I. In reſpect of their Time.

1. The tide day following a ſpring tide is 24h. 27' when the moon is in perigee, but 24h. 33' when ſhe is in apogee.

2. The tide day following neap tide is 25 h. 15', and 25 h. 40' in theſe two ſituations of the moon.

3. The greateſt interval of time between high water and the moon’s ſouthing is 39' and 61' ; the angle *y* being 9⁰45' in the firſt case, and 15⁰ 15' in the ſecond.

II. In reſpect of their Heights.

I. If the moon is in perigee when new or full, the ſpring tide will be 8 feet inſtead of 7, which corresponds to her mean diſtance. The very next ſpring tide happens when ſhe is neat her apogee, and will be 6 feet inſtead of 7. The neap tides happen when ſhe is at her mean diſtance, and will therefore be 3 feet.

But if the moon be at her mean diſtance when new or full, the two succeeding spring tides will be regular or 7 feet, and one of the neap tides will be 4 feet and the other only *2* sect.

Mr Bernoulli has given us the following table of the time of high water for theſe three chief ſituations of the moon, namely, her perigee, mean diſtance, and apogee. It may be had by interpolation for all intermediate poſitions with as great accuracy as can be hoped for in phenomena which are subject to ſuch a complication of diſturbances. The firſt column contains the moon’s elongation from the ſun. The columns P, M, A, contain the minutes of time which elapſe between the moon’s ſouthing and high water, according as ſhe is in perigee, at her mean diſtance, or in apogee. The ſign — indicates the priority, and + the poſteriority, of high water to the moon’s ſouthing.

|  |  |  |  |
| --- | --- | --- | --- |
| D and Θ | P. | Μ. | A. |
| 0 | 0 | 0 | 0 |
|  |  |  |  |
| 10 | 9½ | 11½ | 14 |
| 20 | 18 | 22 | 27½ |
| 30 | 26 | 31½ | 39½ |
| 40 | 33 | 40 | 50 |
| 50 | 37½ | 45 | 56 |
| 60 | 38½ | 46½ | 58 |
| 70 | 33½ | 40½ | 50½ |
| 80 | 22 | 25 | 31 |
| 90 | 0 | 0 | 0 |
|  | + | + | + |
| 100 | 21 | 25 | 31 |
| 110 | 33½ | 40½ | 50½ |
| 120 | 38½ | 46½ | 58 |
| 130 | 37½ | 45 | 56 |
| 140 | 33 | 40 | 50 |
| 150 | 26 | 31½ | 39½ |
| l60 | 18 | 22 | 27½ |
| 170 | 9½ | 11½ | 14 |
| 180 | 0 | 0 | 0 |

The reader will undoubtedly be making ſome compariſon in his own mind of the deductions from this theory with the actual ſtate of things. He will find ſome conſiderable reſemblances ; but he will alſo find ſuch great differences as will make him very doubtful of its juſtneſs. In very few places does the high water happen within ¾ths of an hour of the morn’s ſouthing, as the theory leads him to expect ; and in no place whatever does the ſpring tide fall on the day of new and full moon, nor the neap tide on the day of her quadrature. These always happen two or three days later. By comparing the difference of high water and the moon’s southing in different places, he will hardly find any connecting principle. This ſhows evidently that the cauſe of this irregularity is local, and that the juſtneſs of the theory is not affected by it. By conſidering the phenomena in a navigable river, he will learn the real cauſe of the deviation. A flood tide arrives at the mouth of a river. The true theoretical tide differs in no reſpect from a wave. Suppoſe a ſpring tide actually formed on a fluid sphere, and the ſun and moon then annihilated. The elevation muſt sink, presſing the under waters aſide, and cauſing them to rise where they were depressed. The motion will not stop when the surface comes to a level ; for the waters arrived at that poſition with a motion continually accelerated. They will therefore paſs this poſition as a pendulum passes the perpen­dicular, and will rise as far on the other side, forming a high water where it was low water, and a low water where it was high water ; and this would go on for ever, oſcillating in a time which mathematicians can determine, if it were not for the viſcidity, or ſomething like friction, of the waters. If the ſphere is not fluid to the centre, the motion of this wave will be different. The elevated waters cannot sink without diffuſing themſelves ſidewiſe, and occaſioning a great horizontal motion, in order to fill up the hollow at the place of low water. This motion will be greateſt about half way between the places of high and low water. The ſhallower we ſuppoſe the ocean the greater muſt this hori­zontal motion be. The reſiſtance of the bottom (tho’ per­fectly ſmooth and even) will greatly retard it all the way to the ſurface. Still, however, it will move till all be level, and will even move a little farther, and produce a ſmall flood and ebb where the ebb and flood had been. Then a con­trary motion will obtain ; and after a few oſcillations, which can be calculated, it will be inſenſible. If the bottom of the ocean (which we ſtill ſuppoſe to cover the whole earth) be uneven, with long extended valleys running in various di­rections, and with elevations reaching near the ſurface, it is evident that this muſt occaſion great irregularities in the motion of the undermoſt waters, both in respect of velocity and direction, and even occaſion ſmall inequalities on the ſurface, as we see in a river with a rugged bottom and ra­pid current. The deviations of the under currents will drag with them the contiguous incumbent waters, and thus oc­caſion greater ſuperficial irregularities.

Now a flood arriving at the mouth of a river, muſt act precisely as this great wave does. It muſt be propagated up the river (or along it, even though perfectly level) in a certain time, and we ſhall have high water at all the diffe­rent places in ſucceſſion. This is diſtinctly ſeen in all ri­vers. It is high water at the mouth of the Thames at three o’clock, and later as we go up the river, till at London bridge we have not high watcr till three o’clock in the morning, at which time it is again high water at the Nore. But, in the mean time, there has been low water at the Nore, and high water about half way to London; and while the high water is proceeding to London, it is ebbing at this intermediate place, and is low water there when it is high water at London and at the Nore. Did the tide ex­tend as far beyond London as London is from the Nore, we ſhould have three-high waters with two low waters interposed. The most remarkable instance of this kind is the Maragnon or Amazon river in South America. it appears by the obſervations of Condamine and others, that between Para, at the mouth of the river, and the conflux of the Ma-