



WHY ARE THERE TWO TIDES A DAY, INSTEAD OF JUST ONE?

Those who live in the Bosham area are usually very well aware of the rise and fall of the tide. Neglecting this knowledge, and parking on Shore Road, can be an expensive mistake! Most people know that the tides are ‘something to do with the moon and the sun’, but few really understand what is going on. I have puzzled for some time as to why there are two tides a day. If the complete explanation is that

The moon’s ‘tidal force’ is the difference between the moon’s gravity on the side of the earth facing the moon and the moon’s gravity on the opposite side of the earth. For those who have forgotten about centrifugal force, it is what causes things to fly outwards from something which is spinning. For you physicists out there, I *know* there is really no such thing as centrifugal force—it is actually an object’s inertia reacting against a centripetal force—but it doesn’t affect the explanation, and centrifugal force is a lot easier to understand!

The moon in its orbit goes around the earth once every four weeks. This has two effects on the earth’s oceans. Firstly—the easy one—the moon’s tidal force pulls the water in the direction of the moon, causing it to bulge out on the side of the earth facing the moon.

The second bulge is on the side of the earth opposite the moon, which is where the centrifugal force comes in. It is not strictly true to say that the moon revolves around the earth. What actually happens is

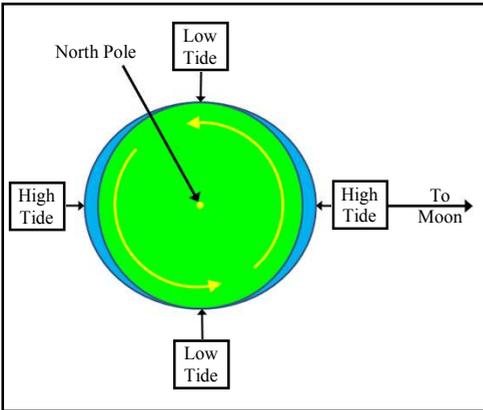


Figure 1: Tides are caused by bulges in the oceans, one on each side of the earth

the water is pulled towards the moon, there should only be one tide!

The simple answer is that the oceans bulge out on both sides of the earth. As the earth rotates, each point on the coastline passes through these two bulges, in turn, and also through the low points between them (Figure 1). This causes two high tides and two low tides per day. However, that only replaces the question of ‘why there are two tides?’ by ‘why are there two bulges?’!

The answer, unfortunately, is not particularly easy to understand! Forgetting the (minor) effect of the sun, the tides are caused by two things—the pull of the moon’s ‘tidal force’, and centrifugal force.

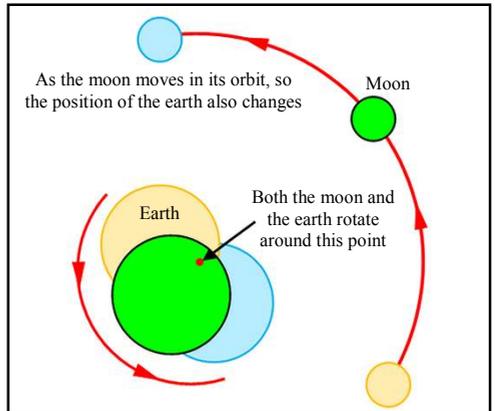


Figure 2: Both the moon and the earth rotate about the centre of gravity of the earth-moon system

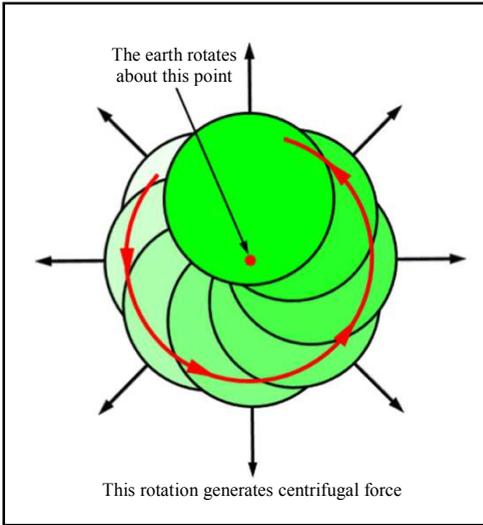


Figure 3: The rotation of the earth about the centre of gravity of the earth-moon system produces a centrifugal force

that both the moon and the earth revolve around a single point—their common centre of gravity—which is 2900 miles away from the centre of the earth, in the direction of the moon. Figure 2 shows the positions of the moon and the earth at three times during the month. The movement of the moon in its orbit is obvious, but the movement of the earth is more subtle. If you want a way to visualise this, think of

the sporting event of hammer throwing. As the hammer spins around in a circle, the competitor spins around in a smaller circle. Both the hammer and the thrower rotate about a single point, which is between them, but closer to the thrower.

Because the earth is moving around in a circle, it produces a centrifugal force (Figure 3), which causes the oceans to bulge out on the side away from the moon. Hence the second tidal bulge, and the second tide in the course of a day.

The description given above only seeks to explain why there are two tides per day, and not just one. The actual height of those two tides, and when they occur, depends on a large number of factors, including the phase of the moon, the position of the sun, the depth of the ocean, and the shape of the coastline. These factors will be examined in further articles. The height of a particular tide also depends on the atmospheric pressure, and the direction and strength of the wind. On 10th March 2008, a particularly high tide coincided with especially low air pressure and a southwest gale, causing serious flooding in Bosham, the flood waters coming up Bosham Lane (Figure 4) as far as Bosham Walk!

© 2009 *Mike Whittle*
(Revised February 2015)



Figure 4: Floods in Bosham Lane on 10th March 2008— Photo by Barry Colgate