the water is ſaid to flow and to ebb ; and the rising is called the flood-tide, and the falling is called the ebb tide.

*2d,* It is obſerved, that this riſe and fall of the waters is variable in quantity. At Plymouth, for inſtance, it is ſometimes 21 feet between the greateſt and leaſt depth of the water in one day, and ſometimes only 12 feet.

Theſe different heights of tide are obſerved to ſucceed each other in a regular series, diminishing from the greateſt to the leaſt, and then inereaſing from the leaſt to the greateſt. The greateſt is called a spring tide, and the leaſt is called a neap tide.

3d, This ſeries is completed in about 15 days. More careful obſervation ſhows that two serieſes are completed in the exact time of a lunation. For the ſpring tide in any place is obſerved to happen preciſely at a certain interval of time (generally between two and three days) after new or full moon, and the neap tide at a certain interval after half moon ; or, more accurately ſpeaking, it is obſerved that the ſpring tide always happens when the moon has got a certain number of degrees eaſtward of the line of conjunc­tion and oppoſition, and the neap tide happens when ſhe is a certain number of degrees from her first or laſt quadrature. Thus the whole ſeries of tides appears to be regulated by the moon.

*4th,* It is obſerved that high water happens at new and full moon when the moon has a certain determined poſition with reſpect to the meridian of the place of obſervation, preceding or following the moon’s southing a certain inter­val of time ; which is constant with reſpect to that place, but very different in different places.

*5th,* The time of high water in any place appears to be regulated by the moon ; for the interval between the time of high water and the moon’s ſouthing never changes above three quarters of an hour, whereas the interval between the time of high water and noon changes six hours in the courſe of a fortnight.

*6th,* The interval between two ſucceeding high waters is variable. It is leaſt of all about new and full moon, and greateſt when the moon is in her quadratures. As two high waters happen every day, we may call the double of their interval a tide day, as we call the diurnal revolution of the moon a *lunar day.* The tide day is ſhorteſt about new and full moon, being then about 24⁰ 37' ; about the time of the moon’s quadratures it is 25⁰ 27'. Theſe values are taken from a mean of many observations made at Barbadoes by Dr Maſkelyne.

7th, The tides in ſimilar circumſtances are greateſt when the moon is at her ſmalleſt diſtance from the earth, or in her perigee, and, gradually diminiſhing, are ſmalleſt when ſhe is in her apogee.

8th, The ſame remark is made with reſpect to the sun’s diſtance, and the greateſt tides are obſerved during the win­ter months of Europe.

9th, The tides in any part of the ocean increaſe as the moon, by changing her declination, approaches the zenith of that place.

10th, The tides which happen while the moon is above the horizon are greater than the tides of the ſame day when the moon is below the horizon.

Such are the regular phenomena of the tides. They are important to all commercial nations, and have therefore been much attended to. It is of the tides, in all probability, that the Bible ſpeaks, when God is ſaid to ſet bounds to the ſea, and to ſay “ this far ſhall it go, and no ſarther.”

Homer is the earlieſt profane author who ſpeaks of the tides. Indeed it is not very clear that it is of them that he ſpeaks (in the XIIth book of the Odyſſey ) when he ſpeaks of Charybdis, which rises and retires three in every day. Herodotus and Diodorus Siculus ſpeak more diſtinctly of the tides in the Bed Sea. Pytheas of Marſeilles is the first who ſays any thing of their cauſe. According to Strabo he had been in Britain, where he muſt have obſerved the tides of the ocean. Plutarch ſays expreſsly that Pytheas aſcribed them to the moon. It is ſomewhat wonderful that Ariſtotle ſays ſo little about the tides. The army of Alexander, his pu­pil, were ſtartled at their first appearance to them near the Perſian Gulph ; and we ſhould have thought that Ariſtotle would be well informed of all that had been obſerved there. But there are only three passages concerning them in all Ariſtotle’s writings, and they are very trivial. In one place he ſpeaks of great tides obſerved in the north of Europe ; in another, he mentions their having been aſcribed by ſome to the moon ; and in a third, he ſays, that the tide in a great ſea exceeds that in a small one.

The Greeks had little opportunity of obſerving the tides. The conqueſts and the commerce of the Romans gave them more acquaintance with them. Cæsar ſpeaks of them in the 4th book of his Gallic War. Strabo, after Poſidonius, classes the phenomena into daily, monthly, and annual. He obſerves, that the ſea riſes as the moon gets near the meri­dian, whether above or below the horizon, and falls again as ſhe riſes or falls ; alſo, that the tides increaſe at the time of new and full moon, and are greateſt at the ſummer ſolſtice. Pliny explains the phenomena at ſome length; and ſays, that both the sun and moon are their cauſe, dragging the wa­ters along with them (B. II. c. 9'7). Seneca (Nat. Quest. *III*. 28.) ſpeaks of the tides with correctneſs ; and Macro­bius ( Somn. *Scip.* I. 6.) gives a very accurate description of their motions.

It is impoſſible that ſuch phenomena ſhould not exerciſe human curiosity as to their cauſe. Plutarch *( Plaut. Phil.* III. 17), Galileo *(Syst. Mund.* Dial. 4.), Riccioli in his *Almagest,* ii. p. 374, and Gassendi, ii. p. 27. have collected moſt of the notions of their predeceſſors on the ſubject ; but they are of ſo little importance, that they do not deserve our notice. Kepler ſpeaks more like a philoſopher (De *Stella Martis,* and *Epit. Astrom.* p. 555). He ſays that all bodies attract each other, and that the waters of the ocean would all go to the moon were they not retained by the attraction of the earth ; and then goes on to explain their elevation under the moon and on the oppoſite side, be­cauſe the earth is leſs attracted by the moon than the nearer waters, but more than the waters which are more remote.

The honour of a complete explanation of the tides was reſerved for Sir Iſaac Newton. He laid hold of this claſs of phenomena as the moſt inconteſtable proof of univerſal gravitation, and has given a moſt beautiful and ſynoptical view of the whole ſubject ; contenting himſelf, however, with merely exhibiting the chief conſequences of the gene­ral principle, and applying it to the phenomena with singu­lar addreſs. But the wide ſteps taken by this great philoſopher in his inveſtigation leave ordinary readers frequently at fault : many of his aſſumptions require the greateſt ma­thematical knowledge to ſatisfy us of their truth. The academy of Paris therefore propoſed to illuſtrate this among other parts of the principles of natural philoſophy, and: publiſhed the theory of the tidea as a prize problem. This produced three excellent differtations, by Μ’Laurin, Dan. Bernoulli, and Euler. Aided by theſe, and chiefly by the ſecond, we ſhall here give a phyſical theory, and accommo­date it to the purpoſes of navigation by giving the rules of calculation. We have demonſtrated in our diſſertations on the phyſical principles of the celeſtial motions, that it is an unexcepted fact, that every particle of matter in the ſolar ſyſtem is actually deflected toward every other particle ; and