How to proceed with a PhD Thesis writing

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1. Introduction

When one is about to begin, writing a thesis, it appears to be a really difficult job. It is just like an expecting mother for the new born baby. However, if one were to do one or few chapters it may turn out to be looking easy. As you progress one will find the job enjoyable since it is a creation that is being described a creation of a new knowledge. This enjoyment arises out of the feeling that one is giving new knowledge to the world and also arising out of the satisfaction in the achievement, and the realization that one has improved in his presentation of technical matter and above all one is going to find the end of the reporting soon. As we all know at the beginning of a job, the job appears insurmountable, so also to start to write a thesis. It is therefore necessary for us to see how best one get organized to write a thesis. The objective of this presentation is to make us understands how best one can be prepared and also proceed with the writing of a thesis.

2. Starting the Thesis Writing Work

The starting phase of thesis writing will appear to be a heavy one. Many different possibilities will come to the mind. The best thing to do will be:

- **1.** Assemble all the observations notes and documents in one place and number them for easy identification.
- 2. Collect and sort out all the figures and tables so far compiled and leave them in a separate folder.
- **3.** Sort out all the literature documents that may be relevant to the writing of the thesis and bring them in one formulation.
- 4. After all the collections, write down a rough outline of the thesis but this will not be straight away possible , in that case write down the outline of the simplest chapter like the experimental methods or Preparation procedure which is a mere statement of what you have done. This way you will gain confidence to make an outline of the whole thesis.
- 5. After the outline of the thesis is formulated, discuss the same first with one of your coworkers and also with your thesis supervisor. At this stage you will find there are various alternatives possible and the selection or choice will be difficult. The thesis supervisor may bring many suggestions from his experience and this will resolve some of the confusions one may have on his/her thesis contents.
- 6. At this stage note that the contents are only tentative and these can undergo changes as one proceeds in his/her thesis writing.
- 7. The first level thesis outline can run to several pages with sub headings some indications of what figures to be used where, what tables may be appropriate for a subheading and note down all the details.
- 8. When one sits down to write a chapter (as stated earlier the easiest chapter, normally one tends to keep this chapter to the last which is not the correct procedure) then the scope is no longer a full thesis but something simpler. At this stage the important thing is just to write a paragraph or section about

one of the subheadings. It helps to start with an easy one: this gets one into the habit of writing and gives some self-confidence. Often the Materials and Methods chapter is the easiest to write---just write down what one had done; carefully, formally and in a logical order.

3. How to Make an Outline of a Chapter?

This is a big question always in the mind of the person writing the thesis. He has so many ideas, data, and also theoretical framework which he or she wants to place in a chapter but does not know in what order they have to be presented. Normally many of these people fortunately have some experience in writing a communication or a scientific paper. In compiling or formulating a scientific communication most of us follow a format wherein we decide which of the figures, tables and references are essential for the paper to be written. Then we sort them in the order in which they may have to be presented so that it gives a coherent flow to the reader. This method is one procedure that can be followed.

Alternatively one might as well rehearse explaining it to someone else---after the entire researcher will probably give several seminars and presentations in symposia and workshops based on his/her thesis work. Once one has found the most logical order, note down the key words of the explanation. These key words provide a skeleton for much of the chapter outline.

The next step is important but it is not always followed for various reasons, usually the time factor is given as the reason. However, the attempt to skip this step may give rise to more hurdles in subsequent steps. It is better to discuss the outline of the chapter with ones adviser. This step is important as has been stated already and one should not attempt to skip this step. The adviser will have useful suggestions, but it also serves notice that the thesis adviser can expect a steady flow of chapter drafts that will make high priority demands on the time of the thesis adviser. It is some kind of commitment on the part of the thesis adviser for his time and attention. Once both the scholar and the thesis adviser have agreed on a logical structure, it is necessary that the scholar submits a copy of this outline for reference when reading the chapters which the scholar will probably present out of order. If one has a co-adviser, discuss the outline with him/her as well, and present all chapters to both advisers for comments.

4. How to Organize Oneself for the Thesis Writing?

It will be helpful to follow some kind of ordering. This means that the total material that will go into the thesis in what ever form they are (partially as data partially as figures some figures fully drawn some of them in rough form. At this stage one can have a physical filing system: a collection of folders with chapter numbers on them. This will make you feel good about getting started and also help clean up your desk. Your files will contain not just the plots of

results and pages of calculations, but all sorts of old notes, references, calibration curves, suppliers' addresses, specifications, speculations, letters from colleagues etc., which will suddenly strike one as relevant to the chapter on hand or the other chapter to be written. Stick them in that folder. Then put all the folders in a box or a filing cabinet. As one writes bits and pieces of text, one can place the hard copy, the figures etc from the folder to the chapter folder. It is necessary to periodically touch the folders and feel their thickness from time to time---as the thesis is taking shape since its reduction is a measure of the work completed.) They must be sorted out and appropriate notes and identifications have been This is particularly true for the made for easy reference subsequently. references one wishes to cite, since if you cannot find the reference as you compose the text, then subsequently one will find it difficult to insert that reference and reference listing will be always incomplete even after the thesis is completed. Some of us think we can number or identify them but one look for the same afterwards, this will lead to placing some reference at the end and not the reference one wanted to give. Second point is if the reference is not easily available at the time of writing, then the material referring to this will be from ones memory and hence there is a danger of misrepresentation of the referenced Another important point is when you wish to give cross references, material. one should do it with proper notes at appropriate places and make a note of them separately to be recalled when a subsequent chapter is written. If one were to think that he will be able to refer in a subsequent chapter, when that chapter is written, it may slip out or even if you remember, the exact details for the reference will be missing in the context of writing the previous chapter. After all the mind tracks and records them in a particular sequence and the sequence chain has to be maintained. In fact if one has notes on subsequent chapters while writing previous chapters, writing the subsequent chapter can become easier.

As one proceeds writing different versions of a chapter, there can be various sections written in different times and different formats. It is better to record them with respect to time of writing and it is desirable to destroy the versions which are definitely not required. The ideal situation would be to have only one draft version which will be carried further rather than too many of them. However for some reasons one were to have many versions of the same material, there must be proper indications of the versions so that one can easily lay hands on the version which one wants to adopt for the final version.

This is the appropriate time to make a copy of the version most suited and give it to a coworker for his remarks. This will help in refining and also gives you feedback how the reader and others in the scientific fields are able to comprehend what you have written. It has another added advantage, that an alternate copy of the version is available so that in case if any thing were to happen to the copy that you have, then still you have some resource where you will be able to look for.

5. A Time schedule

Now that one has organized oneself and also formulated sample chapter writing you have to work out a detailed time table and discuss the time table with the thesis adviser. This is necessary since there are some concurrent activities which have to be pursued. The thesis adviser has to seek the permission from some prospective thesis examiners. The administration may have to get the acceptance of the proposed thesis examiner. In this direction, the administration may like to send the abstract of the thesis to the prospective examiners for their acceptance. This implies one has to prepare a well planned abstract of the thesis and this will be possible only a well thought out plan and outline is already available. It may be also better to indicate the outline in the abstract so that the examiner may be comprehend the contents and the time required for evaluating the thesis and commit for that time period. The thesis adviser also has to commit for his time to go through the full thesis in one or more versions and hence all these require a proper planning of the time period. Some thesis advisers may like to read chapter by chapter, some others will like to see the total thesis in one frame and this means that he should be prepared to see in whatever manner and he should have the time period available for him to devote to this work.

5.1. How to Make the Time Table

It is strongly recommended that one sits down with the adviser and make up a timetable for writing the thesis. This must contain a list of dates for when one will give the first and second drafts of each chapter to the thesis adviser(s). This structures ones own time and provides many intermediate targets to achieve. If one were to merely aim "to have the whole thing done by some distant date", one can deceive oneself and procrastinate more easily. If one has told his/her adviser that one will deliver a first draft of chapter 3 on Wednesday, it focuses ones attention.

It may be necessary to make ones own timetable into a chart with items that one can check off as one has finished them. This is particularly useful towards the end of the thesis when one finds there will be quite a few loose ends here and there. At that time it will help one to tie these loose ends easily to complete the work on time.

6. Iterative Solution

Once one sits to write something then one should write something even if it not useful ultimately. It can be telegraphic, or simple paragraph or some notes or some scribbling it does not matter. After all we all know that most of us find it easier, however, to improve something that is already written than to produce text from nothing. So it is necessary to put down a draft (as rough as one likes) for ones own purposes, then clean it up for the thesis adviser or any other to read. People tend to think low of writing multiple drafts, but it is a pleasure to see how in various drafts the contents are improving and make better sense from the earlier drafts. One has to enjoy this effort.

As one writes initial drafts, it is possible that one will not be able to select the appropriate words, mostly the adjective (the attributes in general) and one tends to use most effective adjectives and over emphasize the comparative degree by reinforcing with words like much stronger and these usages in any way imply any higher degree other than the conventional comparative degree implies. This type of excessive writing, that is use of many words where a single word can suffice, and other over emphasis of comprehension as well as undue emphasis given may be able to be modified/altered/and adopted appropriately if various drafts were to be written for the same written material. The improvements seen from draft to draft will also pave the way for a well conceived, appropriately formulated write-up ultimately. It may appear necessary that in thesis writing one cannot avoid making many drafts as the number of drafts is proportional to the ideality being achieved. Secondly the drafts give the flexibility to leave gaps to be filled in after clarity, or leave notes which can be altered subsequently. Therefore, one should not hesitate to make as many drafts as required to achieve the levels of ideality one can achieve.

It is necessary that one marks the various drafts in order and date wise so that a re-reading of the drafts will help the composition of the final draft easy. One can easily see how from draft to draft ambiguities are removed, how statements tend to reflect exactly what one wanted to convey and how the earlier drafts could have been mistaken or misinterpreted.

The thesis advisers normally like to read each chapter in draft form. S/he will then return it with suggestions and comments. *Do not be upset if a chapter--especially the first one that was submitted--- returns covered in red ink*. The thesis adviser will want the thesis to be as good as possible, because his/her reputation as well as the candidates is affected. Scientific writing is a difficult art, and it takes a while to learn. As a consequence, there will be many ways in which the first draft can be improved. So take a positive attitude to all the scribbles with which the adviser decorates the text: each comment informs you how one can improve his written thesis.

We have already indicated the need for writing various drafts of the thesis. As one writes the thesis, scientific writing skill is almost certain to improve. Even for native speakers of English who write very well in other styles, one notices an enormous improvement in the first drafts from the first to the last chapter written. The process of writing the thesis is like a course in scientific writing, and in that sense each chapter is like an assignment in which one is taught and learning, but not assessed. Only the final draft is assessed: the more comments the adviser adds to first or second draft, the better it is for the thesis to improve. It is necessary before the drafts are given to the thesis adviser for his comments one must read it once to correct for spell errors and most often one tends to make errors with respect to subject and predicate especially in terms of singular noun carrying a plural very or vice versa especially when phrases are formed for the subject carrying both forms of nouns. It will be irritating for the thesis adviser to have a document full of spell errors or avoidable trivial grammatical errors. This can be easily avoided if you can run through your draft once before handing it over to the thesis adviser.

So much is enough for making various drafts of the thesis. Now it is time if one can understand what is a thesis?

7. What is a thesis?

The thesis is a research report and not a laboratory report or practical record. This confusion may arise but one must know in the laboratory you do an experiment which is already known and the observations and results are already known. One will be only stating how he or she could reproduce them and at most may mention a few points of difficulties and some striking observations. But the results are never to be new though observations can be different set of data.

The thesis must report on a problem this is desirable and hence one must try to connect all his studies in some form or other and if this were not to be then it is a series of problems in the area of research and it should describe what was known about it previously, what are the gaps existing in the knowledge, what further questions arise from the previous knowledge, how the previous knowledge needed a reexamination in terms of interpretation or in terms of new data to substantiate, or what new questions the previous knowledge gave rise and how or what one did towards solving it. The thesis must also faithfully record all the observations as they were made (to enable others to reproduce) and then how the results were derived from these observations and what these results mean to any one and where or how further progress in the field can be made.

One tends to write a thesis as though one is writing an assignment. A thesis is not an answer to an assignment question. One important difference is this: the reader of an assignment is usually the one who has set it. S/he already knows the answer (or one of the answers), not to mention the background, the literature, the assumptions and theories and the strengths and weaknesses of them. The readers of a thesis do not know what the "answer" is. If the thesis is for a PhD, the university requires that it make an original contribution to human knowledge: the research carried out must reveal something hitherto unknown. 8. What is the extent of details to be given in the thesis?

8.1. How much detail?

Most often we tend to think thesis is exactly the same as a scientific paper. But this is not true. In scientific papers many details are not given since the reader is only interested in the new knowledge that is being presented. In a thesis this is not the case. The thesis should contain all details, all precautions taken, the extent of uncertainties that could have crept in and most certainly how one has treated the results and extracted the information. His is essential for verifying by the thesis examiners and also for those who wish to follow the work like your co workers in the laboratory.

In fact after the thesis examination, the only people who will read a thesis is the future research student pursuing the same research in the same laboratory and he or she may be interested to find out exactly what one has done. Other than this the readership for a thesis is limited and also the non-availability of a number of copies and even if it were to be available, it is not certain that many others will read the thesis as a book is read.

However, the future researchers in the laboratory will certainly want to refer to the thesis a number of times as and when one gets some doubt or question how to carry out a particular experiment or how to extract a data from the observations. In order to facilitate this readership one should include many appendices of the drawings, computer programs used and other material which will not for part of the scientific reporting done in the main part of the thesis. Most often one tend not to include them and this way the utility of the thesis is greatly reduced since even the few readers will be driven away from the thesis since he or she could not find answers from your thesis and most often they have doubts and questions on this aspect only and for that only they want to refer to the thesis.

It is often true the person who is writing a thesis has consulted many of the theses which have been available in his laboratory and in that way, one can easily realize what research students would like to see in a given thesis. One should foresee all these from the own experience and try to fulfill this condition. This will be the extent to which the details should be given in the thesis.

8.2. How and When to Cite a Reference?

This is an important aspect of thesis writing. Honesty is one; and also not stating that one is standing on the shoulder of another scientist who has reported it before is a great disservice one is doing to the scientific community and this fate may descend on the shoulders of the person who is producing the thesis. If a reference is not properly cited one may tend to think it will be considered as though it is the new knowledge created by the person who is writing the thesis, but this is an illusion, since the person who is writing the thesis has read a particular paper and uses it in his/her thesis, it is certain many others also would have seen that publication and also read them and they will be able to identify the place from which the material has been taken. This will lead to loss of reputation not only for the person who is writing the thesis but also to the whole group. One is bringing discredit to the group from which he or she has benefited. This must certainly be not done at any cost.

If a result, observation or generalization that is not generated by the person then he or she must usually state where in the scientific literature that result is reported. The only exceptions are cases where every researcher in the field already knows it: dynamics equations need not be followed by a citation of Newton, circuit analysis does not need a reference to Kirchoff. The importance of this practice in science is that it allows the reader to verify your starting position. Science in particular is said to be a vertical: results are built upon results which in turn are built upon results etc. Good referencing allows one to check the foundations of new additions to the structure of knowledge in the discipline, or at least to trace them back to a level which we judge to be reliable. Here lies the credit and reputation one will get for his or her work and effort in the creation of new knowledge. Good referencing also tells the reader which parts of the thesis are descriptions of previous knowledge and which parts are the additions to that knowledge. In a thesis, written for the general reader who has little familiarity with the literature of the field, this should be especially clear. It may seem tempting to leave out a reference in the hope that a reader will think that a nice idea or a nice bit of analysis is created by the person who is writing the thesis. This is a gamble. The reader who could estimate the capability of the author of the thesis will probably think: "What a nice idea---If this could be the original idea of the author of thesis? If such doubts were to arise then the reader will try to find out the source and there ends even the small readership that one will have for his thesis.

When reporting in active or passive voice, one has to be clear to state if the said experiment was done by the author or it was reported in literature and the author simply repeated it or stated it to substantiate an observation in his or her thesis.

People tend to write in passive voice with out stating by whom it was done and this is not the correct way to write passive voice sentences.

9. The Style of the Text of the Thesis

This is an important aspect of the thesis. The text should be clear, simple and brief. One must be sure of the use of words. One should avoid ambiguous sentences; use of many words where one word will say it better and also the text has to be direct and pointed instead of long story like narration. Use of local slang and informal writing should be avoided in thesis writing. Too many

abbreviations other than the ones that are normally accepted (with or without their expansions listed elsewhere in the thesis) must be avoided. It is true one tends to use many abbreviations while discussing scientific contents with others but in written thesis only the accepted abbreviations alone can be used.

There are many instances where English writing can be improved or alternatives used and a few examples of these will be given in appendix. However it must be stated that one should sacrifice accuracy for the sake of brevity. And it is also necessary where qualification and attribute should be employed they must be employed to the required degree never overstep in the use of attributes. This aspect has been already mentioned elsewhere in this report.

It is true that Bullets and numbered statements are easier to comprehend rather than giving a long unwieldy paragraph. However caution should be exercised since too much of this presentation in terms of bullets and numbered points can sometimes lead to simply appear as list of facts and observations whereas what one wants to achieve is a well connected convincing argument to substantiate an observation and deduction.

It has been already mentioned that writing the thesis in passive voice is preferred by many from the point of modesty. However it gives rise to much ambiguity. For example if one were to state that "for the above reasons, substance X was chosen" it may mean that it was chosen by others in the literature and so an explicit statement that was chosen in the present study may directly indicate the author's judgment and discretion. Another common error that happens is the use of plural where singular is the necessity. It is a thesis of the person and not of the thesis adviser or of the group. So, one has to avoid the use of 'we' since its use implies to share the blame with others other than those mentioned in the acknowledgment. 'We' normally implies a whole lot of persons. Another common singular /plural confusion is datum and data.

A list of such common misconceptions will be given in the appendix [An excellent and widely used reference for English grammar and style is *A Dictionary of Modern English Usage* by H.W. Fowler].

In the presentation of thesis, one is tempted to duplicate the data in the form of tables and also figures. This need not be done. When the data will be perceived well if presented in the form of a figure one should depict it in a figure. Where the data may be appealing one should only give data and not present it in a figure how ever much the figure may be appealing. The same is true of a photograph, since photograph is elegant, one tend to use photographs but a well drawn sketch with details may have been useful for the reader rather than a glassy print of a photograph. It is also natural that one spends too much time in making the drawings. This is not going to add to the value of the thesis. A well presented substantive argument will be better than number figures. Also one should not tend to write too much (volume is not the criterion of the quality) and avoid unnecessary use of available space in a thesis.

10. Keeping the Schedule

One must always remember the time schedule that was made in the beginning of the thesis writing. This deadline must be kept so that one can hand in the draft of the thesis or thesis chapter even if thesis or chapter were to require further drafts to the thesis adviser. Please remember that thesis writing is an enormous job and it cannot be perfected in a finite time and perfection can be tended to only when it undergoes various levels of exposure, modifications and corrections. There will inevitably be things in it that one could have done better. There will be inevitably some typos. It will be certain that when one opens the finished bound copy itself he or she will find mistakes. No matter how much one reflects and how many times one proof reads it, there will be some things that could be improved. There is no point hoping that the examiners will not notice: many examiners feel obliged to find some examples of improvements (if not outright errors) just to show how thoroughly they have read it. So it is necessary to set oneself a deadline and stick to it. Make it as well as one can in that time and then hand it in!

10.1. Other logical issues to be decided upon:

There are a number of other logical issues to be sorted out. They are

- 1. Preparation of a synopsis (this is required in a number of universities) for the internal system to make sure there enough contents for the award of a Ph D degree and the presentation is logical without obvious flaws. It is also used to fix up the examiners who will agree to examine the thesis on the basis of the synopsis submitted to him. This has some logistics like the time you wish to submit and how many copies of this synopsis has to be made. This depends on the university since each university follows its own format with or without a doctoral committee and hence you must prepare as many copies of the synopsis so that a copy is available for all the members who assess the contents of the thesis within the university framework.
- 2. When it comes to the thesis, one tends to prepare exactly the number of copies required for submission plus one copy for self and one copy for the thesis adviser. This is not good. It must be possible to send copies of the thesis to those who will be working in the same field at least a few of them whom one may know. This will have the following effects:

(i) They can discover what marvelous work one has done before it is published in journals. (ii) They can look up the fine details of methods and results that will or have been published more briefly elsewhere; and (iii) they can realize what an excellent researcher one is. This realization could be useful if a post- doctoral position was available in their laboratory or if they were reviewers of your research/post-doctoral proposal. Even having ones name in their bookcases might be an advantage since the visitors to that laboratory may come to know or even the researchers of this laboratory can talk about the work one has done.

The list of recipients of one's thesis must be carefully prepared with the consultation of the thesis adviser. It will not be a bad idea to give copies who have indirectly sacrificed for ones career even if they do not understand what is contained in the thesis. This can be parents or siblings but they will treasure such a gift and will probably show to others what their ward or otherwise has achieved.

10.2. Some useful hints

The production exercise should be enjoyable and should not become a tiresome exercise or should not be the cause for some illness. Also do not use any stimulants even if they were to be allowed like drinking excess of coffee. It is also necessary that one relaxes and spends quality time with ones friends and others. Avoid complaining to others especially to fellow researchers regarding your thesis adviser or others who are contributing to the thesis writing. They may have valid reasons for their actions and hence it will only spoil the relationships that one has built over the years.

As one progresses in thesis writing, there will be a number of frustrating situations when one will like to give up. But one should not give up at the writing stage after years of hard research work and it would be regrettable for a long time afterwards.

Writing a thesis is tough work. Some one has said that writing thesis is going to be unpleasant, it can mess up ones life, it can cause breaking friendship and even one may loose some social life. It is certainly a tough period in the career of a research student. One has to put up with this situation. It is necessary one has to build up a rhythm with this stressful period. Once one is through it, one will cherish the period that he spend in writing the thesis

10.3. On thesis structure

There is no universal thesis structure that can be recommended. It also varies from university to university. Even if one were to provide a thesis contents, it may be possible that it may not be suitable for the particular research that has been reported in thesis. For example results and discussion can be built in the chapters themselves or can form a separate chapter. This depends how you organize ones thesis. The presentation should be logical and also consider which format will be easy to follow.

There can be a number of logistics to be followed.

1. If one were to make use of come copyright material (like figures or tables or other materials), then proper copyright waiver has to be obtained from the publishers. This is not usually done but it can cause some problems

afterwards. It is easier to this and one should attempt to do this before finishing the thesis.

- 2. Some universities need some declaration from the candidate and even from the thesis adviser that the material reported is original and has not been submitted for any degree of diploma in any other organization. There can be standard formats for each university one should get this and prepare the same.
- 3. The universities insist on a format for the title page and this must be known to the person who is writing the thesis and should follow this meticulously.
- 4. After the title page is the Abstract of the thesis. This is the one that is difficult to prepare. Kindly note that abstract is not summary or conclusions. It is the abridged form of the contents of the thesis highlighting the new knowledge generated. Usually writing the abstract is most difficult and this should be done only when the whole thesis is completed and a comprehensive picture has emerged.
- 5. The contents that one has prepared can be now adopted with suitable alterations and corrections of the contents of the thesis.
- 6. This has to follow the list of figures tables and list of abbreviations. Even if the university does not have a regulation regarding this it is better to do this since it is a facility that one creates for easy reference to the reader and the person who is writing the thesis also can be one of the readers of the thesis subsequently.

It may be a good idea to place the acknowledgement in the beginning of the thesis. However it is also possible to place it at the end of the thesis. It is necessary that one acknowledges all those who have directly or indirectly contributed to the work reported in the thesis. If the work reported is collaborative in nature, then one must make it explicitly clear the contributions from others. This will avoid subsequent embarrassments.

Invariably the first chapter is titled as introduction. However how far it serves an introduction to the contents of the thesis depends how well one can prepare this chapter. While writing the introduction, one should try to think in a broader sense and place the work in the framework of the broader perspective rather than limiting it to the specific aims or objectives that one wished to achieve. This is necessary since only the researcher alone can clearly see the scope of the work done in the broader sense.

The introduction should be interesting even for a reader from another area to understand and comprehend the status of literature in the area on which the thesis is concerned with. Since this is the first chapter of the thesis sustaining the interest of the reader depends how interesting and also intriguing this chapter is? The best solution is to read introductions of a few theses and one can easily identify which one he or she wanted to read further. This will give some clue how an introduction should be. Introduction might go through several drafts to make it read well. For this section, it is a good idea to ask someone who is not a specialist to read it and to comment on the following questions. Is it an adequate introduction? Is it easy to follow? The introduction should tell where the thesis is going and how far it will be going to unravel the new knowledge.

The coverage of the background literature appears to be person based. This is not the correct situation. It is necessary that it covers the following aspects. (i) Where did the problem originated? (ii) what is already know about this problem and what is the critical assessment of the situation (iii) what techniques and methodologies have been adopted and how they were unable/able to generate the new knowledge?

There can be a dilemma on the number of papers to be quoted in this section. At the start of the thesis work one would have vowed that he will cover the whole literature in the area of research and even if he or she has fulfilled the vow, it is time now to distill that and provide them in the introduction so that the introduction can be the starting point for some one to follow or initiate his or her research career towards a Ph D degree.

Your judgment for the selection of research publications to be quoted in the introduction can also be damaging to oneself. If one were to omit the publications of the possible examiners or potential employers then it can or may cause damage. At the same time if you are not making a critical assessment of the literature, they it will become a listing of the publications in the narrow field of research. The person writing the thesis is the expert for that narrow area he or she should be able to make a judgment of literature to be quoted in this section.

Subsequent chapters often take the form of journal articles of which the person writing the thesis is the principal author. This is not always the best method. The thesis is expected to have more details than a journal article. Journal articles are restricted from the point of view of number of figures and pages. A thesis is not. In a thesis all the interesting and relevant data have to in the thesis but could not have appeared in the journal. The degree of the experimental detail contained in the thesis is usually greater than what is generally accepted in a journal article. Most often the thesis is usually referred in order to obtain details and the person writing the thesis should not disappoint this expectation.

In the journal articles, if the person is the principal author for a number of related publications, it is often the practice that the introduction and Materials and Methods may have many overlapping contents within the set of publications, Whereas the thesis is not one such in the chain of publications from the principal author. The structure of the middle chapters can be routine or can reflect the originality of the author. In some theses, it is necessary to establish some theory, to describe the experimental techniques, then to report what was done on several different problems or different stages of the problem, and then finally to present a model or a new theory based on the new work. For such a thesis, the chapter headings can be different from others which simply report experimental methods employed and the substances synthesized and how were their structures established. It is also possible one may have to resort to discussing the different techniques, rather than to have a single Materials and Methods chapter. In essence, the middle chapters reflect the originality of the author and his capacity to bring new formats.

Assuming that a thesis carries the usual contents then one can see what should be contained in these conventional chapters.

Materials and Methods

This varies enormously from thesis to thesis, and may be absent in theoretical theses. It should be possible for a competent researcher to reproduce exactly what one has done by following the description given. Most often a subsequent researcher wants to use the gear outlined in the thesis to try another experiment and the description in the thesis must be able to guide this new researcher.

In some theses, particularly multi-disciplinary or developmental ones, there may be more than one such chapter. If this were to be so then the reader should be able to distinguish which of the chapters is useful for his problem on hand and should be able to adopt the same.

If a theoretical framework is involved in the thesis and the theory is not formulated by the author but is taken from literature, it should be kept in mind that the whole reproduction of the theory and the mathematical background should be avoided since the reader can find the same in the original publications. However, there can be finer details of the theory and its application that one has dug out and these should be explicitly stated in this section. Avoid the aspects of the theory which is not related to the work reported.

When writing this section, one has to concentrate on the physical arguments as on the equations. What do the equations mean? What are the important cases?

On the other hand if one is reporting on the theory developed by him or her, one must include all details. However if there is a lengthy derivation it can be placed in the appendix. By this way the reader is tuned to read on the theory and can look for the finer details if necessary in the appendix. This way one is keeping the interest of the reader focused on the theory described. Another important aspect in reporting the theory is the structure and the sequence you have adopted to develop the theory may not be exactly the same in which it should be reported to keep the interest of the reader. Suspense is not necessary in reporting science:

Results and discussion chapter

This is an important component of any thesis. It is most often combined in theses.

This is sensible because of the length of a thesis: one can have several chapters of results and, if one has to wait till all the results are presented before one can begin discussion, the reader may have difficulty remembering all that have been considered. The division of Results and Discussion material into chapters is usually best done according to subject matter.

Make sure that one has described the conditions under which each set of results were obtained. What are the parameters that were held constant? What were the other relevant parameters? Make sure too that one has used appropriate statistical analyses. Where applicable, one should show measurement errors and standard errors on the graphs. Use appropriate statistical tests. Also one should not report data in more precision beyond the measurement. This has become a habit now since calculations are carried out using computers and calculators which can give results in more significant figures while measurements cannot provide such precision.

When one plots the data in graphs some care has to be taken. The origin and intercepts are often important so, unless the ranges of the data make it impractical, the zeros of one or both scales should usually appear on the graph. The graph should show error bars on the data, unless the errors are very small. For single measurements, the bars should be the best estimate of the experimental errors in each coordinate. For multiple measurements these should include the standard error in the data. The errors in different data are often different, so, where this is the case, regressions and fits should be weighted (i.e. they should minimize the sum of squares of the differences weighted inversely as the size of the errors.) (A common failing in many simple software packages that draw graphs and do regressions is that they do not treat errors adequately). These days there are some soft wares which are able to treat the data and generate suitable plots. One of the sources of this kind of soft ware is given in the appendix.

When one examines the data he or she should find answers for the following questions. (i) What do the data mean? (ii) How do they fit into the existing body of knowledge? (iii) Are they consistent with current theories? (iv) Do they give new insights? (v) Do they suggest new theories or mechanisms? The list of questions is endless and the person who has generated the data is the

best person to raise the appropriate questions. It may be useful to look at the data not only from the point of view of the group but also from others point of view also. This can give rise new insights and new knowledge.

The final chapter

Like the abstract this final chapter dealing with conclusions and suggestions for further work is also important and difficult to compose. A summary of conclusions is usually longer than the abstract. It can briefly summarize the findings in shorter form and then outline the new knowledge generated or arising from the observations recorded in the thesis. It might be helpful to put the conclusions in point form.

It is often stated that a thesis raises more questions than it answers. It is necessary to find if the thesis has opened any new avenues. Is there any possibility the work reported can be improved further by others. What other implications (even in other areas) the work reported can have? Such questions can be written in the final chapter.

11. Citing References

This is one of the parts of the thesis where one can find more frequent errors. This is because of the names of the authors are not usually familiar to the author of the thesis, he is not sure what abbreviations have to be used for the journals under reference and what formatting has to be used for citing a reference. The style citing a reference varies from university to university, country to country and also from discipline to discipline. Some times the author cites references which he or she has never seen or read. This should be avoided. The best thing would be to give complete bibliographical details of the reference including the full title of the paper, but this will become a tremendous job if the number of reference cited exceeds a particular number.

These days the web sites are also referenced. If one cites a journal article or book, the reader can go to a library and check that the cited document and check whether or not it says what one has stated. A web site may disappear, and it may have been updated or changed completely. So references to the web are usually less satisfactory. Nevertheless, there are some very useful and authoritative sources. So, *if the rules of the institution permit it*, it may be appropriate to cite web sites. If one can have a hard citation, then it is better to place that citation rather than a web citation. Web citation must be resorted to only as a lost resort. While citing a web, one can give the date of downloading so that one can defend at a later date.

12. Appendices – Are They Necessary?

If there is material that should be in the thesis but which would break up the flow then include it as an appendix. Some things which are typically included in appendices are: important and original computer programs, data files that are too large to be represented simply in the results chapters, pictures or diagrams of results which are not important enough to keep in the main text. There are also other items included in the appendix. These can be the publications of the author of the thesis, some related work carried out but does not form part of the thesis and any other new knowledge generated but could not be accommodated in the main text for want of flow can be included in the appendix.

13. Acknowledgments

The author has to record that the motivation to write this piece came from his own experiences and also while dealing with the writing of thesis by his coworkers. He has been of late hearing on communication skills of graduate students in the institution where he is holding a position. Above all he came across a master piece by Joe Wolfe on How to Write a PhD Thesis, http://www.phys.unsw.edu.au/~jw/thesis.html. This gives an elegant account of how to use the modern tools and compose a thesis directly using the various softwares available. The only reason why he ventured to write another one is that the requirements and demands for the universities and institutions in his country were different. Secondly he felt that one should write a PhD thesis rather than composing it directly on the computer. There are various differences and lessons to be learnt. It is only to bring out the additional lessons that can be learnt from such an exercise this write up is composed. It must be admitted that the author was not only motivated by the write up of Joe Wolfe he also extensively used his write up as guide and even taken some of his thoughts directly in this write up. A companion write up by Prof Joe Wolfe is How to survive a thesis defense which can be found at the web site http://www.phys.unsw.edu.au/~jw/viva.html. This must be read all those who wish to face a thesis defense.

Another important source would be Research resources and links at the http://www.deakin.edu.au/library/findout/research/research_skills.php

14. Some Other Sources

 Stevens, K. and Asmar, C (1999) 'Doing postgraduate research in Australia'. Melbourne University Press, Melbourne ISBN 0 522 84880 X.
Phillips, E.M and Pugh, D.S. (1994) 'How to get a PhD: a handbook for students and their supervisors'. Open University Press, Buckingham, England
Tufte, E.R. (1983) 'The visual display of quantitative information'. Graphics 4. One of the soft ware sources for plotting the data with error bars:

Mike Johnston: http://www.phys.unsw.edu.au/3rdyearlab/graphing/graph.html.

15. Some Final Remarks

We do not claim that we have covered or included all the possible references and we have only listed only a very limited number. It is our request that the contents may be brought to the attention of any one who may need this and it can be freely distributed to any one. If any one of you have any suggestions to offer for inclusions, amendments, corrections, modifications and other improvements please feel free to bring to our attention. The opinions expressed in these notes are that of the author and hence no one else person or institution has to be associated with this.

Appendix:

It has been pointed out that some illustrations of writing will be given. In the following notes we have indicated them in various places. It is hoped that it will be useful.

Writing a Scientific Paper

1. How to Get Started

Although there is no fixed set of "writing rules" to be followed like a cookbook recipe or an experimental procedure, some guidelines can be helpful. One can start with few questions and try to answer them in his mind before writing the paper. Or one can have a scientific concept on which he can try to expand. First let us see some questions that can be asked for producing a scientific document.

- **O** What is the function or purpose of this paper?
- Are you describing original and significant research results?
- Are you reviewing the literature? What aspects of a topic you are reviewing? Are there questions for which you are finding answers in the review? (Please note a review is not a simple listing of the literature, it has to be critical and also seeking something in the literature to see beyond what has already been seen.)
- Are you providing an overview of the topic? Something else?
- How is your work different from that described in other reports on the same subject? (Unless you are writing a review, be sure that your paper will make an original contribution.)
- What is the best place for this paper to be published--in a journal or as part of a book? If a journal, which journal is most appropriate?
- Who is the audience? What will you need to tell them to help them understand your work?

Answering these questions will clarify your goals and thus make it easier for you to write the paper with the proper amount of detail. Writing is like so many other things: if you clarify your overall goal, the details fall into place.

Once you know the function of your paper and have identified its audience, review your material for completeness or excess. Then, organize your material into the standard format: introduction, experimental details or theoretical basis, results, discussion, and conclusions. This format has become standard because it is suitable for most reports of original research, it is basically logical, and it is easy to use. The reason it accommodates most reports of original research is that it parallels the scientific method of deductive reasoning: define the problem, create a hypothesis, and devise an experiment to test the hypothesis, conduct the experiment, and draw conclusions. Furthermore, this format enables the reader to understand quickly what is being presented and to find specific information easily. This ability is crucial now more than ever because scientists, if not all professionals, must read much more material than their time seems to allow. [It must be noted that one need not jacket everything in the same format that is followed. In fact many of the original thinkers go beyond this and even make a strategy to accommodate their sections. The sections and section heads can also be catchy so that it will induce some curiosity in the mind of the readers.]

Even if your results are more suited to one of the shorter types of presentation, the logic of the standard format applies, although you might omit the standard headings or one or more entire sections. As you write, you can modify, delete, or add sections and subsections as appropriate.

Writing Style and Word Usage

Short declarative sentences are the easiest to write and the easiest to read, and they are usually clear. However, too many short sentences in a row can sound abrupt or monotonous. To add sentence variety, it is better to start with simple declarative sentences and then combines some of them than to start with long rambling sentences and then try to shorten them.

You and your colleagues probably have been discussing the project for months, so the words seem familiar, common, and clear to you. However, the readers will not have been part of these discussions. That is where copy editors can help. Their job is to make sure that readers understand the material you are presenting. [It is most often seen that you use terms which are not in general use but you have been using them for convenience and easy for discussing and when you want to incorporate them in the text be careful that the readers will understand them if not do not use such words phrases, abbreviations, acronyms etc.]

By all means, write in your own personal style, but keep in mind that scientific writing is not literary writing. Scientific writing serves a purpose completely different from that of literary writing, and it must therefore be precise and unambiguous.

Choosing the Correct Word or Phrase

Use words in their primary meanings; do not use a word to express a thought if such usage is uncommon, informal, or primarily literary. Examples are using "since" when you mean "because", and "while" when you mean "although". Many words are clear when you are speaking because you can amplify your meaning with gestures, expressions, and vocal inflections--but when these same words are written, they may be clear only to you. This is one of the common practices of scientists since they use many short names in their conversation they tend to use them in writing too but these may not make much sense to the readers so be careful when you generate your own shortened forms of words.

Use appropriate verb tenses. (Another aspect where we tend to make mistakes. It is common to use plural verb for singular noun etc.) [This is a trap for most Indian writers since they do not identify the noun and since the preceding word is plural one tends to use the plural verb] Second common temptation is to use past and present tense interchangeably. This should be carefully avoided.

- Simple past tense is correct for stating what was done, either by others or by you: "The solutions were heated to boiling." "The spectra were recorded." "Jones reviewed the literature and gathered much of this information." "We recently found that relativistic effects enhance the bond strength." "The structures were determined by neutron diffraction methods."
- Present tense is correct for statements of fact: "Absolute rate constants for a wide variety of reactions are available." "Hyper-branched compounds are macromolecular compounds that contain a branching point in each structural repeat unit."
- Present and simple past tenses may both be correct for results, discussion, and conclusions: "The characteristics of the voltammetric wave indicate that electron transfer and breaking of the carbon-iodine bond are concerted." "The absence of substitution was confirmed by preparative-scale electrolysis at a potential located at the foot of the voltammetric wave." "IR spectroscopy shows that nitrates are adsorbed and are not removed by washing with distilled water."

Use the active voice when it is less wordy and more direct than the passive.

Poor: The fact that such processes are under strict stereo electronic control is demonstrated by our work in this area. (Example of passive voice)

Better: Our work in this area demonstrates that such processes are under strict stereo electronic control. (Same in active voice conveys better)

Use first person when it helps to keep your meaning clear and to express a purpose or a decision.

Jones reported xyz, but I (or we) found . . . I (or we) present here a detailed study . . . My (or our) recent work demonstrated . . . To determine the effects of structure on photo physics, I (or we) . . .

However, avoid phrases such as "we believe", "we feel", "we concluded", and "we can see", as well as personal opinions. Also it is better to avoid personal pronoun use unless you wish to distinguish as shown above. [This is another aspect where scientific writings need to be different. Personal and demonstrative pronouns (here or this) should be avoided as much as possible since Here does not convey anything in writing. It does not either denote the location, or context or idea.

Use an affirmative sentence rather than a double negative. Some examples are given in the Table 1 for easy comprehension.

Instead of writing like this below	Use the following
This reaction is not uncommon	This reaction is common
	This reaction is rare
	This reactions takes place only for a limited time or
	degree
The transition was not unexpected.	This transition was expected
	It was known that such transitions were possible
This strategy is not infrequently used.	This strategy is frequently used.
	This strategy is occasionally used.
	This frequency is not always used.
The result is not unlikely to occur	The result is likely to occur
	The result is possible.

Table.1. why do we need to use affirmative sentence.

Some common usages and their significance:

Watch the placement of the word "only". It has different meanings in different places in the sentence.

Only the largest group was injected with the test compound. (Meaning: and no other group)

The largest group was only injected with the test compound. (Meaning: and not given the compound in any other way)

The largest group was injected with only the test compound. (Meaning: and no other compounds)

The largest group was injected with the only test compound. (Meaning: there were no other test compounds)

Similarly the word here

Many of us tend to use the word here in the meaning at that occasion but it also denotes the place and hence gives some times not the correct meaning.

Be sure that the antecedents of the pronouns "this" and "that" are clear. If there is a chance of ambiguity, use a noun to clarify your meaning.

Ambiguous: The photochemistry of transition-metal carbonyl complexes has been the focus of many investigations. This is due to the central role that metal carbonyl complexes play in various reactions.

Unambiguous: The photochemistry of transition-metal carbonyl complexes has been the focus of many investigations. This interest is due to the central role that metal carbonyl complexes play in various reactions.

Use the proper subordinating conjunctions. "While" and "since" have strong connotations of time. Do not use them where you mean "although", "because", or "whereas".

As you have noticed the time connotation is not appropriate for the reason which is denoted by the set of words like although, because, whereas, etc.

Poor: Since solvent reorganization is a potential contributor, the selection of data is very important. *Better:* Because solvent reorganization is a potential contributor, the selection of data is very important.

Poor: While the reactions of the anion were solvent-dependent, the corresponding reactions of the substituted derivatives were not.

Better: Although the reactions of the anion were solvent-dependent, the corresponding reactions of the substituted derivatives were not.

Also: The reactions of the anion were solvent-dependent, but (or whereas) the corresponding reactions of the substituted derivatives were not.

Use "respectively" to relate two or more sequences in the same sentence.

The excitation and emission were measured at 360 and 440 nm, respectively. (That is, the excitation was measured at 360 nm and the emission was measured at 440 nm.)

Use the more accurate terms "greater than" or "more than" rather than the imprecise "over" or "in excess of".

Greater than 50%, *not* in excess of 50% more than 100 samples, *not* over 100 samples more than 25 mg, *not* in excess of 25 mg, *not* over 25 mg

Use "fewer" to refer to number; use "less" to refer to quantity. Fewer than 50 animals fewer than 100 samples

Fewer products less time less work

However, use "less" with number and unit of measure combinations because they are regarded as singular. Less than 5 mg

less than 3 days

Use "between" with two named objects; use "among" with three or more named or implied objects. Communication between scientists and the public is essential.

Communication among scientists, educators, and the public is essential.

Communication among scientists is essential.

Choose "assure", "ensure", and "insure" depending on your meaning. To assure is to affirm; to ensure is to make certain; to insure is to indemnify for money. He assured me that the work had been completed. The procedure ensures that clear guidelines have been established.

You cannot get a mortgage unless you insure your home.

Choose "affect", "effect", and "impact" depending on your meaning.

"Affect" is a verb meaning to influence, modify, or change.

"Effect" as a verb means to bring about, but as a noun it means consequence, outcome, or result. "Impact" is a noun meaning a significant effect. The increased use of pesticides affects agricultural productivity. Some examples for the use of these words are given below

The use of polychlorinated benzenes has an effect on the cancer rate.

The effect of the added acid was negligible.

The new procedure effected a 50% increase in yield.

The impact of pesticide use on health is felt throughout the world.

The acid did not have a great impact on the reaction rate.

It is acceptable to use split infinitives to avoid awkwardness or ambiguity.

Awkward: The program is designed to assist financially the student who is considering a career in chemistry.

Better: The program is designed to financially assist the student who is considering a career in chemistry.

This is an example of how to place the qualifying adverb in proper position. Another example is also given below.

Ambiguous: The bonded phases allowed us to investigate fully permanent gases. *Better:* The bonded phases allowed us to fully investigate permanent gases.

Use "whether" to introduce at least two alternatives, either stated or implied. I am not sure whether I should repeat the experiment. I am not sure whether I should repeat the experiment or use a different statistical treatment. (Stated) I am going to repeat the experiment whether the results are positive or negative.

Use "whether or not" to mean "regardless of whether".

Incorrect: I am not sure whether or not to repeat the experiment. *Correct:* I am not sure whether to repeat the experiment. *Also correct:* Whether or not the results are positive, I will repeat the experiment. *Also correct:* Whether or not I repeat the experiment, I will probably leave the laboratory late tonight.

Use "to comprise" to mean "to contain" or "to consist of"; it is not a synonym for "to compose". The whole comprises the parts, or the whole is composed of the parts, but the whole is not comprised of the parts. Never use "is comprised of".

Incorrect: A book is comprised of chapters. *Correct:* A book comprises chapters. *Also correct:* A book is composed of chapters.

Incorrect: Our research was comprised of three stages. *Correct:* Our research comprised three stages.

The correct use of Articles

Choose the articles "a" and "an" according to the pronunciation of the words or abbreviations they precede. A nuclear magnetic resonance spectrometer an NMR spectrometer Use "a" before an aspirated "h"; use "an" before the vowel sounds of a, e, i, o, "soft" u, and y.

Table 2 The use of a and an – some examples

a house	but	an hour
a history		an honor

a union	but	an ultimate
a U- ¹⁴ C		an ylide
		an yttrium compound

Choose the proper article to precede B.A., B.S., M.A., M.S., and Ph.D., according to pronunciation of the first letter. a B.S. degree an M.S. degree a Ph.D.

Comparisons

Introductory phrases that imply comparisons should refer to the subject of the sentence and be followed by a comma.

Incorrect: Unlike alkali-metal or alkaline-earth-metal cations, hydrolysis of trivalent lanthanides proceeds significantly at this pH.

Correct: Unlike that of alkali-metal or alkaline-earth-metal cations, hydrolysis of trivalent lanthanides proceeds significantly at this pH.

Also correct: Unlike alkali-metal or alkaline-earth-metal cations, trivalent lanthanide ions hydrolyze significantly at this pH.

Incorrect: In contrast to bromide anion, there is strong distortion of the free fluoride anion on the vibrational spectroscopy time scale.

Correct: In contrast to bromide anion, the free fluoride anion is strongly distorted on the vibrational spectroscopy time scale.

Compare to and compare with

Use the verb "compare" followed by the preposition "to" when similarities are being noted. Use "compare" followed by the preposition "with" when differences are being noted.

Only things of the same class should be compared. Compared to compound **3**, compound **4** shows an NMR spectrum with corresponding peaks.

Compared with compound **3**, compound **4** shows a more complex NMR spectrum.

Do not omit words needed to complete comparisons, and do not use confusing word order. The subordinating conjunction "than" is often used to introduce the second element in a comparison, following an adjective or adverb in the comparative degree.

Incorrect: The alkyne stretching bands for the complexes are all lower than the uncoordinated alkyne ligands.

Correct: The alkyne stretching bands for the complexes are all lower than those for the uncoordinated alkyne ligands.

Also correct: The alkyne stretching bands are all lower for the complexes than for the uncoordinated alkyne ligands.

Incorrect: The decrease in isomer shift for compound **1** is greater in a given pressure increment than for compound **2**.

Correct: The decrease in isomer shift for compound **1** is greater in a given pressure increment than that for compound **2**.

Also correct: The decrease in isomer shift in a given pressure increment is greater for compound **1** than for compound **2**.

Some combination of words often used in comparisons are "different from", "similar to", "identical to", and "identical with". Generally these idioms should not be split.

Incorrect: The complex shows a significantly different NMR resonance from that of compound **1**. *Correct:* The complex shows an NMR resonance significantly different from that of compound **1**.

Incorrect: Compound **5** does not catalyze hydrogenation under similar conditions to compound **6**. *Correct:* Compound **5** does not catalyze hydrogenation under conditions similar to those for compound **6**.

Exception: These combination of words (phrases) can be split if an intervening prepositional phrase modifies the first word in the combination of words.

The single crystals are all similar in structure to the crystals of compound 7. Solution A is identical in appearance with solution B.

Phrases such as "relative to", "as compared to", and "as compared with" and words such as "versus" are also used to introduce the second element in a comparison. The things being compared must be in parallel structure (that is, grammatically equal). The greater acidity of nitric acid relative to nitrous acid is due to the initial-state charge distribution in the molecules.

The lowering of the vibronic coupling constants for Ni as compared with Cu is due to configuration interaction.

This behavior is analogous to the reduced Wittig-like reactivity in thiolate versus phenoxide complexes.

Parallelism

Use coordinating conjunctions ("and", "but", "or", "nor", "yet", "for", and sometimes "so"), correlative conjunctions ("either, or"; "neither, nor"; "both, and"; "not only, but also"; "not, but"), and correlative constructions ("as well as"; e.g., "as well as") to connect words or groups of words of equal grammatical rank.

Incorrect: Compound **12** was prepared analogously and by Lee's method (5). *Correct:* Compound **12** was prepared in an analogous manner and by Lee's method (5).

Incorrect: It is best to use alternative methods both because of the condensation reaction and because the amount of water in the solvent increases with time.

Correct: It is best to use alternative methods both because of the condensation reaction and because of the increase in the amount of water in the solvent with time.

Incorrect: The product was washed either with alcohol or acetone. *Correct:* The product was washed with either alcohol or acetone. *Also correct:* The product was washed either with alcohol or with acetone.

Incorrect: Not only was the NiH functionality active toward the C-donor derivatives but also toward the N donors.

Correct: The NiH functionality was active not only toward the C-donor derivatives but also toward the N donors.

Also correct: The NiH functionality was not only active toward the C-donor derivatives but also active toward the N donors.

Also correct: Not only was the NiH functionality active toward the C-donor derivatives, but it was also active toward the N donors.

Use parallel constructions in series and lists, including section headings and subheadings in text and tables and listings in figure captions.

Do not try to use parallel construction around the word "but" when it is not used as a coordinating conjunction.

Increasing the number of fluorine atoms on the adjacent boron atom decreases the chemical shift, but only by a small amount.

The reaction proceeded readily, but with some decomposition of the product.

Words and Phrases To Avoid

Avoid slang and jargon.

Avoid abbreviations that you use for your convenience in your recordings, only those abbreviations that are known in scientific circles should be used (consult Chemical Abstracts for a list of approved abbreviations) we may provide a hard copy of these to you when you come for the orientation programme.

Be brief and concise. (long documents with verbose and Wordiness obscures your presentation, annoys the reader. Lengthy documents require cost for production and also scares the reader most of the times. .

Omit phrases such as: As already stated

- It has been found that
- It has long been known that
- It is interesting to note that
- It is worth mentioning at this point
- It may be said that
- It was demonstrated that
- Omit excess words. (some examples for the excess words are given in Table 3.

Table 3 how to optimse word usage - Some examples

Instead of	Use
It is a procedure that is often used.	This procedure is often used
There are seven steps that must be completed.	Seven steps must be completed

This is a problem that is	The problem is
These results are preliminary in nature	These results are preliminary

Some examples of use of single words instead of phrases.

Instead of	use
A number of	Many or several
A small number of	a few
Are in agreement	agree
Are found to be	Are
Are known to be	Are
At present	Now
At the present time	now
Based on the fact that	because
By means of	by
Despite the fact that	although
Due to the fact that	Because
During that time	while
Fewer in number	fewer
For the reason that	because
Has been shown to be	is
If it is assumed that	If
In colour e.g., red in colour	Just state the colour, e.g., red
In consequence of this fact	Therefore, consequently
In length	long
In order to	to
In shape e.g., round in shape	The shape, e.g., round
In size e.g., small in size	Just state the size, e.g., small
In spite of the fact that	although
In the case of	In for,
In the near future	Soon
In view of the fact that	because
It is known to be	is
It appears that	Apparently
It is clear that	Clear
It is likely that	Likely
It is possible that	possibly
It would appear that	apparently
Of great importance	important
On the order of	About
Owing to the fact that	Because
Prior to	Before
Reported in the literature	Reported
Subsequent to	After
Much better	Better
inden oottol	Detter

This list given in the table are only a few selected ones many more can be added to the list and the list will also be expanding depending on the person.

Do not use contractions in scientific papers.

Incorrect: The identification wasn't confirmed by mass spectrometry.

Correct: The identification was not confirmed by mass spectrometry.

Do not use the word "plus" or the plus sign as a synonym for "and".

NCCR Internal Document Prepared on October 1st, 2007

Incorrect: Two bacterial enzymes were used in a linked-enzyme assay for heroin plus metabolites. *Correct:* Two bacterial enzymes were used in a linked-enzyme assay for heroin and its metabolites.

Do not use "respectively" when you mean "separately" or "independently".

Incorrect: The electrochemical oxidations of chromium and tungsten tricarbonyl complexes, respectively, were studied.

Correct: The electrochemical oxidations of chromium and tungsten tricarbonyl complexes were studied separately.

Avoid misuse of prepositional phrases introduced by "with".

Poor: Nine deaths from leukemia occurred, with six expected. *Better:* Nine deaths from leukemia occurred, and six had been expected.

Poor: Of the 20 compounds tested, 12 gave positive reactions, with three being greater than 75%. *Better:* Of the 20 compounds tested, 12 gave positive reactions; three of these were greater than 75%.

Poor: Two weeks later, six more animals died, with the total rising to 25. *Better:* Two weeks later, six more animals died, and the total was then 25.

Do not use a slash to mean "and" or "or".

Incorrect: Hot/cold extremes will damage the samples. *Correct:* Hot and cold extremes will damage the samples.

Replace "and/or" with either "and" or "or", depending on your meaning.

Incorrect: Our goal was to confirm the presence of the alkaloid in the leaves and/or roots. *Correct:* Our goal was to confirm the presence of the alkaloid in the leaves and roots. *Also correct:* Our goal was to confirm the presence of the alkaloid in either the leaves or the roots. *Also correct:* Our goal was to confirm the presence of the alkaloid in the leaves, the roots, or both.

Gender-Neutral Language

Gender-neutral language can be accurate and unbiased and not necessarily awkward.

The most problematic words are the noun "man" and the pronouns "he" and "his", but there are usually several satisfactory gender-neutral alternatives for these words. Choose an alternative carefully and keep it consistent with the context. Avoid the use of words like his, him,

Instead of "man", use "people", "humans", "human beings", or "human species", depending on your meaning.

Outdated: The effects of compounds **I-X** were studied in rats and man. *Gender-neutral:* The effects of compounds **I-X** were studied in rats and humans. *Outdated:* Men working in hazardous environments are often unaware of their rights and responsibilities. *Gender-neutral:* People working in hazardous environments are often unaware of their rights and responsibilities.

Outdated: Man's search for beauty and truth has resulted in some of his greatest accomplishments. *Gender-neutral:* The search for beauty and truth has resulted in some of our greatest accomplishments.

Instead of "manpower", use "workers", "staff", "work force", "labor", "crew", "employees", or "personnel", depending on your meaning.

Instead of "manmade", use "synthetic", "artificial", "built", "constructed", "manufactured", or even "factory-made".

Instead of "he" and "his", change the construction to a plural form ("they" and "theirs") or first person ("we", "us", and "ours"). Alternatively, delete "his" and replace it with "a", "the", or nothing at all. "His or her", if not overused, is not terribly unpleasant.

Outdated: The principal investigator should place an asterisk after his name. *Gender-neutral:* Principal investigators should place asterisks after their names. *Gender-neutral:* If you are the principal investigator, place an asterisk after your name. *Gender-neutral:* The name of the principal investigator should be followed by an asterisk.

However, do not use a plural pronoun with a singular antecedent.

Incorrect: The principal investigator should place an asterisk after their name.

Instead of "wife", use "family" or "spouse" where appropriate.

Outdated: The work of professionals such as chemists and doctors is often so time-consuming that their wives are neglected.

Gender-neutral: The work of professionals such as chemists and doctors is often so time-consuming that their families are neglected.

Outdated: the society member and his wife *Gender-neutral:* the society member and spouse

Components of a Paper

Use the standard format for reports of original research but for literature reviews or theoretical papers some variations or appropriate format can be evolved. The paper should be as concisely as possible.

Title

The best time to determine the title is after you have written the text, so that the title will reflect the paper's content and emphasis accurately and clearly. However if you have thought of the publication in mind and wish to choose the title before writing the paper it is also possible but review the title after you have written the paper. The best way is to write down at least 6-8 titles and strike of words that do not really represent the theme of the paper and choose the words that are appropriate to theme of the paper, then the title will fall in line automatically. [We have found this method to be the appropriate method to come out with a most appealing and reflective title. It is better to undergo this methodology once to find out how effective this method can be]

The title must be brief and grammatically correct but accurate and complete enough to stand alone. A two- or three-word title may be too vague, but a 14- or 15-word title is unnecessarily long. Choose terms that are as specific as the text permits: "a vanadium-iron alloy" rather than "a magnetic alloy". Avoid phrases such as "on the", "a study of", "research on", "report on", "regarding", and "use of". In most cases, omit "the" at the beginning of the title. Avoid non-quantitative, meaningless words such as "rapid" and "new". The title should reflect what you want to leave in the mind of the readers. This means that a question as a title means that the theme answers the question asked, a proposition in the title means the validity of the proposition is reflected in the theme of the paper. Hence the title has a definite role to play in the paper.

Spell out all terms in the title, and avoid jargon, symbols, formulas, and abbreviations. Whenever possible, use words rather than expressions containing superscripts, subscripts, or other special notations.

The title serves two main purposes: (1) to attract the potential audience and (2) to aid retrieval and indexing. Therefore, be sure to include several keywords. The title should provide the maximum information for a computerized title search.

If you cannot create a title that is short, consider breaking it into title and subtitle.

Byline and Affiliation The authorship is a very tricky point and order of authorship also is another moot point. In all probability, only one of the authors will write the paper but contribution will vary. This point is not considered here since there are certain ethical guidelines to publication in of each discipline and one should follow them accordingly. Please consult suitable guidelines for this aspect. There are variations in the presentation of the names this also will affect retrieval and hence there should be some standard in writing the names. However do not include professional, religious, or official titles or academic degrees. Any document should have proper identification of the person generating the document all his contact possibilities (like postal address, telephone and fax number and email address. It will also be necessary to give the affiliation of the institution where from the idea or work was generated. These have many other implications and those of us who wish to know more on these aspects we shall try to deal with them subsequently.

Abstract

Most publications require an informative abstract. For a research paper, briefly state the problem or the purpose of the research, indicate the theoretical or experimental plan used, summarize the principal findings, and point out major conclusions. Include chemical safety information when applicable. Do not supplement or evaluate the conclusions in the text. For a review paper, the abstract describes the topic, the scope, the sources reviewed, the questions answered, the postulates analyzed and the conclusions. It is better to write the abstract last to be sure that it accurately reflects the content of the paper. However, many of us try to summarize and call it an abstract. This is not to be done. For example you have used a number of techniques to study a problem you need not state these techniques were employed since the problem. The abstract allows the reader to determine the nature and scope of the paper and induces him to read the full paper. For this reason, the abstract has to be inducing and intriguing to the reader. The abstract also helps to identify key features for indexing and retrieval.

Although an abstract is not a substitute for the article itself, it must be concise, self-contained. The abstract should be complete enough to appear separately in abstract publications. The abstract should have an optimal length.

Do not cite references, tables, figures, or sections of the paper in the abstract. You may refer to equations or structures presented in the body of the paper if they occupy only a single line and can readily

be incorporated into the running text when the abstract is used in the secondary literature (e.g., *Chemical Abstracts*). Do not include equations and structures that take up more than one line.

Use abbreviations and acronyms only when it is necessary to prevent awkward construction or needless repetition. Define abbreviations at first use in the abstract (and again at first use in the text).

Introduction

A good introduction is a clear statement of the problem and the reasons that one is studying the problem. This information should be contained in the first few sentences. Give a concise and appropriate background discussion of the problem and the significance, scope, and limits of your work. Outline what has been done before by citing truly pertinent literature, but do not include a general survey of semi-relevant literature. State how your work differs from or is related to work previously published. Demonstrate the continuity from the previous work to yours. The introduction can be one or two paragraphs long. Often, the heading "Introduction" is not used because it is superfluous; opening paragraphs are usually introductory. [our experience is that we must write the introduction last but one the last being the title. At least revisit the introduction after you have completed the paper and place the introduction in the context of the contents of the paper.]

Experimental Details or Theoretical Basis

In research reports, this section can also be called "Experimental Methods", "Experimental Section", or "Materials and Methods". The subheading has to be chosen depending on the nature of the work reported or on the place where the publication is to be placed. For experimental work, give sufficient detail about your materials and methods so that other experienced workers can repeat your work and obtain comparable results. When using a standard method, cite the appropriate literature and give only the details needed.

Identify the materials used, and give information on the degree of and criteria for purity, but do not reference standard laboratory reagents. Give the chemical names of all compounds and the chemical formulas of compounds that are new or uncommon. Use meaningful nomenclature; that is, use standard systematic nomenclature where specificity and complexity require, or use trivial nomenclature where it will adequately and unambiguously define a well-established compound.

Describe apparatus only if it is not standard or not commercially available. Giving a company name and model number in parentheses is non-distracting and adequate to identify standard equipment.

Avoid using trademarks and brand names of equipment and reagents. Use generic names; include the trademark in parentheses after the generic name only if the material or product you used is somehow different from others. Remember that trademarks often are recognized and available as such only in the country of origin.

Describe the procedures used, unless they are established and standard.

Note and emphasize any hazards, such as explosive or pyrophoric tendencies and toxicity, in a separate paragraph introduced by the word "Caution:". Include precautionary handling procedures, special waste disposal procedures, and any other safety considerations in adequate detail so that workers repeating the experiments can take appropriate safety measures. This is a safety and warning message to those who wish to repeat your experiments.

In theoretical reports, this section is called, for example, "Theoretical Basis" or "Theoretical Calculations" instead of "Experimental Details" and includes sufficient mathematical detail to enable other researchers to reproduce derivations and verify numerical results. Include all background data, equations, and formulas necessary to the arguments, but lengthy derivations are best presented as Supporting Information. If any

standard or otherwise data are employed the source of these data and typical values employed may be stated.

Results

Summarize the data collected and their statistical treatment. Include only relevant data, but give sufficient detail to justify your conclusions. Use equations, figures, and tables only where necessary for clarity and brevity. Avoid using both tabulated and graphical representation of the same results. However if there are any derived parameters, it is better to indicate how they were arrived at.

Discussion

The purpose of the discussion is to interpret and compare the results. Be objective; point out the features and limitations of the work. Relate your results to current knowledge in the field and to your original purpose in undertaking the project: Have you resolved the problem? What exactly have you contributed? Briefly state the logical implications of your results. Suggest further study or applications if warranted.

Present your results and discussion either as two separate sections or as one combined section if it is more logical to do so. Do not repeat information given elsewhere in the manuscript.

This is one section where manuscripts from India are weak. There can be many reasons for the same. However, the discussion should not be based on the data generated by the author and presented in the Results section, but it should be based on the status of the data with those existing in literature. It may be necessary in the discussion if the author can bring his own perception of the results reported in literature and place the results obtained in that study reported in the paper in the context of the existing literature. This is an important aspect of the paper. One has to put in large attention to this section and it is necessary one discusses this aspect with some of his mentors before proceeding to write this section.

Conclusions

The purpose of the Conclusions section is to put the interpretation into the context of the original problem. Do not repeat discussion points or include irrelevant material. Your conclusions should be based on the evidence presented and as concise as possible.

Summary

A summary is unnecessary in most papers. In long papers, a summary of the main points can be helpful, if you stick to the main points only. If the summary itself is too long, its purpose is defeated.

Acknowledgments

Generally, the last paragraph of the paper is the place to acknowledge people, organizations, and financing. As simply as possible, thank those persons, other than coauthors, who added substantially to the work, provided advice or technical assistance, or aided materially by providing equipment or supplies. Do not include their titles. [This is one aspect we have to learn to be more acknowledging the support we got for the execution of the work]

References

In many journals and books, references are placed at the end of the article or chapter; (However in some others, they are treated as footnotes). In any case, place your list of references at the end of the manuscript.

The accuracy of the references is the author's responsibility. [This is another aspect; the authors have to fulfill their responsibility fully and completely. There are many times some or other corrections are required in the citations as we tend to assemble the references from memory and not from the original literature as reproduction.] If you copy citations from another source, check the original reference for accuracy and appropriate content. It is necessary the references are given in a particular format and all references are in the same format.

Special Sections

This discussion on format applies to most manuscripts, but it is not a set of rigid rules and headings. However the author can have his own selection of sections and need not necessarily follow the typical sections given in this guide lines. However make sure that such subsections are meaningful and necessary for the document that you generate. For example, an appendix contains material that is not critical to understanding the text but provides important background information.

Types of Presentations

There are various types of presentations like short notes, letter to the editor, articles, and so on.

Articles

Articles, also called full papers, are definitive accounts of significant, original studies. They present important new data or provide a fresh approach to an established subject.

The organization and length of an article should be determined by the amount of new information to be presented and by space restrictions applicable. The standard format is suitable for most papers in this category.

Notes

Notes are concise accounts of original research of a limited scope. They may also be preliminary reports of special significance. The material reported must be definitive and may not be published again later. Appropriate subjects for notes include improved procedures of wide applicability or interest, accounts of novel observations or of compounds of special interest, and development of new techniques.

Communications

Communications, called "Letters" or "Correspondence" in some publications, are usually preliminary reports of special significance and urgency that are given expedited publication. They are accepted if the editor believes that their rapid publication will be a service to the scientific community. They may also be comments on the work of others, in which case the original authors' rebuttal may be published at the same time. Communications are subject to strict length limitations; they must contain specific results to support their conclusions, but they may not contain polemics or nonessential experimental details.

These types of publications are meant for publishing your results in scholarly scientific journals.

Reviews

Reviews integrate, correlate, and evaluate results from published literature on a particular subject. They seldom report new experimental findings. Effective review articles have a well-defined theme, are usually critical, and present novel theoretical interpretations. Ordinarily, they do not give experimental details, but in special cases (as when a technique is of central interest), experimental procedures may be included. An important function of reviews is to serve as a guide to the original

literature; for this reason, accuracy and completeness of references cited are essential. Reviews critically analyze the literature.

Book Chapters

In multi-authored books, chapters may be accounts of original research or literature reviews (like journal articles), but they may also be topical overviews More details on this aspect can be discussed later on in the orientation programme.

The following is some statements reproduced from other sources for the benefit of the readers.

Advice from the Authorities

The Elements of Style by William Strunk, Jr., and E. B. White

Omit needless words. Vigorous writing is concise. A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts. This requires not that the writer make all his sentences short, or that he avoid all detail and treat his subjects only in outline, but that every word tell.

Avoid fancy words. Avoid the elaborate, the pretentious, the coy, and the cute. Do not be tempted by a thousand rupee word when there is a fifty paise handy, ready, and able.... All [words] are good, but some are better than others.

Writing Successfully in Science by Maeve O'Connor

When you start writing the draft, or your share of it, you should, ideally, cut yourself off from the outside world. Try to find a time when you can remain undisturbed for several hours and a place where no one will interrupt you. Write at the time of day when you feel freshest and most alert. [This is one aspect one has to be careful usually we tend to write in midst of several activities and hence there is always breaks in the thought process and also the written document does not give the effectivenesss required. This is our comment not that of the author of the style guide given above]

If you find it difficult to start writing on the blank page or screen in front of you, leave the introduction for later and start with any section you have already drafted or made detailed notes about. The materials and methods section is often the easiest place to begin, and the results section the next easiest. Once you get going, write as quickly as you can. If the article is short, try to finish it in one sitting, to give it as much unity as possible. [do not always think you should go in the order of the presentation in the writing you can write which ever is convenient to you and then build and place them appropriately.]

Long words and complicated sentences are not essential features of good scientific writing, although they are often thought to be so. The best writing in science, as elsewhere, is simple, clear, precise, and vigorous. Decide what you want to say and say it as simply, informatively, and directly as possible.

Line by Line: How To Improve Your Own Writing by Claire Kehrwald Cook

You probably should delete all intensive adverbs--very, really, truly, actually, and the like. [This is a usual temptation to many of us] If you've chosen the right word, adding a very defeats your purpose. If you

haven't got the right word, the very offers poor compensation. Readers pay no attention to this overused word. If you want to put a very in front of a large, you should consider substituting enormous, huge, gigantic, or massive.

Writing To Learn by William Zinsser

I would say this to everyone who feels that his main aptitude is for science or technology, or for any other field that lies outside the humanities, and that therefore he can't write: Learn to use the tools without fear. They are not some kind of secret apparatus owned by the English teacher or any other teacher. They are simple mechanisms for putting your thoughts on paper. Enjoy finding out how they work. Take as much pleasure in what an active verb will do for you as in what a mathematical formula will do, or a computer, or a centrifuge.

The Scientist as Editor by Maeve O'Connor

Write simply and concisely.... Use short words rather than long ones, and concrete rather than abstract terms; where appropriate, prefer the first person singular or plural to the third person, and the active to the passive voice. Avoid vague statements, jargon and laboratory slang, and words not defined in dictionaries.

Errors in English and Ways To Correct Them by Harry Shaw

No standards can be absolute. Our language is constantly changing. Also, diction, like fashions in dress and food, is influenced by changes in taste. Again, what is acceptable in daily speech and conversation may not be suitable in written form. The use of this or that word cannot be justified by saying that it is often heard or seen in print. Advertisements, newspapers, magazines, and even some "good" books may exhibit faulty diction.

Scientific English: A Guide for Scientists and Other Professionals by Robert A. Day

Scientists (and perhaps scholars in all fields) should learn to use English simply. Short, simple words--in short, straightforward sentences--usually convey meaning more clearly than do esoteric words and convoluted sentences. This concept is a bit controversial, because the skilled writer, using that wonderful, massive vocabulary we have available in English, can paint word pictures of overwhelming beauty. On the other hand, clarity and meaning can easily fade into the background.

The Chemist's English by Robert Schoenfeld

Don't be frightened of grammar. When you sit down to write your paper or thesis or report, your most dangerous enemy is not the split infinitive--it is ambiguity. A split infinitive is very often acceptable anyway, but where it needs correcting it can be corrected by a copy editor. However, the copy editor, unless he is a mind-reader, cannot correct an ambiguity. So, even if you are not a smooth writer, don't sit there staring at the blank page: get your facts down first and fix up the dangling participles afterwards.

Scientists Must Write: A Guide to Better Writing for Scientists, Engineers, and Students by Robert Barrass

In science, every statement should be based on evidence and not on unsupported opinion. Speculation cannot take the place of evidence. The scientist should therefore avoid excessive qualification. Words and

phrases such as possible, probably, perhaps, it is likely to, and is better referred to perhaps should cause you to think again. Have I considered the evidence sufficiently? Is there enough evidence for the qualification to be omitted? If not, are further investigations needed before the work is ready for publication?

On Writing Well by William Zinsser

Clutter is the disease of American writing. We are a society strangling in unnecessary words, circular constructions, pompous frills, and meaningless jargon.... But the secret of good writing is to strip every sentence to its cleanest components. Every word that serves no function, every long word that could be a short word, every adverb which carries the same meaning that is already in the verb, every passive construction that leaves the reader unsure of who is doing what--these are the thousand and one adulterants that weaken the strength of a sentence. And they usually occur, ironically, in proportion to education and rank.

"The Development of Research Writing" (from *Scholarly Publishing*, January 1989) by Robert A. Day

A scientific experiment is not complete until the results have been published. Therefore, to do science, one must also write science. Realizing this, scientists should weigh the words in their manuscripts as carefully as they weigh the reagents in their laboratories.

In scientific writing, there is no room for and no need for ornamentation. The flowery literary embellishments, the metaphors, the similes, and the idiomatic expressions are very likely to cause confusion and should seldom be used in writing research papers. Science is simply too important to be communicated in anything other than words of certain meaning. The meaning should be clear not only to peers of the author, but also to students just embarking on their careers, to scientists reading outside their narrow discipline, and especially to those readers (the majority of readers today) whose native language is other than English.

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[The texts in these brackets are the additions by us. The authors of the documents referred have not written these lines]

Kindly note this is a liberal and extensive reproduction from the ACS style guide. Of course, certain critical inputs are coming from some of the experiences gained by us.