Then everywhere on the island are the penguins (*Eudyptula minor*). These little blue and white birds are among the most engaging of all the penguins, despite the fact that all their island activities are nocturnal. In solemn thousands they come ashore from the surf, and always at the same place, and in a sudden rush, every evening.

Every evening the whole company marches and hops up the same well-marked pathway to the island plateau and, at the plateau, disperses along numerous tracks to the breeding burrows. Every step of the way, every jump, every turn, is performed by every individual in the whole great army in exactly the same manner, and with the utmost solemnity. Every bird that, after the whole long journey, arrives at its home, finds two fluffy chicks awaiting it at the mouth of the burrow and regarding it with solemn expectancy. The little blue penguin is attractive beyond all birds in its serious and ordered ways of life, and in its queer sturdy independence that is combined with a most remarkable communal spirit. It is a strange thing that all these birds coming to the island at nightfall should forgather in the surf until their numbers are complete, and then, making a concerted rush through the breakers to the landing rock, start their long climb together (Fig. 2). For this coming and going is their time of peril, and a visit to any island upon which penguins breed tells its own tale. Penguin carcases, killed by harriers, peregrines and seals, strew the pathway from the surf to the breeding places; and around the rock holes or the burrows in which they breed are downy chicks ripped open by hawks or gulls. On Lady Julia Percy Island they did not have to run the gauntlet of gulls, for, strangely enough, these birds were not present on the island; but despite this, their mortality was very high.

During the hours of daylight, the island was a comparatively quiet place. Always there were the farmyard noises of the sea lions, for every sound, from the bleating of the lamb to the snarling of dogs and the lowing of oxen, came perpetually from the seal beaches. But when dusk came on there were added the indescribable groaning, mewing and caterwauling tumult from the mutton birds; the noise, rising from human snoring almost to donkey braying, of the penguins, and the newborn puppy sounds from the diving petrels and the prions. But despite all this, and the scarcity of fresh water, the members of the McCoy Society spent six happy weeks camped upon this volcanic island. They examined and collected everything, from soil bacteria to sea lions, and endeavoured to link the whole together in one complete ecological survey.

Terminology in Physics

By Prof. C. G. Darwin, F.R.S.

THERE has for some time existed an international committee, the 'S.U.N.', charged with the duty among other subjects of standardizing the nomenclature of physical quantities. So far as concerns such things as the names of units and their symbols it has proved effective. There has perhaps been a tendency for some of the members to point out that the majority were marching out of step; but in view of the very different approaches of different schools of thought, a certain latitude is perhaps permissible in the meaning and symbol of such a thing as *free energy*. This side of the question of nomenclature is adequately cared for, and is not the subject of the present article. Here it is proposed to consider certain obvious deficiencies and nonconformities in descriptive technical terms as they have arisen during the last decade or so in both English and American writings on atomic physics. It is not to be expected, perhaps not even to be desired, that any exact uniformity should be reached, but there are a number of cases where there is complete anarchy, and it is the aim of the present review to examine what principles should guide us in giving names to things, and possibly in a few examples to suggest appropriate solutions which may appeal to some of those who have not a conscientious preference for anarchy.

One of the greatest difficulties in the naming of physical ideas lies in the difficulty of translating a name out of one language into another. Consider, for example, the energy that remains in a body at the absolute zero of temperature. This idea was chiefly developed in German writings, and the quantity, following the polysynthetic spirit of the language, was called *Nullpunktsenergie*—name and definition in a single mouthful. Unfortunately, those who are charged with the literary side of education in England seem to hold that the best way to teach the writing of English is by drill in the very different rules of Latin grammar, and that nothing further is needed. The consequence of this curious opinion is that those, who will later have to invent new English terms, have been given no literary principles whatever to guide them in doing so, and therefore, since the idea was acquired in German, they can do no better than a literal translation, *zero-point-energy*, or even *zeropointenergy*. Now this is quite a different kind of name from any given when the original idea was invented by an English-speaking physicist; for example, if the α-particle had first been studied in Germany, we should, on this principle, be now calling its *range* its *reach-width*. Moreover, the translation of *Nullpunktsenergie* is a poor one, because we do not translate *Nullpunkt* as *zero-point*, but simply use the English term *zero*. It must rest with individuals to judge whether the expressions *zero-point energy*, *zero-point displacement* and so on (anyhow with only one hyphen) are so well established that their ugliness must be accepted, but it does seem a pity not to create an English technical term and speak of *residual energy*, etc., which could be done without ambiguity.

The expression *zero-point energy* is merely clumsy and ugly; but our next example is rank bad grammar. One of the great advantages of English is the latitude allowed in grammatical construction, but even this has its limits. Contrary to the rules of most European languages, it is admissible to use a noun as an adjective qualifying another noun, and this makes it unnecessary to coin many adjectival forms that would otherwise be needed, but it is not allowable to use a noun to qualify an adjective. One may not infrequently see in learned journals such a phrase as "This may be proved by *quantum theoretical* methods". What part of speech is *quantum* here? Some writers, perhaps conscious of offence, run the two words into one—a pure Germanism. Others hyphenate them, and if the expression must be used at all this is the least intolerable form. The proper English form would be *quantum theory methods*, though even that is very clumsy, and *quantum methods* is quite good enough. However, for such a fundamentally important idea there is need for a real adjective, if only to make the contrast with *classical*. Moreover, there is absolutely no need to have the word *theory* (or the word *mechanics*) in the name, and so the right procedure is to coin the adjective *quantal*. To justify its adequacy it is only necessary to notice the impossibility of finding anything that would be *quantally* right, but *quantum-mechanically* wrong.

The general difficulty about the translation of technical terms is that when an idea is first invented one is not sure if it will be worth translating at all, and later, when its utility is established, one is so accustomed to the awkward literal translation that one is like the cricketer who was asked the origin of the 'yorker' and replied, "I don't see what else you could call it". In the choice of a name for a new idea there are several alternative methods. First it is easy to overrate the danger of taking an ordinary word and giving it a technical meaning: witness such words as *force*, *strain*, *susceptibility*. In spite of the double meanings, these are good names, but not all such words have been so well chosen; the word must be recognizably a technical term, which means that there must be no likelihood of its ordinary use being needed in the same context as its technical use. The difficulty of this method of choosing a name is that the word will always have a whole set of mental associations different from the new intention, so that the inventor is conscious of objections against any choice; for this reason it is inadvisable to stretch the meaning of a common word very far.

Another method of nomenclature gives up the problem altogether by simply taking the name of the inventor. This is often a good method, but it must not be carried too far or the reader will have to construct a special dictionary in order to remember the meanings of the various names. Another confusion arises when two things, cognate but different, are named after the same author. For example, there are a *function* and *equations* and a *principle*, all named after *Hamilton*. The first two belong together and are habitually called after him, but the *Hamiltonian principle* is something rather different, and is better called, by a slight misdescription, the *principle of least action*. Another thing to avoid with this method is what appears to be a growing fashion, the stringing together of a sequence of the names of all those who have worked at a subject. There is a most useful process in quantum theory often called the *Wentzel-Kramers-Brillouin method*, and it is no disparagement of the brilliant work of these writers to say that this is a very inconvenient name. If no better technical name can be found, then physics should borrow a rule established in taxonomic biology and take the name of the author who had the strict priority of publication; in the present case it happens that it would be none of the three names above, for the method has been discovered no less than four times independently, and *Jeffreys* has the priority.

Another way of making a name is to construct it from parts out of the classical languages, and this method has the great advantage that the word, being a new one, is immediately recognized as being a technical term. A thing like *entropy* has to be given some sort of name, though the idea is really incapable of any short description, and we feel that this is a better kind of name than the artificial *gas*, even though Aristotle would have been equally unable to make anything of either. There are, however, many words which do aim at explaining themselves, so that the classical scholar, perhaps repressing a shudder at faults of synthesis, would have some idea what they meant, and the guiding principle for these ought to be that their composing parts should be fairly well-known words in the original language; for this reason, Latin is perhaps more suitable than Greek. Following this line, and without suggesting that established practice should be changed, it seems a pity that one must use the word *hæmatopoietic*, instead of *sanguinific*, always supposing that there are objections to the honest and simple *blood-making*.

Yet another method is to take a word straight out of some foreign language and use that. This is a method that needs much caution; for the borrowed word must be such as will fit into a spoken English sentence. Consider Gibbs's *ensemble*. It is a most embarrassing word to have to speak in a lecture, since all the letters have different values from those in the accompanying words. Even the skilled bilinguist has to 'change gear' in the middle of his sentence, and the less accomplished can scarcely fail to exhibit the deficiencies of his international culture. When such a word has been adopted, the proper course is boldly to give every letter its English value*. This word also exhibits the general difficulty of nomenclature. In French it does not really describe the idea at all well, since a *together* does not convey the idea of the simultaneous consideration of a set of quite separate motions of an assembly of atoms. Indeed, one would naïvely suppose that it meant the assembly itself, and such a word as *collection* seems to describe the idea better in English than does *ensemble* in French. As it turns out, the French word, used in English and anglicized, is best of all, but this may be partly because the inventor had the field entirely to himself for many years, so that his word has been accepted without having to prove its superiority over possible rivals. German words on the whole fit the English mouth better than French, but their uncongenial length gives them an alien character much more marked than that of an anglicized French word; we may accept *eigen*-functions, etc. (though the more usual prefix would have been *auto-*) but most others are unsuitable.

There is quite a different matter in which our present terminology is bad; unfortunately, sometimes in well-established practice. This is when two words which express opposite ideas sound nearly the same. To make a contrast between *intra-molecular* forces and *inter-molecular* forces confuses listener, reader, printer and sometimes even speaker as well. Here the right course is undoubtedly to make names which, even if less exactly suitable, sound quite different; the proper contrast to *intra* is *extra*. A worse example is *microscopic* and *macroscopic* when used in physics. To the inventor, this contrast may have had a pleasing epigrammatic flavour, but when the freshness has gone it becomes fantastic. We have two diametrically opposite ideas described by eleven letters with only one of them different, and they are such that the pronunciation of either in some of the English dialects would give the impression that the other was meant*. Both words are objectionable. *Microscopic* in this contrast habitually refers to things far too small to be seen in any microscope; it might just do in the popular sense of 'awfully small', but if a change is to be made we might as well get it right. *Macroscopic* is worse, because *μάκρος* is not one of the words otherwise used for derivatives, so that it will not convey its meaning to any but a scholar, and to be understood by others the word ought to have been *megascopic*. We want a word which the dictionary would describe as 'of, or pertaining to, bulk', and the best seems to be *molar*. It is true that this word has other meanings both in physical chemistry and in dentistry, but there is little danger of confusion. The contrasted word would be *atomic* (better than *molecular* because so much less like *molar*), since this describes the actual scale of magnitude which has hitherto been misdescribed as *microscopic*.

Finally we may refer to a less important matter, but one which makes an inconvenient gap in our language; this is the non-existence of an ordinal number corresponding to the cardinal number *zero*. In the literature one can find the expressions, "Bessel function of *zero* order", "*null* approximation", "*zeroth* law of thermodynamics", where in each case the next of the sequence would be called *first*, not *one*. The word *zeroth* is a terrible hybrid, but the mere fact that it has been tried shows that the need of a distinction between ordinal and cardinal is really felt. On the whole, this seems to be a case for the technical use of an ordinary word, and the word *null* might be adopted. It may be objected that it does not quite mean what is wanted; of course, it has not meant it hitherto, for if it had the question would not arise, and this paragraph would not have been written. But it is a true adjectival form connected with the number *zero*, and so seems to fill the bill with less strain than any other word.

* In the same way *spin* has recently been adopted abroad, and it is to be hoped that it is called *shpin* in Germany, and nasalized in France.

* There is less danger in other languages when spoken, but a careless printer might give just as much trouble.

There are no doubt other examples where improvements are needed, but the above are among the most glaring. The present article does not aim at inducing any exact conformity to its suggestions, but rather at directing attention to the real difficulty in the invention of suitable names for new things, and to the importance of doing it carefully. It may also be hoped that the actual suggestions may be of service, so that those future writers who have not yet firmly established their own usages may be induced to accept at least some of them.

Control of the Prickly-pear in Australia

THE control of the prickly-pears, *Opuntia inermis* and *O. stricta*, in Australia affords one of the most outstanding examples of the application of biological knowledge to economic purpose. It needs to be recollected that in 1925, about sixty million acres of grazing and farming land were known to be under infestation by prickly-pear in Queensland and New South Wales: the rate of spread of this scourge was stated to be reliably figured at almost one million acres a year. About fifty per cent of the infested territory was under dense prickly-pear, 3–5 ft. high, while the remaining area was affected by scattered infestations of varying intensity. To-day, the enormous rate of increase has been arrested, and less than ten per cent of the former great body of infestation survives: the whole of the primary pear in Queensland and much in New South Wales has broken down and collapsed. Approximately, twenty-five million acres of good land are now cleared and are being developed and brought under production.

The history of the campaign of control and eradication of prickly-pear has recently been briefly discussed by Mr. Allan P. Dodd, officer-in-charge of prickly-pear investigations, Brisbane. All interested in the subject should read his important paper in the September issue of the *Bulletin of Entomological Research* (27; 1936); a comprehensive history of the whole subject is promised in book form within two years time.

At the outset, the problem was how to eradicate a plant pest which had overrun, and rendered valueless, vast areas of territory. A pest, in fact, which could not be controlled by cultural, mechanical or chemical means, since the cost of widespread treatment by any of these methods rendered their application out of the question. The first steps towards applying biological methods of control were taken in 1912, and in 1920 the Commonwealth Prickly-pear Board came into being. This Board was charged with the study of prickly-pear in its natural home in America and the introduction, if possible, of insect or other enemies into Australia.

Since 1921, officers of the Board have visited most of the known prickly-pear regions of North and South America. Their investigations resulted in the discovery of about 145 species of insects which appear to be confined, in feeding habits, to prickly-pears and other Cactaceæ. Fungal and bacterial diseases also came in for investigation, but it was revealed that they did not afford much promise of direct utility, since many of these diseases were already established in Australia.

The Board's policy was based upon the conception that biological control offered best chance of success if a carefully selected group of species, working more or less in association, was established. A variety of promising species readily became adapted to Australian conditions and it was anticipated that their combined activities would, in course of time, result in gradual thinning out of the prickly-pear, in reduction of fruiting and consequently restriction of the spread of the pest.

It was quite unforeseen that the outstanding success evident to-day would have been effected by the agency of a single species of insect in the space of a few years. Nevertheless, this is what actually has happened, and the insect in question is the phycitid moth, *Cactoblastis cactorum* Berg. The fact is all the more remarkable for the reason that only 2,750 eggs (from the Argentine) of the insect were introduced into Australia, yet between 1926–30, about three thousand million eggs, laid by descendants of insects issuing from the original batch, have been distributed in the great prickly-pear areas. The eggs are laid by the moth in 'sticks', averaging seventy-five eggs in each: these 'sticks' are readily collected and artificially attached to the cladodes of the host plant. The resulting larvæ are gregarious, internal feeders which tunnel in companies through the tissues of the plant, thus also providing for the ingress of disease organisms. In this way the prickly-pear ultimately becomes so completely destroyed that it is reduced to a rotting mass of pulp. The various insects, established prior to the *Cactoblastis*, have