out of the 30 parts of the air have been withdrawn, leaving only about 23 parts out of 30 pressing on the water, it will be observed instantly to commence giving off steam in rapid ebullition. If next the process be repeated, only allowing the water to cool to 190°, the ebullition will not commence in this lower temperature till about 12 out of the 30 volumes of air have been with drawn ; and if, in a third experiment, the water be cooled down to 180°, the elastic force communicated by this degree of heat will not be capable of overcoming the resistance arising from the pressure of the air, until one half of the original pressure of 30 has been removed. To this pro cess there is no limit ; for as we go on lowering the temperature, we can always find a point at which the water will boil, provided the counteracting pressure be suffi cient[y diminished. The following is Dr Dalton’s table, containing the results of his experiments, as given in his *Meteorology.,* in 1793:

|  |  |
| --- | --- |
| Heat of the Water when boiling under diminished Pressure. | Quantity of Pressure of Air remaining on the Fluid. |
| 212° | 300 |
| 200 | 22∙8 |
| 190 | 16∙6 |
| 180 | 15∙2 |
| 170 | 12∙2 |
| 160 | 9∙45 |
| 150 | 7∙48 |
| 140 | 5∙85 |
| 130 | 4∙42 |
| 120 | 3∙27 |
| 110 | 252 |
| 100 | 1∙97 |
| 90 | 1∙47 |
| 80 | 1∙03 |

15. In vacuo, therefore, or under a rarified atmosphere»

the boiling point of water is lower than 212°. Now, the barometer informs us, that the pressure of our atmosphere is not constantly the same ; it has normal and abnormal variations, it has horary, and menstrual, and annual varia tions. It frequently stands at 30 inches, sometimes at 31 inches ; and on the morning of the 7th of January, 1839, it was observed at Edinburgh, by Sir John Robison, to be as low as 27 inches and six-tenth parts. Now, on that morning, water would have been found to boil in the open air at about 208°, instead of 212 ; and for every depres sion of the barometer, there is a corresponding depression of the boiling point. This variation of the boiling temperature with the variation of the barometer, and of the corresponding density of the air, is important : and the following short table shows the changes which take place within the limits of the usual variations of the weather : When the barometer stands at 31∙8, water boils at 215°

31∙2, 214

30∙6, 213

30\* inches, 212

When the barometer falls to 294, 211

28∙8 210

28∙2, 209

27∙7 208

And at 27∙2, it would boil at 207

But these extremes are probably greater than have ever been observed on the ordinary level of this country.

16. There is yet another variation of circumstance which affects the point of ebullition, and that is, distance from the centre of the earth and height above the level of the sea. It is well known, that, on the summit of *a* moun­tain, the pressure of the air is less than on a plain, and still less there than at the bottom of a pit or deep valley. It is now equally well known, that the cause of this is the

very limited height to which air in a dense state covers the earth, the whole atmosphere being equivalent to not more than 5 miles in depth of such air as we breathe ; and it is hence obvious, that after a vertical ascent of a mile to the top of a mountain, there would be only about 4/5 of the atmosphere remaining above the person on its summit. One of the highest of the Andes has been ascended to such a height, that there remained only 13/30 of the whole atmosphere above the observer. Now, in this case, the barometer, instead of being sustained at 30 inches, its usual height, had fallen to 13 inches, because, according to the constitution of the barometer (See Arts. BAROMETER and Pneumatics), the height of the column of mercury in it is proportional to the quantity of air resting above it. Hence, a barometer being carried up a mountain by an observer, falling as he ascends, enables him to ascertain the height of his ascent. This he does with perfect precision, so as to determine accurately the height of any point of the mountain to which he has ascended, and where he has noticed the fall of the haro meter from the point where it stood when at the bottom, by means of an allowance of nearly 100 feet of height for every tenth part of an inch that the barometer has fallen, as explained more fully under the heads Barometer and Atmosphere.

The steam of water may be rendered the means of determining the height of a mountain, on the principle of diminished atmospheric pressure, so as to act as a substitute for the barometer. We have just seen that water gives off steam by ebullition, above or below the temperature 212°, according as the pressure of the atmosphere is greater or less than the standard pressure which sustains the barometer at 30 inches. And we have already given a table (Arts. 14 and 15), showing how much the boiling point was raised or depressed by diminishing the pressure of the atmosphere. On consulting Dr Dalton’s table, we see that, when of the air were removed, water boiled at so low a temperature as 180°. This, therefore, would show that, if water boiled on the top of any mountain at 180°, the barometer would stand there at a height of little more than 15 inches ; and if nt the bottom of the moun tain water boiled at 212°, showing the barometer to be then at 30 inches, a similar allowance of height being made, viz. about 1000 feet for each inch, or 15,000 feet, would be *a* rude approximation to the true height. The table at the end of the third section, and the rules under the head BAROMETER in this work, will enable any one who studies this subject to form rides for closer approximation ; but the following table will be of use to those who may merely wish to put it in practice.

*Rule for finding heights by boiling water.*—Boil pure water in an open vessel at the bottom of the elevation, and observe on the thermometer the point at which it boils. Boil it again at the top of the mountain, and observe with the thermometer the height at which it now boils : the difference of temperature, multiplied by 530 feet, will give a close approximation to the height of the upper above the lower station.

This will give an approximation ; but, if greater ac curacy be required, it will further be necessary to correct for the difference of the temperature of the air at the two stations, in the following manner. Add the temperatures of the air at the stations, and subtract 64 from their sum, multiply the remainder by one-thousandth part of the height found ; and this will be the correction to be added to the height formerly found. The result thus found will still require a slight correction for the figure of the earth and latitude of the place ; but this does not amount to more in our latitude than an addition of about two feet in a thousand, which forms a second correction. This method is, however, to be regarded only as an approximation,