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SCIENTIFIC ABSTRACTING

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Corning Glass Works

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SCIENTIFIC ABSTRACTING¹

Is it worth while for scientific journals to provide abstracts at the beginning of their articles?

The answer to this question depends, of course, on the nature of the abstracts. If they are sketchy, incomplete and unreliable, as many abstracts published at present are, they may be worse than useless. But suppose each abstract describes the contents of the article so completely and precisely that any reader can tell with assurance whether the article contains any results of interest to him, and suppose it summarizes the methods, conclusions and theories so as to give all the information any reader not a specialist in the narrow field involved needs; that is, suppose each is the result of a careful analysis of the article by a competent abstractor, would not such abstracts enable the reader to grasp the significant results in the articles not only more quickly but more completely and clearly than by skimming through the articles?

Such abstracts would save much time for the scientist not only as a *reader* of current literature but also as an *investigator*. For when he desires information on a certain narrow subject, such abstracts would help him to determine more quickly than otherwise which of the articles referred to in a bibliography or other list contain what he needs; and frequently the abstracts would give him the information directly and make a search through the articles unnecessary. Finally, such ab-

¹ The method of analytic abstracting described in this paper was developed by the writer during 1919-20 while on the staff of the Research Information Service of the National Research Council.

stracts would save his time as an *abstractor* at home and abroad. For abstract journals are recognized to be such useful, almost indispensable guides to scientific literature that most sciences have one or more in each of the great scientific languages. At present, then, most of the articles in the fields of astronomy, physics, chemistry, biology, and medicine are abstracted from three to six times each, while if an abstract suitable for reprinting in an abstract journal were prefixed to each original article, a reabstracting of the article would be unnecessary and much duplication of effort would be avoided. Moreover the practise would enable abstract journals to report current literature with less delay than at present.

But to render this service to scientists, the abstracts must, as stated above, adequately describe and summarize the contents of the articles. The standard must not only be high; it must be uniform, so that the abstracts may be beyond suspicion of incompleteness and inaccuracy.

During 1920 the National Research Council devoted considerable attention to various questions relating to abstracts, such as: how they might be improved in form so as to render more effective service; how the rules might be made more definite and the method of preparation more systematic so as to result in more uniformly good abstracts. As a result of study and experimentation a type of abstract was developed which is believed to be well suited to the needs both of abstract journals and of scientific journals with preliminary abstracts.

Abstracts of this type; which are called *analytic abstracts*, have been appearing in the *Astrophysical Journal* and, less consistently, in the *Physical Review* since January, 1920. Their main characteristics are illustrated in the following samples.

1. *A new method of determining the atomic weight of iodine.* Marcel Guichard; Ann. chim., 6, 279–318 (1916); 7, 5–49 (1917).

ABSTRACT

Atomic weight of iodine.—The pentoxide method used involves the preparation of I_2O_5 , the decomposition of this anhydrid, and the collection of the iodine by condensation and of the oxygen by combination with pure copper. The mean of five determinations is 126.915. The article gives in voluminous detail the refinements employed to guard against error.

Iodine pentoxide; preparation, purification and decomposition with heat.—The results of a thorough study are presented. As it was found impracticable to prepare it by direct combination of I_2 and O_2 , the method adopted was to oxidize I_2 with fuming HNO_3 and subsequently expel free I_2 and HNO_3 by heating to 450°. This was carried out in an evacuated train which is fully described.

Preparation of pure iodine.—Detailed directions are given.

Occlusion of oxygen by glass, porcelain and copper was studied in order to determine the best material for the apparatus.

2. *On K. S. magnet steel.* K. Honda and S. Saito; *Physical Review*, 16, 495–500, December, 1920.

ABSTRACT

K. S. magnet steel (C 0.4–0.8, Co 30–40, W 5–9, Cr 1.5–3 per cent).—This remarkable new alloy steel possesses, when tempered, an extremely high coercive force, 226–257 gauss, and a strong residual magnetism, varying from 620 to 920 C.G.S. units for different specimens. The effect of repeated shock was to reduce these values by only 6 per cent. The hysteresis

curves for a magnetizing force of ± 1300 gauss show for the hardened steel an energy loss of 900,000 ergs per cycle. *Tempering* is best effected by heating to 950° C. and quenching in heavy oil. This treatment applied to annealed specimens increases the Brinell *hardness* number from 444 to 652 and makes the *microstructure* finer grained.

3. *The structure of the helium atom.* Irving Langmuir; *Physical Review*, 17, 339-353, March, 1921.

ABSTRACT

Helium atom models.—(1) *Bohr's model* is unsatisfactory because it gives too great a value for the ionizing potential and is not in accord with some of the optical and magnetic properties of helium. Since the chemical evidence suggests that each electron in an atom has its own orbit, separated from the other orbits but closely interrelated with them, two new models are considered. (2) In the *double circle model* the two electrons are assumed to move in two circular orbits, separate but parallel. This model, however, is unstable, for the ionizing potential computed by applying the quantum theory, comes out negative. Another objection to this model is that the magnetic moment is not zero. (3) In the *semi-circular model* each electron is assumed to oscillate back and forth along an approximately semi-circular path in accordance with classical mechanics, each being brought to rest at each end of its path by the repulsion of the other. Assuming the maximum angular momentum of each electron equal to $h/2\pi$ the absolute dimensions come out such as to give a total energy 0.9618 times that of the Bohr model, and the computed ionizing potential, 25.62 volts, agrees closely with the experimental value. The magnetic moment is zero.

Application of the quantum theory to coupled electrons.—The success of the semi-circular model of helium suggests that in the case of coupled electrons the quantum theory should be applied not to the momentum of the individual electrons according to the relation $spdq = h/2\pi$, but rather to the momentum which by being relayed from one electron to another, passes in each direction around the nucleus.

4. *Studies on inbreeding. IV. Effects of inbreeding on the growth and variability in body weight of the albino rat.* . Helen D. King; *Jour. Exp. Zool.*, 29, No. 1 (1919).

ABSTRACT

Effects of inbreeding on the growth and variability in body weight of the albino rat.—In continuation of previous work, data are given concerning over 600 rats belonging to the sixteenth to twenty-fifth generations of a strain bred brother to sister from the same litter only. Allowing for the effect of certain unfavorable conditions, determined by control rats, the results confirm previous conclusions and show that close inbreeding continued for 25 generations has not produced any deterioration in the stock as regards the growth curve, the body weight, the variability of body weight for various ages, and the relative behavior of the sexes in these respects. Selected rats were used as the parents of each generation. If there is any tendency to deterioration it was counteracted in these experiments by the selection employed.

Effect of nutrition on the growth and variability in body weight of the albino rat.—Rats are particularly sensitive to food conditions. Alfalfa, cottonseed and linseed meal were found to be injurious. A change from a satisfactory diet to one less suitable resulted in a

marked increase in variability of body weight both for inbred and stock rats.

Sex ratio in the albino rat.—By selection the inbred strain has been separated into two lines, one with a high, the other with a low, sex ratio; but the *effect of selection* seems to be limited. The two strains are alike in body weight, growth curve and variability of body weight.

It will be noticed that each of the one or more paragraphs of each abstract begins with an italicized *paragraph title*. In some cases words or phrases within a paragraph are also italicized. This is not done for emphasis but to associate them with the paragraph titles which they supplement and complete. Paragraph titles and italicized words and phrases will collectively be called *subtitles*. If the reader will run through the sample abstracts, skipping all but these italicized subtitles, he will get in each case a descriptive index of the information in the article. For example:

ABSTRACT NO. 1

Atomic weight of iodine.

Pentoxide method.

Determinations.

Iodine pentoxide.

Preparation, purification.

Decomposition with heat.

Preparation of pure iodine.

Occlusion of oxygen by glass, porcelain and copper.

ABSTRACT NO. 3

Helium atom models.

(1) *Bohr's model.*

(2) *Double circle model.*

(3) *Semi-circular model.*

Application of the quantum theory to coupled electrons; suggestion.

The subtitles, then, form in each case an *index of the abstract*. By glancing through

them a reader can tell with assurance whether the article deals with anything of interest to him. It is well known that one can not rely upon the author's title alone, for many articles contain incidental information or a variety of information which a short title can not fully describe. The first and last articles abstracted above are good instances of this fact. On the other hand, the subtitles of this type of abstract, since they may be as numerous as is necessary, can give in all cases the precise scope of the information contained in the article; in particular they can call attention to incidental results whose presence would not be suspected from the title, such as the data relating to the occlusion of oxygen given in the article on the atomic weight of iodine.

Besides providing a complete index in the form of subtitles, the abstracts are required to describe the new information with sufficient precision and to summarize the results with sufficient completeness and in sufficient detail to satisfy the needs of the great majority of readers. Each abstract should be a carefully prepared report on the contributions to scientific knowledge set forth in the article, by a scientist who feels his responsibility to his scientific colleagues to make it complete and accurate.

But why go to the trouble of preparing such abstracts? Why not let each reader glance through each article and determine what it contains for himself? Because for each scientist to do his own abstracting, as this would amount to, is as wasteful as for each to prepare his own indexes of the reference books he uses; it means not only an unnecessary duplication of effort but, worse still, a poor quality of abstracting, in most cases. Then there is to be considered the waste involved in the simultaneous abstracting of each article by

several abstract journals. Efficiency demands that a good preliminary abstract be provided with each article, so that all readers may benefit by the careful work of one abstracter and none need abstract that article again.

Anyone may readily convince himself of the value of preliminary analytic abstracts if he will turn to one of the longer articles in the *Astrophysical Journal* since January, 1920, and, after spending three to five minutes in abstracting the article for himself by glancing through it, will compare the information he thus gains with what he might have obtained in an equal time from the abstract.

There can be no doubt, then, that good preliminary abstracts would save much time for scientists as readers, investigators and abstractors. But is this of any importance? Before the war many would have said, No. Research was generally regarded as a hobby. Now it is more generally realized that the research output of the country is a matter of national concern and is an important factor in national progress.

The number of scientists actively engaged in research work is relatively small. Their research time is correspondingly valuable, especially as it is further limited by the fact that most of them have teaching or executive duties which take much of their energy. Of this time the larger the part devoted to securing the necessary foundation of scientific information, both current and past, the less the part available for actual research. Therefore, everything possible should be done to make it as easy as practicable for each investigator to obtain the information he needs; that is, *our whole scientific information service, including original scientific journals, abstract journals, handbooks, tables, etc., should be made in its parts and as a whole, as efficient as possible.* All this is self-evident. In this

note we are considering merely the scientific journals. Their part is to provide preliminary abstracts. And since this can be done at very small additional expense to each and since the saving of time for scientists would be in the aggregate considerable, surely there can be no question as to the advisability of the adoption of this policy by every scientific journal.

What obstacles stand in the way? The additional expense is, as just stated, small. The abstract would be less than five per cent of the article on the average, and if the summary usually placed at the end were omitted, as could well be done because its function would be served by the abstract, the increase in length of the article would be little or nothing. But, on the other hand, the addition of abstracts would undoubtedly considerably increase the burdens of the already overburdened editors, and one would shrink from suggesting that they add to their labors the drudgery associated with securing and editing the abstracts if it were not clear that the gain to the many investigators would be many times the cost to the few.

At present, in addition to the *Astrophysical Journal*, *Physical Review*, and *Journal of the American Ceramic Society*, which require analytic abstracts, the following fourteen scientific and engineering journals give preliminary abstracts: The group of biological journals published by the Wistar Institute of Anatomy and Biology—*American Journal of Anatomy*, *American Anatomical Memoirs*, *Anatomical Record*, *Journal of Comparative Neurology*, *Journal of Experimental Zoology*, and *Journal of Morphology*; also *Physiological Researches*; *Proc. of London Physical Society*, *Trans. of American Electrochemical Society*, *Trans. of American Institute of Electrical Engineers*, *Trans. of American Society of Civil Engineers*, *Trans. of American Society of Mechanical En-*

gineers, *Trans. of Society of Automotive Engineers*, and *Trans. of American Foundrymen's Association*. The abstracts now being provided by these journals are prepared as a rule by the authors and vary greatly in quality. It would be relatively easy for those journals whose abstracts are not as useful as is desirable to change their rules so as to require abstracts of the quality of analytic abstracts.

The directions and rules which have been formulated for the guidance of authors in the preparation of analytic abstracts may be found in current numbers of the *Astrophysical Journal* and also, somewhat abbreviated, in those of the *Physical Review* and of the *Journal of the American Ceramic Society*. With slight modification they would serve for any science. But while some authors will take the trouble to master the technique and prepare satisfactory abstracts, a uniformly high standard can not be maintained unless all the abstracts for each journal are checked and revised by a competent abstractor. Therefore, after deciding to require analytic abstracts, the first step taken by a journal should be the selection of a suitable man as abstract editor. If the man appointed should care to get in touch with me, I should be glad to give any assistance I can in getting the new policy started.

In conclusion, attention should be directed to the fact that those journals which provide analytic abstracts may easily combine an index of the subtitles in the abstracts with the usual index of author's titles, and thus greatly increase the completeness and precision of their subject indexes and hence the value of the journal for reference purposes.

It may not seem of much importance whether any particular journal provides efficient abstracts or not. Yet it is clearly the duty of each to do so. For when all have adopted this policy and the abstract journals promptly

reprint all the abstracts and completely index them, we shall have gone far toward making our scientific information service really efficient. And because of the cooperation involved, it will require less effort to maintain than our present much less efficient service.

SUGGESTIONS AND RULES FOR PREPARING
ANALYTIC ABSTRACTS

The preparation of an abstract naturally proceeds in four steps, as follows:

1. *Notes*.—First I read the article carefully, making notes covering all the new information which I find in it, keeping an especially sharp lookout for new incidental results or suggestions not directly related to the main subject of the paper. These notes are rough and intended merely as memory aids. If this search is not thorough, the abstract will probably be incomplete.

RULE 1. *Material not new* need not be analyzed or described; a valuable summary of previous work, however, should be noted with a statement indicating its nature and scope.

2. *Subtitles*.—Next comes the analysis of the information and the formulation of the subtitles. I ask myself to what subject do the main results of the article relate. Perhaps it is "the atomic weight of iodine." Are all phases of this subject included or only certain ones? In this case a new method of determination is described and also a series of experimental results obtained by that method. Therefore I make the subtitle more precise by adding the necessary phrases, in this case "pentoxide method" and "determinations." This disposes of the main subject. But are there any results which do not belong under the main subtitle? If so, to what subject or subjects do they relate? I write them down: "Iodine pentoxide"; "Occlusion of oxygen by glass, etc., " or whatever they may be, and

I add any modifying phrases necessary to make these subtitles precise. The analysis, then, consists merely in sorting the details of information into as many groups as there are distinct subjects involved. Then for each group, the scope of the information included is determined and a subtitle is written just as one would write a title for an article which contained the information in that group. Each subtitle should cover *all* the details in its group and yet should not imply the inclusion of material not actually contained; that is, it should be both complete and precise.

RULE 2. *Each subtitle should describe the corresponding information so precisely that the chance of any investigator being misled into thinking the article contains the particular information he desires when it does not, or vice versa, may be small.* "Zeeman effect for metallic spectra" is too broad unless all metals have been studied, for the investigator may be interested at the time in only one metal; but "Infra-red arc spectrum of iron to 3μ " evidently satisfies the rule. In general, a subtitle is sufficiently precise if it carries the classification of the information involved three stages or the equivalent, for instance if it gives (*a*) the elements and substances, (*b*) the property, and (*c*) the phase or range studied.

RULE 3. *The subtitles should together form a complete index of the new information;* that is, they should include every measurement, observation, method, suggestion and theory which is presented as new and of value in itself. They should be complete in themselves and independent of the main title of the article.

3. *Text.*—Not until the subtitles are formulated, do I proceed to the writing of the text of the abstract. I devote a paragraph to each group of details beginning, as a rule, with those relating to the main subject of the article. In case several phases of a subject are dealt with as in the second sample abstract above, it is often convenient to begin the para-

graph with a paragraph-title which merely gives the subject, and then to write the text in such a way as to bring in the additional words or phrases which the analysis has shown are needed as additional subtitles to indicate with precision the information involved. When several subtitles are coordinate, as, for instance, in the third sample abstract above, I call attention to this fact, when it can be done conveniently, by numbering them. The main thing, however, besides seeing that the necessary subtitles are included, is to make the abstract *as informing as practicable*. It should never be merely a sketch of the scope of the article unless this contains no new information.

RULE 4. *A separate paragraph should be used for each distinct subject involved*, but no more paragraphs than necessary. All material which can easily be grouped together under a single title should be summarized in the same paragraph. Parts of subtitles may be scattered through the text but the subject of each paragraph must be given at the beginning. Underscore subtitles but no other words or phrases.

RULE 5. *The text should summarize the author's conclusions and should transcribe all numerical results of general interest* including all that might be looked for in a table of physical and chemical constants. It should give all the information that any one, not a specialist in the narrow field involved, might care to have in his notebook.

RULE 6. *Complete sentences* should be used except in the case of subtitles. The abstract should be made as readable as the necessary brevity will permit.

As to what should constitute a group and how many groups should be made, rules can not be given which will cover all cases. Since abstracts should be as unified as is practicable without defeating the purpose of the abstract, it is my policy to group together as much as

can be put comfortably under a single paragraph title. In the samples above, for instance, all the properties of K. S. magnet steel are put in a single paragraph, and the data regarding the preparation, purification and decomposition of iodine pentoxide by heat are grouped together. But "the preparation of pure iodine" could not conveniently be combined with "atomic weight of iodine," at least without blurring the emphasis on the main contribution of the paper; and for similar reasons I have separated "the effect of nutrition on the growth of the albino rat" from "the effects of inbreeding on the growth of the albino rat." The tendency of beginners seems to be to make too many groups and thus to chop up the abstract unnecessarily. However, the number of groups is of minor importance provided all the new results are included in one or other.

As to the length of the abstract, brevity is important, and useless words and unimportant details should be rigorously pruned. The abstracts in the *Astrophysical Journal* contain on the average one twentieth as many words as the article abstracted. Usually the proportion is greater for short articles and less for longer, but of course it depends on the type of article.

4. *Checking the Abstract.*—Finally I re-read the article in order to check the abstract and to correct any omissions or mistakes; I read the underscored subtitles by themselves to see whether they properly index the information; and I read the abstract through to see whether I can not gain in brevity without losing in clearness or improve the English without adding too much to the length. By combining or rearranging sentences, it is frequently possible to make a series of condensed statements less disjointed.

An examination of the series of abstracts in the *Astrophysical Journal* will give a much

clearer idea of the form and character of analytic abstracts than a set of rules. Any author who will take the trouble to make such an examination and who will follow the procedure suggested above, *particularly in the matter of formulating adequate subtitles before writing the text*, should have little difficulty in preparing satisfactory abstracts.

GORDON S. FULCHER

CORNING GLASS WORKS,

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