Correspondence

Naming the Units

THE letter to which these correspondents refer (*Nature*, **219**, 765; 1968) was written by Professor George Gamow shortly before he died.

SIR,—Professor Gamow proposes names to be applied to a new series of units 10^9 greater than those in current use: the thought of adding yet another unit of length (for example) to the thirty or so already in use in Great Britain is frightening indeed. Professor Gamow finds the SI prefix giga (G : 10^9) unfortunate and one must agree that all the names mega (M : 10^6), giga (G : 10^9) and tera (T : 10^{12}) relating as they do to Roman and Greek giants and monsters rather than to the power indices 6, 9 and 12 could be improved on. But there is an overwhelming measure of international agreement for their use. The real need now is for the naming on a logical basis of new prefixes carrying the series up into the range of 10^{15}, 10^{18} and so on.

For example, in the energy industry generally the joule is inconveniently small and in particular when dealing with national energy outputs even the terajoule is too small.

Is there some exotic language which provides readily voiced prefixes suggesting 15, 18 and so on with initial letters acceptable for use as abbreviated forms ?

As an interim and somewhat retrograde step pending international agreement on such further prefixes, we can revert to the use of compound prefixes: the teraterametre (TTm: 10^{24} metres), for example, would be unambiguous and could cope immediately with cosmic distances.

The case for avoiding new unit names may be pointed by arguing the extreme (and currently impracticable) proposition that, with everyone using the same system, units need not be named at all. For example, even now, few in Britain would misunderstand the answers "56", "10–7½—17", "24 front, 26 rear, please", "one eighty", "100 in the shade" and "36–24–36" to the questions, "How old are you ?", "What are your shoe/hat/collar sizes ?", "What pressures do you want in your tyres ?", "What was your weight given as in the United States ?", "What was the temperature ?" and "Vital statistics", respectively; no units are mentioned but all are clearly understood. Similarly, it was not strictly necessary to apply names to the derived SI units such as that for force (Newton: N : kg m/s²). Pascal is being suggested for pressure (Pa: N/m²). The adoption of such names, in fact, increases the temptation to invent names for other derivatives or multiples/sub-multiples which can only store up terror once again for future generations of schoolchildren who will have to remember the affiliation of each.

We suggest that, even with the admitted imperfections, there is an overwhelmingly strong case for early world-wide adoption of metrication and decimalization using SI basic units and prefixes together with a firm veto on the creation of any new unit names whatsoever.

Yours faithfully,

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SIR,—The letter from G. Gamow proposing names for units involving 10^9 contains some well merited honours such as 1 Rutherford (=10^9 electron volts) and some happy inventions such as 1 inferno (=10^9 °K). However, his statement that the British, *inter alia*, have no name for 10^9 is surely very surprising. In adopting SI units, the giga was accepted, being, one may think appropriately, of G.(I) Gamow!

Yours faithfully,

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SIR,—Gamow has suggested names for four large physical quantities, 10^9 times the following units: a year (time), a light year (distance), a kelvin degree (temperature) and an electron volt (electrical energy). These large quantities arise in the "big bang" theory of cosmology. The names proposed by him are aeon, hubble, inferno (I°) and rutherford, respectively. I should like to make the following comments.

(1) Gamow sets out with the criticism that there are different and confusing names for the number 10^9 in the principal languages of Europe and the United States, but finally he suggests no name for this number for universal adoption. Instead, he proposes names for the four physical quantities mentioned. In fact, the Conference International des Poids et Mesures (CIPM), at its meeting in 1948, had approved the names for some large numbers in excess of one million (Jerrad, H. G., and McNeill, D. B., *A Dictionary of Scientific Units*, Science Paperbacks, 1966). They called 10^{12} a billion. (The United States should fall into line.) CIPM at its meeting in 1958 recommended the prefix giga (pron. ji'ga; symbol G) for the multiple 10^9. Thus, for example, 10^9 light years become giga light years, which may be abbreviated into Gly. GeV for 10^9 electron-volts is already common. The prefix giga (G) will serve all quantities and there is really no need for the new names suggested by Gamow.

Two of the proposed names are of famous scientists, but in one case it is apparently suggested that we drop the name of another great scientist, Kelvin, and accept inferno in its place. We honour the great men of science by understanding their works and not by taking their names more often. Naming laws and principles after their discoverers is a different matter.

(2) Synge (in *Relativity: The General Theory*, 421, North Holland, 1960) has suggested an alternative to the recommendations made by CIPM in 1958, but we may examine the matter *ab ovo*.

Posterity is bound to criticize us for the uneconomical use of the alphabet. (We can blame our forefathers for an unscientific alphabet.) We still coin new words as haphazardly as, probably, the Cro-Magnon man did. (It is interesting to see how the name Googol, for the number 10^{100}, arose, page 58 of *Relativity: The General Theory*). Often we turn to Greek and Latin for the sake of consensus. Combinations of letters like ab (already an abbreviation for absolute), ac (a.c. is used for alternating current), ad (abbreviation for advertisement), af, and so on, can be used to name various quantities. If af is taken to represent 10^9, fa can conveniently stand for 10^{-9}. Thus elementary combinations of suitable consonants and vowels can yield many new simple words for use in science.

(3) Giving new names to different magnitudes of already familiar units of time, distance, temperature and electrical energy will add to vocabulary without adding to knowledge. At the same time, this may become an obstacle to understanding or a load on memory. Which do you prefer, Hertz or cycles per sec, galileos or cm per sec² ? Surely a

Newton for mere 10^5 dynes $\sim$ 1/4 lb force is sheer waste of a great name.

(4) A minor point: Dante's inferno was not at a very high temperature. Liquids and solids were visible. In fact, the central portion of inferno, filled with the foulest, was found frozen.

Yours, etc.,

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More About the Units

Sir,—The internationally agreed symbol for 10^6 is M and this is the initial letter of million. Would it not be logical and convenient to turn this happy accident into a principle and use G, the internationally agreed symbol for 10^9, as the initial letter of the word for 1,000,000,000? That number would thus be called a gillion. Whether the g should be hard or soft is a matter of opinion. I incline to hard because of the derivation from giga.

Yours faithfully,

N. W. Pirie

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Science Not Applied

Sir,—It is gratifying, if in a rather pessimistic sense, to find the Swann committee confirm what increasing numbers of QSEs have come to realize in recent years, namely the growing disillusion with applied science among newly qualified young people. The ills of industrial research are well known; perhaps the report will encourage the general transformation needed in our educational structure, and, one hopes, stimulate a more enlightened view in that most conservative of all our institutions—British industry. To promote science for the sake of the economy is, however, rather like making an offering to propitiate the rain god; the result is unpredictable. Until economic forecasting progresses beyond the primitive use of first and second derivatives ("trends" and "levelling off" respectively) and can take some account of mutual interactions the possibility of the proposed measures triggering off limit-cycle behaviour (as exemplified by "stop-go" policies) will always be with us.

Yours faithfully,

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Chemists into Economists

Sir,—In your issue of October 5 (**220**, 6, 1968) you published an account of a meeting of a group of economists and chemists held recently at ICI Mond Division, Runcorn, to discuss whether economics can be usefully introduced into undergraduate chemistry courses. The possibility of creating "new courses in which chemistry and economics stand in equal partnership" was mooted and it was stated that a combined chemistry and economics course had been proposed at Oxford.

The purpose of this letter is to point out that such a course has been in existence in the University of Exeter since October 1965. The course is one of the options in the Inter-Faculty BSc degree in science, social studies and philosophy which is a combined honours degree in either chemistry or physics and either economics or sociology or politics or economic history with ancillary mathematics and, at present, philosophy. This is just the sort of degree course which is being widely advocated at the present time. The response to the provision of this course has been very disappointing to those of us who were instrumental in setting it up, believing it to be a useful and desirable new development. This year, for twenty available places, there were only twenty-five applicants, of whom four have, in the event, come into residence, two to read chemistry and economics; this represents a marked decrease in applications in comparison with the previous three years.

It is possible that this poor response is in part due to the somewhat uninformative description of this course (Exeter 24/85000/SSSP) in the UCCA handbook (*How to Apply for Admission to a University*, 1968 edition). I hope very much that publication of this letter will stimulate many more potential candidates to apply for admission to this course, the nature of which is so much in keeping with modern trends and ideas.

Yours sincerely,

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Superconductors in Power Plant

Sir,—Some of the comments made by Mr Wilkinson about the IRD superconducting motor in the article "Superconductors in Power Plants" (*Nature*, **219**, 1317; 1968) have now been retracted, but the implications were so damaging to our work that an answer is necessary.

The development of superconducting machines has been in progress at IRD for 5 years, and following the success of a 50 H.P. machine over two years ago we are now constructing a 3,250 H.P. motor with the support of NRDC. We have established that there are good market prospects for both superconductiong d.c. motors and generators and many designs are at an advanced stage. We have not yet published details of our work for reasons of commercial and military security, and Mr Wilkinson's remarks will be answered in detail when we publish next year. However, we took strong exception to his main comment (now retracted) that copper could replace the superconductor and that the cost of the refrigerator would pay for the copper, power supplies and capitalized value of the losses.

If the superconducting winding of our motor, which I wish to emphasize is a prototype for much larger machines, is replaced with 99·999 per cent pure copper the power consumption would be 14 MW which is quite impractical. This neglects magneto-resistance effects which would increase the loss significantly and assumes the same average current density as the superconducting winding. The capitalized cost of the losses at the modest figure of £100 per kilowatt is £1·4m. If the current density is reduced to a more realistic value of 10,000 amp/inch^2 the power loss is 5·7 MW but the useful magnetic flux of the machine is reduced by 20 per cent because of the large coil volume. Further reductions in current density bring the machine flux to an even more unrealistic level. Cryogenic cooling is no better than water cooling in these machines; the total loss (joule heating and refrigerator power) is 30 MW for liquid nitrogen and 20 MW for liquid hydrogen. The only practical way to use copper windings is in conjunction with an iron magnetic circuit that is the conventional type of machine; our reason for departing from conventional machines was to achieve cost and weight reductions and there is a very sound case for superconducting machines which will be published later.

Finally, I must add that we (and others who have been collaborating with us in this field) performed many similar calculations to the aforementioned over the last 5 years and substantial sums of our own and public money have not been committed without extremely careful checks of our calculations.

Yours faithfully,

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