sary, is extended both ways beyond the two points. This method, however, does not provide against any inequality in the bore of the tube. But it is obvious that any error from such inequality might be obviated by marking a suf­ficient number of points at different temperatures ; and also that by the same means an alcohol thermometer may be graduated to agree with a mercurial one, notwithstand­ing their very different rates of expansion. This we should think greatly preferable to the perpetual application of cor­rections for their difference. However, when an alcohol thermometer does require a correction, this ought to be effected by means of a table formed from actual compari­son with a good mercurial one ; because alcohol thermo­meters differ so much among themselves that no general table can be applicable to all. See Dr Richardson’s re­marks, with examples of this, in Journal of the Royal Geo­graphical Society, vol. ix. p. 332.

As the division of the scale is an arbitrary matter, ther­mometers differ much in this circumstance. Fahrenheit made 180 degrees between the freezing and boiling water points, Celsius made 100, Reaumur 80, Amontons 73, and Newton only 34. For a general comparison of various scales, see fig. 4. A very accurate method of verifying the scales of thermometers, and an example of the dis­cordance of two standard thermometers, are given by Pro­fessor Forbes in the Philosophical Transactions for 1836, p. 577. The history of several thermometers is briefly given in the article Βαrομετεr, and a description of the Dif­ferential Thermometer, and of metallic thermometers, will be found under the article Meteorology. For a differ­ential thermometer Dr Marshall Hall employs a mercurial thermometer, with a very minute bore and large degrees; and to avoid an inconveniently long tube, he has a ball at the top, into which he can at pleasure throw up a portion of the mercury. But, owing to the quantity of mercury actually used being thus rendered variable and uncertain, the indications of such an instrument are not comparable with those of a common thermometer. About twenty years ago, the journals announced a great improvement which Dr Howard had made on Leslie’s differential thermometer, by substituting alcohol for sulphuric acid. But had the learn­ed doctor been sufficiently acquainted with the subject, he would have known that Leslie had purposely avoided using any liquid which sensibly emits vapours ; because a variable quantity of elastic vapours mixed with the included air, must necessarily occasion similar but incomparably greater uncertainties than those in Dr Hall’s instrument.

As to the point at which the scale ought to commence, various opinions have been entertained. If we knew the beginning or lowest degree of heat, all would agree that this ought to be the lowest point of the thermometer ; but we know neither the lowest nor the highest degrees of heat ; we observe only the intermediate parts. All we can do, then, is to begin it at some invariable point, to which ther­mometers made in different places may easily be adjusted. Fahrenheit began his scale at the point where snow and salt congeal. Kirwan and Blagden proposed the freezing point of mercury. Sir Isaac Newton, Hales, Reaumur, and Celsius, adopted the freezing point of water. Fahrenheit’s zero is placed at an artificial cold which few can ever ex­perience. There would be several advantages in adopting the freezing point of mercury. It is the lowest degree to which liquid mercury can be applied ; and it would super­sede the use of the signs plus and minus on a mercurial thermometer. But it is not a point well known, for few can have an opportunity of seeing mercury congealed. As to the abolition of negative numbers, it would not counter­balance the advantage of using a well-known point. Of heat and cold we can only judge by our feelings. The po'∣Dt, then, at which the scale should commence, ought to be one which can form to us a standard of heat and cold.

Such is the freezing point of water chosen by Newton ; for of all the general effects of cold it is the most remarkable. It therefore suits thermometers to be used all over the globe ; for even in the hottest countries there are mountains perpetually covered with snow.

The thermometers at present in most general use, are Fahrenheit’s in Britain, Holland, and North America ; De l'Isle's in Russia ; Reaumur’s and the centigrade in France ; and Celsius’s, the same as the last named, in Sweden. They are generally filled with mercury. But here it may be pro­per to observe, that the mercurial thermometer which goes by the name of Reaumur’s, was not in use till long after his time, and was first introduced by Deluc.

The relative values of the degrees of Fahrenheit F, of Celsius C, and Reaumur R, are expressed by the following formulæ.

F = 32 + 9/5C = 32 + 9/4R.

C = 5(F-32)/9 = 5/4R.

R = 4(F-32)/9 = 4/

These expressions are perfectly general, proper regard being always had to the signs when any of the symbols be­come negative. The formulæ usually given in books of chemistry expressly for negative degrees are not simply useless, but so wild that they cannot fail to mislead and perplex those whom they are intended to guide. In Fah­renheit’s scale it is seldom necessary to use either fractions or negative degrees, which is by no means the case with the other two. Instead of a single thermometer whose scale would extend from the freezing to the boiling point of mercury, or through nearly 720° F., and which must either be inconveniently long, or have exceedingly minute degrees, it is better to have several thermometers, each of which will in succession apply to a different part of the whole range, so as to embrace or share the whole among them. In this way, while the degrees may be large, the stem of each thermometer, containing but a small propor­tion of the whole mercury, will occasion so much the less error when its temperature differs from that of the bulb. Fig. 3 shows a thermometer adapted to the ordinary at­mospheric temperatures. In thermometers intended for cor­rosive liquors, the divisions or degrees are sometimes mark­ed on the bare glass. In some, either the scale does not extend quite down to the bulb, or a portion of it is made to fold up with a joint.

It is not improbable that the freezing points of many old thermometers may have originally been marked too low, either from using water cooled artificially, or the ice of brackish or of other impure water. At any rate, it is now found, that when placed in melting ice, they generally stand above their freezing points. But supposing this to be a real deterioration which has taken place during the lapse of time, the following would seem to be the most probable of the causes which have been assigned for it, particularly in mercurial thermometers. 1. A permanent contraction of the bulb, gradually induced by the excess of the atmosphe­ric pressure over that within, owing to the air having been more or less expelled. 2. If, after the air has been entire­ly expelled from the bulb, either some of it still remain in the tube, although sealed, or the tube have been left quite open, the air will gradually insinuate itself again between the mercury and glass of the tube, till it at length enter the bulb and form a complete lining to the inside of the glass. By this means, the air, slightly displacing the mercury, will raise it higher in the stem. 3. A rather question­able change, independently of the preceding, is supposed gradually to take place for some time in the molecular structure of the glass. But why this process should con-