg/m^3} = 145 * 10^7 m^3$$

$V_{water} = 145 * 10^{7} m^{3}$

$1 m^{3} = 1000 l$

$\Rightarrow V_{water} = 145 * 10^{10} l$

$1 l = 26 * 10^{-2} \, gallons$

$\Rightarrow V_{water} = 145 * 26 * 10^{8} \, gallons =$

$= 377 * 10^{9} \, gallons$

b) Based on the information in Question 5, how many astronauts, living and working at bases on the moon, could this much water sustain for a year?

We have decided to approximate 377 to 365 (the total number of days in a year)

During one year, the highest number of people who can survive with the amount of water that we found in the moon soil is :

$\frac{365 * 10^{9}}{365} \cong 1.000.000.000$ **People**

c) Do you think it is realistic to harvest all this water?

Suggest ways to help astronauts working at a base in the moon's polar regions to obtain ice from lunar soil. Estimate how much water could be harvested in one year of base operations.

If people harvest all this water, moon soils can dehydrate and degrade.

A robot rover designed for digging within lunar craters has to operate in continual darkness at extremely cold temperatures with little power. The moon has one-sixth the gravity of Earth, so a lightweight rover will have a difficult job resisting drilling forces and remaining stable. Lunar soil, known as regolith, is abrasive and compact, so if a drill strikes ice, it likely will have the consistency of concrete. This kind of robot will be able to extract ice, but in small quantities(about 2.6 gallons).

If on the Moon live 1000000000 people, that we answered at b), they will consume 1000000000 gallons per day. We have 377*10⁹ gallons, then they can live 377 days there.

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OTHER PROJECTS

We enjoyed working on this project, because we like learning new things and communicating with students of our age and same interests as ours. **Please feel free to visit our websites:**

1) Planet Phoenix (http://library.thinkquest.org/07aug/02110/prim.htm)
Planet Phoenix is the ideal planet where everyone would like to live. The planet is localized in the Fordt Way galaxy. The real goal of this project is to teach people to take care our planet. We don't need to colonize Phoenix for living better. We still have Earth.

2) Rocket Project (http://rocket-project.uv.ro)
Rocket Project helped us to learn new things. We built rockets made of recyclable materials like water bottles and paper. After we found out how to calculate the distance our rockets were going to fly, we filled them with water and launched them using a pump.

3) Light Pollution (http://nasacnitv7.ws43.com/lightp.ppt)

Light pollution, also known as photo pollution or luminous pollution, is excessive or obtrusive artificial light. The signal we brought is that Of all the pollutions we face, light pollution is perhaps the most easily remedied.