TIDES

How the Sun and Moon cause tides. Spring tides, neap tides, and the three patterns of tides on earth caused by the rotation of Earth and local topographical features: Diurnal, Semi-Diurnal and Mixed tides.

The gravity of the Moon and the Sun pull the water in the oceans up, and this is the cause of the tides. How big this pull, the gravity, of a thing like the Moon or the Sun is, depends how heavy it is and how far away it is. The Sun is much heavier than the Moon, but the Moon is much, much closer to us. You will read in many texts that the gravity of the Moon is larger than that of the Sun because it so close to Earth. This is not true. The Sun's pull on Earth is in fact about 175 times larger than the pull of the Moon! But it is true that the Moon that influences the tides the most. This is because tides are caused by the differences in the gravity on different places on Earth. You can visualise this by placing the Moon on one side of Earth in your mind, and keep everything still, no rotation yet! Now, its gravity is different say on the part of Earth facing the Moon, than the part that is on the other side. Have a look at figure 1. And it is this difference that causes tides. Because the Sun is so far away, these differences are much smaller for the gravity of the Sun. And so, it is the Moon that mainly causes the tides.

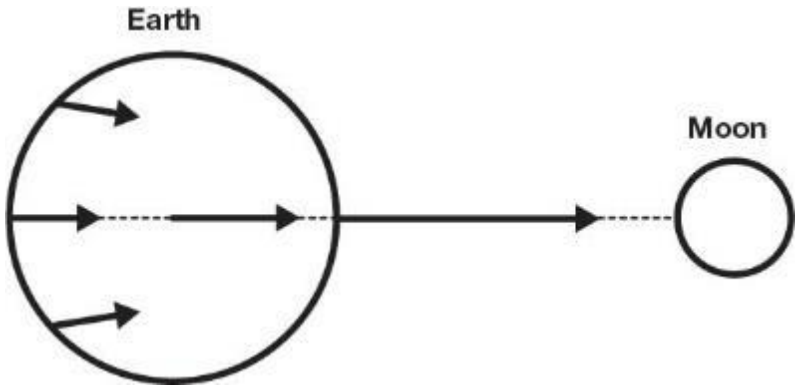


Figure 1 Different gravity force of the moon on different places on earth

So it is logical to first look at the Moon. To make it simple, imagine that Earth is perfectly round and standing still, and that it is completely covered with water without any land. On the side of Earth where the Moon is hanging (where the gravity is greatest) the water swells outwards. The gravitational field also causes the water on exactly opposite side of Earth to swell outwards, because the pull is the least at that location. You can see it like this: The Moon pulls the water directly underneath it up, and the further away you go from the Moon, the less it pulls. When you are the other side of Earth, the force is gone, and you will have another swell. (Again, many texts explain this wrong. The fact that there are swells on both sides has nothing to do with Earth turning around its own axis, the centrifugal force, as

some texts will claim. Do not listen to them). This is hard to imagine, I know. You do not have to understand exactly how and why, but you should understand this: the gravitational pull of the Moon creates two swells in the water of either side of Earth, one where the Moon is, and one on the opposite side (in more technical terms these swells are called bulges, that is term you would mostly see on websites and in books). Can you visualise this? Good, it should look something like figure 2. Now, because Earth turns, these swells of water move around Earth (or, rather, Earth moves underneath them). You can see this happening in your mind? Now we are finally there: where there is no swell, it is low tide, and where there is a swell, it is high tide.

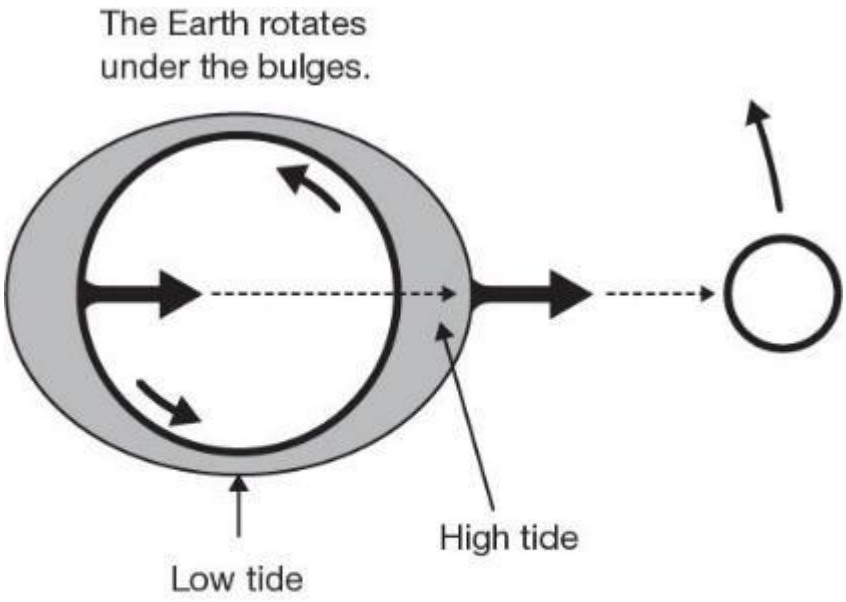
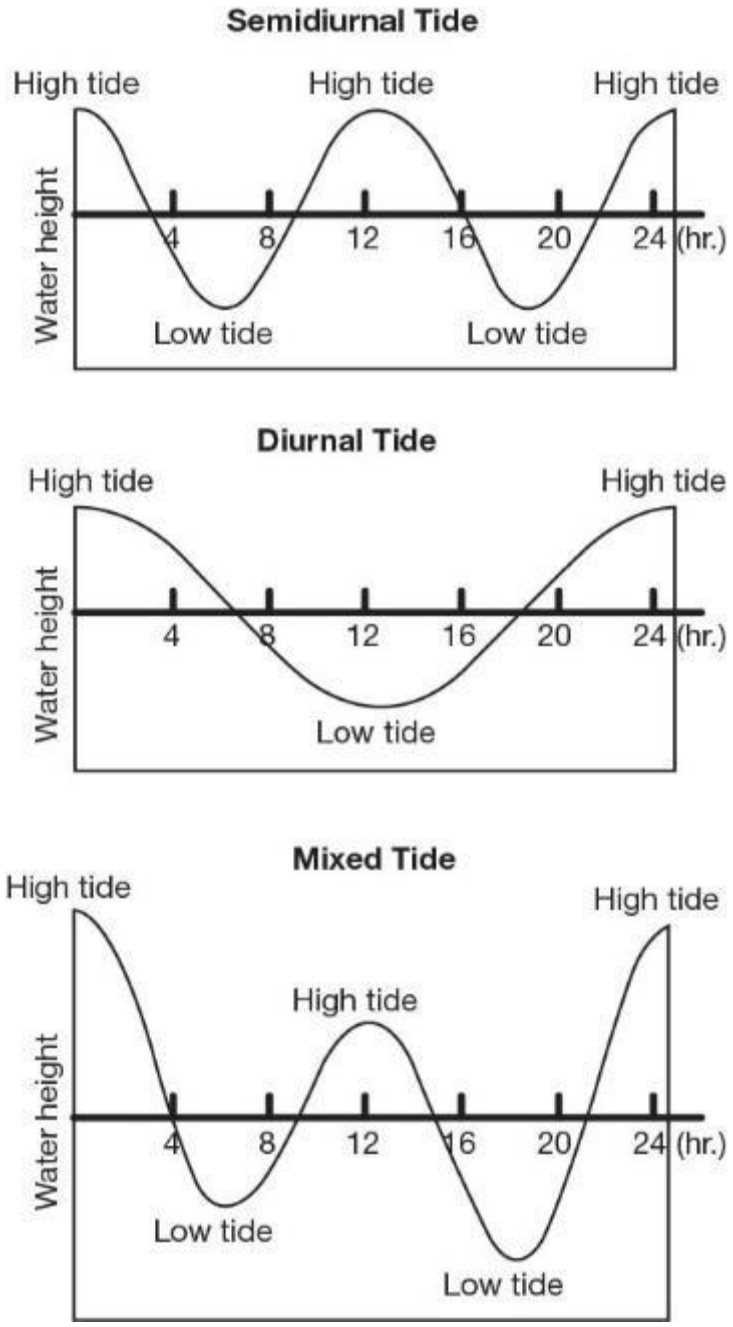


Figure 2 Two bulges of seawater caused by the gravity of the moon

Now that you know the Moon creates two swells in the water on opposite sides of Earth, you may think that there would be a high tide twice a day, and a low tide twice a day. After all, Earth spins in 24 hours around its axis, so you would meet two swells per day. But it is not that simple. First, the shape of the sea bottom. This is called the topographical features of the sea, remember this term. The topographical features affect the amount and duration of the tides. In the middle of the Pacific Ocean, where there is no land, the difference is only a few inches. But in Calais and Dover there is a huge difference between high and low tide (around 15 meters or more), because all the water coming from the open ocean is forced through the narrow funnel of the English Channel between France and England. Second, the rotation of Earth has a direct effect on the tides. The rotation of Earth causes the water in the oceans to move in big slow whirlpools around certain points (if you want to know, these points are called amphidromic points, but you are welcome to forget that, although you might impress people with this knowledge). So, the shape of the sea bottom and the big whirlpools currents disturb our nice simple two-high-tides-two-low-tides picture. There are in fact three different patterns of tides on Earth. First,



in some places there are semi-diurnal (that means half-daily) tides: twice daily tides with two high tides equal in height and two low tides equal in height (semi means half and diurnal means daily, so it is a that tide occurs once every half day). Second, in some places there are diurnal (daily) tides: tides that occur once a day. And third, there are places with mixed tides: twice daily tides with two high tides of unequal heights and two low tides of unequal heights. Yes, you need to know these terms: diurnal tides, semi-diurnal tides, and mixed tides and how they are caused. See figure 3.

Figure 3 Diurnal, semi-diurnal and mixed tides

Ok, we have dealt with the Moon. Now let's look at the Sun. The same story is true for the Sun: the gravitational pull creates two swells in the water on either side of Earth. But because the Sun is much, much, further away than the Moon, the swells it creates are much smaller. We hardly notice them. However, because everything rotates, at certain times in the month the swells created by the Moon and by the Sun align. This alignment happens at what we know as Full Moon (when the Sun and Moon are on opposite sides of Earth and we can see the whole Moon) and at New Moon (when the Moon is directly in front of the Sun and we can barely see the Moon) Have a look at figure 4 to make these clear. At Full Moon and New Moon the high tides are extra high and the low tides are extra low. We call this a spring tide. When the Sun and Moon work against each other because they are located at a 90 degrees angle to each other (you can see this in the sky as a Half-Moon), the tidal change is the smallest. This is when there is the least difference between high tides and low tides. We call this a neap tide. So, you need to remember what spring tides and neap tides are, and why they occur.

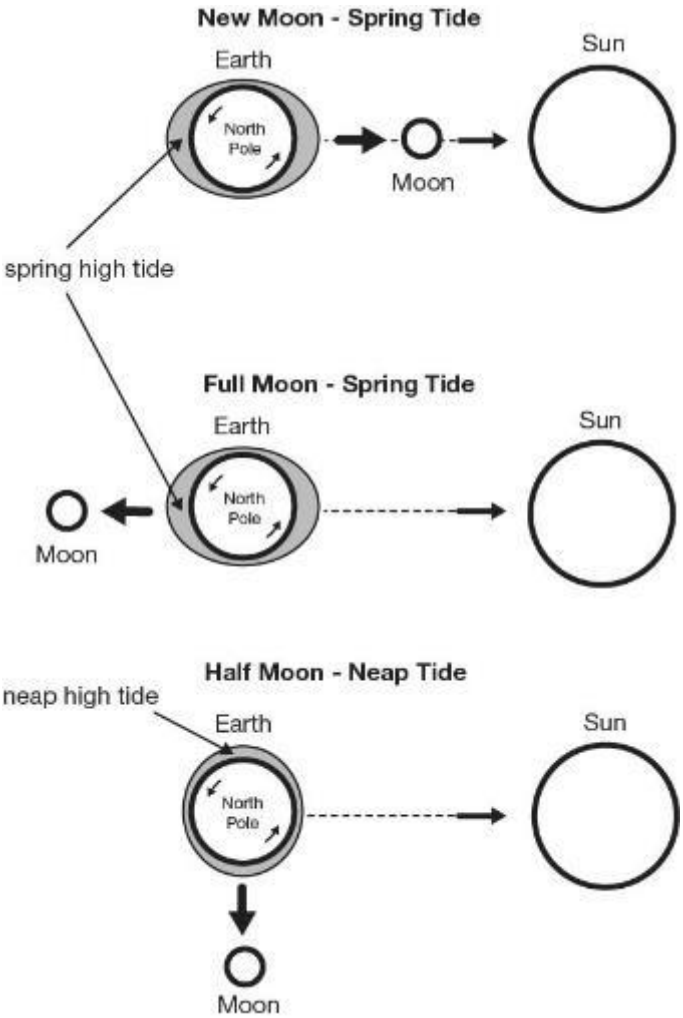


Figure 4 Spring tides and neap tides caused by the sun and the moon

What does that mean for us divers? Simple: when there is a big difference between a high and low tide there is a lot of water movement, which means that there will be strong currents. You don't want to go diving at those times. In theory, the best time to dive is during slack high tide (the time when the water has reached its highest point before it begins to ebb again) at a Half-Moon, when the tide swells are smallest. Remember this, and remember why this is. Some of your students or buddies might want to know.

Key things to remember*:*

The pull of gravitational fields of the Moon and the Sun creates tides. Although the Sun is larger, the Moon is much closer and has a larger effect. Because of the influence of land formations and the rotation of Earth, there are three different types of tidal patterns in different places on Earth: semi-diurnal (two high tides and two low tides of equal heights per day), diurnal (one high tide and one low tide per day) and mixed tides (two high tides and two low tides of unequal heights per day).At Full Moon and New Moon the pull of the gravitational fields is strongest and we call this spring tide. Currents are strongest in the water at this time and conditions for diving are less favourable. At Half-Moon the gravitational fields of the Moon and Sun work against each other and we call this neap tide. Currents are generally weakest around this time, meaning that the conditions for diving tend to be better.

Find out more:

http://scienceblogs.com/startswithabang/2010/02/24/how-tides-work