Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Class \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Dialogue Concerning the Two Chief World Systems* by Galileo Galileo**

Excerpted from <http://law2.umkc.edu/faculty/projects/ftrials/galileo/dialogue4.html>

*Instructions*: Galileo published this work in 1632, one year before his condemnation. It is indeed the work that caused him to be brought before the Holy Office. In it, he presents his argument for the physical movement of the Earth around the sun. The work takes place as a dialogue between three men. Simplicio is a proponent of the Ptolemaic system, while Salviati presents the arguments for the Copernican system. Read the arguments carefully and prepare for a quick quiz at the start of next class.

*Glossary*:

**Tides** - the movement of water up and down along oceanic coastlines.

**Diurnal** - something that happens over the course of a day (as opposed to a week, month, or year)

**SIMPLICIO:**  These events, Salviati, did not just commence; they are very ancient, and have been observed by innumerable men, many of whom have contrived to give one reason or another to account for them…

Then there are many who refer the tides to the moon, saying that this has a particular dominion over the water. Lately a certain prelate has published a little tract wherein he says that the moon, wandering through the sky, attracts and draws up toward itself a heap of water which goes along following it, so that the high sea is always in that part which lies under the moon. And since when the moon is below the horizon, this rising nevertheless returns, he tells us that he can say nothing to account for this effect except that the moon not only retains this faculty naturally in itself, but in this case has also the power to confer it upon the opposite sign of the zodiac…

**SALVIATI:** Everything that has been said up to this point pertains to the diurnal period of the tides, of which the primary and universal cause has first been proved, without which no effect whatever would take place. Next, passing on to the particular events to be observed in this diurnal period (which vary and are in a certain sense irregular), the secondary and concomitant causes upon which these depend remain to be dealt with.

Now two other periods occur, the monthly and the annual. These do not introduce new and different events beyond those already considered under the diurnal period, but they act upon the latter by making them greater or less at different parts of the lunar month and at different seasons of the solar year -- almost as though the moon and sun were taking part in the production of such effects. But that concept is completely repugnant to my mind; for seeing how this movement of the oceans is a local and sensible one, made in an immense bulk of water, I cannot bring myself to give credence to such causes as lights, warm temperatures, predominances of occult qualities, and similar idle imaginings. These are so far from being actual or possible causes of the tides that the very contrary is true. The tides are the cause of them; that is, make them occur to mentalities better equipped for loquacity and ostentation than for reflections upon and investigations into the most hidden works of nature. Rather than be reduced to offering those wise, clever, and modest words, "I do not know," they hasten to wag their tongues and even their pens in the wildest absurdities.

We see that the moon and the sun do not act upon small receptacles of water by means of light, motion, and great or moderate heat; rather, we see that to make water rise by heat, one must bring it almost to boiling. In short, we cannot artificially imitate the movement of the tides in any way except by movement of the vessel. Now should not these observations assure anyone that all the other things produced as a cause of this effect are vain fantasies, entirely foreign to the truth of the matter?

Thus I say that if it is true that one effect can have only one basic cause, and if between the cause and the effect there is a fixed and constant connection, then whenever a fixed and constant alteration is seen in the effect, there must be a fixed and constant variation in the cause. Now since the alterations which take place in the tides at different times of the year and of the month have their fixed and constant periods, it must be that regular changes occur simultaneously in the primary cause of the tides. Next, the alterations in the tides at the said times consist of nothing more than changes in their sizes; that is, in the rising and lowering of the water a greater or less amount, and its running with greater or less impetus. Hence it is necessary that whatever the primary cause of the tides is, it should increase or diminish its force at the specific times mentioned. But it has already been concluded that an irregularity and unevenness in the motion of the vessel containing the water is the primary cause of the tides; therefore this unevenness must become correspondingly still more irregular from time to time (that is, must increase or diminish).

Now we must remember that the unevenness (that is, the varying velocity of the vessels which are parts of the earth's surface) depends upon these vessels moving with a composite motion, the resultant of compounding the annual and the diurnal motions which belong to the entire terrestrial globe. Of these the diurnal whirling, with its alternate addition to and subtraction from the annual movement, is the thing that produces the unevenness of the compound motion. Thus the primary cause of the uneven motion of the vessels, and hence of that of the tides, consists in the additions and subtractions which the diurnal whirling makes with respect to the annual motion. And if these additions and subtractions were always made in the same proportion with respect to the annual motion, the cause of tides would indeed continue to exist, but only a cause for their being perpetually made in the same manner…

First, this could be done by the velocity of the annual motion increasing and decreasing while the additions and subtractions made by the diurnal whirling remained constant in magnitude. For since the annual motion is about three times as fast as the diurnal motion, even taking the latter at the equator, then if we were to increase it further, the addition or subtraction of the diurnal motion would make less of an alteration. On the other hand if it were made slower, this same diurnal motion would alter it proportionately more. Thus to add or subtract four degrees of speed when dealing with something which moves with twenty degrees will alter its course less than if the same four degrees were added to or subtracted from something which moved with only ten degrees of speed.

The second way would be by making the additions and subtractions greater or smaller, retaining the annual motion at the same velocity. This is very easy to see, since it is obvious that a velocity of twenty degrees (for instance) will be altered more by the addition or subtraction of ten degrees than by the addition or subtraction of four.

The third manner would be a combination of these two, the annual motion diminishing and the diurnal additions and subtractions increasing…

Now if it is true that the force which moves the earth and the moon around the sun always retains the same strength, and if it is true that the same moving body moved by the same force but in unequal circles passes over similar arcs of smaller circles in shorter times, then it must necessarily be said that the moon when at its least distance from the sun (that is, at conjunction) passes through greater arcs of the earth's orbit than when it is at its greatest distance (that is, at opposition and full moon). And it is necessary also that the earth should share in this irregularity of the moon. For if we imagine a straight line from the center of the sun to the center of the terrestrial globe, including also the moon's orbit, this will be the radius of the orbit in which the earth would move uniformly if it were alone. But if we locate there also another body carried by the earth, putting this at one time between the earth and the sun and at another time beyond the earth at its greatest distance from the sun, then in this second case the common motion of both along the circumference of the earth's orbit would, because of the greater distance of the moon, have to be somewhat slower than in the other case when the moon is between the earth and the sun, at its lesser distance. So that what happens in this matter is just what happened to the rate of the clock, the moon representing to us that weight which is attached now farther from the center, in order to make the vibrations of the stick less frequent, and now closer, in order to speed them up.

From this it may be clear that the annual movement of the earth in its orbit along the ecliptic is not uniform, and that its irregularity derives from the moon and has its periods and restorations monthly. Now it has already been decided that the monthly and annual periodic alterations of the tides could derive from no other cause than from varying ratios between the annual motion and the additions to it and subtractions from it of the diurnal rotation; and that such alterations might be made in two ways; that is, by altering the annual motion and keeping fixed the magnitudes of the additions, or by changing the size of these and keeping the annual motion uniform. We have now detected the first of these two ways, based upon the unevenness of the annual motion; it depends upon the moon, and has its period monthly. Thus it is necessary that for this reason the tides should have a monthly period within which they become greater and smaller.

Now you see how the cause of the monthly period resides in the annual motion, and at the same time you see what the moon has to do with this affair, and how it plays a role without having anything to do with oceans or with waters.