The Moon's radius is about 1/4 that of the Earth. Referring to Newton's Universal Law of Gravitation, how does this difference affect the strength of the Moon's gravitational field ("little g") felt by an astronaut on its surface as compared to the strength of the Earth's gravitational field that we experience every day? Hint: there are several aspects to consider.

And the two factors are ...

In Newton's universal law of Gravitation, what we call "little g" is represented by G*mass of the earth divided by the radius of the earth squared. In this case, **if the radius of the moon is 1/4 that of the earth, and this is squared, the bottom term in "little g" is actually 1/16. However, the moon is much less massive than Earth, by about 80 times**. With both of these terms adjusted for the moon, the strength of the gravitational field on the Moon is actually 6 times smaller than that of earth.

Another similar, though suspicious evidence of calculator usage and the wrong units for little g (just to annoy me I'm sure)

Mathematically, the gravitational field (little g) is defined as $g = G(M/r^2)$. **Decreasing r by a factor of 1/4 would decrease the denominator by a factor of $(1/4)^2$ which would make g larger. Despite this change, the mass of the moon is smaller than Earth's by a factor of roughly 100 causing the numerator to decrease which gives a smaller number for g**. With the new equation we have $g = G[0.01*M/(r/4)^2] = G[0.01*M/(r^2/16)] = 6.25*G[M/r^2]$ balancing the equations gives $g/6.25 = G[M/r^2]$ so on the surface of the moon, **little g is smaller than Earth's little G by a factor of 6.25 making the gravity of the moon $(9.8 m/s^2)/(6.25)$ = roughly $1.6 m/s^2$**

An excellent example of using what you know to determine something you don't!

When on the surface of the moon, the 'r' value used in Newton's universal law of gravitation becomes around 1/4 as large. As $F_g = -G(m_1*m_2)/(r^2)$, this turns into a ratio of $1/(1/16) = 16$. Obviously, this can't be the full picture, as this would imply that the moon has a gravity 16 times stronger than that of Earth. To reconcile this, we consider that 'little g' is $g = (Gm/(r^2))$. Here it becomes more clear: **the gravity experienced on the moon would be 16 times stronger than on Earth if the Moon had mass equal to the Earth. In reality, the moon is much, much less massive than the Earth. In fact, off the top of my head, I know that things weigh around 1/6 as much on the Moon**. So, with the radius taken into account, the Moon must have some mass relative to Earth m_{moon} so that $16m_{moon} = 1/6$. **So, by this rough calculation, the mass of the Moon is around 1/96 that of the Earth.** Otherwise, the smaller radius of the Moon would give it a much stronger gravity at the surface, which we know to not be the case.

The Earth's gravity does still exerts a force on objects on the Moon's surface, but that's in addition to the Moon's own much stronger gravity. The moon is about 63 times farther from the center of the Earth than you are right now. Use that to estimate the force that Earth's gravity would exert on you if you were standing on the Moon. To be clear, I'm not asking about the Moon's gravitational force on you, I'm asking about the additional force of the Earth's gravity when you are on the Moon!

Hint: You do not need to look up the value of "big G" or the Earth's radius. Simple algebra and a little cleverness with the "little g" you know is sufficient.

An excellent answer because the error is immediately apparent

If the moon is 63 times farther from the center of the earth than we are right now, and (G * m_earth/r^2_earth) = 9.8 N/kg, then the earth's gravity on the moon would be 1/63 what it is on earth.

so 9.8 * 1/63 would be about 0.16 N/kg. So Fg = .16 N/kg * 90 kg = 13 N

An excellent answer that methodically lays out the calculation

Force due to gravity on Earth= g of Earth * my mass

Force due to gravity when on the moon= new g of Earth* my mass

g=(G* mass of Earth)/(r of Earth^2)

g when on Earth = 9.8 m/s^2 or about 10m/s^2 (dp — ahem, should be N/kg)

when r is increased by 63, the denominator is increased by about 3600, and g is divided by 3600.

g when on Moon = 10/3600 N/kg approximately equals 0.003 N/kg

Since my mass is the same on both bodies, the only changing aspect for the force of gravity I feel is little g. My mass is about 60 kg.

Force of gravity on Moon=(0.003 N/kg)(60 kg) is about 0.18 N

If the reference position where gravitational potential energy is set to be zero is chosen to be infinitely far away, then the total mechanical energy of a satellite in a circular orbit around the Earth

a. varies depending on the satellite's position
b. is always positive
c. is always negative
d. is always exactly zero