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^{12}C AS REFERENCE NUCLIDE

THERE exist at present three scales of atomic masses of weights: (*i*) the absolute scale based on the gram, (*ii*) that defined by taking the mass of one atom of the nuclide ^{16}O equal to 16 units (the "Physical scale" of "atomic masses" or "nuclidic masses"), and (*iii*) that taking the average atomic masses of the isotope mixture of "natural" oxygen as 16 units (the "Chemical scale" of "atomic weights"). Of these, only the last two are in common and extensive use. The chemical scale is indefinite to the extent of the variation in the average atomic mass of oxygen from various natural sources (some 15 parts per million) resulting from variations in the relative proportions of ^{16}O, ^{17}O and ^{18}O.

Recently, proposals for improving this situation have been made and discussed. The necessity of matching the proper value of the Avogadro number with the mass values employed arises especially often in the domain of nuclear chemistry.

Proposals to unite the scales by adopting the physical scale for chemical atomic weights have been regarded with disfavour by many chemists because of the relatively large change, about 275 parts per million, which would have to be made in all of the quantities whose values depend on the size of the mole. There are many physicochemical data whose precision is greater than that and whose value would therefore have to be changed. On the other hand, the serious consideration which has been given by chemists to the proposal of a new unified scale based on $^{19}F = 19$, which would result in a change of 41 parts per million, indicates that many chemists would be willing to accept a unified scale if the atomic weights would not be changed by more than about this amount. There are relatively few chemical data bearing such high precision.

Fortunately, there is a possible scale definition which, as the basis of a unified scale, would suit chemists and by which, moreover, physicists would benefit greatly.

Evidently, that definition is to be preferred which allows most nuclidic masses to be expressed with the smallest errors, not only now but also in the foreseeable future. As is shown below, this purpose is fulfilled by taking ^{12}C as the reference nuclide. The best definition of the atomic mass unit is, accordingly,

Mass of ^{12}C equals exactly 12 atomic mass units. The unit defined in this way is 318 parts per million larger than the present physical mass unit and 43 parts per million larger than the present chemical one.

In the mass-spectroscopic determination of nuclidic masses, the most important substandard is ^{12}C. Not only do the doubly, triply, and quadruply charged atomic ions of ^{12}C occur at integral mass numbers so that they can be paired in doublets with nuclides having mass numbers 6, 4 and 3 respectively, but—much more important—no other element besides carbon can be found which forms molecular ions containing as many atoms of but one kind (up to 10 and more). Therefore, the scale $^{12}C = 12$ would allow many more direct doublet comparisons of masses, especially of heavy nuclides, with the reference nuclide than any other scale. 12-Carbon has the additional advantage that carbon forms many more hydrides than any other element, so that an easy reference line for doublets can be produced at almost every mass number up to $A \sim 120$. Many stable nuclides in the mass region $120 < A < 240$ can also be measured in reference to ^{12}C by pairing in doublets their doubly charged ions with singly charged ions of $^{12}C_n$ or of $^{12}C_nH_m$ fragments. Use can then be made of nuclear disintegration data to obtain accurate masses of many other, especially unstable nuclides.—*Science*, 20th June 1958, 127 (3312), 1431.