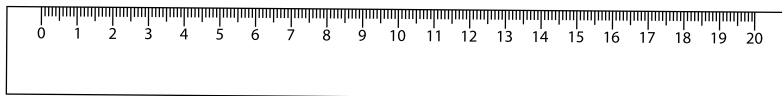


CONTENTS



Introduction 7

Height, Depth and Distance 11

Volume and Area 41

Weight, Displacement and Density 75

Time 103

Temperature and Pressure 126

Sound and Light 152

Miscellaneous 181

Bibliography 182

Index 187

HEIGHT, DEPTH AND DISTANCE

Measuring the height of anything is entirely dependent on which baseline you use. When it comes to mountains, most work to feet or metres above sea level, which is all well and good but which body of water is being taken as the benchmark and at what time of year? The surface heights of all bodies of water change quite significantly by the hour, due to the tides, and from week to week, due to shifts in the planetary and lunar orbits. Nova Scotia's Minas Basin, for example, has a tidal range of between 40 or 50 feet, while the Severn Estuary, between the UK and South Wales, experiences a rise-and-fall of about 30 feet.

To solve this problem, the scientific collective opted for mean sea level as measured at the mid-point between high and

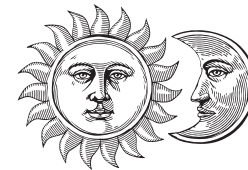
low tides – but, again, different nations took their readings from different bodies of water.

In the UK, this was fixed in 1915 as the mid-tide point in Cornwall's Newlyn Harbour, which is fine for measuring promontories throughout the UK but not much use for measuring peaks and promontories in other lands. When you see a height claiming to be an accurate measure in feet or metres above sea level, you have to ask which sea was taken as the baseline and in which month was that mean level established – even if the figures quoted are based on satellite readings, as all the seas are in a permanent state of flux.

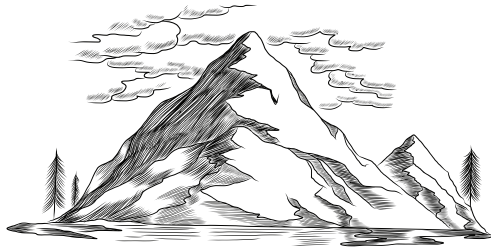
TIDES

Most people imagine that tides are an exclusively oceanic phenomenon for which the moon alone is responsible – but the sun, too, plays a significant part with its own gravitational pull and, combined, these two heavenly bodies have no trouble in pulling ripples on the land masses.

Known as earth tides, these ripples can lift the earth's surface by as much as 55 centimetres (about 2 feet) at the Equator, and have been responsible for triggering earthquakes. So, the next time someone tells you they felt the earth move – they probably did!



MOUNT EVEREST



Argued by some to be the world's highest mountain, this was more accurately known to the Victorian British as Peak XV, as they were aware that the now iconic mountain was a rather modest promontory with its own base over 17,000 feet up the Tibetan Plateau. Mount Everest, from its own base to peak is only about 12,000 feet, with the unfair advantage of its sitting atop the Himalayan massif. The tallest free-standing edifice is Africa's Mount Kilimanjaro, at 19,340 feet.

Everest (properly pronounced Eve-rest, as in the name of Sir George Everest, one-time Surveyor General of India) was first surveyed in the 1850s but after numerous careful readings Sir Andrew Waugh was mortified to reach a final figure of 29,000 feet – one he felt sure would draw accusations of his having been lazy and opting for a sloppy rounding-off. Now humorously hailed as the first man to put two feet on the top of Everest, Waugh decided to publish a figure of 29,002 feet. A more accurate figure was determined by an American expedition of 1999, members of which swept away all the snow from the peak to hold a GPS unit to the tip of the rock to get a reading of 29,035 feet.

Or, at least, that is the latest 'accurate' measurement. As the Himalayas are still rising out of the ground by as much as one inch per year as the entire range moves steadily northwards into China, come the next millennium the tip of that peak will be about 80 feet higher.

THE HAIRSBREADTH

Now abandoned to the realm of metaphor, the smallest measure of width ever in general use was the (human) hair's breadth. Once common to cultures ranging from Ancient Hebrew to Medieval English, there were forty-eight hair's breadths to the inch. Used until the turn of the twentieth century by jewellers and watchmakers, the hair's breadth enjoyed a brief revival during World War 2, when it was used in the crosshairs of snipers' telescopic sights and bombsights – specifically the Norden bombsight as used to great effect by the United States Air Force.

As spiders' web was found to corrupt and break when subjected to extremes of temperature, the hair's breadth was resurrected by a series of advertisements run in American newspapers in early 1943, asking for women with blonde (the strongest) hair in excess of 22 inches in length to come forward – but only if their hair had never been weakened by dyes, bleaches, perming solutions, conditioners, any other chemical applications or been subjected to the rigours of hot-irons. Needless to say, this narrowed the field to the point that

only one applicant stepped forward – Mary Babnick Brown (1907–91) of Colorado, a dancer with 34-inch-long tresses that had only ever been washed with baby-shampoo.

Having been told that her hair was needed to manufacture meteorological instruments, Mary allowed her head to be shaved and resorted to a bandana made from a small Stars and Stripes while her hair was in fact being used to produce the reticules, or crosshairs, of the Norden bomb-sight. In the August of 1945 Mary’s hair was in the sights of both the *Enola Gay* and *Bockscar* as they dropped their bombs on Hiroshima and Nagasaki and, in 1987, President Reagan wrote to Mary on her eightieth birthday to tell her how her hair had helped win the war.

THE INCH

Most early measurements were based on parts of the body or on natural items that tended to have a consistency of size, and the inch embraces both of these concepts. The word is derived from the Latin ‘uncia’, meaning ‘one twelfth part’, which in this case is one twelfth of a foot, so the term is thus cognate with ‘ounce’, which was fixed at one twelfth of a Troy pound. This is not a reference to the city of mythical war fame, as allegedly started by the warrior Paris, but to the French town of Troyes, about 150 miles to the southwest of the city of Paris, and once famous for its precious metals markets.

With the width of the adult thumb at the middle-knuckle

approximating to one inch this was used as a rough measure throughout most of Europe and Scandinavia which explains why in French, Spanish, Portuguese, Dutch, Swedish, Norwegian, Danish, Czech, Hungarian and Slovak, the words for ‘thumb’ and ‘inch’ are pretty much the same.

But the size of thumbs can vary from person to person so, after the Norman invasion of 1066, William the Conqueror fixed the inch at the length of three barleycorns lying end to end. This was later enshrined in a statute of 1324, imposed by Edward II, which defined the inch as being the length of ‘three grains of barley, dried and round, placed end to end, lengthwise’. The only echo of this definition to still resound in modern life is seen in British shoe-sizes, which Edward also decreed should be defined by the barleycorn.

RULE OF THUMB

There is a belief – dating back to the 1700s – that ‘rule of thumb’ relates to the legal entitlement of men to beat their wives with a stick no thicker than their thumbs. As recently as 1982, the US Commission of Civil Rights issued a report of spousal abuse entitled *Under the Rule of Thumb* yet no such statute can be found in any American or European legislature.

More prosaically, the expression relates to the use of the thumb by carpenters, and the like, as a rough guide to the inch; the thumb was also used in planting as a both a measure between seeds and the depth to which they should be pushed. Artists have long used the thumb of the outstretched arm as a means of establishing perspective because the thumb is a handy gauge of distance.

Your arm measures ten times the distance between your eyes so, with one eye shut, hold out your arm with the thumb vertical and align it with a distant building of known size, say a 100 foot barn. Holding still, shut the first eye and open the other to see the thumb jump to one side. If it appears to jump five barns' width, that gives you a 'jump' figure of 500 feet, which, multiplied by ten as per the ratio of arm-to-eye, gives you a final figure of 5,000 feet, which places you about a mile from said barn.

THE FIRST MAN TO MEASURE THE WORLD

Eratosthenes of Cyrene (b. 276BC) knew that on the summer solstice the sun at noon was in its zenith, or directly overhead, in the Egyptian town of Swenet, modern Aswan. He also knew it was 5,000 stadia from Swenet to Alexandria, a stadion being an Ancient Greek linear measure of about 200 yards, or 183 metres, which was used to mark out sporting grounds, hence 'stadium'.

Armed with these two basics and a sundial, he lay in wait for the next solstice in Alexandria to establish that the variance between the two locations at noon was 7 degrees and 12 minutes, or $1/50^{\text{th}}$ of a circle. Using the Egyptian stadion or stade, which equated to 157.5 metres, he calculated there to be 700 stadia to the degree which gave him a final figure of 252,000 stadia for the circumference of the earth. This would now equate to 39,690 kilometres, which, given the now established circumference at the Equator of 40,075 kilometres

is a pretty fair effort for some chap working over 2,000 years ago with nothing more than a sundial.



MILE

The mile was arguably the first metric unit of measurement introduced to Britain and was one thousand, or 'mille', full marching paces of a Roman Legionnaire. When marching through uncharted territory there was always one officer delegated to keep count of the pace so he could drive into the ground a specially carved stick to mark off each mille, or thousand, paces. At the end of a day's march, a stone marker was put in place to denote the number of miles from the starting point of the trek, and so was born the milestone.