SCIENCE.

FRIDAY, DECEMBER 14, 1883.

THE SIGNAL-SERVICE AND STANDARD TIME.

It has been announced that the chief signal-officer has ordered his corps of observers to continue to be governed by the local time of their respective stations. It is difficult to understand this action on the part of Gen. Hazen. It would seem, that, next to the transportation companies, the weather bureau would be most benefited by the adoption of a system of time which would render all observations strictly and easily comparable with each other. The position taken by the service is all the more remarkable, when it is remembered that only two or three years ago its chief was himself a warm advocate of the new scheme, and declared his anxiety to further its introduction in every way in his power. It will be everywhere admitted that the adoption of standard time by all observers would greatly aid in securing its acceptance by the people generally; and it is to be hoped that it will be shortly done, unless some grave reason, which is certainly not apparent, exists for its rejection.

A SUGGESTION TO AUTHORS.

Authors who republish in a separate form papers originally printed in society transactions or journals should be careful to preserve the original pagination of the serial from which they are extracted, or to indicate the same in some clear way for purposes of ready and correct reference. It would really be worth calling a convention of our scientific societies for the purpose, if a reform could be effected in this matter. Time is too precious to be wasted in search, often fruitless, for an original source, when it could have been indicated, without additional cost, upon the separated copies. It would also be far better if the original page itself could be left intact without overrunning: otherwise errors of reference will be entailed on posterity, which will prove justly exasperating to the student obliged to consult the vast literature of that coming day. The reform cannot come too soon nor be too thorough.

EXPERIMENTS IN BINARY ARITHMETIC.

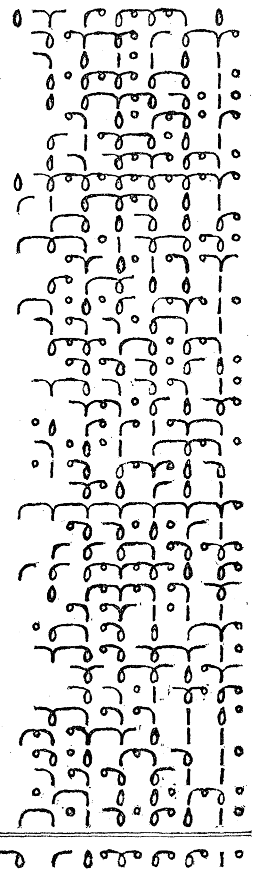
Those who can perform in that most necessary of all mathematical operations, simple addition, any great number of successive examples, or any single extensive example, without consciousness of a severe mental strain followed by corresponding mental fatigue, are exceptions to a general rule. These troubles are due to the quantity and complexity of the matter with which the mind has to be occupied at the same time that the figures are recognized. The sums of pairs of numbers from zero up to nine form fifty-five distinct propositions that must be borne in memory, and the 'carrying' is a further complication. The strain and consequent weariness are not only felt, but seen, in the mistakes in addition that they cause. They are, in great part, the tax exacted of us by our decimal system of arithmetic. Were only quantities of the same value, in any one column, to be added, our memory would be burdened with nothing more than the succession of numbers in simple counting, or that of multiples of two, three, or four, if the counting is by groups.

It is easy to prove that the most economical way of reducing addition to counting similar quantities is by the binary arithmetic of Leibnitz, which appears in an altered dress, with most of the zero-signs suppressed, in the example below. Opposite each number in the usual figures is here set the same according to a scheme in which the signs of powers of two repeat themselves in periods of four: a very small circle, like a degree-mark, being used to express any fourth power in the series; a long loop, like a narrow 0, any square not a fourth power; a curve upward and to the right, like a phonographic *l*, any double fourth power; and a curve to the right and downward, like a phonographic *r*, any half of a fourth power; with a vertical bar to denote the absence of three successive powers not fourth powers. Thus the equivalent for one million, shown in the example slightly below the middle, is 2^{16} (represented by a degree-mark in the fifth row of these marks, counting from the right) plus $2^{17}+2^{9}$ (two *l*-curves in the fifth and third places of *l*-curves) plus $2^{18}+2^{14}+2^{6}$ (three loops) plus 2^{19} (the *r*-curve at the extreme left); while the absence of 2^{3}, 2^{2}, and 2^{1}, is shown by the vertical stroke at the right. This equivalent expression may be verified, if desired, either

Example in addition by two notations.

77,823,876
14,348,907
8,654,912
5,764,801
4,635,857
1,594,323
6,417,728
4,782,969
83,886,075
34,012,224
2,903,111
48,828,125
1,724,826
7,529,536
43,344,817
10,000,000
8,334,712
1,953,125
11,308,417
759,375
21,180,840
9,765,625
18,643,788
1,000,000
44,739,243
1,889,568
2,517,471
40,353,607
4,438,414
1,679,616
23,708,715
11,390,625
945,754
823,543
15,308,805
60,466,176
30,685,377
10,077,696
19,416,381
43,046,721

740,685,681



by adding the designated powers of two, from 524,288 down to 64, or by successive multiplications by two, adding one when necessary. The form of characters here exhibited was thought to be the best of nearly three hundred that were devised and considered, and in about sixty cases tested for economic value by actual additions.

In order to add them, the object for which these forty numbers are here presented in two notations, it is not necessary to know just *why* the figures on the right are equal to those on the left, or to know any thing more than the order in which the different forms are to be taken, and the fact that any one has twice the value of one in the column next succeeding it on the right. The addition may be made from the printed page, first covering over the answer with a paper held fast by a weight, to have a place for the figures of the new answer as successively obtained. The fingers will be found a great assistance, especially if one of each hand be used, to point off similar marks in twos, or threes, or fours, — as many together as can be certainly comprehended in a glance of the eye. Counting by fours, if it can be done safely, is preferable, because most rapid. The eye can catch the marks for even powers more easily in going up, and those for odd powers (the *l* and *r* curves) in going down, the columns. Beginning at the lower right-hand corner, we count the right-hand column of small circles, or degree-marks, upwards: they are twenty-three in number. Half of twenty-three is eleven, and one over: one of these marks has therefore to be entered as part of the answer, and eleven carried to the next column, the first one of *l*-curves. But since the curves are most advantageously added downward, it is best, when the first column is finished, simply to remember the remainder from it, and not to set down any thing until the bottom is reached in the addition of the second column, when the remainders, if any, from both columns, can be set down together. In this case, starting with the eleven carried, and counting the number of the *l*-curves, we find ourselves at the bottom with twenty-four, — twelve to carry, and nothing to set down except the degree-mark from the first column. With the twelve we go up the adjoining loop-column, and the sum must be even, as this place is vacant in the answer; the *r*-curve column next, downward, and then another row of degree-marks. The succession must be obvious by this time. When the last column, the one in loops to the extreme left, is added, the sum has to be reduced to unity by successive halvings. Here we seem to have eleven: hence we enter one loop, and carry five to the next place, which, it must be remembered, is of *r*-curves. Halving five, we express the remainder by entering one of these curves, and carry the quotient, two, to the degree-mark place. Halving again gives one in the next place, that of *l*-curves; and the work is complete.

It is recommended that this work be gone over several times for practice, until the appearance and order of the characters, and the details of the method, become familiar; that, when the work can be done mechanically and without hesitation, the time occupied in a complete addition of the example, and the mistakes made in it, be carefully noted; that this be done several times, with an interval of some days between the trials, and the result of each trial kept separate; that the time and mistakes by the ordinary figures in the same example, in several trials, be observed for comparison. Please pay particular attention to the difference in the kind of work required by the two methods in its bearing on two questions, — which of them would be easier to work by for hours together, supposing both equally well learned? and in which of them could a reasonable degree of skill be more readily acquired by a beginner? The answer to these questions, if the comparison be a fair one, is as little to be doubted as is their high importance.

Eight volunteer observers to whom this example has already been submitted showed wide difference in arithmetical skill. One of them took but a few seconds over two minutes, in the best of six trials, to add by the usual figures, and set down the sum, but one figure in all the six additions being wrong; another added once in ten minutes fifty-seven seconds, and once in eleven minutes seven seconds, with half the figures wrong each time. The last-mentioned observer had had very little training in arithmetical work, but perhaps that gave a fairer comparison. In the binary figures she made three additions in between seven and eight minutes, with but one place wrong in the three. With four of the observers the binary notation required nearly double the time. These observers were all well practised in computation. Their best record, five minutes eighteen seconds, was made by one whose best record was two minutes forty seconds in ordinary figures. The author's own best results were two minutes thirty-eight seconds binary, and three minutes twenty-three seconds usual. He thus proved himself inferior to the last observer, as an adder, by a system in which both were equally well trained; but a greater familiarity (extending over a few weeks instead of a few hours) with methods in binary addition enabled him to work twice as fast with them. Of the author's nine additions by the usual figures, four were wrong in one figure each; of his thirty-two additions by different forms of binary notation, five were wrong, one of them in two places. One observer found that he required one minute thirty-three seconds to add a single column (average of five tried) by the usual figures, and fifteen seconds to count the characters in one (average of six tried) by the binary. Though these additions were rather slow, the results are interesting. They show, making allowance for the greater number of columns (three and a third times as many) required by the binary plan, a saving of nearly half; but they also illustrate the necessity of practice. This observer succeeded with the binary arithmetic by avoiding the sources of delay that particularly embarrass the beginner, by contenting himself with counting only, and not stopping to divide by two, to set down an unfamiliar character, or to recognize the mark by which he must distinguish his next column. One well-known member of the Washington philosophical society and of the American association for the advancement of science, who declined the actual trial as too severe a task, estimated his probable time with ordinary figures at twenty minutes, with strong chances of a wrong result, after all.

These statistics prove the existence of a class of persons who can do faster and more reliable work by the binary reckoning. But too much should not be made of them. Let them serve as specimens of facts of which a great many more are to be desired, bearing on a question of grave importance. Is it not worth our while to know, if we can, by impartial tests, whether the tax imposed on our working brains by the system of arithmetic in daily use is the necessary price of a blessing enjoyed, or an oppression? If the strain produced by greater complexity and intensity of mental labor is compensated by a correspondingly greater rapidity in dealing with figures, the former may be the case. If, on the contrary, a little practice suffices to turn the balance of rapidity, for all but a small body of highly drilled experts, in favor of an easier system, the latter must be. This is the question that the readers of SCIENCE are invited to help in deciding. The difficulties attending a complete revolution in the prevalent system of reckoning are confessedly stupendous; but they do not render undesirable the knowledge that experiment alone can give, whether or not the cost of that system is unreasonably high; nor should they prevent those who accord them the fullest recognition from assisting to furnish the necessary facts.

Those who are willing to undertake the addition on the plan proposed or on any better plan, or who will submit it to such acquaintances, skilled or unskilled, as may be persuaded to take the trouble to learn the mechanism of binary adding, will confer a great favor by informing the writer of the time occupied, and number of mistakes made, in each addition. All observations and suggestions relating to the subject will be most gratefully received.

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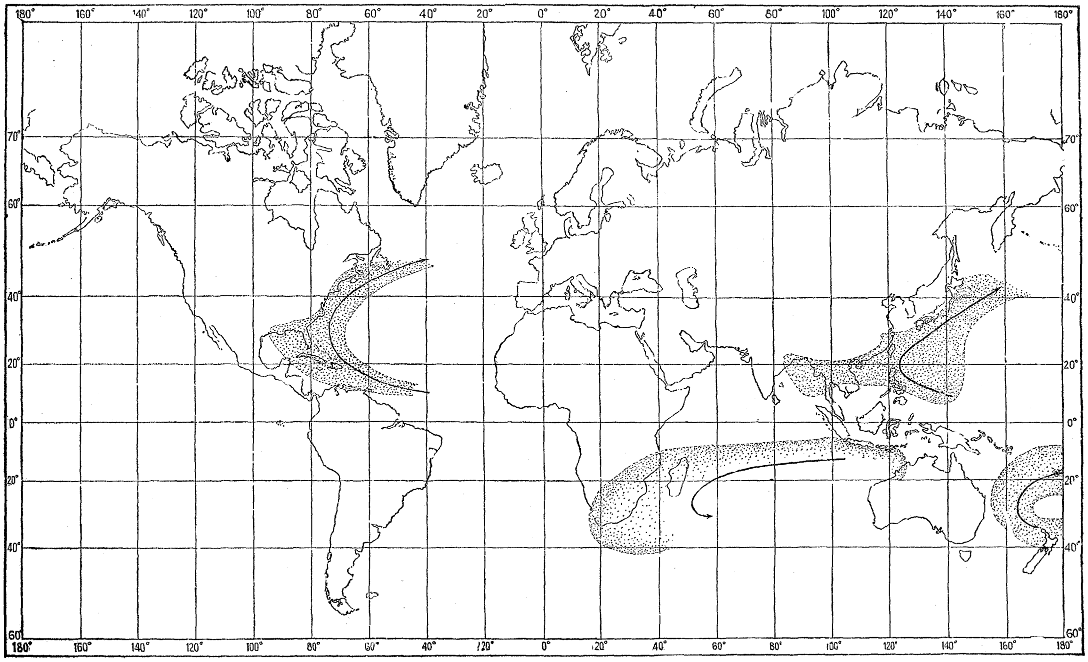
WHIRLWINDS, CYCLONES, AND TORNADOES.[1]—VI.

HAVING seen how storms arise, and examined the general motions of their spiral winds, we must next consider their progression from place to place. It is now a familiar fact, that storms do not remain stationary, but advance forth. The apparently lawless winds of a storm could be reduced to system if they were supposed to blow around a centre which itself has a progressive motion. In nearing the centre, the barometer falls, and the winds increase their strength. The manner and cause of the progressive motion must now be examined.

The four regions where tropical storms move into temperate latitudes — the seas south and east of India and China, and south-east of the United States, in the northern hemisphere; and those east of Madagascar and (probably) of Australia, in the southern hemisphere — are



THE REGIONS OF TROPICAL CYCLONES. (TAKEN FROM STIELER'S ATLAS.)

at a velocity of from five to fifty miles an hour along a line known as their track. Although perceived by Franklin about 1750, this, as well as their whirling motion, first found full and satisfactory proof at the hands of Dove of Berlin (1828), and Redfield of New York (1831). The latter gave the more numerous examples, and was the first to explain the motions of storm-winds at sea. The method of his discovery was simple enough. Information concerning the storm was gathered from all attainable records, and the condition of the winds and weather was plotted for certain hours. At once the result stood clearly all crossed by storm-tracks, running first westward near the equator, then turning toward the pole, and passing around the apex of a parabolic curve near latitude 30°, into an obliquely eastward course. The more numerous storms of temperate latitudes have less regular tracks, but are nearly always characterized by a strong eastward element in their motion; their chief variations to the right or left being dependent on thermal changes with the seasons, and on the configuration of land and water which they traverse. There have been four causes suggested to determine the progression of the storm-centre: namely, the general winds of the region, and especially the stronger and less

[1] Continued from No. 44.