

# Universal Physics Journal

## Question 8: What causes Earth's dual high tides?

Hello Ethan:

I have read that the greater high tide on the moon side of the earth is caused by attraction of the water toward the moon while the lesser high tide on the opposite side of earth is caused by that water lagging behind in earth's acceleration around the center of mass it shares with the Moon. I think this comes from Newton's theories. Do you think this is the correct cause of these high tides? Walter E., Vancouver BC, Canada.

Hello Walter:

While not the whole truth, your description of the cause of Earth's tides is a pretty good one. For a deeper understanding of the cause of Earth's tides, you have to consider the forces at work, not only those affecting the water but also those affecting all the matter that serves to support Earth's oceans nearly 4,000 miles above Earth's core. Let me explain.

To begin with, we tend to think of water as being non-compressible. But in practice, such is not the case. The deeper you go in the ocean, the less volume a given quantity of water occupies. This compression effect does not stop at the ocean floor. It continues to apply to Earth's solid and molten matter right down to the core. I see this as forming an air/water/crust/molten rock/solid/matter column that is 4,000 miles tall. The pressure at the top of the column is 0 psi in the upper reaches of the atmosphere, about 15 psi at the ocean surface, up to 16,000 psi at the deepest portion of the ocean floor and from there increasing to some unimaginable pressure at Earth's core.

Think of this air/water/crust/molten rock/solid/matter column as a tall compression spring whose height responds to variations in the force of its own gravitational weight. While the gravitational weight of the column's matter does approach zero as it nears Earth's core, it nevertheless is extremely dense as it is being held in compaction on one side by the weight of all the matter located higher up in the column.

Now to understand the cause of Earth's tides, think of what happens to this column when it is located at Earth's equator and is rotating one revolution about Earth's axis over a 24 hour period. Moon Above (0 hours)

When the Moon is above the column, the gravitational forces being generated within the column's components of matter toward the Moon cause a slight reduction in the downward weight of all the column's matter toward Earth's core. As the column's weight is reduced, the current density of the column's matter is no longer maintained. So the lighter column's matter expands a little in height. The result is a raising of the ocean's floor along with an increase in the height of the water above the floor resulting overall in an increase of the elevation of the water's surface on the side of Earth that is facing the Moon. In this Moon-overhead position there is also an upward-directed acceleration/Reaction force within the portion of the column above the Earth/Moon baricenter or axis which is close to 1000 miles underground. This upward-directed a/R force provides termination for a portion of the baricenter-column's downward-directed

gravitational action force of weight that is transferred beyond the baricenter to bear against Earth's core. Again, a lighter column is a taller column. This lighter column on one side of Earth is also finding support against a lighter column on the opposite side of Earth since there is a downward-directed a/R force present within all remaining portions of both columns below the baricenter which provides termination for a portion of the opposing baricenter-column's "upward"-directed supporting action force of gravitation. With the Moon overhead, when all acceleration/Reaction reductions are considered, it is easy to recognize why Earth's surfaces bulge both on Earth's side closest to the Moon as well as Earth's side farthest away from the Moon.

While one may be inclined to think that the sideways attraction of Earth's waters at the 6 hour and 18 hour positions will cause a bunching up of the water at the 0 hour position where the Moon is directly overhead, I think this effect is probably minimal. Understand that at the 6 hour and 18 hour positions there is an equilibrium of Moon-directed gravitational and supporting acceleration/Reaction forces. This equilibrium means that Earth's waters on each side are neither attracted toward nor repelled from the Moon's direction relative to the ocean floor below. Any bunching effect will have to occur in waters in about the 0-2 hour and 22-0 hour positions. I think this bunching effect will be minimal since Earth's waters respond slowly to changes in forces and in these near 0 positions the forces of gravitation toward the Moon are directed very nearly overhead causing a reduction in the water's weight far more than causing the water to bear sideways in a horizontal direction.

Moon To One Side (6 hours)

When the Moon (and to a lesser extent, the Sun) is located to one side of the column then the column returns to its "normal" weight and thus begins to reduce its height. This height reduction is a downward-directed acceleration supported by a matching upward-directed a/R force. Consider that while the ocean's surface (and all the solid matter below) is subsiding (compressing) after the Moon is no longer overhead, an incredible acceleration/Action force from Earth's core is required to bring the motion of this incredible quantity of matter toward Earth's core to a halt. The result will be an over-compaction of the column during the acceleration of the slowing process. Here the tide is at its lowest "subnormal" level in mid-ocean.

Moon Below (12 hours)

When the Moon is located on the opposite side of Earth and therefore below the column, the Moon is at a greater distance from the column which reduces its gravitational effect on the column. Here is where the "lagging behind" effect comes into play. Consider that the average force of the Earth's gravitation toward the Moon occurs on the Moon's side of Earth's center of mass. Moving away from the Moon, away from this center of Moon gravitation, and toward Earth's surface on Earth's far side, relative to the Moon, the acceleration of Earth's matter toward the Earth/Moon baricenter is increasing while this same matter's force of gravitation toward the Moon is decreasing. The extra force needed to meet the required total acceleration/Action force is made up by the force of the matter's gravitational attraction toward Earth's core. With a portion of this matter's gravitational force now acting as the cause of the matter's acceleration in the Moon's direction and the direction of the Earth/Moon baricenter, less of the matter's gravitational force is available to act as the cause of the matter's weight against Earth's core. Just as Earth's

matter weighs less, so does the 4000 mile high column weigh less causing a second expansion in the height of this column resulting in a second high tide on Earth's far side.

This second high tide is also augmented by the "rebound effect" at work when the Moon is below the column. After being over-compacted at low tide 6 hours earlier, the column rebounds aiding in the cause of the lesser high tide on Earth's surface opposite to the Moon. This 12 hour cycle begins repeating itself in another 6 hours to aid in causing an increase in the next greater high tide on Earth's side nearest the Moon.

Despite the Sun's far greater quantity of matter, its effect on Earth's tides is less than that of the Moon due to the great distance Earth maintains from the Sun/Earth baricenter or mutual axis of rotation. This huge distance, some 92 million miles, means that the average force of Earth's gravitational attraction toward the Sun varies little from Earth's center of mass to Earth's surface on both the near side and far side relative to the Sun. On Earth's near side, for example, the force of Earth's gravitation toward the Sun is only slightly greater than average so the small excess beyond what is required to cause this matter's acceleration toward the Sun works in opposition to the column's gravitational weight toward Earth's core effecting a small reduction in the column's weight and therefore causing a small increase in the column's height thereby adding somewhat to the height of Earth's tide. On Earth's far side, relative to the Sun, the "lagging behind" effect also takes place but to a smaller degree than the "lagging behind" effect caused by the Moon.

When all forces and accelerations are taken into account then the true cause and nature of Earth's tides is revealed. With these thoughts in mind, surely this is a fertile area that remains open to study by today's open-minded Physics students.

Thanks for "forcing" me to work my way through this one, Walter.

Cheers to all my good neighbors to the North!

Ethan Skyler  
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